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Telecommunications and information exchange between systems — Wireless Regional Area Networks (WRAN) — Specific requirements —

Part 22: Cognitive Wireless RAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications: Policies and procedures for operation in the bands that allow spectrum sharing where the communications devices may opportunistically operate in the spectrum of primary service

Télécommunications et échange d'information entre systèmes — Réseaux régionaux sans fil (WRAN) — Exigences spécifiques —

Partie 22: Spécifications du contrôle d'accès du milieu sans fil cognitif (MAC) et de la couche physique (PHY) : Politiques et procédures pour le fonctionnement dans les bandes qui permettent le partage du spectre, où les dispositifs de communication peuvent fonctionner de manière opportuniste dans le spectre du service primaire

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Abstract: This standard specifies the air interface, including the cognitive medium access control layer (MAC) and physical layer (PHY), of point–to–multipoint wireless regional area networks (WRANs) comprised of a professional fixed base station (BS) with fixed and portable user terminals operating in the VHF/UHF TV broadcast bands between 54 MHz to 862 MHz, and potentially in the 1300 MHz to 1750 MHz, and 2700 MHz to 3700 MHz bands provided the regulatory regime allows it.

Keywords: broadband wireless access network, cognitive radio, fixed user terminals, IEEE 802.22™, portable user terminals, radio spectrum sensing, regional area network, WRAN standards

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This standard specifies the air interface, including the cognitive radio MAC and PHY, of point-to-multipoint and backhaul WRANs comprised of a professional fixed BS with fixed and portable user terminals. The standard specifies operation in the bands that allow spectrum sharing where the communications devices may opportunistically operate in the spectrum of the primary service, such as the VHF/UHF TV broadcast bands between 54 MHz to 862 MHz, and the 1300 MHz to 1750 MHz and 2700 MHz to 3700 MHz bands provided the regulatory regime allows it.

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**IEEE Standard for Information Technology—
Telecommunications and information exchange between systems
Wireless Regional Area Networks (WRAN)—
Specific requirements**

Part 22: Cognitive Wireless RAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications: Policies and Procedures for Operation in the Bands that Allow Spectrum Sharing where the Communications Devices May Opportunistically Operate in the Spectrum of Primary Service

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1. Overview

1.1 Scope

This standard specifies the air interface, including the cognitive radio medium access control layer (MAC) and physical layer (PHY), of point-to-multipoint and backhaul wireless regional area networks (WRANs) comprised of a professional fixed base station (BS) with fixed and portable user terminals. The standard specifies operation in the bands that allow spectrum sharing where the communications devices may opportunistically operate in the spectrum of the primary service, such as the VHF/UHF TV broadcast bands between 54 MHz to 862 MHz, and the 1300 MHz to 1750 MHz and 2700 MHz to 3700 MHz bands provided the regulatory regime allows it.

1.2 Purpose

This standard is intended to enable deployment of interoperable IEEE 802® multivendor WRAN products, to facilitate competition in broadband access by providing alternatives to wireline broadband access and extending the deployability of such systems into diverse geographic areas, including sparsely populated rural areas, while preventing harmful interference to incumbent licensed services. The standard specifies operation in the bands that allow spectrum sharing where the communications devices may opportunistically operate in the spectrum of the primary service, such as the VHF/UHF TV broadcast bands between 54 MHz to 862 MHz, and the 1300 MHz to 1750 MHz and 2700 MHz to 3700 MHz bands provided the regulatory regime allows it.

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1.3 Introduction

The WRANs for which this standard has been developed are expected to operate primarily in low population density areas in order to provide broadband access to data networks. The WRAN systems will use vacant channels in the VHF and UHF bands allocated to the Television Broadcasting Service in the frequency range between 54 MHz and 862 MHz while avoiding interference to the broadcast incumbents in these bands. A typical application can be the coverage of the rural area around a village, as illustrated in Figure 1(a), within a radius of 10 km to 30 km from the BS depending on its EIRP and antenna height. The MAC can also accommodate user terminals located as far as 100 km with proper scheduling of the traffic in the frame when exceptional radio frequency (RF) signal propagation conditions are present. With the PHY implemented in this standard, WRAN systems can cover up to a radius of 30 km without special scheduling.

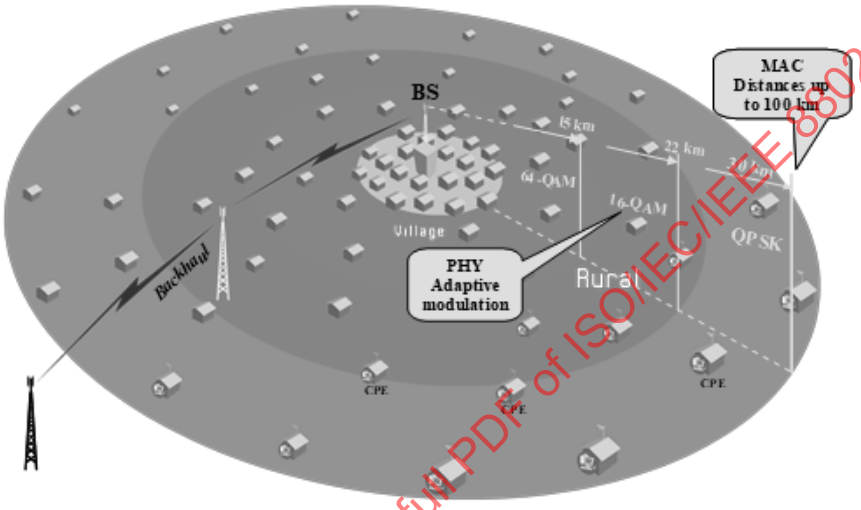

Figure 1(a)—IEEE 802.22 WRAN cell with a base station and user terminals

A BS complying with this standard shall be able to provide high-speed Internet service for up to 512 fixed or portable customer premise equipment (CPE) devices or groups of devices within its coverage area assuming different quality of service (QoS) requirements for various CPEs, while meeting the regulatory requirements for protection of the incumbents.

This standard includes cognitive radio techniques to mitigate interference to incumbents, including geolocation capability, provision to access a database of incumbent services, and spectrum-sensing technology to detect the presence of incumbent services, other WRAN systems, and IEEE 802.22.1 wireless beacons.

The Advanced Wireless Regional Area Networks (A-WRANs) for which this standard has also been developed are expected to support enhanced broadband services and monitoring applications such as real-time and/or near real-time monitoring, emergency broadband services, remote medical services, etc. The A-WRAN provides all essential functionalities of PHY, MAC, security, and cognitive radio technologies defined in the original IEEE 802.22 WRAN and supports an additional PHY Operational mode (PHY-OM2) and additional functionalities of multi-hop relay operations, multiple channel operations, multiple-input-multiple-output (MIMO) operations, and advanced security to extend regional area broadband services to the regional monitoring applications and the enhanced broadband services. The A-WRAN provides connectivity through two new types of services, multi-hop relay and multi-channel operation. Figure 1(b) and Figure 1(c) are examples of the A-WRAN providing enhancement to connectivity using multi-hope relay. Figure 1(d) and Figure 1(e) are examples of the A-WRAN increasing capacity in the network using multi-channel operation at the A-BS, or at the A-BS and A-CPEs. The A-WRAN can only operate in the multirelay or multi-channel services at any given time.

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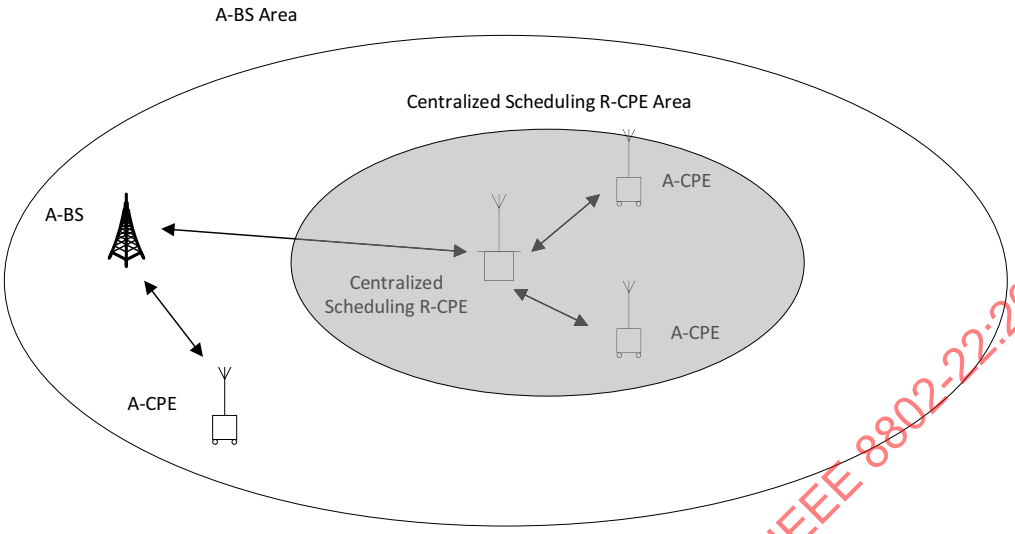

Figure 1(b)—Example of an IEEE 802.22 A-WRAN cell with centralized scheduling multi-hop relay

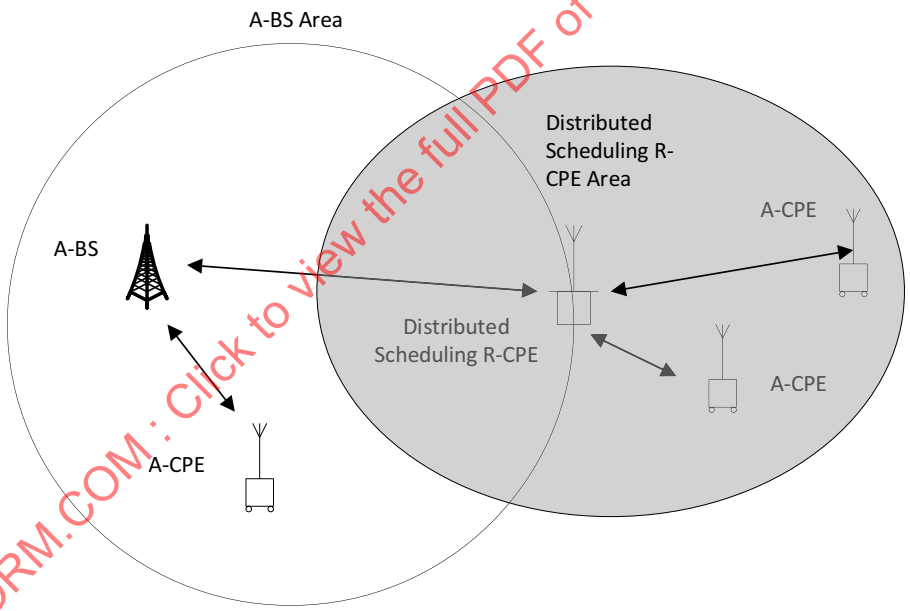

Figure 1(c)—Example of IEEE 802.22 A-WRAN cell with distributed scheduling multi-hop relay

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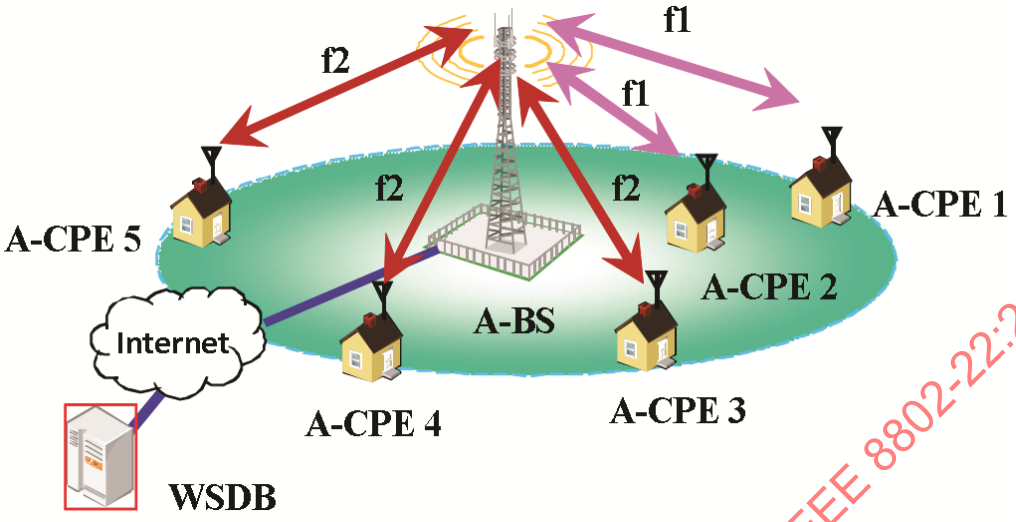

Figure 1(d)—Example of IEEE 802.22 A-WRAN cell with multi-channel operation at the A-BS

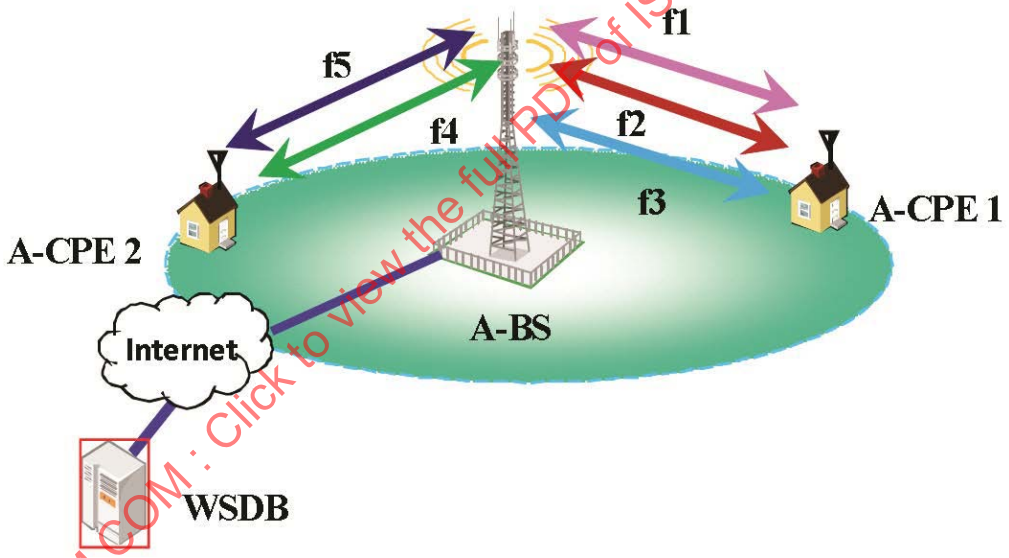

Figure 1(e)—Example of IEEE 802.22 A-WRAN cell with multi-channel operation at the A-BS and the A-CPE

An advanced base station (A-BS) complying with this standard shall be able to provide broadband services for the CPEs such as the advanced CPE (A-CPE) through direct connectivity to the A-BS, and/or through a relay CPE (R-CPE) that is an A-CPE configured to act as a relay CPE. An A-BS complying with this standard shall be able to provide broadband services to A-CPEs operating on multiple channels when multi-channel operation is enabled.

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1.4 Word usage

The word *shall* indicates mandatory requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted (shall equals is required to).[1, 2]

The word *should* indicates that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others; or that a certain course of action is preferred but not necessarily required (should equals is recommended that).

The word *may* is used to indicate a course of action permissible within the limits of the standard (may equals is permitted to).

The word *can* is used for statements of possibility and capability, whether material, physical, or causal (can equals is able to).

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[1] The use of the word *must* is deprecated and cannot be used when stating mandatory requirements, *must* is used only to describe unavoidable situations.

[2] The use of *will* is deprecated and cannot be used when stating mandatory requirements, *will* is only used in statements of fact.

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2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

ANSI X9.62-2005, Public Key Cryptography for the Financial Services Industry: The Elliptic Curve Digital Signature Algorithm (ECDSA).[3]

ANSI X9.63-2001, Public Key Cryptography for the Financial Services Industry: Key Agreement and Key Transport Using Elliptic Curve Cryptography.

Federal Communications Commission 08-260, Second Report and Order and Memorandum Opinion and Order in the Matter of Unlicensed Operation in the TV Broadcast Bands, November 14, 2008.[4]

Federal Communications Commission 10-174, Second Memorandum Opinion and Order in the Matter of Unlicensed Operation in the TV Broadcast Bands, September 23, 2010.

FIPS 180-3, Secure Hash Standard (SHS), October 2008.[5]

FIPS 186-3, Digital Signature Standard (DSS), June 2009.

FIPS 197, Advanced Encryption Standard, November 2001.

IEEE Std 802®, IEEE Standard for Local and metropolitan area networks: Overview and Architecture.[6, 7]

IEEE Std 802.1Qcp™-2018, IEEE Standard for Local and metropolitan area networks—Bridges and Bridged Networks—Amendment 30: YANG Data Model.

IEEE Std 802.3™, IEEE Standard for Ethernet.

IEEE Std 802.16™, IEEE Standard for Local and metropolitan area networks—Part 16: Air Interface for Broadband Wireless Access Systems.

IEEE Std 802.22.1™-2010, IEEE Standard for Information Technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements: Part 22.1: Standard to Enhance Harmful Interference Protection for Low-Power Licensed Devices Operating in TV Broadcast Bands.

IETF RFC 2437, PKCS #1: RSA Cryptography Specifications Version 2.0, October 1998.[8]

IETF RFC 2578, Structure of Management Information Version 2 (SMIv2), April 1999.

[3]ANSI publications are available from the American National Standards Institute (http://www.ansi.org/).

[4]FCC publications are available at https://www.fcc.gov/edocs.

[5]FIPS publications are available from the National Technical Information Service, U. S. Department of Commerce (http://www.ntis.org/).

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[8]IETF documents (i.e., RFCs) are available for download at http://www.rfc-archive.org/.

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IETF RFC 2758, Definitions of Managed Objects for Service Level Agreements Performance Monitoring, February 2000.

IETF RFC 3279, Algorithms and Identifiers for the Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile, April 2002.

IETF RFC 4492, Elliptic Curve Crytopgraphy (ECC) for Transport Layer Security (TLS), May 2006.

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IETF RFC 5281, Extensible Authentication Protocol Tunneled Transport Layer Security Authenticated Protocol Version 0 (EAP-TTLSv0), August 2008.

IETF RFC 5649, Advanced Encryption Standard (AES) Key Wrap with Padding Algorithm, August 2009.

IETF RFC 6020, YANG—A Data Modeling Language for the Network Configuration Protocol (NETCONF), October 2010.

International Telecommunications Union, Radio Regulations, Geneva, Switzerland, Edition of 2008.[9]

NIST Special Publication 800-38D, Recommendation for Block Cipher Modes of Operation: Galois/Counter Mode (GCM) and GMAC, November 2007.[10]

NMEA 0183, Interface Standard of the National Marine Electronics Association, Version 4.00.[11]

Standards for Efficient Cryptography Group (SECG), SEC 4: Elliptic Curve Qu-Vanstone Implicit Certificate Scheme (ECQV), Version 1.0, January 24, 2013.[12]

Trusted Computing Group, TPM Main Part 1 Design Principles Specification Version 1.2 Level 2 (Revision 103) 9 July 2007.[13]

Trusted Computing Group, TPM Main Part 2 TPM Structures Specification Version 1.2 Level 2 (Revision 116) 1 March 2011.

Trusted Computing Group, TPM Main Part 3 Commands Specification Version 1.2 Level 2 (Revision 116) 1 March 2011.

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[9]ITU-T publications are available from the International Telecommunications Union (http://www.itu.int/).
[10]NIST publications are available from the National Institute of Standards and Technology (http://www.csrc.nist.gov/).
[11]NMEA publications are available from the National Marine Electronics Association at https://www.nmea.org/.
[12]Available at https://www.secg.org/.
[13]Trusted Computing Group publications available at https://trustedcomputinggroup.org/resource/tpm-main-specification/.

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3. Definitions

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.[14]

access zone (AZ): A communication zone between an advanced base station (A-BS) and relay customer premise equipment (R-CPE) or between an A-BS and an advanced customer premise equipment (A-CPE) in a frame defined by frame structure for PHY Operation Mode 2 (PHY-OM2).

advanced base station (A-BS): A generalized equipment set providing connectivity, management, and control of the advanced customer premise equipment (A-CPE) and the relay customer premise equipment (R-CPE).

NOTE—The functionalities attributed to the A-BS, in the context of this standard, may be implemented by a device or a collection of devices.[15]

advanced customer premise equipment (A-CPE): A generalized equipment set providing connectivity between an advanced base station (A-BS) and a subscriber premise, or between an relay customer premise equipment (R-CPE) and a subscriber premise. A-CPE is used for any customer premise equipment that is not a CPE or an R-CPE. When multi-hop relay is not operational in the Advanced Wireless Regional Area Network (A-WRAN), the A-CPE can be configured to operate in multi-channel mode.

Advanced Wireless Regional Area Network (A-WRAN): The A-WRAN provides all essential functionalities of PHY, MAC, security, and cognitive radio technologies defined in the IEEE 802.22 WRAN and supports additional functionalities of an additional PHY Operation Mode 2 (PHY-OM2), multi-hop relay operations, multiple channel operations, multiple-input-multiple-output (MIMO) operations, and advanced security to extend regional area broadband services to the regional monitoring applications and the enhanced broadband services.

analog television: Radio frequency (RF) transmission of audio and video by analog signals [e.g., NTSC, PAL, SECAM).

NOTE—See ITU-R BT.470 [B47].[16]

authenticator: An entity at one end of a point-to-multipoint Wireless Regional Area Network (WRAN) link that facilitates the authentication of the entity attached at the other end of that link.

backup channel: A channel that has been cleared [i.e., verified that no incumbent service will be affected by Wireless Regional Area Network (WRAN) operation in this channel] to immediately become the operating channel in case the WRAN needs to switch channel.

NOTE—See 11.2.2.

base station (BS): Generalized equipment set providing connectivity, management, and control of the customer premise equipment (CPE).

NOTE—The functionalities attributed to the BS, in the context of this standard, may be implemented by a device or a collection of devices.

broadcast connection: A connection established to transport MAC management messages and data from the base station (BS) to all of the customer premise equipment (CPE) in the cell on the downstream (DS).

[14] *IEEE Standards Dictionary Online* is available at: http://dictionary.ieee.org.

[15] Notes in text, tables, and figures of a standard are given for information only and do not contain requirements needed to implement this standard.

[16] The numbers in brackets correspond to those of the bibliography in Annex H.

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burst: A two-dimensional segment of OFDM subchannels (frequency domain) and symbols (time domain). It may comprise multiple MAC Protocol Data Units (PDUs) that are encoded with the same physical modulation and coding.

candidate channel: A channel that, once cleared from potential harmful interference to incumbents, can become a backup channel.

NOTE—See 11.2.2.

carrier-to-noise ratio (CNR): Ratio of the power of a subcarrier to the noise power in a bandwidth corresponding to the subcarrier spacing for a set of system parameters.

NOTE—See Table 248.

cell: An IEEE 802.22 cell (or simply, a cell) is formed by a single IEEE 802.22 base station (BS) and zero or more IEEE 802.22 customer premise equipment (CPE) associated with and under control of this IEEE 802.22 BS. The coverage area of this cell extends up to the point where the signal received from the IEEE 802.22 BS is sufficient to allow IEEE 802.22 CPEs to associate and maintain communication with the BS.

centralized relay zone (CRZ): A communication zone between a centralized scheduling relay customer premise equipment (R-CPE) and advanced customer premise equipment (A-CPE) in a frame defined by frame structure for PHY Operation Mode 2 (PHY-OM2).

centralized scheduling relay customer premise equipment (R-CPE): A generalized equipment set providing relay connectivity between an advanced base station (A-BS) and advanced customer premise equipment (A-CPE) using centralized scheduling mode.

centralized scheduling mode: A mode where an advanced customer premise equipment (A-CPE) operates as a centralized scheduling relay customer premise equipment (R-CPE).

channel: Refers to a specific physical radio frequency (RF) channel, a contiguous segment of spectrum in the TV broadcast frequency bands, which may be 6 MHz, 7 MHz, or 8 MHz wide, depending on the relevant regulatory domains. *See also:* **logical channel.**

cognitive plane: The cognitive plane consists of all the entities in the IEEE 802.22 reference architecture that relate to cognitive functions. These cognitive functions are the spectrum manager/spectrum automaton, spectrum sensing function, the geolocation function, and the security sublayer 2. The spectrum manager/spectrum automaton reside at the same level as the MAC common part sublayer in the data plane whereas the spectrum sensing function (SSF) and the geolocation function reside at the same level as the PHY in the data plane.

cognitive radio: A functionality of some wireless communication devices in which either a network or a wireless node can change the devices' transmission and/or reception parameters to communicate efficiently and to avoid interference with licensed or license-exempt users. This alteration of parameters is based on the active monitoring of several factors in the external and internal radio environment, such as radio frequency spectrum, location information, user behavior, network state, etc.

coexistence: State by which license-exempt wireless communication systems of various types can share a same radio frequency (RF) transmission channel in a common area while minimizing harmful interference to each other by the use of appropriate means.

coexistence beacon: Series of bursts that is transmitted with the goal of improving self-coexistence among overlapping IEEE 802.22 cells, potentially improving coexistence among license-exempt wireless

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communication systems of various types if so equipped, regularly signaling the identity of the transmission device for potential interference resolution and enhancing geolocation ranging resolution between customer premise equipment (CPE) within a cell. The beacon is transmitted under the control of the base station (BS) during self-coexistence windows.

connection: Data path established between base station (BS) and customer premise equipment (CPE) for transport of data.

customer premise or portable equipment (CPE): A generalized equipment set providing connectivity between a base station (BS) and a subscriber premise.

cyclic prefix (CP): The portion of an OFDM symbol used to absorb inter-symbol interference caused by transmission channel time dispersion. The cyclic prefix is actually a copy of the last portion of the symbol appended to the front of the same symbol. Its size is defined in terms of a ratio to the useful part of the OFDM symbol

NOTE—See Table 249.

database service: Service officially operated under the rules of the local regulatory authority that provides a list of available channels and possibly the maximum EIRP allowable on these channels based on queries containing the geolocation of the Wireless Regional Area Network (WRAN) devices.

digital television: Radio frequency (RF) transmission of audio and video by digital signals (e.g., ATSC, DVB-T, ISDB-T).

NOTE—See ITU-R BT-798 [B49].

distributed relay zone (DRZ): A communication zone between a distributed scheduling relay customer premise equipment (R-CPE) and advanced customer premise equipment (A-CPE) frame defined by frame structure for PHY Operation Mode 2 (PHY-OM2).

distributed scheduling relay customer premise equipment (R-CPE): A generalized equipment set providing relay connectivity between an advanced base station (A-BS) and advanced customer premise equipment (A-CPE), and providing connectivity, management and control of the A-CPEs within a local network, while operating in distributed scheduling mode.

distributed scheduling mode: A mode where an operates as a distributed scheduling relay customer premise equipment (R-CPE).

downstream (DS): The direction of the transmitted signal from a base station (BS) to customer premise equipment (CPE).

downstream channel descriptor (DCD): A medium access control layer (MAC) message that describes the physical layer (PHY) characteristics of a downstream burst.

downstream interval usage code (DIUC): An interval usage code specific to a downstream burst. *See also:* **interval usage code.**

downstream map (DS-MAP): A medium access control layer (MAC) message that defines the structure of the downstream subframe, i.e., burst locations in the time and frequency domain of the OFDM.

flow Type (FT): An identifier that identifies a particular flow of traffic assigned to a specific customer premise equipment (CPE) or group of CPEs. *See also:* **station ID (SID)**.

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frame: Basic time unit over which base stations (BSs) and customer premise equipment (CPE) communicate with each other. It is comprised of one downstream subframe, one upstream subframe, and a self-coexistence window when present.

frame contention source (FC-SRC): A Wireless Regional Area Network (WRAN) cell that is demanding additional spectrum resources (i.e., data frame transmission opportunities on a channel) and is initiating an interactive frame contention process with the target frame contention destination (FC-DST).

frame contention destination (FC-DST): A Wireless Regional Area Network (WRAN) cell that is the target of the frame contention request initiated by a frame contention source (FC-SRC), and is the occupier of the spectrum resources being requested by the FC-SRC.

frame contention number (FCN): Number randomly generated by the frame contention sources (FC-SRCs) and frame contention destinations (FC-DSTs) for determining by contention the priority of frame access.

geolocation: The process of acquiring the location data of a device, determining its latitude and longitude, and producing the corresponding NMEA string.

group resource allocation (GRA): The group is composed of one relay customer premise equipment (R-CPE) and many advanced customer premise equipment (A-CPE). The advanced base station (A-BS) allocates the resources on a group basis, and manages the backup and candidate channels on a group basis.

harmful interference: Any emission, radiation, or induction that endangers the functioning of a radio navigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunications service operating in accordance with the ITU and local Regulations.

NOTE—See Article 1 of the ITU Radio Regulations, 1.169, and the FCC 47 CFR 15.3(m).[17]

IEEE 802.22.1 wireless beacon: A radio frequency (RF) device that provides enhanced protection to licensed low-power auxiliary devices such as those used in the production and transmission of broadcast programs [e.g., devices licensed as secondary under Title 47 of the Code of Federal Regulations (CFR) in the USA and equivalent devices in other regulatory domains] from harmful interference potentially caused by Wireless Regional Area Network (WRAN) operation.

in-band: The operating channel (N) and its first adjacent channels (N–1 and N+1).

incumbents: Licensed transmission systems operating in the TV bands on a primary or secondary basis according to international and local regulatory rules.

interval usage code: A code identifying a particular burst profile that can be used for a downstream (DS) or upstream (US) transmission interval.

local cell: A cell is formed by a distributed scheduling relay customer premise equipment (R-CPE) and zero or more advanced customer premise equipment (A-CPEs) associated with and under control of the distributed scheduling R-CPE. The coverage area of this local cell extends up to the point where the signal received from the distributed scheduling R-CPE is sufficient to allow A-CPEs to associate and maintain communication with the advanced base station (A-BS) on relay connection.

logical channel: This is the channel number used by the medium access control layer (MAC), and does not necessarily reflect a physical channel. This can be mapped into any representation as defined by the physical layer (PHY). *See also:* **channel.**

[17]Information on references can be found in Clause 2.

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MAC Protocol Data Unit (PDU): The smallest unit of transmission/reception to be processed by the medium access control layer (MAC). It is comprised of the MAC header, the payload, and Cyclic Redundancy Check (CRC).

managed node: A node that collects and stores the managed objects in the format of a management information base (MIB) that is made available to the network management system via the Simple Network Management Protocol (SNMP).

managed object: A specific characteristic, among many, of a managed device. Managed objects are comprised of one or more object instances, which are essentially variables. A managed object is also referred to as a management information base (MIB) object or an object.

management connection: A connection established to transport medium access control layer (MAC) management messages and data between the base station (BS) and a particular customer premise equipment (CPE).

Management Information Base (MIB): A collection of information that is organized hierarchically. MIBs are accessed using Simple Network Management Protocol (SNMP). They are comprised of managed objects that are identified by object identifiers.

multicast management connection: A connection established to transport medium access control layer (MAC) management messages and data from the base station (BS) to a particular group of customer premise equipment (CPE) on the downstream (DS).

multicast transport connection: A connection established to transport user data from the base station (BS) to a particular group of customer premise equipment (CPE) on the downstream (DS).

multiple channel: Refers to more than one specific physical radio frequency (RF) channel in the TV broadcast frequency bands, which may be 6 MHz, 7 MHz, or 8 MHz wide depending on the relevant regulatory domains.

multiple-input, multiple-output (MIMO): A system employing at least two transmit (Tx) antennas and at least two receive (Rx) antennas to improve the system capacity, coverage, or throughput

OFDM slot: A two-dimensional entity defined as one OFDM symbol by one subchannel.

operating channel: Channel being used by a Wireless Regional Area Network (WRAN) system.

out-of-band: Any channel that is not in-band. *See also:* **in-band.**

PHY Operation Mode 1 (PHY-OM1): A physical layer mode supporting the system defined in Clause 9.

PHY Operation Mode 2 (PHY-OM2): A physical layer mode supporting the system defined in Clause 10.

protected contour: The regulator-defined boundary of an area within which a TV station is entitled to protection from harmful interference.

quiet period: A specific period of time during which the base station (BS) has scheduled a cessation of all transmission in its cell for the purpose of sensing.

receive/transmit transition gap (RTG): A gap between the last sample of the upstream (US) subframe and the first sample of the subsequent downstream (DS) subframe at the antenna port of the base station (BS) in a time division duplex (TDD) transceiver. This gap allows time for the BS to switch from receive (Rx) to

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transmit (Tx) mode. During this gap, the BS is not transmitting modulated data but simply allowing the BS transmitter carrier to ramp up and the Tx/Rx antenna switch to actuate.

relay customer premise equipment (R-CPE): An advanced customer premise equipment (A-CPE) configured to provide relay connectivity between an advanced base station (A-BS) and A-CPEs. An R-CPE can operate in one of two modes: centralized scheduling mode or distributed scheduling mode.

relay receive/transmit transition gap (RRTG): A gap between the last sample of the downstream (DS) access zone and the first sample of the subsequent DS relay zone at the antenna port of the relay customer premise equipment (R-CPE) in a time division duplex (TDD) transceiver. This gap allows time for the R-CPE to switch from receive (Rx) to transmit (Tx) mode. During this gap, the R-CPE is not transmitting modulated data but simply allowing the R-CPE transmitter carrier to ramp up and the Tx/Rx antenna switch to actuate.

relay transmit/receive transition gap (RTTG): A gap between the last sample of the upstream (US) access zone and the first sample of the subsequent US relay zone at the antenna port of the relay customer premise equipment (R-CPE) in a time division duplex (TDD) transceiver. This gap allows time for the R-CPE to switch from transmit (Tx) to receive (Rx) mode. During this gap, the R-CPE is not transmitting modulated data but simply allowing the R-CPE transmitter carrier to ramp down and the Tx/Rx antenna switch to actuate, and the R-CPE receiver section to activate.

relay zone (RZ): A communication zone between any relay customer premise equipment (R-CPE) and an advanced customer premise equipment (A-CPE) or advanced base station (A-BS). A relay zone is operated as one of the following two relay zones: centralized relay zone (CRZ) and distributed relay zone (DRZ).

RSSL: Received Wireless Regional Area Network (WRAN) signal strength level at a base station (BS) or customer premise equipment (CPE).

RSSI: Received signal strength indication (estimate) on the sensing signal path or Wireless Regional Area Network (WRAN) signal path in sensing mode 2 at a base station (BS) or customer premise equipment (CPE).

security association (SA): The set of security information a base station (BS) and one or more of its customer premise equipment (CPE) share in order to support secure communications. This shared information includes traffic encryption keys (TEKs) and the cipher suite that is to be applied to the SA.

security association identifier (SAID): An identifier shared between the base station (BS) and a customer premise equipment (CPE) that uniquely identifies a security association (SA).

security sublayer 1: Security functions for the Data/Control Plane.

security sublayer 2: Security functions for the Cognitive Plane.

self-coexistence: A state by which wireless communication systems of the same type can share a radio frequency (RF) transmission channel in a common area while minimizing harmful interference to each other by the use of appropriate means.

NOTE—In the case of IEEE 802.22, this means coexistence of multiple nearby IEEE 802.22 cells.

sensing mode: A mode of operation of the spectrum sensing function that specifies the valid outputs of the spectrum sensing function.

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service flow: Defines the quality of service (QoS) parameters for the Protocol Data Units (PDUs) that are exchanged on a connection, and provides a mechanism for upstream (US) and downstream (DS) QoS management.

service flow identifier (SFID): A unique identifier for a service flow dealing with how higher layer packets/application sessions are mapped to their quality of service (QoS) requirements and scheduling constraints.

signal type array (STA): A one-dimensional array indicating which signal types the spectrum sensing function is to sense.

spectrum manager: The cognitive function at the base station (BS) that will use the inputs from the database service based on the geolocation at the BS and the customer premise equipment (CPE), as well as the input from the spectrum sensing automaton (SSA) at the BS and the CPEs to decide on the channel to be used by the Wireless Regional Area Network (WRAN) cell as well as the EIRP limits imposed on the specific WRAN devices.

spectrum sensing automation: Cognitive function resident at the base station (BS) and the customer premise equipment (CPE) that includes essential features to allow autonomous and directed sensing at the BS and at the CPE as well as proper CPE operation when it is not under the control of a BS.

spectrum sensing function (SSF): The function that observes the radio frequency (RF) spectrum for a defined set of signal types and reports the results of its observations.

station ID (SID): A unique identifier for a customer premise equipment (CPE) under the control of a base station (BS). This can reflect a single CPE, or a group of CPEs (e.g., multicast group).

subchannel: The basic unit of a logical channel used for subcarrier allocation in both downstream (DS) and upstream (US). A subchannel is composed of 28 subcarriers (24 data and 4 pilot subcarriers).

subframe: Formed by a number of bursts transmitted in the same direction [e.g., downstream (DS) subframe, upstream (US) subframe].

superframe: Group of 16 frames initiated by the transmission from the base station (BS) of the superframe preamble and the Superframe Control header (SCH).

Supplicant: An entity at one end of a point-to-multipoint Wireless Regional Area Network (WRAN) link that seeks to be authenticated by an Authenticator attached to the other end of that link.

symbol period: Fundamental unit of duration in the time domain that is equal to the duration of an OFDM symbol in the time domain.

NOTE—See Table 284.

time division duplex (TDD): A duplex scheme where upstream (US) and downstream (DS) transmissions occur at different times but may share the same transmission channel.

transmit/receive transition gap (TTG): A gap between the last sample of the downstream (DS) subframe and the first sample of the subsequent upstream (US) subframe at the antenna port of the base station (BS) in a time division duplex (TDD) transceiver. This gap allows time for the BS to switch from transmit (Tx) to receive (Rx) mode. During this gap, the BS is not transmitting modulated data but simply allowing the BS transmitter carrier to ramp down and the Tx/Rx antenna switch to actuate, and the BS receiver section to activate.

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transport connection: A connection established to transport user data between the base station (BS) and a particular customer premise equipment (CPE).

upstream (US): The direction of the transmitted signal from a customer premise equipment (CPE) to the base station (BS).

upstream channel descriptor (UCD): A medium access control layer (MAC) message that describes the physical layer (PHY) characteristics of an upstream transmission burst.

upstream interval usage code (UIUC): An interval usage code specific to an upstream burst. *See also:* **interval usage code.**

upstream map (US-MAP): A medium access control layer (MAC) message that defines the media access parameters (i.e., burst start time, burst length, and subchannel usage) for the OFDMA upstream (US) subframe for the customer premise equipment (CPE) scheduled to transmit toward the base station (BS).

urgent coexistence situation (UCS): A situation where a Wireless Regional Area Network (WRAN) detects incumbents in the current operating channel.

wireless microphone: A wireless microphone with licensed use of the TV broadcast bands (e.g., Part 73 and 74 devices in the U.S.A.) and equivalent low-power auxiliary devices allowed under the rules of various regulatory domains.

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4. Abbreviations and acronyms

AAA	Authentication, Authorization, and Accounting
AAD	additional authenticated data
A-BS	advanced base station
A-CPE	advanced customer premise equipment
AES	Advanced Encryption Standard
A-FCH	advanced frame control header
AK	authorization key
ARQ	Automatic Repeat Request
AU	antenna unit
A-WRAN	advanced wireless regional area network
AZ	access zone
BCC	binary convolutional coding
BE	best effort
BS	base station
BSN	block sequence number
BTC	Block Turbo Code
CA	Certificate Authority
CAM	channel allocation manager
CBP	Coexistence Beacon Protocol
CC	confirmation code
CDMA	Code Division Multiple Access
CHU	channel transceiver unit
CID	connection identifier
CINR	carrier-to-interference and noise ratio
CNR	carrier-to-noise ratio
CoS	class of service
CP	cyclic prefix
CPE	customer premise equipment
CPS	Common Part sublayer
CRC	Cyclic Redundancy Check

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CRZ	centralized relay zone
CS SAP	Convergence sublayer Service Access Point
CS	Convergence sublayer
C-SAP	Control Service Access Point
CTC	Convolutional Turbo Code
CTR	Counter Mode Encryption
DAMA	Demand Assigned Multiple Access
DCD	Downstream Channel Descriptor
DFS	Dynamic Frequency Selection
DHCP	Dynamic Host Configuration Protocol
DIUC	Downstream Interval Usage Code
DL	downlink
DRZ	distributed relay zone
DS	downstream
DSA	Dynamic Service Addition
DSC	Dynamic Service Change
DSD	Dynamic Service Deletion
DSx	Dynamic Service Addition, Change, or Deletion
DTT	downstream transit test
EAP	Extensible Authentication Protocol
ECC	Elliptic Curve Cryptography
EIRP	Effective Isotropic Radiated Power
Ext-FCH	extended frame control header
FC-DST	Frame Contention Destination
FCH	Frame Control Header
FCN	Frame Contention Number
FC-SRC	Frame Contention Source
FDD	Frequency Division Duplex
FFT	Fast Fourier Transform
FT	flow type
GCM	Galois Counter Mode

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GMAC	AES-GCM Message Authentication Code
GMH	generic MAC header
GRA	group resource allocation
HCS	Header Check Sequence
IANA	Internet Assigned Numbers Authority
ID	identification
IDRP	Incumbent Detection Recovery Protocol
IE	information element
IETF	Internet Engineering Task Force
IFFT	Inverse FFT
IP	Internet Protocol
IUC	Interval Usage Code
LAN	Local Area Network
LBS	Location Based Service
LCU	local cell update
LDPC	Low Density Parity Check Code
LLC	Link Layer Control
LSB	least significant bit
LTS	Long Training Sequence
MAC SAP	Medium Access Control Service Access Point
MAC	Medium Access Control Layer
MD-TCM	multidimensional trellis coded modulation
MIB	Management Information Base
MIC	Message Integrity Check
MIMO	multiple-input, multiple-output
MPDU	MAC Layer Protocol Data Unit
MPEG	Moving Pictures Experts Group
MPFA	Maximum Probability of False Alarm
MPR	microphone protection radius
M-SAP	Management Service Access Point
MSB	most signification bit

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MSDU	MAC Layer Service Data Unit
NCMS	Network Control and Management System
NCS	Network Control System
NMEA	National Marine Electronics Association
NMS	Network Management System
nrtPS	Non-real-time Polling Service
ODFC	on-demand frame contention
OFDM	Orthogonal Frequency Division Multiplexing
OFDMA	Orthogonal Frequency Division Multiple Access[18]
OSIC	ordered successive interference cancellation
OSTBC	orthogonal space-time block codes
PAPR	Peak-to-Average Power Ratio
PDU	Protocol Data Unit
PER	Packet Error Rate
PHY SAP	Physical Layer Service Access Point
PHY	Physical Layer
PHY-OM1	Physical Layer Operation Mode 1
PHY-OM2	Physical Layer Operation Mode 2
PMP	point to multipoint
PN	Packet Number, also used for pseudo-noise
PPDU	Physical Layer Protocol Data Unit (PHY burst)
PRM	Protocol Reference Model
PSDU	Physical Layer Service Data Unit (equivalent to MPDU)
QAM	Quadrature Amplitude Modulation
QoS	quality of service
QP	quiet period
QPSK	Quadrature Phase-Shift Keying
RAN	Regional Area Network
R-CPE	relay customer premise equipment

[18] To align with accepted usage, OFDMA is also used in this standard to refer to the multi-user variant of OFDM.

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ROHC	Robust Header Compression
RRM	Radio Resource Management
RRTG	relay receive/transmit transition gap
RS	Reed-Solomon
RSSI	Received Signal Strength Indication on the WRAN signal path or sensing path in sensing mode 2
RSSL	Received WRAN Signal Strength
RTG	Receive/Transmit Transition Gap
rtPS	Real-time Polling Service
RTTG	relay transmit/receive transition gap
SA	security association
SAID	security association identifier
SAP	service access point
SBTC	Shortened Block Turbo Code
SCH	superframe control header
SCM	Security for Control and Management
SCW	self-coexistence window
SDU	Service Data Unit
SFID	service flow identifier
SID	station ID
SM	spectrum manager
SM-GL SAP	Spectrum Manager, Geolocation Service Access Point
SM-SSF SAP	Spectrum Manager, Spectrum Sensing Function Service Access Point
SNMP	Simple Network Management Protocol
SNR	signal-to-noise ratio
SPA	Signal Present Array
SPC	Subcarrier Power Control
SPD	Secondary Protecting Device
SSA	Spectrum Sensing Automaton
SSF	Spectrum Sensing Function
STA	Signal Type Array

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STC	space time coding
STS	Short Training Sequence
SWS	Sensing Window Specification
SWSA	Sensing Window Specification Array
TCP	Transmission Control Protocol
TDD	time division duplex
TDM	time division multiplex
TDMA	Time Division Multiple Access
TEK	Traffic Encryption Key
TFTP	Trivial File Transfer Protocol
TPC	Transmit Power Control
TRU	transceiver unit
TTG	Transmit/Receive Transition Gap
TU	Time Unit corresponding to a nominal sampling period (see Table 199)
UCD	Upstream Channel Descriptor
UCS	urgent coexistence situation
UGS	Unsolicited Grant Service
UIUC	Upstream Interval Usage Code
UL	uplink
US	upstream
WG	working group
WGS	World Geodetic System
WRAN	Wireless Regional Area Network
YANG	Yet Another Next Generation
ZF	zero-forcing

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5. System architecture

5.1 Reference architecture

The IEEE 802.22 reference architecture is depicted in Figure 3 and Figure 4. A unique characteristic of this architecture is the addition of cognitive components. Spectrum availability in the TV bands can be fragmented, i.e., some channels can be occupied by incumbents in an area (see Figure 2) while others can be available for WRAN transmission, and this availability can vary in time. As shown in Figure 2, channel 3 is allocated to the IEEE 802.22 WRAN system, while channels 1 and 5 are in use by overlapping IEEE 802.22 cells. Channels 2, 4, and 6 would be available for more WRAN services in the area. Also, proper frequency separation is enforced in order to protect incumbent services using cognitive radio techniques—the air interface must be frequency agile, must adjust to the fragmented and time-varying spectrum availability, and must avoid interference to the TV band incumbent services. The required functional capabilities of these cognitive radio techniques are established in this standard (see Clause 11). In particular, the cognitive components of the system architecture must keep track of multiple channels, know which of these channels are occupied by incumbents and which can be used for WRAN transmission, allow for dynamic frequency selection, and avoid interference to incumbents on a real-time basis.

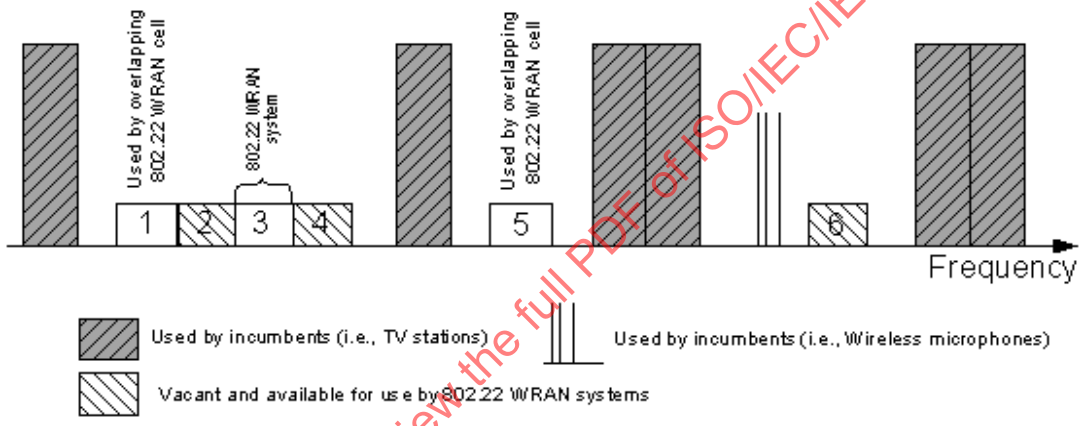

Figure 2—Illustrative diagram of spectrum allocations in TV bands

The Protocol Reference Model (PRM), shown in Figure 3 and Figure 4, keeps the usual data and management/control plane functionality intact, while creating a new cognitive plane to support cognitive radio capabilities. The data plane must carry the end user data as well as the management and control information. Figure 3 and Figure 4 show the PRMs at the BS and at the CPE, respectively.

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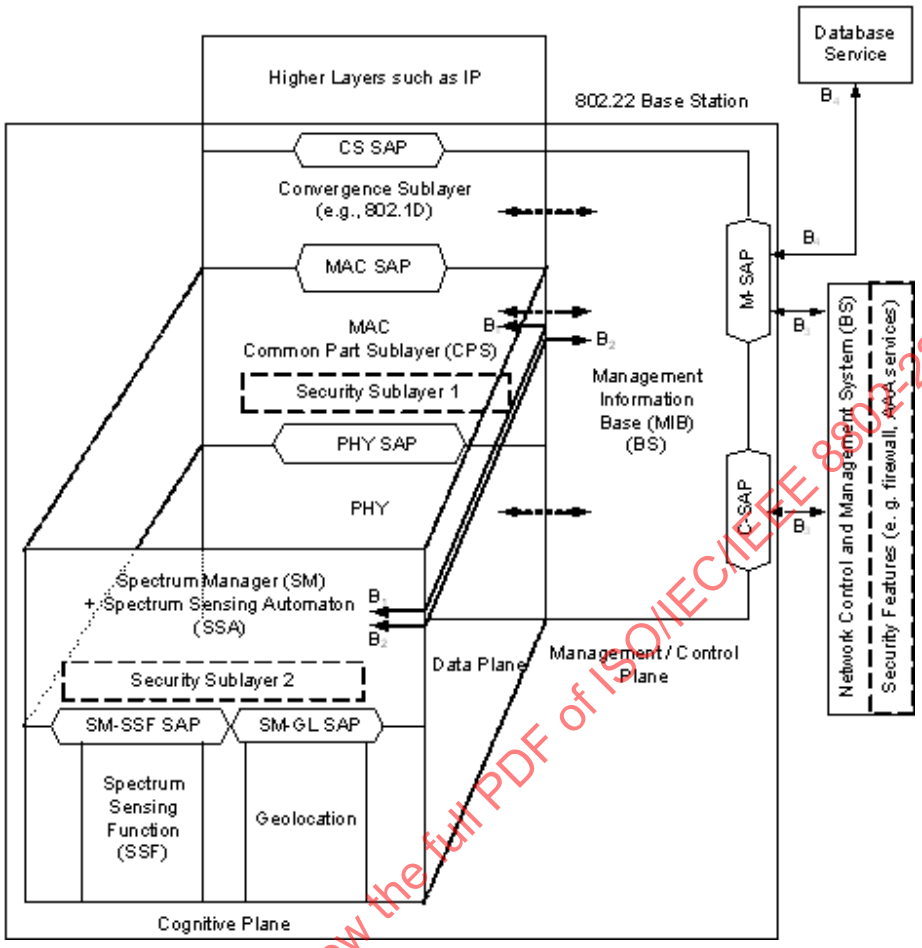

Figure 3—Protocol Reference Model (PRM) of the IEEE 802.22 BS

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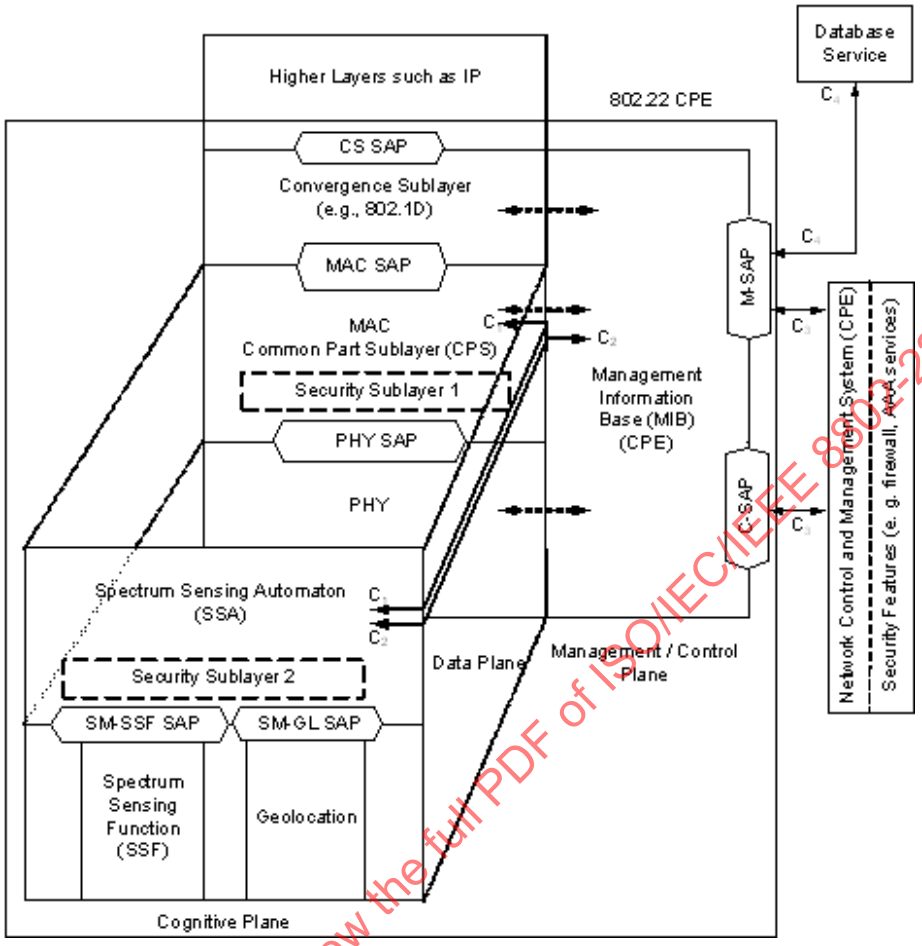

Figure 4—Protocol Reference Model (PRM) of the IEEE 802.22 CPE

5.1.1 Data plane

The data plane consists of the Physical Layer (PHY), the Medium Access Control Layer (MAC) and the Convergence sublayer (CS). Service Access Points (SAPs) are added in between these layers to allow modularization of the system where different components may be disjointed and/or supplied by different vendors. A SAP is provided with a well-defined interface or set of primitives to exchange the information, by virtue of which these different components can talk to each other.

The Data & Control/Management plane of the MAC shall be comprised of three sublayers: service-specific CS, the MAC Common Part sublayer (CPS), and the security sublayer 1. The service-specific CS shall provide transformation or mapping of external network data that is received through the CS SAP, into MAC Service Data Units (SDUs) and data that is received by the MAC CPS through the MAC SAP. This transformation or mapping shall include classifying external network SDUs and associating them to the proper MAC service flow identifier (SFID) and flow type (FT). Multiple CS specifications are provided for interfacing with various protocols. The internal format of the CS payload is unique to the CS, and the MAC CPS is not required to understand the format of or parse any information from the CS payload.

The MAC Common Part sublayer shall provide the core MAC functionality of system access, connection establishment, and connection maintenance. The data that the MAC layer receives from the various CSs through the MAC SAP shall be classified onto particular MAC connections. An example of the MAC CPS

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service definition is given in Clause 6. QoS is applied to the transmission and scheduling of data over the PHY. The MAC security sublayer 1 shall provide mechanisms for authentication, secure key exchange, encryption, etc. Data, PHY control, and monitoring statistics (spectrum sensing, RSSI, RSSL, etc.) shall be transferred between the MAC CPS and the PHY via the PHY SAP.

5.1.2 Management/control plane

The management/control plane shall consist of the Management Information Base (MIB), or optionally consist of the YANG data model (see IEEE 802.1Qcp-2018 and IETF 6020). SNMP is used to communicate with the MIB database and some of its primitives may be used to manage the network entities (BS, CPE, switches, routers, etc.). The MIB primitives shall be used for system configuration, monitoring statistics, notifications, triggers, CPE and session management, Radio Resources Management (RRM), communication with the database service, spectrum sensing and geolocation reporting, etc. The MIB data may be obtained either from the network, predefined within the system, or obtained from another device (e.g., BS) after an exchange of information using SNMP over the communication medium.

5.1.3 Cognitive plane

The cognitive plane shall be comprised of the spectrum sensing function (SSF), the geolocation (GL) function, the spectrum manager/spectrum sensing automaton (SM/SSA) and a dedicated security sublayer 2.

The SSF shall implement spectrum sensing algorithms and the GL module shall provide the information to determine the location of the IEEE 802.22 device (BS or CPE). The SSF and the GL modules are described in 15.2.2 and 15.2.3, respectively.

5.1.3.1 Spectrum Manager (SM)

The SM shall reside in the cognitive plane of the BS at the same layer as the MAC CPS in the data plane as shown in Figure 3. The SM shall maintain spectrum availability information, manage channel lists, manage quiet periods scheduling, and implement coexistence mechanisms. The SM shall also take requests from the MAC/PHY. For example, the MAC must inform the SM if an interference situation has been detected (e.g., with incumbents or other IEEE 802.22 cells) during normal operation in the channel. The SM must then take appropriate actions to resolve the issue such as moving to another channel (as specified in 11.2.3). In order to do this, the SM must first provide sufficient quiet period time for the CPEs to carry out in-band sensing (on channels N and N±1) to clear these channels within the specified channel monitoring requirement (see Annex A), and then keep an updated list of backup and candidate channels in a prioritized order and make sure that the CPEs have enough idle time to clear a sufficient number of backup channels. If an incumbent is found from the in-band sensing, the MAC shall use the informed response from the SM to perform the switching operation.

The SM has a key role in the overall architecture as it is the central point at the BS where all the information on the spectrum availability resulting from the database service and the spectrum sensing function is gathered. Based on this combined information, local regulations, and predefined SM policies (as specified in 11.2.5), the SM shall provide the necessary configuration information to the MAC, which shall remotely configure all the registered CPEs. Explicit connections B_1 and B_2 are shown in Figure 3. This signifies that different kinds of information are exchanged between the SM and the MAC, and the SM and the MIBs. Connection B2 shall be used for configuration of the SM at the BS, transmission of the available channel list to the SM, as well as reporting the RF environment information via the MIBs. Connection B_1 shall be used by the SM to initiate channel move, to configure the SSA at the CPE (backup/candidate channel list, specific channels to be sensed, etc.) as well as to gather information from the CPEs (local sensing information, local geolocation information, etc.).

The functions of the SM are described in 11.2.

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5.1.3.2 Spectrum Sensing Automaton (SSA)

A simpler spectrum management entity, called Spectrum Sensing Automaton, is present at the BS and at the CPEs and independently implements specific procedures for sensing the RF environment at initialization of the BS and before the registration of a CPE with the BS. The SSA at the CPE shall also include essential features to allow proper operation when the CPE is not under the control of a BS such as independent procedures during initialization and channel change and, while the CPE is idle, the SSA shall conduct out-of-band sensing and report to the BS so that it can refresh the status of the channels in the backup/candidate channel list. At any other time, the SSA at the CPE is under the control of the SM. The SSA at the BS is also active when the BS is not transmitting to conduct out-of-band sensing. The SSA located at the BS can also carry-out sensing to clear channels when the BS is not transmitting. The functions of the SSA are described in 11.3.

Explicit connections C_1 and C_2 at the CPE are shown in Figure 4. Connection C_2 shall be used to convey the environment monitoring information (e.g., list of service providers detected) via the MIBs to the CPE local interface in order to allow for the choice of the WRAN service by a professional installer through upper layers at the CPE. Connection C_1 shall be used to convey the local environment information such as sensing and geolocation to the BS.

5.1.3.3 Security sublayer 2

In addition to the security sublayer 1 at the data plane, security sublayer 2 is introduced in the cognitive plane. Security sublayer 2 enhances the security for the cognitive radio based access. The detailed operation of the security sublayers 1 and 2 are described in Clause 8. The functions of the security sublayers 1 and 2 shall help ensure spectrum and service availability; provide data and signal authentication; as well as ensure data, control and management message integrity, confidentiality and non-repudiation. The role of the security sublayer 2 is to provide enhanced protection to the incumbents as well as necessary protection to the IEEE 802.22 systems. If the IEEE 802.22.1 beacon has to be detected in the given regulatory domain and the transmission needs to be authenticated, the security sublayer 2 shall be used along with the security mechanism provided (ECC-based signature) to authenticate this beacon. Similarly, security sublayer 1 shall be used to authenticate a CBP packet originating from a neighboring cell CPE.

5.2 Management reference architecture

IEEE 802.22 network cells consist of a BS and up to 512 CPE devices or groups of devices. IEEE 802.22 networks may contain multiple cells. For multiple cells operation, interfacing with entities for management and control purposes is required. This standard refers to an abstract “black box” Network Control and Management System (NCMS) containing these entities. The NCMS allows the PHY/MAC layers specified in this standard to be independent of the network architecture, the transport network, and the protocols used at the backend and therefore allows greater flexibility. NCMS logically exists at the BS and CPE sides of the radio interface, termed NCMS (BS) and NCMS (CPE) respectively. Any necessary inter-BS coordination is handled through the NCMS (BS).

Figure 5 shows an example of a management reference model for WRANs. This example consists of a Network Management System (NMS), a Network Control System (NCS), and managed nodes. The BS and CPEs shall collect and store the managed objects (see 5.2.4) in the format as defined in the WRAN Management Information Base (MIB). The MIB is defined and specified in Clause 13. The Network Control System contains the service flow and the associated QoS information that is pre-populated in service classes at the BS and instantiated when a CPE requests services.

Interfaces B4 in Figure 3 and C4 in Figure 4 describe the interface between the CPE/BS and the database service. These interfaces are used to register with the database and request a set of available channels. Interfaces B3 in Figure 3 and C3 in Figure 4 describe the interface between the CPE/BS and the NCMS.

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In the management reference architecture example in Figure 5, management information that is stored in the form of MIBs must be conveyed using SNMP messages. Use of MIBs to define the structure of management information and SNMP to convey this data is optional. If MIBs and the SNMP are not used to store and transport management information, the network operator and device manufacturers will have to specify another means (e.g., YANG data models, see IEEE Std 802.1Qcp-2018 and IETF 6020) to enable management functions. The management information between the CPE and the BS may be carried over a secondary management connection.

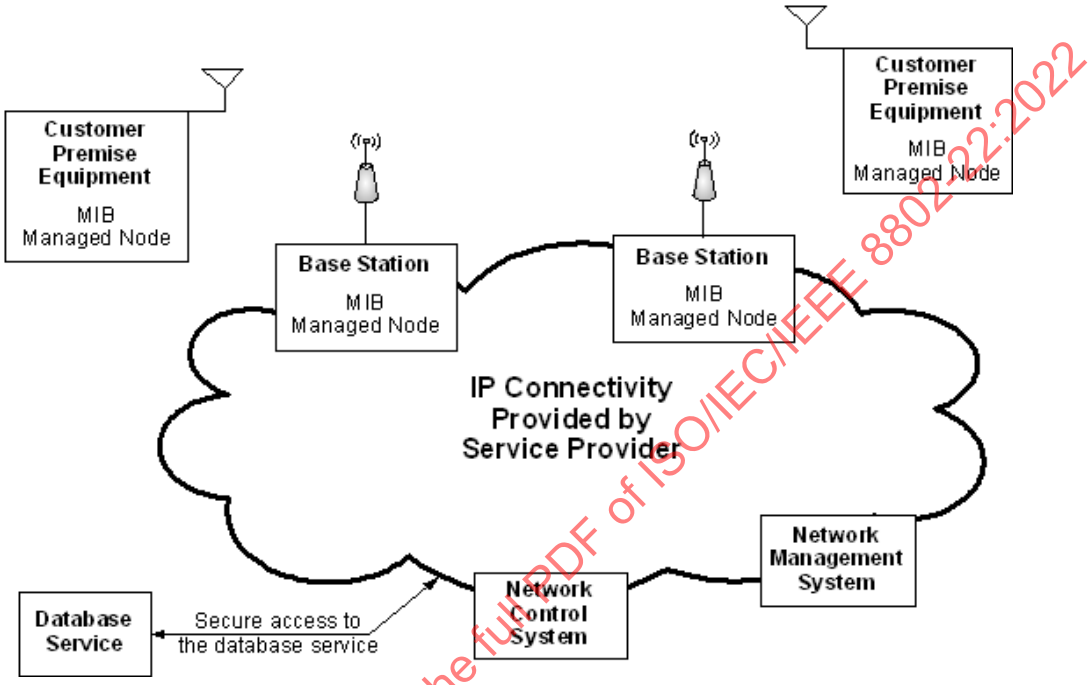

Figure 5—Management reference model

Examples of services that may be provided by the NCMS include: Authentication, Authorization, and Accounting (AAA) services, Radio Resources Management (RRM) services, security services, Service Flow Management services, Location-Based services (LBS) management, and Network Management services.

5.2.1 Service access primitives (SAPs)

In the Management/Control Plane, the NCMS is interfaced to the MAC and PHY layer entities of the CPE and BS through two Service Access Primitives (SAPs). The BS and CPE shall include a Control-SAP (C-SAP) and Management-SAP (M-SAP) that provide NCMS access to the control plane and management plane functions from upper layers. The M-SAP is used for less time-sensitive Management plane primitives, and the C-SAP is used for more time-sensitive Control plane primitives. The C-SAP and M-SAP interfaces are described in 5.2.1.1 and 5.2.1.2. The NCMS uses the C-SAP and M-SAP to interface with the IEEE 802.22 managed nodes.

In the Cognitive Plane, the SM is interfaced with the SSA through two SAPs. The SM uses the SM-SSF SAP to interface with the Spectrum Sensing Function on the SSA and the SM-GL SAP to interface with the geolocation function on the SSA.

5.2.1.1 Management SAP (M-SAP)

The M-SAP may include, but is not limited to primitives related to the following:

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- System configuration
- Monitoring statistics
- Notifications/triggers
- Sensing and geolocation reporting
- Communication with the database service

5.2.1.2 Control SAP (C-SAP)

The Control SAP may include, but is not limited to primitives related to the following:

- Subscriber and Session management
- Security context management
- Radio Resource Management
- AAA server signaling

5.2.1.3 SM-SSF SAP (SM-SSF-SAP)

The SM-SSF SAP includes, but is not limited to, primitives related to the following:

- Channel Sensing configuration
- Channel Sensing reporting

5.2.1.4 SM-GL SAP (SM-GL-SAP)

The SM-GL SAP includes, but is not limited to, primitives related to the following:

- Geolocation fix calculation request
- Geolocation fix calculation results

5.2.2 Network Reference Model

Figure 6 describes a simplified network reference model. Multiple CPEs may be attached to a BS. CPEs communicate to the BS over the U interface using a Basic Management Connection, a Primary Management Connection, or a Secondary Management Connection (see 7.2).

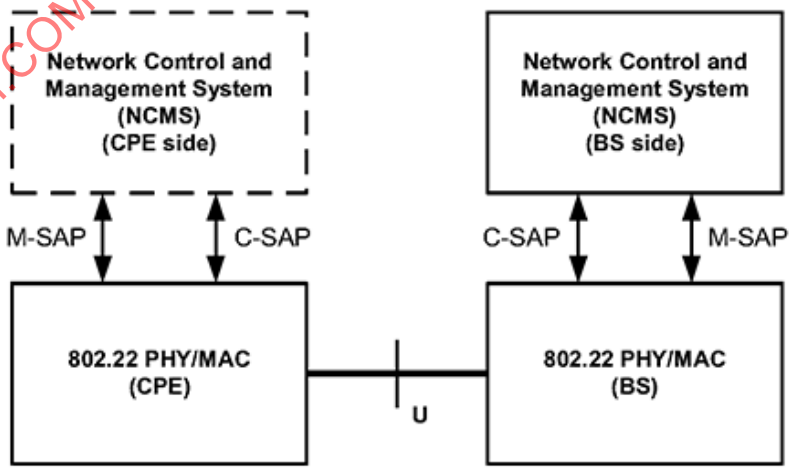

Figure 6—IEEE 802.22 Network Reference Model

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5.2.3 CPE and BS Interface

This standard observes the following correlation:

— MAC management PDUs that are exchanged on the basic management connection trigger or are triggered by primitives that are exchanged over the C-SAP.

— MAC management PDUs that are exchanged on the primary management connection trigger or are triggered by primitives that are exchanged over either the C-SAP or the M-SAP depending on the particular management or control operation.

— Messages that are exchanged over the secondary management connection trigger or are triggered by primitives that are exchanged over the M-SAP.

5.2.4 Managed objects

Managed information items are also known as “managed objects.” If managed objects are defined as MIBs (see Clause 14), the definition of them shall follow conventions expressed in IETF RFC 2578. It supports a management protocol agnostic approach, including SNMP. If managed objects are not defined as MIBs, use of conventions defined in IETF RFC 2578 to define them is optional; use of SNMP to transport this information is optional as well.

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6. Packet Convergence sublayer

The Packet Convergence sublayer (CS) resides on top of the MAC Common Part sublayer (CPS). The CS shall perform the following functions using classification governed by rules (see 6.3.2 or 6.4.2) defined by the implementer/operator to process higher layer SDUs so they can be sent and received by the IEEE 802.22 BS and CPE. This process can be broken down into the following four steps, each utilizing the services of the MAC:

— Receiving higher-layer packet protocol data units (PDUs) from the higher layer
— Classifying the higher-layer PDUs into the appropriate connection
— Delivering the resulting CS PDUs to the MAC SAP associated with the service flow for transport to the peer MAC SAP
— Receiving the CS PDUs from the peer MAC SAP

The sending CS is responsible for delivering the MAC SDU to the MAC SAP. The MAC is responsible for delivery of the MAC SDU to peer MAC SAP in accordance with the QoS, fragmentation, concatenation, and other transport functions associated with the service flow characteristics of a particular connection. The receiving CS is responsible for accepting the MAC SDU from the peer MAC SAP and delivering it to a higher-layer entity.

The packet CS is used for transport of the following two packet-based protocols supported by this standard, i.e., IEEE Std 802.3™ (Ethernet) and Internet Protocol (IP).

6.1 MAC SDU format

Once classified and associated with a specific MAC connection, a higher-layer PDU shall be encapsulated in a MAC SDU according to the format illustrated in Figure 7.

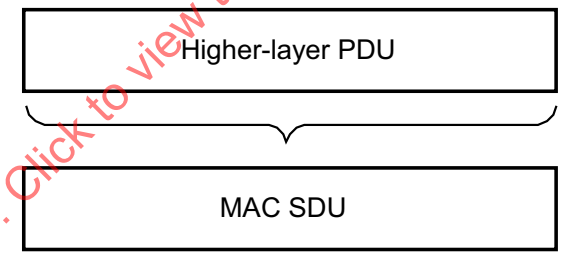

Figure 7—MAC SDU format

6.2 Classification

Classification is the process by which a MAC SDU is mapped onto a particular connection for transmission between MAC peers. The mapping process associates a MAC SDU with a connection, which also creates an association with the service flow characteristics of that connection. This process facilitates the delivery of MAC SDUs with the appropriate QoS constraints.

A classification rule is a set of matching criteria applied to each packet entering the IEEE 802.22 network. It consists of some protocol-specific packet matching criteria (destination IP address, for example), a classification priority, and a reference to a flow type (FT, see 7.2). If a packet matches the specified packet matching criteria, it is then delivered to the SAP for delivery on the connection defined by the FT and the station identifier (SID, see 7.2) assigned to the CPE. Classification rules, which are to be defined by the

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WRAN operator, shall be downloadable to the BS and CPEs in a uniform and standardized format at the MIB level (see Clause 14) and shall be fully interoperable between the BS and CPEs. The service flow characteristics of the connection provide the QoS for that packet.

Several classification rules may each refer to the same service flow. The classification priority is used for ordering the application of classification rules to packets. Explicit ordering is necessary because the patterns used by classification rules may overlap. The priority needs not be unique, but care shall be taken within a classification priority to prevent ambiguity in classification. Downstream classification rules are applied by the BS to packets that it transmits and upstream classification rules are applied at the CPE. Figure 8 and Figure 9 illustrate the mappings discussed in the previous paragraph.

It is possible for a packet to fail to match the set of defined classification rules. In this case, the CS shall discard the packet.

The parameters for the classification rules shall be provided as MIB objects at the BS (see 14.1.3) and these parameters shall be downloaded from the BS to its associated CPEs for interoperability and consistency.

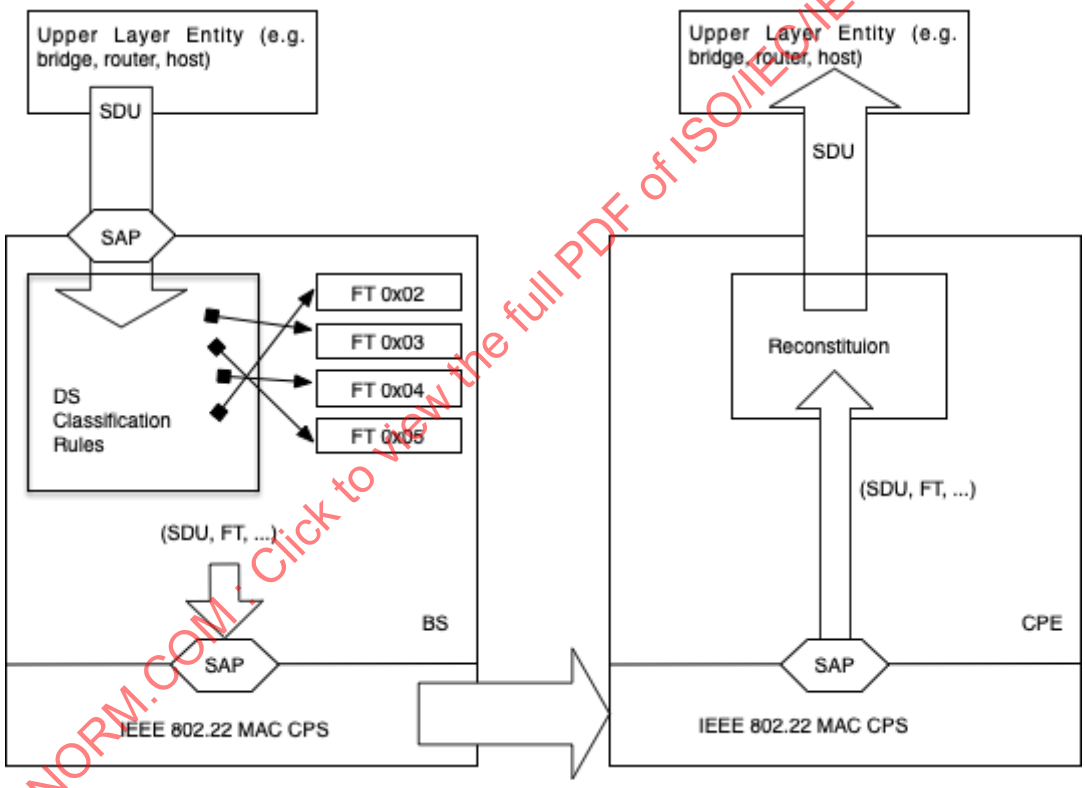

Figure 8—Classification and FT mapping (BS to CPE)

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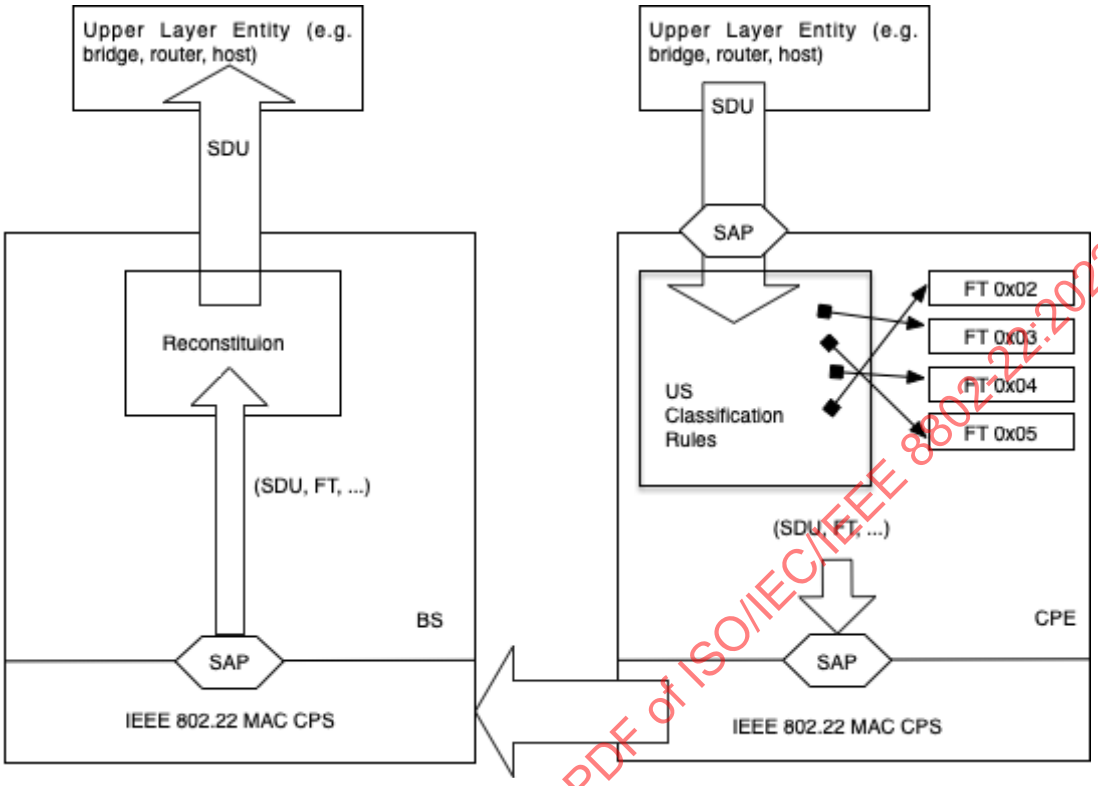

Figure 9—Classification and FT mapping (CPE to BS)

6.3 IEEE 802.3/Ethernet-specific part

6.3.1 IEEE 802.3/Ethernet CS PDU format

An IEEE 802.3/Ethernet packet PDU is directly mapped to a CS PDU (MAC SDU).

6.3.2 IEEE 802.3/Ethernet CS classification rules

The following parameters are relevant for IEEE 802.3/Ethernet CS classification rules:

— IEEE 802.3/Ethernet and VLAN headers shall be processed by zero or more of the LLC classification parameters (see 7.9.8.9.18.3.2 to 7.9.8.9.18.3.12)

— For IP over IEEE 802.3/Ethernet, IP headers may be included in classification (see 7.9.8.9.18.3.2 to 7.9.8.9.18.3.7 and 7.9.8.9.18.3.14)

— For IP headers compressed with ROHC (IETF RFC 3095 [B27], IETF RFC 3749 [B31], IETF RFC 3243 [B28], IETF RFC 4995 [B36], IETF RFC 3843 [B32], IETF RFC 4996 [B37]) only the LLC parameters shall be used for classification (see 7.9.8.9.18.3.8 through 7.9.8.9.18.3.12).

Use of IP header compression (ROHC) is negotiated during registration (REG-REQ/RSP) and enabled during service flow setup.

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6.4 IP specific part

This subclause applies when IP (IETF RFC 791 [B17], IETF RFC 2460 [B23]) is carried over the IEEE 802.22 network.

IPv6 CS requirements are only applicable if IPv6 support is enabled during registration.

6.4.1 IP CS PDU format

An IP packet PDU is directly mapped to a CS PDU (MAC SDU).

6.4.2 IP classification rules

IP classification rules operate on the fields of the IP header and the transport protocol. Classification rules shall be the same as long as the MIB is defined. Classification rules will be downloaded from the BS to its associated CPEs for interoperability and consistency (see 6.2). IP classification rules shall be based on the IP classification parameters (see 7.9.8.9.18.3.2 through 7.9.8.9.18.3.7 and 7.9.8.9.18.3.14).

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7. MAC Common Part sublayer

This clause describes the MAC layer used by the IEEE 802.22 WRAN point-to-multipoint medium access control standard and the IEEE 802.22b advanced WRAN (A-WRAN) multi-hop relay medium access control standard. The MAC provides tools for protection of TV bands incumbent services as well as for coexistence. The A-WRAN MAC provides all functionalities of the WRAN MAC and additionally supports multi-hop relay operations, multiple channel operations, multiple-input-multiple-output (MIMO) operations, etc. Both WRAN and A-WRAN MACs are connection-oriented and provide flexibility in terms of QoS support. The WRAN MAC and the A-WRAN MAC regulate downstream (DS) medium access by TDM (time division multiplex), and the upstream (US) is managed by using a DAMA/OFDMA system. In the WRAN MAC, the BS manages all the activities within its IEEE 802.22 cell, and the associated CPEs are under the control of the BS. In the A-WRAN MAC, the A-BS manages all the activities within its cell and the associated A-CPEs/R-CPEs under the control of the A-BS.

7.1 General

In an IEEE 802.22 WRAN cell, multiple CPEs are managed by a single BS that controls the medium access. The DS is TDM where the BS transmits and the CPE receives. The US transmissions, where the CPEs transmit and the BS receives, are shared by CPEs on a demand basis, according to a DAMA/OFDMA scheme. Depending on the class of service (CoS) utilized, a CPE may be issued continuing rights to transmit, or is dynamically allocated by the BS after receipt of a request from the CPE. The MAC supports unicast (addressed to a single CPE), multicast (addressed to a group of CPEs) and broadcast (addressed to all CPEs in a cell) services.

In an A-WRAN cell consisting of A-CPEs and R-CPEs, all R-CPEs and multiple A-CPEs are managed by a single A-BS, and other A-CPEs are managed by distributed scheduling R-CPEs. The DS is TDM where the A-BS transmits and the A-CPEs/R-CPEs receive. The US transmissions, where the A-CPEs/R-CPEs transmit and the A-BS receives, are shared by the A-CPEs/R-CPEs on a demand basis, according to a DAMA/OFDMA scheme. Within a local cell consisting of a distributed scheduling R-CPE and A-CPEs, multiple A-CPEs are managed by the distributed scheduling R-CPE. The DS within a local cell is TDM where the distributed scheduling R-CPE transmits and the A-CPEs receive. The US transmissions within a local cell, where the A-CPEs transmit and the distributed scheduling R-CPE receives, are shared by the A-CPEs on a demand basis, according to a DAMA/OFDMA scheme.

Both WRAN MAC and A-WRAN MAC implements a combination of access schemes that efficiently control contention between CPEs within a cell and overlapping cells sharing the same channel while at the same time attempting to meet the latency and bandwidth requirements of each user application. This is accomplished through four different types of US scheduling mechanisms that are implemented using unsolicited bandwidth grants, polling, and two contention procedures (i.e., MAC header and CDMA based). The use of polling simplifies the access operation and attempts to allow applications to receive service on a deterministic basis if it is required.

Both WRAN MAC and A-WRAN MAC are connection-oriented, and as such, connections are a key component that require active maintenance and hence can be dynamically created, deleted, and changed as the need arises. A connection defines both the mapping between convergence processes at CPEs and BS or the mapping between the A-BS and the related service flow (one connection per service flow). For the purposes of mapping to services on CPEs and associating varying levels of QoS, all data communications are instantiated in the context of a connection, and this provides a mechanism for US and DS QoS management. In particular, the QoS parameters are integral to the bandwidth allocation process as the CPE requests US bandwidth on a per connection basis (implicitly identifying the service flow). In the WRAN MAC the BS, grants bandwidth to a CPE as an aggregate of grants in response to per-connection requests from the CPE. In the A-WRAN MAC, the A-BS or distributed scheduling R-CPE grants bandwidth to an A-CPE as an aggregate of grants in response to per-connection requests from the A-CPE.

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An A-WRAN may support multiple connections between A-BS and R-CPE(s) or A-CPE(s) when multi-hope relay is enabled, or between A-BS and A-CPE(s) when multi-channel operation is enabled (7.26). When multi-channel operation is enabled, a frame is assigned to the connection on each of the different channels. The frame format on each channel shall follow the frame format described in 7.4 for A-BS and A-CPE connections, and in 7.5 and 7.6 for A-BS and R-CPE connections.

7.2 Addressing and connections

Each IEEE 802.22 BS and CPE shall have a 48-bit universal MAC address, as defined in IEEE Std 802-2014. This address uniquely defines the BS and CPE within the network, and the CPE can choose CPE Privacy (see 8.7). It is used as part of the authentication process by which the BS and CPE each verify the identity of the other at the time of network association. It is used as part of the authentication process by which the BS and CPE each verify the identity of the other at the time of network association. The BS MAC address is broadcast by the BS and is present in every CBP burst, being part of the Superframe Control header (SCH) data. Each WRAN device regularly broadcasts a CBP burst containing its Device ID and Serial Number. This is done as part of the device's self-identification process that helps identify potential interference sources to incumbent services and for coexistence purposes.

Each A-BS and CPE in an A-WRAN shall have a 48-bits universal MAC address (EUI-48), as defined in IEEE Std 802. This address uniquely defines the A-BS and CPE from within the set of all possible vendors and equipment types. It is used as part of the authentication process by which the A-BS and CPE each verifies the identity of the other at the time of network association. The A-BS MAC address is broadcast by the A-BS on the advanced frame control header (A-FCH) on PHY Operation Mode 2 (Clause 10) and is present in every CBP burst. Each A-WRAN device regularly broadcasts a CBP burst containing its Device ID and Serial Number. This is done as part of the device's self-identification process that helps identify potential interference sources to incumbent services and for coexistence purposes.

Connections are identified by two items, a 9-bit station ID (SID) and a 3-bit flow type (FT). The SID uniquely identifies a station that is under the control of the BS, the A-BS, or the distributed scheduling R-CPE. A SID can be for a unicast station, when referencing a single CPE, or for a multicast station, when referencing a multicast group (of CPEs). A FT identifies a particular traffic flow assigned to a CPE. The tuple of SID and F (SID | FT) forms a connection identifier (CID) that identifies a connection for the CPE. The SID is signaled in the DS/US-MAP allocation, and the FT is signaled in the generic MAC header (GMH) of a MAC PDU. This allows for a total of up to 512 stations, each with a maximum of eight flows that can be supported within each DS and US channel.

At CPE initialization in the WRAN, three flows shall be dedicated for management connections (see 13.2). These management connections serve the purpose of carrying MAC management messages and data between a CPE and the BS. At R-CPE/A-CPE initialization in the A-WRAN, three flows shall be dedicated for management connections (see 13.2). These management connections serve the purpose of carrying MAC management messages and data between a R-CPE/A-CPE and the A-BS, or between A-CPEs and a distributed scheduling R-CPE. In the WRAN, the three flows reflect the fact that there are inherently three different levels of QoS for traffic sent on management connections between a CPE and the BS. In the A-WRAN, the three flows reflect the fact that there are inherently three different levels of QoS for traffic sent on management connections between a R-CPE/A-CPE and A-BS, or between the A-BS and the distributed scheduling R-CPE.

The basic flow is used in the WRAN/A-WRAN to exchange short, time-urgent IEEE 802.22-based management messages; whereas the primary management flow is used to exchange longer, more delay-tolerant MAC management messages (Table 26 specifies which MAC management messages are transferred on which type of connections). Finally, the secondary management flow is used to transfer more delay-tolerant, standards-based (e.g., DHCP, TFTP, and SNMP) messages that are carried in IP datagrams. The secondary management flow may be packed and/or fragmented, similarly to the primary management

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except that no ARQ should be used for the latter since it is more time critical. CPEs attempt initialization with the BS in the WRAN (PHY-OM1) cell using the mechanism described in 7.16.2. R-CPEs/A-CPEs attempt initialization with the A-BS in the A-WRAN (PHY-OM2) cell using the mechanism described in 7.16.4.

The FTs for these connections shall be assigned according to the specification in 13.2. The same FT value is assigned to both US and DS members of each connection.

The CID, which is a tuple of SID | FT, can be considered a connection identifier even for nominally connectionless traffic like IP, since it serves as a pointer to destination and context information.

Many higher-layer sessions may operate over the same wireless connection. For example, many users within a company may be communicating with Transmission Control Protocol (TCP)/IP to different destinations, but since they all operate within the same overall service parameters, all of their traffic is pooled for request/grant purposes. A service flow is a unidirectional flow of traffic (BS to CPE, or CPE to BS, A-BS to A-CPE, A-CPE to A-BS, distributed scheduling R-CPE to A-CPE, or A-CPE to distributed scheduling R-CPE) that defines the mapping of higher-layer application service parameters (e.g., QoS) to a FT assigned to a particular CPE's unicast SID or multicast group (multicast SID).

The type of service and other current parameters of an application service are implicit in the SFID. A service flow definition may be accessed reading the appropriate service flow MIB (see 14.1.3) indexed by the SFID of the service flow assigned to a particular CPE.

Service flow, once established, may require active maintenance. The maintenance requirements vary depending upon the type of service connected. Modifiable service flows may require maintenance due to stimulus from either the CPE or the network side of the connection.

Service flow may also be terminated. This generally occurs only when a subscriber's service has changed or when the BS has not been able to communicate with the CPE. The BS or CPE can terminate a service flow.

Service Flow Management functions are supported through the use of static configuration and dynamic addition, modification, and deletion of service flow parameters and/or service flows themselves as described in 7.20.

7.3 General superframe structure

The WRAN supports one PHY Operational mode: PHY Operation Mode 1 (PHY-OM1, Clause 9). The A-WRAN supports one PHY operational mode: PHY Operation Mode 2 (PHY-OM2, Clause 10).

The WRAN system on PHY-OM1 shall support the superframe structures defined in 7.3.1 and 7.3.2.

The A-WRAN on PHY-OM2 does not support the following superframe structures defined in 7.3.1 and 7.3.2.

The WRAN system includes two MAC Operational Modes: a normal mode and a self-coexistence mode. In normal MAC mode, one WRAN cell occupies one or more channels and operates on all the frames in a superframe. In self-coexistence MAC mode, multiple WRAN cells share the same channel, and each coexisting WRAN cell operates on one or several different frames exclusively.

When operating in normal MAC mode, a WRAN cell shall transmit the Superframe Control header (SCH) at the beginning of the first frame of a superframe on the operating channel; when operating in self-coexistence MAC mode, a WRAN cell shall transmit its SCH at the beginning of the first frame allocated to it in the superframe. The structure of the SCH for both normal and self-coexistence MAC modes can be found in

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7.7.1. A WRAN runs in normal MAC mode by default and transitions to self-coexistence MAC mode when the WRAN can detect and decode an SCH or a CBP from an adjacent WRAN cell on its operating channel.

The MAC version field (carried in SCH of superframe for PHY-OM1 and A-FCH of in PHY-OM2) shall be handled so as to allow communication of what the capabilities of the cell are between the BS and CPE and between the A-BS and A-CPE/R-CPE, respectively. The MAC version field shall take on the following values:

— MAC Version 0-31 PHY-OM1
— MAC Version 32-63 PHY-OM2

7.3.1 General superframe structure for normal MAC mode

The superframe structure depicted in Figure 10 shall be used and the first frame shall be constituted of the following:

— A PHY superframe preamble, see Clause 9
— A PHY frame preamble, see Clause 9
— A Superframe Control header (SCH), see 7.7.1
— The rest of the first frame including its frame header and data payload

This first frame is then followed by 15 frames that each include a frame preamble, a frame header, and the data payload. See 7.6.

At the beginning of every superframe, the BS shall transmit the superframe preamble and the SCH on the operating channel using the modulation/coding specified in 9.4.1.2 and Table 250, respectively. In order to associate with a BS, a CPE shall receive the SCH to establish communication with the BS. During each MAC frame, the BS shall manage the US and DS operations, which may include ordinary data communication, measurement activities, coexistence procedures, and so on.

The superframe shall start with a superframe preamble, followed by the first frame preamble, the SCH, and finally the first frame payload. The first frame payload shall be reduced by two symbols with 1/4 cyclic prefix to keep the frame size consistent.

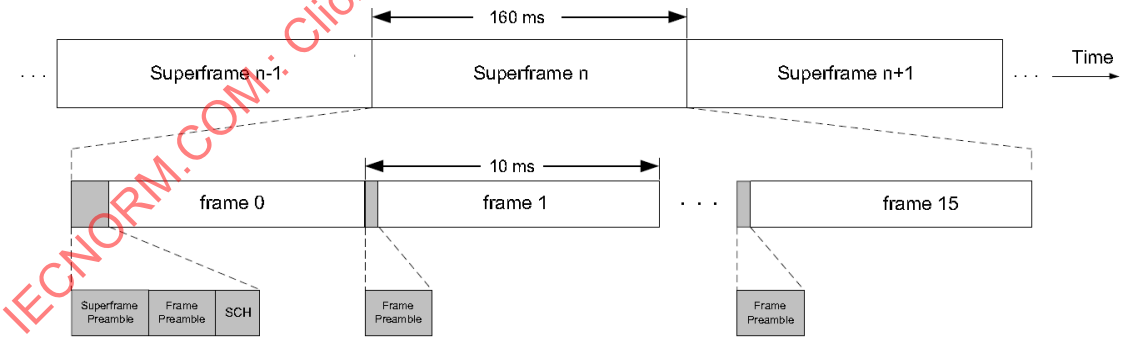

Figure 10—General superframe structure

7.3.2 General superframe structure for self-coexistence MAC mode

The superframe structure in self-coexistence MAC mode is shown in Figure 11. The self-coexistence MAC mode is for the scenario when multiple BSs with overlapping coverage have to share the same channel. The frequency reuse factor cannot be maintained as one due to their mutual interference. In this case, these BSs

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shall share the channel on a per frame basis, i.e., each BS is allocated a subset of the frames of a superframe on a non-interference basis. The negotiation process of frame allocation can be found in 7.22.3.

In self-coexistence MAC mode, the BS shall transmit its superframe preamble, frame preamble, and SCH during the first active frame allocated to it. The BS and CPEs in a WRAN cell shall only transmit during the active frames allocated to that WRAN cell. They can only transmit during other frames when a self-coexistence window (SCW) has been scheduled. During the frames not allocated to the present cell, the BS and CPEs may monitor the channel for any transmission from neighboring WRAN cells to improve self-coexistence.

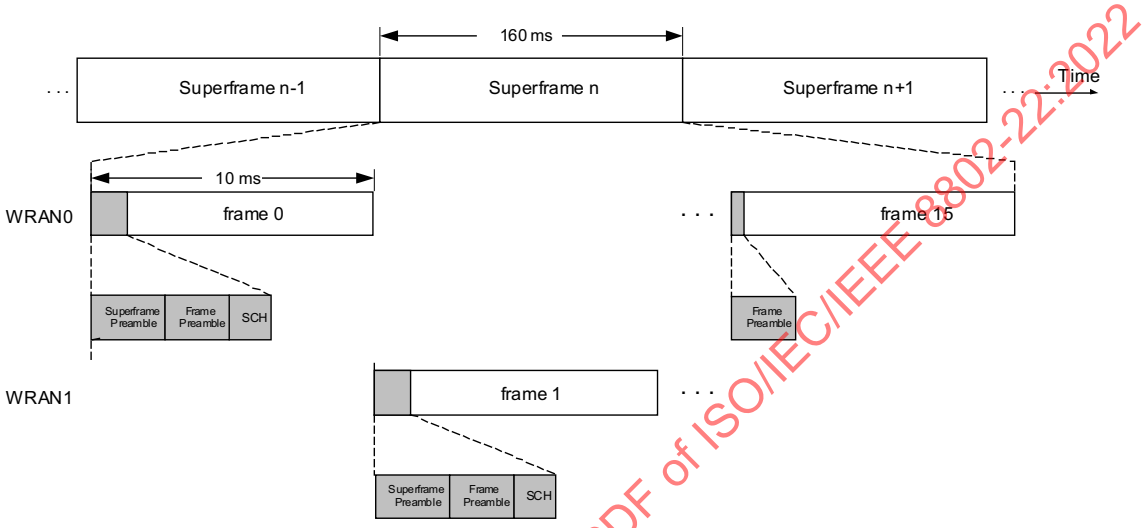

Figure 11—General superframe structure in the self-coexistence MAC mode

7.4 General frame structure (on PHY-OM1)

The WRAN system on PHY-OM1 described in Clause 9 shall support the following frame structure.

The top-down **time division duplex** (TDD) frame structure employed in the MAC is illustrated in Figure 12.

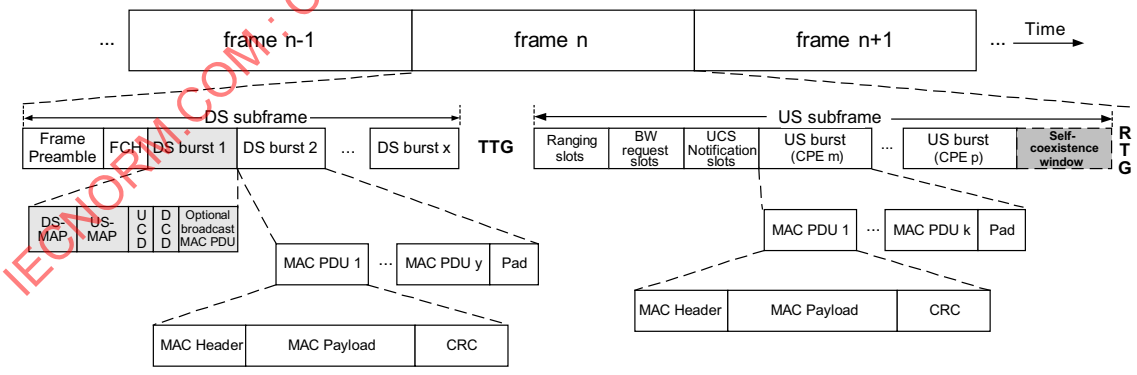

Figure 12—MAC Frame structure

As illustrated in Figure 12, a frame is comprised of two parts: a DS subframe and a US subframe. A portion of the US subframe may be allocated as a window to facilitate self-coexistence. This SCW may be scheduled by the BS at the end of the US subframe when necessary to allow transmission of opportunistic

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coexistence beacon protocol bursts. The SCW includes the necessary time buffers to absorb the difference in propagation delay between close-by and distant BSs and CPEs operating on the same channel. The boundary between the DS and US subframes shall be adaptive to adjust to the DS and US relative capacity. The US subframe may contain scheduled US PHY PDUs, each transmitted from different CPEs for their US traffic. It may also include contention intervals scheduled for the following:

— CPE association (initial ranging)
— CPE link synchronization, power control, and geolocation (periodic ranging)
— Bandwidth request
— Urgent coexistence situation (UCS) notification
— Quiet period resource adjustment

The definitions of the fields/messages are given in 7.8 and 7.9.

The PHY PDUs depicted in Figure 12 may be transmitted across several subchannels as shown in Figure 13, which depicts how a frame may be transmitted (in time and frequency) by the PHY layer.

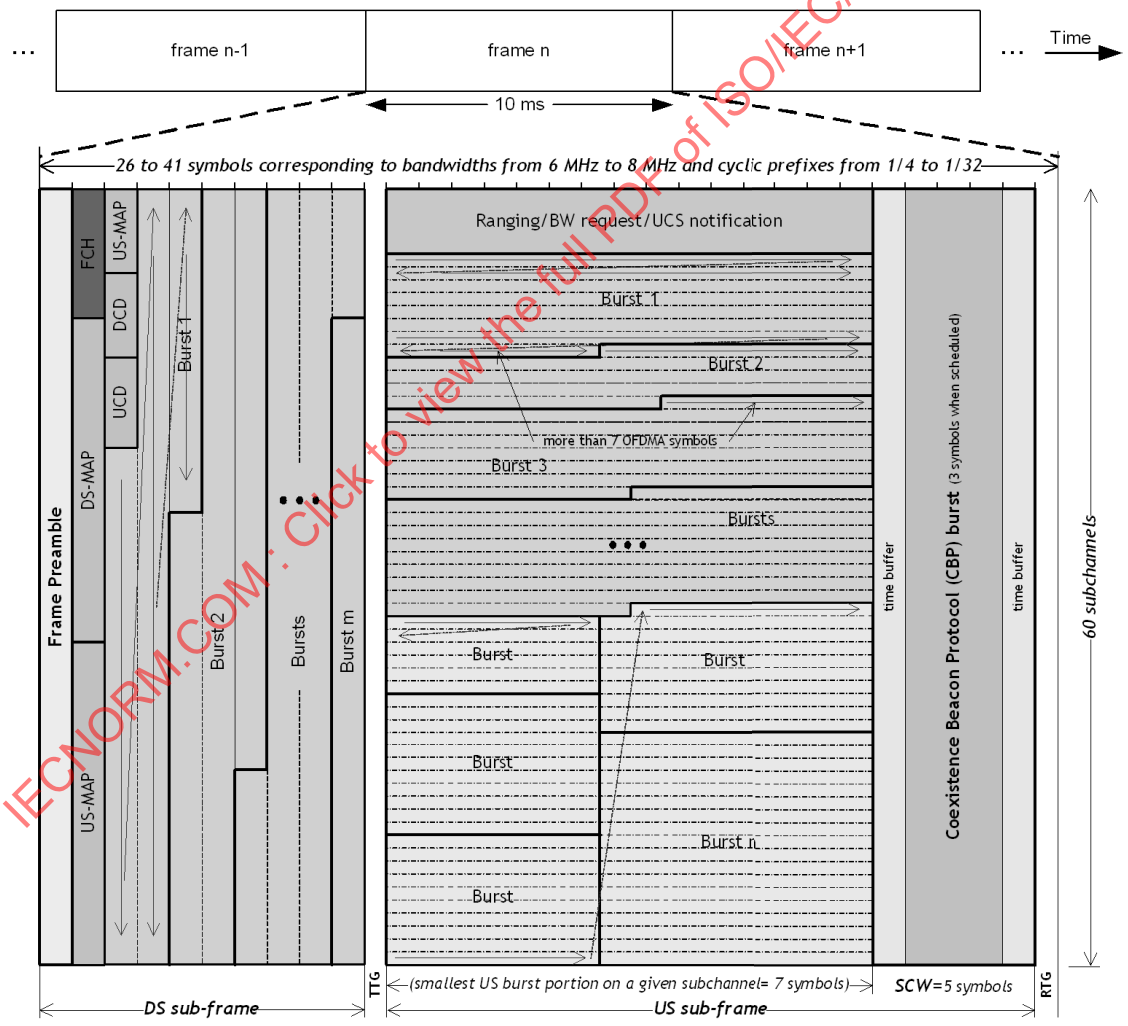

Figure 13—Example of a time/frequency structure of a MAC frame

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Figure 13 shows an example of the two-dimensional (time/frequency) structure of the MAC frame that shall consist of an integer number of fixed size OFDM slots. Each slot shall consist of one OFDM symbol by one subchannel (i.e., 1 OFDM slot = 1 symbol × 1 subchannel). To help understand Figure 13, the MAC packets are assumed to be structured in a linear TDM manner (see Figure 12) while the PHY packets are arranged in a two-dimensional time/frequency domain (symbol in the horizontal direction, logical subchannels in the vertical direction). For the FCH, the DS/US-MAP, the DCD, and UCD, as well as for the DS payload, the MAC information is first laid vertically by subchannels then stepped horizontally in the time direction. This vertical layering allows early scheduling of DS bursts assigned to distant CPEs to compensate for propagation delays and to avoid potential interference at the CPE in the case of overlapping WRAN cells with different DS/US capacity split.

The MAC data elements from Figure 12, starting from the FCH and including the first broadcast burst, shall be entered into the second OFDM symbol, as shown in Figure 13, in the increasing order of logical subchannels until all logical subchannels are occupied. Then, the subsequent data elements, if they have not all been mapped, shall be placed in the same order on the following OFDM symbols. The balance of the last OFDM symbols shall be padded with zeros. The modulation and coding schemes for the padding zeros are defined by the DIUC for the last DS burst in the DS-MAP. Another category of bursts, padding bursts, may exist to perform block alignment with symbol boundaries and to control or limit the total power of individual symbols. Such padding bursts should use ‘000’ as Subcarrier Power Control (SPC) (see Table 26), i.e., 0 power, to minimize the transmitted power. These bursts shall be duly defined bursts addressing a dummy (non-associated) CPE SID for which the DIUC and SPC shall be indicated in the DS-MAP.

The MAC data elements that are contained in US bursts shall be mapped to the US subframe in a different order as shown in Figure 13. They are first mapped horizontally, OFDM symbol by OFDM symbol, in the same logical subchannel. Once a logical subchannel has been filled to the end of the US subframe, the balance of the MAC data elements shall be mapped to the next logical subchannel, in an increasing subchannel order. This process continues until all of the subchannels and symbols allocated to the burst are filled. If the quantity of MAC data elements is insufficient to fill a US burst so that an integer number of OFDMA slots is occupied once encoded, zero padding shall be inserted at the end.

Alternatively, the horizontal laying of the MAC data elements may fill one subchannel with at least 7 OFDM symbols at a time and continue on the following subchannels. However, when all logical subchannels have been filled, the next MAC data elements shall be placed in the first available logical subchannel in the following burst. The width of the last vertical burst will be between 7 and 13 symbols depending on the total number of symbols in the US subframe.

The long US packet structure, where a logical subchannel is completely filled before moving to the next subchannel, is used to maximize the allowed power per subcarrier for a given CPE EIRP limit, i.e., this horizontal laying reduces the EIRP required by the CPE for its US burst by minimizing the number of subchannels needed. In the US, the shorter burst alternative shown in Figure 13 is used to reduce latency by allowing advance of the US burst in the US subframe to give the BS time to react before the start of the next frame, at the cost of reduced transmit power and efficiency (e.g., video game near real-time versus transmission efficiency).

The format of the FCH MAC burst is described in 7.7.2. The FCH is modulated using the data mode selected (e.g., Mode 4 or 5, see Table 251) in the SCH. Binary convolutional coding (BCC, 9.1.2.1) shall also be applied to the FCH burst. The FCH specifies the burst profile and the length of either the DS-MAP, if transmitted, or the US-MAP. If neither the DS-MAP nor the US-MAP is transmitted, the value shall be set to zero. The DS-MAP message, if transmitted, shall be the first MAC PDU in the burst following the FCH. A US-MAP message, if transmitted, shall immediately follow either the DS-MAP message, if transmitted, or the FCH. If DCD and UCD messages are transmitted in the frame, they shall immediately follow the DS-MAP and US-MAP messages. The symbols containing these broadcast MAC control messages shall be modulated using data mode 5 as described in Table 251 with the mandatory BCC mode (see 9.1.2.1).

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In the US direction, if a CPE does not have any data to transmit in its US allocation, it shall transmit a US PHY burst containing a generic MAC header (see 7.8.1.1) with its basic FT, together with a Bandwidth Request subheader (see 7.8.1.2.1). This would allow the BS to reclaim this CPE's allocation in the following frames and use the resource for some other purpose.

The BS may schedule up to five types of contention windows (see 7.15): the initial ranging window is used for initializing the association; the periodic ranging window is used for regularly adjusting the timing and power at the CPE; the BW request window is for CPEs to request US bandwidth allocation from the BS; the UCS notification window is used by CPEs to report an urgent coexistence situation with incumbents; while the SCW is employed by CBP packets for signaling information to adjacent and overlapping WRAN cells for the purpose of self-coexistence, signaling the device identification for resolving interference situations with incumbents when requested by local regulation, and for carrying out terrestrial geolocation between CPEs of the same WRAN cell. However, CBP burst transmissions for terrestrial geolocation purpose shall have lower priority than any other coexistence transmission on the CBP burst.

The SCW shall be scheduled at the end of the frame as depicted in Figure 13. The CBP packets are transmitted by selected CPEs or the BS, and carry information, among other things, about the IEEE 802.22 cell as a whole, the device that transmits it, as well as information to support the self-coexistence mechanism (see 7.22).

A CBP packet shall be transmitted by each CPE associated to a BS as specified by the parameter "T34" in for periodic identification of its device ID and serial number and the associated BS ID as may be required by local regulations (see Annex A).

Whenever a CPE is neither receiving nor sending data to its BS (idle state), it shall be capable of decoding CBP packets transmitted by nearby CPEs belonging to other WRAN cells, either on the same channel (N), or on adjacent channels (N±1), or on alternate channels (N±2 and beyond). This capability shall also be available at CPE initialization. In addition, BS frame synchronization is based on the absolute local start time of their superframe period to the start of every minute referenced to UTC as specified in 7.25. Hence, multiple co-located or nearby IEEE 802.22 cells can efficiently communicate with each other and align their SCW for CBP exchange as well as their quiet periods for sensing incumbents.

7.5 General frame structure (on PHY-OM2)

The A-WRAN on PHY-OM2 described in Clause 10 shall support the following frame structure.

The A-WRAN on PHY-OM2 includes two operational MAC modes: a normal mode and a self-coexistence mode. In normal MAC mode, one A-WRAN cell occupies one or more channels and operates on all the frames. In self-coexistence MAC mode, multiple A-WRAN cells share the same channel, and each coexisting WRAN cell operates on one or several different frames exclusively.

The A-WRAN on PHY-OM2 shall transmit the Advanced Frame Control Header (A-FCH) (Table 4) at the beginning of every frame on the operating channel in both normal and self-coexistence MAC modes. An A-WRAN runs in normal MAC mode by default and transitions to self-coexistence MAC mode when the A-WRAN can detect and decode an A-FCH or a CBP from an adjacent A-WRAN cell on its operating channel.

7.5.1 General frame structure for normal MAC mode

The A-WRAN frame structure depicted in Figure 12 shall be used and the first frame shall be constituted of the following:

— A PHY frame preamble (Clause 10)
— An Advanced Frame Control header (A-FCH, Table 4)

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— The rest of the first frame including its frame header and data payload

At the beginning of every frame, the A-BS shall transmit the frame preamble and the A-FCH on the operating channel using the modulation/coding specified in 10.2 and Table 286, respectively. In order to associate with an A-BS, a CPE shall receive the A-FCH to establish communication with the A-BS. During each MAC frame, the A-BS shall manage the US and DS operations, which may include ordinary data communication, measurement activities, coexistence procedures, and so on.

7.5.2 General frame structure for self-coexistence MAC mode

The A-WRAN frame structure in self-coexistence MAC mode is shown in Figure 14. The self-coexistence MAC mode is for the scenario when multiple A-BSs with overlapping coverage have to share the same channel. The frequency reuse factor cannot be maintained as one due to the mutual interference of these A-BSs. In this case, the A-BSs shall share the channel on a per-frame basis, i.e., each A-BS is allocated the frames on a non-interference basis. The negotiation process of frame allocation can be found in 7.22.

In self-coexistence MAC mode, the A-BS and CPEs in an A-WRAN cell shall transmit only during the active frames allocated to that A-WRAN cell. They can transmit during other frames only when a self-coexistence window (SCW) has been scheduled. During the frames not allocated to the present cell, the A-BS and CPEs may monitor the channel for any transmission from neighboring A-WRAN cells to improve self-coexistence.

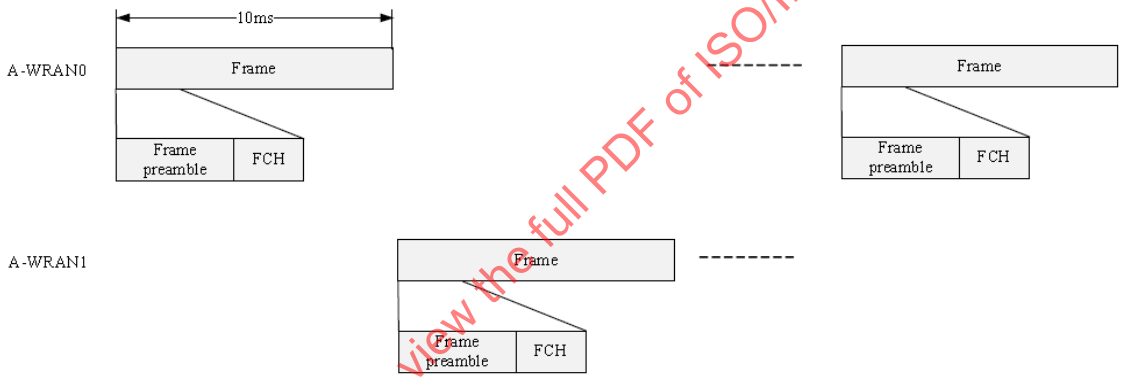

Figure 14—General frame structure on PHY-OM2 for self-coexistence MAC mode

7.5.3 Frame format

The A-WRAN system on PHY-OM2 described in Clause 10 shall support the following frame structure.

The top-down time division duplex (TDD) frame structure employed in the MAC is illustrated in Figure 12.

As illustrated in Figure 15, a frame comprises two parts: a DS subframe and a US subframe. A portion of the US subframe may be allocated as a window to facilitate self-coexistence. This SCW may be scheduled by the A-BS at the end of the US subframe when necessary to allow transmission of opportunistic coexistence beacon protocol bursts. The SCW includes the necessary time buffers to absorb the difference in propagation delay between nearby and distant A-BSs and CPEs operating on the same channel. The boundary between the DS and US subframes shall be adaptive to adjust to the DS and US relative capacity. The US subframe may contain scheduled US PHY PDUs, each transmitted from different CPEs for their US traffic. It may also include contention intervals scheduled for the following:

— CPE association (initial ranging)
— CPE link synchronization, power control, and geolocation (periodic ranging)
— Bandwidth request

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— Urgent coexistence situation (UCS) notification

— Quiet period (QP) resource adjustment

The definitions of the fields/messages are given in 7.8 and 7.9.

The PHY PDUs may be transmitted across several subchannels as shown in Figure 15, which depicts how a frame may be transmitted (in time and frequency) by the PHY.

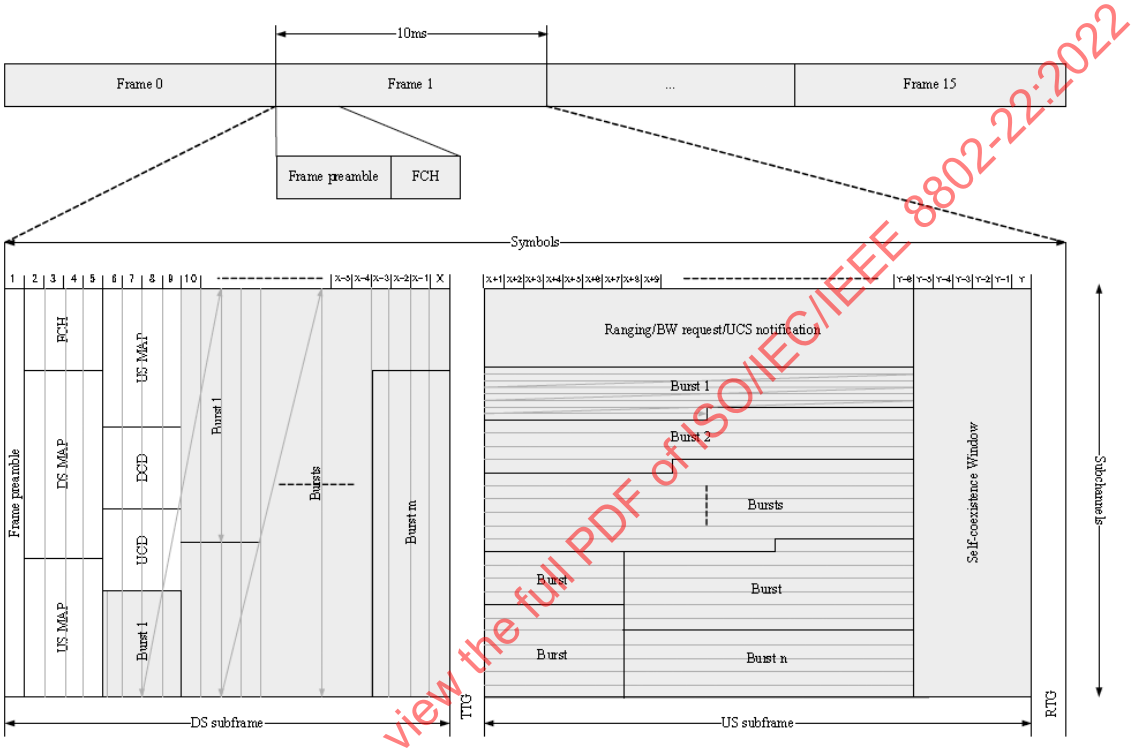

Figure 15—Example of a time/frequency structure of a MAC frame for PHY-OM2

Figure 15 shows an example of the two-dimensional (2D) (time/frequency) structure of the MAC frame that shall consist of an integer number of fixed-size OFDM slots. Each slot shall consist of 4 OFDM symbols by one subchannel (i.e., 1 OFDM slot for DS = 4 symbols × 1 subchannel) for DS and shall consist of 7 OFDM symbols by subchannel (i.e., 1 OFDM slot for US = 7 symbols × 1 subchannel) for US (10.1.3.1). A subchannel consists of 16 subcarriers. In Figure 15, the MAC packets are assumed to be structured in a linear TDM manner (see Figure 12), and the PHY packets are arranged in a 2D time/frequency domain (symbol in the horizontal direction, logical subchannels in the vertical direction). For the A-FCH, DS/US-MAP, DCD, UCD, and DS payload, the MAC information is first laid vertically by subchannels and then stepped horizontally in the time direction. This vertical layering allows early scheduling of DS bursts assigned to distant CPEs to compensate for propagation delays and to avoid potential interference at the CPE if overlapping A-WRAN cells with different DS/US capacity split.

The MAC data elements, starting from the A-FCH and including the first broadcast burst, shall be entered into the portion between the second OFDM symbol and fifth OFDM symbol, which is based on the number of symbols defined in a tile (10.1.3.1), as shown in Figure 15, in the increasing order of logical subchannels until all logical subchannels are occupied. Then, the subsequent data elements, if they have not all been mapped, shall be placed in the same order on the following OFDM symbols. The balance of the last OFDM symbols shall be padded with zeros. The modulation and coding schemes for the padding zeros

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are defined by the DIUC for the last DS burst in the DS-MAP. Note that the DS-MAP indicates the length of the contiguous DS MAC elements, not their absolute position in the DS subframe.

The MAC data elements that are contained in US bursts shall be mapped to the US subframe in a different order as shown in Figure 15. They are first mapped horizontally, 7 OFDM symbols by 7 OFDM symbols, in the same logical subchannel. Once a logical subchannel has been filled to the end of the US subframe, the balance of the MAC data elements shall be mapped to the next logical subchannel, in an increasing subchannel order. This process continues until all of the subchannels and symbols allocated to the burst are filled. If the quantity of MAC data elements is insufficient to fill a US burst so that an integer number of OFDMA slots is occupied once encoded, zero padding shall be inserted at the end.

Alternatively, the horizontal laying of the MAC data elements may fill one subchannel with at least 7 OFDM symbols at a time and continue on the following subchannels. However, when all logical subchannels have been filled, the next MAC data elements shall be placed in the first available logical subchannel in the following burst. The width of the last vertical burst will be between 7 and 13 symbols depending on the total number of symbols in the US subframe.

The long US packet structure, where a logical subchannel is completely filled before moving to the next subchannel, is used to maximize the allowed power per subcarrier for a given CPE EIRP limit, i.e., this horizontal laying reduces the EIRP required by the CPE for its US burst by minimizing the number of subchannels needed. In the US, the shorter burst alternative shown in Figure 15 is used to reduce latency by allowing advance of the US burst in the US subframe to give the BS time to react before the start of the next frame, at the cost of reduced transmit power and efficiency (e.g., video game near real-time versus transmission efficiency).

The format of the A-FCH MAC burst is described in Table 3. The A-FCH is modulated using the data mode and the SPC level selected (e.g., Mode 2) (Table 288). Binary convolutional coding [BCC; BCC mode (mandatory)] shall also be applied to the A-FCH burst. The A-FCH specifies the length of the frame in OFDM symbols and the length of either the DS-MAP, if transmitted, or the US-MAP. If neither the DS-MAP nor the US-MAP is transmitted, this length shall be set to zero. The DS-MAP message, if transmitted, shall be the first MAC PDU in the burst following the A-FCH since it defines the length and the transmission format of the following MAC PDUs. If a DS-MAP message is not transmitted, the US-MAP message, shall follow the A-FCH. If the DCD message is transmitted in the frame, it shall follow the DS-MAP. If the DS-MAP is transmitted, the US-MAP message and the UCD message, if transmitted, should be placed sufficiently early in the DS burst to leave the time for the distant CPEs to receive the relevant information in time for their upcoming US transmission. The first messages following the A-FCH shall be modulated using data mode 2 as described in Table 288 with the mandatory BCC mode (see 10.7.2.1). These broadcast MAC control messages can be transmitted in more than one MAC PDU in the DS burst as long as they precede the MAC PDUs for which they contain transmission format information.

In the US direction, if a CPE does not have any data to transmit in its US allocation, it shall transmit a US PHY burst containing a generic MAC header (see 7.8.1.1) with its basic FT, together with a Bandwidth Request subheader (see 7.8.1.2.1). This would allow the A-BS to reclaim this CPE's allocation in the following frames and use the resource for some other purpose.

The A-BS may schedule up to five types of contention windows (see 7.15):

— The Initial Ranging window is used for initializing the association.
— The periodic ranging window is used for regularly adjusting the timing and power at the CPE.
— The BW request window is used by CPEs to request US bandwidth allocation from the A-BS.
— The UCS notification window is used by CPEs to report a UCS with incumbents.
— The SCW is employed by CBP packets for signaling information to adjacent and overlapping A-WRAN cells for self-coexistence, signaling the device identification for resolving interference

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situations with incumbents when requested by local regulation, and carrying out terrestrial geolocation between CPEs of the same A-WRAN cell.

However, CBP burst transmissions for terrestrial geolocation shall have lower priority than any other coexistence transmission on the CBP burst.

The SCW shall be scheduled at the end of the frame as depicted in Figure 15. The CBP packets (see 10.5) are transmitted by selected CPEs or the A-BS and carry information, among other things, about the A-WRAN cell as a whole and the device that transmits it as well as information to support the self-coexistence mechanism (see 7.22).

A CBP packet shall be transmitted by each CPE associated to an A-BS as specified by the parameter "T34" in Table 272 for periodic identification of its device ID and serial number and the associated BS ID as may be required by local regulations (see Annex A).

Whenever a CPE is neither receiving nor sending data to its A-BS (idle state), it shall be capable of decoding CBP packets transmitted by nearby CPEs belonging to other A-WRAN cells, on the same channel (N), or on adjacent channels (N±1), or on alternate channels (N±2 and beyond). This capability shall also be available at CPE initialization. In addition, A-BS frame synchronization is based on the absolute local start time of their frame period to the start of every minute referenced to UTC as specified in 7.25. Hence, multiple co-located or nearby A-BS cells can efficiently communicate with each other and align their SCW for CBP exchange as well as their quiet periods for sensing incumbents.

7.6 General frame structure for a relay network

The A-WRAN system on PHY-OM2 shall support the following frame structure for relay.

A frame structure has two different modes for relay: a centralized scheduling mode and a distributed scheduling mode.

For centralized scheduling mode, a centralized scheduling R-CPE relays frames including control frames or data frames received from (to) the A-BS to (from) the A-CPE, which will enhance connection reliability between the A-BS and A-CPEs. Moreover, a centralized scheduling R-CPE may relay network management information received from an A-BS such as the preamble, A-FCH, MAPs, etc., to A-CPEs to assist the network management of the A-BS

For distributed scheduling mode, a distributed scheduling R-CPE configures a local cell containing more than one A-CPE within an A-WRAN cell and manages the A-CPEs locally by producing and transmitting network management information (such as a local frame preamble, distributed relay zone (DRZ)-FCH (7.7.4), MAPs, etc., which allows for reducing the network management overhead of the A-BS as well as could extend the service coverage of A-WRAN.

7.6.1 General frame structure for a centralized scheduling mode

Each of the DS and US subframes for a centralized scheduling mode may include two zones: access zone (AZ) and centralized relay zone (CRZ) as shown in Figure 16**.** Each AZ in the DS and US subframes is used for transmission between an A-BS and CPEs (i.e., centralized scheduling R-CPEs or A-CPEs), and each CRZ in the DS and US subframes is used for transmission between a centralized scheduling R-CPE and A-CPEs.

For centralized scheduling mode, both the AZs and CRZs in the DS and US subframes are managed by an A-BS. The AZ of the DS subframe shall appear earlier than other zones of the AZ of the US subframe or the CRZs of the DS and US subframes. Except for the AZ of the DS, the order of the AZ of the US subframe,

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the CRZ of the DS subframe, and the CRZ of the US subframe in the frame may be changed during the operations.

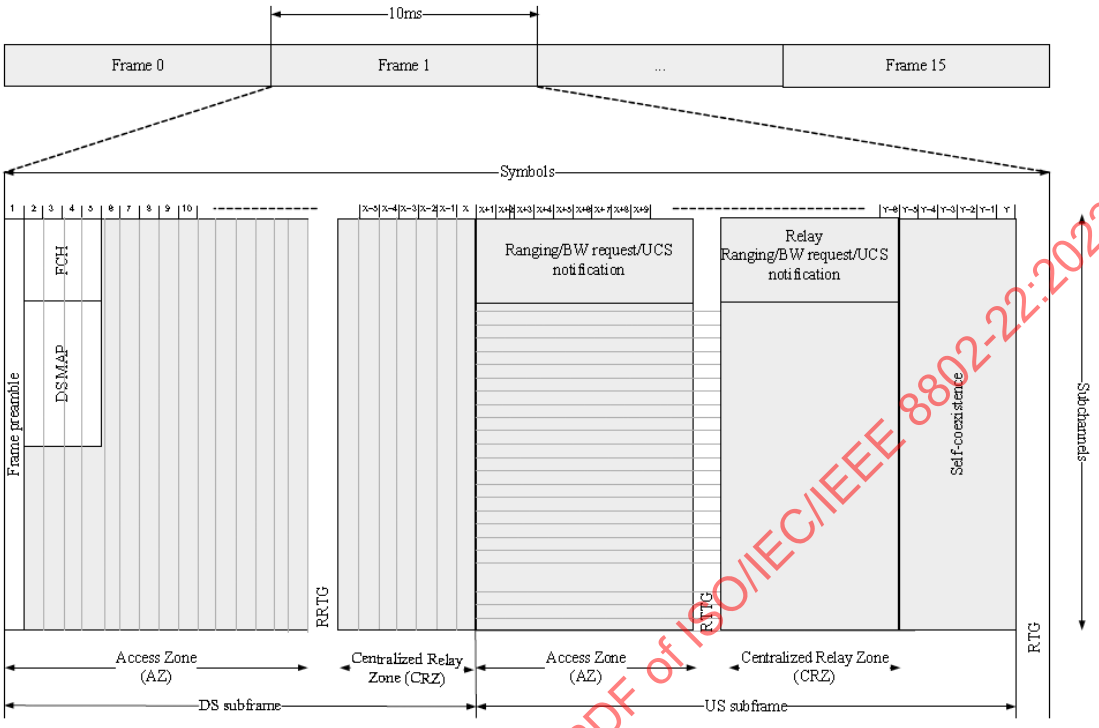

Figure 16—Example of a time/frequency structure of a MAC frame for a centralized scheduling mode on PHY-OM2

7.6.2 General frame structure for a distributed scheduling mode

Each of the DS and US subframes for a distributed scheduling mode may include two zones: access zone (AZ) and distributed relay zone (DRZ) as shown in Figure 17. Each AZ in the DS and US subframes is used for transmission between an A-BS and CPEs (i.e., distributed scheduling R-CPEs or A-CPEs), and each DRZ in the DS and US subframe is used for transmission between a distributed scheduling R-CPE and A-CPEs.

Both the AZs and DRZs in the DS and US subframes are scheduled by an A-BS. For distributed scheduling mode, the AZs in the DS and US subframes are managed by an A-BS, and the DRZs in the DS and US subframes are controlled by a distributed scheduling A-CPE, which is capable of configuring and maintaining a local cell within an A-WRAN cell. The AZ of the DS subframe shall appear earlier than other zones of the AZ of the US subframe or the DRZs of the DS and US subframes. Except for the AZ of the DS, the order of the AZ of the US subframe, the DRZ of the DS subframe, and the DRZ of the US subframe in the frame may be changed during the operations.

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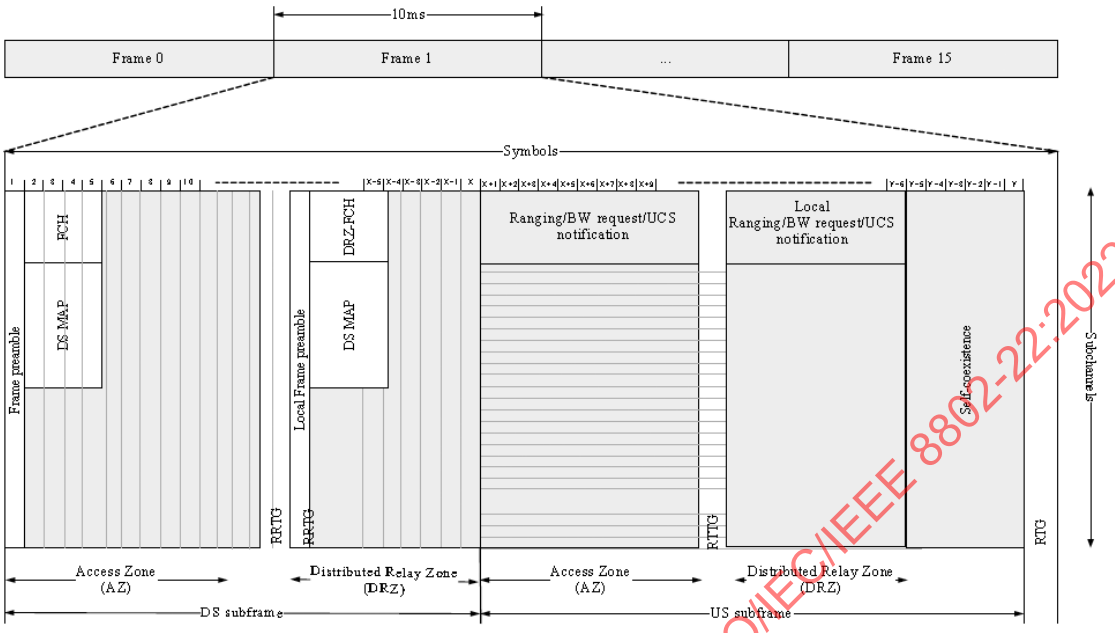

Figure 17—Example of a time/frequency structure of a MAC frame for a distributed scheduling mode on PHY-OM2

For the A-WRAN on PHY-OM2, the subchannels of the DRZs in the DS and US subframes can be grouped by up to three segments with the fixed number of subchannels as shown in Figure 18. The segment bandwidth is scalable up to the occupied subchannel as shown in Figure 19. For the DS of PHY-OM2, the number of tiles per occupied channel bandwidth is not divided by 3. Thus segments 0, 1, and 2 have a different number of tiles, i.e., 72, 68, and 68 tiles, respectively. For the US of PHY-OM2, the number of tiles per segment all equal 70. Figure 19 and Figure 20 show all the combinations of three segment bandwidths and three start positions. As shown in Figure 20, the number of segment bandwidth modes is 3, 2, and 1 for the first, second, and third start positions, respectively. The configuration of the segmentation scheme can be identified by local frame preamble as defined in 10.4.1.1. The segmentation can be scheduled by the A-BS, and each segment is assigned to the different distributed scheduling R-CPEs. This segmentation is used to increase network capacity.

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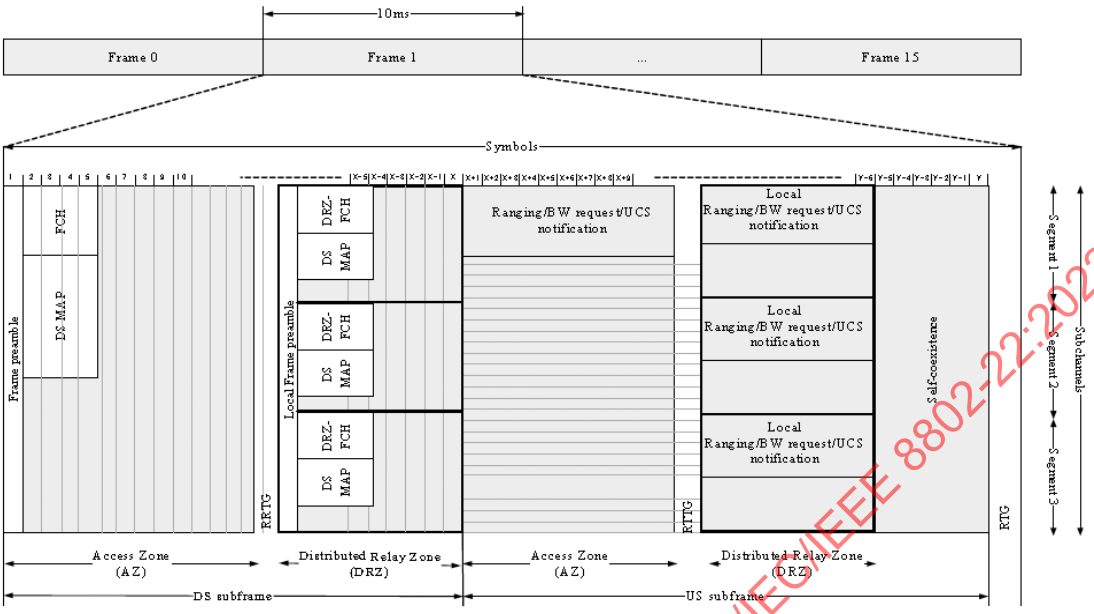

Figure 18—Example of a time/frequency structure of a MAC frame for a distributed scheduling mode on segmentation on PHY-OM2

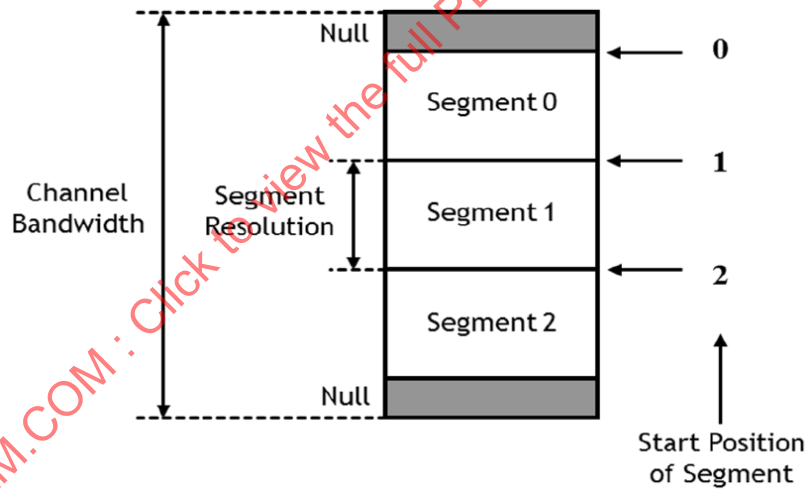

Figure 19—Segment structure

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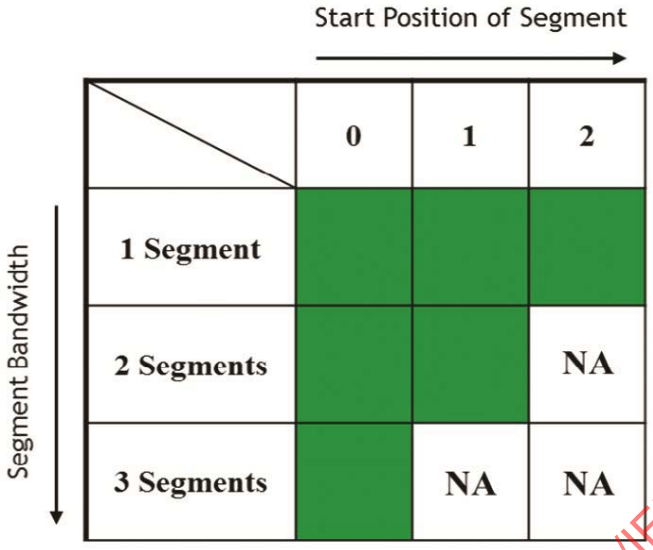

Figure 20—Combination of segment start position and segment bandwidth

7.6.3 Detail of zones

7.6.3.1 Access zone (AZ)

At the beginning of every frame in AZ on PHY-OM2, the A-BS shall transmit the frame preamble and the A-FCH on the operating channel using the modulation/coding specified in 10.1 and Table 288, respectively. In order to associate with an A-BS, a CPE shall receive the A-FCH to establish communication with the A-BS.

An AZ in the US subframe may contain scheduled US PHY PDUs, each transmitted from different CPEs for their US traffic. It may also include contention intervals scheduled for the following:

— CPE association (initial ranging)
— CPE link synchronization, power control, and geolocation (periodic ranging)
— Bandwidth request
— UCS notification
— Quiet period resource adjustment

The 2D (time/frequency) structure of the MAC frame shall consist of an integer number of fixed-size OFDM slots. For PHY-OM2, each slot shall consist of 4 OFDM symbols by one subchannel (i.e., 1 OFDM slot for DS = 4 symbols × 1 subchannel) for DS and shall consist of 7 OFDM symbols by subchannel (i.e., 1 OFDM slot for US = 7 symbols × subchannel) for US (10.1.3.1). For the A-FCH, DS/US-MAP, DCD, UCD, and DS payload in an AZ, the MAC information is first laid vertically by subchannels and then stepped horizontally in the time direction. This vertical layering allows early scheduling of DS bursts assigned to distant CPEs to compensate for propagation delays and to avoid potential interference at the CPE if overlapping A-WRAN cells with different DS/US capacity split.

In an AZ, the MAC data elements, starting from the A-FCH and including the first broadcast burst, shall be mapped to the DS subframe in the manner described in 7.5.3 for PHY-OM2.

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In an AZ, the MAC data elements that are contained in US bursts shall be mapped to the US subframe in the manner described in 7.5.3 for PHY-OM2.

7.6.3.2 Centralized relay zone (CRZ)

During a CRZ in the DS subframe, the centralized scheduling R-CPE transmits the MAC frames, which may be transferred from the A-BS during an AZ in the DS subframe, to the A-CPE on the scheduled slots determined by the A-BS.

A CRZ in the US subframe may contain scheduled US PHY PDUs, each transmitted from different A-CPEs for their US traffic, which forwards the centralized scheduling R-CPE. It may also include contention intervals scheduled for the following:

— CPE relay association (7.17.2.4.2)
— CPE link synchronization, relay power control, and geolocation (7.17.2.6.2)
— Relay bandwidth request
— Relay UCS notification
— Quiet period resource adjustment

The 2D (time/frequency) structure of the MAC frame in a CRZ is the same manner as that in an AZ (7.6.3.1).

If a CRZ appeared in the DS subframe, the CRZ shall be followed by the DS AZ in the MAC frame. The MAC data bursts in the CRZ shall be entered into the first subchannel within the portion, calculated by CRZ Start Offset and Length in CRZDS-MAP IE (0), in the increasing order of logical subchannels until all logical subchannels are occupied in the portion. Then, the subsequent data elements, if they have not all been mapped, shall be placed in the same order on the following OFDM symbols. The balance of the last OFDM symbols within the portion shall be padded with zeros. The modulation and coding schemes for the padding zeros are defined by the DIUC for the last DS burst in CRZDS-MAP IE.

If a CRZ appeared in the US subframe, the MAC data elements that are contained in relay US bursts shall be mapped to the CRZ in the US subframe in the same manner as US subframe mapping in AZ (7.6.3.1).

The A-BS may schedule up to four types of contention windows (see 7.15) in the CRZ:

— The relay initial ranging window is used for initializing the relay association.
— The relay periodic ranging window is used for regularly adjusting the timing and power at the CPE.
— The relay BW request window is used by CPEs to request relay US bandwidth allocation from the A-BS.
— The relay UCS notification window is used by CPEs to report a UCS with incumbents.

7.6.3.3 Distributed relay zone (DRZ)

For local cell operations within an A-WRAN, the A-BS will schedule a DRZ for a distributed scheduling R-CPE, which is capable of managing a local cell. During a DRZ, the distributed scheduling R-CPE shall transmit the local frame preamble (see 10.4.1.1) and the DRZ-FCH (see 7.7.4) on the operating channel using the modulation/coding and data rates (see 10.2) and Table 288 for PHY-OM2. In order to associate with the distributed scheduling R-CPE, an A-CPE shall receive the DRZ-FCH to establish communication with the distributed scheduling R-CPE. During each DRZ in the DS and US subframes, the distributed scheduling R-CPE shall manage the US and DS operations within its local cell, which may include ordinary data communication, measurement activities, coexistence procedures, and so on.

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A DRZ in the US subframe may contain scheduled US PHY PDUs, each transmitted from different A-CPEs for their US traffic to the distributed scheduling R-CPE. It may also include contention intervals scheduled for the following:

- CPE local association (7.17.2.4.1)
- CPE local link synchronization, power control, and geolocation (7.17.2.6.1)
- Local bandwidth request
- Local UCS notification
- Quiet period resource adjustment

The 2D (time/frequency) structure of the MAC frame in a DRZ is the same manner as that in an AZ (7.6.3.1).

If a DRZ appeared in the DS subframe, the DRZ shall be followed by the DS AZ in the MAC frame. The MAC data elements that are contained in DS bursts shall be mapped to the DRZ in the DS subframe in the same manner as the AZ in DS subframe mapping.

If a DRZ appeared in the US subframe, the MAC data elements that are contained in US bursts shall be mapped to the DRZ in the US subframe in the same manner as the AZ in US subframe mapping (7.6.3.1).

The format of the DRZ-FCH MAC burst is described in 7.7.4. The DRZ-FCH is modulated using the data mode selected. BCC (10.7.2.1 for PHY-OM2) shall also be applied to the DRZ-FCH burst. The DRZ-FCH specifies the burst profile and the length of either the DS-MAP, if transmitted, or the US-MAP. If neither the DS-MAP nor the US-MAP is transmitted, the value shall be set to zero. The DS-MAP message, if transmitted, shall be the first MAC PDU in the burst following the DRZ-FCH. A US-MAP message, if transmitted, shall immediately follow either the DS-MAP message, if transmitted, or the DRZ-FCH. If DCD and UCD messages are transmitted in the frame, they shall immediately follow the DS-MAP and US-MAP messages. The symbols containing these broadcast MAC control messages shall be modulated using data mode 3 as described in Table 288 for PHY-OM2 with the mandatory BCC mode (see 9.7.2.1).

The distributed scheduling R-CPE may schedule up to four types of contention windows (see 7.15):

- The local Initial Ranging window is used for initializing the association.
- The local periodic ranging window is used for regularly adjusting the timing and power at the CPE.
- The local BW request window is used by CPEs to request local US bandwidth allocation from the distributed scheduling R-CPE.
- The local UCS notification window is used by CPEs to report a UCS with incumbents.

7.6.3.4 Application of PHY Operation Mode to Zone Type

When the A-BS is operating in PHY-OM2, the DS AZ and DS CRZ shall be operated by PHY-OM2. R-CPEs shall use PHY-OM2 to communicate with the A-BS in the DS AZ and DS CRZ.

The R-CPEs operating in the DS DRZ, shall operate in PHY-OM2.

The A-BS may switch between PHY operation modes. If the A-BS switches to PHY-OM1, all A-CPEs shall have to reacquire the A-BS as a WRAN cell on PHY-OM1, and all R-CPEs shall be deregistered. Switching from PHY-OM2 to PHY-OM1 PHY Operational mode shall be done only on a frame-by-frame basis. Switching from PHY-OM1 to PHY-OM2, the A-BS and R-CPE indicate the PHY Operational mode by selecting one of several different local frame preamble types (10.4.1.1). When the A-WRAN cell switches back to PHY-OM2, the R-CPEs that were previously de-registered may be brought back on-line to re-establish the relay network.

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The corresponding US portion of a zone shall use the same PHY Operational mode as the DS portion of the zone.

When a A-BS is operating is operating in PHY-OM1, WRAN CPEs shall operate by connecting to the A-BS directly (without relays). If A-BS switches back to PHY-OM2, WRAN CPEs shall have to reacquire a new WRAN cell. To support WRAN CPEs, which can process only the Frame Preamble defined in 9.4.1, the A-BS shall transmit only the Frame Preamble defined in 9.4.1 in the AZ.

7.7 Control headers

As can be seen in Figure 10 and Figure 12, in the WRAN there are two mandatory control headers that provide essential information about the superframe (SCH) and the frame (FCH). The A-WRAN control headers that provide essential information exist on the frame (A-FCH/Ex-FCH) and distributed relay zone boundaries (DRZ-FCH). The content and intent of each of these control headers is described in the following subclauses.

7.7.1 Superframe Control header

The SCH specification is shown in Table 1. Since the SCH decoding is critical, the SCH shall be transmitted using the modulation described in 9.7.2.4. The SCH provides information about the IEEE 802.22 cell, in order to protect incumbents, support self-coexistence mechanisms, and support the intra-frame and inter-frame mechanisms for management of quiet periods for sensing as described in 7.23.1.

Transmission of a SCH indicates that the WRAN cell is operating in one of the two possible MAC Operational modes: normal mode or self-coexistence mode. These are described in 7.3.

All bits indicated as *Reserved* in tables throughout this standard shall be transmitted as zeros unless otherwise explicitly specified.

Table 1—Superframe Control header format

Syntax	Size	Notes
Superframe_Control_Header_Format() {		One OFDM symbol long and transmitted with modulation/coding described in 9.4.2.1
BS_ID	48 bits	MAC address that uniquely identifies the BS transmitting the SCH.
Frame Allocation Map	16 bits	Indicates which frames in the present superframe are allocated to the BS transmitting the SCH.
Superframe Number	8 bits	Positive integer that represents the superframe number (modulo 256). This field shall be incremented by 1 upon every new superframe.
CP	2 bits	Cyclic Prefix Factor Specifies the size of the cyclic prefix used by the PHY in the frame transmissions in this superframe (see 9.1.1.1). Predetermined values are 00: 1/4 T_{FFT} 01: 1/8 T_{FFT} 10: 1/16 T_{FFT} 11: 1/32 T_{FFT}
FCH Encoding Flag	1 bit	0: FCH packet encoded with PHY MCS mode 5 (See Table 252) 1: FCH packet encoded with PHY MCS mode 4

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Table 1—Superframe Control header format *(continued)*

Syntax	Size	Notes
Self-coexistence Capability Indicator	2 bits	00: no self-coexistence capability supported 01: only Spectrum Etiquette 10: Spectrum Etiquette and Frame Contention 11: *Reserved*
MAC version	8 bits	IEEE 802.22 MAC version to which the message originator conforms. 0x00: *Reserved* 0x01: IEEE 802.22 WRAN MAC on PHY-OM1 0x02-0x1F*: Reserved for future IEEE 802.22 WRAN MACs using PHY-OM1* 0x20-0x3F: IEEE 802.22 A-WRAN MACs on PHY-OM2 0x40–0xFF: *Reserved*
Current Intra-frame Quiet Period Cycle Length	8 bits	Specified in number of superframes, it indicates the spacing between the superframes for which the intra-frame quiet period specification is valid. For example, if this field is set to 1, the Quiet Period Cycle repeats every superframe; if it is set to 2, the Quiet Period Cycle repeats every 2 superframes, etc. If this field is set to 0, no intra-frame quiet period is scheduled or the current intra-frame quiet period is canceled.
Current Intra-frame Quiet Period Cycle Offset	8 bits	Valid only if Current Intra-frame Quiet period Cycle Length > 0. Specified in number of superframes, it indicates the offset from this SCH transmission to the beginning of the first superframe in the Current Intra-frame Quiet period Cycle Length.
Current Intra-frame Quiet period Cycle Frame Bitmap	16 bits	Valid only if Current Intra-frame Quiet Period Cycle Length > 0. Valid for each superframe identified by the Current Intra-frame Quiet Period Cycle Length, each bit in the bitmap corresponds to one frame within the superframe. If the bit is set to 0, no intra-frame quiet period shall be scheduled in the corresponding frame. If the bit is set to 1, an intra-frame quiet period shall be scheduled within the corresponding frame for the duration specified by the Current Intra-frame Quiet period Duration.
Current Intra-frame Quiet Period Duration	8 bits	Valid only if Current Intra-frame Quiet Period Cycle Length > 0. If this field is set to a value different from 0 (zero), it indicates the number of symbols starting from the end of the frame during which no transmission shall take place.
Claimed Intra-frame Quiet Period Cycle Length	8 bits	Specified in number of superframes, it indicates the spacing between the superframes for which the intra-frame quiet period specification claimed by a BS would be valid. For example, if this field is set to 1, the Quiet Period Cycle would repeat every superframe; if it is set to 2, the Quiet Period Cycle would repeat every 2 superframes, etc. If this field is set to 0, no intra-frame quiet period is claimed by the BS.
Claimed Intra-frame Quiet Period Cycle Offset	8 bits	Valid only if Claimed Intra-frame Quiet Period Cycle Length > 0. Specified in number of superframes, it indicates the offset from this SCH transmission to the time where the Claimed Quiet Period Cycle resulting from the inter-BS negotiation (see 7.23.2) shall become the Current Intra-frame Quiet Period Cycle.
Claimed Intra-frame Quiet period Cycle Frame Bitmap	16 bits	Valid only if Claimed Intra-frame Quiet Period Cycle Length > 0. Valid for each superframes identified by the Claimed Intra-frame Quiet Period Cycle Length, each bit in the bitmap corresponds to one frame within each specified superframe. If the bit is set to 0, no intra-frame quiet period will be scheduled in the corresponding frame. If the bit is set to 1, an intra-frame quiet period will be scheduled within the corresponding frame for the duration specified by Claimed Intra-frame Quiet period Duration.

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Table 1—Superframe Control header format *(continued)*

Syntax	Size	Notes
Claimed Intra-frame Quiet Period Duration	8 bits	Valid only if Claimed Intra-frame Quiet Period Cycle Length > 0. If this field is set to a value different from 0 (zero): it indicates the number of symbols starting from the end of the frame during which no transmission will take place.
Synchronization Counter for Intra-frame Quiet Period Rate	8 bits	Valid only if Claimed Intra-frame Quiet Period Cycle Length > 0. This field is used for the purpose of synchronizing the Claimed Intra-frame Quiet Period rate among overlapping BSs in order to allow dynamic reduction of the Intra-frame Quiet Period rate. This Quiet Period rate is defined as the number of frames with quiet periods identified by the Cycle Frame Bitmap in the superframes designated by the Cycle Length, divided by this Quiet Period Cycle Length (see 7.23.2).
Synchronization Counter for Intra-frame Quiet Period Duration	8 bits	Valid only if Claimed Intra-frame Quiet Period Duration > 0. This field is used for the purpose of synchronizing the Claimed Intra-frame Quiet Period Durations among overlapping BSs in order to allow dynamic reduction of the Intra-frame Quiet Period Duration (see 7.23.2).
Inter-frame Quiet Period Duration	4 bits	Duration of Quiet Period It indicates the duration of the next scheduled quiet period in number of frames. If this field is set to a value different from 0 (zero), it indicates the number of frames that shall be used to perform in-band inter-frame sensing. If this field is set to 0, no inter-frame quiet period is scheduled or the current inter-frame quiet period is canceled.
Inter-frame Quiet Period Offset	12 bits	Time to Quiet Period It indicates the time span between the transmission of this information and the next scheduled quiet period for in-band inter-frame sensing. The 8 left most bits (MSB) indicate the superframe number and the 4 right most bits (LSB) indicate the frame number when the next scheduled quiet period for inter-frame sensing shall start.
SCW Cycle Length	8 bits	Specified in number of superframes. If this field is set to 0, then no SCW cycle is scheduled. This field has to be 1 or larger to be effective. To limit the number of possibilities, the field shall be one of five following choices {1, 2, 4, 8, 16}. For example, if this field is set to 1, SCW Cycle repeats every superframe, if it is set to 2, SCW Cycle repeats every 2 superframes, etc.
SCW Cycle Offset	8 bits	Specified in number of superframes, it indicates the offset from this SCH transmission to the superframe where the SCW cycle starts, or repeats (i.e., the superframe contains SCWs and is specified by the SCW Cycle Frame Bitmap). For example, if this field is set to 0, the SCW cycle starts from the current superframe. The value of the field shall be less than SCW Cycle length unless initial countdown. For initial countdown, this field can equal or be larger than SCW Cycle Length. Larger initial countdown gives neighboring WRANs longer time to discover and avoid any potential SCW reservation collision.

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Table 1—Superframe Control header format *(continued)*

Syntax	Size	Notes
SCW Cycle Frame Bitmap	32 bits	Valid for a unit of superframe, each 2-bit in the bitmap corresponds to one frame within the superframe. If the 2-bit is set to 00, this means that there is no SCW scheduled for this frame. If the 2-bit is set to 11, a reservation-based SCW (reserved by the current WRAN) is scheduled in the corresponding frame. If the 2-bit is set to 10, a reservation-based SCW has been scheduled by a direct-neighbor WRAN cell in the corresponding frame and needs to be avoided by other WRAN cells receiving this SCH. If the 2-bit is set to 01, a contention-based SCW (that could be shared with other WRANs) is scheduled by the current WRAN cell in the corresponding frame. The number of reservation-based SCWs cannot exceed 2 per WRAN cell per SCW Cycle. At least one contention-based SCW shall be scheduled in one SCW Cycle (code 01). The BSs shall start scheduling their contention-based SCWs from the last frame of the superframe, going backward for multiple contention-based SCWs. This bitmap applies only to the superframes scheduled by the SCW Cycle. See NOTE.
Current DS/US Split	6 bits	Effective start time (in OFDM symbols from the start of the frame including all preambles) of the first symbol of the US allocation when a BS-to-BS interference situation has been identified by direct reception of this parameter by a BS from a SCH or a CBP burst transmitted by another BS. The Allocation Start Time as provided in the US-MAP (see Table 45) shall be equal to this value if BS-to-BS interference has been identified. This value shall be set to zero if no BS-to-BS interference has been identified (i.e., BS has not received this parameter from another BS). In this case, the Allocation Start Time in the US-MAP (see Table 45) can be defined independently on a frame-by-frame basis by the respective BSs based on their traffic requirement.
Claimed US/DS Split	6 bits	Specified by each BS in the case of BS-to-BS interference (i.e., when SCH and/or CBP burst can be received by a BS directly from another BS) indicating the required DS/US split based in the traffic requirement of the transmitting BS and the negotiation process between the BSs (see 7.22.3). This value shall be set to zero if no BS-to-BS interference has been identified.
DS/US Change Offset	12 bits	It indicates the time span between the transmission of this information and the next scheduled change of the DS/US split where the “Claimed DS/US split” value will become the “Current DS/US split” value. The 8 left most bits (MSB) indicate the superframe number and the 4 right most bits (LSB) indicate the frame number when the next DS/US split change shall take place. The value of this parameter is determined by the negotiation process between concerned BSs (see 7.22.3). This value shall be set to zero if no BS-to-BS interference has been identified.
Incumbent detection reporting inhibit timer	32 bits	In the case where the BS is informed by the database service that it can continue operating on the current channel even though its CPEs are repetitively reporting an incumbent detection situation (i.e., on N or N±1), the BS can use this parameter to inhibit such reporting by the CPEs for a specified period of time. This will avoid the CPEs flooding the US subframe with unnecessary incumbent detection reports. Bit 0–4: Signal type (see Table 319) Bit 5–31: Inhibit Period (number of frames)
HCS	8 bits	Header Check Sequence See Table 6.

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Table 1—Superframe Control header format *(continued)*

Syntax	Size	Notes
Padding bits	51 bits	Padding bits to fill the rest of the 360 bits of the SCH symbol. All bits shall be set to 0.
}		
NOTE—Quiet period scheduling should be done prior to the SCW scheduling so that SCWs avoid frames already reserved for QP. If SCW conflicts with QP, QP overrides the SCW.		

7.7.2 Frame Control header

The format of the FCH for PHY-OM1shown in Table 2. Since FCH decoding is critical, the FCH shall be encoded using either the modulation specified by the PHY MCS mode 4 or PHY MCS mode 5 as described in as signaled in the SCH in Table 1. The FCH contains the length of either the DS-MAP or US-MAP that immediately follows the FCH for which PHY MCS mode 4 shall be used (note that Length = 0 indicates the absence of any burst in the frame). In the case where the DS-MAP is specified, the US-MAP length information shall be contained in the first DS-MAP information element. In the case where the US-MAP length is indicated in the FCH, there shall be no DS burst in the current frame. DCD and UCD messages, if present, are carried by the next DS bursts specified by the DS-MAP. Location and profile of the data bursts are specified in the rest of the DS-MAP and US-MAP management messages. A HCS field occupies the last byte of the FCH.L

Table 2—Frame control header format

Syntax	Size	Notes
Frame_Control_Header_Format() {		
Length of the frame	6 bits	Indicates the length of the frame in number of OFDM symbols from the start of the frame including all preambles.
Length of the MAP message	10 bits	This field specifies the length of the MAP information element following the FCH in OFDM slots. A length of 0 (zero) indicates the absence of any burst in the frame.
HCS	8 bits	Header Check Sequence See Table 6.
}		

7.7.3 Advanced Frame control header for PHY-OM2

7.7.3.1 General

The format of the A-FCH for PHY-OM2 is shown in Table 3. Since A-FCH decoding is critical, the A-FCH shall be encoded using the modulation specified by the PHY-OM2 as described in Table 286. The A-FCH contains the length of either the DS-MAP or US-MAP that immediately follows the A-FCH (note that Length = 0 indicates the absence of any burst in the frame). When the DS-MAP is specified, the US-MAP length information shall be contained in the first DS-MAP information element. When the US-MAP length is indicated in the A-FCH, there shall be no DS burst in the current frame. DCD and UCD messages, if present, are carried by the next DS bursts specified by the DS-MAP. Location and profile of the data bursts

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are specified in the rest of the DS-MAP and US-MAP management messages. A HCS field occupies the last byte of the A-FCH.

Table 3—Advanced Frame control header format for PHY-OM2

Syntax	Size	Note
Advanced Frame_Control_Header_Format () {		
A-BS ID	48 bits	MAC address that uniquely identifies the BS transmitting the A-FCH.
Length of the frame	6 bits	Indicates the length of the frame in number of OFDM symbols from the start of the frame including all preambles.
Length of the MAP message	10 bits	Specifies the length of the MAP information element following the A-FCH in OFDM slots. A length of 0 (zero) indicates the absence of any burst in the frame.
Frame Number	8 bits	Positive integer that represents the frame number (modulo 256). This field shall be incremented by 1.
CP	2 bits	Cyclic Prefix Factor Specifies the size of the cyclic prefix used by the PHY in the frame transmissions in this frame. Predetermined values are as follows: 00: 1/4 T_{FFT} 01: 1/8 T_{FFT} 10: 1/16 T_{FFT} 11: 1/32 T_{FFT}
Self-coexistence Capability Indicator	4 bits	0000: no self-coexistence capability supported 0001: only Spectrum Etiquette 0010: Spectrum Etiquette and Frame Contention 0011–1111: *Reserved*
Extended FCH	2 bits	00: No Extended FCH 01: Extended FCH appears following this A-FCH 10-11: *Reserved*
MAC version	8 bits	IEEE 802.22 MAC version to which the message originator conforms. 0x00: *Reserved* 0x01-0x1F*: Reserved for IEEE 802.22 WRAN MACs using PHY-OM1* 0x20: IEEE 802.22 A-WRAN Non-Relay/Non-Multichannel Network on PHY-OM2 0x21: IEEE 802.22 A-WRAN Centralized Relay Network on PHY-OM2 0x22: IEEE 802.22 A-WRAN Distributed Relay Network on PHY-OM2 0x23: IEEE 802.22 A-WRAN Multi-channel Network on PHY-OM2 0x24-0x3F: *Reserved for future IEEE 802.22 A-WRAN MACs using PHY-OM2* 0x40–0xFF: *Reserved*
HCS	8 bits	Header Check Sequence
}		

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7.7.3.2 Extended frame control header (Ex-FCH)

The Ex-FCH specification is shown in Table 4. The Ex-FCH decoding is the same as A-FCH. The Ex-FCH provides information about the A-WRAN cell in order to protect incumbents, support self-coexistence mechanisms, and support the intra-frame and inter-frame mechanisms for management of quiet periods for sensing.

Table 4—Extended frame control header format

Syntax	Size	Notes
Extended_FCH_Format() {		
Length	8 bits	Length of Extended FCH
Current Intra-frame Quiet Period Cycle Length	8 bits	Specified in number of frames, it indicates the spacing between the frames for which the intra-frame quiet period specification is valid. For example, if this field is set to 1, the Quiet Period Cycle repeats every frame; if it is set to 2, the Quiet Period Cycle repeats every 2 frames; etc. If this field is set to 0, no intra-frame quiet period is scheduled, or the current intra-frame quiet period is canceled.
Current Intra-frame Quiet Period Cycle Offset	8 bits	Valid only if Current Intra-frame Quiet Period Cycle Length > 0. Specified in number of frames, it indicates the offset from this Extended FCH transmission to the beginning of the first frame in the Current Intra-frame Quiet Period Cycle Length.
Current Intra-frame Quiet Period Cycle Frame Bitmap	16 bits	Valid only if Current Intra-frame Quiet Period Cycle Length > 0. Valid for each frame identified by the Current Intra-frame Quiet Period Cycle Length. Each bit in the bitmap corresponds to one frame within the frame. If the bit is set to 0, no intra-frame quiet period shall be scheduled in the corresponding frame. If the bit is set to 1, an intra-frame quiet period shall be scheduled within the corresponding frame for the duration specified by the Current Intra-frame Quiet period Duration.
Current Intra-frame Quiet Period Duration	8 bits	Valid only if Current Intra-frame Quiet Period Cycle Length > 0. If this field is set to a value different from 0 (zero), it indicates the number of symbols starting from the end of the frame during which no transmission shall take place.
Claimed Intra-frame Quiet Period Cycle Length	8 bits	Specified in number of frames, it indicates the spacing between the frames for which the intra-frame quiet period specification claimed by an A-BS would be valid. For example, if this field is set to 1, the Quiet Period Cycle would repeat every frame; if it is set to 2, the Quiet Period Cycle would repeat every 2 frames; etc. If this field is set to 0, no intra-frame quiet period is claimed by the A-BS.
Claimed Intra-frame Quiet Period Cycle Offset	8 bits	Valid only if Claimed Intra-frame Quiet Period Cycle Length > 0. Specified in number of frames, it indicates the offset from this Extended FCH transmission to the time where the Claimed Quiet Period Cycle resulting from the inter-BS negotiation (see 7.23.2) shall become the Current Intra-frame Quiet Period Cycle.

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Table 4—Extended frame control header format *(continued)*

Syntax	Size	Notes
Claimed Intra-frame Quiet Period Cycle Frame Bitmap	16 bits	Valid only if Claimed Intra-frame Quiet Period Cycle Length > 0. Valid for each frames identified by the Claimed Intra-frame Quiet Period Cycle Length. Each bit in the bitmap corresponds to one frame within each specified frame. If the bit is set to 0, no intra-frame quiet period will be scheduled in the corresponding frame. If the bit is set to 1, an intra-frame quiet period will be scheduled within the corresponding frame for the duration specified by Claimed Intra-frame Quiet period Duration.
Claimed Intra-frame Quiet Period Duration	8 bits	Valid only if Claimed Intra-frame Quiet Period Cycle Length > 0. If this field is set to a value different from 0 (zero), it indicates the number of symbols starting from the end of the frame during which no transmission will take place.
Synchronization Counter for Intra-frame Quiet Period Rate	8 bits	Valid only if Claimed Intra-frame Quiet Period Cycle Length > 0. This field is used for synchronizing the Claimed Intra-frame Quiet Period rate among overlapping A-BSs in order to allow dynamic reduction of the Intra-frame Quiet Period rate. This Quiet Period rate is defined as the number of frames with quiet periods identified by the Cycle Frame Bitmap in the frames designated by the Cycle Length, divided by this Quiet Period Cycle Length (see 7.23.2).
Synchronization Counter for Intra-frame Quiet Period Duration	8 bits	Valid only if Claimed Intra-frame Quiet Period Duration > 0. This field is used for synchronizing the Claimed Intra-frame Quiet Period Durations among overlapping A-BSs in order to allow dynamic reduction of the Intra-frame Quiet Period Duration (see 7.23.1).
Inter-frame Quiet Period Duration	4 bits	Duration of Quiet Period Indicates the duration of the next scheduled quiet period in number of frames. If this field is set to a value different from 0 (zero), it indicates the number of frames that shall be used to perform in-band inter-frame sensing.
Inter-frame Quiet Period Offset	12 bits	Time to Quiet Period Indicates the time span between the transmission of this information and the next scheduled quiet period for in-band inter-frame sensing. The 8 leftmost bits (MSB) indicate the frame number and the 4 rightmost bits (LSB) indicate the frame number when the next scheduled quiet.
SCW Cycle Length	8 bits	Specified in number of frames. If this field is set to 0, then no SCW cycle is scheduled. This field has to be 1 or larger to be effective. To limit the number of possibilities, the field shall be one of five following choices {1, 2, 4, 8, 16}. For example, if this field is set to 1, SCW Cycle repeats every frame; if it is set to 2, SCW Cycle repeats every 2 frames, etc.
SCW Cycle Offset	8 bits	Specified in number of frames, it indicates the offset from this Extended FCH transmission to the frame where the SCW cycle starts or repeats (i.e., the frame contains SCWs and is specified by the SCW Cycle Frame Bitmap). For example, if this field is set to 0, the SCW cycle starts from the current frame.

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Table 4—Extended frame control header format *(continued)*

Syntax	Size	Notes
SCW Cycle Frame Bitmap	32 bits	Valid for a unit of frame, each 2-bit in the bitmap corresponds to one frame within the frame. If the 2-bit is set to 00, there is no SCW scheduled for this frame. If the 2-bit is set to 11, a reservation-based SCW (reserved by the current WRAN) is scheduled in the corresponding frame. If the 2-bit is set to 10, a reservation-based SCW has been scheduled by a direct-neighbor WRAN cell in the corresponding frame and needs to be avoided by other WRAN cells receiving this Extended FCH. If the 2-bit is set to 01, a contention-based SCW (that could be shared with other WRANs) is scheduled by the current WRAN cell in the corresponding frame. The number of reservation-based SCWs cannot exceed 2 per WRAN cell per SCW Cycle. At least one contention-based SCW shall be scheduled in one SCW Cycle (code 01). The A-BSs shall start scheduling their contention-based SCWs from the last frame of the frame, going backward for multiple contention-based SCWs. This bitmap applies only to the frames scheduled by the SCW Cycle. See NOTE.
Current DS/US Split	6 bits	Effective start time (in OFDM symbols from the start of the frame including all preambles) of the first symbol of the US allocation when an A-BS-to-A-BS interference situation has been identified by direct reception of this parameter by an A-BS from a Extended FCH or a CBP burst transmitted by another A-BS. The Allocation Start Time as provided in the US-MAP (see Table 45) shall be equal to this value if A-BS-to-A-BS interference has been identified. This value shall be set to zero if no MA-BS-to-A-BS interference has been identified (i.e., A-BS has not received this parameter from another A-BS). In this case, the Allocation Start Time in the US-MAP (see Table 45) can be defined independently on a frame-by-frame basis by the respective A-BSs based on their traffic requirement.
Claimed US/DS Split	6 bits	Specified by each A-BS for A-BS-to-A-BS interference (i.e., when Extended FCH and/or CBP burst can be received by an A-BS directly from another A-BS) indicating the required DS/US split based in the traffic requirement of the transmitting A-BS and the negotiation process between the A-BSs (see 7.22.3). This value shall be set to zero if no A-BS-to-A-BS interference has been identified.
DS/US Change Offset	12 bits	Indicates the time span between the transmission of this information and the next scheduled change of the DS/US split where the “Claimed DS/US split” value will become the “Current DS/US split” value. The 8 leftmost bits (MSB) indicate the frame number and the 4 rightmost bits (LSB) indicate the frame number when the next DS/US split change shall take place. The value of this parameter is determined by the negotiation process between concerned A-BSs (see 7.22.3). This value shall be set to zero if no A-BS-to-A-BS interference has been identified.

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Table 4—Extended frame control header format *(continued)*

Syntax	Size	Notes
Incumbent detection reporting inhibit timer	32 bits	When the BS is informed by the database service that it can continue operating on the current channel even though its CPEs are repetitively reporting an incumbent detection situation (i.e., on N or N±1), the A-BS can use this parameter to inhibit such reporting by the CPEs for a specified period of time. This will avoid the CPEs flooding the US subframe with unnecessary incumbent detection reports. Bit 0–4: Signal type (see Figure 266) Bit 5–31: Inhibit Period (number of frames)
HCS	8 bits	Header Check Sequence
}		
NOTE—Quiet period (QP) scheduling should be done prior to the SCW scheduling so that SCWs avoid frames already reserved for QP. If SCW conflicts with QP, QP overrides the SCW.		

7.7.4 Distributed relay zone (DRZ) Frame Control header (DRZ-FCH)

The DRZ-FCH is used in a DRZ for a distributed scheduling mode. The format of the DRZ-FCH is shown in Table 5. The DRZ-FCH shall have the same encoding as the A-FCH in each mode PHY-OM2. The DRZ-FCH contains the length of either the DS-MAP or US-MAP that immediately follows the DRZ-FCH (note that Length = 0 indicates the absence of any burst in the frame). When the DS-MAP is specified, the US-MAP length information shall be contained in the first DS-MAP information element. When the US-MAP length is indicated in the DRZ-FCH, there shall be no DS burst in the current frame. DCD and UCD messages, if present, are carried by the next DS bursts specified by the DS-MAP. Location and profile of the data bursts are specified in the rest of the DS-MAP and US-MAP management messages. A HCS field occupies the last byte of the DRZ-FCH.

Table 5—DRZ Frame Control header (DRZ FCH) format

Syntax	Size	Notes
DRZ Frame_Control_Header_Format() {		
Distributed Scheduling R-CPE ID	48 bits	MAC address that uniquely identifies the distributed scheduling R-CPE transmitting the DRZ-FCH.
Length of the MAP message	10 bits	Specifies the length of the MAP information element following the A-FCH in OFDM slots. A length of 0 (zero) indicates the absence of any burst in the frame.
Frame Number	8 bits	This field is same at the frame number indicated in A-FCH (Table 4)
CP	2 bits	Cyclic Prefix Factor Specifies the size of the cyclic prefix used by the PHY in the frame transmissions in this frame. Predetermined values are 00: 1/4 T_{FFT} 01: 1/8 T_{FFT} 10: 1/16 T_{FFT} 11: 1/32 T_{FFT}

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Table 5—DRZ Frame Control header (DRZ FCH) format *(continued)*

Syntax	Size	Notes
MAC version	8 bits	This field is same as the MAC version indicated in the A-FCH.
HCS	8 bits	Header Check Sequence.
}		

7.8 MAC PDU formats

The MAC PDU is illustrated in Figure 21. Figure 12 depicts how the MAC PDU fits in the overall frame structure when used for intra-cell communication. Each PDU begins with a fixed-length generic MAC header, which shall be followed by a Payload. The Payload shall consist of zero or more subheaders, zero or more IEs, and zero or more MAC SDUs and/or fragments thereof. The payload information may vary in length, so that a MAC PDU may represent a variable number of bytes. A CRC shall be applied to all the MAC PDUs transmitted on the broadcast, Initial Ranging, Basic and Multicast transport FTs. This is because the MAC PDUs transmitted on these FTs do not have any other protection. For all other FTs, a MAC PDU may or may not carry a CRC since MAC PDUs belonging to all these FTs contain an integrity check vector (see 8.4). Such PDU will have to fit in a given integer number of OFDM slots once encoded and this will result in specific data bit lengths possible as indicated in Table 277. Bit padding is used to make each PDU fit these bit lengths as explained in 7.10.6.

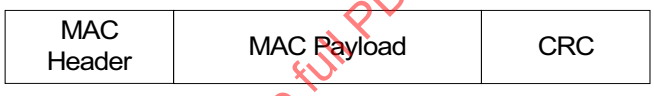

Figure 21—MAC PDU format

7.8.1 MAC headers

Two MAC headers are defined: the generic MAC header used for intra-cell communication (between BS and CPEs within a cell), and the coexistence beacon MAC header used by the CBP protocol for inter-cell communication to foster appropriate self-coexistence among overlapping IEEE 802.22 cells, to provide a way to identify the transmitting device for potential interference resolution, and for intra-cell communication between the CPEs in the same cell to contribute to terrestrial geolocation.

In addition to these headers, there is also the possibility of including subheaders and special payloads associated to the generic MAC header. In the following subclauses, the MAC headers, together with the subheaders and special payloads, are described.

7.8.1.1 Generic MAC header

The format of the generic MAC header (GMH) is shown in Table 6. This header begins each MAC PDU containing either higher layer traffic or MAC management data.

The IEEE 802.22 MAC is connection-oriented. As discussed in 7.2, these connections are addressed by two components, the station ID (SID) and the flow Type (FT). The SID indicates the allocation assigned to a connection in a DS/US-MAP IE. The FT is a critical field in the GMH, because it indicates a specific flow of traffic mapped to an SID's allocation. To differentiate between PDUs assigned to different flows for QoS (see 7.20), the FT is signaled in the GMH. Another critical field included in the header for the purpose of

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protecting incumbent services is the UCS bit. This field is used by CPEs that already have an allocated US burst to immediately signal the BS of a newly detected UCS with incumbents in the current channel or in either of its adjacent channels by setting the UCS bit to 1 in their US burst.

The subheader Type indication field is used to signal the presence and order of subheaders that follow the GMH. For example, if the Type field is equal to 11001, the following subheaders are attached (given in order): Bandwidth Request subheader, ARQ Feedback Payload, and finally the Grant Management subheader. Subheader formats and usage are discussed in 7.8.1.2. The generic MAC header also includes other fields (e.g., security related), and these can be found in Table 6.

In the WRAN cell, CPEs shall ignore the value of Bit2 of the Type indication field in the GMH. In the A-WRAN cell, R-CPEs/A-CPEs shall not ignore the value of Bit2 of the type indication field in the GMH, and process any extended subheaders that follow the GMH.

Table 6—Generic MAC header format

Syntax	Size	Notes
General_MAC_Header_Format() {		
Length	11 bits	The length in bytes of the MAC PDU including the MAC header and the CRC. Any length smaller than 4 bytes shall be reserved for future use and the data shall be discarded by receivers only able to comply with this standard release.
UCS	1 bit	Urgent Coexistence Situation Used by the CPE to alert the BS about an UCS with incumbents in the channel currently being used by the BS or either of its adjacent channels: 0: no incumbent (default) 1: incumbent detected
QPA	1 bit	Quiet Period Adjustment sent by the CPE when it is missing QP opportunities to complete its in-band sensing within the required in-band detection time (see 11.3.3): 0: no adjustment needed (default) 1: increase of the number of quiet periods is needed
EC	1 bit	Encryption control: 0: payload is not encrypted 1: payload is encrypted
EKS	2 bits	Encryption key sequence The index of the traffic encryption key (TEK) and initialization vector used to encrypt the payload. This field is only meaningful if the EC field is set to 1. When transitioning to newer TEK/GTEK (see 8.3.1.4 and 8.3.1.5), EKS is incremented +1 (modulo 4).
Type	5 bits	Indicates the subheaders and special payload types present in the message payload. See Table 7.
FT	3 bits	Flow Type

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Table 6—Generic MAC header format *(continued)*

Syntax	Size	Notes
HCS	8 bits	Header check sequence The transmitter shall calculate the HCS value for the content of the header excluding the HCS field, and insert the result into the HCS field which is the last byte of the header). It shall be the remainder of the division (Modulo 2) by the generator polynomial $g(D = D^8 + D^2 + D + 1)$ of the polynomial D^8 multiplied by the content of the header excluding the HCS field. (Example: [Length=0x447, UCS=0, QPA=0, EC=1, EKS=01, Type=11001, FT=010; the resulting GMH=0x88E5CB and the HCS calculated over it = 0x27]).
}		

Table 7—Encoding of the Type field

Type bit	Values
4	Bandwidth Request subheader Indicates whether this is a bandwidth request frame, and hence contains a special payload related to bandwidth allocation (see Table 8) 1:present; 0: absent
3	ARQ feedback payload 1: present; 0: absent
2	Extended Subheader types Indicates whether the Extended Type subheader is present 1: Extended Type subheader is present 0: Extended Type subheader is absent.
1	Fragmentation/Packing subheader 1: present; 0: absent
0	In the US: Grant Management subheader 1: present; 0: absent

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7.8.1.2 MAC subheaders and special payloads

Five types of subheaders may be present. These subheaders can be categorized into two types: subheaders attached to each PDU (per-PDU) and subheaders attached to each packed SDU (per-SDU). The Fragmentation/Packing subheader is considered to be per-PDU when the “Purpose bit” in Table 8 is set to 0 (e.g., set to Fragmentation). The other per-PDU subheaders are the Bandwidth Request, Extended, Grant Management, and ARQ Feedback. The per-PDU subheaders may be inserted in MAC PDUs immediately following the generic MAC header. If indicated, the Bandwidth Request subheader shall always follow the Generic MAC header. In the US, if both the Grant Management subheader and Fragmentation/Packing subheader (set to Fragmentation) are indicated, the Grant Management subheader shall come first. If both the Grant Management subheader and Bandwidth Request subheader are indicated, the Grant Management subheader shall come first. If Extended Subheader and Bandwidth Request subheader are both present, the Extended Subheader comes first.

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For the US, the following order for per-PDU subheaders, when multiple subheaders are present in the same MAC PDU, shall be followed: Grant Management, Extended, Bandwidth Request, Fragmentation/Packing (set to Fragmentation), and ARQ Feedback Payload. For the DS, the following order of per-PDU subheaders shall be followed: Extended, Fragmentation/Packing (set to Fragmentation), and ARQ Feedback Payload.

The only per-SDU subheader is the Fragmentation/Packing subheader set to packing. There can be more than one Fragmentation/Packing subheader in a MAC PDU, all configured for packing. There can only be one Fragmentation/Packing subheader in the MAC PDU if configured for fragmentation. The Fragmentation/Packing subheader may be inserted before each MAC SDU if so indicated by setting Bit 1 in the Type field of the generic MAC Header and by setting the “Purpose bit” in Table 8 to 1.

When present, per-PDU subheaders shall always precede the first per-SDU subheader.

7.8.1.2.1 Bandwidth Request subheader

Bandwidth Request subheaders are transmitted by the CPE to the BS to request additional bandwidth for a connection. They shall be sent in a PDU by itself or in a PDU with other subheaders and/or data. (See Table 8.)

Table 8—Bandwidth Request subheader format

Syntax	Size	Notes
BW_ Request_Subheader_Format() {		
Type	1 bit	Indicates the type of the bandwidth request adjustment 0: incremental 1: aggregate
BR	20 bits	The number of bytes of US bandwidth requested by the CPE. The request shall not include any PHY overhead.
Reserved	3 bits	All bits shall be set to zero.
}		

7.8.1.2.2 Fragmentation/Packing subheader

Table 9 shows the format of the Fragmentation/Packing subheader.

Table 9—Fragmentation/Packing subheader format

Syntax	Size	Notes
Fragmentation/Packing_Subheader_Format() {		
Purpose	1 bit	0: Fragmentation subheader 1: Packing subheader
FC	2 bits	Indicates the fragmentation state of the payload: 00: no fragmentation 01: last fragment 10: first fragment 11: continuing (middle) fragment
if (ARQ-enabled Connection) {		Type bit 3==1 (see Table 7)

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Table 9—Fragmentation/Packing subheader format *(continued)*

Syntax	Size	Notes
BSN	10 bits	Sequence number of the first block in the current SDU fragment
} else {		
FSN	10 bits	Sequence number of the current SDU fragment. This field increments by one (modulo 1024) for each fragment, including unfragmented SDUs.
}		
if (Purpose==1) {		
Length	11 bits	Length of SDU fragment being packed
} else {		#if (Purpose==0)
Reserved	3 bits	All bits shall be set to zero.
}		

7.8.1.2.3 Grant Management subheader

Table 10 shows the format of the Grant Management subheader.

Table 10—Grant Management subheader format

Syntax	Size	Notes
Grant_Management_Subheader_Format() {		
if (Type bit 0==1) {		Scheduling service type = Unsolicited Grant Service (UGS) (see Table 7)
SI	1 bit	Slip Indicator 0: No action 1: Used by the CPE to indicate a slip of US grants relative to the US queue depth.
PM	1 bit	Poll-Me 0: No action 1: Used by the CPE to request a bandwidth poll.
Reserved	6 bits	All bits shall be set to zero.
}		
}		

7.8.1.2.4 ARQ Feedback Payload

If the ARQ Feedback Payload bit in the MAC Type field (see Table 7) is set, the ARQ Feedback Payload shall be transported. If packing is used, it shall be transported as the first packed payload. ARQ feedback is provided for each FT that has ARQ-enabled for service flows carried on it. The format of the ARQ Feedback is described in Table 224 and Table 225.

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7.8.1.2.5 Extended subheader types

7.8.1.2.5.1 General

Two types of Extended Subheaders are defined to be used in IEEE 802.22 A-WRAN cells. The Extended Bandwidth Request Subheader is used by an R-CPE to request bandwidth to service A-CPEs in its relay zone. The Channel Aggregation Subheader is used during multi-channel operation. Each Extended Subheader is defined by a Extended Subheader Type field that identifies the Extended Subheader and its functionality. Only two types (0x00 for Extended Bandwidth Request and 0x01 for Channel Aggregation) are defined; all other types (0x02–0xFF) are reserved.

7.8.1.2.5.2 Extended Bandwidth Request subheader

Extended Bandwidth Request subheaders are transmitted by the centralized scheduling R-CPE to the A-BS to request additional bandwidth for a CRZ connection. They shall be sent in a PDU by itself or in a PDU with other subheaders and/or data. (See Table 11.)

Table 11—Extended Bandwidth Request subheader format

Syntax	Size	Notes
Extended_BW_ Request_Subheader_Format() {		
Extended Subheader Type	8 bits	0x00—Extended BW Request Subheader
Request Node	9 bits	SID of Centralized scheduling R-CPE
Number of BR CPEs; n	8 bits	The number of CPEs, which require bandwidth request
For (i = 1; i ≤ n; i ++){	Variable	
BW Request Type	2 bits	00: CDMA bandwidth request 01: Bandwidth request subheader 10–11: *Reserved*
SID	9 bits	SID of CPE, which require bandwidth request
Type	1 bit	Indicates the type of the bandwidth request adjustment 0: incremental 1: aggregate
BR	20 bits	The number of bytes of US bandwidth requested by the CPE. The request shall not include any PHY overhead.
CRZ bandwidth ranging code	8 bits	CRZ bandwidth ranging codes when BW Request Type is set to 0
}		
}		

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7.8.1.2.5.3 Channel Aggregation subheader

The format of Channel Aggregation subheader is shown in Table 12. This Channel Aggregation subheader is used to manage the aggregation data sequence during the multi-channel operation. The channel

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aggregation header with fixed-length size of 3 bytes shall be added to each PDU after the generic MAC header.

Table 12—Channel Aggregation subheader format

Syntax	Size	Notes
Channel_Aggregation_Subheader_ Format() {		
Extended Subheader Type	8 bits	0x01 = Channel Aggregation Extended Subheader
Aggregation ID	16 bits	Indicates the sequence management ID of the transmitted data during multi-channel operation. The value of Aggregation ID is from 0 to 8191. The Aggregation ID shall be incremented by one after each transmission and shall be reset to 0 after the maximum value (8191).
}		

7.8.1.3 CBP MAC PDU format

The coexistence beacon protocol (CBP) beacons (discussed in 7.22.1) are inter-cell and intra-cell packets that are transmitted with the goal of improving self-coexistence among overlapping IEEE 802.22 cells, of identifying the transmitting device for potential interference resolution, and of enhancing geolocation/ ranging resolution between CPEs within a cell (11.5.2). These beacons are transmitted by the BS or CPEs under the control of the BS during a SCW. As discussed in 7.20.1, the coexistence beacon MAC PDU described in Table 14 (for PHY-OM1) and Table 15 (for PHY-OM2) is utilized by the CBP packets.

Table 13—CBP MAC PDU format (PHY-OM1)

Syntax	Size	Notes
CBP_MAC_PDU _Format() {		
Length	8 bits	The length in bytes of the CBP MAC PDU including the MAC header and the CRC.
SCH Data Index	4 bits	SCH Data included in the CBP_MAC_PDU contains the sum of the following elements (see Table 1): 0000: 7 first parameters of the SCH = 11 bytes 1000: 10 parameters related to intra-frame QP = 12 bytes 0100: 2 parameters related to inter-frame QP = 2 bytes 0010: 3 parameters on SCW scheduling = 6 bytes 0001: 3 parameters on DS/US Split = 3 bytes Note that this last 3 parameters segment can only be included in CBP burst transmitted by BSs.
SCH Data	Variable (integer number of bytes)	Data extracted from the SCH transmitted by the BS sourcing this CBP (see Table 1). This data includes the BS_ID. Only the useful information contained in the SCH should be replicated here. This indicates that the SCH should be built with IEs only present when needed. Table 1 should be modified accordingly.
Frame Number	4 bits	The frame number within the current superframe in which the CBP burst is transmitted.
HCS	8 bits	Header Check Sequence.

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Table 13—CBP MAC PDU format (PHY-OM1) *(continued)*

Syntax	Size	Notes
IEs	Variable (integer number of bytes)	CBP information elements (see 7.8.1.3.1)
}		

Table 14—CPB_MAC_PDU format (PHY-OM2)

Syntax	Size	Notes
CBP_MAC_PDU_Format() {		
Length	8 bits	The length of bytes of the CBP MAC PDU including the MAC header and the CRC.
Advanced FCH and Extended FCH Index	4 bits	A-FCH and Extended FCH Data included in the CBP_MAC_PDU contains the sum of the following elements (see Table 3 and Table 4): 0000: 8 first parameters of the A-FCH for PHY-OM2 (see Table 3 and Table 4) = 11 bytes 1000: 10 parameters related to intra-frame QP of the Extended FCH (Table 4) = 12 bytes 0100: 2 parameters related to inter-frame QP of the Extended FCH (Table 4) = 2 bytes 0010: 3 parameters on SCW scheduling of the Extended FCH (Table 4) = 6 bytes 0001: 3 parameters on DS/US Split of the Extended FCH (Table 4) = 3 bytes Note that this last 3-parameter segment can be included only in CBP bursts transmitted by A-BSs.
A-FCH and Extended FCH Data	Variable (integer number of bytes	Data extracted from the A-FCH and Extended FCH transmitted by A-BS sourcing this CBP. This data includes the A-BS_ID. Only the useful information contained in the A-FCH and Extended FCH should be replicated here. This indicates that the A-FCH and Extended FCH should be built with IEs only present when needed.
Frame Number	8 bits	The frame number in which the CBP burst was transmitted.
HCS	8 bits	Header Check Sequence.
IEs	Variable (integer number of bytes	CBP information elements (see 7.8.1.3.1).
}		

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7.8.1.3.1 CBP information elements

CBP packets shall at least carry a Backup/Candidate Channel information element (IE) in their payload (see Table 15). This is to allow WRANs to execute the spectrum etiquette mechanism before deciding to execute the other spectrum sharing mechanisms described in 7.23.3.

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If an A-BS is generating a CBP packet to be forwarded by a distributed R-CPE or an A-CPE attached to a distributed R-CPE, it may optionally add a CBP Local Cell ID IE to the CBP MAC PDU. The purpose of the CBP Local Cell ID IE is to provide the identity of the local cell maintained by a distributed R-CPE. The CBP MAC PDU header (which would contain contents of transmission types indicated in 7.20.4) would contain the MAC Address of the A-BS that serves the distributed R-CPE. When the CBP Local Cell ID IE is added to a CBP MAC PDU, the transmissions indicated in 7.20.4 would contain the MAC Address of the A-BS in the CBP MAC PDU header.

Table 15—CBP IEs

Element ID	Name
0x00	Backup_and_Candidate_Channel_List IE
0x01	FC_REQ IE
0x02	FC_RSP IE
0x03	FC_ACK IE
0x04	FC_REL IE
0x05	CBP_Identification IE
0x06	Signature IE
0x07	CERT-REQ IE
0x08	CERT-RSP IE
0x09	CBP_Local_Cell_ID_IE (PHY-OM2 only)

7.8.1.3.1.1 Backup and Candidate Channel List IE

The Backup and Candidate Channel List IE, as defined in Table 16, carries a list of the current backup channels and identified candidate channels becoming backup channels when cleared by all CPEs as defined by the BS. The Backup and Candidate Channel List IE shall be included in the CBP MAC PDU to allow for network discovery and implementation of the spectrum etiquette self-coexistence mechanism.

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Table 16—Backup and Candidate Channel List IE

Syntax	Size	Description
Backup_and_ candidate_channel_list_IE_Format() {		
Element ID	8 bits	0x00
Number_Backup_and_candidate_TV_ Channels	4 bits	Number of backup and candidate channels in the list
Number_Backup_TV_Channels	4 bits	Number of backup channels in the list
For (i=0; i < Number_Backup_and_candidate_TV_ Channel; i++) {		List of backup channels in order of priority to be used by CPEs in case of loss of communication with the BS due to incumbents. This list may also include candidate channels, in which case they will follow the backup channels in the list and will also be included in order of priority. The list shall be a disjoint set with the current operating channel.
Channel Number	8 bits	8 bits per channel
}		
}		

7.8.1.3.1.2 Frame Contention Request IE

The Frame Contention Request (FC_REQ) IE, defined in Table 17 is used in the On-demand Frame Contention Protocol (see 7.22.3.2). The FC_REQ is transmitted in the payload of a CBP packet by a WRAN cell—the frame contention source, which intends to acquire spectrum resources (data frame transmission opportunities) of a channel currently occupied by another neighboring WRAN cell—the frame contention destination, in order to satisfy the QoS requirements of the frame contention source's data transmission.

Table 17—FC_REQ IE format

Syntax	Size	Notes
FC_REQ_IE_Format() {		
Element ID	8 bits	0x01
BS ID of Contention Destination	48 bits	The MAC address of the frame contention destination BS.
Sequence number	8 bits	Incremented by 1 by the source whenever any of the following three fields change. The frame contention destinations shall discard the repeated FC_REQ IEs.
Frame contention number (FCN)	16 bits	A random number indicating the priority for the frame contention on the current channel.

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Table 17—FC_REQ IE format *(continued)*

Syntax	Size	Notes
Contention Request Frame Index Vector	16 bits	A bit map indicating the indexes of each data frame within a superframe that the Contention Source WRAN requests to acquire (through the contention process) for its data services starting from a to-be-scheduled next superframe after the current superframe (see Table 18). For each of the 16 bits of the frame bit map, the corresponding frame is requested for the contention when the bit value is set to 1. Otherwise, the bit value of the corresponding frame is set to 0.
}		

7.8.1.3.1.3 Frame Contention Response IE

The Frame Contention Response (FC_RSP) IE defined in Table 18 is used in the On-demand Frame Contention Protocol (see 7.22.3.2). The FC_RSP IE is sent in a CBP packet payload by the contention destination WRAN cell in order to inform the contention source WRAN cell of the contention results. This IE is transmitted by the contention destination WRAN Cell after it has received a FC_REQ IE from the contention source WRAN cell and has run the contention resolution algorithm.

Table 18—FC_RSP IE format

Syntax	Size	Notes
FC_RSP_IE_Format() {		
Element ID	8 bits	0x02
BS ID of the Frame Contention Source	48 bits	MAC address of the Frame Contention Source copied from the CBP PDU header received (from the included SCH data).
Sequence number	8 bits	Copy from the FC_REQ.
Contention Response Frame Index Vector	16 bits	A bit map indicating the contention results determined by the channel contention algorithm for the data frames that the contention source WRAN requests to acquire. These contention results will be effective starting from a to-be-scheduled next superframe after the current superframe (see Frame Release Time below). For each of the 16 bits of the frame bit map corresponding to a superframe, a frame is granted to the contention source when the corresponding bit value is set to 1. If the bit value is set to 0, the frame is not granted. Also, for a data frame that is not requested by any contention source, the corresponding bit is set to 0. For these two last cases, the frame allocation does not change.
Frame Release Time	8 bits	Starting from the next superframe, the number of superframes after which the channel shall be released by the frame contention destination BS.
}		

7.8.1.3.1.4 Frame Contention Acknowledgment IE

The Frame Contention Acknowledgment (FC_ACK) defined in Table 19 is used in the On-demand Frame Contention Protocol (see 7.22.3.2). The FC_ACK is a broadcast acknowledgment message transmitted by

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the winner of the frame contention (FC-SRC) indicating the confirmation and the scheduling of the frame acquisitions.

Table 19—FC_ACK IE format

Syntax	Size	Notes
FC_ACK_IE_Format() {		
Element ID	8 bits	0x03
BS ID of the granting FC-DST	48 bits	The MAC address of the BS of the frame contention destination (FC-DST) WRAN cell granting access to the data frames that are being acquired by the winning WRAN cell (FC-SRC) (this is used to enable “clear to send”).
Sequence number	8 bits	Same as the corresponding FC_REQ IE. The contention destinations shall discard the repeated FC_ACK IE being received.
Frame Contention Number	16 bits	The winning FCN used in FC_REQ message, showing the priority to contend for the target data frame.
Contention Acknowledgment Frame Index Vector	16 bits	A bit map indicating the frames that the FC-SRC has won through the channel contention algorithm from the FC-DST and that it intends to acquire starting from the scheduled next superframe after the current superframe (see Frame Release Time in the cell below). For each of the 16 bits of the frame bit map corresponding to a superframe, a frame will be occupied by the contention source when the corresponding bit value is set to 1. Otherwise, the allocation of the frame does not change.
Frame Release Time	8 bits	Starting from the next superframe, the number of superframes after which the channel shall be released by the frame contention destination BS.
}		

7.8.1.3.1.5 Frame Contention Release IE

Frame Contention Release (FC_REL) is a broadcast message IE transmitted by the WRAN cell granting the frames (FC-DST) as a result of the frame contention indicating the announcement of the frame releases.

Table 20—FC_REL IE format

Syntax	Size	Notes
FC_REL_IE_Format() {		
Element ID	8 bits	0x04
BS ID of the winning FC-SRC	48 bits	The MAC address of the BS of the frame contention source (FC-SRC) WRAN cell that was granted access to the data frames that are being released by the granting FC-DST (this is used to enable efficient spectrum reuse).
Sequence number	8 bits	Same as the corresponding FC_REQ IE. The contention destinations shall discard the repeated FC_REL IE being received.
Frame Contention Number (FCN)	16 bits	The winning FCN used in FC_REQ message, showing the priority to contend for the target data frames.

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Table 20—FC_REL IE format *(continued)*

Syntax	Size	Notes
Contention Release Frame Index Vector	16 bits	A bit map indicating the frames that will be released to the winning FC-SRC according to the contention results and the acknowledgment from the FC-SRC that it intends to acquire starting from the scheduled next superframe after the current superframe. For each of the 16 bits of the frame bit map corresponding to a superframe, a frame will be occupied by the contention source when the corresponding bit value is set to 1. Otherwise, the allocation of the frame does not change.
}		

7.8.1.3.1.6 Device Identification IE

The Device Identification IE to be transmitted regularly by the BS and CPEs according to local regulation is intended for potential interference resolution. This IE is also used for terrestrial geolocation (see 11.5.2). The coordinates represented in this IE are based on the WGS 84 Datum. See Table 21.

Table 21—Device Identification IE format

Syntax	Size	Notes
Device_Identification _ IE {		
Element ID	8 bits	0x05
Device ID	17 bytes	Device identifier (e.g., FCC ID) (see 8.5.1.4.2).
Serial Number	12 bytes	Device serial number (see 8.5.1.4.2).
Latitude	24 bits	Bit 23: 1 bit indicator of hemisphere, N = 0, S = 1 Bit 22–16: 7 bits of degree, sufficient to cover 0° < latitude < 90° Bit 15–0: 16 bits of decimal degree fraction corresponding to a precision of 1.7 m. If Latitude and Longitude are set to zero, this shall indicate that the location is not known.
Longitude	24 bits	Bit 23: 1 bit indicator of hemisphere, E = 0, W = 1 Bit 22–15: 8 bits of degree, sufficient to cover 0° < longitude < 180° Bit 14–0: 15 bits of decimal degree fraction corresponding to a precision of 3.4 m at the equator. If Latitude and Longitude are set to zero, this shall indicate that the location is not known.
}		

7.8.1.3.1.7 CBP Protection IEs

The CBP protection method (8.6.2.1) is an optional security procedure that can be used to provide authentication of CBP MAC PDU transmissions. If it is enabled then the three following IEs are required: CBP Signature IE, Certificate Request (CERT-REQ) IE, and Certificate Response (CERT-RSP) IE. The Signature IE is used to provide a signature that is calculated over the CBP MAC PDU, and is verified by the receiving BS. When the CBP Protection is enabled, the Signature shall be transmitted in every CBP MAC PDU.

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7.8.1.3.1.8 Signature IE

Table 22—Signature IE format

Syntax	Size	Description
Signature_IE_Format {		
Element ID	8 bits	0x06
Key ID	9 bits	Identifier of the key associated with the BS implicit certificate used to generate the signature. This identifier is generated by the Certificate Authority (CA) when the certificate is created.
Time Stamp	44 bits	Derived from a NMEA 0183 ($..ZDA) string (each letter represents a digit, encoded by different numbers of bits): X: year = 2010+X, X is 6 bits M: month, e.g., 01–12, total is 4 bits D: day, e.g., 01–31, total 5 bits H: hour, e.g., 00–23, total 5 bits m: minute, e.g., 00–59, total 6 bits ss: seconds, e.g., 00–59, total 6 bits ss: 10 ms boundary, e.g., 0.00–.99, 7 bits zZ: hours off of GMT; z is 1 bit ± indication, 2nd Z is number of hours, e.g., 1–13, 4 bits, total 5 bits
Version	5 bit	00000: ECQV implicit certificates, ECSSR-PV signature scheme, K-233 EC Domain parameters in compressed form and 233 bit keys 00001: ECQV implicit certificates, ECSSR-PV signature scheme, B-233 EC Domain parameters in compressed form and 233 bit keys 00010: ECQV implicit certificates, ECSSR-PV signature scheme, sect233k1 EC Domain parameters in compressed form and 233 bit keys 00011: ECQV implicit certificates, ECSSR-PV signature scheme, sect233r1 EC Domain parameters in compressed form and 233 bit keys 00100–11111: *Reserved*
Padding	6 bits	All bits shall be set to 0.
Signature	Variable	Output of signature process. This includes the *Recoverable Message* part (*C*) and the Signature Data (*d*) as described in 8.6.2.5.2. The signature is calculated over the entire CBP MAC PDU. The signature process is detailed in 8.6.2.3. If Version==00000 or 00010, Size= 43 bytes If Version==00001 or 00011, Size= 44 bytes
}		

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7.8.1.3.1.9 Certificate Request (CERT-REQ) IE

Table 23—Certificate Request (CERT-REQ) IE

Syntax	Size	Description
CERT-REQ_IE_Format {		
Element ID	8 bits	0x07
Destination BS ID	48 bits	ID of BS to which that request is directed.
CA ID	8 bits	ID of Certificate Authority that issued the certificate to the BS that is initiating the certificate request.
Key ID	9 bits	Identifier of public key associated with certificate as assigned by CA. This identifier is generated by the Certificate Authority (CA) when the certificate is created.
Key Validity Date (Not Before)	31 bits	Date that signifies the start of period for which the certificate of the BS that is making the request is valid. Derived from a NMEA 0183 ($..ZDA) string (each letter represents a digit, encoded by different numbers of bits): — X: year= 2010+X, X is 6 bits — M: month, e.g., 01–12, total is 4 bits — D: day, e.g., 01–31, total 5 bits — H: hour, e.g., 00–23, total 5 bits — m: minute, e.g., 00–59, total 6 bits — s: seconds, assumed to be 00, not actually encoded — zZ: hours off of GMT; z is 1 bit ± indication, 2nd Z is the number of hours, e.g., 1–13, 4 bits, total 5 bits
Key Validity Time Period	7 bits	Amount of time, in 6 month increments, that the certificate is valid.
Version	5 bit	00000: ECQV implicit certificates, ECSSR-PV signature scheme, K-233 EC Domain parameters in compressed form and 233-bit keys 00001: ECQV implicit certificates, ECSSR-PV signature scheme, B-233 EC Domain parameters in compressed form and 233-bit keys 00010: ECQV implicit certificates, ECSSR-PV signature scheme, sect233k1 EC Domain parameters in compressed form and 233-bit keys 00011: ECQV implicit certificates, ECSSR-PV signature scheme, sect233r1 EC Domain parameters in compressed form and 233-bit keys 00100–11111: *Reserved*
Padding	4 bits	All bits shall be set to 0.
Public Key Reconstruction Data	248 bits	Key data used to reconstruct the public key, i.e., 31 bytes for 233 bit ECC keys.
}		

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7.8.1.3.1.10 Certificate Response (CERT-RSP) IE

Table 24—Certificate Response (CERT-RSP) IE

Syntax	Size	Description
CERT-RSP_IE_Format {		
Element ID	8 bits	0x08
Source BS ID	48 bits	ID of BS to which that Certificate Response is directed.
CA ID	8 bits	ID of Certificate Authority that issued the certificate to the BS that is transmitting the certificate response.
Key ID	9 bits	Identifier of public key associated with certificate as assigned by CA. This identifier is generated by the Certificate Authority (CA) when the certificate is created.
Key Validity Date (Not Before)	31 bits	Date that signifies the start of period for which the certificate of the BS, that is transmitting the certificate response, is valid. Derived from a NMEA 0183 ($..ZDA) string (each letter represents a digit, encoded by different numbers of bits): — X: year = 2010+X, X is 6 bits — M: month, e.g., 01–12, total is 4 bits — D: day, e.g., 01–31, total 5 bits — H: hour, e.g., 00–23, total 5 bits — m: minute, e.g., 00–59, total 6 bits s: seconds, assumed to be 00, not actually encoded — zZ: hours off of GMT; z is 1 bit ± indication, 2nd Z is the number of hours e.g., 1–13, 4bits, total 5 bits
Key Validity Time Period	7 bits	Amount of time, in 6 month increments, that the certificate is valid.
Version	5 bit	00000: ECQV implicit certificates, ECSSR-PV signature scheme, K-233 EC Domain parameters in compressed form and 233-bit keys 00001: ECQV implicit certificates, ECSSR-PV signature scheme, B-233 EC Domain parameters in compressed form and 233-bit keys 00010: ECQV implicit certificates, ECSSR-PV signature scheme, sect233k1 EC Domain parameters in compressed form and 233-bit keys 00011: ECQV implicit certificates, ECSSR-PV signature scheme, sect233r1 EC Domain parameters in compressed form and 233-bit keys 00100–11111: *Reserved*
Public Key Reconstruction Data	248 bits	Key data used to reconstruct the public key, i.e., 31 bytes for 233-bit ECC keys.
Time Stamp	44 bits	Copied from Signature IE of the CBP MAC PDU in which the CERT-REQ IE was received.
}		

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7.8.1.3.1.11 CBP Local Cell ID IE

The CBP Local Cell ID IE shown in Table 25 may be added to CBP MAC PDUs that are to be forwarded by a distributed scheduling R-CPE or A-CPEs attached to the distributed scheduling R-CPE. This IE allows the recipient of the CBP MAC PDU containing this IE to distinguish the presence of a local cell from that of CBP MAC PDUs emitted by the A-BS and A-CPEs operating within the serving cell.

Table 25—CBP Local Cell ID IE

Syntax	Size	Description
CBP_Local_Cell_ID_IE_format (){		
Element ID	8 bits	0x09 (Table 15)
Local Cell MAC ID	48 bits	IEEE 48-bit MAC address of the distributed R-CPE that manages the local cell
}		

7.9 Management messages

As can be seen in Table 26, the MAC defines a collection of management messages to support and implement its basic functions. All these messages are carried in the payload of a MAC PDU, and share the same message structure as depicted in Figure 22. Management messages begin with a Type field that uniquely identifies the message in question, while its payload varies according to the message type. As for transmission, management messages can only be transmitted in Broadcast, Initial Ranging, Basic, Primary, Multicast Management type of FTs (see Table 339, Table 340, and Table 341). No other types of FTs shall carry management messages.

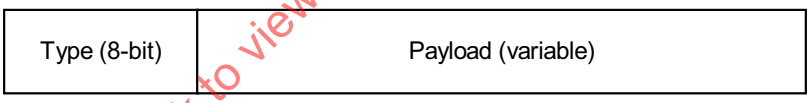

Figure 22—General management message structure

Each of the management messages shown in are described in the following subclauses. The last column of Table 26 (“PHY Operational Mode”) indicates what network type each message is applicable to/used in. A value “Both” means that the message is us in both the WRAN and A-WRAN, whereas a value of “A-WRAN only” means that the message is only used in an A-WRAN cell.

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Table 26—Management messages

Type	Message	Description	Reference	Class of connection	PHY operational mode
0	DCD	Downstream Channel Descriptor	7.9.1	Broadcast	Both
1	DS-MAP	Downstream Access Definition	7.9.2	Broadcast	Both
2	UCD	Upstream Channel Descriptor	7.9.3	Broadcast	Both
3	US-MAP	Upstream Access Definition	7.9.4	Broadcast	Both
4	RNG-REQ	Ranging Request	7.9.5	Initial Ranging or Basic	Both
5	RNG-CMD	Ranging Command	7.9.6	Initial Ranging or Basic	Both
6	REG-REQ	Registration Request	7.9.7.1	Primary Management	Both
7	REG-RSP	Registration Response	7.9.7.2	Primary Management	Both
8	DSA-REQ	Dynamic Service Addition Request	7.9.8.1	Primary Management	Both
9	DSA-RSP	Dynamic Service Addition Response	7.9.8.2	Primary Management	Both
10	DSA-ACK	Dynamic Service Addition Acknowledge	7.9.8.3	Primary Management	Both
11	DSC-REQ	Dynamic Service Change Request	7.9.8.4	Primary Management	Both
12	DSC-RSP	Dynamic Service Change Response	7.9.8.5	Primary Management	Both
13	DSC-ACK	Dynamic Service Change Acknowledge	7.9.8.6	Primary Management	Both
14	DSD-REQ	Dynamic Service Deletion Request	7.9.8.7	Primary Management	Both
15	DSD-RSP	Dynamic Service Deletion Response	7.9.8.8	Primary Management	Both
16	DSX-RVD	Dynamic Service Request acknowledgment before authentication	7.9.8.10	Primary Management	Both
17	MCA-REQ	Multicast Assignment Request	7.9.9	Primary Management	Both
18	MCA-RSP	Multicast Assignment Response	7.9.10	Primary Management	Both
19	CBC-REQ	CPE Basic Capability Request	7.9.11.1	Basic	Both

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Table 26—Management messages *(continued)*

Type	Message	Description	Reference	Class of connection	PHY operational mode
20	CBC-RSP	CPE Basic Capability Response	7.11.3.2	Basic	Both
21	DREG-CMD	De/Re-register Command	7.9.12	Basic Primary Management	Both
22	DREG-REQ	CPE De-registration Request	7.9.13	Primary Management	Both
23	ARQ-Feedback	Stand-alone ARQ Feedback	7.9.14	Primary Management	Both
24	ARQ-Discard	ARQ Discard	7.9.15	Primary Management	Both
25	ARQ-Reset	ARQ Reset	7.9.16	Primary Management	Both
26	CHS-REQ	Channel Switch Request	7.9.17.1	Primary Management or Broadcast	Both
27	CHS-RSP	Channel Switch Response	7.9.17.2	Primary Management	Both
28	CHQ-REQ	Channel Quiet Request	7.9.17.3	Primary Management, Multicast Management or Broadcast	Both
29	CHQ-RSP	Channel Quiet Response	7.9.17.4	Primary Management, Multicast Management or Broadcast	Both
30	IPC-UPD	Incumbent Prohibited Channels Update	7.9.17.4	Primary Management, Multicast Management or Broadcast	Both
31	BLM-REQ	Bulk Measurement Request	7.9.18.1	Primary Management, Multicast Management or Broadcast	Both
32	BLM-RSP	Bulk Measurement Response	7.9.18.2	Primary Management	Both
33	BLM-REP	Bulk Measurement Report	7.9.18.3	Primary Management	Both
34	BLM-ACK	Bulk Measurement Acknowledgment	7.9.18.4	Primary Management	Both
35	TFTP-CPLT	Config File TFTP Complete	7.9.19	Primary Management	Both
36	TFTP-RSP	Config File TFTP Complete Response	7.9.20	Primary Management	Both
37	SCM-REQ	Security Control Management Request	7.9.21	Primary Management	Both

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Table 26—Management messages *(continued)*

Type	Message	Description	Reference	Class of connection	PHY operational mode
38	SCM-RSP	Security Control Management Response	7.9.21	Primary Management	Both
39	FRM_UPD	The first active frame allocation update in self-coexistence MAC Operational mode	7.9.22	Basic	Both
40	CBP -RLY	CBP Relay	7.9.23	Primary Management, Multicast Management	Both
41	LCU-IND	Local Cell Update Indication	7.9.25.1	Primary Management	A-WRAN only
42	LCU-ACK	Local Cell Update Acknowledgment	7.9.25.2	Primary Management	A-WRAN only
43	Container	Container	7.9.26	Primary Management	A-WRAN only
44	Container ACK	Container acknowledgment	7.9.26.2	Primary Management	A-WRAN only
45	DTT-REQ	Downstream Transit Test Request	7.9.27.1	Primary Management	A-WRAN only
46	DTT-RSP	Downstream Transit Test Response	7.9.27.2	Primary Management	A-WRAN only
47	DTT-RPT	Downstream Transit Test Report	7.9.27.3	Primary Management	A-WRAN only
48	DTT-CFM	Downstream Transit Test Confirmation	7.9.27.4	Primary Management	A-WRAN only
49	Relay-SCHE	Relay Schedule	7.9.28	Primary Management	A-WRAN only
50	CAM-ADD	Add new operating channel	7.9.29.2	Primary Management	A-WRAN only
51	CAM-STP	Stop operating channel	7.9.29.3	Primary Management	A-WRAN only
52	CAM-STP-ACK	Stop operating channel acknowledgment	7.9.29.4	Primary Management	A-WRAN only
53	CAM-SWH	Switch operating channel	7.9.29.5	Primary Management	A-WRAN only
54	CAM-SWH-ACK	Switch operating channel acknowledgment	7.9.29.6	Primary Management	A-WRAN only
55	GRA-CFG	Group Resource Allocation Configuration	7.9.30.1	Primary Management	A-WRAN only
56	GRA-UPD	Group Resource Allocation Update	7.9.30	Primary Management	A-WRAN only
57	RNG-RPT	Ranging Report	7.9.31	Primary Management	A-WRAN only

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7.9.1 Downstream Channel Descriptor (DCD)

The format of a DCD message is shown in Table 27. This message shall be transmitted by the BS/A-BS or the distributed scheduling R-CPE at a periodic interval (Table 335) to define the characteristics of a DS physical channel.

Table 27—DCD message format

Syntax	Size	Notes
DCD_Message_Format() {		
Management Message Type = 0	8 bits	
Configuration Change Count	8 bits	Incremented by one (modulo 256) by the BS/A-BS or the distributed scheduling R-CPE whenever any of the values of this channel descriptor change. If the value of this count in a subsequent DCD remains the same, the CPE can quickly decide that the remaining fields have not changed and may be able to disregard the remainder of the message. This value is also referenced from the DS-MAP messages (see Table 31).
DCD Channel Information Elements (IEs)	Variable in integer number of bytes	Table 28
Begin PHY Specific Section {		
Number of DS burst profiles: n	8 bits	Number of burst profiles described in the current DCD message. Its maximum size corresponds to the maximum number of DIUC burst profiles contained in Table 33 and 7.9.11.3.2.2.1.
for (i = 1; $i \leq$ n; i++) {		"n" is defined as the "Number of DS burst profiles" to be described in the current DCD message.
Downstream_Burst_Profile	Variable	PHY specific (Table 30)
}		
}		
}		

7.9.1.1 DCD Channel information elements

The elements in Table 28 are the allowed information elements that can be included in the DCD message. The last column of Table 29 ("PHY Operational Mode") indicates what network type each DCD IE is applicable to/used in. A value "Both" means that the DCD IE is used in both the WRAN and A-WRAN, a value of "WRAN only" means that the DCD IE is only used in the WRAN cell, whereas a value of "A-WRAN only" means that the DCD IE is only used in an A-WRAN cell.

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Table 28—DCD channel information elements

Name	Element ID (1 byte)	Length (bits)	Description	PHY Operational Mode
$EIRP_{BS}$	1	8	Signed in units of dBm in 0.5 dB steps with a range from –64 dBm (encoded 0x00) to +63.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme.	Both
TTG	2	2	00: TTG = 0 TU 01: TTG = 1428 TUs (for 6MHz channel bandwidth) 10: TTG = 1666 TUs (for 7MHz channel bandwidth) 11: TTG = 1903 TUs (for 8MHz channel bandwidth) (to allow for 210 us, which corresponds to a maximum of 30 km distance between a BS and its associated CPE allowed by the system PHY, larger distances can be accommodated by proper MAC scheduling)	Both
$RSS_{IR_BS_nom}$	3	8	Initial ranging nominal signal strength per subcarrier to be received at the BS by a 0 dBi antenna gain, i.e., corrected for the gain of the BS receive antenna in the direction of the CPE and for the coupling and cable loss (see 7.16.2.8.1). Signed in units of dBm in 0.5 dB steps ranging from –104 dBm (encoded 0x00) to +23.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme.	Both
Channel Action	4	3	Action to be taken by all CPEs in a cell. 000: None 001: Switch 010–111: *Reserved*	Both
Action Mode	5	1	This is valid only for channel switch (Action = 001). Indicates a restriction on transmission until the specified Channel Action is performed. The BS shall set the Action Mode field to either 0 or 1 on transmission. A value of 1 means that the CPE to which the frame containing this element is addressed shall transmit no further frames until the scheduled Channel Action is performed. An Action Mode set to 0 does not impose any requirement on the receiving CPE.	Both
Action Superframe Number	6	8	The superframe number (modulo 256) at which Channel Action shall be performed.	Both

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Table 28—DCD channel information elements *(continued)*

Name	Element ID (1 byte)	Length (bits)	Description	PHY Operational Mode
Action Frame Number	7	48	Integer value greater than or equal to zero that indicates the starting frame number, within the Action Superframe Number, at which the Channel Action shall be performed by all CPEs.	Both
Number of Backup channels	8	4	Number of backup channels in the backup and candidate channel list IE (see Table 29).	Both
WRAN Backup and Candidate channel list.	9	Variable	See Table 29 for specification.	WRAN only
A-WRAN Backup and Candidate channel list.	14	Variable	See Table 29a for specification.	A-WRAN only
Relay-RTG (RRTG)	10	8	0x00–0xFF: range of Relay RTG in 2.75 µs increments. Default set to 0x4D to allow for 210 µs for 30 km propagation.	A-WRAN only
$EIRP_{R\text{-}CPE}$	11	8	Signed in units of dBm in 0.5 dB steps with a range from –64 dBm (encoded 0x00) to +63.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme.	A-WRAN only
$RSS_{IR_R\text{-}CPE_nom}$	12	8	Initial ranging nominal signal strength per subcarrier to be received at the BS by a 0 dBi antenna gain, i.e., corrected for the gain of the BS receive antenna in the direction of the CPE and for 0 coupling and cable loss (see 7.14.2). Signed in units of dBm in 0.5 dB steps ranging from –104 dBm (encoded 0x00) to +23.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme.	A-WRAN only
Padding bits	13	0-7 bits	Padding to octet alignment—All bits shall be set to 0.	Both

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Table 29—WRAN Backup and Candidate channel list

Syntax	Size	Notes
WRAN_Backup_and_candidate_channel_list_IE_ Format() {		
Element ID = 9	8 bits	
Number of Channels in the list	8 bits	
For (*i*=0; *i* < Number of Channels in the list; *i*++) {		List of backup channels in order of priority to be used by CPEs in case of loss of communication with the BS due to incumbents. This list may also include candidate channels, in which case they will follow the backup channels in the list, and will also be included in order of priority. The number of backup channels in the list is indicated in DCD Element ID 9 (see Table 28). The list shall be a disjoint set with the current operating channel.
Channel Number	8 bits	
}		
Padding bits	0-7 bits	Padding to octet alignment—All bits shall be set to 0.
}		

Table 29a—A-WRAN Backup and Candidate channel list

Syntax	Size	Notes
A-WRAN_Backup_and_candidate_channel_list_ IE_Format() {		
Element ID = 10	8 bits	
Number of Channels in the list	8 bits	

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Table 29a—A-WRAN Backup and Candidate channel list *(continued)*

Syntax	Size	Notes
For (*i*=0; *i* < Number of Channels in the list; *i*++) {		List of backup channels in order of priority to be used by A-CPEs in case of loss of communication with the A-BS or distributed scheduling R-CPE, due to incumbents. This list may also include candidate channels, in which case they will follow the backup channels in the list, and will also be included in order of priority. The number of backup channels in the list is indicated in DCD Element ID 14 (see Table 28). The list shall be a disjoint set with the current operating channel.
Channel Number	8 bits	
Group Flag	1 bit	Flag to indicate whether the backup and candidate channels are used globally within a cell or locally within a group 0: Used globally within a cell 1: Used locally within a group
If (Group Flag=1){		
GID	10 bits	Group ID at which the backup and candidate channels are used locally within a group
}		
}		
Padding bits	0–7 bits	Padding to octet alignment—All bits shall be set to 0.
}		

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7.9.1.2 Downstream burst profile

Table 30—Downstream burst profile format

Syntax	Size	Notes
Downstream_Burst_Profile_Format() {		
Type = 1	8 bits	
DIUC	6 bits	7.9.2.1.1
Reserved	2 bits	All bits shall be set to zero
DIUC mandatory exit threshold	8 bits	–64 dB (encoded 0x00) to +63.5 dB (encoded 0xFF) CINR at or below which this DIUC can no longer be used and where change to a more robust DIUC is required (in 0.5 dB units).
DIUC mandatory entry threshold	8 bits	–64 dB (encoded 0x00) to +63.5 dB (encoded 0xFF) The minimum CINR required to start using this DIUC when changing from a more robust DIUC is required (in 0.5 dB units)
}		

7.9.2 Downstream Map (DS-MAP)

The format of a DS-MAP message is shown in Table 31. The DS-MAP message defines the access to the DS information. The length of the DS-MAP shall be an integer number of bytes.

Table 31—DS-MAP message format

Syntax	Size	Notes
DS-MAP_Message_Format() {		
Management Message Type = 1	8 bits	
DCD Count	8 bits	Matches the value of the configuration change count of the DCD, which describes the DS burst profiles that apply to this map.
If (transmitted by BS, A-BS, or distributed scheduling R-CPE) {		
Begin PHY Specific Section {		
Number of IEs: n	12 bits	Number of IEs in the DS map
for (i = 1; i < n; i++) {		
DS-MAP_IE()	Variable	PHY specific (7.9.2.1)
}		

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Table 31—DS-MAP message format *(continued)*

Syntax	Size	Notes
}		
}		
If (!byte_boundary)		
Padding bits	0–7 bits	Padding to octet alignment—All bits shall be set to 0.
}		

7.9.2.1 DS-MAP IE

The format of the DS-MAP IE is shown in Table 32. The format of the DS-MAP Extended DIUC IE is shown in Table 34 (see 7.9.2.1.2).

Table 32—DS-MAP information elements

Syntax	Size	Description
DS-MAP_IE() {		
DIUC	6 bits	7.9.2.1.1
SID	9	Station ID of CPE or multicast group
Length	12 bits	Number of OFDM slots linearly allocated to the DS burst specified by this IE.
Subcarrier Power Control	3 bits	111: *Reserved* 110: *Reserved* 101: *Reserved* 100: 1, normal (0 dB gain) 011: 2/3 010: 1/2, (in voltage ratio) 001: 1/3 000: 0
If (DIUC == 62) {		
Extended DIUC value	6 bits	
}		
}		

7.9.2.1.1 DIUC allocations

Table 33 illustrates the various DIUC values used in the MAC. Table 35 illustrates the various Extended DIUC values used in the MAC. The “PHY Operational Mode” column of Table 33 and Table 35 indicates which network these DIUCs are available in: WRAN only, A-WRAN only, or both.

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Table 33—DIUC code assignment

DIUC	Usage			PHY Operational Mode
0-12	*Reserved*			Both
13	Uncoded	NA	BPSK	Both
14	Convolutional Code	FEC rate = 1/2	QPSK	Both
15	Convolutional Code	FEC rate = 2/3	QPSK	Both
16	Convolutional Code	FEC rate = 3/4	QPSK	Both
17	Convolutional Code	FEC rate = 5/6	QPSK	Both
18	Convolutional Code	FEC rate = 1/2	16-QAM	Both
19	Convolutional Code	FEC rate = 2/3	16-QAM	Both
20	Convolutional Code	FEC rate = 3/4	16-QAM	Both
21	Convolutional Code	FEC rate = 5/6	16-QAM	Both
22	Convolutional Code	FEC rate = 1/2	64-QAM	Both
23	Convolutional Code	FEC rate = 2/3	64-QAM	Both
24	Convolutional Code	FEC rate = 3/4	64-QAM	Both
25	Convolutional Code	FEC rate = 5/6	64-QAM	Both
26	CTC	FEC rate = 1/2	QPSK	Both
27	CTC	FEC rate = 2/3	QPSK	Both
28	CTC	FEC rate = 3/4	QPSK	Both
29	CTC	FEC rate = 5/6	QPSK	Both
30	CTC	FEC rate = 1/2	16-QAM	Both
31	CTC	FEC rate = 2/3	16-QAM	Both
32	CTC	FEC rate = 3/4	16-QAM	Both
33	CTC	FEC rate = 5/6	16-QAM	Both
34	CTC	FEC rate = 1/2	64-QAM	Both
35	CTC	FEC rate = 2/3	64-QAM	Both
36	CTC	FEC rate = 3/4	64-QAM	Both
37	CTC	FEC rate = 5/6	64-QAM	Both
38	LDPC	FEC rate = 1/2	QPSK	Both
39	LDPC	FEC rate = 2/3	QPSK	Both
40	LDPC	FEC rate = ¾	QPSK	Both
41	LDPC	FEC rate = 5/6	QPSK	Both

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Table 33—DIUC code assignment *(continued)*

DIUC	Usage			PHY Operational Mode
42	LDPC	FEC rate = 1/2	16-QAM	Both
43	LDPC	FEC rate = 2/3	16-QAM	Both
44	LDPC	FEC rate = 3/4	16-QAM	Both
45	LDPC	FEC rate = 5/6	16-QAM	Both
46	LDPC	FEC rate = 1/2	64-QAM	Both
47	LDPC	FEC rate = 2/3	64-QAM	Both
48	LDPC	FEC rate = 3/4	64-QAM	Both
49	LDPC	FEC rate = 5/6	64-QAM	Both
50	SBTC	FEC rate = 1/2	QPSK	Both
51	SBTC	FEC rate = 2/3	QPSK	Both
52	SBTC	FEC rate = 3/4	QPSK	Both
53	SBTC	FEC rate = 5/6	QPSK	Both
54	SBTC	FEC rate = 1/2	16-QAM	Both
55	SBTC	FEC rate = 2/3	16-QAM	Both
56	SBTC	FEC rate = 3/4	16-QAM	Both
57	SBTC	FEC rate = 5/6	16-QAM	Both
58	SBTC	FEC rate = 1/2	64-QAM	Both
59	SBTC	FEC rate = 2/3	64-QAM	Both
60	SBTC	FEC rate = 3/4	64-QAM	Both
61	SBTC	FEC rate = 5/6	64-QAM	Both
62	DS-MAP Extended DIUC IE (Table 34)			Both
63	End of Map			Both

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7.9.2.1.2 DS-MAP Extended DIUC IE

A DS-MAP IE entry with a DIUC value of 62 indicates that the IE carries special information and conforms to the structure shown in Table 34. A CPE shall ignore an extended IE entry with an extended DIUC value for which the CPE has no knowledge. In the case of a known extended DIUC value but with a length field longer than expected, the CPE shall process information up to the known length and ignore the remainder of the IE.

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Table 34— DS-MAP Extended IE general format

Syntax	Size	Notes
DS-MAP Extended DIUC IE() {		
Extended DIUC IE Type	6 bits	See Table 35
Length	8 bits	Length of this IE in bytes.
Unspecified Data	Variable	
}		

Table 35—Extended DIUC IE Type code assignment

Extended DIUC	Usage	PHY Operational Mode
0	Convolutional Code / FEC rate = ½ / 256-QAM	A-WRAN only
1	Convolutional Code / FEC rate = 2/3 / 256-QAM	A-WRAN only
2	Convolutional Code / FEC rate = 3/4 / 256-QAM	A-WRAN only
3	Convolutional Code / FEC rate = 5/6 / 256-QAM	A-WRAN only
4	Convolutional Code / FEC rate = 7/8 / 256-QAM	A-WRAN only
5	Convolutional Code / FEC rate = 10/11 for two 2D symbols / 4D-TCM 48QAM	A-WRAN only
6	Convolutional Code / FEC rate = 10/11 for two 2D symbols / 4D-TCM 192QAM	A-WRAN only
7	CTC / FEC rate = ½ / 256-QAM	A-WRAN only
8	CTC / FEC rate = 2/3 / 256-QAM	A-WRAN only
9	CTC / FEC rate =3/4 / 256-QAM	A-WRAN only
10	CTC / FEC rate = 5/6 / 256-QAM	A-WRAN only
11	CTC / FEC rate = 7/8 / 256-QAM	A-WRAN only
12	CTC / FEC rate = 10/11 for two 2D symbols / 4D-TCM 48QAM	A-WRAN only
13	CTC / FEC rate = 10/11 for two 2D symbols / 4D-TCM 192QAM	A-WRAN only
14	LDPC / FEC rate = ½ / 256-QAM	A-WRAN only
15	LDPC / FEC rate = 2/3 / 256-QAM	A-WRAN only
16	LDPC / FEC rate =3/4 / 256-QAM	A-WRAN only
17	LDPC / FEC rate = 5/6 / 256-QAM	A-WRAN only
18	LDPC / FEC rate = 7/8 / 256-QAM	A-WRAN only

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Table 35—Extended DIUC IE Type code assignment *(continued)*

Extended DIUC	Usage	PHY Operational Mode
19	LDPC / FEC rate = 10/11 for two 2D symbols / 4D-TCM 48QAM	A-WRAN only
20	LDPC / FEC rate = 10/11 for two 2D symbols / 4D-TCM 192QAM	A-WRAN only
21	SBTC / FEC rate = ½ / 256-QAM	A-WRAN only
22	SBTC / FEC rate = 2/3 / 256-QAM	A-WRAN only
23	SBTC / FEC rate =3/4 / 256-QAM	A-WRAN only
24	SBTC / FEC rate = 5/6 / 256-QAM	A-WRAN only
25	SBTC / FEC rate = 7/8 / 256-QAM	A-WRAN only
26	SBTC / FEC rate = 10/11 for two 2D symbols / 4D-TCM 48QAM	A-WRAN only
27	SBTC / FEC rate = 10/11 for two 2D symbols / 4D-TCM 192QAM	A-WRAN only
28–31	*Reserved*	A-WRAN only
32	DS-MAP WRAN Dummy Extended IE	WRAN only
33	DS-MAP A-WRAN Dummy Extended IE	A-WRAN Only
34	DS Multi-Zone Configuration IE	A-WRAN only
35	AZDS-MAP IE	A-WRAN only
36	CRZDS-MAP IE	A-WRAN only
37	DRZDS-MAP GRA IE	A-WRAN only
38–63	*Reserved*	A-WRAN only

7.9.2.1.2.1 DS-MAP WRAN Dummy Extended IE

A CPE shall be able to decode the DS-MAP Dummy Extended IE. A BS shall not transmit this IE (unless under test). A CPE may skip decoding downlink bursts scheduled after the start time of this IE within the current frame. See Table 36.

Table 36—DS-MAP WRAN Dummy Extended IE format

Syntax	Size	Notes
DS_MAP_WRAN_Dummy_Exteneded_IE() {		
DIUC	6 bits	DIUC values 13-61 from Table 34
Padding	2 bits	00
}		

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7.9.2.1.2.2 DS-MAP A-WRAN Dummy Extended IE

An A-CPE or R-CPE shall be able to decode the DS-MAP Dummy IE. An A-BS shall not transmit this IE (unless under test). An A-CPE or R-CPE may skip decoding downlink bursts scheduled after the start time of this IE within the current frame. See Table 37.

Table 37—DS-MAP A-WRAN Dummy Extended IE format

Syntax	Size	Notes
DS_MAP_AWRAN_Dummy_Extended_IE() {		
DIUC Set Flag	2 bits	00: DIUC field in IE assumes Table 34 DIUCs 13-61 01: DIUC field in IE assumes Table 36 Extended DIUCs 0-27
DIUC	6 bits	DIUC values 13-61 from Table 34
}		

7.9.2.1.2.3 DS Multi-Zone Configuration IE

A CPE shall be able to decode the DS Multi-Zone Configuration IE shown in Table 38. An A-BS shall transmit this IE for multi-hop relay operations.

Table 38—DS Multi-Zone Configuration IE format

Syntax	Size	Notes
DS Multi-Zone Configuration_IE() {		
Multi-Zone Configuration {		
Number of zones	8 bits	Number of zones including access and relay zones. Number of zones (0) is not available of DS. Number of zone (1) shall be access zone.
For (i = 1; $i \leq$ Number of zones; i++){		
Zone Index	8 bits	Increase the index from 0 to Number of Zones–1
Zone Mode	2 bits	0: access zone 1: centralized relay zone 2: distributed relay zone
Start Position of Segment	2 bits	00: 0 01: 1 10: 2 11: If ‘Zone Mode’ is set to Access or Centralized Relay Zone
Segment Bandwidth	2 bits	00: one segment from start position 01: two segments from start position 10: three segments from start position 11: If ‘Zone Mode’ is set to Access or Centralized Relay Zone
}		

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Table 38—DS Multi-Zone Configuration IE format *(continued)*

Syntax	Size	Notes
}		
for (i = 0; i < Number of zones; i++){		
OFDMA symbol offset	7 bits	The zone starts at the OFDMA symbol offset, counted after the preamble of the frame
Zone duration	5 bits	The zone ends after the zone duration starting from the OFDMA symbol offset. The unit of duration is an OFDMA symbol
if (Zone mode == 2) {		Distributed Relay Zone (DRZ) mode
SID	9 bits	SID of distributed scheduling R-CPE
}		
}		
}		

7.9.2.1.2.4 Access Zone DS-MAP IE (AZ DS-MAP IE)

Encodings of AZ DS-MAP IE for the DS from the A-BS are provided in Table 39.

Table 39—AZDS MAP IE format

Syntax	Size	Notes
AZDS-MAP_IE(){		
Zone Index	8 bits	See Table 38
DIUC	6 bits	7.9.2.1.1
if (DIUC == 62)		
{ Extended DIUC Value }	6 bits	See Table 35
SID	9 bits	Station ID of CPE or centralized scheduling R-CPE.
Length	12 bits	Number of OFDM slots linearly allocated to the DS burst specified by this IE.
Subcarrier Power Control	3 bits	111: *Reserved* 110: *Reserved* 101: *Reserved* 100: 1, normal (0 dB gain) 011: 2/3 010: 1/2, (in voltage ratio) 001: 1/3 000: 0
Relay Mode	1 bit	0: No relay 1: Relay mode on

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Table 39—AZDS MAP IE format *(continued)*

Syntax	Size	Notes
CRZ DS-MAP Index	16 bits	For relaying through the centralized scheduling R-CPE, it indicates the matched CRZDS-MAP IE. Increase the index from 0 to 65535
}		

7.9.2.1.2.5 Centralized Relay Zone DS-MAP IE (CRZ DS-MAP IE)

Encodings of CRZ DS-MAP IE for the relay DS from the centralized scheduling R-CPE to the A-CPE are provided in Table 40.

Table 40—CRZDS MAP IE format

Syntax	Size	Notes
CRZDS-MAP_IE(){		
Zone Index	8 bits	See Table 38
CRZ DS-MAP Index	16 bits	See Table 39
DIUC	6 bits	
if (DIUC == 62)		
Extended DIUC Value	6 bits	See Table 35
SID	9 bits	Station ID of CPE or multicast group.
CRZ Start Offset	12 bits	Number of OFDMA slots counted after the centralized relay zone mode start
Length	12 bits	Number of OFDM slots linearly allocated to the CRZDS burst specified by this IE.
Boosting	3 bits	111: *Reserved* 110: *Reserved* 101: *Reserved* 100: 1, normal (0 dB gain) 011: 2/3 010: ½, (in voltage ratio) 001: 1/3 000: 0
}		

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7.9.2.1.2.6 Distributed Relay Zone DS-MAP Group Resource Allocation IE (DRZ DS-MAP GRA IE)

The format of the DRZ DS-MAP GRA IE is shown in Table 41.

Table 41—DRZ DS MAP GRA IE format

Syntax	Size	Notes
DRZDS-MAP_GRA_IE() {		
Resource Allocation Bitmap	Variable (1 bit × number of devices in the group)	Indicates whether the resources are allocated to the device in a group. The number of devices in the group is determined by the Device Bitmap Size in GRA Configuration Message. 0: not allocated in the frame 1: allocated in the frame
Resource Starting Index	11 bits	Indicates the starting index of resource in the unit of OFDMA slot. In the DS subframe, the index starts right after the frame preamble from 0. In the US subframe, the index 0 starts from the ranging/BW request/UCS notification contention windows (not including SCW) if it exists.
Resource Size Bitmap	Variable (3 bits × number of devices in the group)	Indicates the resource allocation size for the device in the unit of OFDMA slot. 000: 1 001: 2 010: 4 011: 8 100: 16 101: 32 110: 64 111: 128
Group DIUC Flag	1 bit	Indicates whether the DIUC is fixed within group. 0: not fixed within group 1: fixed within group
Group SPC Flag	1 bit	Indicates whether the Subcarrier Power Control is fixed within group. 0: not fixed within group 1: fixed within group
If (Group DIUC Flag = 0) {		
Group DIUC Bitmap	Variable (6 bits × number of devices in the group)	Specifies the DIUC of each device in a group
}		
Else{		
DIUC	6 bits	Same DIUC is used by all device in a group
if (DIUC == 62)		
Extended DIUC Value	6 bits	See Table 35

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Table 41—DRZ DS MAP GRA IE format *(continued)*

Syntax	Size	Notes
}		
If (Group SPC Flag = 0) {		
Group SPC Bitmap	Variable (3 bits × number of devices in the group)	Specifies the Subcarrier Power Control of each device in a group
}		
Else{		
SPC	3 bits	Same Subcarrier Power Control is used by all device in a group
}		
}		

7.9.3 Upstream Channel Descriptor (UCD)

The format of a UCD message is shown in Table 42. This message shall be transmitted by the BS/A-BS or the distributed scheduling A-CPE at a periodic interval (Table 272) to define the characteristics of a US physical channel.

Table 42—UCD message format

Syntax	Size	Notes
UCD_Message_Format() {		
Management Message Type = 2	8 bits	
Configuration Change Count	8 bits	Incremented by one (modulo 256) by the BS whenever any of the values of this channel descriptor change. If the value of this count in a subsequent UCD remains the same, the CPE can quickly decide that the remaining fields have not changed and may be able to disregard the remainder of the message. This value is also referenced from the US-MAP messages (see Table 46).
BW Request Backoff Start	4 bits	Initial backoff window size in units of BW Request opportunity or DRZ BW Request (see Table 44) used by CPEs to contend to send BW requests to the BS or to send DRZ BW request to the distributed scheduling R-CPE, expressed as a power of 2. Values of *n* range 0–15. See 7.15. Include a subsection that will describe the size and the content of the BW Request US burst and refer to it in the note.

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Table 42—UCD message format *(continued)*

Syntax	Size	Notes
BW Request Backoff End	4 bits	Final backoff window size in units of BW Request opportunity or DRZ BW Request (see Table 39) to contend to send BW requests to the BS or to send DRZ BW request to the distributed scheduling R-CPE, expressed as a power of 2. Values of *n* range 0–15. All declared opportunities for BW request in subsequent frames are concatenated in this potentially large number.
UCS Notification Backoff Start	4 bits	Initial backoff window size in units of UCS notification opportunity or DRZ UCS notification opportunity (see Table 31) used by CPEs to contend to send UCS notifications to the BS or to send DRZ UCS notifications to the distributed scheduling R-CPE. This is expressed as a power of 2. Values of *n* range 0–15.
UCS Notification Backoff End	4 bits	Final backoff window size in units of UCS notification opportunity or DRZ UCS notification opportunity (seeTable 31) used by CPEs to contend to send UCS notifications to the BS or to send DRZ UCS notifications to the distributed scheduling R-CPE. This is expressed as a power of 2. Values of *n* range 0–15. All declared opportunities for UCS Notifications in subsequent frames are concatenated in this potentially large number.
Information elements (IEs) for the overall channel	Variable	See 7.9.3.1.
Begin PHY Specific Section {		
Number of US burst profiles: *n*	8 bits	Number of US burst profiles described in the current UCD message. Its maximum size corresponds to the maximum number of UIUC burst profiles contained in Table 48.
for ($i = 1$; $i < n$; i++) {		*n* = number of US burst profiles
Upstream_Burst_Profile	Variable	PHY specific (see Table 48)
}		
}		
}		

7.9.3.1 UCD Channel IEs

Common channel encodings are provided in Table 43. The last column of Table 43 (Network Applicability) indicates what network type each UCD IEs is applicable to/used in. A value “Both” means that the UCD IE is used in both the WRAN and A-WRAN, a value of “WRAN only” means that the UCD IE is only used in the WRAN cell, whereas a value of “A-WRAN only” means that the UCD IE is only used in an A-WRAN cell.

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Table 43—UCD channel information elements

Name	Element ID (1 byte)	Length (bytes)	Description	Network Applicability
Contention-based reservation timeout	2	1	Number of US-MAPs to receive before contention-based reservation is attempted again for the same connection	Both
Bandwidth request opportunity size	3	1	Size (in OFDM slots) of PHY bursts, mapped horizontally in one subchannel at a time as in the case of normal US data, that a CPE may use to format and transmit a bandwidth request message in a contention request opportunity. The value includes all PHY overhead as well as allowance for the BW Request MAC subheader that the message will hold (see Table 8).	Both
UCS Notification request opportunity size	4	1	Size (in OFDM slots) of PHY bursts, mapped horizontally in one subchannel at a time as in the case of normal US data, that a CPE may use to transmit a UCS notification. The value includes all PHY overhead for the GMH containing the UCS flag (see Table 6).	Both
CRZ Bandwidth request opportunity size	5	1	Size (in OFDM slots) of PHY bursts, mapped horizontally in one subchannel at a time as for normal US data, that a CPE may use to format and transmit a bandwidth request message in a contention request opportunity. The value includes all PHY overhead as well as allowance for the BW Request MAC subheader that the message will hold (see Table 5).	A-WRAN only
CRZ UCS Notification request opportunity size	6	1	Size (in OFDM slots) of PHY bursts, mapped horizontally in one subchannel at a time as for normal US data, that a CPE may use to transmit a UCS notification. The value includes all PHY overhead for the GMH containing the UCS flag (see Table 3).	A-WRAN only
Initial ranging codes	150	1	Number of initial ranging CDMA codes. Possible values are 0–255.	Both
Periodic ranging codes	151	1	Number of periodic ranging CDMA codes. Possible values are 0–255.	Both
Bandwidth request codes	152	1	Number of bandwidth request CDMA codes. Possible values are 0–255.	Both

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Table 43—UCD channel information elements *(continued)*

Name	Element ID (1 byte)	Length (bytes)	Description	Network Applicability
UCS notification codes	153	1	Number of UCS notification CDMA codes. Possible values are 0–255.	Both
Start of CDMA codes group	154	1	Indicates the starting number, S, of the group of codes used for this US. All the ranging codes used on this US will be between S and (S+N+M+L+I) mod 256). Where: N is the number of initial-ranging codes M is the number of periodic-ranging codes L is the number of bandwidth-request codes I is the number of UCS notification codes The range of values is 0 ≤ S ≤ 255.	Both
CRZ initial ranging codes	155	1	Number of CRZ initial ranging CDMA codes. Possible values are 0–255.	A-WRAN only
CRZ periodic ranging codes	156	1	Number of CRZ periodic ranging CDMA codes. Possible values are 0–255.	A-WRAN only
CRZ UCS notification codes	157	1	Number of CRZ UCS notification CDMA codes. Possible values are 0–255.	A-WRAN only
CRZ bandwidth request code	158	1	Number of CRZ bandwidth request CDMA codes. Possible values are 0–255.	A-WRAN only

7.9.3.2 Upstream burst profile

The format of the US burst profile is shown in Table 44, and the information elements contained in the US burst profiles are defined in Table 45.

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Table 44—Upstream burst profile format

Syntax	Size	Notes
Upstream_Burst_Profile_Format() {		
Type = 1	8 bits	
UIUC	6 bits	Table 47
Reserved	2 bits	All bits shall be set to zero.
Ranging data ratio	8 bits	Reduction factor, in units of 0.5 dB, between the EIRP per subcarrier used for this burst and the EIRP per subcarrier that should be used for CDMA Ranging.
Normalized CINR override	56 bits	The first byte shall represent a signed integer which specifies, in dB, the first normalized CNR value in Table 279 (i.e., normalized CNR value corresponding to the CDMA code). Bytes 2–7: represent a list of numbers, where each number is encoded by one nibble, and is interpreted as a signed integer. The number encoded by each nibble represents the difference, in dB, in normalized CNR relative to the previous line in Table 279. Thus the left most nibble of the second byte corresponds to the difference between the normalized CNR value for QPSK, rate: 1/2, and the normalized CNR value for the CDMA code.
}		

7.9.4 Upstream Map (US-MAP)

The format of a US-MAP message is shown in Table 45. The US-MAP message defines the access to the US channel using US-MAP IEs.

Table 45—US-MAP message format

Syntax	Size	Notes
US-MAP_Message_Format() {		
Management Message Type = 3	8 bits	
UCD Count	8 bits	Matches the value of the Configuration Change Count of the UCD, which describes the US burst profiles that apply to this map.
Allocation Start Time	6 bits	Effective start time (in OFDM symbols from the start of the frame including all preambles) of the US allocation defined by the US-MAP.
Begin PHY Specific Section {		
Number of IEs: n	12 bits	Number of IEs in the US map
for (i = 1; $i \leq$ n; i++) {		

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Table 45—US-MAP message format *(continued)*

Syntax	Size	Notes
US-MAP_IE()	Variable	PHY specific (7.9.4.1) Define US bandwidth allocations. Each US-MAP message shall contain at least one IE that marks the end of the last allocated burst. (UIUC=63 as defined in Table 47.
}		
}		
If(!byte_boundary)		
Padding bits	0–7 bits	Padding to octet alignment—All bits shall be set to 0.
}		

7.9.4.1 US-MAP IE

The SID field carried by the US-MAP IE is associated with a unicast address. When specifically addressed to allocate a bandwidth grant, the FT shall be the Basic FT of the CPE. A UIUC shall be used to define the type of US access and the US burst profile associated with that access. An Upstream_Burst_Profile shall be included in the UCD for each UIUC to be used in the US-MAP. The beginning of the US subframe is clearly defined by the allocation start time, which corresponds to the number of symbols from the first preamble symbol of the current frame (e.g., superframe preamble or frame preamble) plus the width of the TTG (see Figure 12). The end of the US subframe is defined either by the SCH in the case of the scheduling of an intra-frame quiet period or by the US-MAP when a SCW is scheduled at the end of the frame by the presence of UIUC's 0 or 1 in the US-MAP.

The US-MAP IE is shown in Table 46 and is used to define the US bandwidth allocations. The first US-MAP IE shall start at the lowest numbered subchannel on the first non-allocated symbol defined by the allocation start time field of the US-MAP message. These IEs shall represent the number of OFDM slots provided for the allocation. Each allocation IE shall start immediately following the previous allocation and shall advance in the time domain. If the end of the US subframe has been reached, the allocation shall continue on the next subchannel at the first symbol (defined by the allocation start time field). The US subframe can also be defined in terms of columns as described in 7.3.2. A Burst Descriptor shall be specified in the UCD for each UIUC to be used in the US-MAP.

The SID field in this message can also refer to a group of CPEs, e.g., a multicast group. In this case, only UIUC = 0 or 1 shall be allowed to enable configuration of that group of CPEs to use an SCW (see 7.19.3 and 7.22.1.2).

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Table 46—US-MAP information elements

Syntax	Size	Description
US-MAP_IE() {		
SID	9 bits	Station ID of the CPE.
UIUC	6 bits	375H (see Table 47).
If ((UIUC ≥ 0) && (UIUC ≤ 1)) {		
CBP Frame Number	4 bits	Frame number where the active or passive CBP action is to take place. If the identified frame falls in the next superframe (e.g., current frame is 9 and the CBP Frame Number is 4), the CPE shall make sure that a SCW is still scheduled for this frame as indicated by the upcoming SCH. If not, the CBP action shall be canceled.
If(UIUC==0) {		Active SCW mode (CPE to transmit a CBP burst as requested by the BS).
Timing advance	16 bits	Signed number in TU corresponding to the advance of the transmission of the CBP burst at the CPE. As the CPE starts to transmit the CBP burst as its fourth symbol before the end of the frame, zero advance corresponds to this signal being received by the BS at the beginning of its fourth symbol before the end of the frame when the CPE is co-located with the BS (see Table 62).
EIRP Density Level	8 bits	EIRP per transmitted subcarrier (see 9.9.4.2). Signed in units of 0.5 dB, ranging from –104 dBm (encoded 0x00) to +23.5 dBm (encoded 0xFF).
}		
If(UIUC==1) {		Passive SCW mode (CPE to receive and demodulate the CBP burst and send content to the BS).
Channel Number	8 bits	Channel number in which the CPE shall listen to the medium for a coexistence beacon.
Synchronization mode	1 bit	= 0 The CPE will capture the CBP burst using its current synchronization (i.e., locked to its BS) for geolocation purposes. = 1 The CPE will re-synchronize on the received CBP burst using the preamble symbol and optionally pilot carriers to decode the payload for self-coexistence purposes.
} else if (UIUC ≥2) && (UIUC ≤ 3)) {		
Number of Subchannels	4 bits	Number of subchannels reserved for the BW Request/UCS Notification opportunistic window.
} else if (UIUC ≥4) && (UIUC ≤ 6)) {		

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Table 46—US-MAP information elements *(continued)*

Syntax	Size	Description
Number of Subchannels	4 bits	Number of subchannels reserved for the CDMA Ranging/BW Request/UCS notification opportunistic window. Note that in case where UIUC=8 and any UIUC in the range 4 to 6 are allocated to a frame, the largest number of subchannel specified shall prevail. Note also that when the CDMA ranging burst is to be used for terrestrially-based geolocation (see 11.5.2) the number of subchannels shall be at least 6.
Number of symbols	5 bits	Number of symbols in the US ranging channel reserved for the opportunistic windows carrying either CDMA Periodic Ranging/ BW Request/UCS notification as specified by the respective UIUC. These shall be placed in the ranging channel following the initial ranging window if scheduled and consecutively (see Figure 202).
} else if (UIUC == 7) {		
CDMA_ Allocation_IE ()	20 bits	See 7.9.4.1.2
} else if (UIUC == 8) {		The first 5 symbols of the US subframe shall be reserved for the opportunistic initial ranging burst.
Number of Subchannels	4 bits	Number of subchannels reserved for the initial ranging burst. Note that in case where UIUC=8 and any UIUC in the range 4 to 6 are allocated to a frame, the largest number of claimed subchannels specified shall prevail.
} else if (UIUC == 9) {		
US-MAP EIRP Control IE	Variable	US-MAP EIRP Control IE (see Table 49)
} else if (UIUC == 62) {		
Extended UIUC value	6 bits	See Table 52
} else {		
Burst_Type	1 bit	This value specifies the burst type for the burst specified by this US-MAP IE. 0: Bursts are mapped in the time axis over the full width of the US subframe before incrementing in the frequency axis. 1: Bursts are mapped in the time axis over segments of 7 symbols before incrementing in the frequency axis and then re-tracing to the lowest unused subchannel in the next 7 symbol segment. The width of the last segment is to be between 7 and 13 symbols depending on the width of the US subframe.
Duration	12 bits	Number of OFDM slots linearly allocated to the US burst specified by this IE. (Up to 60 by 30 slots can be allocated to a US burst.)
MDP	1 bit	Measurement Data Preferred Used by the BS to indicate to the CPE that this US allocation is to be preferably used by the CPE for the specific purpose of reporting back any measurement data. The measurement data to be reported is in connection to the specified Transaction ID. In case the CPE does not have anything to report, it can use this allocation for any other data. This is useful, for example, after a quiet period. 0: Measurement data not required (default) 1: Measurement data preferred

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Table 46—US-MAP information elements *(continued)*

Syntax	Size	Description
MRT	1 bit	Measurement Report Type In case MDP == 1, this field indicates which type of report the BS wants the CPE to send back. 0: Detailed (see 7.9.18.3.1.1 through 7.8.1.3.1.8) 1: Consolidated (see 7.8.1.3.1.9)
CMRP	1 bit	Channel Management Response Preferred Used by the BS to indicate to the CPE that this US allocation is to be used for confirming or not the receipt of the channel management command with the Transaction ID specified. 0: Channel management response not required (default) 1: Channel management response required
}		
}		
Padding bits	0–7 bits	Padding to octet alignment—All bits shall be set to 0.

7.9.4.1.1 UIUC allocations

Table 47 specifies the UIUC incorporated into the MAC. In particular, the self-coexistence UIUCs (in both modes) have the same applicability to their DIUC counterpart (see 7.9.2.1.1). The “PHY Operational Mode” column in Table 47 and Table 51 indicate why PHY the UIUCs are applicable in: WRAN only, A-WRAN only, or both.

Table 47—UIUC code assignment

UIUC	Usage			PHY Operational Mode
0	Self-Coexistence (Active Mode)			Both
1	Self-Coexistence (Passive Mode)			Both
2	UCS Notification			Both
3	BW Request			Both
4	CDMA_UCS Notification			Both
5	CDMA BW Request			Both
6	CDMA Periodic Ranging			Both
7	CDMA Allocation IE (see Table 48)			Both
8	CDMA Initial Ranging			Both
9	US-MAP EIRP Control IE			Both
10–12	*Reserved*			Both
13	Uncoded	N/A	BPSK	Both
14	Convolutional Code	FEC rate = 1/2	QPSK	Both
15	Convolutional Code	FEC rate = 2/3	QPSK	Both

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Table 47—UIUC code assignment *(continued)*

UIUC	Usage			PHY Operational Mode
16	Convolutional Code	FEC rate = 3/4	QPSK	Both
17	Convolutional Code	FEC rate = 5/6	QPSK	Both
18	Convolutional Code	FEC rate = 1/2	16-QAM	Both
19	Convolutional Code	FEC rate = 2/3	16-QAM	Both
20	Convolutional Code	FEC rate = 3/4	16-QAM	Both
21	Convolutional Code	FEC rate = 5/6	16-QAM	Both
22	Convolutional Code	FEC rate = 1/2	64-QAM	Both
23	Convolutional Code	FEC rate = 2/3	64-QAM	Both
24	Convolutional Code	FEC rate = 3/4	64-QAM	Both
25	Convolutional Code	FEC rate = 5/6	64-QAM	Both
26	CTC	FEC rate = 1/2	QPSK	Both
27	CTC	FEC rate = 2/3	QPSK	Both
28	CTC	FEC rate = 3/4	QPSK	Both
29	CTC	FEC rate = 5/6	QPSK	Both
30	CTC	FEC rate = 1/2	16-QAM	Both
31	CTC	FEC rate = 2/3	16-QAM	Both
32	CTC	FEC rate = 3/4	16-QAM	Both
33	CTC	FEC rate = 5/6	16-QAM	Both
34	CTC	FEC rate = 1/2	64-QAM	Both
35	CTC	FEC rate = 2/3	64-QAM	Both
36	CTC	FEC rate = 3/4	64-QAM	Both
37	CTC	FEC rate = 5/6	64-QAM	Both
38	LDPC	FEC rate = 1/2	QPSK	Both
39	LDPC	FEC rate = 2/3	QPSK	Both
40	LDPC	FEC rate = 3/4	QPSK	Both
41	LDPC	FEC rate = 5/6	QPSK	Both
42	LDPC	FEC rate = 1/2	16-QAM	Both
43	LDPC	FEC rate = 2/3	16-QAM	Both
44	LDPC	FEC rate = 3/4	16-QAM	Both
45	LDPC	FEC rate = 5/6	16-QAM	Both
46	LDPC	FEC rate = 1/2	64-QAM	Both
47	LDPC	FEC rate = 2/3	64-QAM	Both

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Table 47—UIUC code assignment *(continued)*

UIUC	Usage			PHY Operational Mode
48	LDPC	FEC rate = 3/4	64-QAM	Both
49	LDPC	FEC rate = 5/6	64-QAM	Both
50	SBTC	FEC rate = 1/2	QPSK	Both
51	SBTC	FEC rate = 2/3	QPSK	Both
52	SBTC	FEC rate = 3/4	QPSK	Both
53	SBTC	FEC rate = 5/6	QPSK	Both
54	SBTC	FEC rate = 1/2	16-QAM	Both
55	SBTC	FEC rate = 2/3	16-QAM	Both
56	SBTC	FEC rate = 3/4	16-QAM	Both
57	SBTC	FEC rate = 5/6	16-QAM	Both
58	SBTC	FEC rate = 1/2	64-QAM	Both
59	SBTC	FEC rate = 2/3	64-QAM	Both
60	SBTC	FEC rate = 3/4	64-QAM	Both
61	SBTC	FEC rate = 5/6	64-QAM	Both
62	US-MAP Extended UIUC IE (Table 51)			Both
63	End of Map			Both

7.9.4.1.2 CDMA Allocation IE

This IE is used by the BS with UIUC = 7 to assign a US bandwidth allocation to a CPE that signaled its wish to either associate through the Initial Ranging CDMA burst, to signal the presence of an incumbent by the CDMA UCS Notification, or to request a BW allocation through the CDMA BW Request burst.

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Table 48—CDMA allocation IE format

Syntax	Size	Notes
CDMA_Allocation_IE() {		
Code	8 bits	Indicates the Code sent by the CPE.
Duration	5 bits	Indicates the duration, in OFDMA slots, of the allocation. (Not necessarily on the same subchannel.)
UIUC	6 bits	UIUC to be used by the CPE for this allocation (see Table 47).
Usage	1 bit	If (Code = Incumbent) This field indicates whether the CPE shall transmit only the MAC header with the notification. 1: yes; 0: no
}		

7.9.4.1.3 US-MAP EIRP Control IE

When an EIRP change for the CPE is needed, this UIUC = 9 is used as shown in Table 49. The EIRP control value is an 8-bit signed integer expressing the EIRP per subcarrier (in 0.5 dB units) that the CPE should apply instead of its current transmission EIRP (see 9.9.4.2). The EIRP accuracy shall be ± 1.5 dB when the level is at least 10 dB below the maximum regulatory power limit and ±0.5 dB elsewhere.

Table 49—US-MAP EIRP control IE format

Syntax	Size	Notes
EIRP_Control_IE() {		
UIUC	6 bits	0x09
EIRP Control	8 bits	Signed integer that indicates the EIRP per subcarrier that the CPE should apply to correct its current transmission EIRP. Signed in units of 0.5 dB, ranging from –104 dBm (encoded 0x00) to +23.5 dBm (encoded 0xFF).
}		

7.9.4.1.4 US-MAP Extended UIUC IE

A US-MAP IE entry with a UIUC value of 62 indicates that the IE carries special information and conforms to the structure shown in Table 50. A BS/CPE shall ignore an extended IE entry with an extended UIUC value for which it has no knowledge. In the case of a known extended UIUC value but with a length field longer than expected, it shall process information up to the known length and ignore the remainder of the IE.

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Table 50—US-MAP extended IE general format

Syntax	Size	Notes
US_Extended_IE() US-MAP Extended UIUC IE (){		
Extended UIUC IE Type	6 bits	Type of Extended UIUC IE as specified in Table 51
Length	8 bits	Length of this IE in bytes
Unspecified Data	Variable	
}		

Table 51—Extended UIUC IE type code assignment

Extended UIUC	Usage	PHY Operational Mode
0	Convolutional Code / FEC rate = ½ / 256-QAM	A-WRAN only
1	Convolutional Code / FEC rate = 2/3 / 256-QAM	A-WRAN only
2	Convolutional Code / FEC rate = 3/4 / 256-QAM	A-WRAN only
3	Convolutional Code / FEC rate = 5/6 / 256-QAM	A-WRAN only
4	Convolutional Code / FEC rate = 7/8 / 256-QAM	A-WRAN only
5	Convolutional Code / FEC rate = 10/11 for two 2D symbols / 4D-TCM 48QAM	A-WRAN only
6	Convolutional Code / FEC rate = 10/11 for two 2D symbols / 4D-TCM 192QAM	A-WRAN only
7	CTC / FEC rate = ½ / 256-QAM	A-WRAN only
8	CTC / FEC rate = 2/3 / 256-QAM	A-WRAN only
9	CTC / FEC rate =3/4 / 256-QAM	A-WRAN only
10	CTC / FEC rate = 5/6 / 256-QAM	A-WRAN only
11	CTC / FEC rate = 7/8 / 256-QAM	A-WRAN only
12	CTC / FEC rate = 10/11 for two 2D symbols / 4D-TCM 48QAM	A-WRAN only
13	CTC / FEC rate = 10/11 for two 2D symbols / 4D-TCM 192QAM	A-WRAN only
14	LDPC / FEC rate = ½ / 256-QAM	A-WRAN only
15	LDPC / FEC rate = 2/3 / 256-QAM	A-WRAN only
16	LDPC / FEC rate =3/4 / 256-QAM	A-WRAN only

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Table 51—Extended UIUC IE type code assignment *(continued)*

Extended UIUC	Usage	PHY Operational Mode
17	LDPC / FEC rate = 5/6 / 256-QAM	A-WRAN only
18	LDPC / FEC rate = 7/8 / 256-QAM	A-WRAN only
19	LDPC / FEC rate = 10/11 for two 2D symbols / 4D-TCM 48QAM	A-WRAN only
20	LDPC / FEC rate = 10/11 for two 2D symbols / 4D-TCM 192QAM	A-WRAN only
21	SBTC / FEC rate = ½ / 256-QAM	A-WRAN only
22	SBTC / FEC rate = 2/3 / 256-QAM	A-WRAN only
23	SBTC / FEC rate =3/4 / 256-QAM	A-WRAN only
24	SBTC / FEC rate = 5/6 / 256-QAM	A-WRAN only
25	SBTC / FEC rate = 7/8 / 256-QAM	A-WRAN only
26	SBTC / FEC rate = 10/11 for two 2D symbols / 4D-TCM 48QAM	A-WRAN only
27	SBTC / FEC rate = 10/11 for two 2D symbols / 4D-TCM 192QAM	A-WRAN only
28–31	*Reserved*	A-WRAN only
32	US-MAP WRAN Dummy Extended IE	WRAN only
33	US-MAP A-WRAN Dummy Extended IE	A-WRAN only
34	US Multi-Zone Configuration IE	A-WRAN only
35	AZUS-MAP IE	A-WRAN only
36	CRZUS-MAP IE	A-WRAN only
37	DRZUS-MAP GRA IE	A-WRAN only
38–63	*Reserved*	A-WRAN only

7.9.4.1.4.1 US-MAP WRAN Dummy Extended IE

A CPE shall be able to decode the US-MAP Dummy Extended IE. A BS shall not transmit this IE (unless under test).

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Table 52—US-MAP WRAN Dummy Extended IE format

Syntax	Size	Notes
US_MAP_WRAN_Dummy_Extended_IE() {		
UIUC	6 bits	UIUC values 13-61 from Table 47
Padding	2 bits	00
}		

7.9.4.1.4.2 US-MAP A-WRAN Dummy Extended IE

An A-CPE or R-CPE shall be able to decode the US-MAP Dummy Extended IE. An A-BS shall not transmit this UE (unless under test).

Table 53—US-MAP A-WRAN Dummy Extended IE format

Syntax	Size	Notes
US_MAP_AWRAN_Dummy_IE() {		
UIUC Set Flag	2 bits	00: UIUCs in this IE assume UIUCs from Table 47 10: UIUCs in this IE assume Extended UIUCs from Table 51 10-11: *Reserved*
UIUC	6 bits	UIUC values
}		

7.9.4.1.4.3 US Multi-Zone Configuration IE

A CPE shall be able to decode the US Multi-Zone Configuration IE shown in Table 54. An A-BS shall transmit this IE for multi-hop relay operations.

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Table 54—US Multi-Zone Configuration IE format

Syntax	Size	Notes
US Multi-Zone Configuration_IE() {		
Multi-Zone configuration{		
Number of zones	8 bits	Number of zones including access and relay zones. Number of zones (0) is not available of DS. Number of zone (1) shall be access zone.
For (i = 1; i ≤ Number of zones; i++){		
Zone Index	8 bits	Increase the index from 0 to Number of Zones–1
Zone Mode	2 bits	0: access zone 1: centralized relay zone 2: distributed relay zone
Start Position of Segment	4 bits	00: 0 01: 1 10: 2 11: If 'Zone Mode' is set to Access or Centralized Relay Zone
Segment Bandwidth	2 bits	00: one segment from start position 01: two segments from start position 10: three segments from start position 11: If 'Zone Mode' is set to Access or Centralized Relay Zone
}		
}		
for (i = 0; i < Number of zones; i++){		
OFDMA symbol offset	7 bits	The zone starts at the OFDMA symbol offset, counted after the preamble of the frame
Zone duration	5 bits	The zone ends after the zone duration starting from the OFDMA symbol offset. The unit of duration is an OFDMA symbol
if (Zone mode == 2) {		Distributed Relay Zone (DRZ) mode
SID	9 bits	SID of distributed scheduling R-CPE
}		
}		
}		

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7.9.4.1.4.4 Access Zone US-MAP IE (AZUS-MAP IE)

Encodings of AZ US-MAP IE for the US to the A-BS are provided in Table 55.

Table 55—AZ US MAP IE format

Syntax	Size	Notes
AZ US-MAP_IE() {		
Zone Index	8 bits	See Table 54
CRZUS-MAP Index	16 bits	For relaying through the centralized scheduling R-CPE, it indicates the matched CRZUS-MAP IE. Increase the index from 0 to 65535
SID	9 bits	Station ID of the CPE or centralized scheduling R-CPE.
UIUC	6 bits	7.9.4.1.1 (see Table 48)
If (UIUC ==62)		
Extended UIUC Value	6 bits	See 7.9.4.1.1
If ((UIUC ≥ 0) && (UIUC ≤ 1)) {		Frame number where the active or passive CBP action is to take place.
CBP Frame Number	4 bits	Active SCW mode (CPE to transmit a CBP burst as requested by the BS).
If(UIUC==0) {		
Timing advance	16 bits	Signed number in TU corresponding to the advance of the transmission of the CBP burst at the CPE. As the CPE starts to transmit the CBP burst as its fourth symbol before the end of the frame, zero advance corresponds to this signal being received by the BS at the beginning of its fourth symbol before the end of the frame when the CPE is co-located with the BS (see Table 44).
EIRP Density Level	8 bits	EIRP per transmitted subcarrier (see 9.9.4.2). Signed in units of 0.5 dB, ranging from –104 dBm (encoded 0x00) to +23.5 dBm (encoded 0xFF).
}		
If(UIUC==1) {		Passive SCW mode (CPE to receive and demodulate the CBP burst and send content to the BS).
Channel Number	8 bits	Channel number in which the CPE shall listen to the medium for a coexistence beacon.
Synchronization mode	1 bit	0: The CPE will capture the CBP burst using its current synchronization (i.e., locked to its BS) for geolocation purposes. 1: The CPE will resynchronize on the received CBP burst using the preamble symbol and optionally pilot carriers to decode the payload for self-coexistence purposes.
} else if (UIUC ≥ 2) && (UIUC ≤ 3)) {		

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Table 55—AZ US MAP IE format *(continued)*

Syntax	Size	Notes
Number of Subchannels	4 bits	Number of subchannels reserved for the BW Request/ UCS Notification opportunistic window.
Number of Symbols	5 bits	Number of symbols reserved for the BW Request/UCS/ Notification opportunistic window.
} else if (UIUC ≥ 4) && (UIUC ≤ 6)) {		
Number of Subchannels	4 bits	Number of subchannels reserved for the CDMA Periodic Ranging/BW Request/UCS notification opportunistic window. Note that in case where UIUC=8 and any UIUC in the range 4 to 6 are allocated to a frame, the largest number of subchannel specified shall prevail. Note also that when the CDMA ranging burst is to be used for terrestrially-based geolocation (see 11.5.2), the number of subchannels shall be at least 6.
Number of symbols	5 bits	Number of symbols CDMA Periodic Ranging/BW Request/UCS notification as specified by the respective UIUC. These shall be placed in the ranging channel following the initial ranging window if scheduled and consecutively (see Figure 157).
} else if (UIUC == 7) {		
CDMA_ Allocation_IE ()	20 bits	See 7.9.4.1.2
} else if (UIUC == 8) {		
Number of Subchannels	4 bits	Number of subchannels reserved for the initial ranging burst. Note that in case where UIUC=8 and any UIUC in the range 4 to 6 are allocated to a frame, the largest number of claimed subchannels specified shall prevail.
Number of Symbols	5 bits	Number of symbols reserved for the initial ranging burst.
} else if (UIUC == 9) {		
US-MAP EIRP Control IE	Variable	See 7.9.4.1.3
} else {		
Burst_Type	1 bit	This value specifies the burst type for the burst specified by this US-MAP IE. 0: Bursts are mapped in the time axis over the full width of the US subframe before incrementing in the frequency axis. 1: Bursts are mapped in the time axis over segments of 7 symbols before incrementing in the frequency axis and then retracing to the lowest unused subchannel in the next 7 symbol segment. The width of the last segment is to be between 7 and 13 symbols depending on the width of the US subframe.
Duration	12 bits	Number of OFDM slots linearly allocated to the US burst specified by this IE. (Up to 60 by 30 slots can be allocated to a US burst.)

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Table 55—AZ US MAP IE format *(continued)*

Syntax	Size	Notes
MDP	1 bit	Measurement Data Preferred Used by the BS to indicate to the CPE that this US allocation is to be preferably used by the CPE for the specific purpose of reporting back any measurement data. The measurement data to be reported is in connection to the specified Transaction ID. In case the CPE does not have anything to report, it can use this allocation for any other data. This is useful, for example, after a quiet period. 0: Measurement data not required (default) 1: Measurement data preferred
MRT	1 bit	Measurement Report Type In case MDP == 1, this field indicates which type of report the BS wants the CPE to send back. 0: Detailed (see 7.9.18.3.1.1 through 7.9.18.3.1.8) 1: Consolidated (see 7.9.18.3.1.9)
CMRP	1 bit	Channel Management Response Preferred Used by the BS to indicate to the CPE that this US allocation is to be used for confirming or not the receipt of the channel management command with the Transaction ID specified. 0: Channel management response not required (default) 1: Channel management response required
}		
}		
}		

7.9.4.1.4.5 Centralized Relay Zone US-MAP IE (CRZ US-MAP IE)

Encodings of CRZ US-MA IE for the relay US to the centralized scheduling R-CPE from the A-CPE are provided in Table 56.

Table 56—CRZUS MAP IE format

Syntax	Size	Notes
CRZ US-MAP_IE() {		
Zone Index	8 bits	See Table 54
CRZ US-MAP Index	16 bits	See Table 54
SID	9 bits	Station ID of the CPE.
UIUC	6 bits	7.9.4.1.1 (see Table 47).
If (UIUC == 62)		
Extended UIUC Value	6 bits	See 7.9.4.1.1.
If ((UIUC ≥ 0) && (UIUC ≤ 1)) {		Frame number where the active or passive CBP action is to take place.

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Table 56—CRZUS MAP IE format *(continued)*

Syntax	Size	Notes
CBP Frame Number	4 bits	Active SCW mode (CPE to transmit a CBP burst as requested by the BS).
If(UIUC==0) {		
Timing advance	16 bits	Signed number in TU corresponding to the advance of the transmission of the CBP burst at the CPE. As the CPE starts to transmit the CBP burst as its fourth symbol before the end of the frame, zero advance corresponds to this signal being received by the BS at the beginning of its fourth symbol before the end of the frame when the CPE is co-located with the BS (see Table 44).
EIRP Density Level	8 bits	EIRP per transmitted subcarrier (see 9.9.4.2). Signed in units of 0.5 dB, ranging from –104 dBm (encoded 0x00) to +23.5 dBm (encoded 0xFF).
}		
If(UIUC==1) {		Passive SCW mode (CPE to receive and demodulate the CBP burst and send content to the BS).
Channel Number	8 bits	Channel number in which the CPE shall listen to the medium for a coexistence beacon.
Synchronization mode	1 bit	0: The CPE will capture the CBP burst using its current synchronization (i.e., locked to its BS) for geolocation purposes. 1: The CPE will resynchronize on the received CBP burst using the preamble symbol and optionally pilot carriers to decode the payload for self-coexistence purposes.
} else if (UIUC ≥ 2) && (UIUC ≤ 3)) {		
Number of Subchannels	4 bits	Number of subchannels reserved for the Relay BW Request/UCS Notification opportunistic window.
Number of Symbols	5 bits	Number of symbols reserved for the Relay BW Request/ UCS/Notification opportunistic window.
} else if (UIUC ≥ 4) && (UIUC ≤ 6)) {		
Number of Subchannels	4 bits	Number of subchannels reserved for the Relay CDMA Periodic Ranging/BW Request/UCS notification opportunistic window. Note that in case where UIUC=8 and any UIUC in the range 4 to 6 are allocated to a frame, the largest number of subchannel specified shall prevail. Note also that when the CDMA ranging burst is to be used for terrestrially based geolocation (see 11.5.2), the number of subchannels shall be at least 6.
Number of symbols	5 bits	Number of symbols Relay CDMA Periodic Ranging/ BW Request/UCS notification as specified by the respective UIUC. These shall be placed in the ranging channel following the initial ranging window if scheduled and consecutively (see Figure 57).
} else if (UIUC == 7) {		
CDMA_ Allocation_IE ()	20 bits	See 7.9.4.1.2.
} else if (UIUC == 8) {		

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Table 56—CRZUS MAP IE format *(continued)*

Syntax	Size	Notes
Number of Subchannels	4 bits	Number of subchannels reserved for the Relay initial ranging burst. Note that in case where UIUC=8 and any UIUC in the range 4 to 6 are allocated to a frame, the largest number of claimed subchannels specified shall prevail.
Number of Symbols	5 bits	Number of symbols reserved for the Relay initial ranging burst.
} else if (UIUC == 9) {		
US-MAP EIRP Control IE	Variable	See 7.9.4.1.3.
} else {		
Burst_Type	1 bit	This value specifies the burst type for the burst specified by this US-MAP IE. 0: Bursts are mapped in the time axis over the full width of the US subframe before incrementing in the frequency axis. 1: Bursts are mapped in the time axis over segments of 7 symbols before incrementing in the frequency axis and then retracing to the lowest unused subchannel in the next 7 symbol segment. The width of the last segment is to be between 7 and 13 symbols depending on the width of the US subframe.
Duration	12 bits	Number of OFDM slots linearly allocated to the US burst specified by this IE. (Up to 60 by 30 slots can be allocated to a US burst.)
MDP	1 bit	Measurement Data Preferred Used by the BS to indicate to the CPE that this US allocation is to be preferably used by the CPE for the specific purpose of reporting back any measurement data. The measurement data to be reported is in connection to the specified Transaction ID. In case the CPE does not have anything to report, it can use this allocation for any other data. This is useful, for example, after a quiet period. 0: Measurement data not required (default) 1: Measurement data preferred
MRT	1 bit	Measurement Report Type In case MDP == 1, this field indicates which type of report the BS wants the CPE to send back. 0: Detailed (see 7.9.18.3.1.1 through 7.9.18.3.1.8) 1: Consolidated (see 7.9.18.3.1.9)
CMRP	1 bit	Channel Management Response Preferred Used by the BS to indicate to the CPE that this US allocation is to be used for confirming or not the receipt of the channel management command with the Transaction ID specified. 0: Channel management response not required (default) 1: Channel management response required
}		
}		
}		

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7.9.4.1.4.6 Distributed Relay Zone US-MAP Group Resource Allocation IE (DRZUS-MAP GRA IE)

The format of the DRZ US-MAP GRA IE is shown in Table 57.

Table 57—DRZUS MAP GRA information element

Syntax	Size	Notes
DRZUS-MAP_GRA_IE() {		
Resource Allocation Bitmap	Variable (1 bit × number of devices in the group)	Indicates whether the resources are allocated to the device in a group. The number of devices in the group is determined by the Device Bitmap Size in GRA Configuration Message. 0: not allocated in the frame 1: allocated in the frame
Resource Starting Index	11 bits	Indicates the starting index of resource in the unit of OFDMA slot. In the DS subframe, the index starts right after the frame preamble from 0. In the US subframe, the index 0 starts from the ranging/BW request/UCS notification contention windows (not including SCW) if it exists.
Resource Size Bitmap	Variable (3 bits × number of devices in the group)	Indicates the resource allocation size for the device in the unit of OFDMA slot. 000: 1 001: 2 010: 4 011: 8 100: 16 101: 32 110: 64 111: 128
Group UIUC Flag	1 bit	Indicates whether the UIUC is fixed within group. 0: not fixed within group 1: fixed within group
Group Burst_Type Flag	1 bit	Indicates whether the Burst_Type is fixed within group. 0: not fixed within group 1: fixed within group
Group MDP Flag	1 bit	Indicates whether the MDP is fixed within group. 0: not fixed within group 1: fixed within group
Group MRT Flag	1 bit	Indicates whether the MRT is fixed within group. 0: not fixed within group 1: fixed within group
Group CMRP Flag	1 bit	Indicates whether the CMRP is fixed within group. 0: not fixed within group 1: fixed within group
If (Group UIUC Flag = 0) {		
Group UIUC Bitmap	Variable (6 bits × number of devices in the group)	Specifies the UIUC of each device in a group

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Table 57—DRZUS MAP GRA information element *(continued)*

Syntax	Size	Notes
}		
Else {		
UIUC	6 bits	Same UIUC is used by all device in a group
If (UIUC == 62)		
Extended UIUC Value	6 bits	See 7.9.4.1.1
}		
If (Group Burst_Type Flag = 0) {		
Group Burst_Type Bitmap	Variable (1 bit × number of devices in the group)	Specifies the Burst_Type of each device in a group
}		
Else{		
Burst_Type	1 bit	Same Burst_Type is used by all device in a group
}		
If (Group MDP Flag = 0) {		
Group MDP Bitmap	Variable (1 bit × number of devices in the group)	Specifies the MDP of each device in a group
}		
Else{		
MDP	1 bit	Same MDP is used by all device in a group
}		
If (Group MRT Flag = 0) {		
Group MRT Bitmap	Variable (1 bit × number of devices in the group)	Specifies the MRT of each device in a group
}		
Else{		
MRT	1 bit	Same MRT is used by all device in a group
}		
If (Group CMRP Flag = 0) {		

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Table 57—DRZUS MAP GRA information element *(continued)*

Syntax	Size	Notes
Group CMRP Bitmap	Variable (1 bit × number of devices in the group)	Specifies the CMRP of each device in a group
}		
Else{		
CMRP	1 bit	Same CMRP is used by all device in a group
}		
}		

7.9.5 RNG-REQ

The format of a Ranging Request (RNG-REQ) message is shown in Table 58. An RNG-REQ shall be transmitted by the CPE at initialization and periodically to determine network delay and to request EIRP and/or DS burst profile change. The RNG-REQ message may be sent in Initial Ranging and data grant intervals.

The FT field carried in the MAC header of the PDU, and the SID in the US-MAP IE indicating from which CPE this message is transmitted shall assume the following values when sent in the granted Initial Ranging US interval:

— SID = Cell SID, FT = Initial ranging FT if the CPE is attempting to join the network.

— SID = Cell SID, FT = Initial ranging FT if the CPE has not yet registered and is changing channel.

— For periodic ranging, the SID is a unicast SID assigned to the CPE in a RNG-CMD MAC message whereas the FT is the Basic FT.

If sent in a data grant interval, the FT is always equal to the Basic FT.

Table 58—RNG-REQ message format

Syntax	Size	Notes
RNG-REQ_Message_Format() {		
Management Message Type = 4	8 bits	
Information elements (IEs)	Variable	
If (!byte_boundary)		
Padding Bits	0–7 bits	Padding to octet alignment—All bits shall be set to 0.
}		

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Table 59—RNG-REQ information elements

Name	Element ID (1 byte)	Length	Description
Downstream burst profile	1	6 bits	Burst profile that can be received by the CPE for the RNG-CMD.
CPE MAC address	2	6 bytes	CPE MAC address that is assigned universally by manufacturer, or locally assigned if CPE Privacy (see 8.7) is being used.
MMP_PN	3	3 bytes	MMP_PN of MMP_Key associated with active authorization key (AK) context installed on CPE (see 8.2.4.6.)
Ciphertext ICV	4	8 bytes	Ciphertext ICV calculated over the RNG-REQ message, excluding the MMP_PN IE (see 8.2.4.6).
Ranging anomalies	5	3 bits	A parameter indicating a potential error condition detected by the CPE during the ranging process. Setting the bit associated with a specific condition indicates that the condition exists at the CPE. Bit 0—CPE already at maximum EIRP. Bit 1—CPE already at minimum EIRP. Bit 2—Timing advance is too large.

7.9.6 RNG-CMD

The format of a Ranging Command (RNG-CMD) message is shown in Table 60. An RNG-CMD shall be transmitted by the BS in response to a received RNG-REQ. In addition, it may also be transmitted without a specific RNG-REQ message received by the BS to send corrections based on measurements that have been made on other received data or MAC messages from the CPE. As a result, the CPE shall be prepared to receive an RNG-CMD at any time, not just following an RNG-REQ transmission.

Table 60—RNG-CMD message format

Syntax	Size	Notes
RNG-CMD_Message_Format() {		
Management Message Type = 5	8 bits	
Information elements (IEs)	Variable	
If (!byte_boundary)		
Padding Bits	0–7 bits	Padding to octet alignment—All bits shall be set to 0.
}		

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Information elements 1–7 of are used for normal CDMA ranging purposes. Information elements 6–9 of Table 61 are used for CDMA geolocation retry purposes. To avoid ambiguity on which IE is being transmitted, its Element ID shall be transmitted before each IE contained in the message.

Table 61—RNG-CMD information elements

Name	Element ID (1 byte)	Length (bits)	Description
Timing advance	1	16	Unsigned timing advance at the CPE, in number of TU, to compensate for the signal propagation delay on both, the DS and the US RF paths, so that the US burst arrives at the BS within the tolerance specified in 9.9.2. The timing advance shall be set to 0 when the CPE is co-located with the BS and shall increase as the CPE is located further away from the BS.
EIRP per subcarrier	2	8	P_{range}: EIRP per transmitted subcarrier (see 9.9.4.2). Signed in units of 0.5 dB and ranging from –104 dBm (encoded 0x00) to +23.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme.
Offset frequency adjust	3	16	Signed number in Hertz
Ranging status	4	3	000: Continue 001: Abort 010: Success 011: Re-range 100: Reauthenticate 101: Re-range and Re-register 110–111: *Reserved*
CPE MAC address	6	48	CPE MAC address that's assigned universally by manufacturer, or locally assigned if CPE Privacy (see 8.7) is being used.
Station ID	7	9	Required parameter when RNG-CMD is sent in response to initial ranging.
Action Superframe Number	8	8	The superframe number (modulo 256) at which Channel Action shall be performed.
Action Frame Number	9	4	Integer value greater than or equal to zero that indicates the starting frame number, within the Action Superframe Number, at which the Channel Action shall be performed by all CPEs.
CDMA code	10	8	A unique code assigned to the CPE, to be used for dedicated ranging. Code is from the initial ranging codeset.
Transmission opportunity offset	11	8	A unique transmission opportunity assigned to the CPE, to be used for dedicated ranging in units of symbol duration.

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7.9.7 REG-REQ/RSP

CPEs shall register with a BS before receiving or being provided any type of service. In the following subclauses, the registration process incorporated in the MAC as well as a series of IEs that may be carried by these messages are presented.

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7.9.7.1 REG-REQ

The format of a REG-REQ message is shown in Table 62. This message shall be transmitted by CPEs at initialization phase.

The FT field carried in the MAC header of the PDU where this message is transmitted shall be the primary management FT for this CPE, which is assigned during the RNG-CMD message.

Table 62—REG-REQ message format

Syntax	Size	Notes
REG-REQ_Message_Format() {		
Management Message Type = 6	8 bits	
Information elements (IEs)	Variable	7.9.7.3
}		

7.9.7.2 REG-RSP

The format of an REG-RSP message is shown in Table 63. This message shall be transmitted by the BS in response to a REG-REQ.

The FT field carried in the MAC header of the PDU where this message is transmitted shall be the primary management FT of the CPE for which this message is intended.

Table 63—REG-RSP message format

Syntax	Size	Notes
REG-RSP_Message_Format() {		
Management Message Type = 7	8 bits	
Response	8 bits	0x00: OK 0x01: Failure (e.g., authentication)
Information elements (IEs)	Variable	7.9.7.3
Confirmation code	8 bits	Code defining error status of registered capability configuration request (see 7.9.24)
}		

7.9.7.3 REG-REQ/RSP information elements

REG-REQ and REG-RSP management messages may carry a number of IEs that support the registration process. The REG-REQ message shall include the CPE NMEA Location String IE. These IEs are described in detail in the following subclauses. In 7.9.7.3.1 to 7.9.7.3.6, each table has a column called Network Applicability, which indicates what network type REG-REQ/RSP IE is applicable to/used in. A value of "Both" means that the IE is used in both the WRAN and A-WRAN, a value of "WRAN only" means that the

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IE is only used in the WRAN cell, whereas a value of "A-WRAN only" means that the IE is only used in an A-WRAN cell.

7.9.7.3.1 CPE NMEA Location String

This is the location data string pertaining to the CPE's location. It shall be in the NMEA 0183 ASCII format. This IE shall be added to the REG-REQ message during initial registration during network entry, as well as in the transmission of a REG-REQ that is in response to a RNG-CMD sent with ranging status set to "Re-range and Re-register" (see 7.16.2.11).

Table 64—CPE NMEA Location String information element

Syntax	Size	Description	Scope	Network Applicability
CPE_NMEA_Location_String() {			REG-REQ	Both
Element ID	1 byte	1		
Length	2 bytes	length of location data string in octets		
Location Data String	Variable	NMEA 0183 ASCII string		
}				

7.9.7.3.2 Convergence sublayer configuration

The Convergence sublayer configuration parameter dictates how the provider intends to operate the CPE on an ongoing basis. If the IE= 0, the CPE shall use the Ethernet CS. This allows the CPE to either act as a bridge or other Ethernet device. If IE = 1, the CPE shall use the IP CS. This allows the CPE to either act as a router, or other IP-based device.

Table 65—Convergence Sublayer Specification information element

Syntax	Size	Description	Scope	Network Applicability
Convergence Sublayer Specification() {			REG-REQ, REG-RSP	Both
Element ID	1 byte	2		
Specification	1 byte	0x00: Ethernet CS 0x01: IP CS 0x02–0xFF: *Reserved*		
}				

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7.9.7.3.3 IP Version

This field indicates the version of Internet Protocol used on the Secondary Management Connection. IPv6 is not mandatory. The omission of the IP Version parameter in the REG-REQ message shall be interpreted as IPv4 support only.

Table 66— IP Version information element

Syntax	Size	Description	Scope	Network Applicability
IP version () {			REG-REQ, REG-RSP	Both
Element ID	1 byte	3		
Specification	1 byte	0x00: IPv4 0x01: IPv6		
}				

7.9.7.3.4 CPE capability

Through the registration process a BS shall become aware of the capabilities of the registering CPEs. The following subclauses describe the IEs that convey the CPE capability information to the BS.

7.9.7.3.4.1 IP ROHC support

This IE indicates the ability of the CPE to support IP Robust Header Compression (ROHC).

Table 67—IP ROHC Support information element

Syntax	Size	Description	Scope	Network Applicability
IP ROCH Support () {			REG-REQ, REG-RSP	Both
Element ID	1 byte	4		
Specification	1 byte	0x00: No IP ROHC support 0x01: IP ROHC supported 0x02–0xFF: *Reserved*		
}				

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7.9.7.3.4.2 ARQ support

This field indicates the availability of CPE support for ARQ. If ARQ is enabled for Secondary Management flow, the IEs that are defined in 7.9.8.9.17.2 to 7.9.8.9.17.8 shall be added to the REG-REQ or REG-RSP to facilitate configuration of ARQ that is to be applied on PDUs traversing the Secondary Management flow. Two-link ARQ support is only available to A-CPEs/R-CPEs operating in an A-WRAN in PHY-OM2.

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Table 68—ARQ Support information element

Syntax	Size	Description	Scope	Network Applicability
ARQ Support () {			REG-REQ, REG-RSP	Both
Element ID	1 byte	5		
Specification	1 byte	0x00: No ARQ support 0x01: ARQ supported on Secondary Management flow only 0x02: ARQ supported on Transport flows only 0x03: ARQ supported on Secondary Management and Transport flows 0x04: Two-link ARQ supported on Secondary Management flow only 0x05: Two-link ARQ supported on Transport flows only 0x06: Two-link ARQ supported on Secondary Management and Transport flows 0x07–0xFF: *Reserved*		
}				

7.9.7.3.4.3 ARQ parameters

This field provides the fragmentation and ARQ parameters applied during the establishment of the secondary management connection. This field is related to the ARQ parameters described in 7.9.8.9.17.

Table 69—ARQ information elements

Syntax	Size	Description	Scope	Network Applicability
ARQ () {			REG-REQ, REG-RSP	Both
Element ID	1 byte	6		
Specification	Variable	Compound		
}				

7.9.7.3.4.4 DSx Flow Control

This field specifies the maximum number of concurrent DSA, DSC, or DSD transactions that may be outstanding.

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Table 70—DSx Flow Control information element

Syntax	Size	Description	Scope	Network Applicability
DSx Flow Control () {			REG-REQ, REG-RSP	Both
Element ID	1 byte	7		
Specification	1 byte	0: no limit (default) 1–255: indicate maximum concurrent transactions		
}				

7.9.7.3.4.5 MCA Flow Control

This field specifies the maximum number of concurrent MCA transactions that may be outstanding.

Table 71—MCA Flow Control information element

Syntax	Size	Description	Scope	Network Applicability
MCA Flow Control () {			REG-REQ, REG-RSP	Both
Element ID	1 byte	8		
Specification	1 byte	0: no limit (default) 1–255: indicate maximum concurrent transactions		
}				

7.9.7.3.4.6 Maximum number of Multicast Groups supported

This field indicates the maximum number of simultaneous Multicast Groups to which the CPE is capable of belonging.

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Table 72—Maximum number of Multicast Groups supported information element

Syntax	Size	Description	Scope	Network Applicability
Maximum number of Multicast Groups Supported () {			REG-REQ, REG-RSP	Both
Element ID	1 byte	9		
Specification	1 byte	0–255 0 (default)		
}				

7.9.7.3.4.7 Measurement support

The CPE adds this IE in the REG-REQ to indicate to the BS what sensing capabilities the CPE supports, as well as how well the CPE can sense for particular signals. In the REG-RSP, the BS sets this IE to configure what sensing capabilities the CPE will make use of and how sensing for particular signals is to be executed. Note that if the "No Sensing" bit (Bit 0) in the Sensing Mode Support Bitmap is set to True, Bits 1, 2, and 3 shall be set to False. When the BS configures the IE for transmission in a REG-RSP, then sensing would be disabled at the CPE.

Table 73—Measurement Support information element

Syntax	Size	Description	Scope	Network Applicability
Measurement Support () {				Both
Element ID	8 bits	10		
Length	16 bits	n×7+5 (bytes) where "n" is equal to the number of ones in the Signal Type Array.		
Sensing Mode Support Bitmap	8 bits	Bit 0: No Sensing Bit 1: Sensing Mode 1 Bit 2: Sensing Mode 2 Bit 3: Sensing Mode 3 Bit 4–7: *Reserved, set to 0* 0: False, 1: True		
Signal Type Array	32 bits	Signal Type Array that Spectrum Sensing Function is capable of sensing (see Table 318).		
for (i = 1; $i \leq$ n; i++) {		n = number of ones in the Signal Type Array.		

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Table 73—Measurement Support information element *(continued)*

Syntax	Size	Description	Scope	Network Applicability
Sensitivity Threshold	12 bits	Only applies for incumbent profiles. Signed number that indicates the threshold (in dBm) to be used by CPEs for detection (see Table 328).	REG-REQ, REG-RSP	
PD	8 bits	Probability of Detection. 0x00 indicates '0' and 0xFF indicates '1'		
MPFA	8 bits	Maximum Probability of False Alarm—0x00 indicates '0' and 0xFF indicates '0.256'		
Recommended NumSensingPeriods	7 bits	See Table 319—Number of sensing periods required.		
Recommended SensingPeriodDuration	10 bits	See Table 319—Sensing Period Duration as specified as an integer number of symbols		
Recommended SensingPeriodInterval	11 bits	See Table 319—Sensing Period Interval as specified in the integer number of frames		
}				
Padding Bits	6 bits	To make this IE an integer number of bytes.		
}				

7.9.7.3.4.8 Manufacturer-specific Antenna Model

Table 74—Manufacturer-specific Antenna Model information element

Syntax	Size	Specification	Scope	Network Applicability
Manufacturer-Specific Antenna Model () {			REG-REQ, REG-RSP	Both
Element ID	1 byte	11		
Length	2 bytes	Length of data stream containing antenna model configuration		
Specification	variable	Data stream identifying the antenna model		
}				

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7.9.7.3.4.9 CPE Antenna Gain

This information provided by the CPE at registration can be used by the BS to prioritize its list of backup/ candidate channels based on the receiving performance of its CPE.

Table 75—CPE Antenna Gain information element

Syntax	Size	Description	Scope	Network Applicability
CPE Antenna Gain () {			REG-REQ	Both
Element ID	8 bits	12		
Number of channels	8 bits	Total number of channels for which the antenna gain is defined.		
for (i = 1; $i \leq$ n; i++) {		n = the number of channels		
Channel number	8 bits			
On-axis gain	8 bits	Maximum on-axis antenna gain in the specified channel in 0.25 dB units from –22.0 dBi (0x01) to 41.0dBi (0xFD) 0x00: the CPE or BS shall refrain from transmitting on this channel 0x01: also used for antenna gain smaller than –22.0 dBi 0xFE: antenna gain larger than 41.0 dBi 0xFF is not allowed.		
}				
}				

7.9.7.3.4.10 CPE residual delay

This residual delay shall be measured by the manufacturer when the CPE is co-located with the BS (i.e., BS and CPE antennas are co-located or the BS and CPE are connected through the proper lengths of feed cables) and the Timing Advance (see Table 61) is set to zero. The manufacturer shall record this residual delay in the CPE, which shall be reported to the BS at the time of registration on the network.

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Table 76—CPE Residual Delay

Syntax	Size	Description	Scope	Network Applicability
CPE Residual Delay () {			CBC-REQ	Both
Element ID	1 byte	13		
Specification	3 byte	CPE Residual Delay Signed integer representing the CPE residual delay in nanoseconds. Positive value indicates a delay. Negative value indicates an advance. Accuracy shall be within ± 30 ns for 10 m distance accuracy.		
}				

7.9.7.3.4.11 Method for allocating IP addresses on secondary management connections

Table 77—IP address allocation information element

Syntax	Size	Description	Scope	Network Applicability
IP addresses on secondary management connections () {			REG-REQ, REG-RSP	Both
Element ID	1 byte	14		
Specification	1 byte	Bit 0: DHCPv4 Bit 1: Mobile IPv4 Bit 2: DHCPv6 Bit 3: IPv6 Stateless Address Auto-configuration Bit 4–7: *Reserved, shall be set to 0.*		
}				

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7.9.7.3.4.12 *Reserved*

Table 78—*Reserved*

Syntax	Size	Description	Scope	Network Applicability

7.9.7.3.4.13 CPE Operational Capability

This field allows the CPE to signal to the BS that it is to be operated as a Fixed or Portable terminal. WRAN CPEs shall only be capable of selecting this value to be 0x00 and 0x01. A-WRAN CPEs shall be capable of using all CPE operational capability values.

Table 79—CPE Operational Capability information element

Syntax	Size	Description	Scope	Network Applicability
CPE Operational Capability () {			REG-REQ/ RSP	Both
Element ID	1 byte	16		
Specification	1 byte	0x00: Fixed (no relay) 0x01: Portable (no relay) 0x02: Centralized scheduling R-CPE (fixed only) 0x03: Distributed scheduling R-CPE (fixed) 0x04: Distributed scheduling R-CPE (portable) 0x05: Fixed Multi-channel Bulk Transmission A-CPE 0x06: Fixed Multi-channel Transmit Diversity A-CPE 0x07: Portable Multi-channel Bulk Transmission A-CPE 0x08: Portable Multi-channel Transmit Diversity A-CPE 0x09–0xFF: *Reserved*		
}				

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7.9.7.3.5 CPE Registration Timer

This timer is used to govern how long a CPE and BS maintain context of each other after registration has been completed. This value is set based on the type of CPE, either portable or fixed, that is currently attempting registration. This value is used to set T30.

Table 80—CPE Registration Timer information element

Syntax	Size	Description	Scope	Network Applicability
CPE Registration Timer () {			REG-REQ, REG-RSP	Both
Element ID	1 byte	17		
Specification	2 bytes	= 0x0000, *Reserved* = 0x0001–0xFFFF, in units of 160 ms		
}				
}				

7.9.7.3.6 Local SID Group

The format of a Local SID IE is shown in Table 81. This IE shall be transmitted by the A-BS to the distributed scheduling R-CPE at registration. Instead of the A-BS, the distributed scheduling R-CPE allocates a Local SID to the A-CPE at initialization.

Table 81—Local SID Ground Information element

Syntax	Size	Notes	Scope	Network Applicability
Local SID Group_IE(){			REG-RSP	A-WRAN only
Element ID = 18	8 bits			
Number of SIDs	13 bits	Total number of SIDs assigned for a distributed scheduling R-CPE		
SIDs	9 bits	Start SID; A group of SIDs will be allocated from SID.		

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7.9.8 Dynamic Service Messages (DSx-REQ/RSP/ACK)

To manage the various traffic flows between CPEs and the BS, the MAC protocol shall have the capability to dynamically manage the addition, deletion, and change of service flows.

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7.9.8.1 DSA-REQ

The format of a Dynamic Service Addition Request (DSA-REQ) message is shown in Table 82. This message is sent by a BS and is to create a new service flow, and shall not contain parameters for more than one service flow.

The FT field carried in the MAC header of the PDU where this message is transmitted shall be the primary management FT of the CPE.

Table 82—DSA-REQ message format

Syntax	Size	Notes
DSA-REQ_Message_Format() {		
Management Message Type = 8	8 bits	
Transaction ID	16 bits	Unique identifier for this transaction assigned by the sender.
Information elements (IEs)	Variable	7.9.8.9
}		

7.9.8.2 DSA-RSP

A DSA-RSP message shall be generated in response to a received DSA-REQ message. The format of a DSA-RSP message shall be as shown in Table 83. If the transaction is successful, the DSA-RSP message may contain the following: Service Flow parameters (the complete specification of the service flow shall be included in the DSA-RSP if it includes a newly assigned FT or an expanded service class name) and CS parameter encodings (specification of the service flow's CS-specific parameters).

Table 83—DSA-RSP message format

Syntax	Size	Notes
DSA-RSP_Message_Format() {		
Management Message Type = 9	8 bits	
Transaction ID	16 bits	
Confirmation code	8 bits	7.9.24
Information elements (IEs)	Variable	7.9.8.9
}		

7.9.8.3 DSA-ACK

A DSA-ACK message shall be generated in response to a received DSA-RSP message. The format of a DSA-ACK message shall be as shown in Table 84.

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Table 84—DSA-ACK message format

Syntax	Size	Notes
DSA-ACK_Message_Format() {		
Management Message Type = 10	8 bits	
Transaction ID	16 bits	
Confirmation code	8 bits	7.9.24
Information elements (IEs)	Variable	7.9.8.9
}		

7.9.8.4 DSC-REQ

A Dynamic Service Change Request (DSC-REQ) message is sent by a BS to dynamically change the parameters of an existing service flow. A BS shall generate DSC-REQ messages in the form shown in Table 85. A DSC-REQ message shall carry parameters for only one service flow. A DSC-REQ message shall contain Service Flow parameters that specify the service flow's new traffic characteristics and scheduling requirements. The admitted and active QoS parameter sets are the ones currently in use by the service flow. If the DSC message is successful and it contains service flow parameters, but does not contain replacement sets for both admitted and active QoS parameter sets, the omitted set(s) shall be set to null. The Service Flow parameters shall contain a SFID.

Table 85—DSC-REQ message format

Syntax	Size	Notes
DSC-REQ_Message_Format() {		
Management Message Type = 11	8 bits	
Transaction ID	16 bits	
Information elements (IEs)	Variable	7.9.8.9
}		

7.9.8.5 DSC-RSP

A DSC-RSP shall be generated in response to a received DSC-REQ. The format of a DSC-RSP shall be as shown in Table 86. If the transaction is successful, the DSC-RSP may contain the Service Flow parameters in which the complete specification of the service flow shall be included in the DSC-RSP only if it includes a newly assigned FT or an expanded service class name. If a Service Flow parameter set contains a US admitted QoS parameter set and this service flow does not have an associated FT, the DSC-RSP shall include a FT. If a Service Flow parameter set contains a service class name and an admitted QoS parameter set, the DSC-RSP shall include the QoS parameter set corresponding to the named service class. If specific QoS parameters are also included in the classed service flow request, these QoS parameters shall be included in the DSC-RSP instead of any QoS parameters of the same type of the named service class.

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Additionally, the DSC-RSP may contain the CS parameter encodings that specify the CS-specific parameters of the service flow.

Table 86—DSC-RSP message format

Syntax	Size	Notes
DSC-RSP_Message_Format() {		
Management Message Type = 12	8 bits	
Transaction ID	16 bits	
Confirmation code	8 bits	7.9.24
Information elements (IEs)	Variable	7.9.8.9
}		

7.9.8.6 DSC-ACK

A DSC-ACK shall be generated in response to a received DSC-RSP. The format of a DSC-ACK shall be as shown in Table 87.

Table 87—DSC-ACK message format

Syntax	Size	Notes
DSC-ACK_Message_Format() {		
Management Message Type = 13	8 bits	
Transaction ID	16 bits	
Confirmation code	8 bits	7.9.24
Information elements (IEs)	Variable	7.9.8.9
}		

7.9.8.7 DSD-REQ

A Dynamic Service Deletion Request (DSD-REQ) is sent by a BS to delete an existing service flow. The format of a DSD-REQ shall be as shown in Table 88.

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Table 88—DSD-REQ message format

Syntax	Size	Notes
DSD-REQ_Message_Format() {		
Management Message Type = 14	8 bits	
Transaction ID	16 bits	
Service Flow ID	32 bits	
Information elements (IEs)	Variable	7.9.8.9
}		

7.9.8.8 DSD-RSP

A DSD-RSP shall be generated in response to a received DSD-REQ. The format of a DSD-RSP shall be as shown in Table 89.

Table 89—DSD-RSP message format

Syntax	Size	Notes
DSD-RSP_Message_Format() {		
Management Message Type = 15	8 bits	
Transaction ID	16 bits	
Confirmation code	8 bits	7.9.24
Service Flow ID	32 bits	
Information elements (IEs)	Variable	7.9.8.9
}		

7.9.8.9 Service Flow encodings

Table 90 and the subsequent subclauses define the parameters associated with US/DS scheduling for a service flow. The encapsulated US and DS flow classification configuration setting strings share the same subtype field numbering plan because many of the subtype fields defined are valid for both types of configuration settings except service flow encodings. One major parameter of the service flow definition is the direction of the service flow (see 7.9.8.9.1). This parameter determines if subsequent service flow parameters are applied in the DS (BS to CPE) or US (CPE to BS) service flow. Classification rule parameterization (see 7.9.8.9.18) is made of a compound set of IEs defined in 7.9.8.9.18.1 through 7.9.8.9.18.3.14. All service flow encodings/parameters are applicable in both WRAN and A-AWRAN cells, with the exception of “Per-RS QoS” 7.9.8.9.19, which is only applicable in the A-WRAN cell.

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Table 90—Service flow encodings information elements

Element ID	Parameter
1	Service Flow Direction
2	Service Flow Identifier
3	Service Class Name
4	QoS Parameter Set Type
5	Maximum Sustained Traffic Rate
6	Maximum Traffic Burst
7	Minimum Reserved Traffic Rate
8	Minimum Tolerable Traffic Rate
9	Service Flow Scheduling Type
10	Request/Transmission Policy
11	Tolerated Jitter
12	Maximum Latency
13	Fixed-length versus Variable-length SDU Indicator
14	SDU Size
15	Target SAID
16	Maximum Tolerable Packet Loss Rate
17.1– 17.9	ARQ Parameter IEs for ARQ-enabled Connections (Compound)
18	Classification Rule Convergence Sublayer Specification
19	Classifier DSC Action
20.1–20.14	Packet Classification Rule (Compound)
21–255	*Reserved*

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7.9.8.9.1 Service Flow Direction

This parameter is used to indicate the direction of the service flow. Service flows are unidirectional and are DS (BS to CPE) or US (CPE to BS).

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Table 91—Service Flow Direction IE

Element ID	Length (bytes)	Value	Scope
1	1	0x00: Downstream 0x01: Upstream 0x02–0xFF: *Reserved*	DSx-REQ, DSx-RSP, DSx-ACK

7.9.8.9.2 SFID

The format of the Service Flow Identifier (SFID) is defined in Table 92.

Table 92—SFID definition information element

Element ID	Length (bytes)	Value	Scope
2	4	Range: from 1 to 4 294 967 295	DSx-REQ, DSx-RSP, DSx-ACK

7.9.8.9.3 Service Class Name

The format of the Service Class Name is defined in Table 93.

Table 93—Service Class Name definition information element

Element ID	Length (bytes)	Value	Scope
3	2 to 128	Null-terminated string of ASCII characters. The length of the string, including null-terminator, may not exceed 128 bytes	DSx-REQ, DSx-RSP, DSx-ACK

7.9.8.9.4 QoS Parameter Set Type

The format of the QoS Parameter Set Type is defined in Table 94 as the three first bits of the octet, and Table 95 enumerates all the combinations for these 3 bits that define controls for how QoS parameter sets are applied to the service flow that is being configured.

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Table 94—QoS Parameter Set Type definition

Element ID	Length (bytes)	Value	Scope
4	1	Bit 0: Provisioned Set Bit 1: Admitted Set Bit 2: Active Set Bits 3–7: *Reserved*	DSx-REQ, DSx-RSP, DSx-ACK

Table 95—Value used in Dynamic Service messages

Value	Messages
001	Apply to Provisioned set only
011	Apply to Provisioned and Admitted sets, and perform admission control
101	Apply to Provisioned and Admitted sets, perform admission control, and activate this service flow
111	Apply to Provisioned, Admitted, and Active sets, perform admission control, and activate this service flow
000	Set Active and Admitted sets to Null
010	Perform admission control and apply admitted set
100	Check against Admitted set in separate service flow encoding, perform admission control if needed, active this service flow, and apply to Active set
110	Perform admission control and activate this service flow, apply parameters to both Admitted and Active sets

7.9.8.9.5 Maximum Sustained Traffic Rate

The format of the Maximum Sustained Traffic Rate is defined in Table 96.

Table 96—Maximum Sustained Traffic Rate definition

Element ID	Length (bytes)	Value	Scope
5	3	Rate (in bytes per second)	DSx-REQ, DSx-RSP, DSx-ACK

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7.9.8.9.6 Maximum Traffic Burst

The format of the Maximum Traffic Burst is defined in Table 97.

Table 97—Maximum Traffic Burst definition

Element ID	Length (bytes)	Value	Scope
6	3	Burst size (bytes)	DSx-REQ, DSx-RSP, DSx-ACK

7.9.8.9.7 Minimum Reserved Traffic Rate

The format of the Minimum Reserved Traffic Rate is defined in Table 98.

Table 98—Minimum Reserved Traffic Rate definition

Element ID	Length (bytes)	Value	Scope
7	3	Rate (in bytes per second)	DSx-REQ, DSx-RSP, DSx-ACK

7.9.8.9.8 Minimum Tolerable Traffic Rate

The format of the Minimum Tolerable Traffic Rate is defined in Table 99.

Table 99—Minimum Tolerable Traffic Rate definition

Element ID	Length (bytes)	Value	Scope
8	3	Rate (in bytes per second)	DSx-REQ, DSx-RSP, DSx-ACK

7.9.8.9.9 Service Flow Scheduling Type

The format of the Service Flow Scheduling Type is defined in Table 100.

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Table 100—Service Flow Scheduling Type definition

Element ID	Length (bytes)	Value	Scope
9	1	0x00: *Reserved* 0x01: for Undefined (BS implementation dependent) 0x02: for BE (Default) 0x03: for nrtPS 0x04: for rtPS 0x05: *Reserved* 0x06: for UGS 0x07–0xFF: *Reserved*	DSx-REQ, DSx-RSP, DSx-ACK

7.9.8.9.10 Request/Transmission Policy

The format of the Request/Transmission Policy is defined in Table 101.

Table 101—Request/Transmission Policy definition

Element ID	Length (bytes)	Value	Scope
10	1	Bit 0: Service flow shall not use broadcast bandwidth request opportunities (Upstream only) Bit 1: *Reserved (shall be set to zero)* Bit 2: The service flow shall not piggyback requests with data (Upstream only) Bit 3: The service flow shall not fragment data Bit 4: The service flow shall not suppress payload headers (CS parameters) Bit 5: The service flow shall not pack multiple SDUs (or fragments) into single MAC PDUs Bit 6: *Reserved (shall be set to zero)* Bit 7: *Reserved (shall be set to zero)*	DSx-REQ, DSx-RSP, DSx-ACK

7.9.8.9.11 Tolerated Jitter

The format of the Tolerated Jitter is defined in Table 102.

Table 102—Tolerated Jitter definition

Element ID	Length (bytes)	Value	Scope
11	3	ms	DSx-REQ, DSx-RSP, DSx-ACK

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7.9.8.9.12 Maximum Latency

The format of the Maximum Latency is defined in Table 103.

Table 103—Maximum Latency definition

Element ID	Length (bytes)	Value	Scope
12	3	ms	DSx-REQ, DSx-RSP, DSx-ACK

7.9.8.9.13 Fixed-length vs. Variable-length SDU Indicator

The format of the Fixed-length vs. Variable-length SDU Indicator is defined in Table 104.

Table 104—Fixed-length vs. Variable-length SDU Indicator definition

Element ID	Length (bytes)	Value	Scope
13	1	0: variable-length SDU (default) 1: fixed-length SDU	DSx-REQ, DSx-RSP, DSx-ACK

7.9.8.9.14 SDU Size

The format of the SDU Size is defined in Table 105.

Table 105—SDU Size definition

Element ID	Length (bytes)	Value	Scope
14	1	Number of bytes Default = 49	DSx-REQ, DSx-RSP, DSx-ACK

7.9.8.9.15 Target SAID

The format of the Target SAID is defined in Table 106.

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Table 106—Target SAID definition

Element ID	Length (bytes)	Value	Scope
15	2	SAID onto which SF is mapped.	DSx-REQ, DSx-RSP

7.9.8.9.16 Maximum Tolerable Packet Loss Rate

The format of the Maximum Tolerable Packet Loss Rate is defined in Table 107.

Table 107—Maximum Tolerable Packet Loss Rate definition

Element ID	Length (bytes)	Value	Scope
16	1	Maximum percentage of packet loss rate tolerated on a logarithm scale before a flow is dropped. Coding: first four bits: mantissa, last four bits: fraction i.e.,: 0x00: $1/\{2^{(0+[0/16])}\}$ = 100% packet loss 0x37: $1/\{2^{(3+[7/16])}\}$ = 9.2% packet loss 0xFF: $1/\{2^{(16+[16/16])}\}$ = 0.0016% packet loss)	DSx-REQ, DSx-RSP, DSx-ACK

7.9.8.9.17 ARQ parameter IEs for ARQ-enabled connections

Parameters related to ARQ configuration are encoded in a compound attribute (Element ID = 17) as shown in Table 108, made up of subattributes described in 7.9.8.9.17.1 through 7.9.8.9.17.8.

Table 108—ARQ common attribute format

Element ID	Length (bytes)	Value
17	Variable	Compound

7.9.8.9.17.1 ARQ Enable

The format of the ARQ Enable IE is defined in Table 109.

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Table 109—ARQ Enable definition

Element ID	Length (bytes)	Value	Scope
17.1	1	0: ARQ not requested/accepted. 1: ARQ requested/accepted	DSA-REQ, DSA-RSP, REG-REQ, REQ-RSP

7.9.8.9.17.2 ARQ_WINDOW_SIZE

The format of the ARQ_WINDOW_SIZE IE is defined in Table 110.

Table 110—ARQ_WINDOW_SIZE definition

Element ID	Length (bytes)	Value	Scope
17.2	2	> 0 and ≤ (ARQ_BSN_MODULUS/2)	DSx-REQ, DSx-RSP, REG-REQ, REQ-RSP

7.9.8.9.17.3 ARQ_RETRY_TIMEOUT

The format of the ARQ_RETRY_TIMEOUT IE is defined in Table 111.

Table 111—ARQ_RETRY_TIMEOUT definition

Element ID	Length (bytes)	Value	Scope
17.3	2	TRANSMITTER_DELAY 0–655350 (10 μs granularity)	DSA-REQ, DSA-RSP, REG-REQ, REQ-RSP
17.4	2	RECEIVER_DELAY 0–655350 (10 μs granularity)	DSA-REQ, DSA-RSP, REG-REQ, REQ-RSP

7.9.8.9.17.4 ARQ_BLOCK_LIFETIME

The format of the ARQ_BLOCK_LIFETIME IE is defined in Table 112.

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Table 112—ARQ_BLOCK_LIFETIME definition

Element ID	Length (bytes)	Value	Scope
17.5	2	0: Infinite 1–65535 (10 µs granularity)	DSA-REQ, DSA-RSP, REG-REQ, REQ-RSP

7.9.8.9.17.5 ARQ_SYNC_LOSS_TIMEOUT

The format of the ARQ_SYNC_LOSS_TIMEOUT IE is defined in Table 113.

Table 113—ARQ_SYNC_LOSS_TIMEOUT definition

Element ID	Length (bytes)	Value	Scope
17.6	2	0: Infinite 1–65535 (10 µs granularity)	DSA-REQ, DSA-RSP, REG-REQ, REQ-RSP

7.9.8.9.17.6 ARQ_DELIVER_IN_ORDER

The format of the ARQ_DELIVER_IN_ORDER IE is defined in Table 114.

Table 114—ARQ_DELIVER_IN_ORDER definition

Element ID	Length (bytes)	Value	Scope
17.7	1	0: Order of delivery is not preserved 1: Order of delivery is preserved	DSA-REQ, DSA-RSP, REG-REQ, REQ-RSP

7.9.8.9.17.7 ARQ_RX_PURGE_TIMEOUT

The format of the ARQ_RX_PURGE_TIMEOUT IE is defined in Table 115.

Table 115—ARQ_RX_PURGE_TIMEOUT definition

Element ID	Length (bytes)	Value	Scope
17.8	2	0: Infinite 1–65535 (10 µs granularity)	DSA-REQ, DSA-RSP, REG-REQ, REQ-RSP

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7.9.8.9.17.8 ARQ_BLOCK_SIZE

The format of the ARQ_BLOCK_SIZE IE is defined in Table 116.

Table 116—ARQ_BLOCK_SIZE definition

Element ID	Length (bytes)	Value	Scope
17.9	2	0: *Reserved* 1–2040: Desired/Agreed size in bytes 2041–65535: *Reserved*	DSA-REQ, DSA-RSP, REG-REQ, REQ-RSP

7.9.8.9.18 Packet CS encodings for configuration and MAC messaging

The following encoded parameters shall be used in Dynamic Service messages (DSx-REQ/RSP).

The following configuration settings shall be supported by all CPEs that are compliant with this specification.

7.9.8.9.18.1 Classification Rule Convergence Sublayer Specification

Each classification rule defines a set of parameters that are encoded within selection of IEs listed in 7.9.8.9.18.3.1 through 7.9.8.9.18.3.14. This IE defines what CS is applied to the classification rule (see Table 117). In the cases of IP over IEEE 802.3 (or IEEE 802.1Q), the relevant IP and IEEE 802.3 (or IEEE 802.1Q) parameters shall be included in the definition of the classification rule contained within a DSx-REQ message. The Convergence Sublayer Specification IE (see 7.9.7.3.2) determines what CS and what rule parameters can be applied in building classification rules.

Table 117—CS Sublayer Parameter Encoding Rules definition

Element ID	Length (bytes)	Value	Scope
18	1	0x00: No CS 0x01: ETH-CS (802.3/VLAN with IPv4, IPv6) 0x02: IP CS (IPv4, IPv6) 0x03–0xFF: *Reserved*	DSA-REQ, DSC-REQ

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7.9.8.9.18.2 Classifier DSC Action

When received in a DSC-REQ, the action to be taken with this classifier in indicated in Table 118.

Table 118—Classifier DSC Action

Element ID	Length (bytes)	Value
19	1	0: DSC Add Classifier 1: DSC Replace Classifier 2: DSC Delete Classifier

7.9.8.9.18.3 Packet Classification rule

This compound parameter for which the format is shown in Table 119 contains the parameters of the classification rule. All parameters pertaining to a specific classification rule shall be included in the same "Packet Classification Rule" compound parameter. A packet classification rule containing only the classification rule index (see 7.9.8.9.18.3.13) and with no other classification parameters matches all packets entering the convergence sublayer. The current version of the standard only defines a simple set of packet classification rules. More elaborate rules will be developed in a later version of the standard.

Table 119—Packet Classification Rule common attribute format

Element ID	Length (bytes)	Value
20	Variable	Compound

7.9.8.9.18.3.1 Classification Rule Priority Field

Several classification rules may each refer to the same service flow. The classification priority is used for ordering the application of classification rules to packets. Explicit ordering is necessary because the patterns used by classification rules may overlap.

The value of this field specifies the priority for the classification rule, which is used for determining the order of the classification rule, which may have priorities in the range 0–255 with the default value being 0. A larger value indicates a higher priority.

Element ID	Length (bytes)	Value
20.1	1	0–255

The following six fields (7.9.8.9.18.3.2 to 7.9.8.9.18.3.7) are designed for IPv4/IPv6, which should be referenced by the IP Classification Rules in 6.4.2.

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7.9.8.9.18.3.2 IP Type of Service/Differentiated Services Codepoint Range and Mask Field

The values of this field specify the matching parameters for the IP type of service (ToS)/differentiated services codepoint (DSCP) octet of the IP packet. IETF RFC 2474 [B24] defines the DSCP values that can be set to the 6 MSBs of this field. The remaining 2 bits are set to 00. If this field is omitted, then the comparison of the IP packet ToS byte for this entry is irrelevant.

Element ID	Length (bytes)	Value
20.2	3	tos-low, tos-high, tos-mask

7.9.8.9.18.3.3 Protocol field

The value of this field specifies a matching value for the IP Protocol Field. For IPv6 (IETF RFC 2460 [B23]), this refers to the next header entry in the last header of the IP header chain. The encoding of the value field is that defined by the IANA document “Protocol Numbers.” If this parameter is omitted, then the comparison of the IP Header Protocol Field for this entry is irrelevant.

Element ID	Length (bytes)	Value
20.3	1	Protocol

7.9.8.9.18.3.4 IP Masked Source Address parameter

This parameter specifies an IP source address (designated “src”) and its corresponding address mask (designated “smask”). An IP packet with IP source address “ip-src” matches this parameter if src = (ip-src AND smask). If this parameter is omitted, then the comparison of the IP packet source address for this entry is irrelevant.

Element ID	Length (bytes)	Value
20.4	8 (IPv4) 32 (IPv6)	src, smask

7.9.8.9.18.3.5 IP Masked Destination Address parameter

This parameter specifies an IP destination address (designated “dst”) and its corresponding address mask (designated “dmask”). An IP packet with IP destination address “ip-dst” matches this parameter if dst = (ip-dst AND dmask). If this parameter is omitted, then the comparison of the IP packet destination address for this entry is irrelevant.

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Element ID	Length (bytes)	Value
20.5	8 (IPv4) 32 (IPv6)	dst, dmask

7.9.8.9.18.3.6 Protocol Source Port Range field

The value of this field specifies a range of protocol source port values. Classification rules with port numbers are protocol-specific, i.e., a rule on port numbers without a protocol specification shall not be defined. An IP packet with protocol port value "src-port" matches this parameter if "src-port" is greater than or equal to "sportlow" and "src-port" is less than or equal to "sporthigh." If this parameter is omitted, the protocol source port is irrelevant. This parameter is irrelevant for protocols without port numbers.

Element ID	Length (bytes)	Value
20.6	4	sportlow, sporthigh

7.9.8.9.18.3.7 Protocol Destination Port Range field

The value of this field specifies a range of protocol destination port values. Classification rules with port numbers are protocol-specific, i.e., a rule on port numbers without a protocol specification shall not be defined. An IP packet with protocol port value "dst-port" matches this parameter if "dst-port" is greater than or equal to "dportlow" and "dst-port" is less than or equal to "dporthigh." If this parameter is omitted, the protocol destination port is irrelevant. This parameter is irrelevant for protocols without port numbers.

Element ID	Length (bytes)	Value
20.7	4	dportlow, dporthigh

7.9.8.9.18.3.8 IEEE 802.3/Ethernet Destination MAC Address parameter

This parameter specifies a MAC destination address (designated "dst") and its corresponding address mask (designated "msk"). An IEEE 802.3/Ethernet packet with MAC destination address "etherdst" corresponds to this parameter if dst = (etherdst AND msk). If this parameter is omitted, then the comparison of the IEEE 802.3/Ethernet destination MAC address for this entry is irrelevant.

Element ID	Length (bytes)	Value
20.8	12	dst, msk

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7.9.8.9.18.3.9 IEEE 802.3/Ethernet Source MAC Address parameter

This parameter specifies a MAC source address (designated "src") and its corresponding address mask (designated "msk"). An IEEE 802.3/Ethernet packet with MAC source address "ethersrc" corresponds to this parameter if src = (ethersrc AND msk). If this parameter is omitted, then the comparison of the IEEE 802.3/Ethernet source MAC address for this entry is irrelevant.

Element ID	Length (bytes)	Value
20.9	12	src, msk

7.9.8.9.18.3.10 Ethertype/IEEE 802.2 SAP

The format of Layer 3 protocol ID in the Ethernet packet is indicated by "type," "eport1," and "eport2" as follows.

— If type = 0, the rule does not use the Layer 3 protocol type as a matching criteria. In addition, eport1 and eport2 are ignored when considering whether a packet matches the current rule.

— If type = 1, the rule applies only to SDUs that contain an Ethertype value. Ethertype values are contained in packets using the DEC-Intel-Xerox (DIX) encapsulation or the Sub-Network Access Protocol (SNAP) encapsulation (IEEE 802.2, IETF RFC 1042) format. In this case, eport1 and eport2 give the 16 bit value of the Ethertype that the packet shall match in order to match the rule.

— If type = 2, the rule applies only to SDUs using the IEEE 802.2 encapsulation format with a Destination Service (DSAP) other than 0xAA (which is reserved for SNAP). In this case, the lower 8 bits of eport1 and eport2 shall match the DSA byte of the packet in order to match the rule.

If the Ethernet SDU contains an IEEE 802.1D and IEEE 802.1Q tag header (i.e., Ethertype 0x8100), this object applies to the embedded Ethertype field within the IEEE 802.1D and IEEE802.1Q header.

Other values of type are reserved. If this parameter is omitted, then the comparison of either the Ethertype or IEEE 802.2 SAP for this rule is irrelevant.

Element ID	Length (bytes)	Value
20.10	3	type, eport1, eport2

7.9.8.9.18.3.11 IEEE 802.1D User Priority field

The values of this field specify the matching parameters for the IEEE 802.1D user_priority bits. An Ethernet packet with IEEE 802.1D user_priority value "priority" matches these parameters if priority is greater than or equal to "pri-low" and priority is less than or equal to "pri-high."

If this parameter is specified for an entry, then Ethernet packets without IEEE 802.1Q encapsulation shall not match this entry. If this parameter is specified for an entry on a CPE that does not support forwarding of IEEE 802.1Q encapsulated traffic, then this entry shall not be used for any traffic.

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If this field is omitted, then the comparison of the IEEE 802.1D user-priority bits for this entry is irrelevant.

Element ID	Length (bytes)	Value
20.11	2	pri-low, pri-high Valid range: 0–7 for pri-low and pri-high

7.9.8.9.18.3.12 IEEE 802.1Q VLAN ID Field

The value of this field specifies the matching value for the IEEE 802.1Q vlan_id bits. Only the first (i.e., the leftmost) 12 bits of the specified vlan_id field are significant; the final 4 bits shall be ignored for comparison.

If this parameter is specified for an entry, then Ethernet packets without IEEE 802.1Q encapsulation shall not match this entry. If this parameter is specified for an entry on a CPE that does not support forwarding of IEEE 802.1Q encapsulated traffic, then this entry shall not be used for any traffic.

If this field is omitted, then the comparison of the IEEE 802.1Q vlan_id bits for this entry is irrelevant.

Element ID	Length (bytes)	Value
20.12	2	vlan_id1, vlan_id2

7.9.8.9.18.3.13 Packet Classification Rule Index field

The Packet Classification Rule Index field identifies a packet classification rule. The packet classification rule index is unique per service flow.

Element ID	Length (bytes)	Value
20.13	2	Packet Classification Rule Index

7.9.8.9.18.3.14 IPv6 Flow Label field

The value of this field specifies a matching value for the IPv6 Flow Label field. As the Flow Label field has a length of 20 bits, the first 4 bits of the most significant byte shall be set to 0x0 and disregarded.

Element ID	Length (bytes)	Value
20.14	3	Flow Label

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7.9.8.9.19 Per-RS QoS

The format of a Per-RS QoS IE is shown in Table 120.

Table 120—Per RS QoS information elements

Name	Element ID	Length	Value	Scope
Per-RS QoS	21	Variable	Compound	DSA-REQ/RSP DSC-REQ/RSP

Per-RS QoS value is shown in Table 121 as follows;

Table 121—Per RS QoS value

Name	Length (1 byte)	Value
RS_Basic_CID	2	RS Basic CID
Maximum Latency for the RS	4	Milliseconds

The value of Maximum Latency for the A-CPE specifies the maximum interval between the reception of an MAC PDU at the A-CPE's air interface that is receiving the MAC PDU and the air interface that is forwarding the MAC PDU.

7.9.8.10 DSX-RVD

The DSX-RVD is used by the BS to indicate that it has received a DSx-REQ message from a CPE when a CPE initiates a DSx-REQ transaction. The BS uses this message to indicate to the CPE that it received the DSx-REQ message, but has not authenticated the DSx-REQ and had a chance to formulate a DSx-RSP.

Table 122—DSX-RVD message

Syntax	Size	Notes
DSX-RVD_Message_Format() {		
Management Message Type = 16	8 bits	
Transaction ID	16 bits	
Confirmation code	8 bits	See Table 199.
}		

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7.9.9 Multicast Assignment Request (MCA-REQ)

The MCA-REQ message is sent to a CPE to assign it to or remove it from a multicast polling group. The format of the message is shown in Table 123.

Table 123—MCA REQ message format

Syntax	Size	Notes
MCA-REQ_Message_Format() {		
Management Message Type = 17	8 bits	
Transaction ID	16 bits	
Station ID	9	Station ID to represent a multicast group to which CPEs are being assigned.
Assignment	8	0x00: Leave multicast group 0x01: Join multicast group
Multicast group type	8	0x00: transport-only multicast flows, 0x01: management-only multicast flows, 0x02: polling-only multicast flows, 0x03: signaling SCW, 0x04: management & polling-only multicast flows, 0x05: signaling SCW as well as management and polling-only multicast flows, 0x06: transport/polling/management multicast flows, 0x07: transport, polling, multicast management flows, as well as signaling SCW 0x08–0x0F: *Reserved*
Periodic allocation parameters	32	This field is only applicable when a CPE is being requested to join a multicast group and the Multicast Group Type is set to 0x02, 0x04, 0x05 or 0x06. Byte 0 (LS byte) = m Byte 1 = k Byte 2 = n Byte 3 = *Reserved* An US allocation is made available to CPEs (see 7.13.3.2) to send a Bandwidth Request at the end of the frame #N if: N mod k = m; size of allocation is n.
Reserved	4 bits	Set to 0000
}		

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7.9.10 Multicast Assignment Response (MCA-RSP)

The MCA-RSP is sent by the CPE in response to a MCA-REQ. The message format shall be as shown in Table 124.

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Table 124—MCA RSP message format

Syntax	Size	Notes
MCA-RSP_Message_Format() {		
Management Message Type = 18	8 bits	
Transaction ID	16 bits	
Confirmation code	8 bits	7.9.24
}		

7.9.11 CPE Basic Capability Request/Response (CBC-REQ/RSP)

The motivation of basic capability negotiation is to facilitate effective communication between the BS and the CPE during the reminder of the initialization protocols, e.g., key exchange, registration. The following shows the CBC-REQ and CBC-RSP message formats, along with their information elements and the physical parameters involved.

7.9.11.1 CBC-REQ

The CPE CBC-REQ shall be transmitted by the CPE during initialization. A CPE shall generate CBC-REQ messages in the form shown in Table 125. Basic Capability Requests contain those CPE capabilities IEs that are necessary for effective communication with the CPE during the remainder of the initialization protocols. Only the following parameters shall be included in the Basic Capabilities Request (see 7.16.2.9), namely the Physical Parameters Supported and the Bandwidth Allocation Supported. Capabilities for Construction and Transmission of MAC PDUs may be supported if needed.

Table 125—CBC REQ message format

Syntax	Size	Notes
CBC-REQ_Message_Format() {		
Management Message Type = 19	8 bits	
Information elements (IEs)	Variable	See 7.9.11.3.1 and 7.9.11.3.2
}		

7.9.11.2 CBC-RSP

The CPE CBC-RSP shall be transmitted by the BS in response to a received CBC-REQ. The following parameters shall be included in the CBC-RSP if found in the CPE CBC-REQ, namely the Physical Parameters Supported (7.9.11.3.2) and the Capabilities for Construction and Transmission of MAC PDUs (7.9.11.3.1). In addition, the BS responds to the subset of CPE capabilities present in the CBC-REQ message. The BS responds to the CPE capabilities to indicate whether they may be used. If the BS does not recognize a CPE capability, it may return this as “off” in the CBC-RSP. Only capabilities set to “on” in the

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CBC-REQ may be set "on" in the CBC-RSP, as this is the handshake indicating that they have been successfully negotiated.

Table 126—CBC RSP message format

Syntax	Size	Notes
CBC-RSP_Message_Format() {		
Management Message Type = 20	8 bits	
Information elements (IEs)	Variable	See 7.9.11.3.1 and 7.9.11.3.2
Confirmation code	8 bits	Code defining error status of basic capability configuration request (see 7.9.24)
}		

7.9.11.3 CBC-REQ/RSP information elements

In 7.9.11.3.1 to 7.9.7.3.3, each table has a column called "Network Applicability," which indicates what network type CBC-REQ/RSP IE is applicable to/used in. A value of "Both" means that the IE is used in both the WRAN and A-WRAN, a value of "WRAN only" means that the IE is only used in the WRAN cell, whereas a value of "A-WRAN only" means that the IE is only used in an A-WRAN cell.

The information elements include the following:

— Capabilities for construction and transmission of MAC PDUs (see Table 127)
— Physical parameters supported (see Table 128 to Table 134)
— Security parameters supported (see Table 135 to Table 137)
— R-CPE configuration parameters (see Table 138)
— Multi-channel parameters (see Table 139)

7.9.11.3.1 Capabilities for of MAC PDUs

Table 127—Construction and transmission information element

Element ID	Length (bytes)	Value	Scope	Network Applicability
1	1	Bit 0:Ability to receive requests piggybacked with data Bits 1–7:*Reserved (set to zero)*	CBC-REQ, CBC-RSP	Both

7.9.11.3.2 Physical parameters supported

7.9.11.3.2.1 Maximum CPE Transmit EIRP

The Maximum CPE Transmit EIRP information element indicates the maximum EIRP achievable at the CPE for the transmission of a full multiplex (60 subchannels) while still meeting the required RF mask (see 9.13) or other performance limits set by the manufacturer. The maximum EIRP parameters are reported in dBm and quantized in 0.5 dB steps ranging from –64 dBm (encoded 0x00) to 63.5 dBm (encoded 0xFF).

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Values outside this range shall be assigned the closest extreme. The EIRP accuracy shall be ±1.5 dB when the level is at least 10 dB below the maximum regulatory power limit and ±0.5 dB elsewhere.

Table 128—Maximum CPE Transmit EIRP information element

Element ID	Length (bytes)	Value	Scope	Network Applicability
2	1	Maximum CPE transmitted EIRP assuming all 60 subchannels are in use.	CBC-REQ	Both

7.9.11.3.2.2 PHY-specific parameters

7.9.11.3.2.2.1 WRAN CPE Demodulator

This field indicates the different demodulator options supported by a WRAN CPE for the DS reception. A bit value of 0 indicates “not supported” while 1 indicates “supported.” The field contains 64 bits, one for each DIUC options, arranged in 8 bytes where the MSB of the first byte corresponds to DIUC option “0” and the second bit from the left corresponds to DIUC option “1,” whereas the support flag for DIUC option “63” is given by the LSB of the eighth byte.

Table 129—WRAN CPE Demodulator information element

Element ID	Length (bytes)	Value	Scope	Network Applicability
3	8	Bit flags indicating support for the 64 DIUC options, see Table 33.	CBC-REQ, CBC-RSP	Both

7.9.11.3.2.2.2 WRAN CPE Modulator

This field indicates the different modulator options supported by a WRAN CPE for US transmission. A bit value of 0 indicates “not supported” while 1 indicates “supported.” The field contains 64 bits, one for each UIUC option, arranged in 8 bytes where the MSB of the first byte corresponds to UIUC option “0” and the second bit from the left corresponds to UIUC option “1,” whereas the support flag for UIUC option “63” is given by the LSB of the eighth byte.

Table 130—WRAN CPE Modulator information element

Element ID	Length (bytes)	Value	Scope	Network Applicability
4	8	Bit flags indicating support for the 64 UIUC options, see Table 47.	CBC-REQ, CBC-RSP	Both

7.9.11.3.2.2.3 A-WRAN CPE Demodulator

This field indicates the different demodulator options for higher order modulation/coding support that is supported by a A-WRAN CPE for the DS reception. The value of this IE is only pertinent if Bit 62 of the “WRAN CPE Demodulator” (7.9.11.3.2.2.1) is set to 1. A bit value of 0 indicates “not supported” while

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1 indicates "supported." The field contains 64 bits, one for each Extended DIUC options, arranged in 8 bytes where the MSB of the first byte corresponds to Extended DIUC option "0" and so on. Bits 28–63 are reserved for future use and are set to 1.

Table 131—A-WRAN CPE Demodulator information element

Element ID	Length (bytes)	Value	Scope	Network Applicability
5	8	Bit 0–27 flags indicating support for the 28 Extended DIUC options, see Table 35. Bit 28–Bit 63 are reserved for future use and all set to 1.	CBC-REQ, CBC-RSP	A-WRAN only

7.9.11.3.2.2.4 A-WRAN CPE Modulator

This field indicates the different demodulator options for higher order modulation/coding support, that is supported by a A-WRAN CPE for the US transmission. The value of this IE is only pertinent if Bit 62 of the "WRAN CPE Modulator" (7.9.11.3.2.2.2) is set to 1. A bit value of 0 indicates "not supported" while 1 indicates "supported." The field contains 64 bits, one for each Extended UIUC options, arranged in 8 bytes where the MSB of the first byte corresponds to Extended UIUC option "0" and so on. Bits 28–63 are reserved for future use and are set to 1.

Table 132—A-WRAN CPE Modulator information element

Element ID	Length (bytes)	Value	Scope	Network Applicability
6	8	Bit 0–27 flags indicating support for the 64 Extended UIUC options, see Table 51. Bit 28–Bit 63 are reserved for future use and all set to 1.	CBC-REQ, CBC-RSP	A-WRAN only

7.7.11.3.2.2.3 Centralized Scheduling R-CPE Demodulator

The format of a Centralized Scheduling R-CPE Demodulator IE is shown in Table 133. This field indicates the different demodulator options supported by a centralized scheduling R-CPE for the DS reception. If an Extended DIUC is supported, Bit 0–7 shall equal 62, and Bits 8–15 shall take on a value from Table 35.

Table 133—Centralized Scheduling R-CPE Demodulator

Element ID	Length (bytes)	Value	Scope	Network Applicability
7	2	Bit 0–bit 7: supported DIUCs (Table 33) Bit 8–bit 15: supported Extending DIUCs (Table 35)	CBC-RSP	A-WRAN only

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7.9.11.3.2.2.5 Centralized Scheduling R-CPE Modulator

The format of a Centralized Scheduling R-CPE modulator IE is shown in Table 134. This field indicates the different modulator options supported by a centralized scheduling R-CPE for US transmission.

Table 134—Centralized Scheduling R-CPE Modulator

Element ID	Length (bytes)	Value	Scope	Network Applicability
8	2	Bit 0–bit 7: supported DIUCs (Table 47) Bit 8–bit 15: supported Extending DIUCs (Table 51)	CBC-RSP	A-WRAN only

7.9.11.3.3 Security parameters supported

These parameters are provided to negotiate some pre-authentication security parameters. These parameters may be renegotiated during the REG-REQ/RSP. The “PN Window Size” IE (7.9.11.3.3.2) and “SCM Flow Control” IE (7.9.11.3.3.3) shall only be added if any other bits beside Bit0 (“Null SA” support bit in “SCM Capability Setup” IE (7.9.11.3.3.1) is set to 1.

7.9.11.3.3.1 SCM Capability Setup

This IE allows the BS and CPE to negotiate which SCM operational mode will be engaged in (see Clause 8). A bit value of 0 indicates that a particular mode is “not supported” while 1 indicates “supported.” If Bit 2 (“Unicast Transport” support) or Bit 3 (“Group SA” support) are set, Bit 1 (“Unicast Management SA”) shall be set.

Table 135—SCM version support

Element ID	Length (bytes)	Value	Scope	Network Applicability
9	1	Bit 0:: Null SA support Bit 1: Unicast Management SA support Bit 2: Unicast Transport SA support Bit 3: Group SA support Bit 4–7: *Reserved (set to 0)*	CBC-REQ, CBC-RSP, REG-REQ, REG-RSP	Both

7.9.11.3.3.2 PN Window Size

This IE allows for negotiation of the size of the PN_WINDOW (see 8.4).

Table 136—PN Window Size

Element ID	Length (bytes)	Value	Scope	Network Applicability
10	2	Size of the PN_WINDOW parameter (see 8.4).	CBC-REQ, CBC-RSP, REG-REQ, REG-RSP	Both

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7.9.11.3.3.3 SCM Flow Control

This IE allows for negotiation of the maximum number of SCM transactions that can be ongoing.

Table 137—SCM Flow Control

Element ID	Length (bytes)	Value	Scope	Network Applicability
7	1	0: No Limit 1–255: Maximum number of ongoing SCM transactions	CBC-REQ, CBC-RSP, REG-REQ, REG-RSP	Both

7.9.11.3.4 Relay CPE Mode

The format of a Relay CPE Mode IE is shown in Table 138. This IE defines a relay operation mode for the CPEs.

Table 138—Relay CPE Mode information element

Element ID	Length (bytes)	Value	Scope	Network Applicability
8	1	0: No support Relay 1: Centralized Scheduling R-CPE Support 2: Distributed Scheduling R-CPE Support	CBC-REQ	A-WRAN only

7.9.11.3.5 Multi-channel operation supported

This information element indicates the capability of the CPE shown in Table 139 whether the multi-channel operation is supported or not supported.

Table 139—Multi-channel operation supported information element

Element ID	Length (bytes)	Value	Scope	Network Applicability
9	1	0x00: Multi-channel operation not supported. 0x01: Multi-channel operation supported. 0x02–0xFF: *Reserved.*	CBC-REQ, CBC-RSP	A-WRAN only

7.9.12 De/Re-Register Command (DREG-CMD)

The DREG-CMD message shall be transmitted by the BS on a CPE's Basic or Primary Management FT to force the CPE to change its access state. The BS may transmit the DREG-CMD unsolicited or in response to a CPE DREG-REQ message. Upon receiving a DREG-CMD, the CPE shall take the action indicated by the action code.

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The format of the message is shown in Table 140.

Table 140——DREG CMD message format

Syntax	Size	Notes
DREG-CMD_Message_Format() {		
Management Message Type = 21	8 bits	
Action Code	8 bits	Table 141
Next Channel Number	8 bits	Corresponding to action codes 0 in Table 141 to indicate the channel that the CPE should tune to after de-registration.
}		

Table 141—Action codes

Action Code	Action
0x00	CPE shall leave the current channel and attempt to access another channel.
0x01	CPE shall listen to the current channel but shall not transmit until a DREG-CMD with an Action Code that allows transmission is received.
0x02	CPE shall listen to the current channel but only transmit on the Basic, Primary Management, and Secondary Management Connections.
0x03	CPE shall return to normal operation and may transmit on any of its active connections.
0x04	CPE shall terminate current Normal Operations with the BS and shutdown. The BS shall transmit this action code in response to CPE DREG-REQ message or when directed to by a governing policy (see Table 315).
0x05	CPE forced to reset itself, reinitialize its MAC, and repeat initial system access on current operating channel. This message may be used if a CPE is unresponsive to the BS or if the BS detects continued abnormalities in the US transmission from the CPE.
0x06–0xFF	*Reserved*

7.9.13 CPE De-Registration Request (DREG-REQ)

A CPE may send a DREG-REQ message to a BS in order to notify the BS of CPE de-registration from Normal Operation service from the BS. The MAC Management Message Type for this message is given in Table 26. The format of the message is shown in Table 142

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.

Table 142—DREG REQ message format

Syntax	Size	Notes
DREG-REQ_Message_Format() {		
Management Message Type = 22	8 bits	
De-registration Request Code	8 bits	Action Codes are listed in Table 141.
Next channel number	8 bits	Channel that the CPE should tune to after de-registration resulting from actions codes 0x00 or 0x04 in Table 141.
}		

7.9.14 ARQ-Feedback

A system supporting ARQ shall be able to receive and process the ARQ Feedback message.

The ARQ Feedback message, as shown in Table 143, can be used to signal any combination of different ARQ ACKs (cumulative, selective, selective with cumulative). The message shall be sent on the appropriate basic management connection.

Table 143—ARG Feedback message format

Syntax	Size	Notes
ARQ_Feedback_Message_Format() {		
Management Message Type = 23	8 bits	
ARQ Feedback Payload	Variable	See 7.10.4.3.
}		

7.9.15 ARQ-Discard

This message is applicable to ARQ-enabled connections only.

The transmitter sends this message when it wants to skip a certain number of ARQ blocks. The ARQ-Discard message shall be sent as a MAC management message on the basic management connection of the appropriate direction. Table 144 shows the format of the Discard message.

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Table 144—ARQ Discard message format

Syntax	Size	Notes
ARQ_Discard_Message_Format() {		This message is sent when the transmitter wants to skip a certain number of ARQ blocks
Management Message Type = 24	8 bits	
Flow Type	3 bits	FT to which message refers
Reserved	5 bits	All bits shall be set to zero
BSN	10 bits	Sequence number of the last block in the transmitter window that the transmitter wants to discard
}		

7.9.16 ARQ-Reset

This message is applicable to ARQ-enabled connections only.

The BS or the CPE may send this message. The message is used in a dialog to reset the parent connection's ARQ transmitter and receiver state machine. The ARQ Reset message shall be sent as a MAC management message on the basic management connection of the appropriate direction. Table 145 shows the format of the Reset message.

Table 145—ARQ Reset message format

Syntax	Size	Notes
ARQ_Reset_Message_Format() {		The transmitter or the receiver may send this message. The message is used in a dialog to reset the parent connection's ARQ transmitter and receiver state machines.
Management Message Type = 25	8 bits	
Flow Type	3 bits	FT to which the message refers
Type	2 bits	00: Original message from Initiator 01: Acknowledgment from Responder 10: Confirmation from Initiator 11: *Reserved*
Reserved	2 bits	All bits shall be set to zero.
}		

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7.9.17 Channel management

The MAC provides a comprehensive set of messages that allows the BS to dynamically manage the channel operations, and so support many essential features such as effective self-coexistence and measurements. This subclause presents the mandatory channel management messages supported by the MAC.

All channel management messages possess a Transaction ID field that uniquely identifies the message in an IEEE 802.22 network. If two or more management messages are received with the same Transaction ID, the parameters of the last message received shall override those of all previously received management messages with the same Transaction ID.

7.9.17.1 Channel Switch Request (CHS-REQ)

This message (Table 146) is sent by the BS in order to switch the entire cell operation (BS and CPEs) to a different channel. Transmission of this message may result from various conditions such as protection of incumbent services or availability of larger number or better quality channel(s).

Table 146—CHS REQ message format

Syntax	Size	Notes
CHS-REQ_Message_Format() {		
Management Message Type = 26	8 bits	
Transaction ID	16 bits	
Confirmation Needed	1 bit	Indicates whether the CPE is required by the BS to confirm the receipt of this message. 0: No confirmation needed (default) 1: Confirmation needed
Switch Mode	1 bit	Indicates any restrictions on transmission until a channel switch. The BS shall set the Switch Mode field to either 0 or 1 on transmission. A value of 1 means that the CPE to which the frame containing the element is addressed shall transmit no further frames until the scheduled channel switch. A Channel Switch Mode set to 0 does not impose any requirement on the receiving CPE.
Switch Count	8 bits	This field either shall be set to the number of frames until the BS sending the Channel Switch message switches to the new channel or shall be set to 0. For example, a value of 1 indicates that the switch will occur immediately before the next frame. A value of 0 indicates that the switch will occur at any time after the frame containing the element is transmitted.
}		

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7.9.17.2 Channel Switch Response (CHS-RSP)

This message (Table 147) is sent by the CPE in response to the receipt of a CHS-REQ. This message shall only be transmitted by the CPE if the Confirmation Needed field in the received CHS-REQ is set.

Table 147—CHS RSP message format

Syntax	Size	Notes
CHS-RSP_Message_Format() {		
Management Message Type = 27	8 bits	
Transaction ID	16 bits	
Confirmation code	8 bits	See 7.9.24.
}		

7.9.17.3 Channel Quiet Request (CHQ-REQ)

This CHQ-REQ message (Table 148) is sent by the BS in order to quiet any transmission activity in the channel currently used by the BS for communication with its associated CPEs. This message shall be used to configure quiet periods in non-coexistence situations. In self-coexistence mode, the quiet period scheduling shall be set in the SCH (see Table 1) to synchronize the quiet periods across nearby WRAN cells operating on N and N±1.

Table 148—CHQ REQ message format

Syntax	Size	Notes
CHQ-REQ_Message_Format() {		
Management Message Type = 28	8 bits	
Transaction ID	16 bits	
Confirmation Needed	1 bit	Indicates whether the CPE is required by the BS to confirm the receipt of this message. 0: No confirmation needed (default) 1: Confirmation needed
Intra-frame Quiet Period Cycle Length	8 bits	Specified in number of superframes, it indicates the spacing between the superframes for which the intra-frame quiet period specification is valid. For example, if this field is set to 1, the Quiet Period Cycle repeats every superframe; if it is set to 2, the Quiet Period Cycle repeats every 2 superframes, etc. = 0, no intra-frame quiet period is scheduled or the current intra-frame quiet period is canceled.
Intra-frame Quiet Period Cycle Offset	8 bits	Valid only if intra-frame Sensing Cycle Length > 0. Used for in-band intra-frame sensing. Specified in number of superframes, it indicates the offset from this SCH transmission to the beginning of the first superframe in the current intra-frame sensing cycle.

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Table 148—CHQ REQ message format *(continued)*

Syntax	Size	Notes
Intra-frame Quiet Period Cycle Frame Bitmap	16 bits	Valid only if Intra-frame Quiet Period Cycle Length > 0. Valid for each superframe identified by the Intra-frame Quiet Period Cycle Length, each bit in the bitmap corresponds to one frame within the superframe. If the bit is set to 0, no intra-frame quiet period shall be scheduled in the corresponding frame. If the bit is set to 1, an intra-frame quiet period shall be scheduled within the corresponding frame for the duration specified by Intra-frame Quiet period Duration.
Intra-frame Quiet Period Duration	4 bits	Valid only if Intra-frame Quiet Period Cycle Length > 0. If this field is set to a value different from 0 (zero), it indicates the number of symbols starting from the end of the frame during which no transmission shall take place.
Inter-Frame Quiet Period Duration	4 bits	Used for in-band inter-frame sensing, it indicates the duration of the next scheduled quiet period. > 0, it indicates the number of frames starting from Inter-frame Quiet Period Offset that shall be used to perform inter-frame sensing. == 0, it cancels the next scheduled quiet period for inter-frame sensing or indicates that no inter-frame sensing are currently scheduled
Inter-Frame Quiet Period Offset	12 bits	Used for in-band inter-frame sensing, it indicates the time span between the transmission of this information and the next scheduled quiet period for inter-frame sensing. Bit 11–4: index the superframe number Bit 3–0: index the frame number when the next scheduled quiet period for inter-frame sensing will start.
Reserved	3 bits	All bits shall be set to zero.
}		

7.9.17.4 Channel Quiet Response (CHQ-RSP)

This message (Table 149) is sent by the CPE in response to the receipt of a CHQ-REQ. This message shall only be transmitted by the CPE if the Confirmation Needed field in the received CHQ-REQ is set.

Table 149—CHQ RSP message format

Syntax	Size	Notes
CHQ-RSP_Message_Format() {		
Management Message Type = 29	8 bits	
Transaction ID	16 bits	See 7.9.24.
Confirmation code	8 bits	
}		

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7.9.17.5 Incumbent Prohibited Channels Update (IPC-UPD)

This IPC-UPD message (Table 150) is sent by the BS in order to inform CPEs of the channels upon which broadcast incumbent operation is prohibited and thus spectrum sensing is not needed (see A.5.5). This will allow the SSA to skip these channels during its in-band channel sensing process to clear N and N±1 and out-of-band sensing process to clear the backup/candidate channel list to shorten the sensing time at the CPE.

Table 150—IPC UPD message format

Syntax	Size	Notes
IPC-UPD_Message_Format() {		
Management Message Type = 30	8 bits	
Transaction ID	16 bits	
Number of Channels	8 bits	
for (i = 1; i ≤ Number of Channels; i++) {		
Channel number	8 bits	
}		
}		

7.9.18 Measurements management

This subclause presents the mandatory measurements management component of the MAC, which is a critical component for many features of the protocol including incumbent system protection.[19]

The BS can transmit the Bulk Measurement request (BLM-REQ) management message (see 7.9.18.1) via unicast, multicast, or broadcast to one or multiple CPEs. This message contains instructions on the type of measurements to be performed, when to perform it, the measurement duration, which channels to be measured, and so on. Since the correct receipt of these management messages may be critical to the correct system behavior (especially for in-band measurements—see 7.21.1), the BS may require CPEs to acknowledge the receipt of BLM-REQ messages. This is done through Bulk Measurement response (BLM-RSP) messages, and these are covered in 7.9.18.2). Next, deals with Bulk Measurement report (BLM-REP) messages that, as the name suggests, allows CPEs to report back to the BS all the measurement data they have collected as per requested by the BS in the corresponding BLM-REQ message.

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[19]The protocol for using the spectrum measurement messages is described in 11.4.

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7.9.18.1 Bulk Measurement request (BLM-REQ)

Table 151 illustrates the format of a BLM-REQ message. BLM-REQ messages can contain a multitude of single measurement messages (see Table 153). Each of these single measurement requests can be associated with a different type of measurement.

Table 151—BLM REQ message format

Syntax	Size	Notes
BLM-REQ_Message_Format() {		
Management Message Type = 31	8 bits	
Transaction ID	16 bits	Shall be set to a nonzero value chosen by the BS sending the measurement request to identify the request/report transaction.
Channel List	Variable	See Table 152.
Confirmation Needed	1 bit	Indicates whether or not the CPE is required by the BS to confirm, with a BLM-RSP message, the receipt of this message. 0: No confirmation needed (default) 1: Confirmation needed
Number of Single Measurement Requests	3 bits	The number of single measurement requests contained in this message
Single Measurement Requests	Variable	A series of single measurement requests. See Table 153.
}		

Table 152—Channel list

Syntax	Size	Notes
Channel_List_Format() {		
Number_of_Channels	8 bits	The number of channels in the current interval.
For (i=0; i < Number_of_Channels; i++){		
Channel Number [i]	8 bits	Channels contained in the list.
}		
}		

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7.9.18.1.1 Single measurement request

Table 153 gives the format of single measurement requests, which are carried in the body of BLM-REQ management messages. These single measurement requests shall be of various types as shown in Table 157. Also, as seen from Table 153, various timing parameters are associated with measurement requests. Figure 23 depicts how these parameters are related to a measurement activity (the Randomization Interval and Duration parameters are introduced in the next subclauses).

Table 153—Single measurement request message format

Syntax	Size	Notes
Single_Measurement_Request_Format() {		
Element ID	8 bits	
Length	8 bits	
Transaction ID	16 bits	
Number of Repetitions	8 bits	Contains the requested number of repetitions per channel for the periodic measurement request elements in this frame. A value of zero in the Number of Repetitions field indicates measurement request elements are executed only once.
Report Frequency	8 bits	This field indicates how often a CPE shall report measurements back to the BS 0: This field is not used to request a measurement report. That is, the CPE will report measurements either autonomously or whenever requested by the BS. 1: The CPE shall either report immediately to the BS (if this is in regards to an existing Transaction ID) or will report to the BS at the end of each repetition interval (in the case of a new Transaction ID). Note that in the case of an existing Transaction ID and Report Frequency == 1, the local information maintained by the CPE shall only be updated for this transaction if Number of Repetitions is not zero. 2–255:The CPE shall send a report to the BS at the end of every number of repetitions indicated by the code.
Restart Delay	16 bits	This field indicates the delay between two measurement repetitions. As shown in Table 161, the Measurement Period is divided into two subfields: Time Scale and Restart Delay. The Time Scale subfield defines the scale for the Restart Delay subfield as shown in Table 161. The subfield consists of a 15-bit unsigned integer number representing the fixed time delay between the completion of the last periodic measurement and the time when the measurement activity is restarted.
Request Mode	3 bits	Table 156
Request Element	Variable	Table 157
}		

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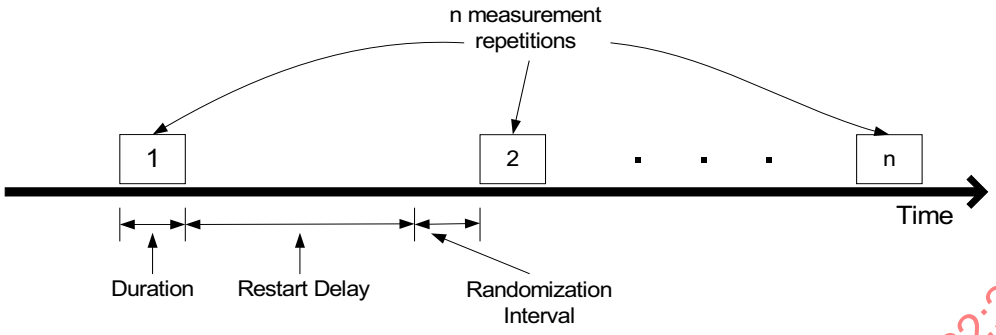

Figure 23—Illustration of the timing parameters used in measurement requests

Table 154—Repetition delay interval

Bits: 1	15
Time Scale	Restart delay

Table 155—Time unit (TU) and time scale definitions

Time Unit	Time Scale value
TU (see Table 248)	0
1000 TU	1

Table 156—Request mode

Syntax	Size	Notes
Request_Mode_Format() {		
Parallel	1 bit	Indicates whether the measurement should start in series or in parallel with the measurement described by any immediately previous Measurement Request element in the same Measurement Request frame. A value of 0 shall mean that the measurement shall start after the previous measurement request has completed. A value of 1 shall mean the measurement shall start at the same time as the previous measurement. The Parallel bit shall be set to 0 in the first or only measurement request element in the frame.

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Table 156—Request mode *(continued)*

Syntax	Size	Notes
Autonomous Report	1 bit	Indicates whether the CPE receiving the request shall enable or disable autonomous measurement reports for the measurements specified in this request. The Report bit shall be set to 1 when enabling autonomous measurement report. The Report bit shall be set to 0 when disabling an autonomous measurement report.
Duration Mandatory	1 bit	Indicates whether the measurement duration contained within the Measurement Request should be interpreted as mandatory by the CPE receiving the request. A value of 0 indicates that the duration is an upper bound and that the measurement can be done over a portion of this duration whereas 1 indicates that the CPE has to do the measurement over the entire specified duration.
}		

Table 157—Request information elements

Element ID (1 byte)	Length (bytes)	Description
0	6	TV System Related Measurement Request—7.9.18.1.1.1
1	6	Wireless Microphone Related Measurement Request—7.9.18.1.1.1
2	10	Beacon (IEEE 802.22 BS and CPE Related) Measurement Request—7.9.18.1.1.2
3	1	Backup/candidate channel list clearance depth
4	2	Measurement Stop Request—7.9.18.1.1.3
5	1	Status of CPE out-of-band sensing results—7.9.18.1.1.4
6	Variable	Location Data Request—7.9.18.1.1.5
7	10	IEEE 802.22.1 Beacon Measurement Request—7.9.18.1.1.2
8	2	Frequency response of active OFDM subcarriers at the CPE—7.9.18.1.1.6
9	2	Silent period FFT output—7.9.18.1.1.7
10–128		*Reserved*

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7.9.18.1.1.1 Signal-Specific Measurement Request

This refers to a particular incumbent signal specific measurement. Incumbent detection thresholds are specified during the registration procedure (see 7.9.7.3.4.7).

Table 158—Signal Specific Measurement request message format

Syntax	Size	Notes
Signal_Specific_Measurement_Request_Format () {		
Signal Type	5 bits	Table 318
Randomization Interval	16 bits	It specifies the upper bound of the random delay that can be used by the CPE prior to making the measurement. It is specified in units of TU (see Table 155). This field can be used for out-of-band measurements in channels that are not occupied by any other WRANs, as in-band measurements as well as out-of-band measurements in channels occupied by WRANs are driven by quiet periods of the WRAN(s) operating in the corresponding channel.
Duration	16 bits	Shall be set to the preferred duration of the requested measurement, expressed in TUs.
Sensing Mode	3 bits	Specifies which SSF outputs are valid and in some cases it specifies the behavior of the SSF. 000 – Sensing Mode 0 001 – Sensing Mode 1 010 – Sensing Mode 2 011 – Sensing Mode 3 (see definition of Sensing Modes in Table 320)
Maximum Probability of False Alarm	8 bits	As defined in the SSF (11.4.1.3.1)
}		

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7.9.18.1.1.2 Beacon Measurement Request

Table 159—Beacon Measurement request message format

Syntax	Size	Notes
Beacon_Measurement_Request_Format() {		
Randomization Interval	16 bits	This field only applies to out-of-band measurements, as in-band measurements are driven by quiet periods. It specifies the upper bound of the random delay that can be used by the CPE prior to making the measurement. It is specified in units of TU (see Table 155).
Duration	16 bits	Shall be set to the preferred duration of the requested measurement, expressed in TUs.
ID	48 bits	Specifies the ID (e.g., MAC ID) to listen to. Can be a broadcast ID or a specific CPE ID. (CBP burst ID or IEEE 802.22.1 beacon ID)
}		

7.9.18.1.1.3 Measurement Stop Request

Table 160—Stop Measurement Request message format

Syntax	Size	Notes
Stop_Measurement_Request_Format() {		
Stop Time	16 bits	Consists of an unsigned integer number representing the time at which the CPE shall stop conducting all measurements activities. The Stop Time field consists of a Time Scale subfield and a Stop Time subfield as shown in Table 161. The Time Scale subfield is defined in Table 154. Table 155 represents the time units for the integer in the Stop Time subfield.
}		

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Table 161—Pause time field

Bits: 1	15
Time Scale	Pause time

7.9.18.1.1.4 Status of CPE out-of-band sensing results

Table 162—Status of out-of-band sensing results request message format

Syntax	Size	Notes
Status_Measurement_Request_Format() {		
Number of channels	8 bits	Consists of an unsigned integer number representing the number of channels for which the out-of-band sensing results are requested.
}		

7.9.18.1.1.5 Location Configuration Measurement Request

Table 163—Location data request message format

Syntax	Size	Notes
Location_Data_Request_Format() {		
Length	16 bits	Length of the location data string in octets (0 to 4095 characters)
}		

7.9.18.1.1.6 Measurement request for frequency response of active OFDM subcarriers at the CPE

Table 164—Measurement request format for frequency response of active OFDM subcarriers at CPE

Syntax	Size	Notes
Frequency response of active OFDM subcarriers at the CPE() {		1680 subcarriers mandatory, 2048 recommended
Measurement Frame	8 bits	Frame number (see Table 28) in which the channel measurement is scheduled

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Table 164—Measurement request format for frequency response of active OFDM subcarriers at CPE *(continued)*

Syntax	Size	Notes
Measurement symbol	8 bits	Symbol number during which the measurement is to be made in the frame. This will likely be the frame preamble symbol for which the signature is known. Another measurement should be the status of the corrections for each carrier maintained and updated at the CPE to remove the channel response from the data at the output of the FFT and before the modulation detection. These carriers are to be updated with the pilot carrier information throughout the frame. This would be better and more stable than the preamble information because of the integration over time.
}		

7.9.18.1.1.7 Silent period channel FFT output measurement request

Table 165—Silent period FFT output measurement request format

Syntax	Size	Notes
Frequency response of OFDM subcarriers at the CPE() {		
Measurement Frame	8 bits	Frame number (see Table 28) in which the channel measurement is scheduled
Measurement symbol	8 bits	Symbol number during which the measurement is to be made in the frame
}		

7.9.18.2 Bulk Measurement response (BLM-RSP)

A BLM-RSP management message (shown in Table 166) is sent in response to a BLM-REQ and serves to confirm the receipt of the BLM-REQ message by the CPE. The need to send a BLM-RSP message is indicated by the BS in the corresponding BLM-REQ message, through the use of the Confirmation Needed field.

Table 166—BLM RSP message format

Syntax	Size	Notes
BLM-RSP_Message_Format() {		
Management Message Type = 32	8 bits	
Transaction ID	16 bits	
Confirmation code	8 bits	7.9.24
}		

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7.9.18.3 Bulk Measurement report (BLM-REP)

A BLM-REP management message (see Table 167) is sent from a CPE to a BS, and contains the measurement data collected by the CPE as per requested by the BS in a preceding BLM-REQ message. Unsolicited BLM-REP management messages can also be sent from a CPE to a BS for the purpose of signaling backup channels that are no longer available.

Table 167—BLM REP message format

Syntax	Size	Notes
BLM-REP_Message_Format() {		
Management Message Type = 33	8 bits	
Transaction ID	16 bits	
Number of Single Measurement Reports	8 bits	The number of single measurement reports contained in this message
Single Measurement Reports	Variable	7.9.8.13.1
}		

7.9.18.3.1 Single Measurement Report

Table 168—Single measurement report message format

Syntax	Size	Notes
Single_Measurement_Report_Format() {		
Element ID	8 bits	Table 169
Length	8 bits	
Transaction ID	16 bits	
Report Information element	Variable	Table 169
}		

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Table 169—Report information elements

Element ID (1 byte)	Length (bytes)	Description
129	10	TV Measurement Report—7.9.18.3.1.1
130	10	Wireless Microphone Measurement Report—7.9.18.3.1.1
131	Variable	Beacon (IEEE 802.22 related) Measurement Report—7.9.18.3.1.2
132	2	Unavailable backup channel—7.9.18.3.1.3
133	2	Backup channel list clearance depth—7.9.18.3.1.4
134	2	Backup/candidate channel list clearance depth—7.9.18.3.1.5
135	12	Status of CPE out-of-band sensing results—7.9.18.3.1.6
136	Variable	Location Data Report—7.9.18.3.1.7
137	Variable	IEEE 802.22.1 Beacon Measurement Report—7.9.18.3.1.8
138	Variable	Consolidated Spectrum Occupancy Measurement Report—7.9.18.3.1.9
139	3362	Frequency response of active OFDM subcarriers at the CPE—7.9.18.3.1.10
140	3362	Silent period FFT output Measurement Report, see 7.9.18.3.1.11
141–255		*Reserved*

7.9.18.3.1.1 Signal-Specific Measurement Report

Table 170—Signal-Specific Measurement Report message format

Syntax	Size	Notes
Signal_Specific_Measurement_Report_Format() {		
Signal Type	5 bits	
Report Mode	8 bits	
Start Frame	8 bits	Frame number (see Table 28) in which the channel measurement started
Duration	16 bits	The actual duration, in units of symbol period, of the measurement
Channel Number	8 bits	

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Table 170—Signal-Specific Measurement Report message format *(continued)*

Syntax	Size	Notes
Sensing Mode	3 bits	Specifies which SSF outputs are valid and in some cases it specifies the behavior of the SSF. 000: Sensing Mode 0 001: Sensing Mode 1 010: Sensing Mode 2 011–111: *Reserved* (see definition of Sensing Modes in Table 320)
Signal Present Output	1 bit	Indicates the decision from the CPE sensing function regarding the presence of the target signal in the channel measured: 0 – FALSE: Indicates the signal is NOT present in the channel (see 11.4.1.3) 1 – TRUE: Indicates the signal is present in the channel (see11.4.1.3)
Confidence Metric	8 bits	This number indicates confidence level in the signal present decision reported in the Signal Present Output. A confidence metric varies between a minimum of zero (0x00) indicating no confidence in the signal present decision and a maximum of one (0xFF) indicating total confidence in the signal present decision. If Sensing Mode =0, the confidence metric shall be set to zero (0x00).
RSSI	10 bits	Received signal strength indication (RSSI) (estimate) measured at the BS or CPE. This RSSI shall be measured in dBm and shall be normalized for a 0 dBi antenna gain and 0 dB coupling and cable loss (see definition in 11.4.1.3). The value will represent the estimated mean when reported for a number of measurements. Signed in units of dBm in 0.5 dB steps ranging from –104 dBm (encoded 0x00) to +23.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme.
Standard Deviation	8 bits	The standard deviation of the RSSI estimated when reported for a number of measurements (see 7.9.18.1.1). Expressed in units of dB in 0.1 dB steps ranging from 0.0 dB (encoded 0x00) to +25.5 dB (encoded 0xFF). Values beyond +25.5 dB shall be encoded as 0xFF.
Reserved	5 bits	All bits shall be set to zero.
}		

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Table 171—Report mode

Syntax	Size	Notes
Report_Mode_Format() {		
Late	1 bit	Indicates whether this CPE is unable to carry out a measurement request because it received the request after the requested measurement time. The Late bit shall be set equal to 1 to indicate the request was too late. The Late bit shall be set to 0 to indicate the request was received in time for the measurement to be executed, or if no start time was specified.
Incapable	1 bit	Indicates whether this CPE is incapable of generating this report requested by the BS. The Incapable bit shall be set to 1 to indicate the CPE is incapable. The Incapable bit shall be set to 0 to indicate the CPE is capable or the report is autonomous.
Refused	1 bit	Indicates whether this CPE is refusing to generate this report requested by the BS. The Refused bit shall be set to 1 to indicate the CPE is refusing. The Refused bit shall be set to 0 to indicate the CPE is not refusing or the report is autonomous.
Unmeasured	1 bit	CPE did not measure the channel.
No_decision	1 bit	This bit shall be set to 1 to indicate the measurement was carried out but no decision was made (see 11.4.1.3)
Reserved	3 bits	All bits shall be set to zero.
}		

7.9.18.3.1.2 Beacon Measurement report

A Beacon Measurement report (see Table 172) is sent from a CPE to its corresponding BS, and conveys information about one single overhead SCH (transmitted by other BSs) and/or CBP packet (transmitted by other CPEs).

Table 172—Beacon Measurement report message format

Syntax	Size	Notes
Beacon_Measurement_Report_Format() {		
Element ID	8 bits	131
Length	8 bits	Length in bytes.
Report Mode	5 bits	Table 171
Reserved	3 bits	All bits shall be set to zero.
Start Frame	8 bits	Table 170
Duration	16 bits	Table 170

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Table 172—Beacon Measurement report message format *(continued)*

Syntax	Size	Notes
Frame Number	8 bits	The frame number in which the beacon was received. See definition in Table 28.
Reception Offset	8 bits	Indicates the offset (in units of symbols) relative to the start of the first symbol of the PHY PDU (including preamble) frame where the beacon was received. The time instants indicated by the Reception Offset values are the reception times of the first symbol of the beacon including preamble (if present).
Channel Number	8 bits	
RCPI	8 bits	Received Carrier Power Indicator (in dBm)
Received CBP MAC PDU	Variable	See 7.8.1.3.1 and 7.22.1.2
}		

7.9.18.3.1.3 Unavailable Backup Channel

This information element is transmitted by the CPE as an unsolicited BLM-RSP message to signal that a backup channel is no longer available after an incumbent has been detected in this backup channel or either of its adjacent channels. This unsolicited message is to be carried by a normal US bandwidth allocation assigned to the CPE in the US-MAP or, if not present, using the opportunistic BW Request mechanism to allow reporting to the BS as soon as possible.

Table 173—Unavailable Backup Channel report message format

Syntax	Size	Notes
Backup channel list clearance depth Report_Format() {		
Report Mode	8 bits	Table 171
Channel number	8 bits	Channel number for the channel that is found to be no longer available after an incumbent has been detected in this backup channel or either of its adjacent channels.
}		

7.9.18.3.1.4 Backup channel list clearance depth

This report is provided by the CPE upon request by the BS (Table 157). It can also be sent as an opportunistic message by the CPE when the backup channel list clearance depth becomes smaller than the number of backup channels indicated by the DCD IE10 in Table 28.

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Table 174—Backup channel list clearance depth report message format

Syntax	Size	Notes
Backup channel list clearance depth Report_Format() {		
Report Mode	8 bits	Table 171
Clearance depth	8 bits	Number of backup channels that the CPE has had the time to verify for absence of incumbents during its idle time.
}		

7.9.18.3.1.5 Backup/candidate channel list clearance depth

This report is provided by the CPE upon request by the BS (Table 159).

Table 175—Backup/candidate channel list clearance depth report message format

Syntax	Size	Notes
Backup/candidate channel list clearance depth Report_Format() {		
Report Mode	8 bits	Table 171
Clearance depth	8 bits	Number of backup/candidate channels that the CPE has had the time to verify for absence of incumbents during its idle time.
}		

7.9.18.3.1.6 Status of CPE out-of-band sensing results

Table 176—Status of CPE out-of-band sensing results

Syntax	Size	Notes
Status of CPE out-of-band sensing results Report_Format() {		
Report Mode	8 bits	Table 171
for (i = 1; i ≤ Number of Channels; i++) {		The order in which the channel results shall be presented will be in the order of the most recent sensed channel to the earliest one fitting in the list.
Channel number	8 bits	Transmission channel number.
Time since last sensing	16 bits	Time since last sensing in symbol periods
Time of last positive	24 bits	Time since the last detection of an incumbent in the channel in symbol periods

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Table 176—Status of CPE out-of-band sensing results *(continued)*

Syntax	Size	Notes
Sensing path RSSI	8 bits	Received signal strength indication at the RF sensor normalized for a 0 dBi antenna gain and 0 dB coupling and cable loss, signed in units of dBm in 0.5 dB steps, ranging from –104 dBm (encoded 0x00) to +23.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme.
Data path RSSL	8 bits	Received signal level at the WRAN detector normalized for a 0 dBi antenna gain and 0 dB coupling and cable loss signed in units of dBm in 0.5 dB steps ranging from –104 dBm (encoded 0xFF) to +23.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme.
Signal Type	8 bits	See Table 318
Sensing path RSSI during quiet period	8 bits	Received signal strength at the RF sensor normalized for a 0 dBi antenna gain and 0 dB coupling and cable loss, measured during WRAN systems quiet periods, signed in units of dBm in 0.5 dB steps, ranging from –104 dBm (encoded 0x00) to +23.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme.
Signal type during quiet period	8 bits	See Table 318
}		
}		

7.9.18.3.1.7 Location Data report

A Location Data report (see Table 177), includes a string of location data that the CPE has obtained from satellite. The report format shall be as described in NMEA 0183, and the length shall be the length of the NMEA 0183 ASCII string plus 3 octets.

Table 177—Location Data report message format

Syntax	Size	Notes
Location_Data_Report_Format() {		
Element ID	8 bits	
Length	12 bits	Length of the location data string in octets (0 to 4095 characters)
Report Mode	8 bits	Table 171
Location Data String	Variable	NMEA 0183 ASCII string
}		

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7.9.18.3.1.8 IEEE 802.22.1 Beacon Measurement report

An IEEE 802.22.1 Beacon Measurement report (see Table 178) is transmitted from a CPE to its corresponding BS, and conveys information from the IEEE 802.22.1 beacon PPDU when it is acquired. This report shall not be sent if the CPE did not receive any IEEE 802.22.1 beacon (i.e., below the required minimum level, see Table 328). If an IEEE 802.22.1 beacon was received, the report should indicate the level of the received beacon signal at detection. In such case, the size of the beacon PPDU shall be indicated by a bitmap depending on which part of the PPDU could be properly decoded. See Annex D for more information on this feature.

Table 178—IEEE 802.22.1 beacon measurement report message format

Syntax	Size	Notes
IEEE 802.22.1 Beacon_Measurement_ Report_Format() {		
Element ID	8 bits	
Length	8 bits	
Report Mode	5 bits	Table 171
Start Frame	16 bits	Table 170
Duration	16 bits	Table 170
RSSI	8 bits	Received signal strength indication at the IEEE 802.22.1 beacon detector, signed in units of dBm in 0.5 dB steps, ranging from –104 dBm (encoded 0x00) to +23.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme.
IEEE 802.22.1 Beacon_Payload_ Bitmap	3 bits	000: Sync Burst 001: PPDU MSF1 011: PPDU MSF1+MSF2 111: PPDU MSF1+MSF2+MSF3
IEEE 802.22.1 Beacon_Payload	Variable	The possible sizes for the payload are as follows: MSF1 (17 bytes) MSF1 + MSF2 (68 bytes) MSF1 + MSF2 + MSF3 (101 bytes) This field is not included if the Beacon_Payload_Bitmap field is set to 000 (Sync Burst).
}		

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7.9.18.3.1.9 Consolidated Spectrum Occupancy Measurement report

A Consolidated Spectrum Occupancy Measurement report (see Table 179) is sent from a CPE to its corresponding BS, and conveys a brief summary about the overall spectrum occupancy from the viewpoint of the CPE.

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Table 179—Consolidated spectrum occupancy measurement report message format

Syntax	Size	Notes
Consolidated_Spectrum_Occupancy_ Measurement_Report_Format() {		
Start Frame	8 bits	Frame number (see Table 28) in which the channel measurement started
Duration	16 bits	The actual duration of the measurement
Starting Channel Number	8 bits	
Number of Channels	8 bits	
for (i = 1; i ≤ Number of Channels; i++) {		
Channel State	3 bits	000: Unmeasured 001: Vacant 010: Occupied 011: Occupied by TV service 100: Occupied by wireless microphones 101: Occupied by IEEE 802.22 110–111: *Reserved*
}		
Padding bits	0–7 bits	Padding to octet alignment—set all bits to 0.
}		

7.9.18.3.1.10 Frequency response of the OFDM subcarriers measurement report

A frequency response of the OFDM subcarriers measurement report (see Table 180) is sent from a CPE to its corresponding BS, and conveys the I&Q values of each 1680 active subcarriers representing the state of the transmission channel (impulse response) in the frequency domain from the viewpoint of the CPE. These values represent the estimated transmission channel state values stored at each CPE and used to correct the received carrier phase and amplitude of each data subcarrier before demodulation.

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Table 180—Frequency response of the OFDM message format

Syntax	Size	Notes
Frequency response_of_OFDM_Report_Format() {		
Measurement Frame	8 bits	Frame number (see Table 28) in which the channel measurement is scheduled.
WRAN RF path RSSL	8 bits	Received signal strength at the WRAN detector normalized for a 0 dBi antenna gain and 0 dB coupling and cable loss, signed in units of dBm in 0.5 dB steps, ranging from –104 dBm (encoded 0x00) to +23.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme.
for (i = 1; $i \leq$ 1680; i++) {		
I_Carrier State	8 bits	
Q_Carrier State	8 bits	
}		
}		

7.9.18.3.1.11 Silent period FFT output measurement report

A channel FFT output measurement report for the OFDM subcarriers during a silent period (see Table 181) is sent from a CPE to its corresponding BS, and conveys the I&Q values of each subcarrier representing the state of interference and noise in the transmission channel from the viewpoint of the CPE. These values represent the raw output of the FFT process done over one selected symbol at the CPE.

Table 181—Silent period FFT output message format

Syntax	Size	Notes
Silent period FFT output _Report_Format() {		
Measurement Frame	8 bits	Frame number (see Table 28) in which the channel measurement is scheduled.
WRAN RF path RSSL	8 bits	Received signal strength at the WRAN detector normalized for a 0 dBi antenna gain and 0 dB coupling and cable loss, signed in units of dBm in 0.5 dB steps, ranging from –104 dBm (encoded 0x00) to +23.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme.
for (i = 1; $i \leq$ 1680; i++) {		
I_Carrier State	8 bits	

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Table 181—Silent period FFT output message format *(continued)*

Syntax	Size	Notes
Q_Carrier State	8 bits	
}		
}		

7.9.18.4 Bulk Measurement Acknowledgment (BLM-ACK)

A BLM-ACK management message (shown in Table 182) shall be sent from the BS to the CPE in response to a received BLM-REP. It serves to confirm to the CPE the reception of the BLM-REP message by the BS.

Table 182—BLM ACK message format

Syntax	Size	Notes
BLM-ACK_Message_Format() {		
Management Message Type = 34	8 bits	
Transaction ID	16 bits	
Confirmation code	8 bits	7.9.24
}		

7.9.19 Config File TFTP Complete (TFTP-CPLT)

The Config File TFTP-CPLT message shall be generated by the CPE whenever it has successfully retrieved its configuration file from the provisioning server (see 7.16). If the CPE does not need a config file, it shall send the TFTP-CPLT message to the BS anyway to indicate that it has completed secondary management connection initialization and is ready to accept services. The format of the TFTP-CPLT shall be as shown in Table 183.

Table 183—TFTP-CPLT message format

Syntax	Size	Notes
TFTP-CPLT_Message_Format() {		The FT in the MAC header shall be set to the CPE's primary management FT
Management Message Type = 35	8 bits	
}		

7.9.20 Config File TFTP Complete Response (TFTP-RSP)

The Config File TFTP-RSP message shall be generated by the BS in response to a TFTP-CPLT message from the CPE (see 7.16). The format of the TFTP-RSP shall be as shown in Table 184.

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Table 184—TFTP-RSP message format

Syntax	Size	Notes
TFTP-RSP_Message_Format() {		The FT in the MAC header shall be set to the CPE's primary management FT
Management Message Type = 36	8 bits	
Response	8 bits	0: OK 1: Message authentication failure
}		

7.9.21 Security Control Management (SCM) messages (SCM-REQ/RSP)

SCM employs two MAC message types: SCM Request (SCM-REQ) and SCM Response (SCM-RSP), as described in Table 185.

Table 185—SCM MAC messages

Type Value	Message name	Message description
37	SCM-REQ	Security Control Management Request [CPE → BS]
38	SCM-RSP	Security Control Management Response [BS → CPE]

These MAC management message types distinguish between SCM requests (CPE-to-BS) and SCM responses (BS-to-CPE). Each message encapsulates one SCM message in the Management Message Payload.

SCM protocol messages transmitted from the CPE to the BS shall use the form shown in Table 186. They are transmitted on the CPEs Primary Management Connection.

Table 186—SCM REQ message format

Syntax	Size	Notes
SCM-REQ_Message_Format() {		
Management Message Type = 37	8 bits	
Element ID	8 bits	Identifies the type of SCM packet. When a packet is received with an invalid Code, it shall be silently discarded. The code values are defined in Table 188.

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Table 186—SCM REQ message format *(continued)*

Syntax	Size	Notes
Transaction ID	16 bits	A CPE uses the identifier Transaction ID to match a BS response to the CPE's requests. The CPE shall increment (modulo 256) the Transaction ID field whenever it issues a new SCM message. A "new" message is an EAP Start, EAP Transfer, or Key Request that is not a retransmission being sent in response to a Timeout event. For retransmissions, the Transaction ID field shall remain unchanged. The Transaction ID field in a BS's SCM-RSP message shall match the Transaction ID field of the SCM-REQ message to which the BS is responding. The Transaction ID field in TEK Invalid messages, which are not sent in response to SCM-REQs, shall be set to zero. On reception of a SCM-RSP message, the CPE associates the message with a particular state machine (the Authentication state machine in the case of indication of EAP Success, or EAP Failure events; a particular TEK state machine in the case of Key Replies, Key Rejects, and TEK Invalids). A CPE shall keep track of the Transaction ID of its latest, pending authentication requests. The CPE shall discard any EAP Start or EAP Transfer messages with Transaction ID fields not matching that of the pending authentication requests. A CPE shall keep track of the Transaction IDs of its latest, pending Key Request for each SA. The CPE shall discard Key Reply and Key Reject messages with Transaction ID fields not matching those of the pending Key Request messages.
Encoded Attributes	Variable	SCM attributes carry the specific authentication and key management data exchanged between client and server. Each SCM packet type has its own set of required and optional attributes. Unless explicitly stated, there are no requirements on the ordering of attributes within a SCM message. The end of the list of attributes is indicated by the Length field of the MAC PDU header.
}		

SCM protocol messages transmitted from the BS to the CPE shall use the form shown in Table 187. They are transmitted on the CPEs Primary Management Connection.

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Table 187—SCM-RSP message format

Syntax	Size	Notes
SCM- RSP_Message_Format() {		
Management Message Type = 38	8 bits	
Element ID	8 bits	Table 186
Transaction ID	16 bits	Table 186
Encoded Attributes	Variable	
}		

Table 188—SCM message codes

Element ID	SCM message type	MAC Management Message Name
1	SCM EAP Start	SCM-REQ
2	SCM EAP Transfer	SCM-REQ/RSP
3	SCM Key-Request	SCM-REQ
4	SCM Key-Reply	SCM-RSP
5	SCM Key-Reject	SCM-RSP
6	SCM GSA-Add	SCM-RSP
7	SCM GSA-Remove	SCM-RSP
8	SCM TEK-Invalid	SCM-RSP
9–255	*Reserved*	

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Formats for each of the SCM messages are described in the following subclauses.

7.9.21.1 SCM EAP Start

SCM EAP Start shall be used during network entry to initiate an EAP session. The BS shall be capable of initiating an EAP session with EAP Start if the network authenticator does not. The “Key Sequence Number” attribute shall only be present in EAP Start messages transmitted during reauthentication. Note that during reauthentication, the EAP Start message shall be protected by the MMP key.

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Table 189—SCM EAP Start Message attribute

Syntax	Size	Notes
Key Sequence Number	4 bits	AK Sequence Number

7.9.21.2 SCM EAP Transfer

EAP Transfer shall be used when an EAP payload has to be transferred between the CPE and the network authenticator (through the BS). The EAP Payload attribute shall be present in all EAP Transfer messages. The "Key Sequence Number" attribute shall only be present in EAP Transfer messages during reauthentication. Note that during reauthentication, the EAP Start message shall be protected by the MMP key.

Table 190—SCM EAP Transfer Message attributes

Syntax	Size	Notes
Key Sequence Number	4 bits	AK Sequence Number
Length of EAP Payload	16 bits	Length of EAP Payload (in octets)
EAP Payload	Variable	Contains EAP authentication Data

7.9.21.3 SCM Key-Request

A CPE sends a SCM Key-Request message to the BS to request new TEK and TEK-related parameters or GTEK and GTEK-related parameters for the multicast or broadcast service.

Table 191—SCM Key Request attributes

Syntax	Size	Notes
Key Sequence Number	4 bits	AK sequence number
SAID	16 bits	Security association identifier – GSAID for multicast or broadcast service
Group Key Indicator	1 bit	0: this key request is for a TEK 1: this key request is for a GTEK, only applicable if SAID refers to a GSA.
CPE Random	64 bits	A 64-bit random number generated in the CPE.

Once a CPE has completed authentication, it has keying material (MMP_KEY) that can be used to sign and/or encrypt further MAC management messages. If SCM Key-Request is only to be signed, then CPE will

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use MMP_KEY derived from the AK identified by AK Sequence Number in Key-Request will be used to generate the Ciphertext ICV (see 8.4.2.1.1.2). If SCM Key-Request is to be encrypted, then CPE will use the MMP_KEY derived from the most current of its AKs to generate the Ciphertext ICV and encrypt the message (see 8.4.2.1.3).

7.9.21.4 SCM Key-Reply

The BS responds to a CPE's SCM Key-Request message with a SCM Key-Reply message.

Table 192—SCM Key Reply attributes

Syntax	Size	Notes
Key Sequence Number	4 bits	AK sequence number
SAID	16 bits	Security association identifier—GSAID for multicast or broadcast service.
Older TEK/GTEK	128 bits	Older generation of TEK/GTEK relevant to SAID/GSAID.
Older TEK/GTEK Sequence Number	2 bits	Sequence Number for older generation of TEK/GTEK. This maps to the value to which the EKS field is set in GMH of PDU encrypted with this TEK/GTEK.
Remaining Lifetime for Older TEK/GTEK	24 bits	Remaining time for older TEK/GTEK in units of 10 ms frames.
Newer TEK/GTEK	128 bits	Newer generation TEK/GTEK relevant to SAID/GSAID.
New TEK/GTEK Sequence Number	2 bits	Sequence Number for newer generation of TEK/GTEK. This maps to the value to which the EKS field is set in GMH of PDU encrypted with this TEK/GTEK.
Remaining Lifetime for New TEK/GTEK	24 bits	Remaining time for new generation of TEK/GTEK in units of 10 ms frames.
CPE Random	64 bits	The same random number included in the SCM Key Request message.
BS Random	64 bits	Random number generated by the BS.

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The GKEK-Parameters attribute is a compound attribute containing all of the GKEK-related parameters corresponding to a GSAID. This would include the GKEK, the GKEK's remaining key lifetime, and the GKEK's key sequence number.

Once the AAA has completed authentication with a particular CPE, both the CPE and BS have keying material (MMP_KEY) that can be used to sign and/or encrypt further MAC management messages. If SCM Key-Reply is only to be signed, then BS will use MMP_KEY derived from the AK identified by AK Sequence Number in Key-Reply will be used to generate the Ciphertext ICV (see 8.4.2.1.1.2). If SCM Key-Reply is to be encrypted, then BS will use the MMP_KEY derived from the most current of its AK's to generate the Ciphertext ICV and encrypt the message (see 8.4.2.1.3).

GKEK parameters shall only be included in Key-Reply message, when responding to Key-Request that is conducted immediately after completion of Authentication exchange. To update GKEK parameters for an existing GSA, the BS shall add new GKEK parameters to the list of SA descriptors in an SA Add message.

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7.9.21.5 SCM Key-Reject

The BS responds to a CPE's SCM Key-Request message with a SCM Key-Reject message if the BS rejects the CPE's traffic keying material request.

Confirmation code is set to 0x0E when the Key Request was made for a SA for which the CPE is not currently authorized. Confirmation code is set to 0x0B when the Key Request message cannot be properly authenticated and decrypted.

Table 193—SCM Key Reject attributes

Syntax	Size	Notes
Key Sequence Number	4 bits	AK sequence number
SAID	16 bits	Security association identifier
Confirmation code	8 bits	Error code (see 7.9.24) identifying reason for rejection of the SCM Key-Request message
CPE Random	64 bits	A same random number included in the SCM Key Request message
BS Random	64 bits	Random number generated by the BS

Once a BS has completed authorization with a particular CPE, both have keying material (MMP_KEY) that can be used to sign and/or encrypt further MAC management messages. If SCM Key-Reject is only to be signed, then BS will use MMP_KEY derived from the AK identified by AK Sequence Number in Key-Reject will be used to generate the Ciphertext ICV (see 8.4.2.1.1.2). If SCM Key-Reject is to be encrypted, then BS will use the MMP_KEY derived from the most current of its AK's to generate the Ciphertext ICV and encrypt the message (see 8.4.2.1.3).

7.9.21.6 SCM GSA-Add

This message is sent by the BS to the CPE to establish one or more additional GSAs, after completion of the Authentication exchange. BS shall use this method to update material (e.g., GKEKs and associated parameters) for existing GSAs.

Table 194—SCM GSA Add attributes

Syntax	Size	Notes
Key Sequence Number	4 bits	AK sequence number
Multicast SID	9 bits	SID of multicast group
SAID	16 bits	SAID for GSA applied to the multicast group
GKEK	128 bits	GKEK for GSA used to protect GTEK when transported to CPE in Key-Reply. This field is protected with the KEK associated with the AK.
Remaining GKEK Lifetime	24 bits	Remaining lifetime in which GKEK can be used to protect GTEKs in SCM Key-Reply messages. In units of 10 ms frames.

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Once the AAA has completed authentication with a particular CPE, both the CPE and BS have keying material (MMP_KEY) that can be used to sign and/or encrypt further MAC management messages. If SCM GSA-Add is only to be signed, then BS will use MMP_KEY derived from the AK identified by AK Sequence Number in GSA-Add will be used to generate the Ciphertext ICV (see xx). If SCM GSA-Add is to be encrypted, then BS will use the MMP_KEY derived from the most current of its AKs to generate the Ciphertext ICV and encrypt the message (see8.4.2.1.3). The format of the GSA Descriptor is described in 8.2.7.

7.9.21.7 SCM GSA-Remove

This message is sent by the BS to the CPE to remove one or more additional GSAs. This message shall only be transmitted to CPEs after the BS has removed those CPEs from the multicast group to which the GSA was applied.

Table 195—SCM GSA-Remove attributes

Syntax	Size	Notes
Number of SAID	8 bits	"N" Number of SAIDs for GSA (GSAIDs) that are to be removed
SAID(s)	N×16 bits	List of SAIDs for GSAs that are to be removed

7.9.21.8 SCM TEK-Invalid

The BS sends a SCM TEK-Invalid message to a client CPE if the BS determines that the CPE encrypted a US PDU with an invalid TEK (i.e., SAID's TEK key sequence number), contained within the received packet's MAC header, is out of the BS's range of known, valid sequence numbers for that SAID.

Message Response Code is set to 0x02 when sending TEK Invalid message.

Table 196—SCM TEK Invalid attributes

Syntax	Size	Notes
Key Sequence Number	4 bits	AK sequence number
SAID	16 bits	Security association identifier
Confirmation code	8 bits	Error code (see 7.9.24) identifying reason for SCM TEK-Invalid message

Once the AAA has completed authentication with a particular CPE, both the CPE and BS have keying material (MMP_KEY) that is used to sign and encrypt further MAC management messages. The SCM TEK-Invalid is to be encrypted, so the BS shall use the MMP_KEY derived from the most current of its AKs to generate the Ciphertext ICV and encrypt the message (see 8.4.2.1.3).

7.9.22 Frame Allocation Management

In self-coexistence mode, multiple WRAN cells share the same channel by per frame-based access. The active frame allocation may change from one superframe to another. When the location of the first active

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frame is changed in the next superframe, the BS shall send the first active frame allocation update information within the present superframe to indicate all its associated CPEs.

Table 197—Frame Allocation Management

Syntax	Size	Notes
FRM-UPD_Message_Format() {		
Management Message Type = 39	8 bits	
Transaction ID	16 bits	
Frame Index of the first frame allocated to the present cell in next superframe	4 bits	Indicate the frame index (0–15) of the first frame allocated in next superframe.
Reserved	4 bits	All bits shall be set to zero.
}		

7.9.23 CBP Relay message

This message is used by the BS to relay CBP MAC PDUs that it has formulated to a CPE or group of CPEs so that these CPEs can transmit the CBP burst in the next available (active) SCW. CBP MAC PDU generation and transmission is discussed in 7.22.1.2.

Table 198—CBP-RLY message format

Syntax	Size	Notes
CBP -RLY_Message_Format() {		
Management Message Type = 40	8 bits	
CBP MAC PDU	Variable	A CBP MAC PDU formulated as per the process described in 7.22.1.2 and is made up by a combination of IEs that are listed in Table 15.
}		

7.9.24 Confirmation codes

The codes in Table 199 are used to set the status of responses in dynamic service configuration (DSx-RSP), security configuration (SCM-RSP), multicast group assignment (MCA-RSP), as well as basic (CBC-RSP) and registered (REG-RSP) capability configuration. In Table 198, a column called “Network Applicability,” indicates what network type particular confirmation codes are is applicable to/used in. A value of “Both” means that the IE is used in both the WRAN and A-WRAN, a value of “WRAN only” means that the IE is only used in the WRAN cell, whereas a value of “A-WRAN only” means that the IE is only used in an A-WRAN cell.

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Table 199—Confirmation codes

CC	Status	Network Applicability
0x00	OK/success	Both
0x01	reject-other	Both
0x02	reject-unrecognized-configuration-setting	Both
0x03	reject-temporary / reject-resource	Both
0x04	reject-permanent / reject-admin	Both
0x05	reject-not-owner	Both
0x06	reject-service-flow-not-found	Both
0x07	reject-service-flow-exists	Both
0x08	reject-required-parameter-not-present	Both
0x09	reject-header-suppression	Both
0x0A	reject-unknown-transaction-id	Both
0x0B	reject-authentication-failure	Both
0x0C	reject-add-aborted	Both
0x0D	reject-exceed-dynamic-service-limit	Both
0x0E	reject-not-configured-for-the-request-SAID	Both
0x0F	reject-fail-to-establish-the-requested-SA	Both
0x10	reject-not-supported-parameter	Both
0x11	reject-not-supported-parameter-value	Both
0x12	reject-invalid-key-sequence-number	Both
0x13	reject-A-CPE-not-supported-parameter-value	A-WRAN only
0x14	reject-unknown-sid	A-WRAN only
0x15	reject-invalid-container-pdu-length	A-WRAN only
0x16	reject-invalid-container-pdu-type	A-WRAN only
0x17	reject-dtt-not-allowed	A-WRAN only
0x18	reject-dtt-rpt-not-allowed-to-transmit	A-WRAN only
0x19	reject-dtt-rpt-need-to-retest	A-WRAN only
0x20	reject-failed-cam-stp	A-WRAN only
0x21	reject-failed-cam-swh	A-WRAN only
0x22–0xFF	*Reserved*	

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7.9.25 Local Cell Update messages

7.9.25.1 Local Cell Update Indication (LCU-IND) message

The format of an LCU-IND message is shown in Table 200. This message shall be transmitted by a distributed scheduling R-CPEs to the A-BS at the update of local cell information.

Table 200—LCU-IND message format

Syntax	Size	Note
LCU_IND_Message_Format() {		
Management Message Type = 41	8 bits	Local Cell Update IND
Transaction ID	16 bits	
Number of CPEs: n	8 bits	The number of CPEs, which are attached by a distributed scheduling R-CPE
For (i = 1; $i \leq$ n; i++){	Variable	
SID	9 bits	SID of CPE, which require local cell update that are attached by a distributed scheduling R-CPE
}		
}		

7.9.25.2 Local Cell Update Acknowledgment (LCU-ACK) message

The format of an LCU-ACK message is shown in Table 201. This message shall be transmitted by an A-BS to a distributed scheduling R-CPEs for the acknowledgment of reception of local cell update indication.

Table 201—LCU-ACK message format

Syntax	Size	Note
LCU_ACK_Format() {		
Management Message Type = 42	8 bits	
Transaction ID	16 bits	
Confirmation Code	8 bits	See 7.9.24
}		

7.9.26 Container message

7.9.26.1 Message format

The format of a Container message is shown in Table 202. A container message is used to convey MAC PDUs between the A-CPE to the A-BS.

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Table 202—Container message format

Syntax	Size	Note
Container_Message_Format() {		
Management Message Type = 43	8 bits	
Transaction ID	16 bits	
Number of Contained MAC PDUs: n	8 bits	The number of contained MAC PDUs
For (i = 1; $i \leq$ n; i++){	Variable	
SID	9 bits	SID of A-CPE, which sends this messages
MAC PDU Type	3 bits	000: REG-RSP 001: DREG-CMD with Action Code = 0x04 or 0x05] 010: DREG-CMD with Action Code = 0x01, 0x02, or 0x03 011: Any other PDU 100–111: *Reserved*
MAC PDU Length	11 bits	The length in bytes of the contained MAC PDU including the MAC header and the CRC.
MAC PDU	Variable	
}		
}		

7.9.26.2 Container ACK message

The format of a Container ACK message is shown in Table 203. A container ACK message is used to acknowledgment for a container message.

Table 203—Container ACK message format

Syntax	Size	Note
Container_ACK_Message_Format() {		
Management Message Type = 44	8 bits	
Transaction ID	16 bits	
Confirmation Code	8 bits	See 9.4.24
}		

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7.9.27 Downstream Transmit Test (DTT) messages

7.9.27.1 DTT Request (DTT-REQ) message

7.9.27.1.1 Message format

The format of a DTT-REQ message is shown in Table 204.

Table 204—DTT-REQ message format

Syntax	Size	Note
DTT-REQ_Message_Format() {		
Management Message Type = 45	8 bits	
Transaction ID	16 bits	
Information elements (IEs)	Variable	See Table 205
}		

7.9.27.1.2 DTT-REQ information element

The format of a DTT-REQ IE is shown in Table 205.

Table 205—DTT-REQ information element

Name	Element ID (1 byte)	Length	Scope
SID	1	9 bits	Selected a centralized scheduling R-CPE to test a relay burst profile

7.9.27.2 DTT Response (DTT-RSP) message

7.9.27.2.1 Message format

The format of a DTT-RSP message is shown in Table 206.

Table 206—DTT-RSP message format

Syntax	Size	Note
DTT-RSP_Message_Format() {		
Management Message Type = 46	8 bits	
Transaction ID	16 bits	
Information elements (IEs)	Variable	See Table 207
}		

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7.9.27.2.2 DTT-RSP information element

The format of a DTT-RSP IE is shown in Table 207.

Table 207—DTT-RSP information element

Name	Element ID (1 byte)	Length	Scope
Action Frame Number Offset	1	4 bits	Integer value greater than zero that indicates the starting frame number for a relay burst profile test
Status	2	8 bits	See 7.9.24

7.9.27.3 DTT Report (DTT-RPT) message

7.9.27.3.1 Message format

The format of a DTT-RPT message is shown in Table 208.

Table 208—DTT-RPT message format

Syntax	Size	Note
DTT-RPT_Message_Format() {		
Management Message Type = 47	8 bits	
Transaction ID	16 bits	
Information elements (IEs)	Variable	See Table 209
}		

7.9.27.3.2 DTT-RPT information element

The format of a DTT-RPT IE is shown in Table 209.

Table 209—DTT-RPT information element

Name	Element ID (1 byte)	Length	Scope
Downstream burst profile	1	6 bits	Burst profile that can be received by the CPE

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7.9.27.4 DTT Confirmation (DTT-CFM) message

7.9.27.4.1 Message format

The format of a DTT-CFM message is shown in Table 210.

Table 210—DTT-CFM message format

Syntax	Size	Note
DTT-CFM_Message_Format() {		
Management Message Type = 48	8 bits	
Transaction ID	16 bits	
Information elements (IEs)	Variable	See Table 211
}		

7.9.27.4.2 DTT-CFM information element

The format of a DTT-CFM IE is shown in Table 211.

Table 211—DTT-CFM information element

Name	Element ID (1 byte)	Length	Scope
Confirmation Code	1	8 bits	See 7.9.24
Action Frame Number Offset	2	4 bits	Integer value greater than zero that indicates the starting frame number for a relay burst profile test

7.9.28 Relay-Schedule (Relay-SCHE) message

The format of a Relay-SCHE message is shown in Table 212. This message may be used for the coordination of the US allocation. It is sent by an A-BS to an R-CPE or sent by an R-CPE to an A-CPE.

Table 212—Relay-SCHE message format

Syntax	Size	Note
Relay-SCHE_Message_Format() {		
Management Message Type = 49	8 bits	
Transaction ID	16 bits	
N_FT	8 bits	The number of FTs included
For (i = 0; i < N_FT; i++) {		

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Table 212—Relay-SCHE message format *(continued)*

Syntax	Size	Note
FT	8 bits	The FT for the CPE
Allocation Frame Offset	8 bits	In terms of number of frames
Bandwidth	8 bits	In number of bytes
}		
}		

7.9.29 Channel Allocation Manager management messages

7.9.29.1 Overview

This subclause (7.9.29) describes the channel allocation manager management messages for the basic multi-channel operations such as add new operating channel operation (CAM-ADD), stop operating channel (CAM-STP and CAM-STP-ACK) and switch operating channel (CAM-SWH and CAM-SWH-ACK).

7.9.29.2 Add new operating channel (CAM-ADD) message

The format of the CAM-ADD message is shown in Table 213. This message is used to configure add new operating channel procedure during the multichannel operation. The aggregation information is needed by the CPE-CAM in order to identify the aggregation information transmitted from the BS-CAM. This message includes the number of maximum aggregation channel allowed and the channel aggregation information for CPE.

Table 213—CAM-ADD message format

Syntax	Size	Note
CAM-ADD_Message_Format() {		
Management Message Type = 50	8 bits	
Transaction ID	16 bits	
Aggregation Information	1 bit	0: Aggregation on 1: Aggregation off
Maximum Aggregation Channels	6 bits	The number of maximum aggregation channels allowed in CPE.
For (i = 0; i < Maximum Aggregation Channels; i++){		List of the channel informations that are available for channel aggregation in CPE.
Channel Number [i]	8 bits	
}		
Reserved	1 bit	This bit shall be set to zero.
}		

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7.9.29.3 Stop operating channel (CAM-STP) message

The format of the CAM-STP message is shown in Table 214. This message is used to configure stop operating channel procedure during the multichannel operation. This message is sent by BS-CHU to the CPE-CHU in order to stop the operating channel in CPE-CHU. Transmission of this message may result from various conditions such as protection of incumbent services (BS incumbent sensing report, CPE incumbent sensing report), channel availability in database and BS channel scheduling.

Table 214—CAM-STP message format

Syntax	Size	Note
CAM-STP_Message_Format() {		
Management Message Type = 51	8 bits	
Transaction ID	16 bits	
Confirmation Needed	1 bit	0: No confirmation needed 1: Confirmation needed
Stop Channel Number	8 bits	Specified destination for channel stop operation request.
}		

7.9.29.4 Stop operating channel acknowledgment (CAM-STP-ACK) message

The format of the CAM-STP-ACK message is shown in Table 215. This message shall be sent by CPE-CHU to the BS-CHU in response to a received CAM-STP. This message serves to confirm to the BS-CHU the reception of the CAM-STP message by the CPE-CHU.

Table 215—CAM-STP-ACK message format

Syntax	Size	Note
CAM-STP-ACK_Message_Format() {		
Management Message Type = 52	8 bits	
Transaction ID	16 bits	
Confirmation Code	8 bits	See 7.9.24
}		

7.9.29.5 Switch operating channel (CAM-SWH) message

The format of the CAM-SWH message is shown in Table 216. This message is used to configure switch operating channel procedure during the multichannel operation. This message is sent by BS-CHU to the CPE-CHU in order to switch the operating channel in CPE-CHU. Transmission of this message may result from various conditions such as protection of incumbent services (BS incumbent sensing report, CPE incumbent sensing report), channel availability in database and BS channel scheduling.

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Table 216—CAM-SWH message format

Syntax	Size	Note
CAM-SWH_Message_Format() {		
Management Message Type = 53	8 bits	
Transaction ID	16 bits	
Confirmation Needed	1 bit	0: No confirmation needed 1: Confirmation needed
Switch Mode	1 bit	0: no restriction on transmission until the scheduled channel switch 1: addressed CPE shall transmit no further frames until the schedules channel switch.
Switch Count	8 bits	The number of frames until the BS sending the switching operating channel message switches to the new operating channel.
Switch Channel Number	8 bits	Specified destination for channel switch request.
}		

7.9.29.6 Switch operating channel acknowledgment (CAM-SWH-ACK) message

The format of the CAM-SWH-ACK message is shown in Table 217. This message shall be sent by CPE-CHU to the BS-CHU in response to a received CAM-SWH. This message serves to confirm to the BS-CHU the reception of the CAM-SWH message by the CPE-CHU.

Table 217—CAM-SWH-ACK message format

Syntax	Size	Note
CAM-SWH-ACK_Message_Format() {		
Management Message Type = 54	8 bits	
Transaction ID	16 bits	
Confirmation Code	8 bits	See 7.9.24
}		

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7.9.30 Group Resource Allocation management messages

7.9.30.1 Group Resource Allocation Configuration (GRA-CFG) message

The format of the GRA-CFG message is shown in Table 218. This message is used to configure the group resource allocation. The BS uses this message to create a new group and identify the devices that belong to the group.

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The A-BS uses bitmaps to allocate the resources on a group basis. The device bitmap size specifies the maximum number of devices that can be supported by a new group. The SID bitmap is used to indicate the device belonging to the group. The total size of the SID bitmap is the number of devices multiplied by the 9-bit station ID. Each group is identified by a unique 10-bit group ID. The group is classified into two types, fixed group and portable or mobile group. The type of group is determined according to the mobility of A-CPE. The location of group is represented by the latitude and longitude of A-CPE.

Table 218—GRA-CFG message format

Syntax	Size	Note
GRA-CFG_Message_Format() {		
Management Message Type = 55	8 bits	
Transaction ID	16 bits	
Device Bitmap Size	4 bits	Maximum number of devices that can be included to a new group 0000: 1 0001: 2 0010: 4 0011: 8 0100: 16 0101: 32 0110: 64 0111: 128 1000–1111: *Reserved*
SID Bitmap	Variable (9 bits × number of devices)	The bitmap of station ID that is belonging to a new group
GID	10 bits	ID of the group to which the device is included
Group Type	1 bit	0: Fixed Group 1: Portable or Mobile Group
Group Location	48 bits	Latitude and longitude of a new group
}		

7.9.30.2 Group Resource Allocation Update (GRA-UPD) message

The format of the GRA-UPD message is shown in Table 219. This message is used to update the group resource allocation configuration. The device can be added to or deleted from a group. This message is also used to update the location of group.

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Table 219—GRA-UPD message format

Syntax	Size	Note
GRA-UPD_Message_Format() {		
Management Message Type = 56	8 bits	
Transaction ID	16 bits	
Device Flag	1 bit	Flag to indicate whether the device information is changed 0: Device information is not changed 1: Device information is changed
Group Flag	1 bit	Flag to indicate whether the group information is changed 0: Group information is not changed 1: Group information is changed
If(Device Flag = 1) {		Indicate that device information is changed
GID	10 bits	Group ID to which the device(s) is added to or deleted from a group.
Number of Added Devices	7 bits	
Number of Deleted Devices	7 bits	
For (i = 0; i < Number of Added Devices; i++) {		
SID [i]	9 bits	Station ID that is added to a group.
Device Bitmap Index	7 bits	New index of the device in a group's device bitmap.
}		
For (i = 0; i < Number of Deleted Devices; i++) {		
SID [i]	9 bits	Station ID that is deleted from a group.
}		
}		
if (Group Flag){		Indicate that group information is changed
Group Location	48 bits	New latitude and longitude of a group
}		
}		

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7.9.31 Ranging Report (RNG-RPT) message

The format of the RNG-RPT message is shown in Table 220. This message is sent by a centralized scheduling R-CPE to A-BS and is used to inform ranging status of A-CPEs.

Table 220—RNG-RPT message format

Syntax	Size	Note
RNG-RPT_Message_Format() {		
Management Message Type = 57	8 bits	
Transaction ID	16 bits	
Information element (IEs)	Variable	See Table 221
}		

Table 221—RNG-RPT information elements

Name	Element ID (1 byte)	Length (bits)	Description
Ranging Status	1	2	00: require initial ranging adjustment 01: Initial Ranging done 10–11: *Reserved*
EIRP per subcarrier	2	8	See Table 44
CDMA Code	3	8	A unique code assigned to the CPE, to be used for the CRZ initial ranging code set.
Transmission opportunity offset	4	8	A unique transmission opportunity assigned to the CPE, to be used for the CRZ initial ranging in units of symbol duration

7.10 Management of MAC PDUs

7.10.1 Conventions

Data shall be transmitted in accordance with the following rules:

a) Data fields of messages are transmitted in the same order as they appear in the corresponding tables and figures in this document.

b) Data fields messages that are specified as binary numbers, are transmitted as a sequence of their binary digits, starting from MSB (here, bit masks are also considered numerical fields). For signed numbers, MSB is allocated for the sign. Length field in the “definite form” of ITU-T X.690 is also considered a numerical field.

c) Data fields specified as SDUs or SDU fragments (e.g., MAC PDU payloads) are transmitted in the same order of bytes as received from upper layers.

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d) Data fields specified as strings are transmitted in the order of symbols in the string.

In item c) and item d), bits within a byte are transmitted in the order "MSB first."

7.10.2 Concatenation

Multiple MAC PDUs may be concatenated into a single transmission in either the US or DS directions, as depicted in Figure 24 for a US burst transmission. Each MAC PDU within that allocation is identified by a unique FT; the receiving MAC entity is able to present the MAC SDU (after reassembling the MAC SDU from one or more received MAC PDUs) to the correct instance of the MAC SAP. MAC PDUs containing management messages or user data may be concatenated into the same transmission.

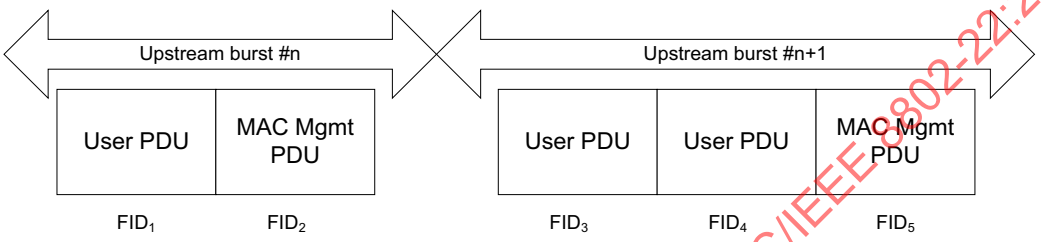

Figure 24—Concatenation of MAC PDUs

7.10.3 Fragmentation

Fragmentation and packing (discussed in 7.10.4) are mandatory features. Fragmentation is the process by which a MAC SDU is divided into one or more MAC PDUs. This process is undertaken to allow efficient use of available bandwidth relative to the QoS requirements of a connection's service flow. Upon the creation of a connection by the MAC SAP, fragmentation capability is defined. Fragmentation may be initiated by a BS for DS connections and by a CPE for US connections. For ARQ-enabled connections, enabling of fragmentation is optional.

Fragments are tagged with their position in their parent SDU in accordance with Table 222.

Table 222—Fragmentation rules

Fragment	Fragmentation control
First fragment	10
Continuing fragment	11
Last fragment	01
Unfragmented	00

7.10.3.1 Non-ARQ connections

For non-ARQ connections, fragments are transmitted once and in sequence. The sequence number assigned to each fragment allows the receiver to recreate the original payload and to detect the loss of any intermediate packets. A connection may be in only one fragmentation state at any given time.

Upon loss, the receiver shall discard all MAC PDUs on the connection until a new first fragment or a non-fragmented MAC PDU is detected.

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7.10.3.2 ARQ-Enabled connections

For ARQ-enabled connections, fragments are formed for each transmission by concatenating sets of ARQ blocks with adjacent sequence numbers (see 7.11). The BSN value carried in the fragmentation subheader is the BSN for the first ARQ block appearing in the segment (see Table 9).

7.10.4 Packing

In the MAC, the transmitting side has full discretion whether or not to pack a group of MAC SDUs into a single MAC PDU. BSs and CPEs shall both have the capability of unpacking. If packing is turned on for a connection, the MAC may pack multiple MAC SDUs into a single MAC PDU. Also, packing makes use of the connection attribute indicating whether the connection carries fixed-length or variable-length packets.

The construction of PDUs varies for ARQ and non-ARQ connections with respect to packing and fragmentation syntax. The packing and fragmentation mechanisms for both the ARQ and non-ARQ connections are specified in 7.10.4.1.

7.10.4.1 Non-ARQ connections

For connections that do not utilize ARQ, the packing procedure described in 7.10.4.1.1 may be used when the connection carries fixed-length MAC SDUs. For all other non-ARQ connections, the variable-length packing algorithm described in 7.10.4.1.2 shall be employed. Please refer to 7.9.8.9.13 for more information on the indication whether a connection carries fixed-length or variable-length SDUs.

7.10.4.1.1 Fixed-length MAC SDUs

For packing with fixed-length blocks, the Request/Transmission Policy (7.9.8.9.10) shall be set to allow packing and prohibit fragmentation, and the SDU size (7.9.8.9.14) shall be included in DSA-REQ message when establishing the connection. The length field of the MAC header implicitly indicates the number of MAC SDUs packed into a single MAC PDU. If the MAC SDU size is n bytes, the receiving side can unpack simply by knowing that the length field in the MAC header will be $n \times k + j$, where k is the number of MAC SDUs packed into the MAC PDU and j is the size of the MAC header and any appended MAC subheaders. A MAC PDU containing a packed sequence of fixed-length MAC SDUs would be constructed as in Figure 25. Note that there is no added overhead due to packing in the fixed-length MAC SDU case.

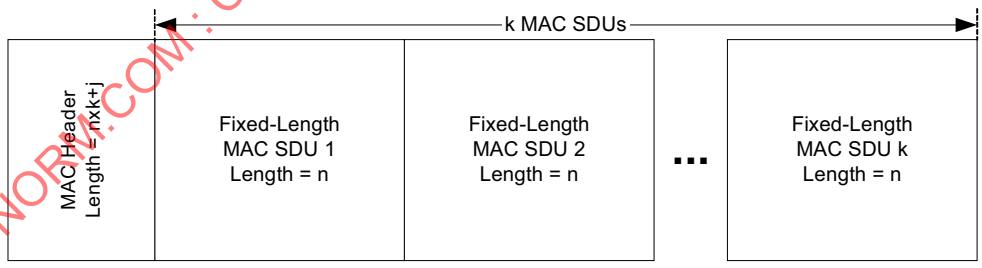

Figure 25—Packing fixed-length MAC SDUs into a single MAC PDU

7.10.4.1.2 Variable-length MAC SDUs

When packing variable-length SDU connections (e.g., IEEE 802.3/Ethernet), the $n \times k + j$ relationship between the MAC header's length field and the higher-layer MAC SDUs no longer holds. Therefore, it is necessary to indicate where one MAC SDU ends and another begins. In the variable-length MAC SDU case, the MAC attaches a Packing subheader (PSH) to each MAC SDU. This subheader is described in 7.8.1.2.2.

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A MAC PDU containing a packed sequence of variable-length MAC SDUs is constructed as shown in Figure 26. If more than one MAC SDU is packed into the MAC PDU, the type field in the MAC header indicates the presence of PSHs. Note that unfragmented MAC SDUs and MAC SDU fragments may both be present in the same MAC PDU (see Figure 27).

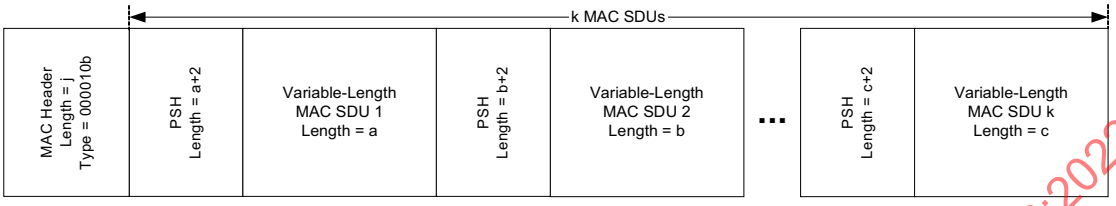

Figure 26—Packing variable-length MAC SDUs into a single MAC PDU

Simultaneous fragmentation and packing allows efficient use of the wireless channel, but requires guidelines to be followed so it is clear which MAC SDU is currently in a state of fragmentation. To accomplish this, when a PSH is present, the fragmentation information for individual MAC SDUs or MAC SDU fragments is contained in the corresponding PSH. If no PSH is present, the fragmentation information for individual MAC SDU fragments is contained in the corresponding Fragmentation subheader (FSH). This procedure is shown in Figure 27.

Finally, note that while it is acceptable to have continuation fragments packed with other fragments, the circumstances for creating continuation fragments would preclude this from happening.

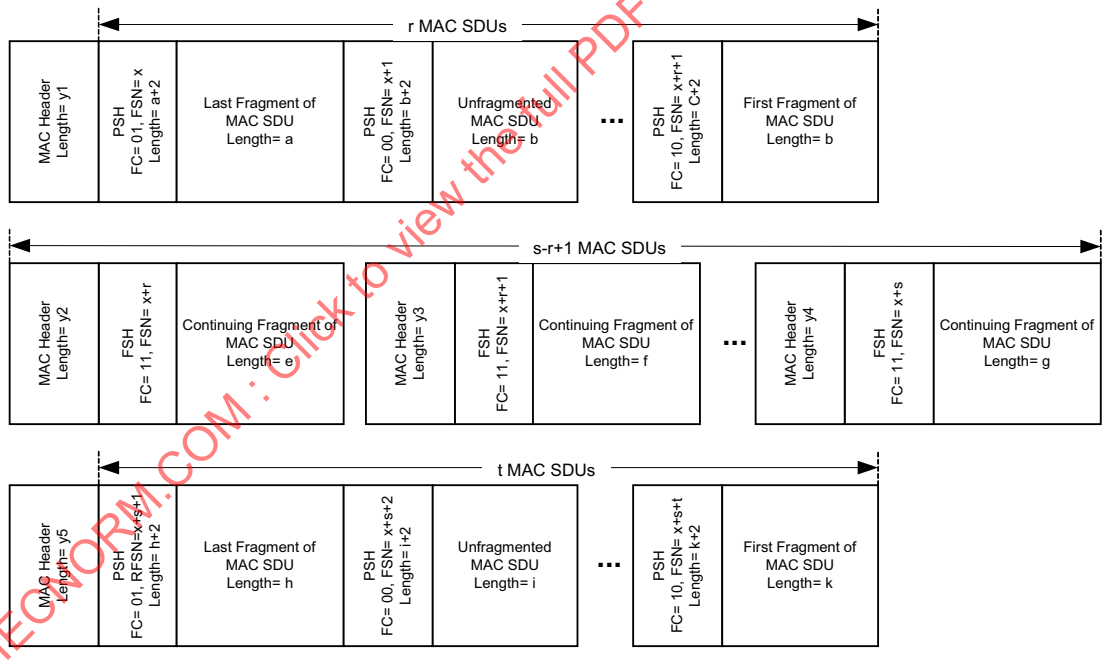

Figure 27—Packing with fragmentation

7.10.4.2 ARQ-enabled connections

The use of PSH for ARQ-enabled connections is similar to that for non-ARQ connections as described in 7.10.4.1.2, except that ARQ-enabled connections shall set the Extended Type bit (Table 7) in the generic MAC header to 1. The packing of variable-length MAC SDUs for the ARQ-enabled connections is similar

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to that of non-ARQ connections, when fragmentation is enabled. The BSN of the PSH shall be used by the ARQ protocol to identify and retransmit lost fragments.

For ARQ-enabled connections, when the type field indicates that PSHs are in use, fragmentation information for each individual MAC SDU or MAC SDU fragment is contained in the associated PSH. When the type field indicates that packing is not in use, fragmentation information for the MAC PDU's single payload (MAC SDU or MAC SDU fragment) is contained in the FSH appearing in the message. Figure 28 illustrates the use of FSH without packing.

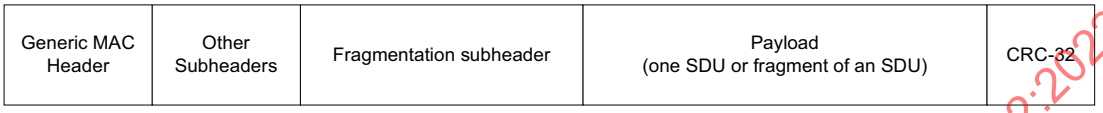

Figure 28—Example of a MAC PDU with extended fragmentation subheader

Figure 29 depicts the structure of a MAC PDU with ARQ PSHs. Each of the packed MAC SDU or MAC SDU fragments or ARQ feedback payload requires its own PSH, and some of them may be transmissions while others are retransmissions.

A MAC SDU may be partitioned into multiple fragments that are then packed into the same MAC PDU for the first transmission. MAC PDUs may have fragments from the same or different SDUs, including a mix of first transmissions and retransmissions. The 10-bit BSN and 2-bit FC fields uniquely identify each fragment or non-fragmented SDU.

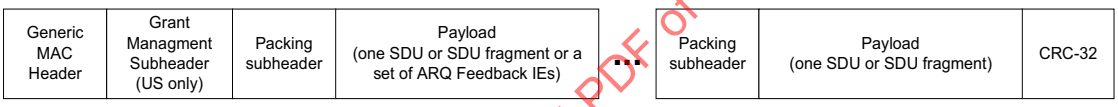

Figure 29—Example of a MAC PDU with ARQ packing subheader

7.10.4.3 ARQ Feedback IEs

The ARQ Feedback Payload (see Table 223) may be sent on an ARQ or non-ARQ connection, and consists of one or more ARQ Feedback IEs (see 7.11). However, policies based on implementation and/or QoS constraints may restrict the use of certain connections for transporting ARQ Feedback Payload. The ARQ Feedback Payload is treated like any other payload (SDU or fragments) from the packing perspective, except that only one ARQ Feedback Payload shall be present within a single MAC PDU.

The presence of an ARQ Feedback Payload in a MAC PDU is indicated by the value of the ARQ Feedback Payload bit in the Type field (see Table 7) in the generic MAC header. When present, the first packed payload shall be the ARQ Feedback Payload. The PSH preceding the ARQ Feedback Payload indicates the total length of the payload including the PSH and all ARQ Feedback IEs within the payload. The FSN/BSN field of the PSH shall be ignored for the ARQ Feedback Payload and the FC bits shall be set to 00.

When operating in a relay network, ARQ Feedback message shall be processed according to the rules outlined in 7.10.7.

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Table 223—ARQ Feedback Message format

Syntax	Size	Notes
ARQ_Feedback_Payload_Format() {		
do		
ARQ_Feedback_IE(last)	Variable	Include as many as needed until last == TRUE. See 7.11.
until(last)		
}		

7.10.5 CRC calculation

CRC shall be calculated as defined in IEEE Std 802.3. The CRC shall cover the MAC header and the Payload of the MAC PDU. The CRC shall be calculated before the inclusion of the 0-padding at the end of the burst to meet the slot and FEC block boundaries according to the concatenation rule contained in 9.7.2.1.3.

There are various conditions in which the CRC shall be used, as follows:

— MAC PDUs containing MAC Management messages sent on the Broadcast and Initial Ranging Fs of the network's Cell SID (e.g. containing DCD, DS-MAP, UCD, US-MAP, RNG-REQ, RNG-CMD)

— MAC PDUs containing MAC Management messages sent on the Basic FT of a CPE's Unicast SID (e.g. RNG-REQ, RNG-CMD, CBC-REQ, CBC-RSP, DREG-CMD, FRM-UPD)

— MAC PDUs containing MAC management messages associated with unicast management FTs (e.g. Primary/Secondary) when the Null SA is enabled and the Unicast Management SA is not enabled

— MAC PDUs containing SDUs associated with unicast transport FTs (e.g. BE, nrtPS, rtPS, UGS) of a CPE's Unicast SID when the Null SA is enabled and the Unicast Transport SA is not enabled (see 7.9.11.3.2.1 and Clause 8)

— MAC PDUs containing Multicast MAC Management messages associated with the Polling and Management FTs of a Multicast SID when the Null SA is enabled and Group SA support is not enabled

— MAC PDUs containing SDUs associated with multicast transport FTs (e.g. BE, nrtPS, rtPS, UGS) of a Multicast SID

There are various conditions in which the CRC shall not be used. In these conditions appending the Ciphertext ICV (see 8.4.2) to the encrypted MAC PDU shall be used instead:

— MAC PDUs containing SDUs associated with unicast transport FTs (e.g. BE, nrtPS, rtPS, UGS) of a CPE's Unicast SID when the Unicast Transport SA is enabled

— MAC PDUs containing MAC management messages associated with unicast management FTs (e.g. Primary/Secondary Management) of a CPE's Unicast SID when the Unicast Management SA is enabled

— MAC PDUs containing Multicast MAC Management messages associated with the Polling and Management FTs of a Multicast SID when Group SA support is enabled

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7.10.6 Padding

Allocated space within a data burst that is unused shall be initialized to a known state. This shall be accomplished by setting each unused byte to the stuff byte value (0x00).Only some specific PPDU lengths shall be permitted to fill some specific integer numbers of OFDM slots depending on the modulation and forward error coding selected (see 9.7). Such specific lengths shall be realized by adding the necessary padding bits, all set to zero, at different stages in the construction of the MAC PPDU so that the total length of the packet [i.e., MAC Header (4 bytes), MAC Payload (variable), the CRC (4 bytes), and all the padding bits] adds up to one of these specific lengths that, once the forward error coding overhead is included, will result in one of the specified integer numbers of OFDM slots depending on the modulation and channel coding selected for the PPDU.

The first step in 0-padding shall be for the octet alignment when the PPDU is not an integer number of bytes. This shall be applied before appending the CRC to the PPDU, when required. The second step shall be for the slot alignment and the FEC block alignment after the CRC when present, and before the scrambling is applied.

As a third step, at the end of the DS subframe, if the payload does not fill the entire DS subframe, 0-padding is to be utilized. As indicated in the standard, padding bytes, all set to zero, will be inserted before application of the scrambling and FEC process. In the case where the required number of padding bytes is less than the number of bits needed to fill the entire size of the last FEC block, the transmitter shall extend the number of padding bytes up to what is needed to fill the complete block once the FEC coding process as been applied. The normal bit scrambling process shall be applied to this augmented data stream before this entire FEC block is encoded (see 9.7.1) as specified by the DIUC of the last DS burst in the DS-MAP, and the resulting bits shall be interleaved as usual (see 10.6.4). Only the first coded and interleaved bits that will fit in the remainder of the DS subframe will be transmitted. The DIUC of the last DS burst in the DS-MAP (see 9.8.2) will be applied to the truncated augmented data, before being carrier-interleaved and presented to the IFFT.

A similar mechanism shall be used by the CPEs to complete the last block of their US burst transmission.

7.10.7 MAC PDU construction for relay in a A-WRAN/PHY-OM2 Cell

7.10.7.1 General

In the relay network, a centralized scheduling R-CPE will not be doing any additional fragmentation and/or packing of PDUs exchanged between the A-BS and the A-CPE. The procedures defined in 7.10.8 shall be followed by the A-BS and A-CPE when exchanging MAC PDUs in either the DS or US, through a centralized scheduling R-CPE. These procedures are applicable to connections between the A-CPE and A-BS that use ARQ and those connections that do not use ARQ.

Distributed scheduling R-CPEs have the ability to locally make decisions with regard to allocating bandwidth and scheduling resources for A-CPEs that are attached to it. Procedures defined in this clause describe how the distributed scheduling R-CPE processes MAC PDUs being exchanged through it between the A-BS and A-CPE. These procedures take into account the configuration of the security sublayer for the A-CPE, and whether or not ARQ is enabled for FTs associated with a particular A-CPE. Indication of encryption/authentication being configured for the A-CPE is given when the EC bit in the GMH is set to 1.

7.10.7.2 MAC PDU construction for distributed scheduling R-CPE on non-ARQ connections

7.10.7.2.1 Overview

In this subclause, four procedures for the construction of MAC PDUs that may or may not require further Fragmentation/Packing on non-ARQ connections are defined as follows:

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1) Security enabled, no further fragmentation/packing by R-CPE of MAC PDUs.
2) Security enabled, R-CPE will further fragment/pack MAC PDUs.
3) Security disabled, no further fragmentation/packing by R-CPE of MAC PDUs.
4) Security disabled, R-CPE will further fragment/pack MAC PDUs.

7.10.7.2.2 Procedure 1 on non-ARQ connections

The following procedure shall be used when the security sublayer for the A-CPE is configured to provide authentication/encryption of MAC PDUs exchanged between the A-BS and A-CPE and the distributed scheduling R-CPE will not further fragment/pack PDUs:

a) When a distributed scheduling R-CPE receives a MAC PDU from an A-CPE or A-BS, the subheaders attached to the PDU are processed as necessary. In the US, this may include the BR subheader and Grant management subheader (GMSH).
b) The R-CPE forwards the MAC PDU as is, i.e., it does not modify the MAC PDU contents (GMH, subheaders, payload).
c) Upon reception of the MAC PDU at the intended destination, the GMH and non-Fragmentation/Packing subheaders are processed first:
    1) In the US: When the A-BS receives a MAC PDU that was relayed by R-CPE for an attached A-CPE with the EC bit set to 1 in the GMH and the Type field indicating the presence of the BR and/or GMSH subheaders, the BR/GMSH subheader will be ignored because those subheaders will have been processed by the R-CPE.
    2) In the DS: When the A-CPE receives a MAC PDU that was relayed by R-CPE on behalf of the A-BS with the EC bit set to 1 in the GMH, the PDU will be authenticated/decrypted.
d) A-BS/A-CPE then processes the Fragmentation/Packing subheaders (included by the A-CPE or A-BS that sent the MAC PDU) as necessary:
    1) Process the fragmentation subheader before decrypting/authenticating the MAC PDU payload.
    2) Decrypt/authenticate the PDU prior to processing each packed SDU.

7.10.7.2.3 Procedure 2 on non-ARQ connections

The following procedure shall be used when the security sublayer for the CPE is configured to provide authentication/encryption of the MAC PDUs exchanged between the A-BS and A-CPE and the R-CPE will further fragment/pack PDUs:

a) When a distributed scheduling R-CPE receives a MAC PDU from an A-CPE or A-BS, the subheaders attached to the PDU are processed as necessary. In the US this may include the BR subheader and/or GMSH.
b) If the R-CPE has to pack multiple PDUs coming from one or more A-CPEs in the US and transmit them to the A-BS:
    1) The R-CPE bundles those PDUs into a Container Message (see 7.9.26) and transmits the burst of MAC PDUs containing the Container Message to the A-BS.
    2) When the A-BS receives the packed PDU, it unpacks each of the A-CPE's MAC PDUs from the Container Message.
    3) Each unpacked MAC PDU will be processed as indicated in Procedure 1 on non-ARQ connections (see 7.10.7.2.2).
c) If the A-BS packs multiple PDUs destined for one or more A-CPEs in the DS:
    1) It bundles those PDUs into a Container Message (see 7.9.26) and sends it to the R-CPE.
    2) The R-CPE processes the Container Message:

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i) For each A-CPE that has >1 MAC PDUs bundled within the Container Message, the A-CPE packs each of those PDUs into one new MAC PDU with a GMH that has the EC bit set to 0 and sends it to the intended A-CPE.

ii) For A-CPEs that have only one MAC PDU in the container message, the R-CPE copies it out of the Container Message and forwards it to the destination A-CPE.

3) Each MAC PDU received at the A-CPE will be processed as indicated in Procedure 1 on non-ARQ connections (see 7.10.7.2.2).

d) If the R-CPE has to fragment a MAC PDU that it is forwarding in the US:

1) It forms a new MAC PDU with a GMH that has the EC bit set to 0, indicating fragmentation subheader for each PDU fragment from an A-CPE, and attaches a CRC.

2) The R-CPE bundles fragments from multiple A-CPEs into a Container Message and forwards the Container Message to A-BS.

3) When the A-BS receives the Container Message, it unpacks and stores the PDU fragment for each A-CPE indicated in the Container Message.

4) It continues to do this until it receives all fragments from the R-CPE.

5) Once it receives all the fragments of the A-CPE's PDU, the A-BS processes the MAC PDU and subheaders as defined in Procedure 1 for non-ARQ connections (see 7.10.7.2.2).

e) If the R-CPE has to fragment a MAC PDU that it is forwarding in the DS:

1) It forms a new MAC PDU with a GMH that has the EC bit set to 0, indicating fragmentation subheader for each PDU fragment from an A-CPE, and attaches a CRC.

2) The R-CPE sends each A-CPE's MAC PDU fragments to the A-CPE.

3) The A-CPE continues to receive all the fragments.

4) Once it receives all the fragments sent by the R-CPE PDU, the A-CPE processes the MAC PDU and subheaders as defined in Procedure 1 for non-ARQ connections (see 7.10.7.2.2).

7.10.7.2.4 Procedure 3 on non-ARQ connections

The following procedure shall be used when A-CPE encryption/authentication is disabled and the R-CPE will not further fragment/pack PDUs:

a) When a distributed scheduling R-CPE receives a MAC PDU from an A-CPE or A-BS, the subheaders attached to the PDU are processed as necessary. In the US this may include the BR subheader and/or GMSH.

b) If the R-CPE receives a MAC PDU from one or more A-CPEs in the US:

1) The R-CPE processes subheaders as necessary.

2) After processing the subheaders, the R-CPE generates a new MAC PDU:

i) Strip out the BR and/or GMSH subheader if present, and strip out the CRC.

ii) Create a new MAC PDU that has a GMH with the BR/GMSH indicators in the Type field set to 0 and a packing/fragmentation subheader, and recalculate the HCS of the GMH.

i) Append a new CRC to the payload.

3) The R-CPE forwards the new MAC PDU as currently defined. If transmission of PDUs from >1 A-CPEs is occurring, repeat step of this procedure, and bundle the MAC PDU of each A-CPE into a Container Message to forward to A-BS.

c) If the R-CPE receives a MAC PDU or Container Message in the DS it unpacks each PDU from the Container Message and forwards it to the intended A-CPE.

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d) In the US, when A-BS receives the Container Message, it unpacks each A-CPE's MAC PDU from the Container Message and processes the Fragmentation/Packing subheaders that are part of the original MAC PDU originated by A-CPE.

e) In the DS, when the A-CPE receives a PDU transmission from the R-CPE, it processes the Fragmentation/Packing subheaders that are part of the original MAC PDU originated by A-BS

7.10.7.2.5 Procedure 4 on non-ARQ connections

The following procedure shall be used when A-CPE encryption/authentication is disabled and the R-CPE will further fragment/pack PDUs:

a) When a distributed scheduling R-CPE receives a MAC PDU from an A-CPE or A-BS, the subheaders attached to the PDU are processed as necessary. In the US this includes the BR subheader and/or GMSH.

b) In the US, for each A-CPE's PDU that is received at the R-CPE when packing is to be used:

1) Each PDU is first transformed by the procedure defined in step b) of Procedure 3 for non-ARQ connections (see 7.10.7.2.4).

2) It then forms a new MAC PDU with a GMH that has the EC bit set to 0, indicating packing subheader for each packed PDU from an A-CPE, and attaches a CRC. The R-CPE forwards the new MAC PDU as currently defined.

i) This step is repeated for each A-CPE that has one or more PDUs that can be packed.

3) It the bundles the new PDUs from one or more A-CPEs in a Container Message and forwards the Container Message to A-BS.

4) When the A-BS receives the Container Message, it unpacks each A-CPEs burst and processes it according to step d) of Procedure 3 for non-ARQ connections (see 7.10.7.2.4).

3) In the DS, when the R-CPE receives the Container Message with one or more bursts associated with a particular A-CPE:

1) Each PDU associated with a particular A-CPE is first transformed by the procedure defined in steps b1), b2), and b3) of Procedure 3 for non-ARQ connections (see 7.10.7.2.4).

2) R-CPE then forms a new MAC PDU with a GMH that has the EC bit set to 0, indicating packing subheader for each packed PDU from an A-CPE, and attaches a CRC. The R-CPE forwards the new MAC PDU to the A-CPE.

d) If the R-CPE has to fragment a MAC PDU that it is forwarding in the US:

1) It forms a new MAC PDU with a GMH that has the EC bit set to 0, indicating fragmentation subheader for each PDU fragment from an A-CPE, and attaches a CRC.

2) The R-CPE bundles fragments from multiple A-CPEs into a Container Message and forwards the Container Message to A-BS.

3) When the A-BS receives the Container Message, it unpacks and stores the PDU fragment for each A-CPE indicated in the Container Message.

4) It continues to do this until it receives all fragments from the R-CPE.

5) Once it receives all the fragments of the A-CPE's PDU, A-BS processes the MAC PDU and subheaders of the constituted/complete MAC PDU originated by the A-CPE associated with the burst in the Container Message.

e) If the R-CPE has to fragment a MAC PDU that it is forwarding in the DS:

1) It forms a new MAC PDU with a GMH that has the EC bit set to 0, indicating fragmentation subheader for each PDU fragment from an A-CPE, and attaches a CRC.

2) The R-CPE sends each A-CPE's MAC PDU fragments to the A-CPE.

3) The A-CPE continues to receive all the fragments.

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4) Once it receives all the fragments sent by the R-CPE PDU, the A-CPE processes the MAC PDU and subheaders as defined in step e) of Procedure 3 for non-ARQ connections (see 7.10.7.2.4).

7.10.7.3 MAC PDU construction for distributed scheduling R-CPE on ARQ connections

7.10.7.3.1 Overview

Procedures 1 to 4 outlined in 7.10.7.3 are applicable to the exchange of MAC PDUs on ARQ connections between the A-BS and A-CPEs through a distributed scheduling R-CPE, as defined by the conditions in this subclause.

7.10.7.3.2 Procedure 1 for ARQ connections

The following procedure shall be used when the security sublayer for the A-CPE is configured to provide authentication/encryption of MAC PDUs exchanged between the A-BS and A-CPE and the distributed scheduling R-CPE will not further fragment/pack PDUs:

a) In the US and DS the ARQ Feedback subheader can be attached to MAC PDUs.

b) Follow Procedure 1 for non-ARQ connections (see 7.10.7.2.2) using the adjustments for ARQ connections in the US and DS as listed in steps c) and d) of this procedure.

c) In the US:

1) If end-to-end ARQ is used:

i) The R-CPE ignores the ARQ feedback subheader (attached to MAC PDU received from A-CPE) and forwards the MAC PDU to the A-BS as is (i.e., forwarding the MAC PDU without altering the GMH, the ARQ Feedback IE, or the contents).

ii) When the A-BS receives the MAC PDU, it processes the ARQ Feedback IE attached to the MAC PDU.

2) If two-link ARQ is used:

i) The R-CPE processes the ARQ feedback subheader (attached to MAC PDU received from the A-CPE).

ii) The R-CPE then wraps the MAC PDU (i.e., without altering the GMH, the ARQ Feedback IE, or the payload) in a new MAC PDU and attaches an ARQ Feedback IE to represent the ARQ process on the R-CPE/A-BS link.

iii) The R-CPE then forwards the MAC PDU to the A-BS.

iv) When the A-BS receives the MAC PDU, it first processes the outer MAC PDU and ARQ Feedback IE, but ignores the ARQ Feedback IE attached to the original MAC PDU

d) In the DS:

1) If end-to-end ARQ is used:

i) The R-CPE ignores the ARQ feedback subheader (attached to MAC PDU received from A-BS) and forwards the MAC PDU to the A-CPE as is (i.e., forwarding the MAC PDU without altering the GMH, the ARQ Feedback IE, or the payload).

ii) When the A-CPE receives the MAC PDU, it processes the ARQ Feedback IE attached to the MAC PDU.

2) If two-link ARQ is used:

i) The R-CPE processes the ARQ feedback subheader (attached to MAC PDU received from the A-BS).

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ii) The R-CPE then wraps the MAC PDU (i.e., without altering the GMH, the ARQ Feedback IE, or the payload) in a new MAC PDU and attaches an ARQ Feedback IE to represent the ARQ process on the R-CPE/A-CPE link.

iii) The R-CPE then forwards the MAC PDU to the A-CPE.

iv) When the A-CPE receives the MAC PDU, it first processes the outer MAC PDU and ARQ Feedback IE, but ignores the ARQ Feedback IE attached to the original MAC PDU.

7.10.7.3.3 Procedure 2 for ARQ connections

The following procedure shall be used when the security sublayer for the CPE is configured to provide authentication/encryption of the MAC PDUs exchanged between the A-BS and A-CPE and the R-CPE will further fragment/pack PDUs:

a) In the US and DS the ARQ Feedback subheader can be attached to MAC PDUs.

b) Follow Procedure 2 for non-ARQ connections (see 7.10.7.2.3) using the adjustments for ARQ connections in the US and DS as listed in steps c) and d) of this procedure.

c) In the US:

1) If the R-CPE shall pack multiple MAC PDUs when end-to-end ARQ is used:

i) The R-CPE ignores the ARQ feedback subheader (attached to MAC PDU received from A-CPE).

ii) It then bundles the MAC PDUs as is (i.e., forwarding the MAC PDU without altering the GMH, the ARQ Feedback IE, or the contents) from one or more A-CPEs into a Container Message.

iii) The R-CPE forwards the Container Message to the A-BS.

iv) When the A-BS receives the Container Message, it unbundles each A-CPE's MAC PDU and processes the ARQ Feedback IE attached to each MAC PDU.

2) If the R-CPE shall pack multiple MAC PDUs when two-link ARQ is used:

i) The R-CPE processes the ARQ feedback header attached to a MAC PDU received from each A-CPE.

ii) It then bundles the MAC PDUs as is (i.e., without altering the GMH, the ARQ Feedback IE, or the payload) from one or more A-CPEs into a Container Message. The MAC PDU that encapsulates the Container Message shall have a ARQ Feedback IE added to it to indicate the ARQ process for the A-BS/R-CPE link.

iii) Successful delivery of the MAC PDU that encapsulates the Container Message depends on the ARQ process on the A-BS/R-CPE link. When the A-BS receives the Container Message, it processes the ARQ Feedback IE attached to the Container Message.

iv) The A-BS processes the Container Message and unbundles each A-CPEs MAC PDU.

v) For each received A-CPE MAC PDU, the A-BS ignores the ARQ Feedback IE attached to the original MAC PDU.

3) If the R-CPE shall fragment MAC PDUs when end-to-end ARQ is used:

i) The R-CPE ignores the ARQ Feedback IE attached to MAC PDU by the A-CPE.

ii) If fragmentation is necessary, the R-CPE forms a new MAC PDU with a GMH that has the EC bit set to 0, indicating fragmentation subheader for each PDU fragment from an A-CPE, and attaches a CRC. When creating the fragments, it will not alter the contents (e.g., GMH, subheaders, payload) of the original MAC PDU.

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iii) The R-CPE bundles fragments from multiple A-CPEs into a Container Message and forwards the Container Message to A-BS.

iv) When the A-BS receives the Container Message, it unpacks and stores the PDU fragment for each A-CPE indicated in the Container Message.

v) It continues to do this until it receives all fragments from the R-CPE.

vi) Once it receives all the fragments of the A-CPE's PDU, A-BS processes the MAC PDU and the ARQ Feedback subheader of the original MAC PDU.

4) If the R-CPE shall fragment MAC PDUs when two-link ARQ is used:

i) The R-CPE processes the ARQ Feedback IE attached to MAC PDU by the A-CPE.

ii) If necessary, the R-CPE forms a new MAC PDU with a GMH that has the EC bit set to 0, indicating fragmentation subheader for each PDU fragment from an A-CPE, and attaches a CRC. When doing this, it will not alter the original contents (e.g., GMH, subheaders, payload) of the MAC PDU.

iii) It then bundles the MAC PDU fragments from one or more A-CPEs into a Container Message. The MAC PDU that encapsulates the Container Message shall have an ARQ Feedback IE added to it to indicate the ARQ process for the R-BS/A-CPE link.

iv) Successful delivery of the MAC PDU that encapsulates the Container Message depends on the ARQ process on the A-BS/R-CPE link.

v) When the A-BS receives the Container Message, it first processes the ARQ Feedback IE attached to the MAC PDU encapsulating the Container Message and then unpacks and stores the PDU fragment for each A-CPE indicated in the Container Message.

vi) It continues to do this until it receives all fragments from the R-CPE.

vii) Once A-BS receives all the fragments of the A-CPE's PDU, the A-BS processes the MAC PDU, and the A-BS shall ignore the ARQ Feedback subheader of the original MAC PDU that it reassembles for each A-CPE.

d) In the DS:

1) If the A-BS shall pack multiple MAC PDUs destined for one or more A-CPEs in the DS when end-to-end ARQ is used:

i) The A-BS bundles packed PDUs for each A-CPE into its own MAC PDU and adds the ARQ feedback subheader.

ii) The A-BS inserts the generated MAC PDUs into a Container Message and sends it to the R-CPE.

iii) The R-CPE receives the Container Message and processes it by unbundling each PDU destined for the A-CPE and forwarding the PDU to the A-CPE as is (i.e., the R-CPE shall ignore the ARQ Feedback IE). This step is repeated until all PDUs in Container Message have been forwarded.

iv) When the A-CPE receives the MAC PDU, it processes the attached ARQ feedback subheader.

2) If the A-BS shall pack multiple MAC PDUs destined for one or more A-CPEs in the DS when two-link ARQ is used:

i) The A-BS bundles packed PDUs for each A-CPE into its own MAC PDU.

ii) The A-BS inserts the generated MAC PDUs into a Container Message and sends it to the R-CPE. The MAC PDU that encapsulates the Container Message shall have a ARQ Feedback IE added to it to indicate the ARQ process for the A-BS/R-CPE link.

iii) Successful delivery of the MAC PDU that encapsulates the Container Message depends on the ARQ process on the A-BS/R-CPE link. When receiving the Container Message, the

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R-CPE first processes the ARQ Feedback IE attached to MAC PDU that encapsulates the Container Message.

iv) The R-CPE receives the Container Message and processes it by unbundling each PDU destined for the A-CPE and encapsulating the unbundled PDU in a new MAC PDU (with the EC bit set to 0 in the GMH) with an ARQ feedback subheader (this represents the ARQ process on the A-CPE/R-CPE link). This step is repeated until all PDUs in Container Message have been forwarded.

v) When A-CPE receives the MAC PDU, it shall process the attached ARQ feedback subheader as defined and then unbundle the original (packed) PDU.

vi) The ARQ Feedback IE attached to the original (packed) PDU shall be ignored by the A-CPE.

3) If the A-BS has PDUs to send to A-CPEs attached to an R-CPE and the R-CPE shall fragment MAC PDUs when end-to-end ARQ is used:

i) The A-BS creates the MAC PDU and adds the ARQ feedback subheader.

ii) Then the A-BS bundles MAC PDUs for multiple A-CPEs into a Container Message and sends it to the R-CPE.

iii) The R-CPE processes each contained MAC PDU in the Container Message by unbundling the MAC PDU from the Container Message and if necessary, fragmenting the PDU by forming a new MAC PDU with a GMH that has the EC bit set to 0, indicating fragmentation subheader for each PDU fragment from an A-CPE, and attaching a CRC. When this is done, the contents of the original MAC PDU will not be altered. The R-CPE then sends each fragment to the destination A-CPE.

iv) Each A-CPE collects those fragments and processes the new fragmentation subheader.

v) Once an A-CPE has collected all of the fragments and has reassembled the original MAC PDU, it processes the ARQ feedback subheader of the original MAC PDU.

4) If the A-BS has PDUs to send to A-CPEs attached to an R-CPE and the R-CPE shall fragment MAC PDUs when two-link ARQ is used:

i) The A-BS shall not add an ARQ feedback subheader to the MAC PDUs it is transmitting in the DS.

ii) The A-BS creates a Container Message to bundle MAC PDUs to be transmitted to A-CPEs that are attached to an R-CPE. The MAC PDU encapsulating the Container Message shall have an ARQ feedback subheader (related to the A-BS/R-CPE ARQ process).

iii) The A-BS then sends the Container Message to the R-CPE.

iv) Successful delivery of the MAC PDU that encapsulates the Container Message depends on the ARQ process on the A-BS/R-CPE link.

v) The R-CPE processes each contained MAC PDU in the Container Message by unbundling the MAC PDU from the Container Message and if necessary, fragmenting the PDU by forming a new MAC PDU with a GMH that has the EC bit set to 0, indicating fragmentation subheader for each PDU fragment from an A-CPE, and attaching a CRC. When this is done, the contents of the original MAC PDU will not be altered. Each new fragment will have the ARQ feedback subheader attached to it, before being sent to A-CPE.

vi) Each A-CPE collects those fragments and processes the new fragmentation subheader and the attached ARQ feedback subheader.

vii) Once an A-CPE has collected all of the fragments, it reassembles the original MAC PDU.

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7.10.7.3.4 Procedure 3 on ARQ connections

The following procedure shall be used when A-CPE encryption/authentication is disabled and the R-CPE will not further fragment/pack PDUs:

a) In the US and DS the ARQ Feedback subheader can be attached to MAC PDUs.

b) Follow Procedure 3 for non-ARQ connections (see 7.10.7.2.4) using the adjustments for ARQ connections in the US and DS as listed in steps c) and d) of this procedure.

c) In the US:

1) If end-to-end ARQ is used:

i) The R-CPE ignores the ARQ feedback subheader (attached to MAC PDU received from A-CPE), but processes any other subheaders attached.

ii) The R-CPE strips out the other subheaders, creates a new MAC PDU, copies the ARQ feedback header, and forwards the MAC PDU to the A-BS.

iii) When the A-BS receives the MAC PDU, it processes the ARQ Feedback IE attached to the MAC PDU

2) If two-link ARQ is used:

i) The R-CPE processes the ARQ feedback header (attached to MAC PDU received from the A-CPE).

ii) It processes the ARQ feedback header (as received from the A-CPE) as well as any other subheaders.

iii) It strips out the existing subheaders and creates a new MAC PDU.

iv) The new MAC PDU will have a new ARQ feedback subheader to indicate the ARQ process between the R-CPE and A-BS.

v) The A-CPE then forwards the MAC PDU to the A-BS.

vi) When the A-BS receives the MAC PDU, it processes the ARQ Feedback IE attached to the MAC PDU.

c) In the DS:

1) If end-to-end ARQ is used:

i) The R-CPE ignores the ARQ feedback subheader (attached to MAC PDU received from R-CPE), but processes any other subheaders attached.

ii) The A-CPE strips out the other subheaders, creates a new MAC PDU, copies the ARQ feedback header, and forwards the MAC PDU to the A-BS.

iii) When the A-CPE receives the MAC PDU, it processes the ARQ Feedback IE attached to the MAC PDU.

2) If two-link ARQ is used:

i) The R-CPE processes the ARQ feedback header (attached to MAC PDU received from the A-BS).

ii) It processes the ARQ feedback header (as received from the A-BS) as well as any other subheaders.

iii) It strips out the existing subheaders and creates a new MAC PDU.

iv) The new MAC PDU will have a new ARQ feedback subheader to indicate the ARQ process between the R-CPE and A-CPE.

v) The A-CPE then forwards the MAC PDU to the A-CPE.

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vi) When the A-CPE receives the MAC PDU, it processes the ARQ Feedback IE attached to the MAC PDU.

7.10.7.3.5 Procedure 4 on ARQ connections

The following procedure shall be used when A-CPE encryption/authentication is disabled and the R-CPE will further fragment/pack PDUs:

a) In the US and DS the ARQ Feedback subheader can be attached to MAC PDUs

b) Follow Procedure 4 for non-ARQ connections (see 7.10.7.2.5) using the adjustments for ARQ connections in the US and DS as listed in steps c) and d) of this procedure.

c) In the US:

1) If the R-CPE shall pack multiple MAC PDUs when end-to-end ARQ is used:

i) The R-CPE ignores the ARQ feedback subheader (attached to MAC PDU received from A-CPE).

ii) It processes any of the other subheaders and strips them out of the MAC PDU.

iii) The R-CPE then creates a new MAC PDU and adds the original ARQ Feedback IE and MAC PDU payload (without modifying them). Do this step for each A-CPE sending a MAC PDU in the US.

iv) It then bundles the MAC PDUs from one or more A-CPEs into a Container Message.

v) The R-CPE forwards the Container Message to the A-BS.

vi) When the A-BS receives the Container Message, it unbundles each A-CPE's MAC PDU and processes the ARQ Feedback IE attached to the MAC PDU.

2) If the R-CPE shall pack multiple MAC PDUs when two-link ARQ is used:

i) The R-CPE processes the ARQ feedback header attached to a MAC PDU received from each A-CPE.

ii) It processes any of the other subheaders and strips them out of the MAC PDU.

iii) The R-CPE then creates a new MAC PDU and copies the original and MAC PDU payload. Do this step for each A-CPE sending a MAC PDU in the US.

iv) It then bundles the MAC PDUs into a Container Message. The MAC PDU that encapsulates the Container Message shall have a ARQ Feedback IE added to it to indicate the ARQ process for the A-BS/R-CPE link.

v) Successful delivery of the MAC PDU that encapsulates the Container Message depends on the ARQ process on the A-BS/R-CPE link.

vi) When the A-BS receives the Container Message, it first processes the ARQ Feedback IE attached to the MAC PDU that encapsulates the Container Message and then unbundles each A-CPE's MAC PDU.

3) If the R-CPE shall fragment MAC PDUs when end-to-end ARQ is used:

i) The R-CPE processes the ARQ feedback header attached to a MAC PDU received from each A-CPE.

ii) It processes any of the other subheaders and strips them out of the MAC PDU.

iii) If necessary, it fragments the MAC PDU payload and forms a new MAC PDU with a GMH that has the EC bit set to 0, indicating fragmentation subheader for each PDU fragment from an A-CPE, and attaches a CRC. When creating the fragments, it will not alter the contents (e.g., ARQ Feedback IE and payload) of the original MAC PDU.

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iv) The R-CPE bundles fragments from multiple A-CPEs into a Container Message and forwards the Container Message to the A-BS.

v) When the A-BS receives the Container Message, it unpacks and stores the PDU fragment for each A-CPE indicated in the Container Message.

vi) It continues to do this until it receives all fragments from the R-CPE.

vii) Once it receives all the fragments of the A-CPE's PDU, A-BS processes the MAC PDU and the ARQ Feedback IE attached to the original MAC PDU.

4) If the R-CPE shall fragment MAC PDUs when two-link ARQ is used:

i) The R-CPE processes the ARQ feedback header attached to a MAC PDU received from each A-CPE.

ii) It processes any of the other subheaders and strips them, as well as the ARQ Feedback IE, out of the MAC PDU.

iii) If necessary, it fragments the MAC PDU payload and forms a new MAC PDU with a GMH that has the EC bit set to 0, indicating fragmentation subheader for each PDU fragment from an A-CPE, and attaches a CRC. When doing this, it will not alter the original contents (e.g., payload) of the MAC PDU.

iv) It then bundles the MAC PDU fragments from one or more A-CPEs into a Container Message. The MAC PDU that encapsulates the Container Message shall have a ARQ Feedback IE added to it to indicate the ARQ process for the A-BS/R-CPE link.

v) Successful delivery of the MAC PDU that encapsulates the Container Message depends on the ARQ process on the A-BS/R-CPE link.

vi) When the A-BS receives the Container Message, it first processes the ARQ Feedback IE attached to the MAC PDU that encapsulates the Container Message and then unpacks and stores the PDU fragment for each A-CPE indicated in the Container Message.

vii) It continues to do this until it receives all fragments from the R-CPE.

viii) Once A-BS receives all the fragments of the A-CPE's PDU, the A-BS processes the MAC PDU.

d) In the DS:

1) If the A-BS shall pack multiple MAC PDUs destined for one or more A-CPEs in the DS when end-to-end ARQ is used:

i) The A-BS bundles packed PDUs for each A-CPE into its own MAC PDU and adds the ARQ feedback subheader.

ii) The A-BS inserts the generated MAC PDUs into a Container Message and sends it to the R-CPE.

iii) The R-CPE receives the Container Message and processes it by unbundling a PDU destined for the A-CPE and forwarding the PDU to the A-CPE as is (i.e., the R-CPE shall ignore the ARQ Feedback IE). This step is repeated until all PDUs in Container Message have been forwarded.

iv) When the A-CPE receives the MAC PDU, it processes the attached ARQ feedback subheader.

2) If the A-BS shall pack multiple MAC PDUs destined for one or more A-CPEs in the DS when two-link ARQ is used:

i) The A-BS bundles packed PDUs for each A-CPE into its own MAC PDU.

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ii) The A-BS inserts the generated MAC PDUs into a Container Message and sends it to the R-CPE. The MAC PDU that encapsulates the Container Message shall have a ARQ Feedback IE added to it to indicate the ARQ process for the A-BS/A-CPE link.

iii) Successful delivery of the MAC PDU that encapsulates the Container Message depends on the ARQ process on the A-BS/R-CPE link.

iv) The R-CPE receives the Container Message and processes it by unbundling a PDU destined for the A-CPE and encapsulating the unbundled PDU in a new MAC PDU (with the EC bit set to 0 in the GMH) with an ARQ feedback subheader (this represents the ARQ process on the A-CPE/R-CPE link). This step is repeated until all PDUs in Container Message have been forwarded.

v) When A-CPE receives the MAC PDU, it shall process the attached ARQ feedback subheader as defined and then unbundle the original (packed) PDU.

3) If the A-BS has PDUs to send to -CPEs attached to an R-CPE, and the R-CPE shall fragment MAC PDUs when end-to-end ARQ is used:

i) The A-BS creates the MAC PDU and adds the ARQ feedback subheader.

ii) Then the A-BS bundles MAC PDUs for multiple A-CPEs into a Container Message and sends it to the R-CPE.

iii) The R-CPE processes each contained MAC PDU in the Container Message by unbundling the MAC PDU from the Container Message and, if necessary, fragmenting the PDU by forming a new MAC PDU with a GMH that has EC bit set to 0, indicating fragmentation subheader for each PDU fragment from an A-CPE, and attaching a CRC. When this is done, the contents of the original MAC PDU will not be altered. The R-CPE then sends each fragment to the destination A-CPE.

iv) Each A-CPE collects those fragments and processes the new fragmentation subheader.

v) Once an A-CPE has collected all of the fragments and has reassembled the original MAC PDU, it processes the ARQ feedback subheader of the original MAC PDU.

4) If the A-BS has PDUs to send to A-CPEs attached to an R-CPE and the R-CPE shall fragment MAC PDUs when two-link ARQ is used:

i) The A-BS shall not add an ARQ feedback subheader to the MAC PDUs it is transmitting in the DS.

ii) The A-BS creates a Container Message to bundle MAC PDUs to be transmitted to A-CPEs that are attached to an R-CPE. The MAC PDU encapsulating the Container Message shall have an ARQ feedback subheader (related to the A-BS/A-CPE ARQ process).

iii) The A-BS then sends the Container Message to the R-CPE.

iv) Successful delivery of the MAC PDU that encapsulates the Container Message depends on the ARQ process on the A-BS/R-CPE link. When the A-CPE first receives the Container Message, it processes the ARQ Feedback IE attached to the MAC PDU that encapsulates the Container Message.

v) The R-CPE processes each contained MAC PDU in the Container Message by unbundling the MAC PDU from the Container Message and, if necessary, fragmenting the PDU by forming a new MAC PDU with a GMH that has the EC bit set to 0, indicating fragmentation subheader for each PDU fragment from an A-CPE, and attaching a CRC. When this is done, the contents of the original MAC PDU will not be altered. Each new fragment will have the ARQ feedback subheader attached to it before being sent to A-CPE.

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vi) Each A-CPE collects those fragments and processes the new fragmentation subheader and the attached ARQ feedback subheader.

vii) Once an A-CPE has collected all of the fragments, it reassembles the original MAC PDU.

7.10.8 MAC PDU transmission for relay in A-WRAN/PHY-OM2 Cell

7.10.8.1 Overview

MAC PDU transmission for relay is shown in 7.10.8.2 and 7.10.8.4 for US and DS through a distributed scheduling R-CPE and 7.10.8.3 and 7.10.8.5 for US and DS through a centralized scheduling R-CPE.

7.10.8.2 US through a distributed scheduling R-CPE

In the US, the distributed scheduling R-CPE would use the following method to forward bursts from A-CPEs to A-BS:

1) Distributed scheduling R-CPE determines N = number of US-MAP IEs on distributed relay zone (DRZ)
2) The R-CPE initializes a empty container message and set number of contained MAC PDUs == N
3) For $i = 1$; $i \leq N$; i++
4) Grab SID from US-MAP IE “i”
5) Read burst (MAC PDU) contents out of slots assigned in US-MAP IE “i”
6) Initialize entry “i” in container message
7) Copy SID value from step 4) into SID of position “i” in container message
8) Copy burst (MAC PDU contents) out of slots assigned in US-MAP IE “i” into burst (MAC PDU storage) for entry “i” in container message
9) Repeat from step 3) until all US MAP IEs have been processed
10) Once container message is finished being constructed, the R-CPE encapsulates it in a MAC PDU and sends it on up to A-BS
11) A-BS receives the container messages and retrieves the burst for each A-CPE contained within

7.10.8.3 US through a centralized scheduling R-CPE

In the US, the centralized scheduling R-CPE would use the following method to forward bursts from A-CPEs to A-BS:

1) A-BS determines AZ US-MAP IE and CRZ US-MAP IE for relay US from A-CPE through the centralized scheduling R-CPE.
   — AZ US-MAP IE contains SID for the centralized scheduling R-CPE and “CRZ US-MAP Index” for mapping CRZ US-MAP IE used for the connection between the centralized scheduling R-CPE and A-CPE.
   — CRZ US-MAP IE contains SID for the A-CPE and “CRZ US-MAP Index” matched with CRZ US-MAP Index of AZ US-MAP IE.
2) In all likelihood, varying channel conditions will prevent the same slots and slot indexing to be used for an A-CPE’s transmission in the CRZ and R-CPE’s forwarding in AZ. The purpose of the “CRZ US-MAP Index” that is matched between the AZ and CRZ US-MAP IE is to allow the A-BS and centralized R-CPE to relate a set of slots allocated in the CRZ to slots allocated in the AZ.
3) When the centralized scheduling R-CPE receives bursts from the A-CPE assigned into CRZ US-MAP IE, the R-CPE allocates received bursts into the slot assigned in AZ US-MAP IE with the same CRZ US-MAP Index.

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4) A-BS maintains tuple of centralized R-CPE SID || A-CPE SID || "CRZ Map Index" used to create the AZ and CRZ US-MAP IEs. When the A-BS receives the burst in the AZ, it retrieves the burst for a particular A-CPE SID from the appropriate slots indicated in AZ US-MAP IE using the CRZ Map Index field.

7.10.8.4 DS through a distributed scheduling R-CPE

In the DS, the distributed scheduling R-CPE would use the following method to forward bursts from the A-BS to A-CPEs:

1) A-BS selects -CPE, known in this method as "Da-cpe"
2) Using current local cell topology info, determine
   — LDa-cpe = list of SIDs of A-CPEs attached through Da-cpe that MAC PDUs need to sent to
   — N = how many A-CPEs attached through Da-cpe, A-BS needs to send MAC PDUs to, e.g., number of SIDs contained in LDa-cpe
3) A-BS may initialize a empty container message and set number of contained MAC PDUs == N
4) For $i = 1$; $i \leq N$; i++
5) Initialize entry "i" in container message
6) Form MAC PDU for SID number "i" in LDa-cpe (this includes forming GMH, setting up any subheads, and applying encryption if that is configured for A-CPE)
7) Copy SID value of the "i" entry in LDa-cpe into the SID of position "i" in container message
8) Copy burst (MAC PDU contents) formed in step 6) into burst (MAC PDU storage) for entry "i" in container message
9) Repeat from step 3) until all A-CPE (each identified by a SID in LDa-cpe) have been processed
10) Once container message is finished being constructed, A-BS encapsulates it in a MAC PDU and sends it on up to the distributed scheduling R-CPE
11) Distributed scheduling R-CPE receives a container message, for each SID+MAC PDU in the container message
12) This forms a DS-MAP IE and maps the SID in container message entry to SID in MAP IE
13) Assigns slots to contain the burst, indicates the slot allocation in MAP IE
14) Transmits DRZ DS MAP and the burst in the assigned slots
15) Repeat from step 10) until all MAC PDUs in container message have been handled.

7.10.8.5 DS through a centralized scheduling R-CPE

In the DS, the centralized scheduling R-CPE would use the following method to forward bursts from the A-BS to A-CPEs:

1) A-BS determines AZ DS-MAP IE and CRZ DS-MAP IE for relay DS to A-CPE through the centralized scheduling R-CPE.
   — AZ DS-MAP IE contains SID for the centralized scheduling R-CPE, "CRZ DS-MAP IE Index" for mapping CRZ DS-MAP IE used for the connection between the centralized scheduling R-CPE and A-CPE, and Relay Mode set to 1. Relay Mode set to 0 indicates that the destination of bursts is the centralized scheduling R-CPE.
   — CRZ DS-MAP IE contains SID for the A-CPE and "CRZ DS-MAP Index" matched with CRZ DS-MAP Index of AZ DS-MAP IE.

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7.11 ARQ mechanism

When implemented, ARQ may be enabled on a per-connection basis. The per-connection ARQ shall be specified and negotiated during connection creation. A connection cannot have a mixture of ARQ and non-ARQ traffic. Similar to other properties of the MAC protocol, the scope of a specific instance of ARQ is limited to one unidirectional connection. When the ARQ mechanism is not implemented in a CPE, the CPE will need to respond to a BS request for a FT with ARQ support with the confirmation code "reject-not-supported-parameter," as indicated in 7.9.24.

For ARQ-enabled connections, enabling of fragmentation is optional. When fragmentation is enabled, the transmitter may partition each SDU into fragments for separate transmission based on the value of the ARQ_BLOCK_SIZE parameter. When fragmentation is not enabled, the connection shall be managed as if fragmentation was enabled. In this case, regardless of the negotiated block size, each fragment formed for transmission shall contain all the blocks of data associated with the parent SDU.

The ARQ feedback information can be sent as a stand-alone MAC management message on the appropriate basic management connection, or it can be piggybacked on an existing connection. ARQ feedback cannot be fragmented.

7.11.1 ARQ block usage

A MSDU is logically partitioned into blocks whose length is specified by the connection TLV parameter ARQ_BLOCK_SIZE. When the length of the SDU is not an integer multiple of the connection's block size, the final block of the SDU is formed using the SDU bytes remaining after the final full block has been determined.

Once an SDU is partitioned into a set of blocks, that partitioning remains in effect until all blocks of the SDU are successfully delivered to the receiver, or the SDU is discarded by the transmitter state machine.

Sets of blocks selected for transmission or retransmission are encapsulated into a PDU. A PDU may contain blocks that are transmitted for the first time as well as those being retransmitted. Fragmentation shall occur only on ARQ block boundaries. If a PDU is not packed, all the blocks in that PDU shall have contiguous block numbers. When a PDU is packed, the sequence of blocks immediately between MAC subheaders and the sequence of blocks after the last PSH shall have contiguous block numbers.

If ARQ is enabled at the connection, FSH and PSH contain a BSN, which is the sequence number of the first ARQ block in the sequence of blocks following the subheader. It is a matter of transmitter policy whether a set of blocks once transmitted as a single PDU should be retransmitted also as a single PDU. Figure 30 illustrates the use of blocks for ARQ transmissions and retransmissions; two options for retransmission are presented—with and without rearrangements of blocks.

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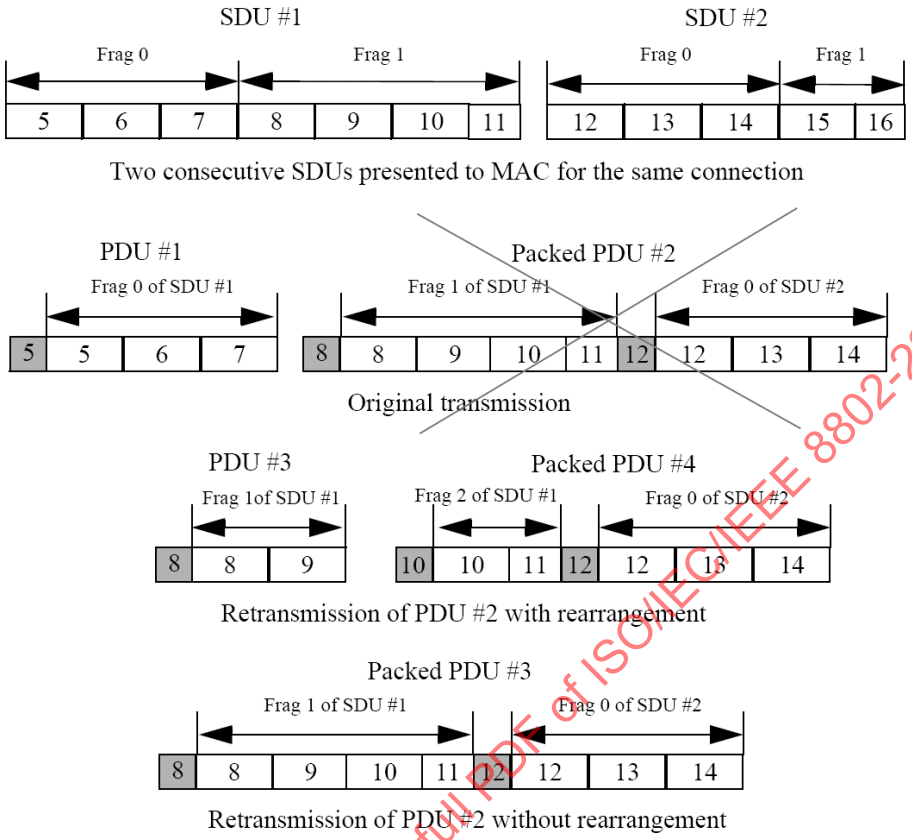

Figure 30—Block usage examples for ARQ with and without rearrangement

7.11.2 ARQ Feedback IE format

Table 224 defines the ARQ Feedback IE used by the receiver to signal positive or negative acknowledgments. A set of IEs of this format may be transported either as a packed payload ("piggybacked") within a packed MPDU or as a payload of a stand-alone MPDU.

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Table 224—ARQ Feedback IE format

Syntax	Size	Notes
ARQ_feedback_IE (LAST) {		
FT	3 bits	The FT of the connection being referenced
LAST	1 bit	0: More ARQ feedback IE in the list 1: Last ARQ feedback IE in the list
ACK Type	2 bits	0x0: Selective ACK entry 0x1: Cumulative ACK entry 0x2: Cumulative with Selective ACK entry 0x3: Cumulative ACK with Block Sequence ACK entry
BSN	10 bits	
Number of ACK Maps	2 bits	If ACK Type == 01, the field is reserved and set to 00. Otherwise the field indicates the number of ACK maps: 0x0: 1, 0x1: 2, 0x2: 3, 0x3: 4
if(ACK Type!= 01) {		
for (*i*=0; *i*< Number of ACK Maps +1; *i*++) {		
if(ACK Type!=3) {		
Selective ACK MAP	16 bits	
}		
else {		Start of Block Sequence ACK Map definition (16 bits)
Sequence Format	1 bit	Number of block sequences associated with descriptor 0: 2 block sequences, 1: 3 block sequences
if(Sequence Format = 0) {		
Sequence ACK MAP	2 bits	
Sequence 1 Length	6 bits	
Sequence 2 Length	6 bits	
Reserved	1 bit	
}		
else {		
Sequence ACK Map	3 bits	
Sequence 1 Length	4 bits	
Sequence 2 Length	4 bits	
Sequence 3 Length	4 bits	
}		
}		

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Table 224—ARQ Feedback IE format *(continued)*

Syntax	Size	Notes
}		
}		
}		

The following parameters in the ARQ Feedback IE are defined as follows:

BSN

If (ACK Type == 0x0): BSN value corresponds to the MSB of the first 16-bit ARQ ACK map and follows an MSB first approach with the BSN incremented by 1 for each bit in the ARQ ACK map, following through for the subsequent ARQ ACK maps.

If (ACK Type == 0x1): BSN value indicates that its corresponding block and all blocks with lesser (see 6.3.4.6.1) values within the transmission window have been successfully received.

If (ACK Type == 0x2): Combines the functionality of types 0x0 and 0x1. If (ACK Type == 0x3): Combines the functionality of type 0x1 with the ability to acknowledge reception of ARQ blocks in terms of block sequences. A block sequence is defined as a set of ARQ blocks with consecutive BSN values. With this option, members of block sequences are identified and associated with the same reception status indication.

Selective ACK Map

Each bit set to one indicates the corresponding ARQ block has been received without errors. The bit corresponding to the BSN value in the IE is the MSB of the first map entry. The bits for succeeding block numbers are assigned left-to-right (MSB to LSB) within the map entry. If the ACK Type is 0x2, then the MSB of the first map entry shall be set to one and the IE shall be interpreted as a cumulative ACK for the BSN value in the IE. The rest of the bitmap shall be interpreted similar to ACK Type 0x0.

Sequence ACK Map

Each bit set to one indicates the corresponding block sequence has been received without error. The MSB of the field corresponds to the first sequence length field in the descriptor. The bits for succeeding length fields are assigned left-to-right within the map entry.

Since the block sequence described by the first descriptor of the first map entry of the IE corresponds to the sequence of blocks immediately after the Cumulative ACK, the ACK map bit for this sequence shall be zero indicating this sequence has not yet been received.

Sequence length: This value indicates the number of blocks that are members of the associated sequence. The BSN of the first block of the block sequence described by the first descriptor of the first IE map entry is the value of the Cumulative ACK plus one. The BSN of the first block of each block sequence is determined by adding the BSN of the first block of the previous block sequence to the length of that sequence. Within a map entry, Sequence Map/Length ordering follows the rule specified in the definition of Sequence ACK Map. Across map entries, ordering moves from the first map entry (i = 0) to the last map entry (i = **Number of ACK maps)**.

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7.11.3 ARQ state machine parameters

7.11.3.1 ARQ_BSN_MODULUS

ARQ_BSN_MODULUS is equal to the number of unique BSN values, i.e., 2^{10}.

7.11.3.2 ARQ_WINDOW_SIZE

ARQ_WINDOW_SIZE is the maximum number of unacknowledged ARQ blocks at any given time. An ARQ block is unacknowledged if it has been transmitted but no acknowledgment has been received.

ARQ_WINDOW_SIZE shall be less than or equal to half of the ARQ_BSN_MODULUS.

7.11.3.3 ARQ_BLOCK_LIFETIME

ARQ_BLOCK_LIFETIME is the maximum time interval an ARQ block shall be managed by the transmitter ARQ state machine, once initial transmission of the block has occurred. If transmission (or subsequent retransmission) of the block is not acknowledged by the receiver before the time limit is reached, the block is discarded.

7.11.3.4 ARQ_RETRY_TIMEOUT

ARQ_RETRY_TIMEOUT is the minimum time interval a transmitter shall wait before retransmission of an unacknowledged block for retransmission. The interval begins when the ARQ block was last transmitted. This interval shall be used to compensate for delays on both transmitter and receiver side. On the transmitter side, this includes time to transmit MAC PDUs and ARQ blocks. On the receiver side, this includes the amount of time to receive and process MAC PDUs as well as transmit ARQ feedback. The transmitter-side and receiver-side delays are distinguished in Table 127, distinctly. These delays may include scheduling and propagation when the BS is the transmitter or the receiver. An ARQ block is unacknowledged if it has been transmitted but no acknowledgment has been received.

7.11.3.5 ARQ_SYNC_LOSS_TIMEOUT

ARQ_SYNC_LOSS_TIMEOUT is the maximum time interval ARQ_TX_WINDOW_START or ARQ_RX_WINDOW_START shall be allowed to remain at the same value before declaring a loss of synchronization of the sender and receiver state machines when data transfer is known to be active. The ARQ receiver and transmitter state machines manage independent timers. Each has its own criteria for determining when data transfer is “active” (see 7.11.6.2 and 7.11.6.3).

7.11.3.6 ARQ_RX_PURGE_TIMEOUT

ARQ_RX_PURGE_TIMEOUT is the time interval the receiver shall wait after successful reception of a block that does not result in advancement of ARQ_RX_WINDOW_START, before advancing ARQ_RX_WINDOW_START (see 7.11.6.3).

7.11.3.7 ARQ_BLOCK_SIZE

ARQ_BLOCK_SIZE is the length used for partitioning an SDU into a sequence of ARQ blocks prior to transmission (see 7.10.4.1).

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7.11.4 ARQ procedures

7.11.4.1 ARQ state machine variables

All ARQ state machine variables are set to 0 at connection creation or by an ARQ reset operation.

7.11.4.1.1 Transmitter variables

ARQ_TX_WINDOW_START: All BSN up to (ARQ_TX_WINDOW_START – 1) have been acknowledged.

ARQ_TX_NEXT_BSN: BSN of the next block to send. This value shall reside in the interval ARQ_TX_WINDOW_START to (ARQ_TX_WINDOW_START + ARQ_WINDOW_SIZE), inclusive.

7.11.4.1.2 Receiver variables

ARQ_RX_WINDOW_START: All BSN up to (ARQ_RX_WINDOW_START – 1) have been correctly received.

ARQ_RX_HIGHEST_BSN: BSN of the highest block received, plus one. This value shall reside in the interval ARQ_RX_WINDOW_START to (ARQ_RX_WINDOW_START + ARQ_WINDOW_SIZE), inclusive.

7.11.5 ARQ-enabled connection setup and negotiation

Connections are set up and defined dynamically through the DSA/DSC class of messages. The conditions for applying or not applying CRC to MAC PDUs is defined in 7.11.5. When CRC is applied to MAC PDU, it shall be used for error detection of PDUs on ARQ-enabled connections. When the Ciphertext ICV (see 8.4.2) is applied to an encrypted MAC PDU, it shall be used for error detection of PDUs on ARQ-enabled connections. All the ARQ parameters (see 7.11.3) shall be set when an ARQ-enabled connection is set up. The transmitter and receiver variables (defined in 7.11.4.1) shall be reset on connection setup.

7.11.6 ARQ operation

7.11.6.1 Sequence number comparison

Transmitter and receiver state machine operations include comparing BSNs and taking actions based on which is larger or smaller. In this context, it is not possible to compare the numeric sequence number values directly to make this determination. Instead, the comparison shall be made by normalizing the values relative to the appropriate state machine base value and the maximum value of sequence numbers, ARQ_BSN_MODULUS, and then comparing the normalized values. Normalization is accomplished by using the following equation.

$$bsn' = (bsn - BSN_base) \bmod ARQ_BSN_MODULUS$$

The base values for the receiver and transmitter state machines are ARQ_TX_WINDOW_START and ARQ_RX_WINDOW_START, respectively.

7.11.6.2 Transmitter state machine

An ARQ block may be in one of the following four states—not-sent, outstanding, discarded, and waiting-for-retransmission. Any ARQ block begins as not-sent. After it is sent it becomes outstanding for a period of time termed ARQ_RETRY_TIMEOUT. While a block is in outstanding state, it is either acknowledged and discarded, or it transitions to waiting-for-retransmission after ARQ_RETRY_TIMEOUT

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or NACK. An ARQ block can become waiting-for-retransmission before the ARQ_RETRY_TIMEOUT period expires if it is negatively acknowledged. An ARQ block may also change from "waiting-for-retransmission" to "discarded" when an ACK message is received for it or after a timeout ARQ_BLOCK_LIFETIME.

For a given connection the transmitter shall first handle (transmit or discard) blocks in "waiting-for-retransmission" state and only then blocks in "notsent" state. Blocks in "outstanding" or "discarded" state shall not be transmitted. When blocks are retransmitted, the block with the lowest BSN shall be retransmitted first.

The ARQ Tx block state sequence is shown in Figure 31.

MPDU formation continues with a connection's "not-sent" MSDUs. The transmitter builds each MPDU using the rules for fragmentation and packing as long as the number of blocks to be sent plus the number of block already transmitted and awaiting retransmission does not exceed the limit imposed by ARQ_WINDOW_SIZE. As each "not-sent" block is formed and included in a MPDU, it is assigned the current value of ARQ_TX_NEXT_BSN, which is then incremented.

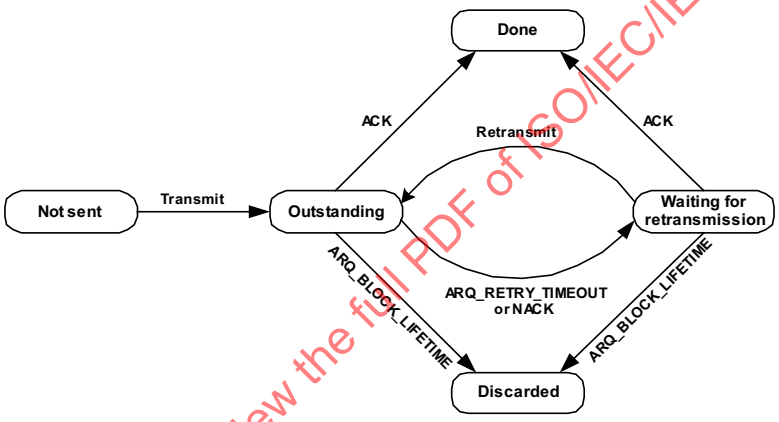

Figure 31—ARQ Tx block states

When an acknowledgment is received, the transmitter shall check the validity of the BSN. A valid BSN is one in the interval ARQ_TX_WINDOW_START to ARQ_TX_NEXT_BSN – 1 (inclusive). If BSN is not valid, the transmitter shall ignore the acknowledgment.

When a cumulative acknowledgment with a valid BSN is received, the transmitter shall consider all blocks in the interval ARQ_TX_WINDOW_START to BSN (inclusive) as acknowledged and set ARQ_TX_WINDOW_START to BSN + 1.

When a selective acknowledgment is received, the transmitter shall consider as acknowledged all blocks so indicated by the entries in the bitmap for valid BSN values. As the bitmap entries are processed in increasing BSN order, ARQ_TX_WINDOW_START shall be incremented each time the BSN of an acknowledged block is equal to the value of ARQ_TX_WINDOW_START.

When ARQ_TX_WINDOW_START has been advanced by either of the above methods and acknowledgment of reception has already been received for the block with the BSN value now assigned to ARQ_TX_WINDOW_START, the value of ARQ_TX_WINDOW_START shall be incremented until a BSN value is reached for which no acknowledgment has been received.

A bitmap entry not indicating acknowledgment shall be considered a NACK for the corresponding blocks.

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Selective ACK bit-maps are referenced to a specific BSN, which indicates to absolute number of the block referenced by the first bit in the bit-map. It is the responsibility of the ARQ feedback sender to assign the BSN so that all bits in the bit-map define either ACK or NAK for a specific ARQ block. This can be achieved by assigning the BSN low enough (modulo 2^{10}) so that every bit in the bit map provides correct feedback information.

When a cumulative with selective acknowledgment and a valid BSN is received, the transmitter performs the actions described above for cumulative acknowledgment, followed by those for a selective acknowledgment.

All timers associated with acknowledged blocks shall be canceled.

A Discard message shall be sent following violation of ARQ_BLOCK_LIFETIME. The message may be sent immediately or may be delayed up to ARQ_RX_PURGE_TIMEOUT + ARQ_RETRY_TIMEOUT. Following the first transmission, subsequent discard orders shall be sent to the receiver at intervals of ARQ_RETRY_TIMEOUT until an acknowledgment to the discarded BSN has been received. Discard orders for adjacent BSN values may be accumulated in a single Discard message.

The actions to be taken by the transmitter state machine when it wants to initiate a reset of the receiver ARQ state machine are provided in Figure 32. The actions to be taken by the receiver state machine when it initiates an ARQ Reset message are provided in Figure 33.

Synchronization of the ARQ state machines is governed by a timer managed by the transmitter state machine. Each time ARQ_TX_WINDOW_START is updated the timer is set to zero. When the timer exceeds the value of ARQ_SYNC_LOSS_TIMEOUT, the transmitter state machine shall initiate a reset of the connection's state machines as described in Figure 32.

When in ARQ reset error state in Figure 32 and Figure 33, the CPE shall reinitialize its MAC, and the behavior for BS is implementation dependent.

A Discard message may be sent to the receiver when the transmitter wants to skip ARQ blocks up to the BSN value specified in the Discard message. Upon receipt of the message, the receiver updates its state information to indicate the specified blocks were received and forwards the information to the transmitter through an ARQ Feedback IE at the appropriate time.

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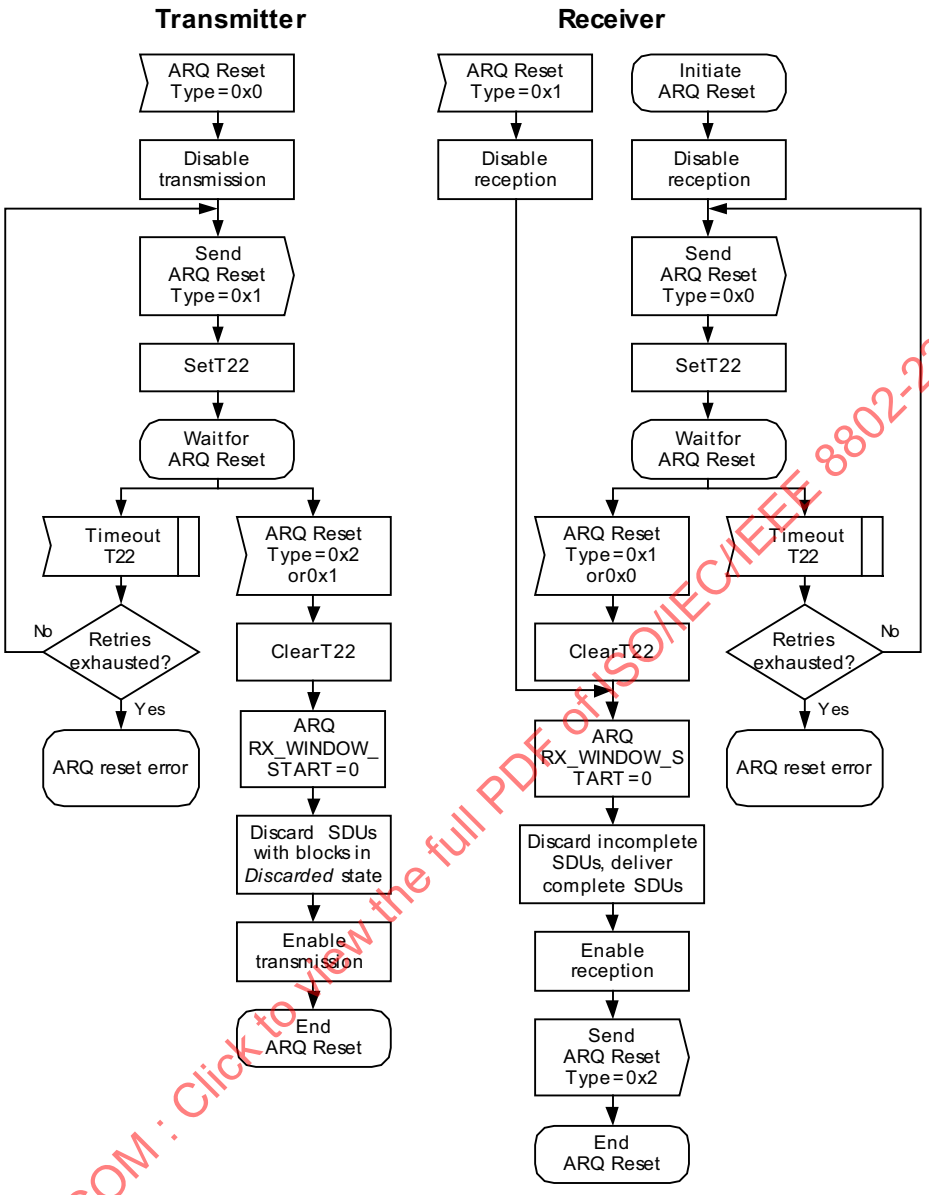

Figure 32—ARQ Reset message dialog—Transmitter initiated

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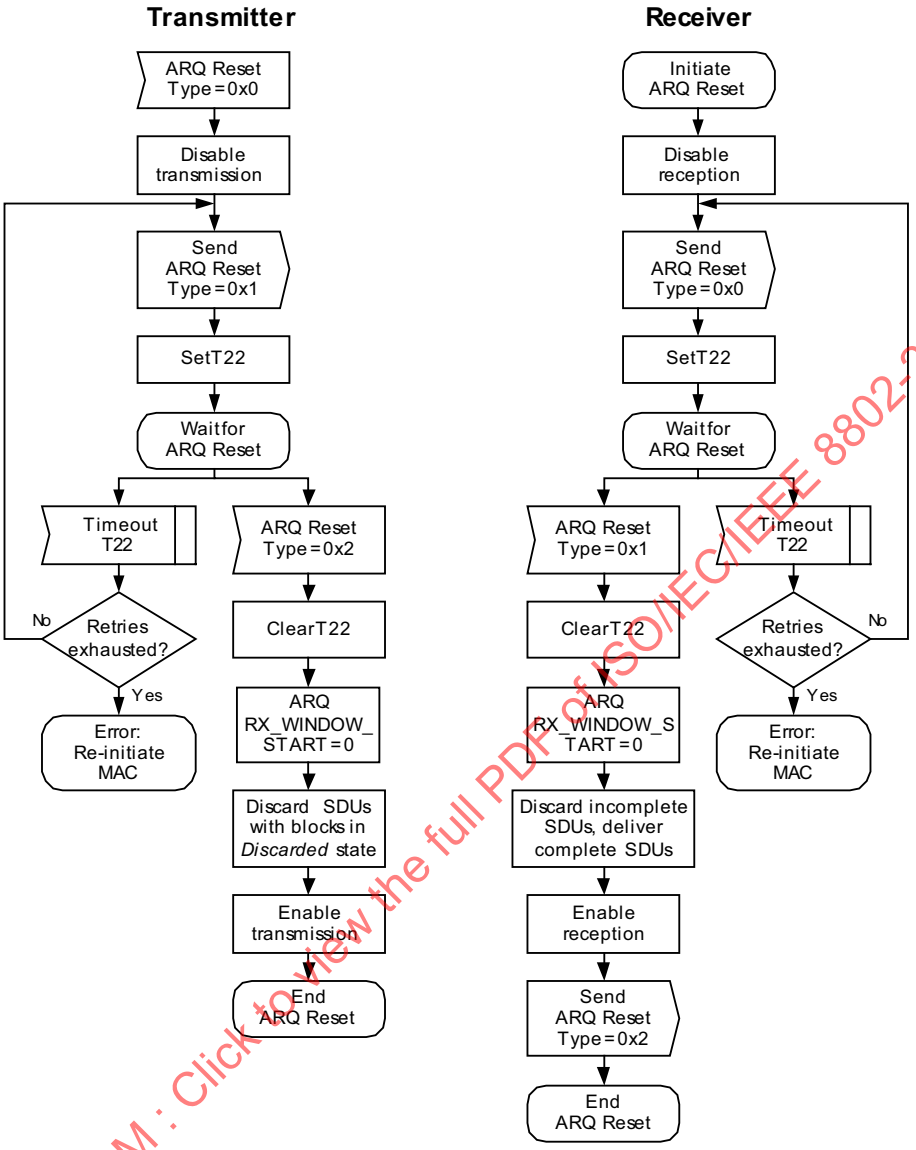

Figure 33—ARQ Reset message dialog—Receiver-initiated

7.11.6.3 Receiver state machine

When a PDU is received, its integrity is determined based on the CRC-32 checksum or verifying the Ciphertext ICV (see 8.2.4). If a PDU passes the checksum, it is unpacked and defragmented, if necessary. The receiver maintains a sliding-window defined by ARQ_RX_WINDOW_START state variable and the ARQ_WINDOW_SIZE parameter. When an ARQ block with a number that falls in the range defined by the sliding window is received, the receiver shall accept it. ARQ block numbers outside the sliding window shall be rejected as out of order. The receiver should discard duplicate ARQ blocks (i.e., ARQ blocks that where already received correctly) within the window. See Figure 34.

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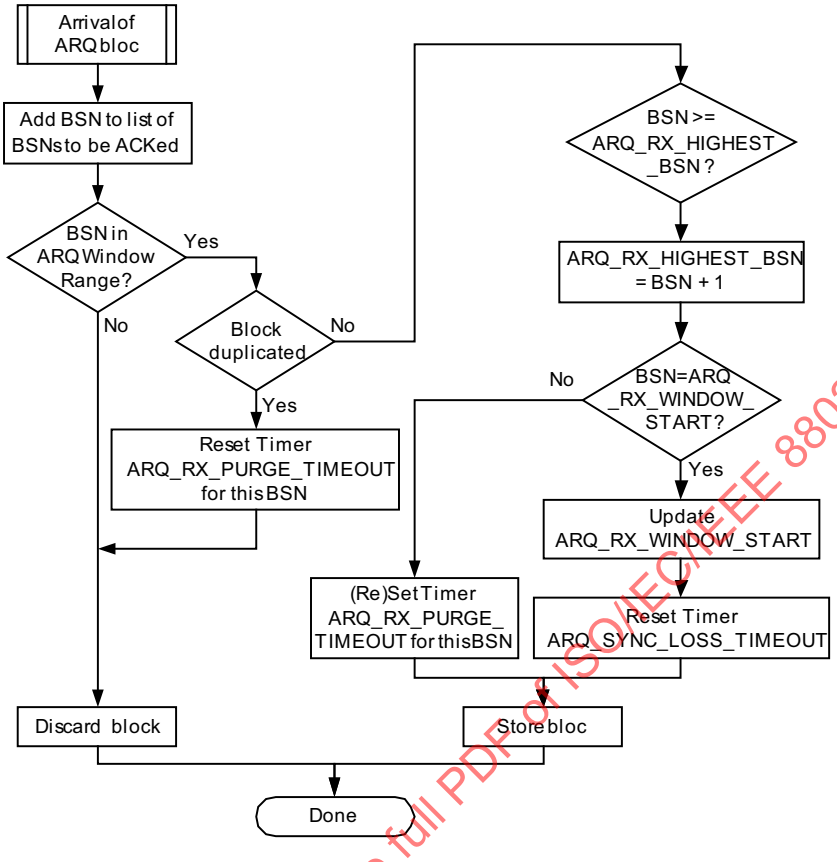

Figure 34—ARQ block reception

The sliding window is maintained so that the ARQ_RX_WINDOW_START variable always points to the lowest numbered ARQ block that has not been received or has been received with errors. When an ARQ block with a number corresponding to the ARQ_RX_WINDOW_START is received, the window is advanced (i.e., ARQ_RX_WINDOW_START is incremented modulo ARQ_BSN_MODULUS) so that the ARQ_RX_ WINDOW_START variable points to the next lowest numbered ARQ block that has not been received or has been received with errors. The timer associated with ARQ_SYNC_LOSS_TIMEOUT shall be reset.

When a block does not result in an advance of the ARQ_RX_WINDOW_START, the ARQ_RX_PURGE_TIMEOUT for that block shall be started. When the value of the timer for a block exceeds ARQ_RX_PURGE_TIMEOUT, the timeout condition is marked. When the timeout condition is marked, ARQ_RX_WINDOW_START is advanced to the BSN of the next block not yet received after the marked block. Timers for delivered blocks remain active and are monitored for timeout until the BSN values are outside the receive window.

When ARQ_RX_WINDOW_START is advanced, any BSN values corresponding to blocks that have not yet been received residing in the interval between the previous and current ARQ_RX_WINDOW_START value shall be marked as received and the receiver shall send an ARQ Feedback IE to the transmitter with the updated information. Any blocks belonging to complete SDUs shall be delivered. Blocks from partial SDUs shall be discarded.

When a discard message is received from the transmitter, the receiver shall discard the specified blocks, advance ARQ_RX_WINDOW_START to the BSN of the first block not yet received after the BSN

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provided in the Discard message, and mark all not received blocks in the interval from the previous to new ARQ_RX_WINDOW_START values as received for ARQ Feedback IE reporting.

For each ARQ block received, an acknowledgment shall be sent to the transmitter. Acknowledgment for blocks outside the sliding window shall be cumulative. Acknowledgments for blocks within the sliding window may be either for specific ARQ blocks (i.e., contain information on the acknowledged ARQ block numbers), or cumulative (i.e., contain the highest ARQ block number below which all ARQ blocks have been received correctly) or a combination of both (i.e., cumulative with selective). Acknowledgments shall be sent in the order of the ARQ block numbers they acknowledge. The frequency of acknowledgment generation is not specified here and is implementation dependent.

A MSDU is ready to be handed to the upper layers when all of the ARQ blocks of the MSDU have been correctly received within the time-out values defined.

When ARQ_DELIVER_IN_ORDER is enabled, a MSDU is handed to the upper layers as soon as all the ARQ blocks of the MSDU have been correctly received within the defined time-out values and all blocks with sequence numbers smaller than those of the completed message have either been discarded due to time-out violation or delivered to the upper layers.

When ARQ_DELIVER_IN_ORDER is not enabled, MSDUs are handed to the upper layers as soon as all blocks of the MSDU have been successfully received within the defined time-out values.

The actions to be taken by the receiver state machine when an ARQ Reset message is received are provided in Figure 32. The actions to be taken by the receiver state machine when it wants to initiate a reset of the transmitter ARQ state machine are provided in Figure 33.

Synchronization of the ARQ state machines is governed by a timer managed by the receiver state machine. Each time ARQ_RX_WINDOW_START is updated, the timer is set to zero. When the timer exceeds the value of ARQ_SYNC_LOSS_TIMEOUT the receiver state machine shall initiate a reset of the connection's state machines as described in Figure 33.

7.11.6.4 ARQ for a relay network in A-WRAN/PHY-OM2 Cell

7.11.6.4.1 Overview

In A-WRAN systems, there are two ARQ modes. The first mode is an end-to-end ARQ mode that is performed between an A-BS and an A-CPE; the second mode is a two-link ARQ mode that is performed both between an A-BS and an R-CPE and between an R-CPE and an A-CPE. The support of ARQ mode is performed during the network entry. Two-link ARQ mode is limited for a distributed scheduling mode.

In the end-to-end ARQ mode, the ARQ operation is same as the operations described in 7.11.6.1, 7.11.6.2, and 7.11.6.3. An R-CPE does not have an additional ARQ functionality.

In two-link ARQ mode, the ARQ operation is divided into two links that are a relay link between A-BS and R-CPE and an access link between a distributed scheduling R-CPE and A-CPE. The detailed procedure for two-link ARQ mode is described in 7.11.6.4.2.

7.11.6.4.2 Two-link ARQ mode

For an access link between a distributed scheduling R-CPE and A-CPE, the ARQ state machine runs between the R-CPE and the A-CPE. For relay link between A-BS and distributed scheduling R-CPE, the ARQ state machine runs between the A-BS and the R-CPE. The A-BS schedules retransmission to the R-CPE when ARQ block is corrupted in the relay link. The distributed scheduling R-CPE schedules retransmission to the A-CPE when ARQ block is corrupted in the access link.

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The ARQ Feedback IE described in Table 176 is used by the A-BS and R-CPE to ACK/NAK corresponding data transmitted between A-BS and R-CPE. The ARQ Feedback IE is transported either as a packed payload ("piggybacked") within a packed MAC PDU or as a payload of a stand-alone MAC PDU defined in 7.8.

In downlink (DL) ARQ operation, when A-BS sends ARQ block to R-CPE, it waits for the ARQ Feedback IE from R-CPE. When ARQ block is corrupted in the relay link, the R-CPE sends NAK to A-BS, and A-BS schedules the retransmission of the corresponding ARQ block to R-CPE as shown in Figure 35. When A-BS receives ACK from the distributed scheduling R-CPE, it waits for the ACK from the A-CPE relayed by R-CPE. R-CPE may modify the ARQ Feedback IE received from A-CPE to inform only ACK to A-BS. When A-BS receives ACK from A-CPE, it clears the buffer corresponding to ARQ block as shown in Figure 35. When ARQ block is corrupted in the access link, R-CPE shall not send NAK to A-BS and shall schedule the retransmission of ARQ blocks to A-CPE. R-CPE shall discard the ARQ block when ARQ block transmission failed in the access link after a timeout of the ARQ_BLOCK_LIFETIME. A-BS or R-CPE discards the corresponding ARQ block after the timeout of its ARQ_BLOCK_LIFETIME. A-BS and RS ARQ_BLOCK_LIFETIME are independently operated in A-BS and R-CPE, respectively.

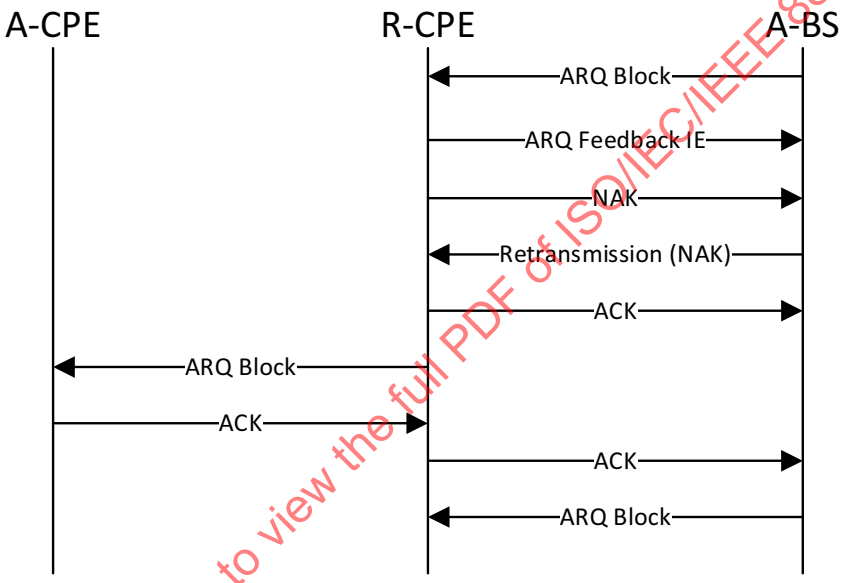

Figure 35—Example of downlink ARQ for relay

In uplink (UL) ARQ operation, when the distributed scheduling R-CPE receives ARQ block correctly from A-CPE, R-CPE sends ARQ block to A-BS. When A-BS receives ARQ block correctly, A-BS sends ACK to R-CPE and the R-CPE sends ACK to A-CPE. When ARQ block is corrupted in the relay link, the retransmission shall be scheduled from R-CPE to A-BS. A-CPE discards the corresponding ARQ block after a timeout of ARQ_BLOCK_LIFETIME in R-CPE.

7.11.6.4.3 ARQ state machine

The ARQ state machine operation in R-CPE and receiver in A-BS is the same as described in 7.11.6.2 and 7.11.6.3. For the transmitter state machine in A-BS, an ARQ block may be in one of the following five states: not sent, outstanding for R-ACK, outstanding for A-CPE-ACK, waiting for retransmission, and data discard. Outstanding for R-ACK is the state waiting to receive ACK from R-CPE. When R-ACK is received, the state transits to outstanding for A-CPE-ACK. In this state, when the A-BS receives A-CPE-NACK or after ARQ_BLOCK LIFE_TIME, the state transits to discard. If A-BS receives A-CPE-ACK in the state of outstanding for R-ACK or waiting for retransmission, the state transits to done. Other state transition descriptions are the same as for transmitter state machine defined in 7.11.6.2. The ARQ Tx block state sequence in A-BS is shown in Figure 36.

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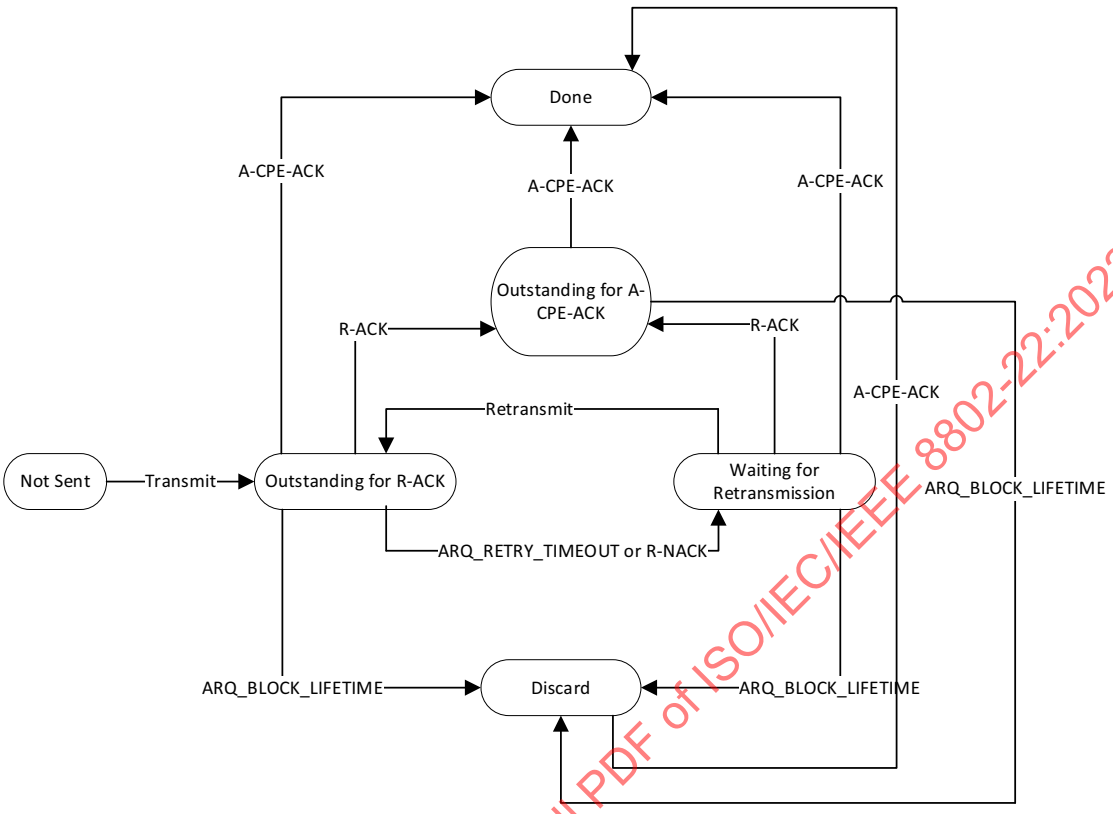

Figure 36—ARQ Tx block state in A-BS

7.12 Scheduling services

Scheduling services represent the data handling mechanisms supported by the MAC scheduler for data transport on a connection. Each connection is associated with a single data service. Each data service is associated with a set of QoS parameters that quantify aspects of its behavior (these parameters are managed using the DSA and DSC messages). Four services (7.9.8.9.9) are supported: Unsolicited Grant Service (UGS), Real-time Polling Service (rtPS), Non-real-time Polling Service (nrtPS), and best effort (BE). A description of each of these services and some of the applications they aim at supporting are described in the paragraphs that follow. Mandatory QoS parameters associated with each of these services are also identified. A detailed description of all supported QoS parameters can be found in 7.9.8.9.

The UGS is designed to support real-time data streams consisting of fixed-size data packets sent at periodic intervals, such as T1/E1 and Voice over IP without silence suppression. The mandatory QoS service flow parameters for this scheduling service are Maximum Sustained Traffic Rate, Maximum Latency, Tolerated Jitter, and Request/Transmission Policy. If present, the Minimum Reserved Traffic Rate parameter shall have the same value as the Maximum Sustained Traffic Rate parameter.

The rtPS is designed to support real-time data streams consisting of variable-sized data packets that are issued at periodic intervals, such as MPEG video. The mandatory QoS service flow parameters for this scheduling service are Minimum Reserved Traffic Rate, Maximum Sustained Traffic Rate, Maximum Latency, and Request/Transmission Policy.

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The nrtPS is designed to support delay-tolerant data streams consisting of variable-sized data packets for which a minimum data rate is required, such as FTP. The mandatory QoS service flow parameters for this scheduling service are Minimum Reserved Traffic Rate, Maximum Sustained Traffic Rate, Traffic Priority, and Request/Transmission Policy.

The BE service is designed to support data streams for which no minimum service level is required and therefore may be handled on a space-available basis. The mandatory QoS service flow parameters for this scheduling service are Maximum Sustained Traffic Rate, Traffic Priority, and Request/Transmission Policy.

7.12.1 Data transmission scheduling

Data transmission scheduling selects the data for transmission in a particular frame/bandwidth allocation and is performed by the BS for DS, and by the CPE for US. In addition to whatever other factors the scheduler may deem pertinent, the following items shall be taken into account for each active service flow:

— The scheduling service specified for the service flow.

— The values assigned to the service flow's QoS parameters.

— The availability of data for transmission.

— The capacity of the granted bandwidth.

In A-WRAN systems, to meet a UGS service flow's need, the A-BS and R-CPE along the path shall grant fixed-size bandwidth to its A-CPE on a real-time periodic basis.

The A-BS or the R-CPE may send RS scheduling information (Relay-SCHE, 7.9.28) in advance to its A-CPE to indicate when and how much bandwidth it will schedule for the service in the future.

7.12.2 Upstream request/grant scheduling

Upstream request/grant scheduling is performed by the BS with the intent of providing each associated CPE with bandwidth for US transmissions or opportunities to request bandwidth. By specifying a scheduling service and its associated QoS parameters, the BS scheduler can anticipate the throughput and latency needs of the US traffic and provide polls and/or grants at the appropriate times. Table 225 summarizes the scheduling services and the poll/grant options available for each. The following subclauses define service flow scheduling services for US operations.

Table 225—Scheduling services and corresponding poll/grant options

Scheduling Type	Piggyback Request	Bandwidth Stealing	Polling
UGS	Not Allowed	Not Allowed	PM bit is used to request a unicast poll for bandwidth needs of non-UGS connections.
rtPS	Allowed	Allowed	Scheduling only allows unicast polling.
nrtPS	Allowed	Allowed	Scheduling may restrict a service flow to unicast polling via the transmission/request policy; otherwise all forms of polling are allowed.
BE	Allowed	Allowed	All forms of polling allowed.

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7.12.2.1 UGS

The UGS service offers fixed-size grants on a real-time periodic basis, which eliminate the overhead and latency of CPE requests and assure that grants are available to meet the flow's real-time needs. The BS shall provide allocations to the CPE, in both the DS or US via MAP IEs, at periodic intervals based upon the Maximum Sustained Traffic Rate of the service flow. The size of these grants shall be sufficient to hold the fixed-length data associated with the service flow (with associated generic MAC header and Grant management subheader) but may be larger at the discretion of the BS scheduler. In order for this service to work correctly, the Request/Transmission Policy (7.9.8.9.10) setting shall be such that the CPE is prohibited from using any contention request opportunities for this connection.

The Grant Management subheader (7.8.1.2.3) is used to pass status information from the CPE to the BS regarding the state of the UGS service flow. The most significant bit of the Grant Management field is the Slip Indicator (SI) bit. The CPE shall set this flag once it detects that this service flow has exceeded its transmit queue depth. Once the CPE detects that the service flow's transmit queue is back within limits, it shall clear the SI flag. The flag allows the BS to provide for long-term compensation for conditions, such as lost maps or clock rate mismatches, by issuing additional grants. The poll-me (PM) bit may be used to request to be polled for a different, non-UGS connection.

The BS shall not allocate more bandwidth than the Maximum Sustained Traffic Rate parameter of the Active QoS parameter set, excluding the case when the SI bit of the Grant Management field is set. In this case, the BS may grant up to 1% additional bandwidth for clock rate mismatch compensation.

There are two additional considerations when servicing UGS requests in A-WRANs operating in PHY-OM2:

— To meet a UGS service flow's need the A-BS and distributed/centralized scheduling R-CPE along the path shall grant fixed size bandwidth to it's A-CPE on a real-time periodic basis.

— The A-BS or the distributed scheduling R-CPE may send RS scheduling information (Relay-SCHE, (7.9.28) in advance to it's A-CPE to indicate when and how much bandwidth it will schedule for the service in the future.

7.12.2.2 rtPS

The rtPS service offers real-time, periodic, unicast request opportunities, which meet the flow's real-time needs and allows the CPE to specify the size of the desired grant. This service requires more request overhead than UGS, but supports variable grant sizes for optimum data transport efficiency.

The BS shall provide periodic unicast request opportunities. In order for this service to work correctly, the Request/Transmission Policy setting (7.9.8.9.10) shall be such that the CPE is prohibited from using any contention request opportunities for that connection. The BS may issue unicast request opportunities as prescribed by this service even if prior requests are currently unfulfilled. This results in the CPE using only unicast request opportunities in order to obtain US transmission opportunities. The CPE could still send a bandwidth request by sending the BR subheader in a MAC PDU on an existing US transmission as well. All other bits of the Request/Transmission Policy are irrelevant to the fundamental operation of this scheduling service and should be set according to network policy.

There are two additional considerations when servicing rtPS requests in A-WRANs operating in PHY-OM2:

— To meet an rtPS service flow's need, the A-BS and distributed scheduling R-CPE along the path shall poll its A-CPE or grant dynamic-size bandwidth to its A-CPE on a real-time periodic basis.

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— The A-BS or the distributed scheduling R-CPE may send RS scheduling information (Relay-SCHE, (7.9.28) in advance to its A-CPE to indicate when and how much bandwidth it will schedule for the service in the future.

7.12.2.3 nrtPS

The nrtPS offers unicast polls on a regular basis, which assures that the service flow receives request opportunities even during network congestion. The BS typically polls nrtPS FT on a CPE on an interval on the order of one second or less.

The BS shall provide timely unicast request opportunities. In order for this service to work correctly, the Request/Transmission Policy setting (7.9.8.9.10) shall be set such that the CPE is allowed to use contention request opportunities. This results in the CPE using contention request opportunities as well as unicast request opportunities and unsolicited bandwidth request via the Bandwidth Request subheader. All other bits of the Request/Transmission Policy are irrelevant to the fundamental operation of this scheduling service and should be set according to network policy.

7.12.2.4 Best effort

The intent of the BE service is to provide efficient service for best effort traffic. In order for this service to work correctly, the Request/Transmission Policy setting shall be set such that the CPE is allowed to use contention request opportunities. This results in the CPE using contention request opportunities as well as unicast request opportunities and unsolicited bandwidth request via the Bandwidth Request subheader. All other bits of the Request/Transmission Policy are irrelevant to the fundamental operation of this scheduling service and should be set according to network policy.

7.13 Bandwidth management

During network entry and initialization, every CPE is assigned up to three dedicated FTs for the purpose of sending and receiving control messages. These connection pairs are used to allow differentiated levels of QoS to be applied to the different connections carrying MAC management traffic. Increasing (or decreasing) bandwidth requirements are necessary for all services except incompressible constant bit rate UGS connections. The needs of incompressible UGS connections do not change between connection establishment and termination. The requirements of compressible UGS connections, such as channelized T1, may increase or decrease, depending on traffic. DAMA services are given resources on a demand assignment basis, as the need arises.

There are numerous methods by which a CPE can send a bandwidth request message to the BS, and these are described in the following subclauses.

7.13.1 Bandwidth Requests

Bandwidth Requests (or simply, Requests) refer to the mechanism that CPEs use to indicate to the BS that they need US bandwidth allocation. Two types of bandwidth requests are available in the MAC layer (with proper PHY support).

7.13.1.1 Contention-based Request

In this case, a Request comes as a subheader appended to the generic MAC header (see 7.8.1.2.1), which may or may not contain payload. Typically, a Request will not contain a payload if it is the first Request made for the connection. It may contain a payload otherwise.

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Because the US burst profile can change dynamically, all requests for bandwidth shall be made in terms of the number of bytes needed to carry the MAC header and payload, but not the PHY overhead. The Bandwidth Request message may be transmitted during any US allocation, except during any initial ranging interval, UCS notification interval, and SCW.

Bandwidth Requests may be incremental or aggregate. When the BS receives an incremental Bandwidth Request, it shall add the quantity of bandwidth requested to its current perception of the bandwidth needs of the connection. When the BS receives an aggregate Bandwidth Request, it shall replace its perception of the bandwidth needs of the connection with the quantity of bandwidth requested. The Type field in the bandwidth request header indicates whether the request is incremental or aggregate. The self-correcting nature of the request/grant protocol requires that CPEs shall periodically use aggregate Bandwidth Requests. The period may be a function of the QoS of a service and of the link quality.

7.13.1.2 CDMA Request

In addition to the transmission of bandwidth requests by the CPE, the PHY also supports the use of a CDMA-based mechanism for the purpose of US bandwidth allocation.

As detailed in the PHY spec, the PHY has available a subset of Ranging codes that shall be used for CDMA Bandwidth Requests. The CPE, upon needing to request bandwidth, shall select, with equal probability, a Ranging Code from the code subset allocated to Bandwidth Requests. This Ranging Code shall be modulated onto a Ranging Subchannel and transmitted during the appropriate US allocation. The Ranging Subchannel shall be selected among the ones reserved by the MAC for the US transmission.

Upon detection, the BS shall provide a US allocation for the CPE. The BS does not respond with an allocation on the CPE's Basic FT. Instead, it broadcasts a CDMA_Allocation_IE, which specifies the transmit region and Code that were used by the CPE. This allows a CPE to determine whether it has been given an allocation by matching these parameters with the parameters it used. The CPE shall use the allocation to transmit a MAC PDU with the Bandwidth Request subheader and/or data (this is indicated by the Usage field—see Table 48). The CPE may only omit the Bandwidth Request PDU when the BS indicated so in the CDMA_Allocation_IE (see Table 48).

If the BS does not issue the US allocation described above, or the MAC PDU with the bandwidth request subheader does not result in a subsequent allocation of any bandwidth, the CPE shall assume that the Ranging Code transmission resulted in a collision and follow the contention resolution as specified in 7.15.

7.13.1.3 Bandwidth Request for a relay network on PHY-OM2

7.13.1.3.1 Overview

In A-WRAN systems, the bandwidth request message, mechanism, and capability defined for the CPE and A-BS shall be applicable for the R-CPE. Capability of incremental BRs is mandatory only if the R-CPE is a distributed scheduling R-CPE.

7.13.1.3.2 Bandwidth Request by a distributed scheduling R-CPE

A distributed scheduling R-CPE directly handles the bandwidth requests it receives from its A-CPEs.

A distributed scheduling R-CPE may receive bandwidth requests from its A-CPEs via the MAC signaling header, the grant management subheader, or the CDMA bandwidth request code.

To forward US traffic to A-BS, a distributed scheduling R-CPE may request uplink bandwidth via a stand-alone bandwidth request header. A distributed scheduling R-CPE may combine the bandwidth

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requests that arrive from A-CPEs together by using a Container message (7.9.26) or with the bandwidth needs of queued packets into one bandwidth request header per QoS class.

The distributed scheduling R-CPE may transmit a BW request header soon after it receives a BW request header from one of its A-CPEs (timed to yield an uplink allocation sequential to the arrival of those packets) instead of waiting for the actual packets to arrive in order to reduce delay in relaying traffic (see Figure 37).

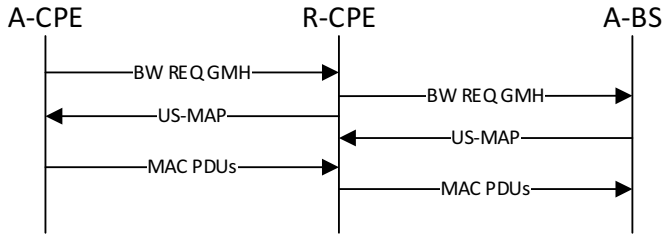

Figure 37—Reducing latency in relaying traffic by transmitting BW request header before packets arrive

7.13.1.3.3 Bandwidth Request by a centralized scheduling R-CPE

In centralized scheduling mode, the A-BS shall determine the bandwidth allocations (i.e., MAPs) for all links in its cell. As a result, centralized scheduling R-CPEs shall receive the MAPs from the A-BS for the links to/from their CPEs before they can transmit them.

For the same reason, centralized scheduling R-CPEs shall forward all bandwidth request headers and bandwidth request CDMA ranging code information they receive from CPEs to the A-BS. The centralized scheduling R-CPEs may combine bandwidth request by using a Container message (7.9.26).

If the centralized scheduling R-CPE has available uplink bandwidth, it shall simply forward the bandwidth request information by using an Extended BW request subheader (Table 11) to the A-BS. Otherwise, the centralized scheduling R-CPEs shall request uplink bandwidth from the A-BS using CDMA bandwidth ranging codes or Contention-based bandwidth request.

When the centralized scheduling R-CPE receives a CRZ CDMA bandwidth ranging code from an A-CPE, the Extended BR subheader contains BW request type set to 0 and the received CRZ bandwidth ranging code. Upon receiving an Extended BR subheader from a centralized scheduling R-CPE, the A-BS shall insert CDMA Allocation IEs in CRZUS-MAP IE for which the CPE performs bandwidth request to the centralized scheduling R-CPE.

When the centralized scheduling R-CPE receives a bandwidth request subheader from an A-CPE, the Extended BR subheader contains BW request type set to 1, SID of the A-CPE, Type, and BR. Upon receiving an Extended BR subheader from a centralized scheduling R-CPE, the A-BS shall insert the allocated bandwidth information in CRZUS-MAP IE for which the A-CPE performs US in US CRZ.

7.13.2 Grants

For a CPE, bandwidth requests reference individual FTs while each bandwidth grant is addressed to the CPE's SID, not to individual FTs. Since it is nondeterministic which request is being honored, when the CPE receives a shorter transmission opportunity than expected (scheduler decision, request message lost, etc.), no explicit reason is given. In all cases, based on the latest information received from the BS and the status of the request, the CPE may decide to perform backoff and request again, discard the SDU, or possibly fragment the SDU to fit the allocation.

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A CPE may make use of a US-MAP IE that is broadcast, directed at a multicast polling group of which it is a member, or directed at its SID. In all cases, the US-MAP IE burst profile (e.g., UIUC = 3, 5, or 7) is used, even if the BS is capable of receiving the CPE with a more efficient burst profile. To take advantage of a more efficient burst profile, the CPE should transmit a Bandwidth Request to the BS on its Basic FT using the Bandwidth Request subheader. Unicast polling of a CPE would normally be done by allocating a US-MAP IE directed at its SID. Also note that, in a US-MAP IE directed at its SID, the CPE may make bandwidth requests for any of its connections.

The procedure followed by CPEs is shown in Figure 39. Note that it is the CPE's local scheduler that decides which connections get the granted bandwidth.

7.13.2.1 Grants for a relay network on PHY-OM2

7.13.2.1.1 Bandwidth grant for relay with a distributed scheduling R-CPE

If the bandwidth request comes from a distributed scheduling R-CPE, the A-BS shall address the bandwidth grant to the R-CPE's Basic FT. The distributed scheduling R-CPE may schedule a MAC PDU or relay MAC PDU on the bandwidth allocation it receives.

An A-BS may send its distributed scheduling R-CPEs uplink scheduling information ahead of time via an Relay-SCHE management message. This message indicates when a given uplink bandwidth allocation will be granted to the distributed scheduling R-CPE (i.e., in how many frames), the size of the allocation, and the intended CID. The actual bandwidth grant is issued to the distributed scheduling R-CPE using a Data Grant IE in an upcoming US-MAP. For periodic bandwidth grants, the scheduling information need only be sent once (see Figure 38).

When a distributed scheduling R-CPE receives an Relay-SCHE management message with uplink scheduling information from the A-BS, it shall look up the target A-CPE of the given F. Based on this scheduling information and the target A-CPE of the FT, the distributed scheduling R-CPE can determine the appropriate bandwidth allocations and associated RS UL allocation frame offset on the uplink it controls.

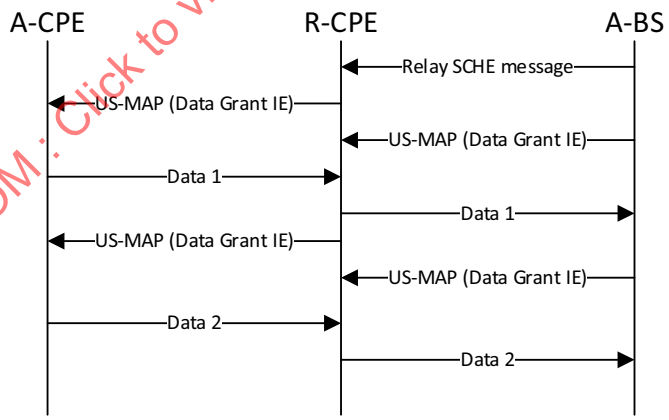

Figure 38—Periodic bandwidth grant with R-CPE scheduling information

7.13.2.1.2 Bandwidth grant for relay with a centralized scheduling R-CPE

For centralized scheduling, when an A-BS allocates bandwidth to forward a packet to/from a given station, it shall allocate bandwidth on all links (relay and access) that make up the path to/from that station taking into account the processing delay and link qualities at each R-CPE.

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7.13.3 Polling

Polling is the process by which the BS allocates to the CPEs bandwidth specifically for the purpose of making bandwidth requests. These allocations may be to individual CPEs or to groups of CPEs. Allocations to groups of connections and/or CPEs actually define bandwidth request contention IEs. The allocations are not in the form of an explicit message, but are contained as a series of IEs within the US-MAP.

Note that polling is done on CPE basis. Bandwidth is always requested on a FT basis and bandwidth is allocated on a CPE basis.

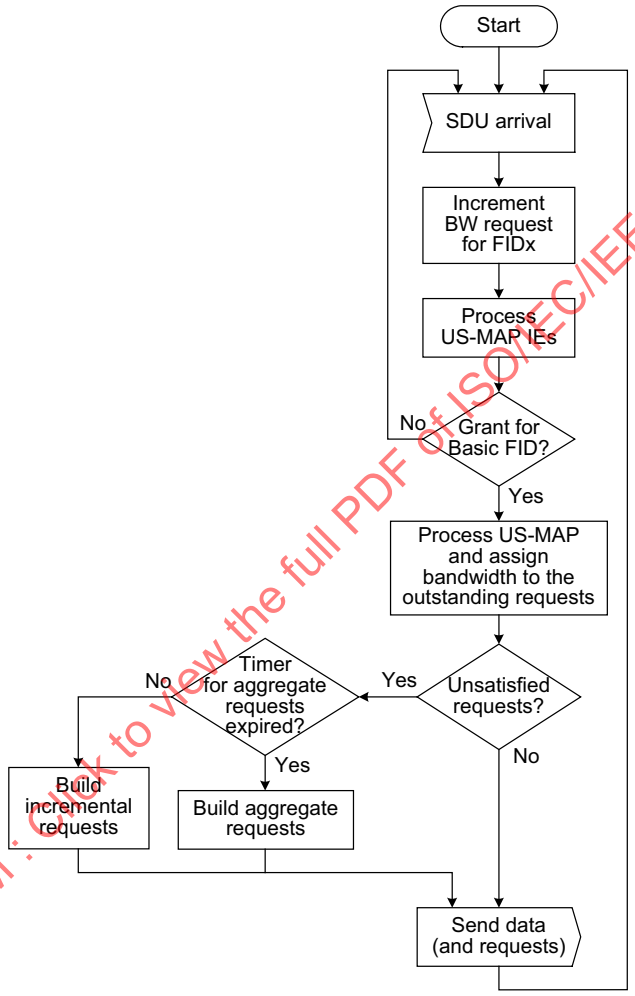

Figure 39—Request/grant mechanism

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7.13.3.1 Unicast

When a CPE is polled individually, no explicit message is transmitted to poll the CPE. Rather, the BS reserves in the US-MAP enough bandwidth for the CPE to respond with a Bandwidth Request. If the CPE does not need bandwidth, the allocation is padded in accordance with 7.10.6. CPEs that have an active UGS connection of sufficient bandwidth shall not be polled individually unless they set the PM bit in the header of a packet on the UGS connection. This saves bandwidth over polling all CPEs individually. Note that unicast polling would normally be done on a per-CPE basis by signaling an allocation in a US-MAP IE (with UIUC = 3, 5, or 7), thereby allowing a CPE to transmit a Bandwidth Request directed at its SID.

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7.13.3.2 Multicast and broadcast

If insufficient bandwidth is available to individually poll many inactive CPEs, some CPEs may be polled in multicast groups or a broadcast poll may be issued. Certain SIDs are reserved for multicast groups and for broadcast, as described in 13.2. As with individual polling, the poll is not an explicit message, but bandwidth allocated in the US-MAP. The difference is that, rather than associating allocated bandwidth with a CPE's Basic FT, the allocation is to the Polling FT (see 13.2) for a multicast group (multicast SID) or Broadcast FT (see 13.2) for the entire cell (Cell SID).

When the poll is directed at a multicast group or via broadcast, a CPE belonging to the polled group may request bandwidth during any request interval allocated to that SID in the US-MAP by a US-MAP IE. In order to reduce the likelihood of collision with multicast and broadcast polling, only CPEs needing bandwidth reply; they shall apply the contention resolution algorithm as defined in 7.15 to select the interval in which to transmit the initial bandwidth request. Zero-length bandwidth requests shall not be used in multicast or broadcast Request Intervals.

The CPE shall assume that the transmission has been unsuccessful if no grant has been received in the number of subsequent US-MAP messages specified by the parameter Contention-based reservation timeout (see 7.9.3.1). If the retransmission of the request is made in a multicast or broadcast opportunity, the CPE continues to run the contention resolution algorithm in . Note that the CPE is not restricted to retransmitting the request in a multicast or broadcast Request Interval only.

7.13.3.3 PM bit

CPEs with currently active UGS connections may set the PM bit (see 7.8.1.2.3) to the BS that they need to be polled to request bandwidth for non-UGS connections. To reduce the bandwidth requirements of individual polling, CPEs with active UGS connections need be individually polled only if the PM bit is set (or if the interval of the UGS is too long to satisfy the QoS of the CPE's other connections). Once the BS detects this request for polling, the process for individual polling is used to satisfy the request. The procedure by which a CPE stimulates the BS to poll it is shown in Figure 40. To minimize the risk of the BS missing the PM bit, the CPE may set the bit in all UGS MAC Grant Management subheaders in the US scheduling interval.

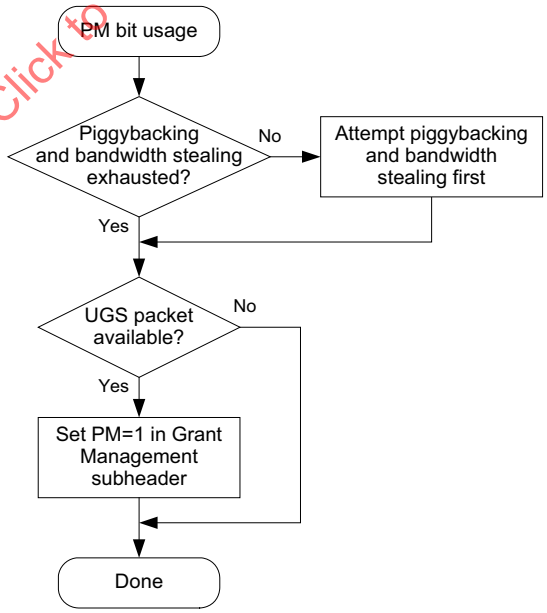

Figure 40—PM bit usage

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7.13.3.4 Polling for a relay network on PHY-OM2

The polling procedure defined in 7.13.3 for the A-CPE and the A-BS may be used between the A-CPE/R-CPE. If an R-CPE is regularly polled, it can transmit a bandwidth request header to the A-BS as soon as it detects impending uplink traffic in order to reduce delay (see Figure 41).

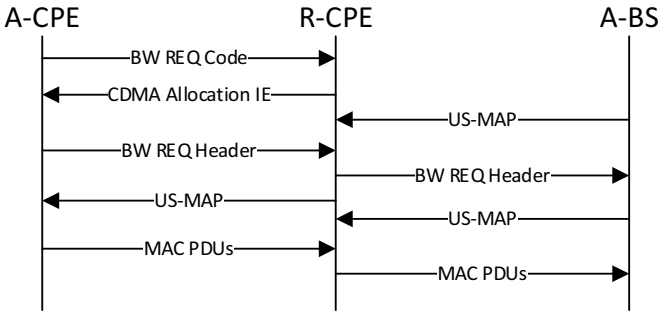

Figure 41—Reducing latency in relaying traffic via R-CPE polling

An A-BS or a distributed scheduling R-CPE may inform a A-CPE of upcoming polling via an Relay SCHE management message (see Figure 42).

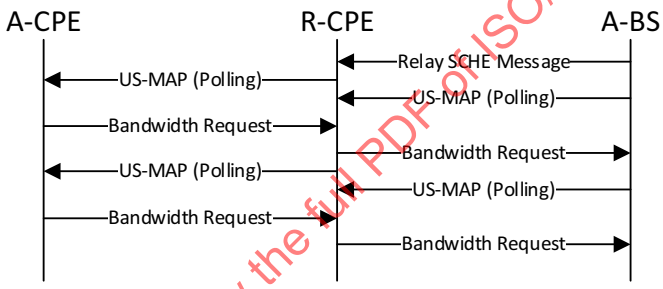

Figure 42—Periodic polling with R-CPE scheduling information

For centralized scheduling, only the A-BS may establish a polling process with a A-CPE or centralized scheduling R-CPE in the MR-cell.

7.14 PHY support

In this subclause, aspects of the MAC that may impact the design of the PHY layer are discussed.

7.14.1 Duplexing

TDD is the only duplexing mode currently supported by this standard.

In TDD, the US and DS transmissions occur at different times and share the same channel. As depicted in Figure 43, a TDD frame in the MAC typically has a fixed duration and contains two subframes: a predominantly DS and a US (see 7.4 for further details). The frame is divided into an integer number of OFDM symbols, which help to partition the bandwidth easily. The TDD framing is adaptive in that the bandwidth allocated to the DS versus the US can vary. The split between US and DS is a parameter that is controlled at higher layers within the system. Note that when multiple WRAN cells have overlapping coverage, they shall share the available bandwidth in frame-based TDMA according to the self-coexistence procedure defined in 7.22.3.2.

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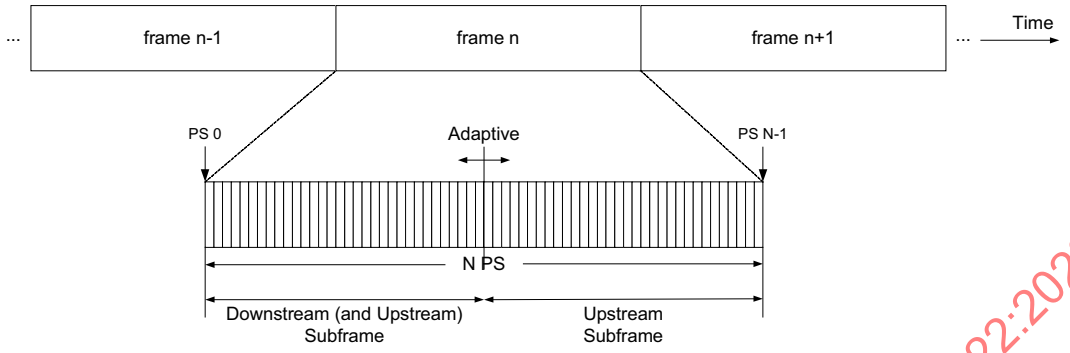

Figure 43—TDD frame structure

7.14.2 DS-MAP

The broadcast message DS-MAP defines the usage of the DS intervals.

7.14.3 US-MAP

The broadcast message US-MAP defines the usage of the US intervals in terms of the offset of the US burst relative to the Allocation Start Time parameter.

7.14.3.1 Timing

The US timing is relative to the beginning of the DS subframe. The Allocation Start Time in the US-MAP is relative to the start of the DS subframe, and is such that the US-MAP references some point in the current frame (see 7.14.3). The CPE shall always adjust its concept of US timing based upon the timing adjustments sent in the RNG-CMD messages.

7.14.3.2 Allocations

The US bandwidth allocation map (US-MAP) employs units of symbols and logical channels (i.e., OFDM slots) to manage resource allocation among CPEs.

7.14.4 MAP timing

The DS-MAP and US-MAP messages provide relative timing information. The following time instants are used as a reference for timing information:

— DS-MAP: The start of the first symbol (including the preamble if present) of the frame in which the message was transmitted.

— US-MAP: The start of the first symbol (including the preamble if present) of the frame in which the message was transmitted plus the value of the Allocation Start Time.

Information contained in both the DS-MAP and US-MAP messages pertain to the current frame (i.e., the frame in which this message was received) as shown in Figure 44.[20] In addition, information carried in the US-MAP pertains to a time interval starting at the Allocation Start Time measured from the beginning of the current frame and ending after the last specified allocation. The Allocation Start Time value shall be equal to

[20] It is important to note that, from a scheduling perspective, allocations specified in a DS-MAP and US-MAP messages shall remain, as much as possible, valid across multiple frames. This way, self-coexistence issues can be best managed.

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the Adaptive TDD (ATDD) split, where ATDD split is the time instant within the frame that divides the DS subframe and the US subframe.

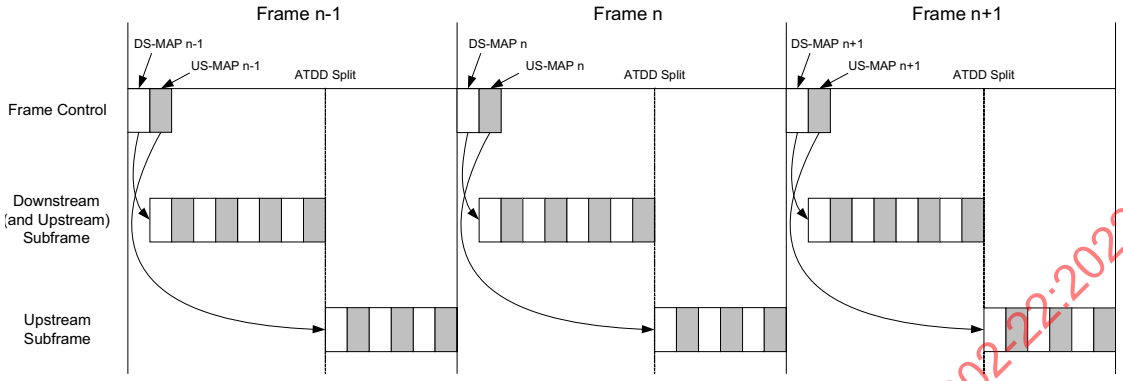

Figure 44—Time relevance of DS-MAP and US-MAP

7.14.5 Channel use policy for the protection of TV incumbents

WRAN CPEs and BSs shall not operate on the same channel or on the first adjacent channels of a TV operation within the TV protected contour. However, they may operate on co-channels or adjacent channels outside this protected contour as long as they are located at sufficient separation distances beyond this protected contour.

Consequently, if there is a TV operation on channel N, a WRAN CPE located within the TV protected contour of that TV station:

- Shall not transmit on channel N–1.
- Shall not transmit on channel N.
- Shall not transmit on channel N+1.
- May be constrained from transmitting on alternate channels (N±2 and beyond), as defined by up-to-date information from the database service.

Furthermore, if there is a TV operation on channel N, a WRAN CPE outside of the TV protected contour of that TV station:

- Shall not transmit on channel N within a separation distance from the TV protected contour.
- Shall not transmit within a separation distance from the TV protected contour on channel N–1.
- Shall not transmit within a separation distance from the TV protected contour on channel N+1.

7.15 Contention resolution

The BS, A-BS, or distributed scheduling R-CPE controls assignments on the US channel through the US-MAP messages and determines which symbol periods are subject to collisions. Collisions may occur during Initial Ranging/Relay Initial Ranging/Local Initial Ranging, Periodic Ranging/Relay Periodic Ranging/Local Periodic Ranging, Bandwidth Request/Relay Bandwidth Request/Local Bandwidth Request, UCS notification/Relay UCS notification/Local UCS notification, and the SCW defined by their respective IEs. The potential occurrence of collisions in the Intervals is dependent upon the number of SIDs whose US-MAP IEs are [simultaneously configures to use an Interval for a specific purpose (e.g., Ranging, UCS notification, BW Request)]. The CPE/A-CPE has to make a decision in order to resolve collision in the US direction for Initial Ranging/Relay Initial Ranging/Local Initial Ranging, Periodic Ranging/Relay Periodic

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Ranging/Local Periodic Ranging, and BW Request/Relay Bandwidth Request/Local Bandwidth Request. Since in the case of UCS notification/Relay UCS notification/Local UCS notification and SCW (CBP packet transmission in the SCW) no explicit feedback is expected to be received from the BS, A-BS, or distributed scheduling R-CPE, collision resolution does not apply.

In the case of Initial Ranging/Relay Initial Ranging/Local Initial Ranging and Periodic Ranging/Relay Periodic Ranging/Local Periodic Ranging, collision resolution is to be done by a CDMA method (see Table 43 and Table 49). In the case of Bandwidth Request/Relay Bandwidth Request/Local Bandwidth Request and UCS notification/Relay UCS notification/Local UCS notification, both those methods, CDMA as well as exponential time backoff, explained later in this subclause, can be used. In the case of collision resolution in the SCW, a special scheduling scheme, described in 7.20.1, shall be used.

Since a CPE/A-CPE may need to service multiple US service flows (each with its own FT), it makes these decisions on a per FT or on a QoS (see 7.19) basis. The method of contention resolution that shall be supported for BW Request/Relay Bandwidth Request/Local Bandwidth Request and UCS notification/Relay UCS notification/Local UCS notification is based on a truncated binary exponential backoff, with the initial backoff window and the maximum backoff window controlled by the BS, A-BS, or distributed scheduling R-CPE (see Table 42). The values, expressed in units of opportunity (see Table 43) are specified as part of the UCD message and represent a power-of-two value. For example, a value of 4 indicates a window between 0 and 15 opportunities; a value of 10 indicates a window between 0 and 1023 opportunities. When a CPE has information to send and wants to enter the contention resolution process, it sets its internal backoff window equal to the BW Request/Relay Bandwidth Request/Local Bandwidth Request or UCS Notification/Relay UCS notification/Local UCS notification Backoff Start defined in the UCD message referenced by the UCD Count in the US-MAP message currently in effect (the map currently in effect is the map whose allocation start time has occurred but which includes IEs that have not occurred).

Note that the number of these opportunities per frame depends on the size of the opportunity window in number of subchannels defined by the US-MAP for UIUC 2 or 3 (see Table 48) and the opportunity size for the BW Request/Relay Bandwidth Request/Local Bandwidth Request and UCS notification/Relay UCS notification/Local UCS notification defined in Table 43. These opportunities shall be mapped horizontally in the time domain and fill a subchannel before moving to the next subchannel as is done for the US data PDU mapping.

The CPE shall randomly select a number within its backoff window. This random value indicates the number of contention transmission opportunities that the CPE shall defer before transmitting. A CPE shall consider only contention transmission opportunities for which this transmission would have been eligible. These are defined by the BW Request or UCS notification IE in the US-MAP messages. Note that each IE may consist of multiple contention transmission opportunities.

Using bandwidth request as an example, consider a CPE whose initial backoff window is 0 to 15 and assume it randomly selects the number 11. The CPE must defer a total of 11 contention transmission opportunities. If the first available US-MAP IE is for 6 requests, the CPE does not use this and has 5 more opportunities to defer. If the next US-MAP IE is for 2 requests, the CPE has 3 more to defer. If the third US-MAP IE is for 8 requests, the CPE transmits on the fourth opportunity, after deferring for 3 more opportunities.

After a contention transmission, the CPE waits for an allocation in a US-MAP IE in a subsequent map. Once received, the contention resolution is complete. The CPE shall consider the contention transmission lost if no data grant has been given within T16 (or no response within T3 for initial ranging). The CPE shall now increase its backoff window by a factor of two, as long as it is less than the maximum backoff window. The CPE shall randomly select a number within its new backoff window and repeat the deferring process described previously.

This retry process continues until the maximum number (i.e., BW Request Retries) of retries has been reached. At this time, the PDU shall be discarded. Note that the maximum number of retries is independent

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of the initial and maximum backoff windows that are defined by the BS. If the CPE receives an allocation in a (unicast) US-MAP IE with UIUC = 3, 5, or 7 at any time while deferring for this FT, it shall stop the contention resolution process and use the explicit transmission opportunity.

The BS has flexibility in controlling the contention resolution. At one extreme, the BS may choose to set up the BW Request/UCS Notification Backoff Start and BW Request/UCS Notification Backoff End to emulate an Ethernet-style backoff with its associated simplicity and distributed nature as well as its fairness and efficiency issues. This would be done by setting the BW Request/UCS Notification Backoff Start = 0 and BW Requestor UCS Notification Backoff End = 10 in the UCD message. At the other end, the BS may make the BW Request/UCS Notification Backoff Start and BW Request/UCS Notification Backoff End identical and frequently update these values in the UCD message so that all CPE are using the same, and hopefully optimal, backoff window.

7.15.1 Transmission opportunities

A transmission opportunity is defined as an allocation provided in a US-MAP or part thereof intended for a group of CPEs authorized to transmit initial ranging requests/relay initial ranging requests/local initial ranging requests, periodic ranging requests/relay periodic ranging requests/local periodic ranging requests, bandwidth requests/relay bandwidth requests/local bandwidth requests, or UCS notifications/relay UCS notifications/local UCS notifications. This group may include either all CPEs that have an intention to join the cell or all registered CPEs or a multicast polling group. The number of transmission opportunities associated with a particular IE in a map is dependent on the total size of the allocation as well as the size of an individual transmission.

The size of an individual transmission opportunity for each type of contention IE shall be published in each transmitted UCD message. The BS may allocate bandwidth for contention IEs. When it does so, it shall use integer multiples of the published values.

7.16 Initialization and network association

Before a CPE can enter the network, it needs to be serviced by a BS and its capabilities need to be negotiated with the BS. This may involve many tasks (e.g., geolocation and sensing channels) and handshaking between the CPE and the BS, and this whole procedure is hereby referred to as initialization and network association. More importantly, during this process the BS needs to minimize the CPE communication so as potentially not to cause harmful interference with incumbents. In other words, the initialization and network association process is *incumbent safe*, which essentially means that incumbent system protection shall be maximized.

7.16.1 BS initialization

The WRAN BS initialization procedure shall consist of the following steps:

1) BS is professionally installed.
2) BS acquires the antenna gain information.
3) Determine the BS geographic location.
4) If a database service exists for BS area of service, the SM at the BS receives an initial list of available channels from the database service. If there is no database service, the SM initially considers all channels available.
5) Operator disallows channels on the available channel list as needed.
6) Perform incumbent detection in all usable channels and synchronize network to neighboring BSs.
7) Presentation of the available channel list to the higher layers for selection of an operating channel.

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8) Commence operation on the selected operating channel(s).

This BS initialization procedure is depicted in Figure 45.

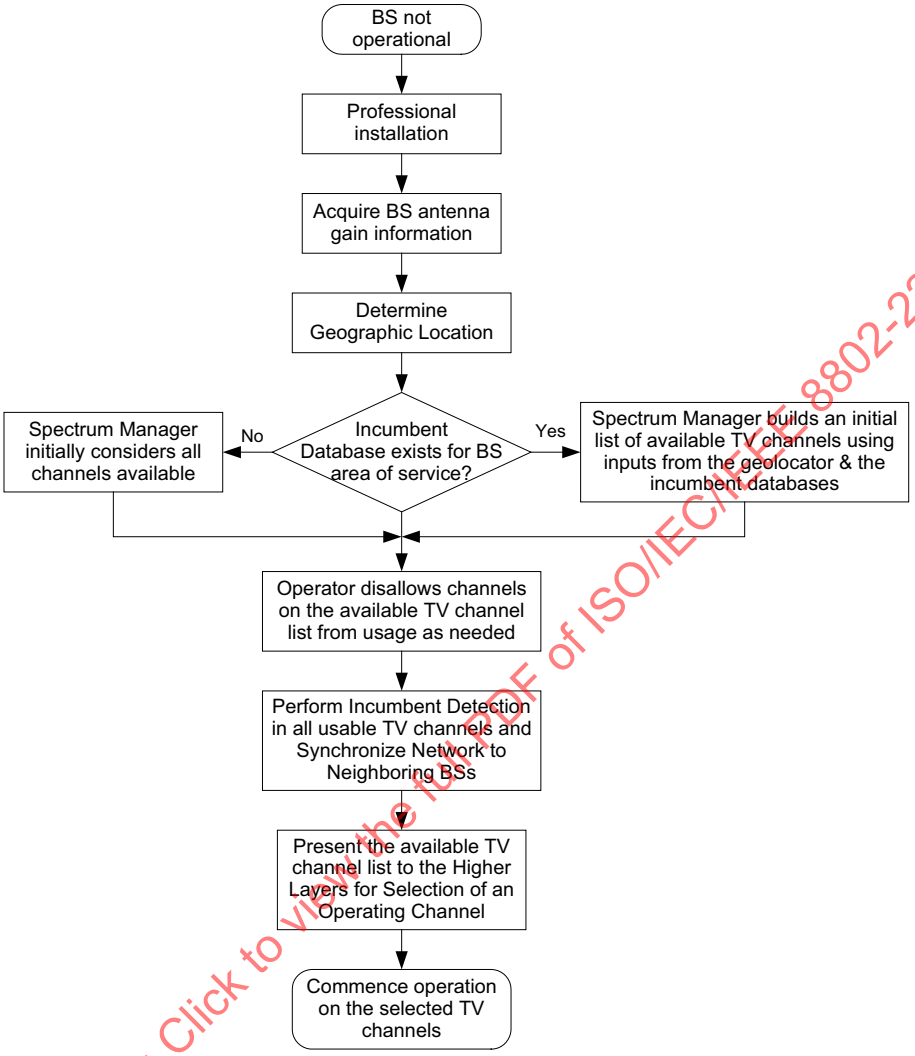

Figure 45—BS initialization procedure

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7.16.1.1 Professional installation

The BS shall be installed by a professional who will be responsible for assuring that its installation is compliant with local regulations (see Annex A) and IEEE Std 802.22.2-2012.[21] The professional installer should make sure that the antenna pattern meets the pattern specified in 9.12.1 and that the antenna is directed toward the selected BS.

7.16.1.2 BS antenna gain information acquisition

The BS shall determine if its antenna is integrated or not by querying it using the M-ANTENNA-INTEGRATED primitive structure described in 15.2.1.6.1 and 15.2.1.6.2. The BS shall acquire the antenna information including the maximum antenna gain information for the channels that can be used in the

[21] IEEE publications are available from the Institute of Electrical and Electronics Engineers (http://standards.ieee.org).

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regulatory domain of interest. This information is stored in a MIB, *wranIfBsCpeAntennaGainTable*. If the antenna is integrated to the BS TRU, this MIB object shall be pre-populated by the manufacturer of the BS. If the antenna is not integrated into the BS TRU, the MIB object shall be populated by querying the antenna unit (AU) through the interface defined in 9.12.2. This information at the antenna shall be pre-populated by the antenna manufacturer.

7.16.1.3 Determine geographic location

The geolocation requirement for the BS is that the WRAN system shall know the latitude and longitude of the BS transmitting antenna within a radius of 15 m and its altitude above mean sea level. The BS geographic location information shall be stored in the BS memory.

7.16.1.4 Access TV bands database service and receive list of available channels

The BS shall access a TV bands database service if one exists.

The BS SM communicates with the TV bands database service using the primitives that are defined in 15.2.1.3. Each WRAN device shall enlist with the TV bands database service by providing information that is required for access to the TV bands. The BS SM, which shall act as a proxy for all of its registered client devices, shall perform enlistment using the M-DEVICE-ENLISTMENT primitives. Each instance that a device is required to get a new set of available channels, the BS SM shall provide its geographic coordinates or those of one of its registered client devices to the TV bands database service using the M-DB-AVAILABLE-CHANNEL-REQUEST primitive. The BS shall receive the available channels from the TV bands database service using the M-DB-AVAILABLE-CHANNEL-INDICATION primitive. The SM shall generate the composite available channel list using only those channels that have been indicated as available for every device on the network.

The BS shall prohibit WRAN operation on any channel not on this initial list of available channels.

7.16.1.5 Operator disallows channels

Access shall be provided for the operator to disallow channels that are listed on the available channel list from being selected for WRAN operation. The operator shall not have access to channels that are not listed on the available channel list. To further classify channels on the available list, the BS SM shall submit an M-AVAIL-TV-CH-REPORT primitive with the mode set equal to 1 to provide the available channel list to the higher layers. Once channels on the available channel list are further classified as disallowed, the SM shall receive an M-DISALLOWED-TV-CHS primitive submitted by the SM.

7.16.1.6 Perform incumbent detection and synchronize network with neighboring networks

The BS shall perform incumbent detection in each of the channels listed on the available channel list and each adjacent channel if its EIRP is beyond the limit specified by the regulatory domain classes in Annex A (e.g., 40 mW in the USA) to detect other legitimate incumbent services that do not exist in the database service. The BS's SM shall use the output from the BS spectrum sensing function to identify occupied channels on the available channel list.

The BS shall perform neighboring IEEE 802.22 network discovery on selected channels according to 7.22.1.3. The BS shall synchronize with neighboring BSs using its installed satellite-based geolocation technology.

7.16.1.7 Present the available channel list to the higher layers

After incumbent detection during which channels may have been identified as protected or occupied, the resulting list shall be presented to the higher layers using an M-AVAIL-TV-CH-REPORT primitive with the

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mode set equal to 2 for selection of an operating channel. The required information presented shall be each channel number that is available for the BS to commence WRAN service and the maximum allowed EIRP for each channel. Additional information can be provided to the higher layers to help with the selection of an optimal channel, such as a list of channels where other wireless services were detected during the incumbent detection stage. As a result of the selection from the higher layer, the SM shall receive an M-OPERATING-TV-CH primitive from the NCMS.

7.16.1.8 Commence operation

The BS may now commence operation on any one channel listed on the available channel list.

7.16.2 CPE initialization

Figure 46 illustrates a scenario where the need for the definition of an incumbent safe CPE initialization can be easily seen. In this figure, consider that CPE 4 is powered down whereas the BS is transmitting in the cell that is under normal operation. Further, assume that the TV station in Figure 46 is powered up and starts transmitting in the same channel (i.e., channel #N in this example) that is being used by the BS for its transmissions in the cell. CPE 4 should be capable of detecting that the BS is operating in a channel that is occupied by an incumbent service. The BS must be capable of determining if CPE 4 is located within interference range of the TV station protected contour (i.e., in the keep-out region). If the CPE4 is already registered with the BS, it will alert the BS. If the CPE4 is not registered with the BS, it shall not transmit. See 11.2.5, policies 5 and 6. In response to the alert from the CPE, the SM at the BS may or may not decide to switch channel to accommodate the CPE (see 11.2.6.6). The purpose of the sensing and geolocation capabilities of the WRAN system shall be to prevent harmful interference to the primary TV service by providing the necessary information to the BS's SM that generates the list of available channels. The definition of an incumbent safe CPE initialization phase is critical for cognitive radio systems. The SM incorporates algorithms to address this need (see Table 315, policies 5 and 6).

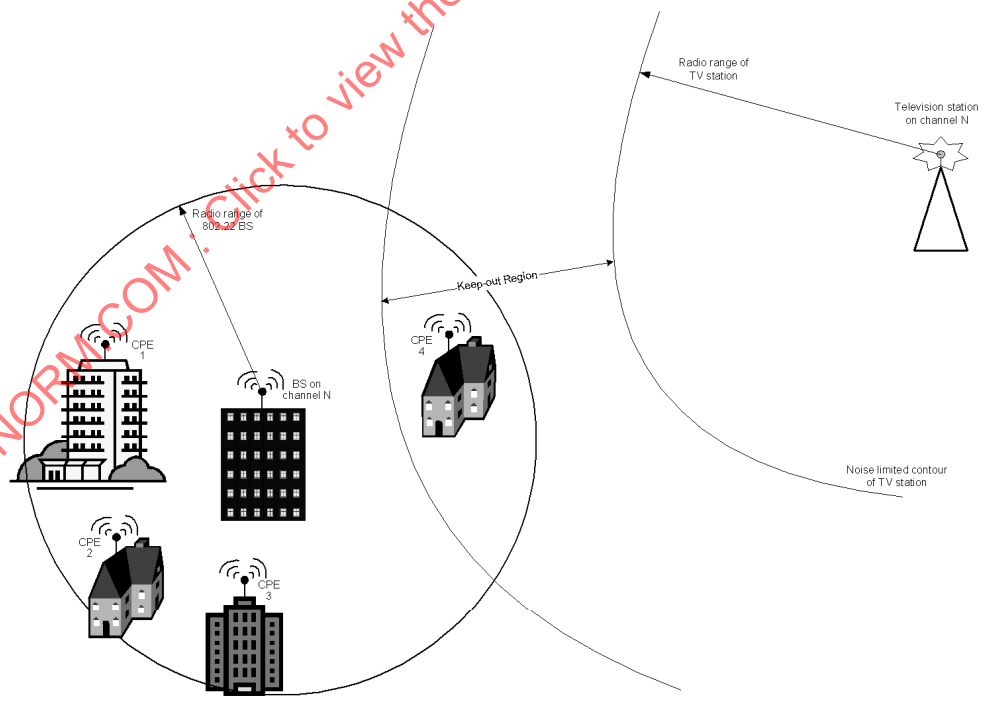

Figure 46—Scenario where a safe bootstrap operation is required to protect incumbents

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First and foremost, the MAC does not presuppose any preassigned channel where a CPE is able to look for a BS given the time-varying and unpredictable nature of channel occupancy. Hence, the first task a CPE shall perform in attempting to join a network is to scan the set of channels for BSs and incumbent services on which the transmissions of the CPE might interfere. Since the BS shall send concentrated OFDM symbols composed of a superframe preamble, a frame preamble and an SCH once every superframe in its operating channel (see 7.3), the CPE will recognize the existence of a BS transmission and, if appropriate, proceed with the CPE initialization procedure with the corresponding BS.

a) The procedure carried out by the BS and the CPE to perform CPE network entry and initialization shall be as follows:

b) CPE performs self test.

c) CPE acquires the antenna gain information.

d) CPE senses for and synchronizes to WRAN services. The sensing thread also begins during this step to detect broadcasting incumbents.

e) CPE presents sensing results to the higher layers.

f) CPE chooses a WRAN service.

g) CPE acquires valid geolocation data from the satellites. If the data acquisition is unsuccessful, CPE initialization shall not continue.

h) CPE acquires the DS and US parameters from the selected WRAN service.

i) CPE directional antenna azimuth adjustment.

j) If channels N and N ±1 pass the sensing and timing requirements, BS and CPE perform initial ranging (see 7.17.2.1).

l) CPE transmits basic capabilities. If all required basic capabilities are present in the CPE, the AAA authenticates the CPE and key exchange is performed; otherwise, the CPE does not proceed to registration and the BS de-registers the CPE.

m) Perform Registration (REG-REQ/RSP). Registration entails the following:

   1) Exchange and verification of CPE NMEA string

   2) Configuration of CPE operational parameters including configuration of IP version to be used by the CPE.

n) Upon completing registration, BS transmits channel sets to CPE.

o) Establish IP connectivity.

p) Establish time of day.

q) Transfer operational parameters.

r) Establish dynamic service flows.

s) CPE reports sensing results and discovered neighboring networks.

Figure 47 summarizes the network entry of the CPE and its initialization procedure. Note that these steps taken by the CPE consist of a set of actions and error verification. In the following subclauses, a more detailed description of these steps and their individual responsibilities are provided.

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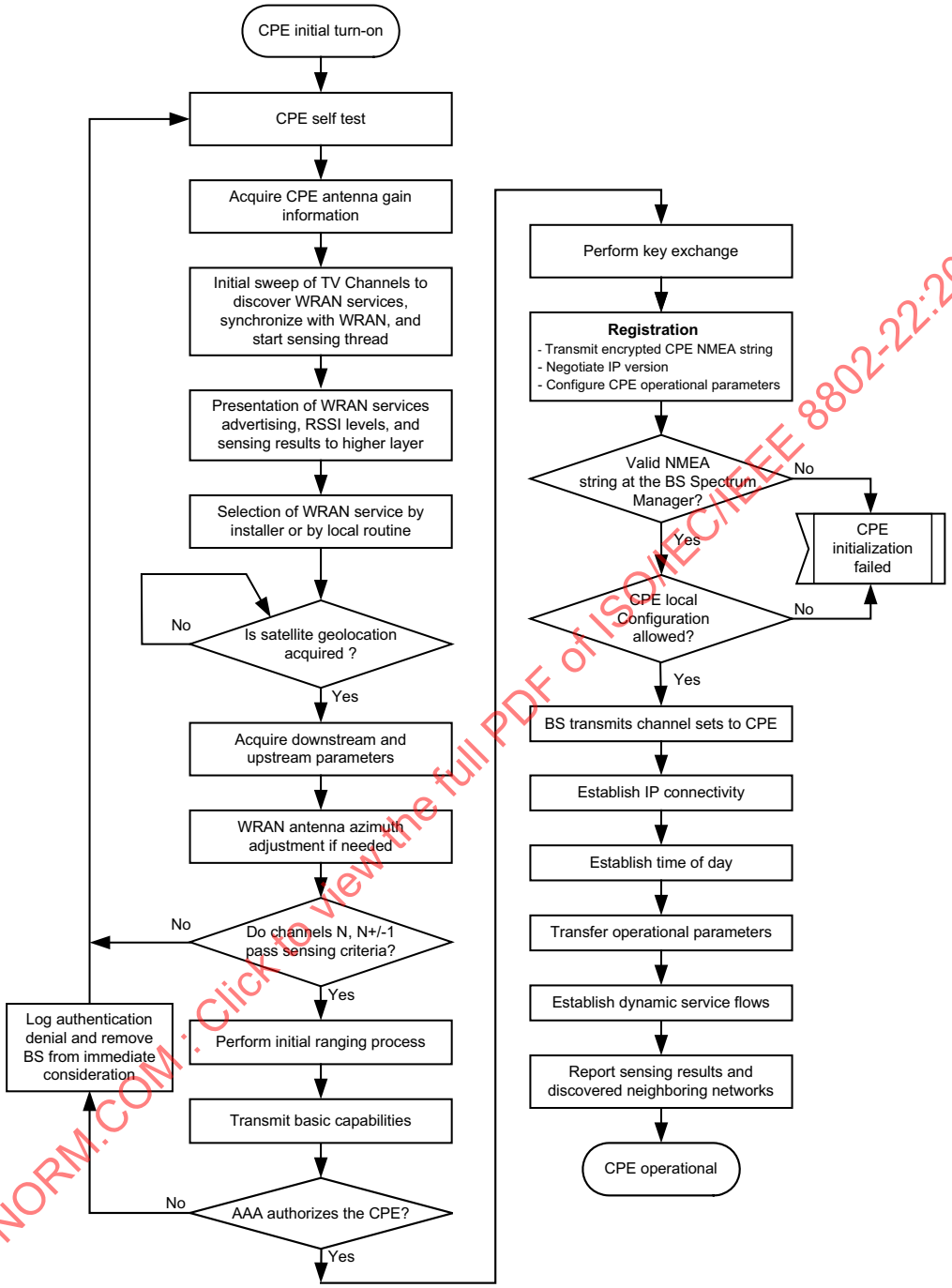

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Figure 47—CPE initialization procedure

7.16.2.1 CPE performs self test

On initialization or after signal loss, the CPE shall perform a self test.

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7.16.2.2 CPE antenna gain information acquisition

The CPE shall determine if its antenna is integrated or not by querying it using the M-ANTENNA-INTEGRATED primitive structure described in 15.2.1.6.1 and 15.2.1.6.2. The CPE shall acquire the antenna information including the maximum antenna gain information for the channels that can be used in the regulatory domain of interest. This information is stored in a MIB, *wranIfBsCpeAntennaGainTable*. If the antenna is integrated to the CPE TRU, this MIB object shall be pre-populated by the manufacturer of the CPE. If the antenna is not integrated into the CPE TRU, the MIB object shall be populated by querying the AU through the interface defined in 9.12.2. The information at the antenna shall be pre-populated by the antenna manufacturer.

7.16.2.3 CPE senses for and identifies WRAN services and incumbents

The CPE shall perform spectrum sensing to detect the BS and to detect and identify legitimate incumbent services that are to be protected on each active WRAN channel in the area and its adjacent channels as described in 11.3.2.

7.16.2.4 Present sensing results to the higher layers

As a result of spectrum sensing, the available BSs in the area are presented to the application layer program via connection C2 and MIBs through M-SAP as shown in IEEE 802.22 reference architecture (Figure 7). The application may be running on the CPE or on an attached computer. The data presented includes the operating channel of the BS and RSSL in addition to the WRAN service being advertised.

7.16.2.5 CPE chooses a WRAN service

A WRAN service is selected at the higher layers of the CPE after preliminary sensing and identification of available BSs and the presence of incumbents in the area as the previous subclauses describe. The CPE SSA shall issue an M-WRAN-SERVICE-REPORT-REQUEST primitive to request the higher layers through the NCMS to select a channel from the available WRAN service list that is included in the primitive, as described in 15.2.1.5.1. The SSA shall receive an M-WRAN-SERVICE-REPORT-CONFIRMATION primitive with the selected channel from the NCMS, as described in 15.2.4.5.3. Once the channel is selected, it and its adjacent channels are more rigorously sensed in order to detect the presence of a weak incumbent service that might be masked by the selected WRAN service. This procedure is described in more detail in 11.3.2.

7.16.2.6 CPE performs satellite-based geolocation

The CPE shall acquire geolocation data from a satellite-based geolocation receiver. A CPE shall not progress to the next step of initialization until the satellite-based geolocation technology successfully establishes lock and acquires valid geolocation data from the satellites. The CPE sends the NMEA string to the BS during registration (see 7.16.2.11).

7.16.2.7 Acquire downstream and upstream parameters

7.16.2.7.1 Obtaining downstream parameters

The MAC shall search for the SCH from the BS, which indicates the beginning of the superframe in normal mode, and the first allocated frame of the superframe in self-coexistence mode. To improve the joining latency, the CPE shall use energy detection to help ascertain about the presence/absence of an IEEE 802.22 BS in a particular channel. If the energy detected is below the detection threshold, the CPE can safely move to the next channel.

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After having received an SCH in a channel, the CPE shall perform sensing not only in the set of channels indicated in the SCH, but also in all other affected channels. During this sensing, the CPE shall attempt to identify incumbent operation. If incumbents are detected on the operating channel or either first adjacent channel, the MAC shall cause the CPE to cease transmitting application traffic on the channel and, at the first transmit opportunity send a short control message to the BS indicating that it is using a channel occupied by an incumbent. In case the BS receives such notification, it may take numerous actions as described in Figure 130. The aggregate duration of the short control messages shall not exceed the Channel Closing Transmission Time (see Table 388) of transmissions by the WRAN system before remedying the interference condition (changing channels, backing off transmit EIRP, terminating transmissions, etc.).

Provided no incumbents are found, the CPE may proceed to the next step. Here, the MAC shall search for the DS-MAP MAC management messages. The CPE achieves MAC synchronization once it has received at least one DS-MAP message. A CPE MAC remains in synchronization as long as it continues to successfully receive the SCH, DS-MAP, and DCD messages for its channel(s). If the Lost DS-MAP Interval (Table 335) has elapsed without a valid DS-MAP message or the T1 interval (Table 335) has elapsed without a valid DCD message or Lost SCH counts of SCH are missed, a CPE shall try to re-establish synchronization. The process of acquiring synchronization is illustrated in. The process of maintaining synchronization is illustrated in Figure 49.

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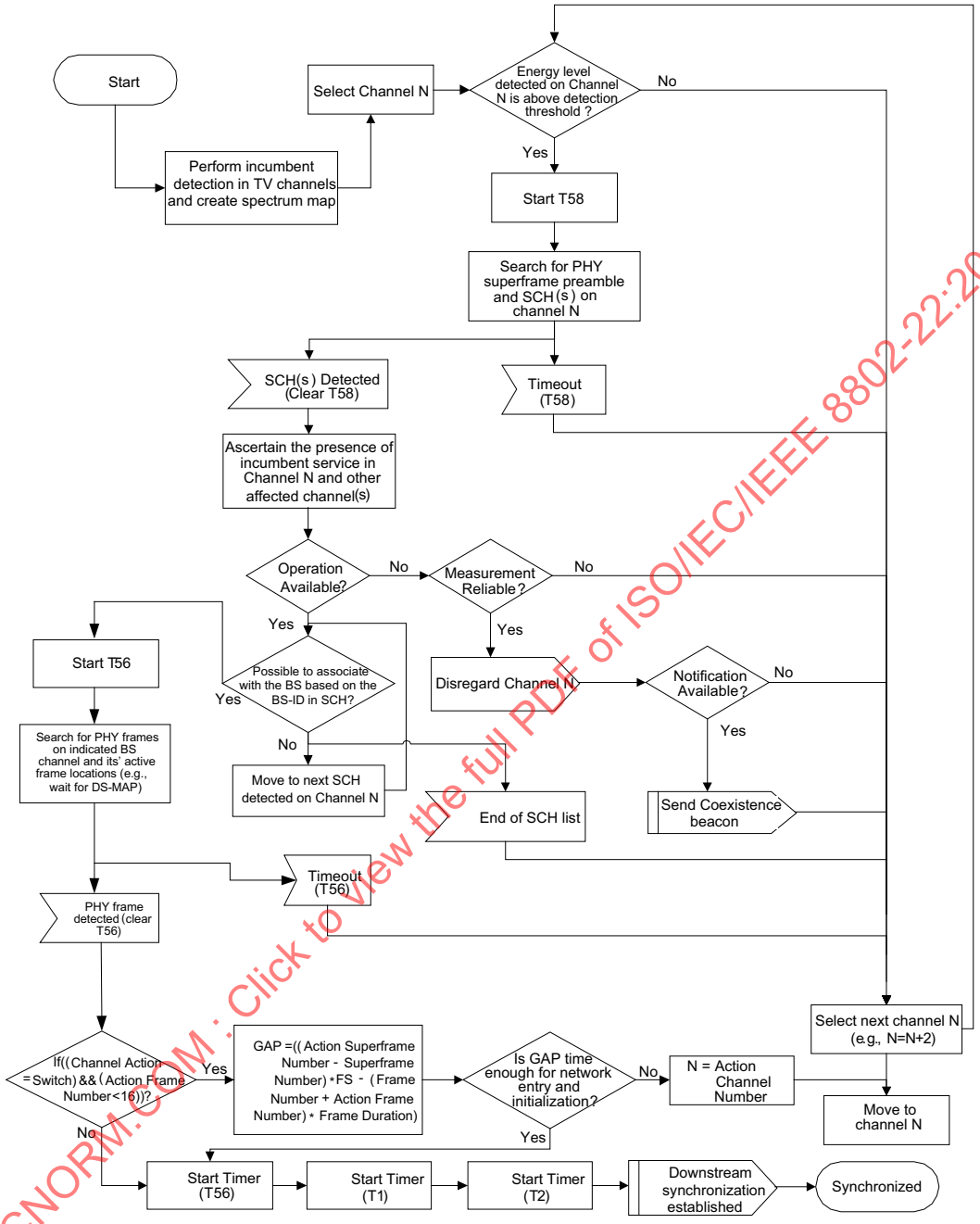

Figure 48—Obtaining downstream parameters

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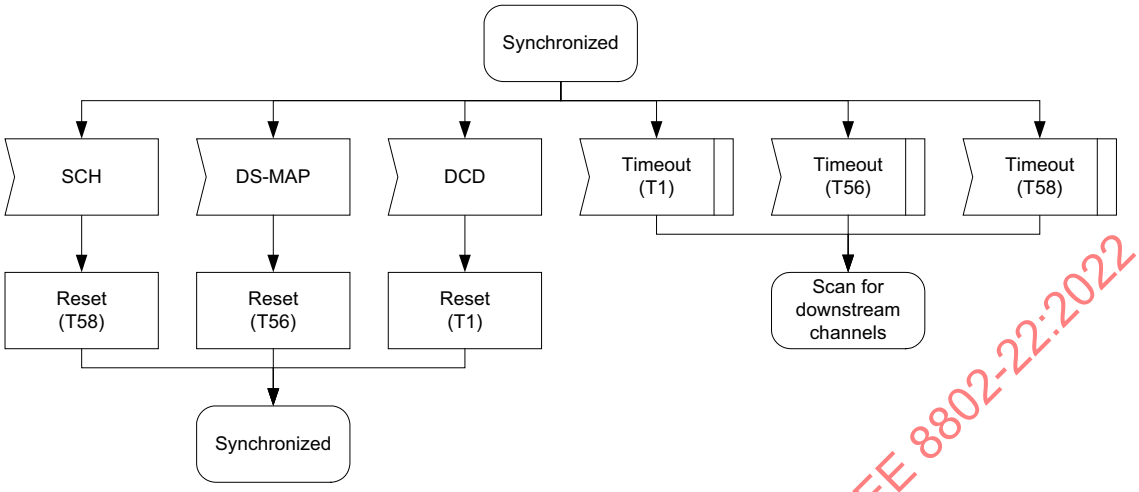

Figure 49—Maintaining downstream parameters

7.16.2.7.2 Obtaining upstream parameters

After synchronization, the CPE shall wait for a UCD message from the BS in order to retrieve a set of transmission parameters for a possible US channel. These messages are transmitted periodically from the BS for all available US channels and are addressed to the MAC broadcast address.

If no US channel can be found after a suitable timeout period, then the CPE shall continue scanning to find another DS channel. The process of obtaining US parameters is illustrated in Figure 50.

The CPE shall determine from the channel description parameters whether it may use the US channel. If the channel is not suitable, then the CPE shall continue scanning to find another DS channel. If the channel is suitable, the CPE shall extract the parameters for this US from the UCD. It then shall wait for the next DS-MAP message and extract the time synchronization from this message. Then, the CPE shall wait for a bandwidth allocation map for the selected channel. It may begin transmitting US in accordance with the MAC operation and the bandwidth allocation mechanism.

The CPE shall perform initial ranging at least once. If initial ranging is not successful, the procedure is restarted from scanning to find another DS channel.

The CPE MAC is considered to have valid US parameters as long as it continues to successfully receive the SCH, US-MAP, and UCD messages. If at least one of these messages is not received within the time intervals specified in Table 335, the CPE shall not use the US. This is illustrated in Figure 51.

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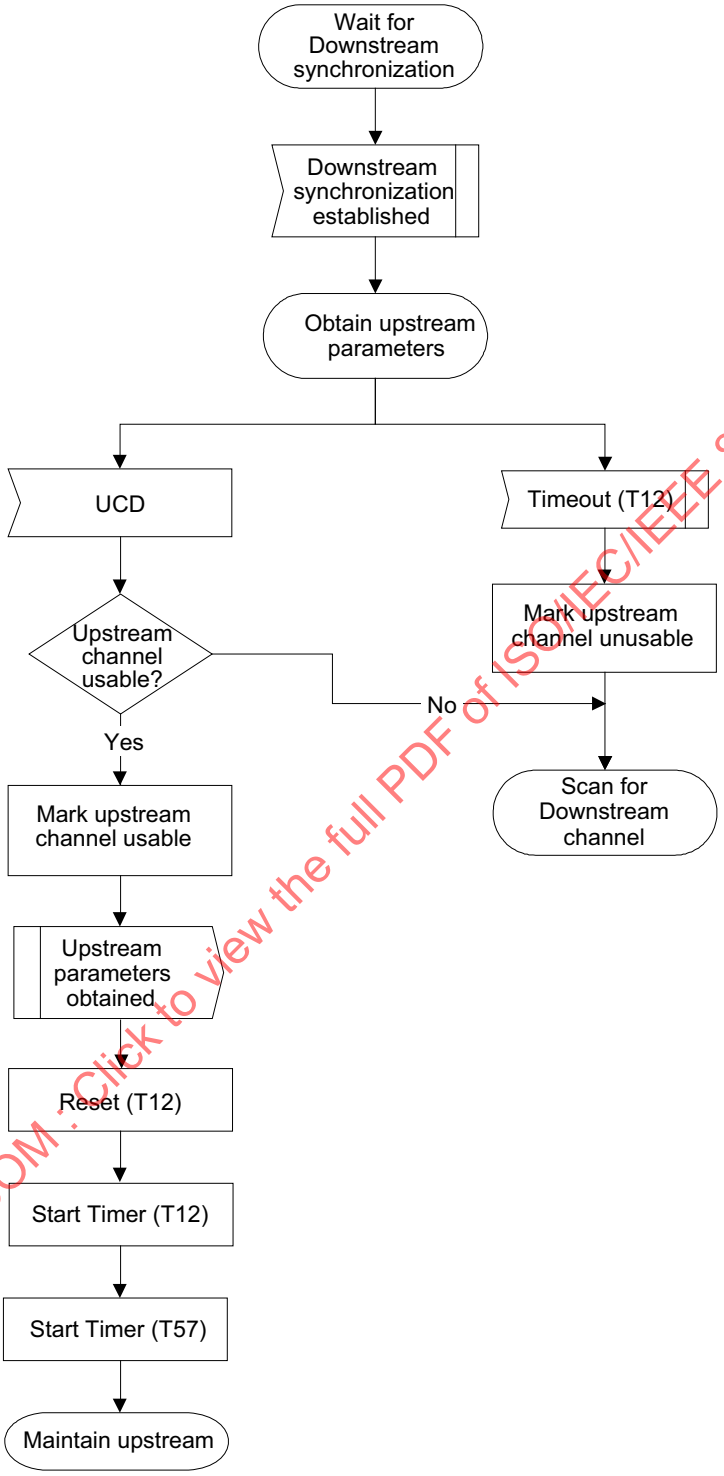

Figure 50—Obtaining upstream parameters

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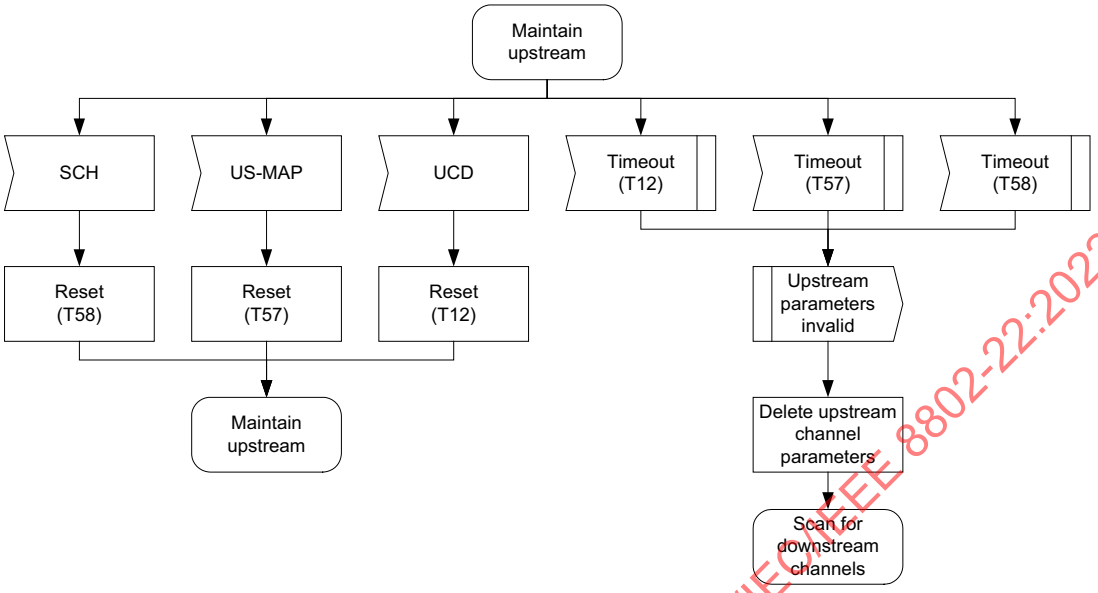

Figure 51—Maintaining upstream parameters

7.16.2.8 CPE transmits ranging/CDMA burst

The selected channel is analyzed to determine if it passes the restrictions specified in 11.3.2. If the selected channel does not pass these restrictions, the association with the selected BS is unsuccessful and the selected channel shall be removed from further consideration. Available BSs are again presented to the higher layers for selection if there exist any other BSs with which to associate.

Next the selected channel and the channels that could be harmfully interfered by operation on this selected channel shall be more finely sensed as to determine if there exists a weak protected incumbent signal that was not detected at an earlier stage in the CPE initialization procedure. This process is described in 11.3.2.

Time in this subclause shall be referenced to two positions in space. One position will be that of the BS and the other position will be that of the CPE. Many such CPE positions will exist. Ranging is the process of acquiring the correct timing offset and EIRP adjustments such that the CPE's transmissions are aligned at the BS position. Ranging also adjusts transmit EIRP of the various CPEs such that the OFDMA signal received at the BS arrives with compatible amplitudes from all the CPEs. The timing delays through the PHY shall be constant to within 25% of the shortest symbol cyclic prefix as indicated in 9.9.1.

7.16.2.8.1 CDMA initial ranging and automatic adjustments

First, a CPE shall synchronize to the DS superframe and frame preamble. At this point, the CPE shall scan the US-MAP message to find an Initial Ranging Interval. The BS may allocate an Initial Ranging Interval consisting of one or more transmission opportunities. The CPE shall extract the number of initial ranging codes (see Table 43, element ID 150) from the UCD MAC management message.

The CPE randomly selects the CDMA code as described in 7.17.2.1 and sends the initial ranging CDMA code on the US allocation dedicated for that purpose. The BS receives the CDMA code. As many CPEs may contend for ranging, the CDMA code received may be the sum of many CPE transmissions. The BS isolates each of these transmissions and computes the ranging adjustments based on the relative time of arrival of

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each CPE US burst, i.e., the timing offset, so that all these bursts arrive at the BS at the beginning of the symbol period within sufficient tolerance.

Ranging adjusts each CPE's timing offset such that each CPE appears to be co-located with the BS. The CPE shall set its initial timing offset to "zero advance" as if it was physically co-located with the BS. When the Initial Ranging transmission opportunity occurs, the CPE shall send a CDMA code. After reception and decoding of this CDMA code, the BS will react by sending a RNG-CMD MAC message in a following frame with the same CDMA code and indicate the timing advance that the CPE should use for its US transmissions (see Table 63) so that the beginning of its bursts is aligned with the center of the cyclic prefix within the tolerance indicated in 9.9.1.

When the Initial Ranging transmission opportunity occurs, the CPE shall send a CDMA code. Thus, the CPE sends the message as if it were co-located with the BS.

The CPE shall calculate the transmit EIRP per subcarrier for initial ranging, $EIRP_{IR_CPE}$, from Equation (1):

$$EIRP_{IR_CPE} = EIRP_{BS} + RSS_{IR_BS_nom} - (RSS_{IR_CPE} - G_{RX_CPE}) + 10\times\log(N_{IR_sub}/1680) \quad (1)$$

where

$RSS_{IR_BS_nom}$ and $EIRP_{BS}$	are defined in a DCD IE (see Table 30)
G_{RX_CPE}	is the antenna gain at the CPE
RSS_{IR_CPE}	is the RSSL measured by the CPE, which is then corrected by the CPE antenna gain to represent the RSSL for an isotropic antenna
N_{IR_sub}	is the number of subcarriers used by the CPE for initial ranging

NOTE—The value of $RSS_{IR_BS_nom}$ corresponds to the nominal signal strength that should be measured at the output of a 0 dBi gain receive antenna at the BS for normal operation. The $EIRP_{BS}$ is the equivalent isotropic radiated power of the BS in the direction of the CPE, which would be computed for a simple single-antenna transmitter as $P_{TX_BS} + G_{TX_BS}$, where P_{TX_BS} is the transmit power and G_{TX_BS} is the BS transmit antenna gain in the direction of the CPE.[22]

The CPE shall send a CDMA code with a power level resulting in the $EIRP_{IR_CPE}$ per subcarrier. If the CPE does not receive a response after waiting at least one frame to allow processing at the BS, the CPE shall send a new CDMA code at the next appropriate Initial Ranging transmission opportunity with 1 dB higher power level. The CPE shall, however, stop increasing the power level at the following condition shown in Equation (2):

$$EIRP_{IR_MAX} + 10\times\log(N_{IR_sub}) > EIRP_{CPE_MAX} \quad (2)$$

where

$EIRP_{CPE_MAX}$	is the upper bound in maximum transmitted EIRP for the CPE on the current operating channel as described in Table 128 or 4 W, whichever is the smallest
$EIRP_{IR_CPE_MAX}$	is the upper bound for the increased $EIRP_{IR_CPE}$

[22] If the BS antenna is not omni-directional, this single $EIRP_{BS}$ value provided in the DCD may at first sight not be sufficient but the process for calculating the initial ranging CPE EIRP level will be self-correcting. The actual EIRP towards the CPE would be reduced by the directivity of the transmit antenna in the direction of the CPE. As a result, the CPE will assume that the additional loss is due to the RF path and it will try to compensate for it by increasing its EIRP on the US. Such higher EIRP will then compensate for the receive antenna discrimination toward the CPE if the same directional antenna with the same azimuth is used for reception. This will result in the proper signal level reaching the BS receiver.

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If the CPE receives a RNG-CMD message containing the parameters of the code it has transmitted and the status "continue," it shall consider the transmission attempt unsuccessful but implement the corrections specified in the RNG-CMD and issue another CDMA code after the appropriate backoff delay. If the CPE receives a US-MAP containing a CDMA allocation IE with the parameters of the code it has transmitted, it shall consider the RNG-CMD reception successful, and proceed to send a unicast RNG-REQ (on Initial Ranging FT, allocated to Cell SID) on the allocated BW.

Once the BS has successfully received the RNG-REQ message, it shall return a RNG-CMD message using the initial ranging connection (see 13.2). Within the RNG-CMD message shall be the Station ID (SID) assigned to this CPE. The message shall also contain information on the required CPE EIRP level, offset frequency adjustment as well as the proper timing advance when needed. At this point the BS shall start using invited Initial Ranging Intervals addressed to the CPE's Basic FT to complete the ranging process, unless the status of the RNG-CMD message is "success," in which case the initial ranging procedure shall end.

If the status of the RNG-CMD message is "continue," the CPE shall wait for an individual Initial Ranging Interval assigned to its Basic FT. Using this interval, the CPE shall transmit another RNG-REQ message using the Basic FT along with any power level and timing offset corrections.

The BS shall return another RNG-CMD message to the CPE with any additional fine-tuning required. The ranging request/response steps shall be repeated until the response contains a "Ranging Successful" notification or the BS aborts ranging. Once successfully ranged (timing, frequency and EIRP are within tolerance at the BS), the CPE shall join normal data traffic in the US. In particular, the retry counts and timer values for the ranging process are defined in Table 335.

NOTE 1—The burst profile to use for any US transmission is defined by the Upstream Interval Usage Code (UIUC). Each UIUC is mapped to a burst profile in the UCD message.

NOTE 2—The BS shall allow the CPE sufficient time to have processed the previous RNG-CMD (i.e., to modify the transmitter parameters) before sending the CPE a specific ranging opportunity. This is defined as CPE Ranging Response Processing Time in Table 335.

On receiving a RNG-CMD instruction to move to a new channel during initial ranging, the CPE shall obtain a new SID via initial ranging and registration.

It is possible that the RNG-CMD may be lost after transmission by the BS. The CPE shall recover by timing out and reissuing its Initial RNG-REQ. Since the CPE is uniquely identified by the source MAC address in the Ranging Request, the BS may immediately reuse the SID previously assigned. If the BS assigns a new SID, it shall immediately age out the old SID and associated CPE.

7.16.2.8.2 Ranging parameter adjustment

Adjustment of local parameters (e.g., transmit EIRP) in a CPE as a result of the receipt or non-receipt of a RNG-CMD message is considered to be implementation-dependent with the following restrictions:

a) All parameters shall be within the approved range at all times.

b) EIRP adjustment shall start from the initial value selected with the algorithm described in 7.16.2.8.1 unless a valid EIRP setting is available from non-volatile storage, in which case this value may be used a the starting point.

c) EIRP adjustment shall be capable of being reduced or increased by the specified amount in response to the RNG-CMD messages.

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d) If, during initialization, EIRP is increased to the maximum value as determined in 7.16.2.8.1 without a response from the BS, it shall go back to the minimum EIRP and ramp up to its maximum EIRP four (4) times before aborting the ranging process with this BS.

On receiving a RNG-CMD message, the CPE shall not transmit until the RF signal has been adjusted in accordance with the RNG-CMD and has stabilized.

7.16.2.9 CPE transmit basic capabilities

Immediately following the completion of initial ranging, the CPE informs the BS of its basic capabilities by transmitting a CBC-REQ message (see Table 125) with its capabilities set to "on" (see Figure 52). Note that T18 is a timer used to wait for CBC-RSP timeout and the default value is indicated in Table 333.

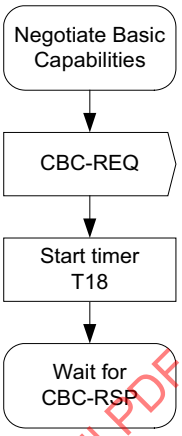

Figure 52—Negotiate basic capabilities—CPE

The BS responds with a CBC-RSP message (see) with the intersection of the CPE's and BS's capabilities set to "on" (see Figure 54 and Figure 54, respectively). The timer T9 refers to the time allowed between the BS sending a RNG-CMD to a CPE, and receiving a CBC-REQ from that same CPE, and the minimum value is specified in Table 333. Note that the CPE capability information is presented in 7.9.7.3.4. When T9 expires, the SID assigned during ranging shall be aged out and the CPE shall have to attempt ranging process over again while not exceeding the maximum number of CDMA ranging retries indicated in Table 335.

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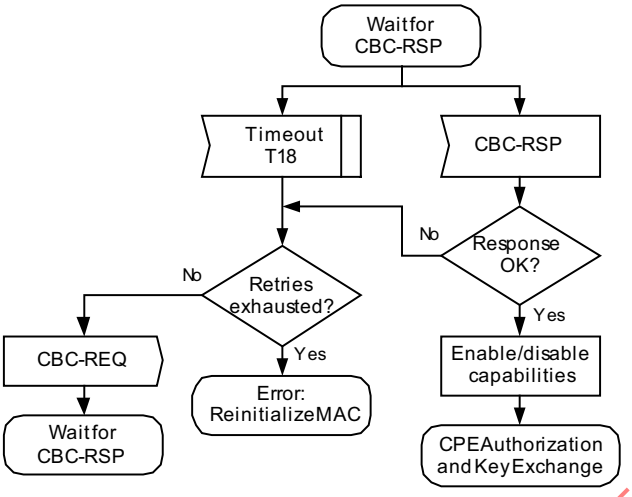

Figure 53—Wait for CBC –RSP at CPE

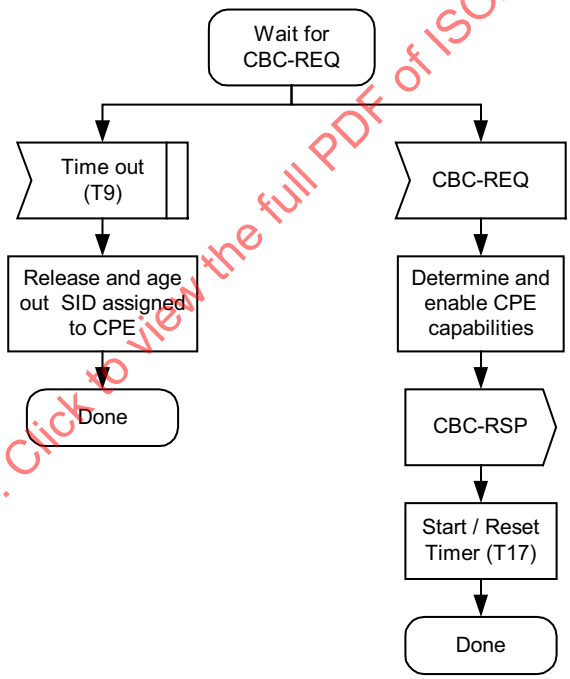

Figure 54—Negotiate basic capabilities at BS

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7.16.2.10 CPE authentication and key exchange

Once configuration of the required basic capabilities is completed, the CPE and AAA continue with performing authentication and exchanging keys, as described in Clause 8. If the AAA and CPE can not authenticate each other, authentication of the CPE fails for the selected WRAN service. This WRAN service on the selected channel is removed from further consideration. If there are any other BSs available with which to associate, the updated list of available WRAN services is presented to the higher user layers.

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7.16.2.11 Registration

Registration is the process by which the CPE verifies its configuration with the BS. If the CPE supports a configuration that is set by the BS, it is allowed entry into the network and thus becomes manageable. To register with a BS, the CPE shall send a REG-REQ message to the BS. The REG-REQ message shall include a CPE NMEA Location string IE.

During registration, the CPE's NMEA Location String and various operational parameters are configured (see 7.9.7.3). The CPE sends its location data string (see 7.8.1.3.1.6) upon initial registration and re-registration. When the IP Address Allocation Information Element (see 7.9.7.3.4.11) is present in the REG-REQ message, the BS shall include this IP address allocation parameter in the REG-RSP message to command the CPE to use the indicated version of IP on the secondary management connection. The BS shall command the use of exactly one of the IP versions supported by the CPE.

The BS shall determine the location of the antenna of each associated CPE with the accuracy as specified in Table A.1 for the specific regulatory domain. The BS's SM shall receive the generated NMEA string and validate its contents.

The BS's SM shall provide the geolocation data to the database service. The BS shall refuse to serve the CPE if

a) The geographic location of the CPE has not been successfully determined as indicated by a failed validation of the data in the NMEA string. Validation shall fail if
   1) The NMEA string contains data that is outside the allowable range of values or;
   2) The distance between the initializing CPE and the BS or other associated CPEs is outside the allowable range of values.
b) The database service has indicated that the CPE cannot operate on the channel on which the WRAN network intends to operate.

In the first case, validation of the NMEA string fails and CPE initialization fails, in the second case, the CPE initialization fails on the current channel and shall proceed to the next channel on its available WRAN services list.

The BS shall respond with a REG-CMD message. Figure 55 shows the procedure that shall be followed by the CPE to initiate registration.

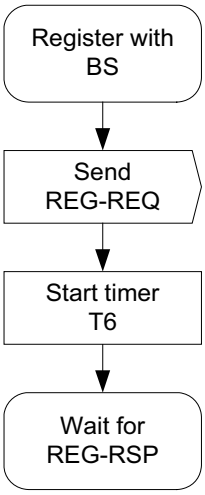

Figure 55—CPE registration

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Once the CPE has sent a REG-REQ to the BS, it shall wait for a REG-RSP to authorize it to forward traffic to the network. Figure 56 shows the waiting procedure that shall be followed by the CPE.

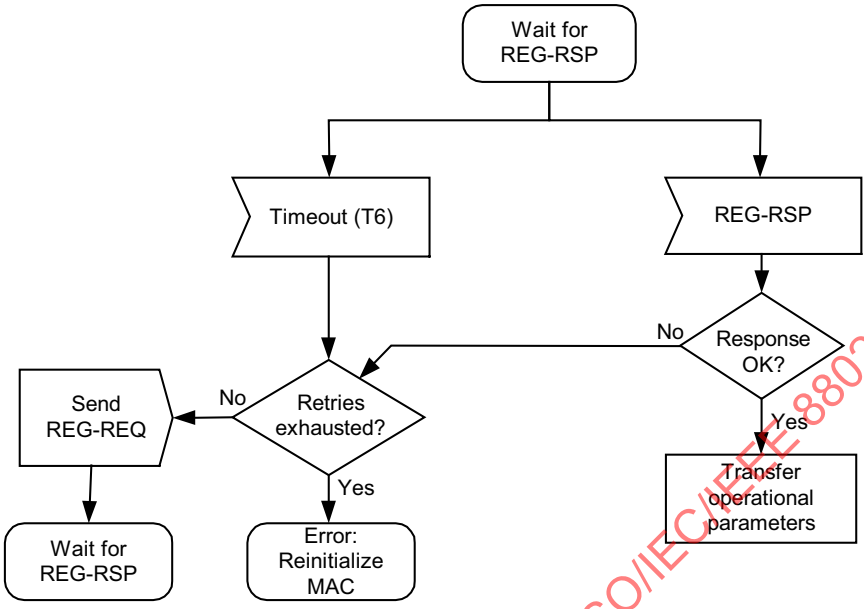

Figure 56—Wait for REG-RSP—CPE

The BS shall perform the operations shown in Figure 57. Note that the Timer T13 represents the time allowed for a CPE, following receipt of a REG-RSP message, to send a TFTP-CPLT message to the BS, and its minimum time is specified in Table 333. In addition, the Timer T28 is the time allowed for the BS to complete the transmission of channel sets; its default value is specified in Table 333.

IEEE 802.22 CPEs are managed devices. Network entry is not considered complete until after the TFTP-CPLT/RSP (see 7.9.19). When the BS and CPE complete the TFTP-CPLT/RSP exchange, timer T30 is scheduled for the value set in CPE Registration Timer (7.9.7.3.5) IE. When T30 expires the BS and CPE shall delete all information pertaining to their associations (e.g., SIDs, registered capabilities, active service-flow parameters, remaining security context), regardless of whether or not the CPE is currently being served by the BS.

Prior to expiration of T30, the BS may attempt to verify connectivity to a CPE via periodic ranging. This can be facilitated by the BS sending an unsolicited RNG-CMD message with Ranging Status field set to "Re-range & Re-register" (see Table 61). Upon receiving said RNG-CMD, the CPE shall attempt to re-range with the BS, as well as send a REG-REQ with the current configuration of the CPE NMEA Location String IE (7.8.1.3.1.6) and Manufacturer-specific Antenna Model IE (7.9.7.3.4.8) to inform the BS of its current position and antenna information. Upon sending this REG-REQ to the BS, the CPE should use the signaling in 9.1.2.2 to repopulate the MIBs used to configure these IEs (see *wranIfCpeAntennaGainTable* and *wranIfAntennaModel* in 14.1) and update the configuration of these IEs by reading the information. If the CPE finds out that this information has changed, it shall re-initialize itself. If the BS does not receive either the RNG-REQ or the REG-REQ (with the location information) from the CPE in the allocated opportunity, the BS shall wait until T30 expires before de-registering the CPE.

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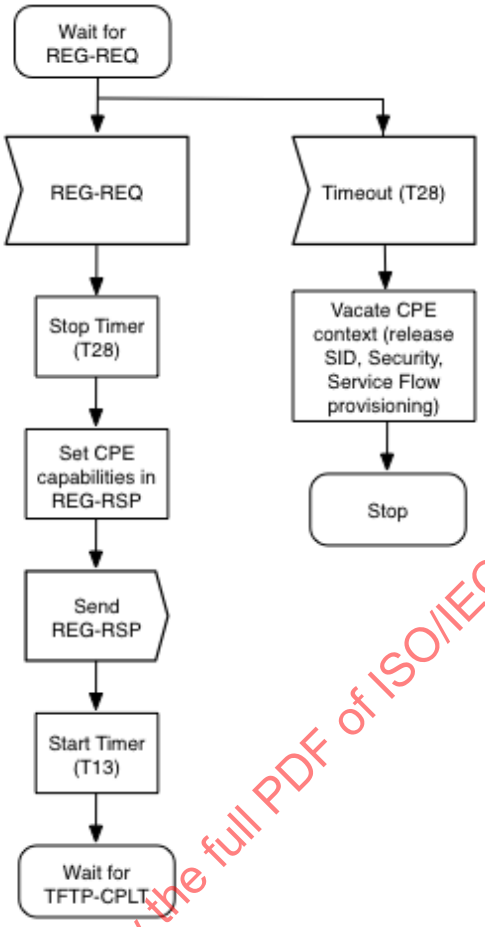

Figure 57—Registration at BS

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If the CPE is currently being served by the BS, the BS can force the CPE to delete the pertinent information before expiration of T30 by the following:

a) Send a DREG-CMD to CPE with Action Code = 0x04 (see Table 141) to shutdown the CPE. This is done if the BS detects that the CPE has moved outside the current coverage area of the BS and is not able to service it.

b) Send a DREG-CMD to CPE with Action Code = 0x05 (see Table 141) to force CPE to reinitialize on the current operating channel. This is done if the CPE's movement is beyond the movement threshold of ±25 m (see policy 8 in Table 315), but the CPE's movement does not result in a new backup/candidate channel list upon query of the database service.

c) Send a DREG-CMD to the CPE with Action Code = 0x01 and subsequently another DREG-CMD with Action Code = 0x03 (see Table 141) to temporarily disable the CPE's transmission. This is done, to temporarily disable the CPE's transmission when a CPE's movement is within the movement threshold of ±25 m (see Policy 8 in Table 315), but the CPE's movement does not results in a new backup/candidate channel list upon query of the database service. This avoids having to reinitialize the CPE.

For case a), T30 shall be cleared when the CPE is shutdown. For case b), the T30 shall be reset upon completion of re-registration. For case c), the T30 shall be reset upon sending the DREG-CMD to re-enable CPE.

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If the SM (upon interrogating the SSA) detected that the CPE has moved, the BS shall request de-registration by sending a DREG-CMD message to the CPE set with the appropriate Action Code as mentioned above.

7.16.2.12 BS transmit channel sets to CPE

The BS shall send the channel sets to the new CPE. The channel sets are described in 11.2.3. The channel sets that are sent to the initializing CPE are the backup channels and the candidate channels. The channel sets are sent in a DCD message, as described in Table 29 for PHY-OM1 and in Table 29a for PHY-OM2. The BS shall send DCD channel information elements 11 and 12. Table 32 describes information element 12 as the backup and candidate channel list. It is a prioritized list of the channels with the backup channel set higher in priority than the candidate channel set. The two sets are identified by sending information element 11, which provides the number of the higher prioritized backup channel set. Each channel in DCD information element 12 is characterized by both the channel number.

7.16.2.13 Establish IP connectivity

The CPE shall invoke DHCP mechanism (IETF RFC 2131 [B20]) in order to obtain an IP address and any other parameters needed to establish IP connectivity. If the CPE has a configuration file, the DHCP response shall contain the name of a file that contains further configuration parameters.

Establishment of IP connectivity shall be performed on the CPE's secondary management connection as shown in Figure 58.

In case where dynamic IP configuration is not preferred, the CPE shall obtain an IP address from its BS.

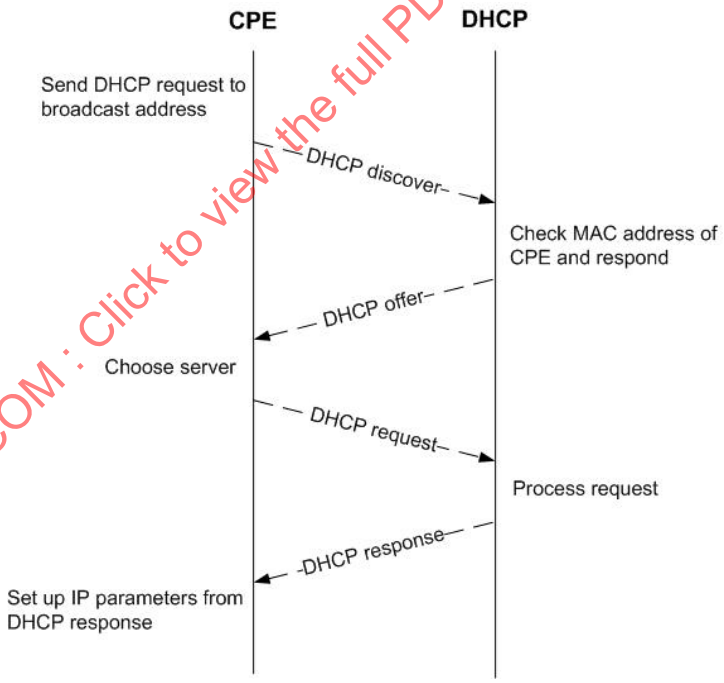

Figure 58—Establishing IP connectivity

7.16.2.14 Establish time of day

The CPE and BS need to have the current date and time. This is required for time-stamping logged events for retrieval by the management system. This needs not be authenticated and needs to be accurate only to the

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nearest second. The current date and time may be obtained from a local time source or a remote service such as an NTP server.

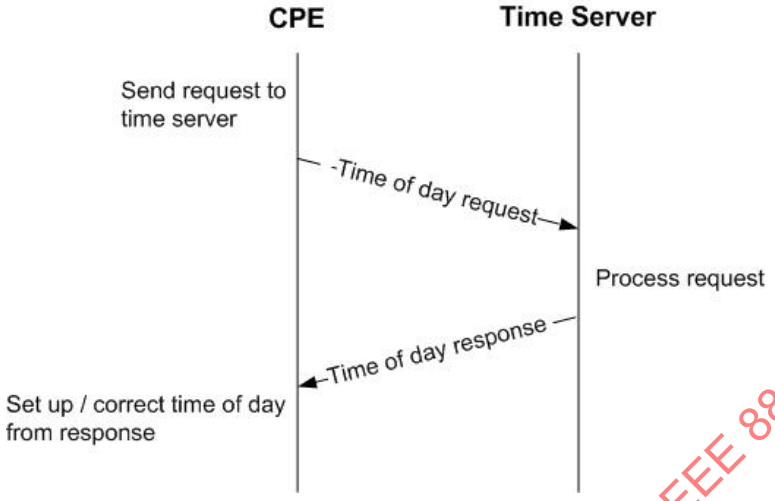

Figure 59—Establishing time of day

Successfully acquiring the Time of Day is not mandatory for a successful registration, but is necessary for ongoing operation. The specific timeout for Time of Day Requests is implementation dependent.

7.16.2.15 Transfer operational parameters

The CPE shall download the CPE's configuration file using TFTP on its own secondary management connection as shown in Figure 59. The CPE shall use an adaptive timeout for TFTP based on binary exponential backoff (IETF RFC 1123 [B19], IETF RFC 2349 [B21]).

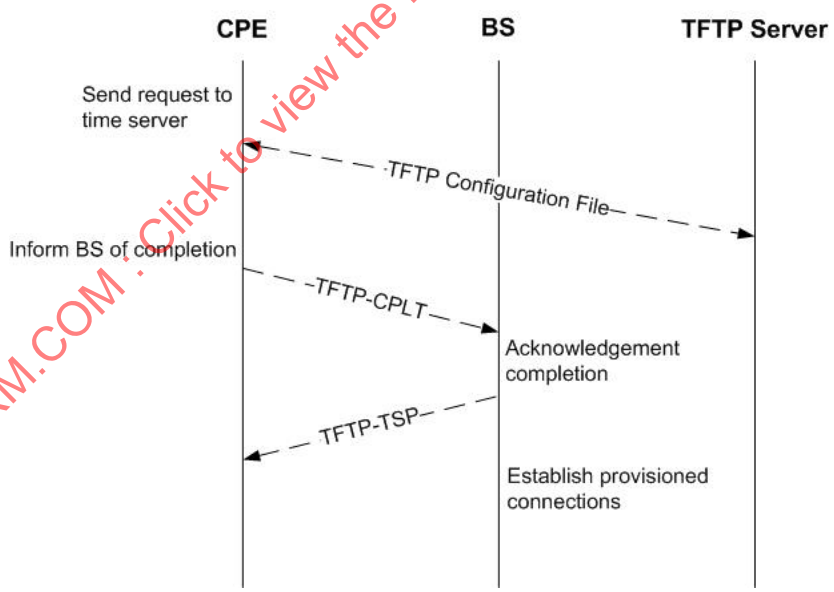

Figure 60—Transferring operational parameters

When the configuration file download has completed successfully, the CPE shall notify the BS by transmitting the TFTP-CPLT message on the CPE's primary management connection. Transmissions shall continue successfully until a TFTP-RSP message is received with response "OK" from the BS (see Figure 61 and Figure 62) or the CPE terminates retransmission due to retry exhaustion.

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Upon sending a REG-RSP, the BS shall wait for a TFTP-CPLT. If the timer T13 (defined in Table 333) expires, the BS shall restart the registration process (REG-REQ/RSP) with the CPE (see Figure 61). Note that the Timer T26 refers to the time waited for TFTP-RSP. If T26 expires, then TFTP-CPLT is attempted until the maximum number of retries is exhausted. Upon the exhaustion, the CPE shall be deregistered (i.e., forced to reinitialize MAC) by sending a DREG-REQ with Action Code set to 0x05 to force itself to reattempt system access or 0x04 to shut itself down (see Figure 62).

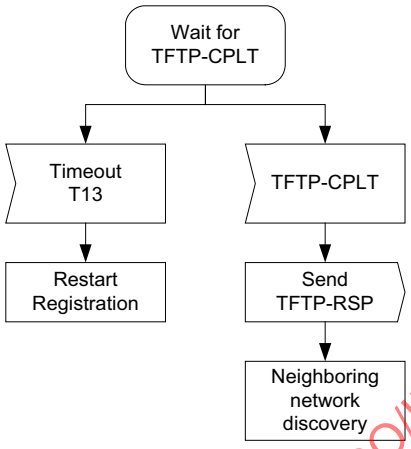

Figure 61—Wait for TFTP-CPLT at the BS

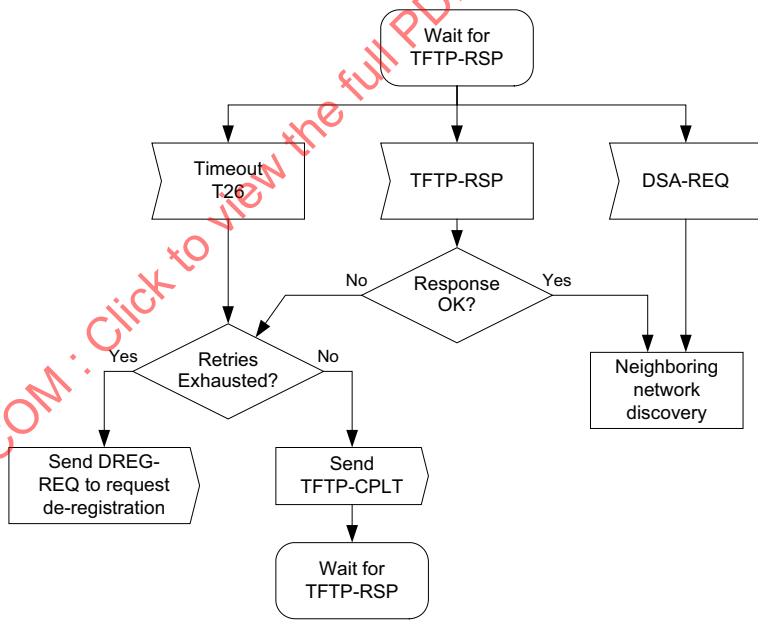

Figure 62—Wait for TFTP-RSP at the CPE

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7.16.2.16 Establish dynamic service flows

After the transfer of operational parameters for the CPE, the BS shall send DSA-REQ messages (Table 82) to the CPE to set up pre-provisioned service flows belonging to the CPE. The CPE responds with DSA-RSP messages. This is described further in 7.20.7.1.

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7.16.2.17 Neighboring network discovery

After a CPE has registered with a WRAN BS, it shall perform neighboring network discovery in order to identify other nearby WRANs and enable efficient self-coexistence, if the CPE has not already done so. The neighboring network discovery involves listening to the medium for CBP packets or BS SCH transmitted by other WRAN BSs. This network discovery mechanism is described in 7.22.1.3.

7.16.3 A-BS initialization in PHY-OM2

7.16.3.1 General

The A-WRAN A-BS initialization procedure shall consist of the following steps:

a) A-BS is professionally installed.

b) A-BS acquires the antenna gain information

c) Determine the A-BS geographic location.

d) If a database service exists for A-BS area of service, Spectrum Manager at the A-BS receives an initial list of available channels from the database service. If there is no database service, Spectrum Manager initially considers all channels available.

e) Operator disallows channels on the available channel list as needed.

f) Perform incumbent detection in all usable channels and synchronize network to neighboring A-BSs.

g) Present the available channel list to the higher layers for selection of an operating channel or operating channels.

h) Commence single channel operation or multi-channel operation on the selected operating channel(s).

This A-BS initialization procedure is depicted in Figure 63.

7.16.3.2 Professional installation

The A-BS shall be installed by a professional who will be responsible for assuring that its installation is compliant with local regulations (see Annex A) and the IEEE Std 802.22.2™-2012. The professional installer should make sure that the antenna pattern meets the pattern specified in 9.12.1 and that the antenna is directed toward the selected A-BS.

7.16.3.3 A-BS antenna gain information acquisition

The A-BS shall determine if its antenna is integrated or not by querying it using the M-ANTENNA-INTEGRATED primitive structure described in 10.7.6.1 and 10.7.6.2. The A-BS shall acquire the antenna information including the maximum antenna gain information for the channels that can be used in the regulatory domain of interest. This information is stored in a MIB, wranIfBsCpeAntennaGainTable. If the antenna is integrated to the A-BS TRU, this MIB object shall be pre-populated by the manufacturer of the A-BS. If the antenna is not integrated into the A-BS TRU, the MIB object shall be populated by querying the antenna unit (AU) through the interface defined in 9.12.2. This information at the antenna shall be pre-populated by the antenna manufacturer.

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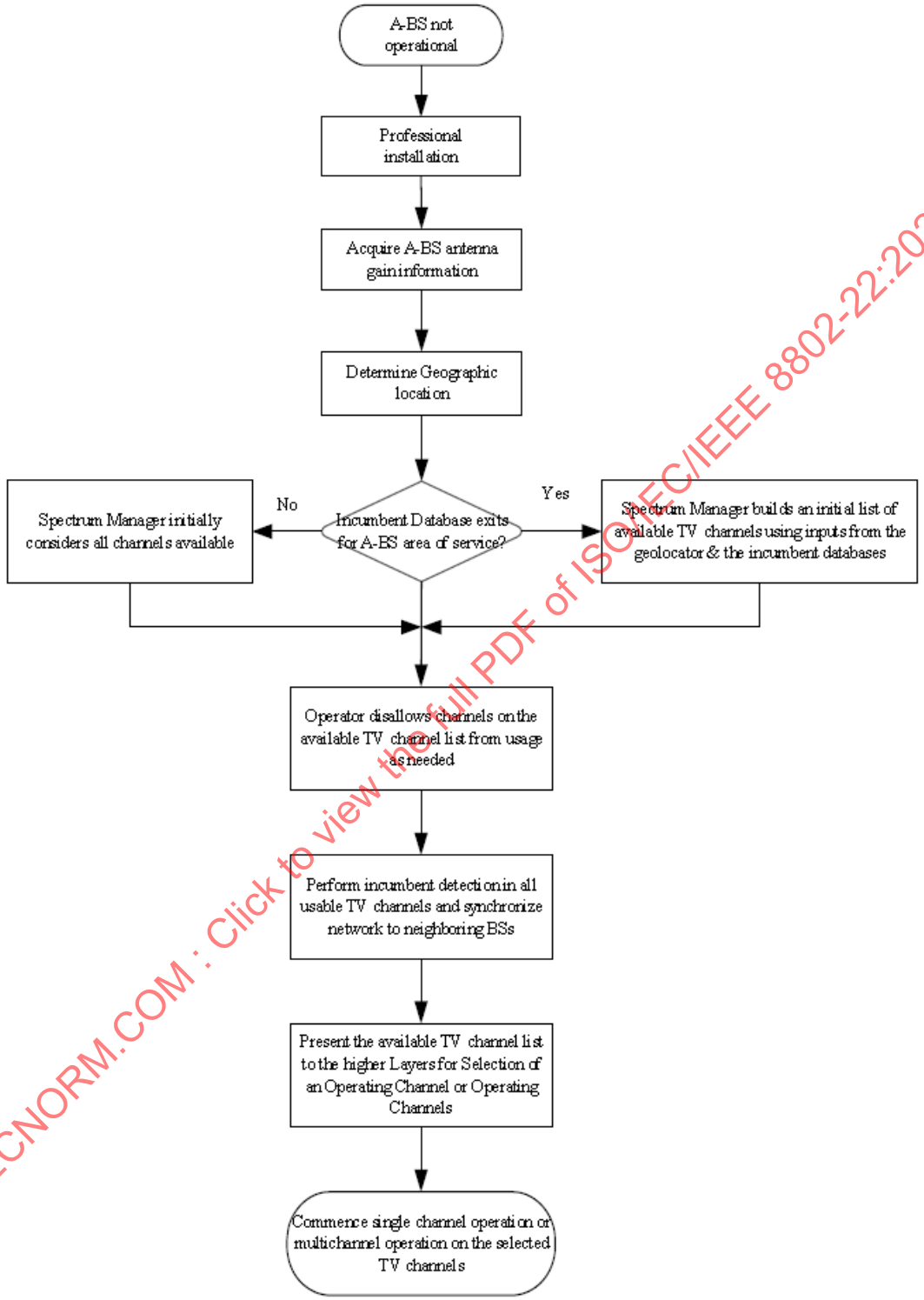

Figure 63—A-BS initialization procedure

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7.16.3.4 Determine geographic location

The geolocation requirement for the A-BS is that the WRAN system shall know the latitude and longitude of the A-BS transmitting antenna within a radius of 15 m and its altitude above mean sea level. The A-BS geographic location information shall be stored in the A-BS memory.

7.16.3.5 Access TV bands database service and receive list of available channels

The A-BS shall access a TV bands database service if one exists.

The A-BS SM communicates with the TV bands database service using the primitives that are defined in 10.7.1. Each WRAN device shall enlist with the TV bands database service by providing information that is required for access to the TV bands. The A-BS SM, which shall act as a proxy for all of its registered client devices, shall perform enlistment using the M-DEVICE-ENLISTMENT primitives. Each instance that a device is required to get a new set of available channels, the A-BS SM shall provide its geographic coordinates or those of one of its registered client devices to the TV bands database service using the MDB-AVAILABLE-CHANNEL-REQUEST primitive. The A-BS shall receive the available channels from the TV bands database service using the M-DB-AVAILABLE-CHANNEL-INDICATION primitive. The SM shall generate the composite available channel list using only those channels that have been indicated as available for every device on the network.

The A-BS shall prohibit WRAN operation on any channel not on this initial list of available channels.

7.16.3.6 Operator disallows channels

Access shall be provided for the operator to disallow channels that are listed on the available channel list from being selected for WRAN operation. The operator shall not have access to channels that are not listed on the available channel list. To further classify channels on the available list, the A-BS SM shall submit an M-AVAIL-TV-CH-REPORT primitive with the mode set equal to 1 to provide the available channel list to the higher layers. Once channels on the available channel list are further classified as disallowed, the SM shall receive an M-DISALLOWED-TV-CHS primitive submitted by the SM.

7.16.3.7 Perform incumbent detection and synchronize network with neighboring networks

The A-BS shall perform incumbent detection in each of the channels listed on the available channel list and each adjacent channel if its EIRP is beyond the limit specified by the regulatory domain classes in Annex A (e.g., 40 mW in the USA) to detect other legitimate incumbent services that do not exist in the database service. The A-BS's SM shall use the output from the A-BS spectrum sensing function to identify occupied channels on the available channel list.

The A-BS shall perform neighboring IEEE 802.22 network discovery on selected channels according to 7.20.1.3. The A-BS shall synchronize with neighboring A-BSs using its installed satellite-based geolocation technology.

7.16.3.8 Present the available channel list to the higher layers

After incumbent detection during which channels may have been identified as protected or occupied, the resulting list shall be presented to the higher layers using an M-AVAIL-TV-CH-REPORT primitive with the mode set equal to 2 for selection of an operating channel or using an M-AVAIL-TV-CH-REPORT primitive with the mode set equal to 3 for selection of operating channels. The required information presented shall be each channel number that is available for the A-BS to commence WRAN service and the maximum allowed EIRP for each channel. Additional information can be provided to the higher layers to help with the selection of an optimal channel or optimal channels, such as a list of channels where other wireless services

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were detected during the incumbent detection stage. As a result of the selection from the higher layer, the SM shall receive an M-OPERATING-TV-CH or M-OPERATING-TV-CHS primitive from the NCMS.

7.16.3.9 Commence single channel operation or multi-channel operation

The A-BS may now commence single channel operation on any one channel listed on the available channel list or multi-channel operation on any channel listed on the available channel list.

7.16.4 CPE initialization for relay on PHY-OM2

7.16.4.1 General

Figure 64 illustrates an A-WRAN scenario where the need for the definition of an incumbent safe CPE initialization can be easily seen.

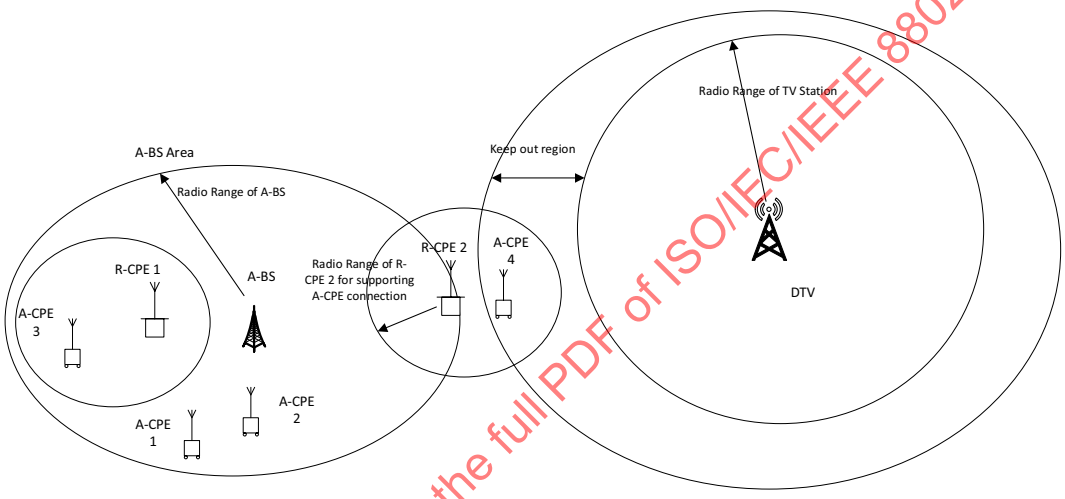

Figure 64—A WRAN scenario where a safe bootstrap operation is required to protect incumbents

In this figure, consider that A-CPE 4, which is located outside of an A-BS's cell but located within a distributed scheduling R-CPE 2's local cell, is powered down whereas the A-BS is transmitting in the cell and R-CPE 2 being a member of the A-BS is transmitting in the local cell that is under normal operation. Further, assume that the TV station in Figure 64 is powered up and starts transmitting in the same channel (i.e., channel #N in this example) that is being used by the A-BS and R-CPE 2 for their transmissions in the cell. A-CPE 4 should be capable of detecting that R-CPE 2 is operating in a channel that is occupied by an incumbent service. The A-BS must be capable of determining if A-CPE 4 is located within interference range of the TV station protected contour (i.e., in the keep-out region). If A-CPE 4 is already registered with the network managed by R-CPE 2, it will alert R-CPE 2. If A-CPE 4 is not registered with the network, it shall not transmit. See 10.2.5, policies 5 and 6. In response to the alert from A-CPE 4, the SM at R-CPE 2 attempts to detect the TV station and shall notify the A-BS when it detects the station. In response to the notification from R-CPE 2, the SM at the A-BS may or may not decide to switch channels to accommodate the connected CPEs (see 10.2.6.6). The purpose of the sensing and geolocation capabilities of the WRAN system shall be to prevent harmful interference to the primary TV service by providing the necessary information to the A-BS's SM that generates the list of available channels. The definition of an incumbent safe CPE initialization phase is critical for cognitive radio systems. The SM incorporates algorithms to address this need (see Table 234, policies 5 and 6).

First and foremost, the MAC does not presuppose any preassigned channel where a CPE is able to look for an A-BS or a distributed scheduling R-CPE given the time-varying and unpredictable nature of channel occupancy. Hence, the first task a CPE shall perform in attempting to join a network is to scan the set of

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channels for A-BSs or R-CPEs and incumbent services with which the transmissions of the CPE might interfere. Since the A-BS shall send concentrated OFDM symbols composed of a frame preamble and SCH once every superframe in PHY-OM1, or a frame preamble and an A-FCH once every frame in PHY-OM2 in its operating channel, and the distributed scheduling R-CPE shall send concentrated OFDM symbols composed of a local frame preamble and a DRZ-FCH in the DS DRZ subframe within a frame, if available, in its operating channel (see 7.3), the CPE will recognize the existence of an A-BS or a distributed scheduling R-CPE transmission and, if appropriate, proceed with the CPE initialization procedure with the corresponding A-BS or distributed scheduling R-CPE. Although a CPE will recognize the existence of an A-BS, in particular, the CPE may not be initialized with the A-BS directly since the transmission of the CPE is not able to reach the A-BS due to the power constraint. In this case, the CPE will make an initialization by relaying on a centralized scheduling R-CPE.

The procedure carried out by the A-BS, the centralized scheduling R-CPE, the distributed scheduling R-CPE, and the A-CPE to perform network entry and initialization shall be as follows:

a) A-CPE performs self test.

b) A-CPE acquires the antenna gain information.

c) A-CPE senses for and synchronizes to A-WRAN services. The sensing thread also begins during this step to detect broadcasting incumbents.

d) A-CPE presents sensing results to the higher layers.

e) A-CPE chooses an A-WRAN service for single channel operation or for multi-channel operation.

f) If A-CPE is capable of geolocation, A-CPE acquires valid geolocation data from the satellites. If the data acquisition is unsuccessful, A-CPE initialization should not continue or may continue to operate as an A-CPE mode. If A-CPE is not capable of geolocation, CPE initialization should not continue or may continue to operate as an A-CPE mode.

g) A-CPE acquires the DS and US parameters from the selected A-WRAN service.

h) A-CPE directional antenna azimuth adjustment.

i) If channels N and N±1 pass the sensing and timing requirements, A-CPE performs initial ranging (see 7.17.2.3).

j) A-CPE transmits basic capabilities.

k) If all required basic capabilities are present in the A-CPE, the AAA authenticates the A-CPE and key exchange is performed; otherwise, the A-CPE does not proceed to registration and the A-BS de-registers the A-CPE.

l) Perform Registration (REG-REQ/RSP).

m) Upon completing registration, A-BS transmits channel sets to A-CPE.

n) Establish IP connectivity.

o) Establish time of day.

p) Transfer operational parameters.

q) Establish dynamic service flows.

r) A-CPE reports sensing results and discovered neighboring networks.

Figure 65 summarizes the network entry of the A-CPE and its initialization procedure in the A-WRAN. Note that these steps taken by the A-CPE consist of a set of actions and error verification. In the following subclauses, a mubclauses, a more detailed description of these steps and their individual responsibilities, are provided.

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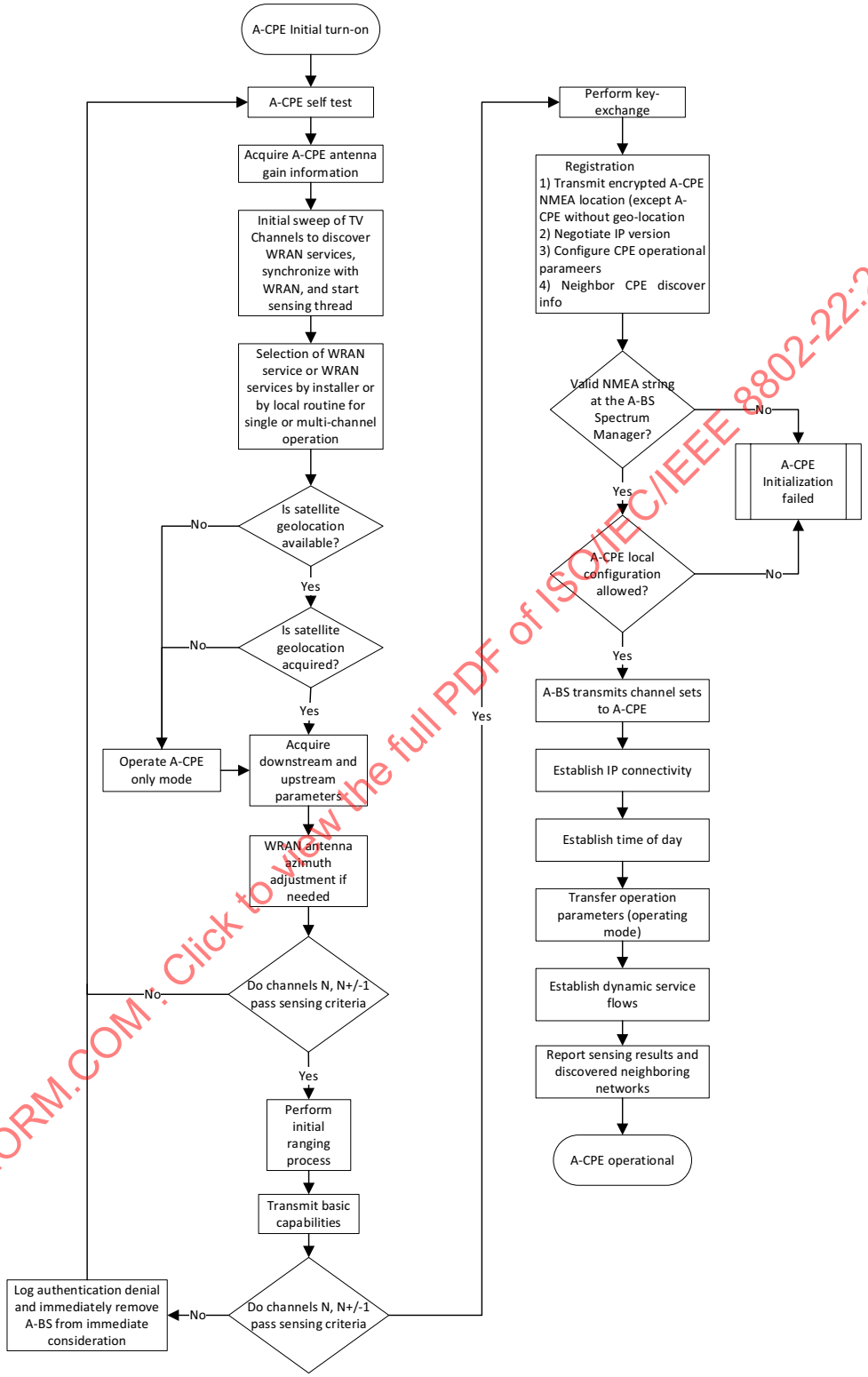

Figure 65—A-CPE initialization procedure for A-WRAN

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7.16.4.2 A-CPE performs self test

On initialization or after signal loss, the A-CPE shall perform a self test.

7.16.4.3 A-CPE antenna gain information acquisition

The A-CPE shall determine if its antenna is integrated or not by querying it using the M-ANTENNA-INTEGRATED primitive structure described in 10.7. The A-CPE shall acquire the antenna information including the maximum antenna gain information for the channels that can be used in the regulatory domain of interest. This information is stored in a MIB, *wranIfBsCpeAntennaGainTable*. If the antenna is integrated to the A-CPE TRU, this MIB object shall be pre-populated by the manufacturer of the A-CPE. If the antenna is not integrated into the A-CPE TRU, the MIB object shall be populated by querying the AU through the interface defined in 9.12.2. The information at the antenna shall be pre-populated by the antenna manufacturer.

7.16.4.4 A-CPE senses for and identifies A-WRAN services and incumbents

The A-CPE identifies A-WRAN services from detecting the A-BS or the distributed scheduling R-CPE. The CPE shall perform spectrum sensing to detect the A-BS or the distributed scheduling R-CPE and may perform spectrum sensing to detect and identify legitimate incumbent services that are to be protected on each active A-WRAN channel in the area and its adjacent channels as described in 10.3.

7.16.4.5 Present sensing results to the higher layers

As a result of spectrum sensing, the available A-BSs or distributed scheduling R-CPEs in the area are presented to the application layer program via connection C2 and MIBs through M-SAP as shown in IEEE 802.22 reference architecture (Figure 7). The application may be running on the A-CPE/R-CPE or on an attached computer. The data presented includes the operating channel of the A-BS and RSSL in addition to the A-WRAN service being advertised.

7.16.4.6 A-CPE chooses an A-WRAN service for single channel operation or for multi-channel operation

An A-WRAN service or multiple WRAN services are selected at the higher layers of the A-CPE after preliminary sensing and identification of available A-BSs or distributed scheduling R-CPEs and the presence of incumbents in the area as the previous subclauses describe. The A-CPE SSA shall issue an M-WRAN-SERVICE-REPORT primitive to request the higher layers through the NCMS to select a channel from the available A-WRAN service list that is included in the primitive, as described in 11.7. The SSA shall receive an M-WRAN-SERVICE-RESPONSE primitive with the selected channel from the NCMS, as described in 11.7.4.3. Once the channel is selected, it and its adjacent channels are more rigorously sensed in order to detect the presence of a weak incumbent service that might be masked by the selected A-WRAN service. This procedure is described in more detail in 11.3.2.

7.16.4.7 A-CPE performs satellite-based geolocation

The A-CPE shall acquire geolocation data from a satellite-based geolocation receiver when it will operate as a fixed mode or as a distributed scheduling R-CPE. An A-CPE shall not progress to the next step of initialization for the fixed-mode operation or the distributed scheduling R-CPE operation until the satellite-based geolocation technology successfully establishes lock and acquires valid geolocation data from the satellites. The CPE sends the NMEA string to the A-BS during registration (see 7.16.2.11).

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7.16.4.8 Acquire DS and US parameters

7.16.4.8.1 Overview

DS and US parameters can be acquired from two sources: an A-BS and a distributed scheduling R-CPE.

7.16.4.8.2 Obtaining DS parameters from an A-BS

The MAC shall search for the A-FCH for PHY-OM2 (Clause 10) from the A-BS, which indicates the beginning of the frame in normal MAC Operational mode and the allocated frame in self-coexistence MAC Operational mode. To improve the joining latency, the A-CPE shall use energy detection to help ascertain about the presence/absence of an A-BS in a particular channel. If the energy detected is below the detection threshold, the A-CPE can safely move to the next channel.

After having received an A-FCH in a channel, the A-CPE shall perform sensing not only in the detected operating channel, but also in all other affected channels. During this sensing, the A-CPE shall attempt to identify incumbent operation. If incumbents are detected on the operating channel or either first adjacent channel, the MAC shall cause the A-CPE to cease transmitting application traffic on the channel and, at the first transmit opportunity, send a short control message to the A-BS indicating that it is using a channel occupied by an incumbent. When the A-BS receives such notification, it may take numerous actions as described in Figure 96. The aggregate duration of the short control messages shall not exceed the Channel Closing Transmission Time (see Table 276) of transmissions by the A-WRAN system before remedying the interference condition (e.g., changing channels, backing off transmit EIRP, terminating transmissions).

Provided no incumbents are found, the A-CPE may proceed to the next step. Here, the MAC shall search for the DS-MAP MAC management messages. The A-CPE achieves MAC synchronization once it has received at least one DS-MAP message. An A-CPE MAC remains in synchronization as long as it continues to successfully receive the A-FCH, DS-MAP, and DCD messages for its channel(s). If the Lost DS-MAP Interval (Table 273) has elapsed without a valid DS-MAP message or the T1 interval (Table 273) has elapsed without a valid DCD message or Lost FCH counts of FCH are missed, an A-CPE shall try to reestablish synchronization. The process of acquiring synchronization is illustrated in Figure 66. The process of maintaining synchronization is illustrated in Figure 67.

7.16.4.8.3 Obtaining DS parameters from a distributed scheduling R-CPE

As another method to obtain DS parameters, the MAC may search for a DRZ-FCH (7.7.4) transmitted from a distributed scheduling R-CPE, which indicates the beginning of the DS DRZ (7.6.3.3).

After having received a DRZ-FCH in a channel, the A-CPE shall perform sensing not only in the detected operating channel but also in all other affected channels. During this sensing, the A-CPE shall attempt to identify incumbent operation. If incumbents are detected on the operating channel or either first adjacent channel, the MAC shall cause the A-CPE to cease transmitting application traffic on the channel and, at the first transmit opportunity in a US DRZ, send a short control message to the distributed scheduling R-CPE indicating that it is using a channel occupied by an incumbent. When the distributed scheduling R-CPE receives such notification, it shall forward the received short control message to the A-BS. When the A-BS receives such notification, it may take numerous actions as described in Figure 96. The aggregate duration of the short control messages shall not exceed the Channel Closing Transmission Time (see Table 276) of transmissions by the A-WRAN system before remedying the interference condition (e.g., changing channels, backing off transmit EIRP, terminating transmissions).

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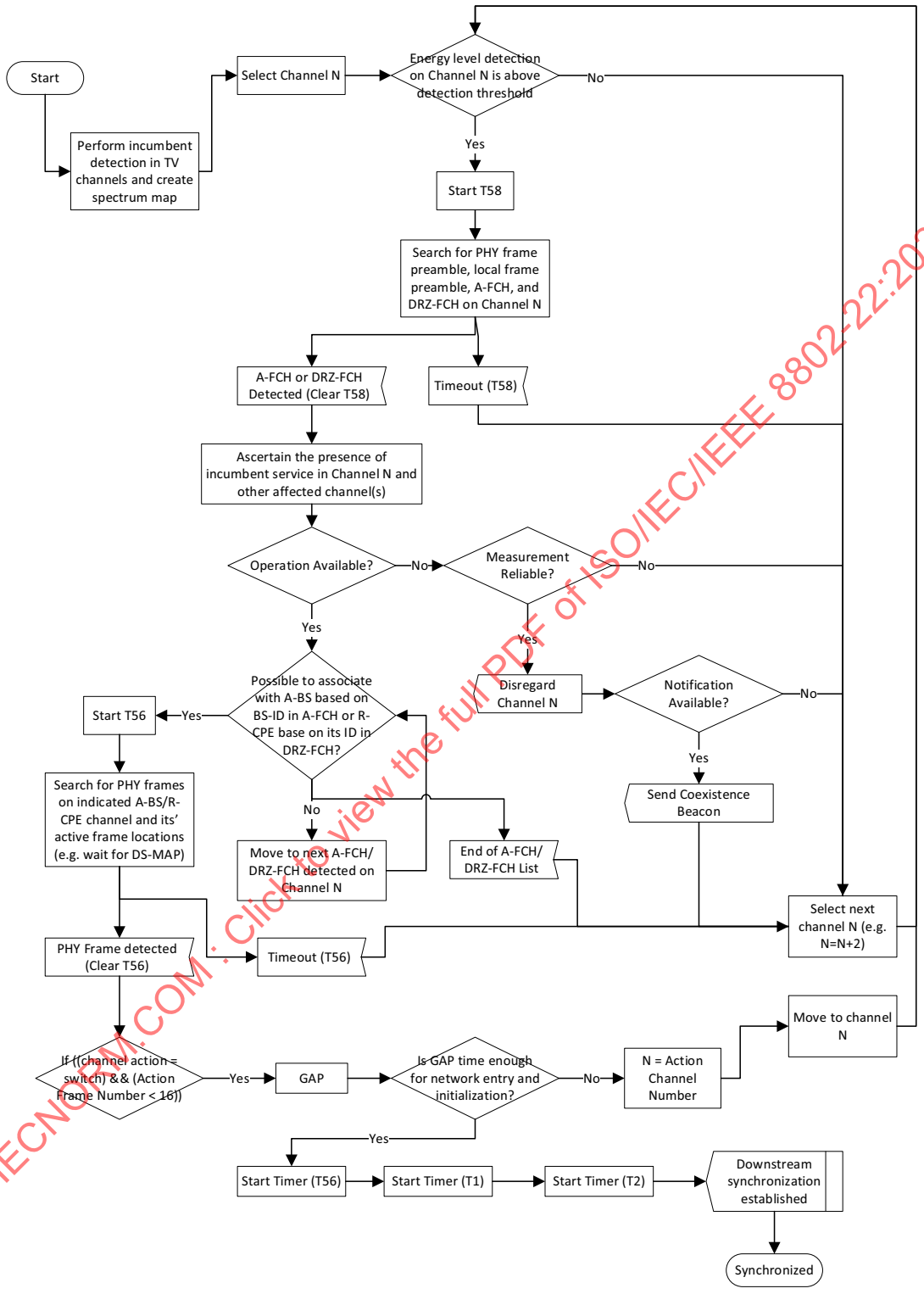

Figure 66—Obtaining DS parameters

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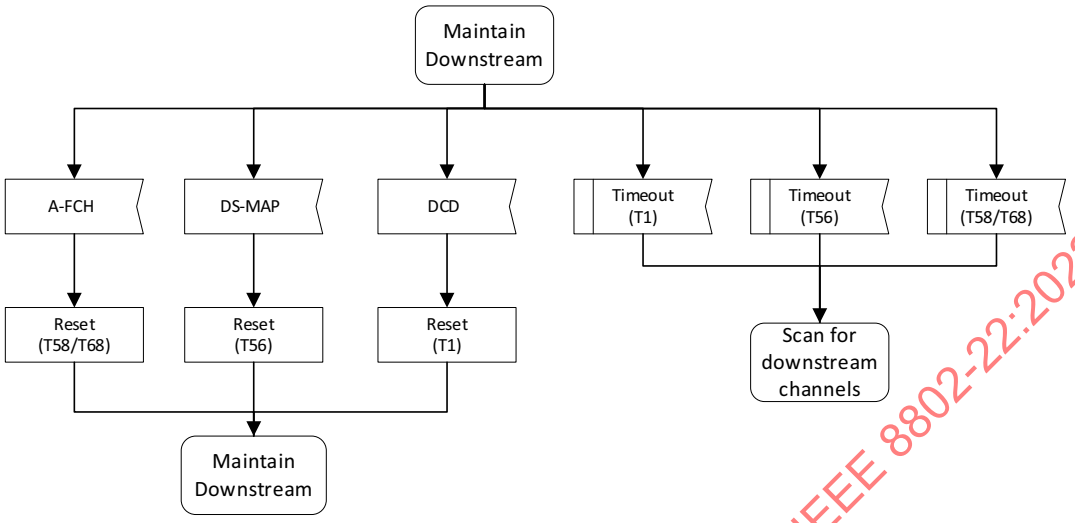

Figure 67—Maintaining DS parameters

Provided no incumbents are found, the A-CPE may proceed to the next step. Here, the MAC shall search for the DS-MAP MAC management messages, which are transmitted from the distributed scheduling R-CPE, in a DS DRZ. The A-CPE achieves MAC synchronization to the distributed scheduling A-CPE once it has received at least one DS-MAP message. A A-CPE MAC remains in synchronization as long as it continues to successfully receive the DRZ-FCH, DS-MAP, and DCD messages for its channel(s) within a DRZ. If the lost DS-MAP Interval (Table 273) has elapsed without a valid DS-MAP message or the T1 interval (Table 273) has elapsed without a valid DCD message or lost DRZ-FCH counts of DRZ-FCH are missed, a CPE shall try to reestablish synchronization. The process of acquiring synchronization is illustrated in Figure 66. The process of maintaining synchronization is illustrated in Figure 68.

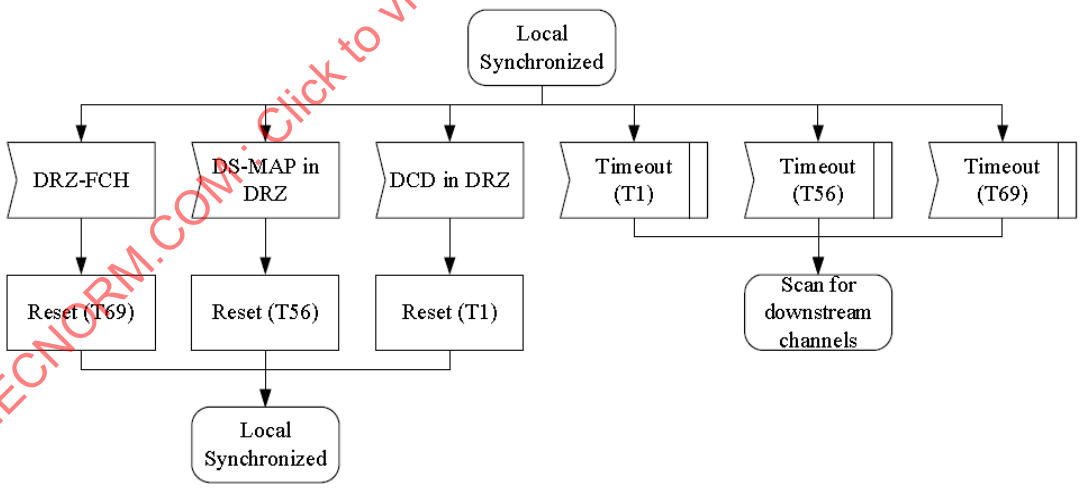

Figure 68—Maintaining DS parameters in DRZ

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7.16.4.8.4 Obtaining US parameters from an A-BS

After synchronization to the A-BS, the CPE shall wait for a UCD message from the A-BS in order to retrieve a set of transmission parameters for a possible US channel. These messages are transmitted periodically from the A-BS for all available US channels and are addressed to the MAC broadcast address.

If no US channel can be found after a suitable timeout period, then the CPE shall continue scanning to find another DS channel. The process of obtaining US parameters is illustrated in Figure 37.

The CPE shall determine from the channel description parameters whether it may use the US channel. If the channel is not suitable, then the CPE shall continue scanning to find another DS channel. If the channel is suitable, the CPE shall extract the parameters for this US from the UCD. It then shall wait for the next DS-MAP message and extract the time synchronization from this message. Then, the CPE shall wait for a bandwidth allocation map for the selected channel. It may begin transmitting US in accordance with the MAC operation and the bandwidth allocation mechanism.

The CPE shall perform initial ranging at least once. If initial ranging is not successful, the procedure is restarted from scanning to find another DS channel.

The CPE MAC is considered to have valid US parameters as long as it continues to successfully receive the A-FCH, US-MAP, and UCD messages. If at least one of these messages is not received within the time intervals specified in Table 273, the CPE shall not use the US. This is illustrated in Figure 69.

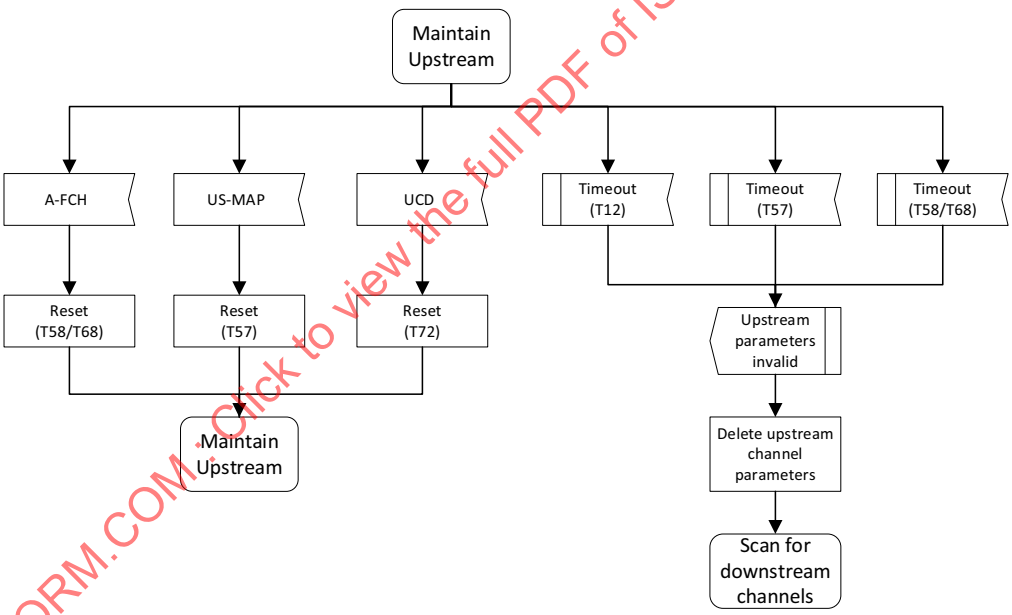

Figure 69—Maintaining US parameters

7.16.4.8.5 Obtaining US parameters from a distributed scheduling R-CPE

After synchronization to the distributed scheduling R-CPE, the CPE shall wait for a UCD message from the distributed scheduling R-CPE in order to retrieve a set of transmission parameters for a possible US channel. These messages are transmitted periodically in a DS DRZ from the distributed scheduling R-CPE for the available US channels and are addressed to the MAC broadcast address.

If no US channel can be found after a suitable timeout period, then the A-CPE shall continue scanning to find another DS channel. The process of obtaining US parameters is illustrated in Figure 50.

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The A-CPE shall determine from the channel description parameters whether it may use the US channel. If the channel is not suitable, then the A-CPE shall continue scanning to find another DS channel. If the channel is suitable, the A-CPE shall extract the parameters for this US from the UCD. It then shall wait for the next DS-MAP message and extract the time synchronization from this message. Then, the A-CPE shall wait for a bandwidth allocation map for the selected channel. It may begin transmitting US in accordance with the MAC operation and the bandwidth allocation mechanism.

The A-CPE shall perform initial ranging to the distributed scheduling R-CPE at least once. If initial ranging is not successful, the procedure is restarted from scanning to find another DS channel.

The CPE MAC is considered to have valid US parameters as long as it continues to successfully receive the DRZ-FCH, US-MAP, and UCD messages. If at least one of these messages is not received within the time intervals specified in Table 273, the A-CPE shall not use the US. This is illustrated in Figure 70.

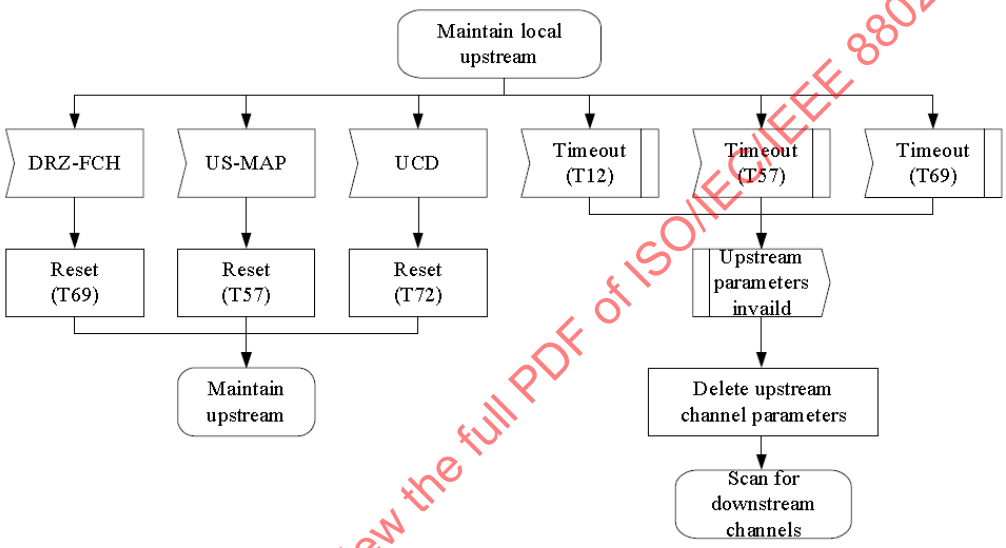

Figure 70—Maintaining US parameters in DRZ

7.16.4.9 CPE transmits ranging/CDMA burst

7.16.4.9.1 General

From the result of synchronization as described in 7.16.4.8, initial ranging will be performed. There are three methods of CPE transmit initial ranging: initial ranging to an A-BS, initial ranging to a distributed scheduling R-CPE, and initial ranging to a centralized scheduling R-CPE on relaying.

The selected channel is analyzed to determine if it passes the restrictions specified in 10.3. If the selected channel does not pass these restrictions, the association with the selected A-BS or distributed scheduling R-CPE is unsuccessful, and the selected channel shall be removed from further consideration. Available A-BSs or distributed scheduling R-CPEs are again presented to the higher layers for selection if there exist any other A-BSs or distributed scheduling R-CPEs with which to associate.

Next the selected channel and the channels that could incur harmful interference by operation on this selected channel shall be more finely sensed to determine if there exists a weak protected incumbent signal that was not detected at an earlier stage in the A-CPE initialization procedure. This process is described in 10.3.

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Time in this subclause shall be referenced to two positions in space. One position will be that of the A-BS or distributed scheduling R-CPE, and the other position will be that of the CPE. Many such A-CPE positions will exist. Ranging is the process of acquiring the correct timing offset and EIRP adjustments such that the A-CPE's transmissions are aligned at the A-BS or distributed scheduling R-CPE position. Ranging also adjusts transmit EIRP of the various A-CPEs such that the OFDMA signal received at the A-BS or distributed scheduling R-CPE arrives with compatible amplitudes from all the A-CPEs.

Although a A-CPE successfully obtains DS parameters from an A-BS, in particular, ranging to the A-BS as described in 7.16.4.9.2 may fail due to the A-CPE transmitting power constraint. However, the A-CPE is still able to have an uplink transmission to the A-BS by relaying on a centralized scheduling R-CPE. In this case, the CPE may perform ranging to a centralized scheduling R-CPE for the relaying operations to acquire the correct timing offset and EIRP adjustments aligned at the centralized scheduling R-CPE.

The timing delays through the PHY shall be constant to within 25% of the shortest symbol cyclic prefix as indicated in 9.9.1.

7.16.4.9.2 CDMA initial ranging and automatic adjustments to an A-BS

First, a CPE shall synchronize to the frame preamble in order to perform initial ranging to an A-BS. At this point, the A-CPE shall scan the US-MAP message to find an Initial Ranging Interval. The A-BS may allocate an Initial Ranging Interval consisting of one or more transmission opportunities. The A-CPE shall extract the number of initial ranging codes (see Table 43, element ID 150) from the UCD MAC management message.

The A-CPE randomly selects the CDMA code as described in 7.17.2.4 and sends the initial ranging CDMA code on the US allocation dedicated for that purpose. The A-BS receives the CDMA code. As many A-CPEs may contend for ranging, the CDMA code received may be the sum of many A-CPE transmissions. The A-BS isolates each of these transmissions and computes the ranging adjustments based on the relative time of arrival of each A-CPE US burst, i.e., the timing offset, so that all these bursts arrive at the A-BS at the beginning of the symbol period within sufficient tolerance.

Ranging adjusts each A-CPE's timing offset such that each A-CPE appears to be co-located with the A-BS. The A-CPE shall set its initial timing offset to "zero advance" as if it was physically co-located with the A-BS. When the Initial Ranging transmission opportunity occurs, the A-CPE shall send a CDMA code. After reception and decoding of this CDMA code, the A-BS will react by sending a RNG-CMD MAC message in a following frame with the same CDMA code and indicate the timing advance that the CPE should use for its US transmissions (see Table 44) so that the beginning of its bursts is aligned with the center of the cyclic prefix within the tolerance indicated in 9.9.1.

When the Initial Ranging transmission opportunity occurs, the A-CPE shall send a CDMA code. Thus, the A-CPE sends the message as if it were co-located with the A-BS.

The A-CPE shall calculate the transmit EIRP per subcarrier for initial ranging, $EIRP_{IR_CPE}$, from Equation (3):

$$EIRP_{IR_CPE} = EIRP_{A\text{-}BS} + RSS_{IR_A\text{-}BS_nom} - (RSS_{IR_CPE} - G_{RX_CPE}) + 10\times\log(N_{IR_sub}/N_{sub}) \quad (3)$$

where

$RSS_{IR_A\text{-}BS_nom}$ and $EIRP_{A\text{-}BS}$ are defined in a DCD IE (see Table 23)
G_{RX_CPE} is the antenna gain at the A-CPE
RSS_{IR_CPE} is the RSSL measured by the A-CPE, which is then corrected by the A-CPE antenna gain to represent the RSSL for an isotropic antenna

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N_{IR_sub} is the number of subcarriers used by the A-CPE for initial ranging

N_{sub} is 840 for PHY-OM2

The A-CPE shall send a CDMA code with a power level resulting in the $EIRP_{IR_CPE}$ per subcarrier. If the A-CPE does not receive a response after waiting at least one frame to allow processing at the A-BS, the A-CPE shall send a new CDMA code at the next appropriate Initial Ranging transmission opportunity with 1 dB higher power level. The A-CPE shall, however, stop increasing the power level at the following condition shown in Equation (4):

$$EIRP_{IR_MAX} + 10 \times \log(N_{IR_sub}) > EIRP_{CPE_MAX} \quad (4)$$

where

$EIRP_{CPE_MAX}$ is the upper bound in maximum transmitted EIRP for the A-CPE on the current operating channel as described in Table 108 or 4 W for the fixed A-CPE, whichever is the smallest

$EIRP_{IR_CPE_MAX}$ is the upper bound for the increased $EIRP_{IR_CPE}$

If the A-CPE receives a RNG-CMD message containing the parameters of the code it has transmitted and the status "continue," it shall consider the transmission attempt unsuccessful but implement the corrections specified in the RNG-CMD and issue another CDMA code after the appropriate backoff delay. If the A-CPE receives a US-MAP containing a CDMA allocation IE with the parameters of the code it has transmitted, it shall consider the RNG-CMD reception successful and proceed to send a unicast RNG-REQ (on Initial Ranging FT, allocated to Cell SID) on the allocated BW.

Once the A-BS has successfully received the RNG-REQ message, it shall return a RNG-CMD message using the initial ranging connection (see Clause 12). Within the RNG-CMD message shall be the Station ID (SID) assigned to this A-CPE. The message shall also contain information on the required CPE EIRP level, the offset frequency adjustment, and the proper timing advance when needed. At this point the A-BS shall start using invited Initial Ranging Intervals addressed to the A-CPE's Basic FT to complete the ranging process, unless the status of the RNG-CMD message is "success," in which case the initial ranging procedure shall end.

If the status of the RNG-CMD message is "continue," the A-CPE shall wait for an individual Initial Ranging Interval assigned to its Basic FT. Using this interval, the A-CPE shall transmit another RNG-REQ message using the Basic FT along with any power level and timing offset corrections.

The A-BS shall return another RNG-CMD message to the A-CPE with any additional fine-tuning required. The ranging request/response steps shall be repeated until the response contains a "Ranging Successful" notification or the A-BS aborts ranging. Once successfully ranged (timing, frequency and EIRP are within tolerance at the A-BS), the A-CPE shall join end user data in the US. In particular, the retry counts and timer values for the ranging process are defined in Table 273.

On receiving a RNG-CMD instruction to move to a new channel during initial ranging, the A-CPE shall obtain a new SID via initial ranging and registration.

It is possible that the RNG-CMD may be lost after transmission by the A-BS. The A-CPE shall recover by timing out and reissuing its Initial RNG-REQ. Since the A-CPE is uniquely identified by the source MAC address in the Ranging Request, the A-BS may immediately reuse the SID previously assigned. If the A-BS assigns a new SID, it shall immediately age out the old SID and associated A-CPE.

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7.16.4.9.3 CDMA initial ranging and automatic adjustments to a distributed scheduling R-CPE (Local initial ranging)

An A-CPE shall synchronize to the local frame preamble within a DRZ in order to perform initial ranging to the distributed scheduling R-CPE. At this point, the A-CPE shall scan the US-MAP message to find an Initial Ranging Interval within a local cell managed by a distributed scheduling R-CPE. The distributed scheduling R-CPE may allocate an Initial Ranging Interval consisting of one or more transmission opportunities in a US DRZ. The A-CPE shall extract the number of initial ranging codes (see Table 43, element ID 150) from the UCD MAC management message.

The A-CPE randomly selects the CDMA code as described in 7.17.2.4 and sends the initial ranging CDMA code on the US DRZ allocation dedicated for that purpose. The distributed scheduling R-CPE receives the CDMA code. As many A-CPEs may contend for ranging, the CDMA code received may be the sum of many CPE transmissions. The distributed scheduling A-CPE isolates each of these transmissions and computes the ranging adjustments based on the relative time of arrival of each A-CPE US burst, i.e., the timing offset, so that all these bursts arrive at the distributed scheduling R-CPE at the beginning of the symbol period within sufficient tolerance.

Ranging adjusts each A-CPE's timing offset such that each A-CPE appears to be co-located with the distributed scheduling R-CPE. The CPE shall set its initial timing offset to "zero advance" as if it was physically co-located with the distributed scheduling R-CPE. When the Initial Ranging transmission opportunity occurs in the DRZ, the A-CPE shall send a CDMA code. After reception and decoding of this CDMA code, the distributed scheduling R-CPE will react by sending a RNG-CMD MAC message in a following frame with the same CDMA code and indicate the timing advance that the A-CPE should use for its US transmissions (see Table 44) so that the beginning of its bursts is aligned with the center of the cyclic prefix within the tolerance indicated in 9.9.1.

When the Initial Ranging transmission opportunity occurs in the DRZ, the A-CPE shall send an initial ranging CDMA code. Thus, the A-CPE sends the message as if it were co-located with the distributed scheduling R-CPE.

The A-CPE shall calculate the transmit EIRP per subcarrier for initial ranging, $EIRP_{IR_CPE}$, from Equation (5):

$$EIRP_{IR_CPE} = EIRP_{A\text{-}CPE} + RSS_{IR_A\text{-}CPE_nom} - (RSS_{IR_CPE} - G_{RX_CPE}) + 10\times\log(N_{IR_sub}/N_{sub}) \quad (5)$$

where

$RSS_{IR_A\text{-}CPE_nom}$ and $EIRP_{A\text{-}CPE}$	are defined in a DCD IE (see Table 23)
G_{RX_CPE}	is the antenna gain at the A-CPE
RSS_{IR_CPE}	is the RSSL measured by the A-CPE, which is then corrected by the A-CPE antenna gain to represent the RSSL for an isotropic antenna
N_{IR_sub}	is the number of subcarriers used by the A-CPE for initial ranging
N_{sub}	is 840 for PHY-OM2

The A-CPE shall send a CDMA code with a power level resulting in the $EIRP_{IR_CPE}$ per subcarrier. If the CPE does not receive a response after waiting at least one frame to allow processing at the distributed scheduling R-CPE, the A-CPE shall send a new CDMA code at the next appropriate Initial Ranging transmission opportunity with 1 dB higher power level. The A-CPE shall, however, stop increasing the power level at the following condition shown in Equation (6):

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$$EIRP_{IR_MAX} + 10 \times \log(N_{IR_sub}) > EIRP_{CPE_MAX} \quad (6)$$

where

$EIRP_{CPE_MAX}$ is the upper bound in maximum transmitted EIRP for the A-CPE on the current operating channel as described in Table 108 or 4 W for the fixed A-CPE, whichever is the smallest

$EIRP_{IR_CPE_MAX}$ is the upper bound for the increased $EIRP_{IR_CPE}$

If the A-CPE receives a RNG-CMD message containing the parameters of the code it has transmitted and the status "continue," it shall consider the transmission attempt unsuccessful but implement the corrections specified in the RNG-CMD and issue another CDMA code after the appropriate backoff delay. If the A-CPE receives a US-MAP containing a CDMA allocation IE with the parameters of the code it has transmitted, it shall consider the RNG-CMD reception successful and proceed to send a unicast RNG-REQ (on Initial Ranging FT, allocated to Cell SID) on the allocated BW.

Once the distributed scheduling R-CPE has successfully received the RNG-REQ message, it shall return a RNG-CMD message using the initial ranging connection (see Clause 12). Within the RNG-CMD message shall be the one SID, which is selected from the Local SID Group (7.9.7.3.6), assigned to this A-CPE. Note that a distributed scheduling R-CPE shall obtain the Local SID Group (7.9.7.3.6) used in a local cell from the A-BS at registration. The RNG-CMD message shall also contain information on the required A-CPE EIRP level, the offset frequency adjustment, and the proper timing advance when needed. At this point the distributed scheduling R-CPE shall start using the invited Initial Ranging Intervals addressed to the CPE's Basic FT to complete the ranging process, unless the status of the RNG-CMD message is "success," in which case the initial ranging procedure shall end.

If the status of the RNG-CMD message is "continue," the A-CPE shall wait for an individual Initial Ranging Interval assigned to its Basic FT. Using this interval, the A-CPE shall transmit another RNG-REQ message using the Basic FT along with any power level and timing offset corrections.

The distributed scheduling R-CPE shall return another RNG-CMD message to the A-CPE with any additional fine-tuning required. The ranging request/response steps shall be repeated until the response contains a "Ranging Successful" notification or the R-CPE aborts ranging. Once successfully ranged (timing, frequency and EIRP are within tolerance at the R-CPE), the A-CPE shall join normal data traffic in the US. In particular, the retry counts and timer values for the ranging process are defined in Table 273.

On receiving a RNG-CMD instruction to move to a new channel during initial ranging, the A-CPE shall obtain a new SID via initial ranging and registration.

It is possible that the RNG-CMD may be lost after transmission by the distributed scheduling R-CPE. The A-CPE shall recover by timing out and reissuing its Initial RNG-REQ. Since the A-CPE is uniquely identified by the source MAC address in the Ranging Request, the distributed scheduling R-CPE may immediately reuse the SID previously assigned. If the distributed scheduling R-CPE assigns a new SID, it shall immediately age out the old SID and associated A-CPE.

7.16.4.9.4 CDMA initial ranging and automatic adjustments by relaying on a centralized scheduling R-CPE (Relay initial ranging)

Although a A-CPE successfully obtains DS parameters from an A-BS, CDMA initial ranging to the A-BS as described in 7.16.4.9.2 may fail due to the A-CPE transmitting power constraint. However, a A-CPE is still able to have an uplink to the A-BS by relaying on a centralized scheduling R-CPE. A A-CPE shall synchronize to the frame preamble in order to perform initial ranging to an A-BS. At this point, the A-CPE shall scan the US-MAP message to find an Initial Ranging Interval in AZ and Initial Ranging Interval in

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CRZ if present. The A-BS may allocate an Initial Ranging Interval consisting of one or more transmission opportunities within a US subframe CRZ. The A-CPE shall extract the number of initial ranging codes and may extract the number of CRZ initial ranging codes (see Table 43, element ID 155) from the UCD MAC management message.

The A-CPE randomly selects the CDMA code as described in 7.17.2.4, sends the initial ranging CDMA code to the A-BS on the Initial Ranging Interval, and sends the CRZ initial ranging CDMA code to the centralized scheduling R-CPE on the CRZ Initial Ranging Interval as well in the US allocation dedicated for that purpose. The initial ranging between the A-CPE and the A-BS shall be as described in 7.16.4.9.2. The following describes when the CRZ initial ranging is performed between the A-CPE and the centralized scheduling R-CPE.

The centralized scheduling R-CPE may receive the CRZ Initial Ranging CDMA code within the Initial Ranging Interval in a US subframe CRZ. As many A-CPEs may contend for ranging, the CDMA code received may be the sum of many CPE transmissions. The centralized scheduling R-CPE isolates each of these transmissions and computes the ranging adjustments based on the relative time of arrival of each CPE US burst, i.e., the timing offset, so that all these bursts arrive at the centralized scheduling R-CPE at the beginning of the symbol period within sufficient tolerance.

Ranging adjusts each CPE's timing offset such that each A-CPE appears to be co-located with the centralized scheduling R-CPE. The A-CPE shall set its initial timing offset to "zero advance" as if it was physically co-located with the centralized scheduling R-CPE. When the Initial Ranging transmission opportunity occurs in the CRZ, the A-CPE may send a CRZ initial ranging CDMA code. After reception and decoding of this CDMA code, the centralized scheduling A-CPE will send a RNG-RPT message (7.9.31) to the A-BS, where instead of the centralized scheduling R-CPE the A-BS will react by sending a RNG-CMD MAC message in a following frame with the received CDMA code and indicate the timing advance that the A-CPE should use for its US transmissions (see Table 44) so that the beginning of its bursts is aligned with the center of the cyclic prefix within the tolerance indicated in 9.9.1. The A-CPE randomly selects the CRZ initial ranging CDMA code as described in 7.17.2.4.2 and sends the CDMA code to the centralized scheduling R-CPE on the Initial Ranging Interval in the CRZ. Thus, the A-CPE sends the message as if it were co-located with the centralized scheduling R-CPE.

The A-CPE shall calculate the transmit EIRP per subcarrier for initial ranging, $EIRP_{IR_CPE}$, from Equation (7):

$$EIRP_{IR_CPE} = EIRP_{A\text{-}CPE} + RSS_{IR_A\text{-}CPE_nom} - (RSS_{IR_CPE} - G_{RX_CPE}) + 10\times\log(N_{IR_sub}/N_{sub}) \quad (7)$$

where

$RSS_{IR_A\text{-}CPE_nom}$ and $EIRP_{A\text{-}CPE}$	are defined in a DCD IE (see Table 123)
G_{RX_CPE}	is the antenna gain at the A-CPE
RSS_{IR_CPE}	is the RSSL measured by the A-CPE, which is then corrected by the A-CPE antenna gain to represent the RSSL for an isotropic antenna
N_{IR_sub}	is the number of subcarriers used by the A-CPE for initial ranging
N_{sub}	is 840 for PHY-OM2

The A-CPE shall send a CDMA code with a power level resulting in the $EIRP_{IR_CPE}$ per subcarrier. If the A-CPE does not receive a response after waiting at least one frame to allow processing at the centralized scheduling R-CPE, the A-CPE shall send a new CDMA code at the next appropriate Initial Ranging transmission opportunity with 1 dB higher power level. The A-CPE shall, however, stop increasing the power level at the following condition shown in Equation (8):

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$$EIRP_{IR_MAX} + 10 \times \log(N_{IR_sub}) > EIRP_{CPE_MAX} \quad (8)$$

where

$EIRP_{CPE_MAX}$ is the upper bound in maximum transmitted EIRP for the A-CPE on the current operating channel as described in Table 108 or 4 W for the fixed A-CPE, whichever is the smallest

$EIRP_{IR_CPE_MAX}$ is the upper bound for the increased EIRPIR_CPE

If the A-CPE receives a RNG-CMD message containing the parameters of the code from the A-BS it has transmitted and the status "continue," it shall consider the transmission attempt unsuccessful but implement the corrections specified in the RNG-CMD and issue another CDMA code after the appropriate backoff delay. If the A-CPE receives an CRZUS-MAP containing a CDMA allocation IE with the parameters of the code it has transmitted, it shall consider the RNG-CMD reception successful and proceed to send a unicast RNG-REQ (on Initial Ranging FT, allocated to Cell SID) on the allocated BW. The centralized scheduling R-CPE shall transmit the RNG-REQ received from the A-CPE to the A-BS.

Once the A-BS has successfully received the RNG-REQ message, the A-BS shall return a RNG-CMD message to the A-CPE. Within the RNG-CMD message shall be the SID assigned to this A-CPE. In addition, the centralized scheduling R-CPE shall maintain the SID of the A-CPE broadcast by the RNG-CMD.

Moreover, a A-CPE can successfully perform CDMA initial ranging to the several devices including an A-BS and centralized scheduling R-CPEs. In this case, the A-CPE shall select one of those.

7.16.4.9.5 Ranging parameter adjustment

Adjustment of local parameters (e.g., transmit EIRP) in a CPE as a result of the receipt or non-receipt of a RNG-CMD message is considered to be implementation-dependent with the following restrictions:

a) All parameters shall be within the approved range at all times.

b) EIRP adjustment shall start from the initial value selected with the algorithm described in 7.16.4.9.2, 7.16.4.8.3, or 7.16.4.8.4 unless a valid EIRP setting is available from non-volatile storage, in which case this value may be used as the starting point.

c) EIRP adjustment shall be capable of being reduced or increased by the specified amount in response to the RNG-CMD messages.

d) If, during initialization, EIRP is increased to the maximum value as determined in 7.16.4.9.2, 7.16.4.8.3, or 7.16.4.8.4 without a response from the A-BS, it shall go back to the minimum EIRP and ramp up to its maximum EIRP four (4) times before aborting the ranging process with this BS.

On receiving a RNG-CMD message, the CPE shall not transmit until the radio frequency (RF) signal has been adjusted in accordance with the RNG-CMD and has stabilized.

7.16.4.10 CPE transmit basic capabilities for a relay network

7.16.4.10.1 CPE transmit basic capabilities to a distributed scheduling R-CPE

Immediately following the completion of initial ranging in a DRZ, the A-CPE informs the distributed scheduling R-CPE of its basic capabilities by transmitting a CBC-REQ message (see Table 105) with its capabilities set to "on" (see Figure 39). Note that T18 is a timer used to wait for CBC-RSP timeout, and the default value is indicated in Table 272.

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The distributed scheduling R-CPE responds with a CBC-RSP message (see Table 106) with the intersection of the A-CPE's and distributed scheduling R-CPE's capabilities set to "on" (see Figure 53 and Figure 71, respectively). The timer T9 refers to the time allowed between when the distributed scheduling R-CPE sends a RNG-CMD to a A-CPE and receives a CBC-REQ from that same A-CPE, and the minimum value is specified in Table 272. Note that the A-CPE capability information is presented in 7.9.7.3.4. When T9 expires, the SID assigned during ranging shall be aged out, and the A-CPE shall have to attempt the ranging process over again while not exceeding the maximum number of CDMA ranging retries indicated in Table 273.

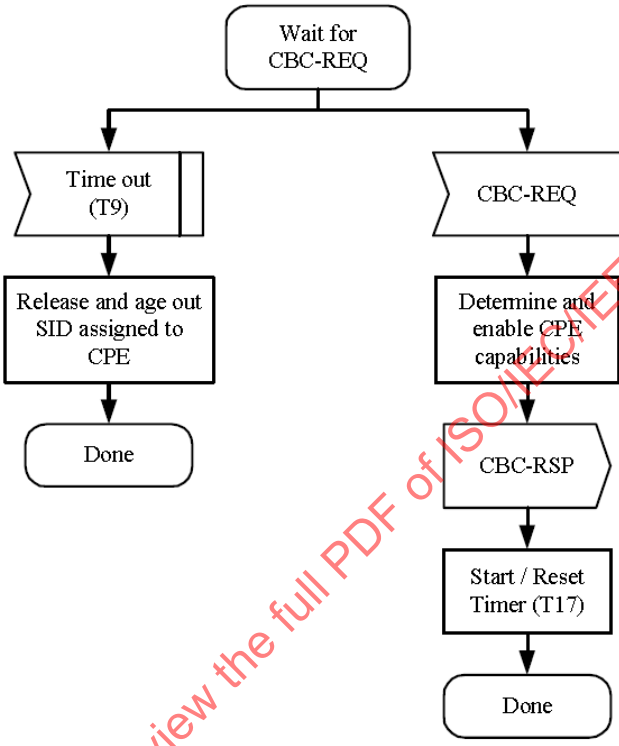

Figure 71—Negotiate basic capabilities at distributed scheduling R-CPE

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7.16.4.10.2 CPE transmit basic capabilities relaying on a centralized scheduling R-CPE

Immediately following the completion of initial ranging in a CRZ, the A-CPE informs the centralized scheduling R-CPE of its basic capabilities by transmitting a CBC-REQ message (see Table 105) with its capabilities set to "on" (see Figure 39). Note that T18 is a timer used to wait for CBC-RSP timeout, and the default value is indicated in Table 272. When the centralized scheduling A-CPE receives the CBC-REQ messages from the A-CPEs, the centralized scheduling R-CPE may transmit CBC-REQ message alone or a Container message (7.9.26) containing the received CBC-REQ messages to the A-BS (see Figure 72). Note that the Container messages may contain not only CBC-REQ messages but also other management messages. Note that T61 is a timer used to wait for Container ACK timeout, which is indicated in Table 272.

When the A-BS has successfully received the CBC-REQ message by encoding the received Container message, it shall return a Container ACK message (7.9.26.2) with a confirmation code for the CBC-REQ to the centralized scheduling R-CPE. If the confirmation code for a certain management message is not "success," the centralized scheduling R-CPE shall retransmit the indicated management message to the A-BS (see Figure 73). After correctly receiving the CBC-REQ, the A-BS responds with a CBC-RSP message (see Table 106) to the A-CPE, with the intersection of the A-CPE's and A-BS's capabilities set to "on." The timer T9 refers to the time allowed between when the A-BS sends a RNG-CMD to a A-CPE and receives a CBC-REQ from that same A-CPE, and the minimum value is specified in Table 272. Note that the CPE

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capability information is presented in 7.9.7.3.4. When T9 expires, the SID assigned during ranging shall be aged out, and the A-CPE shall have to attempt the ranging process over again while not exceeding the maximum number of CDMA ranging retries indicated in Table 273.

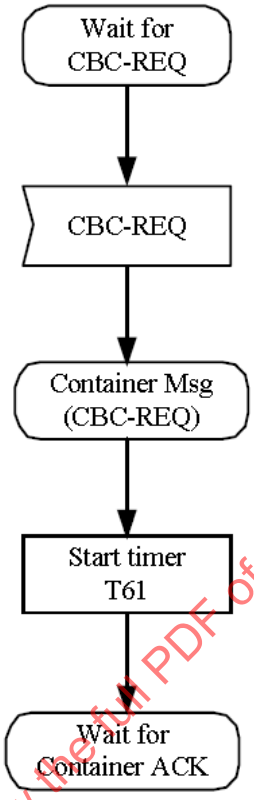

Figure 72—Wait for CBC-REQ and sending container message including CBC-REQ at a centralized scheduling R-CPE

7.16.4.11 A-CPE authentication and key exchange

Once configuration of the required basic capabilities is completed, the A-CPE and AAA continue with performing authentication and exchanging keys, as described in Clause 8. If the AAA and A-CPE cannot authenticate each other, authentication of the A-CPE fails for the selected A-WRAN service. This A-WRAN service on the selected channel is removed from further consideration. If there are any other A-BSs available with which to associate, the updated list of available A-WRAN services is presented to the higher user layers.

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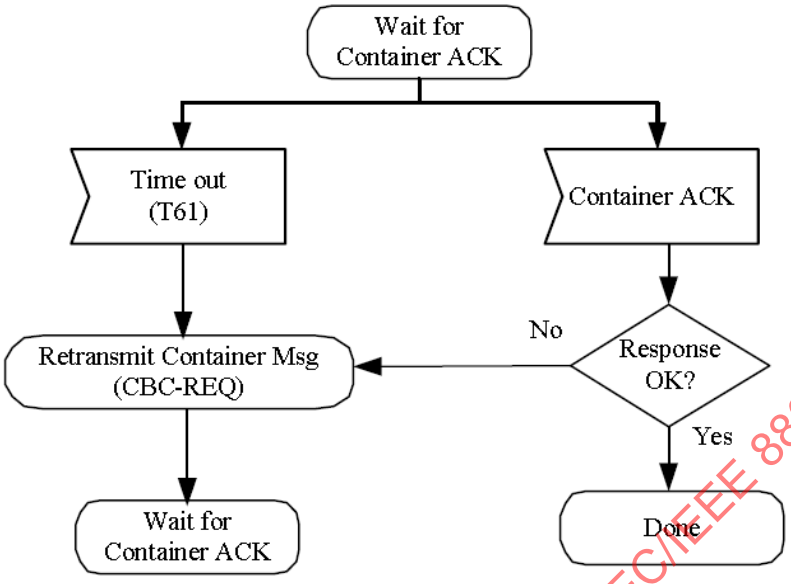

Figure 73—Wait for Container ACK at a centralized scheduling A-CPE

7.16.4.12 Registration for a relay network

7.16.4.12.1 Overview

Registration is the process by which the A-CPE verifies its configuration with the A-BS. If the A-CPE supports a configuration that is set by the A-BS, it is allowed entry into the network and thus becomes manageable. To register with an A-BS, the A-CPE shall send a REG-REQ message to the A-BS directly or send it through a centralized scheduling A-CPE or a distributed scheduling A-CPE by relaying. The REG-REQ message shall include a CPE NMEA Location string IE except for Mode I CPE (see Table A.2).

See 7.14.2 for registration procedures, using "A-BS instead of "BS" in the text.

7.16.4.12.2 Local cell management on relay

A local cell is the grouping of A-CPEs attached to the A-BS through a particular distributed scheduling R-CPE. When an A-CPE completes registration or de-registration at the distributed scheduling R-CPE, the R-CPE shall update the A-BS with any changes to the current membership of the local cell. This is necessary for the A-BS to be able to have a complete picture of the topology of the network.

In order to determine if a local cell update (LCU) is required, the distributed scheduling R-CPE watches for Container Messages or stand-alone management messages coming from the A-BS. For each MAC PDU encapsulated in a Container Message (CON-MSG), the PDU Type subfield (see 7.9.26.1) indicates the purpose of the message encapsulated by the MAC PDU being sent to an A-CPE. The PDU Type field in the CON-MSG shall be handled as follows:

- PDU Type = 0x00, REG-RSP:
  - The A-BS sends REG-RSP to the A-CPE, and then the A-CPE completes the registration upon receiving MAC PDU containing this message (as forwarded by R-CPE).
  - In this case the A-CPE shall send the LCU-IND message to the A-BS to update local cell membership (Figure 74) and wait for an LCU-ACK sent from the A-BS. Figure 75 presents the

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procedure where the R-CPE waits for an LCU-ACK, and Figure 76 presents the procedure where the A-BS sends an LCU-ACK after it has received an LCU-INC from the R-CPE.

- PDU Type = 0x01, DREG-CMD with Action Code = 0x04 or 0x05:
  - The A-BS asks the A-CPE to either terminate operation and shutdown (Action Code = 0x04) or reinitialize on another operating channel (Action Code = 0x05). In either case the A-CPE ceases operation because it is fully de-registered.
  - In this case the R-CPE shall send the LCU-IND message to the A-BS to update local cell membership (Figure 74) and wait for an LCU-ACK sent from the A-BS. Figure 75 presents the procedure where the A-CPE waits for an LCU-ACK, and Figure 76 presents the procedure where the A-BS sends an LCU-ACK after it has received an LCU-INC from the R-CPE.
- PDU Type = 0x02, DREG-CMD with Action Code = 0x01, 0x02, 0x03:
  - The A-BS asks the A-CPE to only listen for transmission on Basic/Primary Management/ Secondary Management FT (Action Code = 0x02), temporarily suspend operation (Action Code = 0x01), or resume operation (Action Code = 0x03).
  - In this case the R-CPE shall not send the LCU-IND message to the A-BS.
- PDU Type = 0x03, Any Other PDU:
  - The A-BS sends any other non-registration or de-registration message or general MAC PDU to the A-CPE.
  - In this case the R-CPE shall not send the LCU-IND message to the A-BS.

The PDU Type field shall be set to 0x03 when the A-CPE sends a CON-MSG in the US to the A-BS.

Given the rules for processing the PDU Type field in the CON-MSG, it is clear that the R-CPE shall not be capable of originating REG-RSP and DREG-CMD messages to be sent to an A-CPE itself.

Regarding other local cell operations, the R-CPE shall be capable of originating messages related to ranging (i.e., RNG-CMD) and basic capability negotiation (i.e., CBC-RSP) with the A-CPE locally in the access zone.

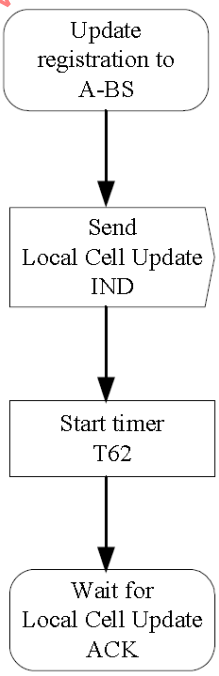

Figure 74—Sending LCU-IND from a distributed scheduling R-CPE

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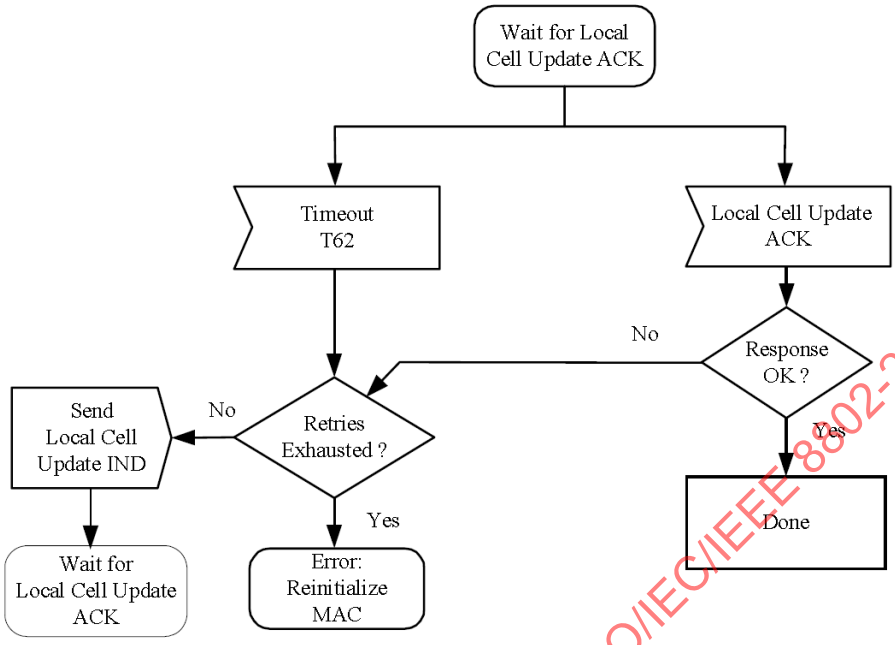

Figure 75—Wait for LCU-ACK at a distributed scheduling R-CPE

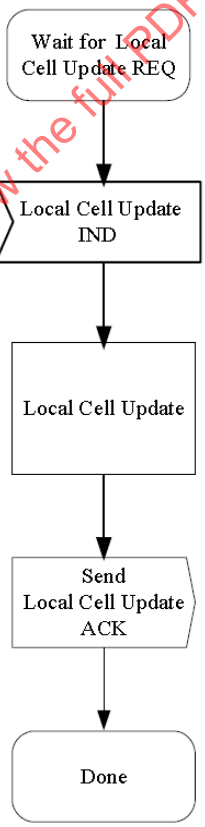

Figure 76—Local cell update at A-BS

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7.16.4.13 A-BS transmits channel sets to A-CPE

The A-BS shall send the channel sets to the new CPE. The channel sets are described in 11.2.3. The channel sets that are sent to the initializing A-CPE are the backup channels and the candidate channels. The channel sets are sent in a DCD message, as described in 7.9.1 and in Table 24 to Table 26. The A-BS shall send DCD channel information elements 11 and 12. Table 26 describes information element 12 as the backup and candidate channel list. It is a prioritized list of the channels with the backup channel set higher in priority than the candidate channel set. The two sets are identified by sending information element 11, which provides the number of the higher prioritized backup channel set. Each channel in DCD information element 12 is characterized by both the channel number.

The distributed scheduling R-CPE shall send the channel sets received from A-BS to the new CPE, which is registered with the distributed scheduling R-CPE. The channel sets are described in 11.2.3. The channel sets that are sent to the initializing A-CPE are the backup channels and the candidate channels. The channel sets are sent in a DCD message in a DRZ, as described in 7.9.1 and in Table 24 to Table 26. The distributed scheduling R-CPE shall send DCD channel information elements 11 and 12. Table 26 describes information element 12 as the backup and candidate channel list. It is a prioritized list of the channels with the backup channel set higher in priority than the candidate channel set. The two sets are identified by sending information element 11, which provides the number of the higher prioritized backup channel set. Each channel in DCD information element 12 is characterized by both the channel number.

7.16.4.14 Establish IP connectivity

The A-CPE shall invoke DHCP mechanism (IETF RFC 2131 [B20]) in order to obtain an IP address and any other parameters needed to establish IP connectivity. If the CPE has a configuration file, the DHCP response shall contain the name of a file that contains further configuration parameters.

Establishment of IP connectivity shall be performed on the A-CPE's secondary management connection as shown in Figure 45.

In case where dynamic IP configuration is not preferred, the A-CPE shall obtain an IP address from its BS.

7.16.4.15 Establish time of day

The A-CPE and A-BS need to have the current date and time. This is required for time-stamping logged events for retrieval by the management system. This needs not be authenticated and needs to be accurate only to the nearest second. The current date and time may be obtained from a local time source or a remote service such as an NTP server. See Figure 46.

Successfully acquiring the Time of Day is not mandatory for a successful registration, but is necessary for ongoing operation. The specific timeout for Time of Day Requests is implementation dependent.

7.16.4.16 Transfer operational parameters

The A-CPE shall download the A-CPE's configuration file using TFTP on its own secondary management connection as shown in Figure 47. The A-CPE shall use an adaptive timeout for TFTP based on binary exponential backoff.

When the configuration file download has completed successfully, the A-CPE shall notify the A-BS directly or through the R-CPE by transmitting the TFTP-CPLT message on the CPE's primary management connection. Transmissions shall continue successfully until a TFTP-RSP message is received with response "OK" from the A-BS (see Figure 48 and Figure 49) or the A-CPE terminates retransmission due to retry exhaustion.

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Upon sending a REG-RSP, the A-BS shall wait for a TFTP-CPLT. If the timer T13 (defined in Table 272) expires, the A-BS shall restart the registration process (REG-REQ/RSP) with the A-CPE (see Figure 48). Note that the Timer T26 refers to the time waited for TFTP-RSP. If T26 expires, then TFTP-CPLT is attempted until the maximum number of retries is exhausted. Upon the exhaustion, the A-CPE shall be deregistered (i.e., forced to reinitialize MAC) by sending a DREG-REQ with Action Code set to 0x05 to force itself to reattempt system access or 0x04 to shut itself down (see Figure 49).

7.16.4.17 Establish dynamic service flows

After the transfer of operational parameters for the A-CPE, the A-BS shall send DSA-REQ messages (Table 64) to the A-CPE to set up pre-provisioned service flows belonging to the A-CPE. The A-CPE responds with DSA-RSP messages. This is described further in 7.20.7.1.

7.16.4.18 Neighboring network discovery

After a A-CPE has registered with an A-WRAN A-BS, it shall perform neighboring network discovery in order to identify other nearby A-WRANs and enable efficient self-coexistence, if the A-CPE has not already done so. The neighboring network discovery involves listening to the medium for CBP packets or A-BS transmitted by other A-WRAN A-BSs. This network discovery mechanism is described in 7.22.1.3.

7.16.5 A-CPE/R-CPE initialization for relay on PHY-OM2 Summary

In the relay network A-CPE can attached to the A-BS in either one of the three ways:

a) A-CPE attaches directly to BS
b) A-CPE attaches directly to A-BS as assisted by a centralized scheduling R-CPE
c) A-CPE attaches indirectly to A-BS assisting a distributed scheduling R-CPE

In the case of (a) and (b), A-CPEs acquire DS/US parameters from and completes ranging with the A-BS use the procedures as defined in 7.16.4. In the case of (c), the A-CPE acquires DS/US parameters from and ranges with the distributed scheduling R-CPE, as defined in 7.16.4. After these steps, the rest of the initialization process is completed by exchanging messages with the A-BS.

R-CPEs attach conduct initialization by acquiring DS/US parameters and conducting ranging with the A-BS directly.

7.17 Ranging

To deal with the large propagation delays and varying RF signal quality between CPEs and the BS, the MAC incorporates a *ranging* procedure. Ranging is a collection of processes by which the CPE and BS maintain synchronization as well as quality of the RF communication link between them. Distinct processes are used for managing DS and US.

The A-WRAN provides the same ranging services as the WRAN provides, in addition ranging services that support relaying. The ranging the A-WRAN supports can be categorized as follows:

a) Between A-CPEs and A-BS (ranging)
b) Between A-CPEs and A-BS from relaying on the centralized scheduling R-CPE (relay ranging)
c) Between A-CPEs and the distributed scheduling R-CPE (local ranging)

Note that when an A-CPE connects directly to an A-BS, the A-CPE shall use the procedure defined in 7.17.1.1.

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7.17.1 Downstream management

7.17.1.1 DS management (WRAN: BS and CPE, A-WRAN: A-BS and A-CPE)

To maintain efficient operation between the BS and CPEs, the DS burst profile is determined by the BS according to the quality of the signal that is received by each CPE. To reduce the volume of US traffic, the CPE monitors the CINR and compares the average value against the allowed range of operation. As shown in Figure 77, threshold levels bound this region. These thresholds parameters are specified in the DCD message, and shall be used by CPEs to determine their optimal burst profile. If the received CINR falls outside of the allowed operating region as determined by the threshold parameters, the CPE requests a change to a new burst profile using one of the following two methods:

a) If the CPE has been granted US bandwidth (a data grant allocation to the CPE's Basic FT), the CPE shall send a RNG-REQ message in that allocation. The BS responds with a RNG-CMD message.

b) If a grant is not available and the CPE requires a more robust burst profile on the DS, the CPE shall send a RNG-REQ message in an Initial Ranging interval.

In either of these methods, the message is sent using the CPE's Basic FT. The coordination of message transmission and reception relative to actual change of modulation is different depending upon whether a CPE is transitioning to a more or less robust burst profile. Figure 78 shows the case where a CPE is transitioning to a more robust profile, while Figure 79 illustrates the transition to a less robust profile.

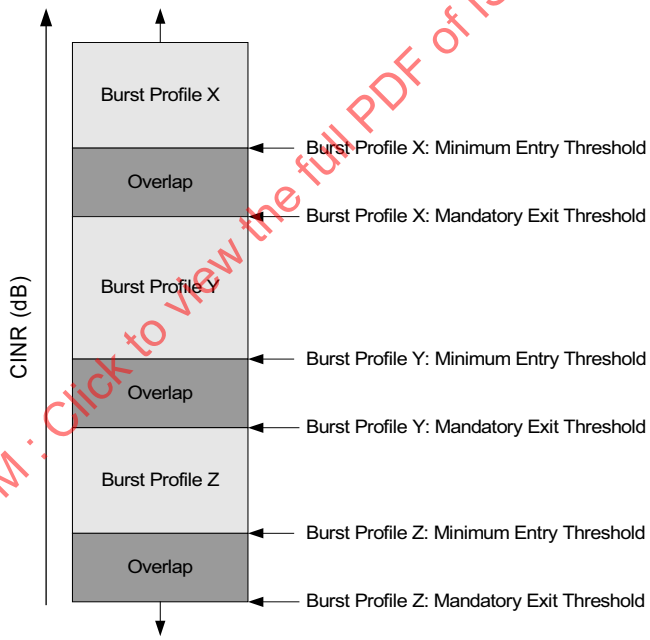

Figure 77—Burst profiles and threshold utilization

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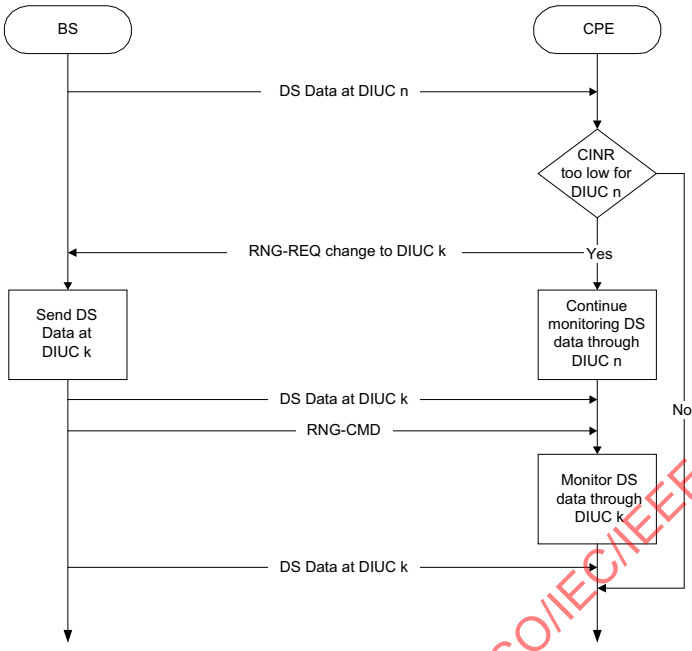

Figure 78—Change to a more robust profile

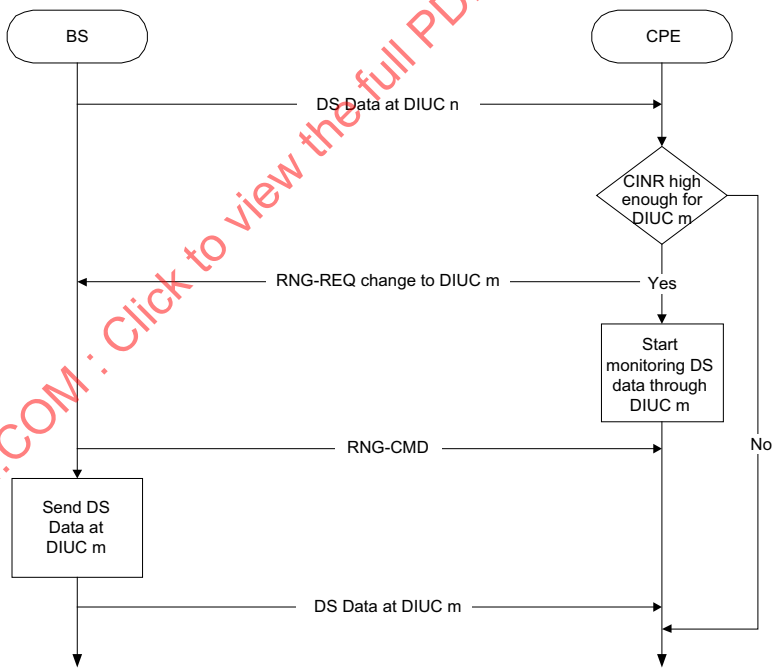

Figure 79—Change to a less robust profile

7.17.1.2 Local DS management (distributed scheduling R-CPE and A-CPE, PHY-OM2)

To maintain efficient local cell operations between the distributed scheduling R-CPE and A-CPEs, the DS burst profile in a DRZ is determined by the distributed scheduling R-CPE according to the quality of the signal that is received by each A-CPE. To reduce the volume of US traffic in a DRZ, the A-CPE monitors

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the CINR and compares the average value against the allowed range of operation. As shown in Figure 50, threshold levels bound this region. These thresholds parameters are specified in the DCD message transmitted by the distributed scheduling R-CPE and shall be used by A-CPEs to determine their optimal burst profile. If the received CINR falls outside of the allowed operating region as determined by the threshold parameters, the A-CPE requests a change to a new burst profile using one of the following two methods:

a) If the A-CPE has been granted US bandwidth in a DRZ (a data grant allocation to the A-CPE's Basic FT), the A-CPE shall send a RNG-REQ message in that allocation. The distributed scheduling R-CPE responds with a RNG-CMD message.

b) If a grant is not available and the A-CPE requires a more robust burst profile on the DS, the A-CPE shall send a RNG-REQ message in an Initial Ranging interval of the DRZ.

In either of these methods, the message is sent using the A-CPE's Basic FT. The coordination of message transmission and reception relative to actual change of modulation is different depending upon whether an A-CPE is transitioning to a more or less robust burst profile. Figure 80 shows the case where an A-CPE is transitioning to a more robust profile, and Figure 81 illustrates the transition to a less robust profile.

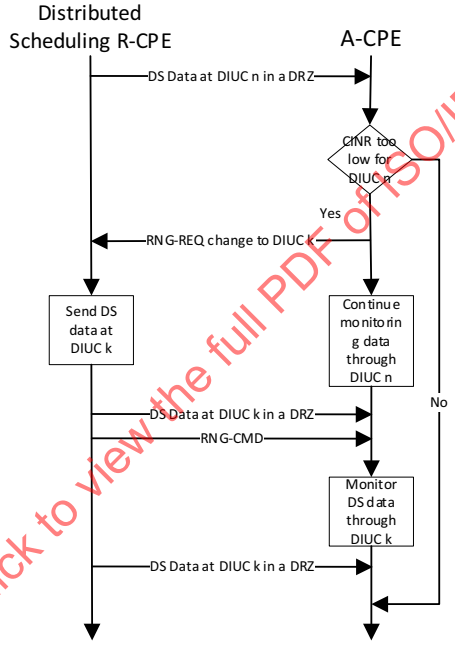

Figure 80—Change to a more robust profile in a local cell

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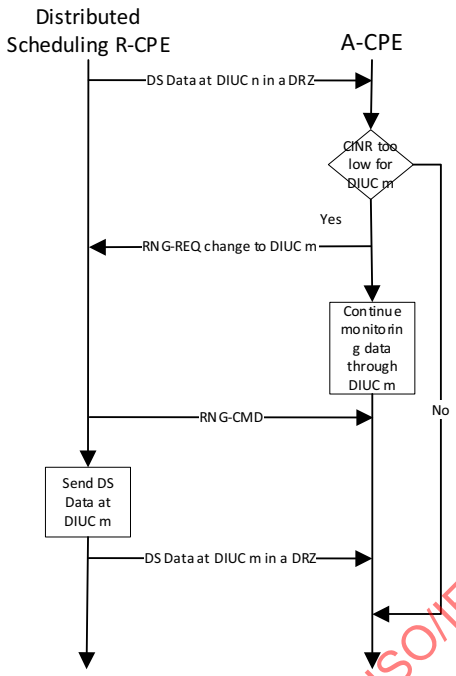

Figure 81—Change to a less robust profile in a local cell

7.17.1.3 Relay DS management (A-BS and A-CPE via centralized scheduling R-CPE, PHY-OM2)

Direct DS from the A-BS to the A-CPE may transit to relay DS from the A-BS to the A-CPE through the centralized scheduling R-CPE as shown in Figure 82 when the relay DS has a higher gain than the DS, and vice versa.

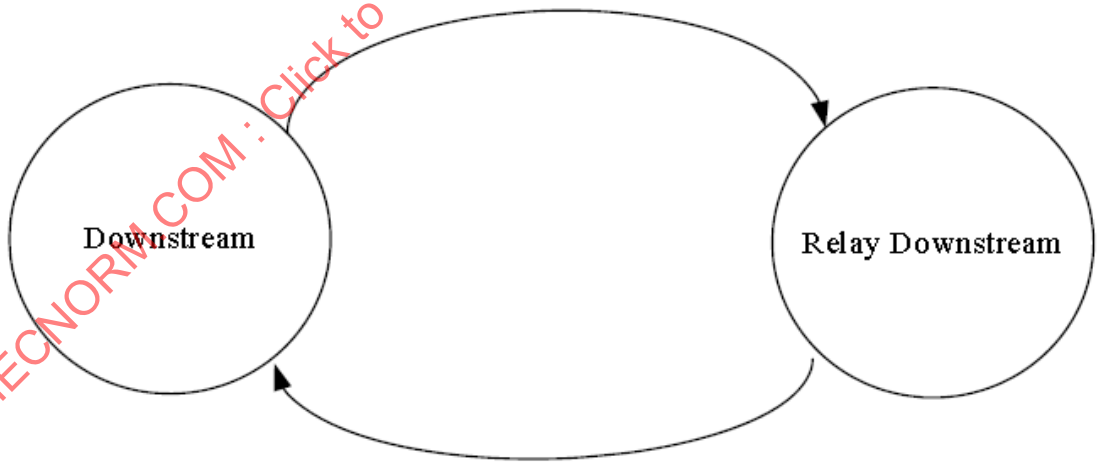

Figure 82—Transit between DS and relay DS

The transit from DS to relay DS may be performed from the request of each A-CPE. Before an A-CPE transits DS to relay DS, the A-CPE shall confirm the relay DS burst profile by the following relay DS test procedure (see Figure 83).

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— The A-CPE shall detect a centralized scheduling R-CPE for relay by a CRZ initial ranging procedure.

— If CRZ initial ranging is successfully finished, the A-CPE requests the A-BS to start a relay DS test by sending a DS Transit Test Request (DTT-REQ, 7.9.27.1), which includes a selected centralized scheduling R-CPE's SID (Figure 84).

— The A-BS sends a DS Transit Test Response (DTT-RSP, 7.9.27.1.2), which indicates the start frame of a bandwidth allocation for a relay DS test, to the A-CPE.

— During the allocated bandwidth, the A-BS transmits test frames to the A-CPE by relaying on the centralized scheduling R-CPE (Figure 85).

— The A-CPE calculates relay DS burst profile and reports the calculation result (DST-RPT, 7.9.27.3), which includes a relay DS bust profile, to the A-BS.

— Based on the relay DS burst profile, the A-BS decides to transit from DS to relay DS, and a DS Transmit Confirmation (DST-CFM, 7.9.27.4) is sent to the A-CPE (Figure 86).

Before an A-CPE transits from relay DS to DS, on the other hand, the A-CPE shall confirm the DS burst profile.

— The A-CPE shall confirm DS burst profile from monitoring signals such as a frame preamble, A-FCH, or DS-MAP transmitted by the A-BS.

— The A-CPE reports the DS burst profile to the A-BS by using a DST-RPT (7.9.27.3).

— Based on the relay DS burst profile, the A-BS decides to transit from relay DS to DS, and a DST-CFM (7.9.27.4) is sent to the CPE.

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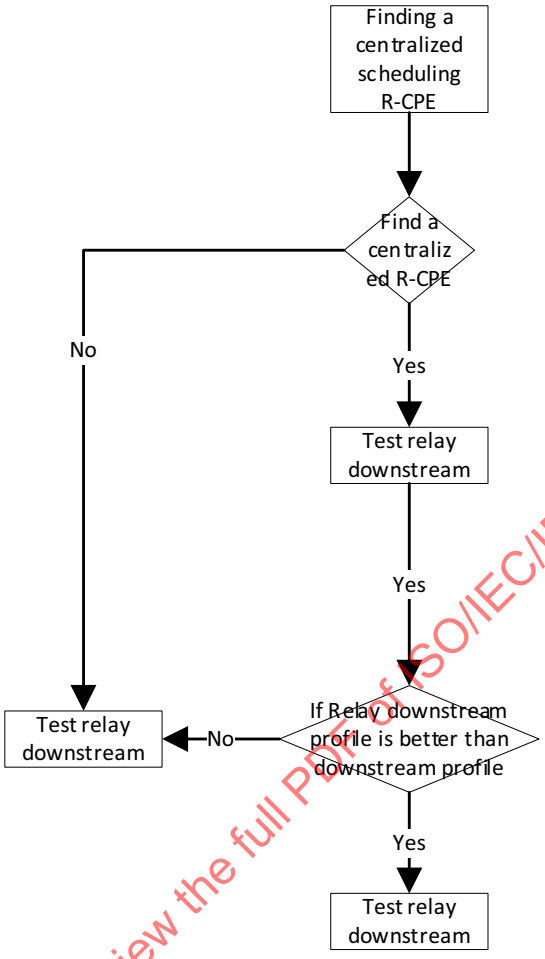

Figure 83—Relay DS test procedure

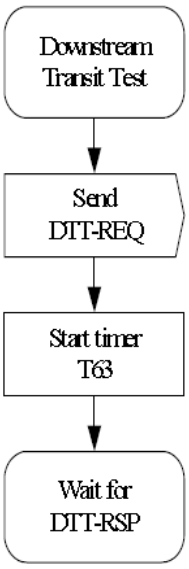

Figure 84—DS transit request—CPE

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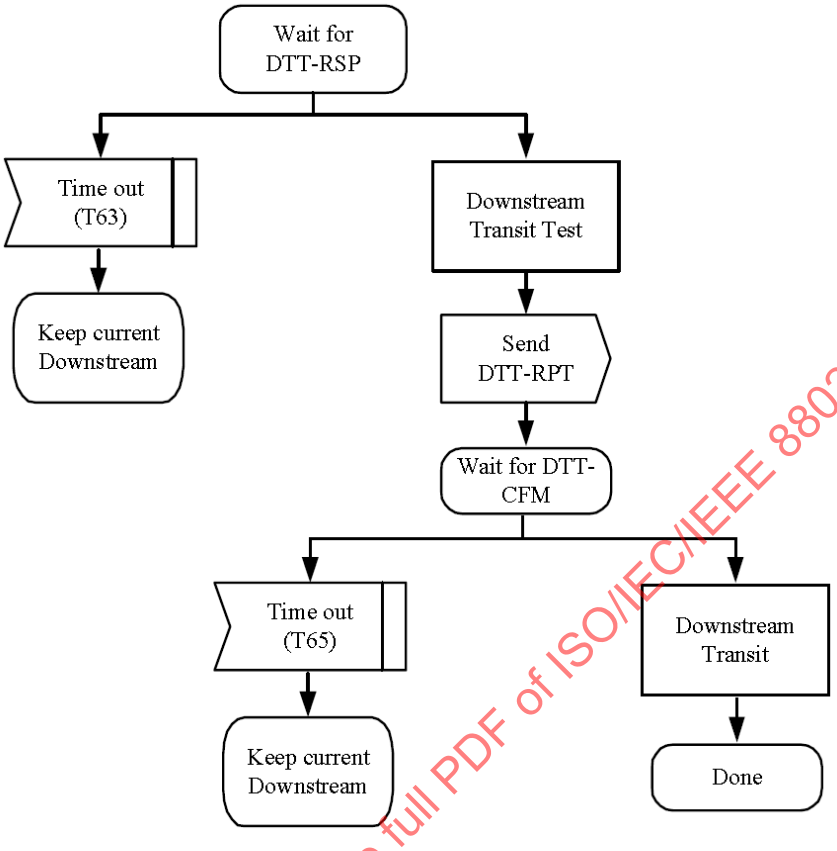

Figure 85—Wait for DTT-RSP and DS Transit Test—CPE

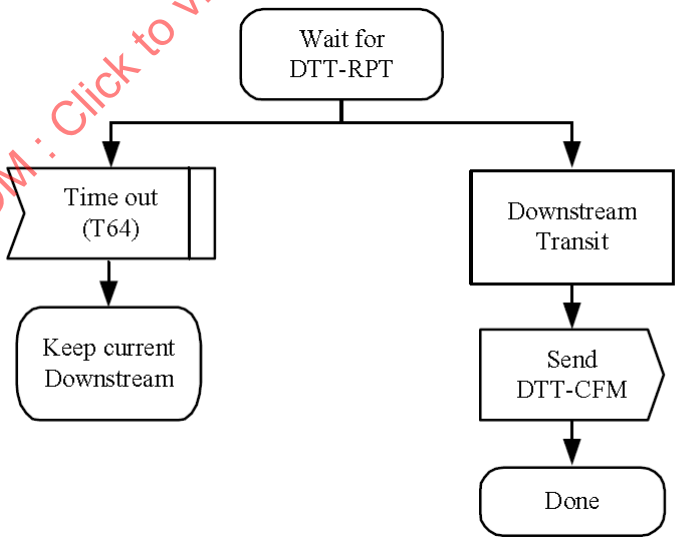

Figure 86—Wait for DTT-RPT—A-BS

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During relay DS, the A-CPE requests a change to a relay DS burst profile using one of the following methods:

- If the A-CPE has been granted US bandwidth in a CRZ (a data grant allocation to the A-CPE's Basic FT), the A-CPE shall send a RNG-REQ message to the centralized scheduling R-CPE in the bandwidth. If a grant is not available, the A-CPE shall send a RNG-REQ message in a CRZ Initial Ranging interval to the centralized scheduling R-CPE. The centralized scheduling R-CPE continues with the following procedure:
  - If the centralized scheduling R-CPE has been granted US bandwidth in an AZ and
    - If the centralized scheduling R-CPE has no change of DS burst profile, then the centralized scheduling R-CPE shall send the RNG-REQ message received from the A-CPE to the A-BS.
    - If the centralized scheduling R-CPE needs to change the DS burst profile, then the centralized scheduling R-CPE shall send a Container message including the RNG-REQ message received from the A-CPE and the RNG-REG message itself to the A-BS.
- If a grant is not available for the centralized scheduling R-CPE and
  - If the centralized scheduling R-CPE has no change of DS burst profile, then the centralized scheduling R-CPE shall send the RNG-REQ message received from the A-CPE in a CRZ Initial Ranging interval to the A-BS.
  - If the centralized scheduling R-CPE needs to change the DS burst profile, then the centralized scheduling R-CPE shall send a Container message including the RNG-REQ message received from the A-CPE and the RNG-REG message itself in an Initial Ranging interval to the A-BS.
- The A-BS responds with a RNG-CMD message and broadcasts the DCD with the relay DS burst profile.

7.17.2 Upstream management

Upstream ranging management consists of two procedures: initial ranging and periodic ranging. Initial ranging (see 7.16) allows a CPE joining the network to acquire correct transmission parameters, such as time offset and Tx EIRP level, so that the CPE can communicate with the BS, A-CPE can communicate with the A-BS, or that the A-CPE the distributed scheduling R-CPE. Initial Ranging is categorized as initial ranging between CPEs and A-BS, relay initial ranging between CPEs and A-BS from relaying on the centralized scheduling R-CPE, and local initial ranging between CPEs and the distributed scheduling R-CPE. The WRAN/A-WRAN PHY specifies a ranging subchannel and a set of special pseudo-noise ranging codes. Initial ranging is performed by using initial ranging codes at initial ranging subchannel in an AZ, relay initial ranging is performed by using CRZ initial ranging codes at relay initial ranging subchannel in a CRZ, and local initial ranging is performed by DRZ initial ranging codes at local initial ranging subchannel in a DRZ. Subsets of codes shall be allocated in the UCD channel encoding for initial ranging, periodic ranging requests, and BRs so that the BS/A-BS can determine the purpose of the received code by the subset to which the code belongs. CPEs/A-CPEs that wish to perform one of the aforementioned operations shall select, with equal probability, one of the codes of the appropriate subset, modulate it onto the ranging subchannel, and subsequently transmit in the ranging slot selected with equal probability from the available ranging slots on the US subframe. A CPE/A-CPE shall select one Ranging Slot from all available ranging slots in the US frame using a uniform random process. Details on the modulation and ranging codes are specified in 9.9.2. Following initial ranging, periodic ranging allows the CPE/A-CPE to adjust transmission parameters so that it can maintain US communications with the BS/A-BS.

The following subclauses summarize the general algorithm for initial ranging and periodic ranging.

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7.17.2.1 CDMA initial ranging and automatic adjustments

A CPE that wishes to perform initial ranging with CDMA code shall take the following steps:

a) The CPE, after acquiring downlink synchronization and uplink transmission parameters, shall select one Ranging Slot using the random backoff. The random backoff shall use a binary truncated exponent algorithm. After selecting the Ranging Slot, the CPE shall choose a Ranging Code (from the Initial Ranging domain) using a uniform random process. The selected Ranging Code is sent to the BS (as a CDMA code) in the selected Ranging Slot.

b) The BS cannot tell which CPE sent the CDMA ranging request; therefore, upon successfully receiving a CDMA ranging code, the BS broadcasts a ranging response message that advertises the received ranging code as well as the ranging slot (OFDMA symbol number, etc.) where the CDMA ranging code has been identified. This information is used by the CPE that sent the CDMA ranging code to identify the ranging response message that corresponds to its ranging request. The ranging response message contains all the needed adjustments (e.g., time, EIRP, and possibly frequency corrections) and a status notification.

c) Upon receiving a ranging response message with the “Continue” status, the CPE shall continue the ranging process as done on the first entry (using random selection rather than random backoff) with ranging codes randomly chosen from the initial ranging domain sent on the ranging slots.

d) When the BS receives an initial-ranging CDMA code that requires no corrections, the BS shall provide BW allocation for the CPE using the CDMA_Allocation IE to send an RNG-REQ message. Sending the RNG-CMD message with status “Success” is optional.

e) The initial ranging process is over after receiving RNG-CMD message, which includes a valid SID (following a RNG-REQ transmission on a CDMA_Allocation IE). If this RNG-CMD message includes a “continue” indication, the ranging process should be continued using the ranging mechanism.

f) The timeout required for the CPE to wait for RNG-CMD, following or not following a CDMA Allocation IE, is defined by the timer T3.

7.17.2.2 CDMA Periodic ranging and automatic adjustments

The following summarizes the general algorithm for CDMA periodic ranging:

a) The CPE shall choose randomly a Ranging Slot (with random selection with equal probability from available Ranging Slots in a single frame) at the time to perform the ranging, and then it chooses randomly a Periodic Ranging Code and sends it to the BS (as a CDMA code).

b) If the CPE does not receive a response, the CPE may send a new CDMA code at the next appropriate ranging transmission opportunity at one step higher EIRP level.

c) The BS cannot tell which CPE sent the CDMA ranging request; therefore, upon successfully receiving a CDMA periodic ranging code, the BS broadcasts a ranging response message that advertises the received periodic ranging code as well as the ranging slot (OFDMA symbol number, etc.) where the CDMA periodic ranging code has been identified. This information is used by the CPE that sent the CDMA periodic ranging code to identify the ranging response message that corresponds to its ranging request. The ranging response message contains all the needed adjustments (e.g., time, EIRP, and possibly frequency corrections) and a status notification.

d) Upon receiving a Ranging Response message with the “Continue” status, the CPE shall continue the ranging process with further periodic ranging codes randomly chosen. Upon receiving an RNG-CMD message with success status, the CPE shall restart timer T4 with the appropriate value depending whether the CPE is fixed or portable (see Table 335).

e) The BS may send an unsolicited RNG-CMD as a response to a CDMA-based bandwidth-request or any other data transmission from the CPE.

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f) Upon timeout of the CPE internal T4 timer, the CPE shall perform Periodic Ranging according to the proceeding procedure

g) When the CPE receives an unsolicited RNG-CMD message, it shall reset the periodic ranging timer and adjust the parameters (timing, EIRP, etc.) as notified in the RNG-CMD message.

7.17.2.3 CDMA initial ranging and automatic adjustments (A-BS and A-CPE, PHY-OM2)

An A-CPE that wishes to perform initial ranging with CDMA code in an AZ shall take the following steps:

a) The A-CPE, after acquiring downlink synchronization and uplink transmission parameters from the A-BS in an AZ, shall select one Ranging Slot using the random backoff. The random backoff shall use a binary truncated exponent algorithm. After selecting the Ranging Slot, the A-CPE shall choose a Ranging Code (from the Initial Ranging domain) using a uniform random process. The selected Ranging Code is sent to the A-BS (as a CDMA code) in the selected Ranging Slot.

b) The A-BS cannot tell which A-CPE sent the CDMA ranging request; therefore, upon successfully receiving a CDMA ranging code, the A-BS broadcasts a ranging response message (RNG-CMD) that advertises the received ranging code as well as the ranging slot (OFDMA symbol number, etc.) where the CDMA ranging code has been identified. This information is used by the A-CPE that sent the CDMA ranging code to identify the ranging response message that corresponds to its ranging request. The ranging response message contains all the needed adjustments (e.g., time, EIRP, and possibly frequency corrections) and a status notification.

c) Upon receiving a RNG-CMD message with the "Continue" status, the A-CPE shall continue the ranging process as done on the first entry (using random selection rather than random backoff) with ranging codes randomly chosen from the initial ranging domain sent on the ranging slots.

d) When the A-BS receives an initial-ranging CDMA code that requires no corrections, the A-BS shall provide BW allocation for the A-CPE using the CDMA_Allocation_IE to send an RNG-REQ message. Sending the RNG-CMD message with status "Success" is optional.

e) The initial ranging process is over after receiving RNG-CMD message, which includes a valid SID (following a RNG-REQ transmission on a CDMA Allocation IE). If this RNG-CMD message includes a "continue" indication, the ranging process should be continued using the ranging mechanism.

f) The timeout required for the A-CPE to wait for RNG-CMD, following or not following a CDMA Allocation IE, is defined by the timer T3.

7.17.2.4 CDMA initial ranging and automatic adjustments on the relay network (PHY-OM2)

7.17.2.4.1 CDMA local initial ranging and automatic adjustments in Distributed Scheduling relay network (PHY-OM2)

A CPE acquires local downlink synchronization and local uplink transmission parameters from distributed scheduling R-CPE only.

An A-CPE that wishes to perform local initial ranging with CDMA code in a DRZ shall take the following steps:

a) The A-CPE, after acquiring downlink synchronization and uplink transmission parameters from the distributed scheduling R-CPE, shall select one Ranging Slot in a DRZ (DRZ Ranging Slot) using the random backoff. The random backoff shall use a binary truncated exponent algorithm. After selecting the DRZ Ranging Slot, the A-CPE shall choose a Ranging Code (from the Initial Ranging domain) using a uniform random process. The selected Ranging Code is sent to the distributed scheduling R-CPE (as a CDMA code) in the selected DRZ Ranging Slot.

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b) The distributed scheduling R-CPE cannot tell which A-CPE sent the CDMA ranging request; therefore, upon successfully receiving a ranging code, the distributed scheduling R-CPE broadcasts a RNG-CMD message that advertises the received DRZ ranging code as well as the DRZ ranging slot (OFDMA symbol number, etc.) where the ranging code has been identified. This information is used by the A-CPE that sent the ranging code to identify the RNG-CMD message that corresponds to its ranging request. The RNG-CMD message contains all the needed adjustments (e.g., time, EIRP, and possibly frequency corrections) and a status notification.

c) Upon receiving a RNG-CMD message with the "Continue" status, the A-CPE shall continue the ranging process as done on the first entry (using random selection rather than random backoff) with ranging codes randomly chosen from the DRZ initial ranging domain sent on the DRZ Ranging Slots.

d) When the distributed scheduling R-CPE receives an initial-ranging CDMA code that requires no corrections, the distributed scheduling R-CPE shall provide BW allocation in a DRZ for the A-CPE using the CDMA_Allocation_IE to send an RNG-REQ message. Sending the RNG-CMD message with status "Success" is optional.

e) The DRZ initial ranging process is over after receiving RNG-CMD message, which includes a valid SID (following a RNG-REQ transmission on a CDMA Allocation IE). The distributed scheduling R-CPE shall choose one SID from the Local SID Group for the A-CPE's SID. If this RNG-CMD message includes a "continue" indication, the ranging process should be continued using the ranging mechanism.

f) The timeout required for the A-CPE to wait for RNG-CMD, following or not following a CDMA Allocation IE, is defined by the timer T3.

7.17.2.4.2 CDMA relay initial ranging and automatic adjustments in Centralized Scheduling relay network (PHY-OM2)

An A-CPE attempting to acquire downlink synchronization and uplink transmission parameters from the A-BS in an AZ shall perform initial ranging with CDMA code. However, the initial ranging request from the CPE may not arrive to the A-BS due to the transmission power constraint of the A-CPE. In this case, a certain centralized scheduling R-CPE may perform relay initial ranging for the A-CPE.

a) The A-CPE, after acquiring downlink synchronization and uplink transmission parameters from the A-BS, may select one Ranging Slot in a US CRZ (CRZ Ranging Slot) using the random backoff. The random backoff shall use a binary truncated exponent algorithm. After selecting the CRZ Ranging Slot, the A-CPE shall choose a CRZ Initial Ranging Code (from the CRZ initial Ranging domain) for the CRZ Ranging Slot using a uniform random process. The selected CRZ Ranging Code is sent to the centralized scheduling R-CPE in the selected CRZ Ranging Slot. In this stage, the A-CPE is not aware whether the centralized scheduling R-CPE exists within the transmission range of the A-CPE.

b) The centralized scheduling R-CPE may receive many CRZ Ranging Codes in the CRZ Ranging Slot. The centralized scheduling R-CPE cannot tell which ACPE sent the ranging request; therefore, upon successfully receiving a CRZ ranging code during the CRZ Ranging Slot, the centralized scheduling R-CPE sends a RNG-RPT message (7.9.31) that contains initial ranging adjustment information such as the initial ranging status, the received CRZ ranging code, and the received CRZ ranging slot (OFDMA symbol number, etc.) where the CRZ ranging code has been identified.

c) When an A-BS receives the RNG-RPT with the status set to 0 (require initial ranging adjustment), the A-BS transmits RNG-CMD to the A-CPE, where the RNG-CMD message contains all the needed adjustments (e.g., time, EIRP, and possibly frequency corrections) and a status notification.

d) When the A-CPE receives several RNG-CMD messages sent from the A-BS, the A-CPE chooses one RNG-CMD from the received RNG-CMDs for the further ranging.

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e) Upon receiving a RNG-CMD message with the "Continue" status, the A-CPE shall continue the ranging process as done on the first entry with CRZ ranging codes on the CRZ ranging slot to the centralized scheduling R-CPE.

f) When an A-BS receives the RNG-RPT with the status set to 1 (initial ranging done), the A-BS allocates a CRZ US bandwidth by using CDMA_Allocation_IE in the CRZ US-MAP IE in which the A-CPE transmitted RNG-REQ to the centralized scheduling R-CPE. In this stage, a valid SID is not assigned for the A-CPE. The centralized scheduling R-CPE shall transmit the RNG-REQ received from the A-CPE to the A-BS.

g) On successfully receiving the RNG-REQ, the A-BS shall provide a valid SID for the A-CPE by sending a RNG-CMD message. If this RNG-CMD message includes a "continue" indication, the ranging process should be continued using the ranging mechanism.

h) The timeout required for the A-CPE to wait for RNG-CMD is defined by the timer T3.

7.17.2.5 CDMA periodic ranging and automatic adjustments (A-BS and A-CPE, PHY-OM2)

The following summarizes the general algorithm for CDMA periodic ranging between the A-BS and the A-CPE:

a) The A-CPE shall choose randomly a Ranging Slot (with random selection with equal probability from available Ranging Slots in a single frame) at the time in an AZ to perform the ranging, and then it chooses randomly a Periodic Ranging Code and sends it to the A-BS (as a CDMA code).

b) If the A-CPE does not receive a response, the A-CPE may send a new CDMA code at the next appropriate ranging transmission opportunity at one step higher EIRP level.

c) The A-BS cannot tell which A-CPE sent the CDMA ranging request; therefore, upon successfully receiving a CDMA periodic ranging code, the A-BS broadcasts a ranging response (RNG-CMD) message that advertises the received periodic ranging code as well as the ranging slot (OFDMA symbol number, etc.) where the CDMA periodic ranging code has been identified. This information is used by the A-CPE that sent the CDMA periodic ranging code to identify the ranging response message that corresponds to its ranging request. The ranging response message contains all the needed adjustments (e.g., time, EIRP, and possibly frequency corrections) and a status notification.

d) Upon receiving a RNG-CMD message with the "Continue" status, the A-CPE shall continue the ranging process with further periodic ranging codes randomly chosen. Upon receiving an RNG-CMD message with success status, the A-CPE shall restart timer T4 with the appropriate value depending on whether the A-CPE is fixed or portable (see Table 335).

e) The A-BS may send an unsolicited RNG-CMD as a response to a CDMA-based bandwidth-request or any other data transmission from the A-CPE.

f) Upon timeout of the A-CPE internal T4 timer, the A-CPE shall perform Periodic Ranging according to the proceeding procedure.

g) When the A-CPE receives an unsolicited RNG-CMD message, it shall reset the periodic ranging timer and adjust the parameters (timing, EIRP, etc.) as notified in the RNG-CMD message.

7.17.2.6 CDMA local periodic ranging and automatic adjustments in relay network (PHY-OM2)

7.17.2.6.1 CDMA local periodic ranging and automatic adjustments in Distributed Scheduling relay network (PHY-OM2)

The following summarizes the general algorithm for CDMA periodic ranging between the distributed scheduling R-CPE and the A-CPE in a local cell:

a) The A-CPE shall choose randomly a Ranging Slot (with random selection with equal probability from available Ranging Slots in a single frame) at the time in a DRZ to perform the ranging, and

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then it chooses randomly a Periodic Ranging Code and sends it to the distributed scheduling R-CPE (as a CDMA code).

b) If the A-CPE does not receive a response, the A-CPE may send a new CDMA code at the next appropriate ranging transmission opportunity at one step higher EIRP level.

c) The distributed scheduling R-CPE cannot tell which A-CPE sent the CDMA ranging request; therefore, upon successfully receiving a CDMA periodic ranging code, the distributed scheduling R-CPE broadcasts a ranging response (RNG-CMD) message that advertises the received periodic ranging code as well as the DRZ ranging slot (OFDMA symbol number, etc.) where the CDMA periodic ranging code has been identified. This information is used by the CPE that sent the CDMA periodic ranging code to identify the ranging response message that corresponds to its ranging request. The ranging response message contains all the needed adjustments (e.g., time, EIRP, and possibly frequency corrections) and a status notification.

d) Upon receiving a RNG-CMD message with the "Continue" status, the A-CPE shall continue the ranging process with further periodic ranging codes randomly chosen. Upon receiving an RNG-CMD message with success status, the A-CPE shall restart timer T4 with the appropriate value depending on whether the A-CPE is fixed or portable (see Table 335).

e) The distributed scheduling R-CPE may send an unsolicited RNG-CMD as a response to a CDMA-based bandwidth-request or any other data transmission from the A-CPE.

f) Upon timeout of the A-CPE internal T4 timer, the A-CPE shall perform Periodic Ranging according to the preceding procedure.

g) When the A-CPE receives an unsolicited RNG-CMD message, it shall reset the periodic ranging timer and adjust the parameters (timing, EIRP, etc.) as notified in the RNG-CMD message.

7.17.2.6.2 CDMA relay periodic ranging and automatic adjustments in Centralized Scheduling relay network

The following summarizes the general algorithm for CDMA periodic ranging between the centralized scheduling R-CPE and the A-CPE:

a) The A-CPE shall choose randomly a Ranging Slot (with random selection with equal probability from available Ranging Slots in a single frame) at the time in a CRZ to perform the ranging, and then it chooses randomly a CRZ Periodic Ranging Code and sends it to the centralized scheduling R-CPE (as a CDMA code).

b) If the A-CPE does not receive a response, the A-CPE may send a new CDMA code at the next appropriate ranging transmission opportunity at one step higher EIRP level.

c) The centralized scheduling R-CPE cannot tell which A-CPE sent the CDMA ranging request; therefore, upon successfully receiving a CDMA periodic ranging code, the centralized scheduling R-CPE sends a RNG-RPT message that contains ranging adjustment information such as the ranging status, the received CRZ periodic ranging code, and the CRZ ranging slot (OFDMA symbol number, etc.) where the CDMA periodic ranging code has been identified. This information is used by the A-CPE that sent the CDMA periodic ranging code to identify the ranging response message that corresponds to its ranging request. The ranging response message contains all the needed adjustments (e.g., time, EIRP, and possibly frequency corrections) and a status notification.

d) Upon receiving a RNG-CMD message with the "Continue" status, the A-CPE shall continue the ranging process with further periodic ranging codes randomly chosen. Upon receiving an RNG-CMD message with success status, the A-CPE shall restart timer T4 with the appropriate value depending on whether the A-CPE is fixed or portable (see Table 335).

e) The A-BS may send an unsolicited RNG-CMD as a response to a CDMA-based bandwidth-request or any other data transmission from the A-CPE.

f) Upon timeout of the A-CPE internal T4 timer, the A-CPE shall perform Periodic Ranging according to the preceding procedure.

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g) When the A CPE receives an unsolicited RNG-CMD message, it shall reset the periodic ranging timer and adjust the parameters (timing, EIRP, etc.) as notified in the RNG-CMD message.

7.18 Channel descriptor management

7.18.1 Channel descriptor management in the WRAN (PHY-OM1)

As previously presented, channel descriptor messages (i.e., DCD and UCD) are broadcast by the BS to all associated CPEs in the WRAN. Among other things, these channel descriptors define burst profiles, which are used by US-MAP and DS-MAP messages for allocating US and DS transmissions, respectively. Once broadcast by the BS (in the WRAN), a given channel descriptor shall remain valid until a new channel descriptor message with a different value for the Configuration Change Count field is again broadcast by the BS in the WRAN. When this happens, this new channel descriptor shall overwrite all the information of the previous descriptor.

Once channel descriptors are known to all CPEs in a WRAN BS's cell, the BS shall set the UCD/DCD count value, contained in US-MAP and DS-MAP messages, equal to the Configuration Change Count of the desired channel description. In the WRAN this allows the BS to easily indicated to its CPEs, which burst profile is to be used for a given allocation, and hence provided high flexibility to the BS in controlling which burst profile to use at any given time by simply changing the UCD/DCD count.

7.18.2 Channel descriptor management in the A-WRAN (PHY-OM2)

As previously presented, channel descriptor messages (i.e., DCD and UCD) are broadcast by the A-BS to A-CPEs directly connected to it, as well as by the distributed scheduling R-CPE to the associated A-CPEs. Among other things, these channel descriptors define burst profiles, which are used by US-MAP and DS-MAP messages for allocating US and DS transmissions, respectively. Once broadcast by the A-BS/ distributed scheduling R-CPE (in the A-WRAN) and received by its associated A-CPEs, a given channel descriptor shall remain valid until a new channel descriptor message with a different value for the Configuration Change Count field is again broadcast by the A-BS/distributed scheduling R-CPE in the A-WRAN. When this happens, this new channel descriptor shall overwrite all the information of the previous descriptor.

In the A-WRAN, when the distributed scheduling R-CPE receives a new DS channel descriptor for channel switching from the A-BS, the distributed scheduling R-CPE shall immediately broadcast the new DS channel descriptor with the same information of channel switching (i.e., channel action, action mode, and action frame number) to the associated A-CPEs in the local cell so the operating channel in the local cell can be changed to the same channel of the A-BS's cell at the same time.

In the A-WRAN cell, the A-BS shall set the UCD/DCD Count value in an AZ, contained in US-MAP and DS-MAP messages, equal to the Configuration Change Count of the desired channel descriptor. Once channel descriptors are known to all A-CPEs in the distributed scheduling R-CPE's local cell, the distributed scheduling R-CPE shall set the UCD/DCD Count value in a DRZ, contained in US-MAP and DS-MAP messages, equal to the Configuration Change Count of the desired channel descriptor. This way, a A-BS or a distributed scheduling R-CPE can easily indicate to the CPEs which burst profile is to be used for a given allocation and hence provide high flexibility to the A-BS or the distributed scheduling R-CPE in controlling which burst profile to use at any given time by simply changing the UCD/DCD Count value.

7.18.2 7.18.3 Channel descriptor migration

Figure 87 describes the procedure to migrate from one US channel descriptor to the next, while Figure 88 focuses on the same procedure but for the DS channel.

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Finally, note that the Configuration Change Count shall be incremented by 1 modulo 256 for every new migration of channel descriptor. After issuing a DS-MAP or US-MAP message with the Configuration Change Count equal to that of the new generation, the old channel descriptor ceases to exist and the BS/A-BS or the distributed scheduling R-CPE shall not refer to it anymore. When migrating from one generation to the next, the BS/A-BS or the distributed scheduling R-CPE shall schedule the transmissions of the UCD and DCD messages in such a way that each CPE/A-CPE has the possibility to successfully hear it at least once.

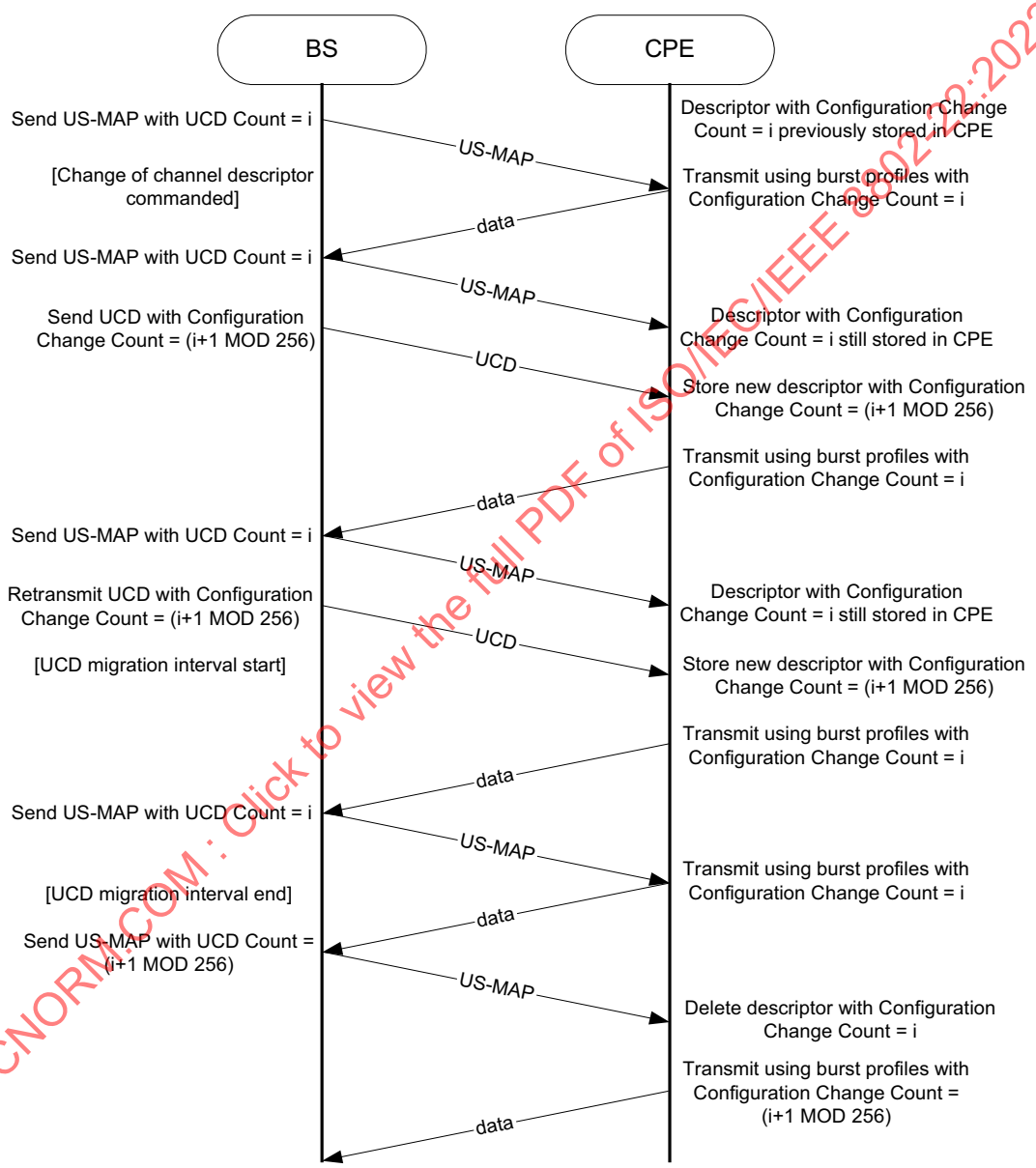

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Figure 87—UCD channel descriptor update

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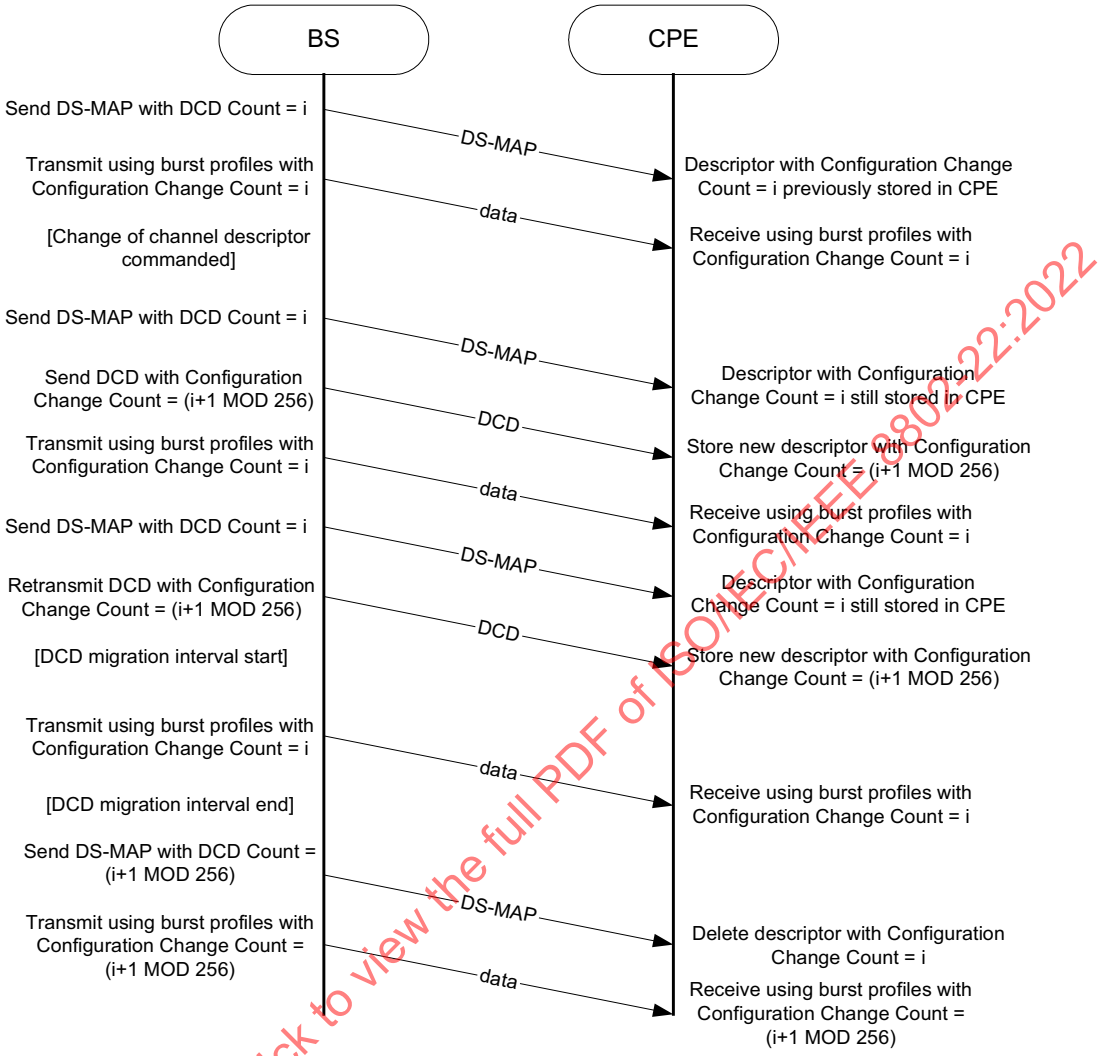

Figure 88—DCD channel descriptor update

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7.19 Multicast support

Multicast support is an important and integral part of the MAC. In the MAC, multicast groups are used not only for their traditional application of data delivery (e.g., streaming), but also for sending management commands to a set of CPEs. For example, the BS may wish to implement clustering algorithms for measurements and use the feature of multicast group to create such clusters. In this case, the BS could, for instance, simultaneously address a set of CPEs and share the load of measurements across clusters. That is, the BS could make certain clusters responsible for DTV measurements while other clusters would target Part 74 services. Another possible use of multicast connections is for CBP (see 7.22.1). In this case, the BS can maximize the use of the self-coexistence IUC by properly selecting the CPEs who will transmit CBP packets.

In order to support multicast services with the purpose of transporting traffic on connections for DS management and transport traffic, the MAC defines a special type of multicast SIDs (which represent a

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group of one or more CPEs) as well as FTs for polling, DS management, and DS traffic. In this subclause, the multicast feature of the MAC is described.

7.19.1 Group management

The BS may add a CPE to a multicast group by sending an MCA-REQ message with the Join command. Upon receiving a MCA-REQ message, the CPE shall respond by sending an MCA-RSP message. A similar procedure is employed in the case of leaving a group. The protocol is shown in Figure 89 and Figure 90.

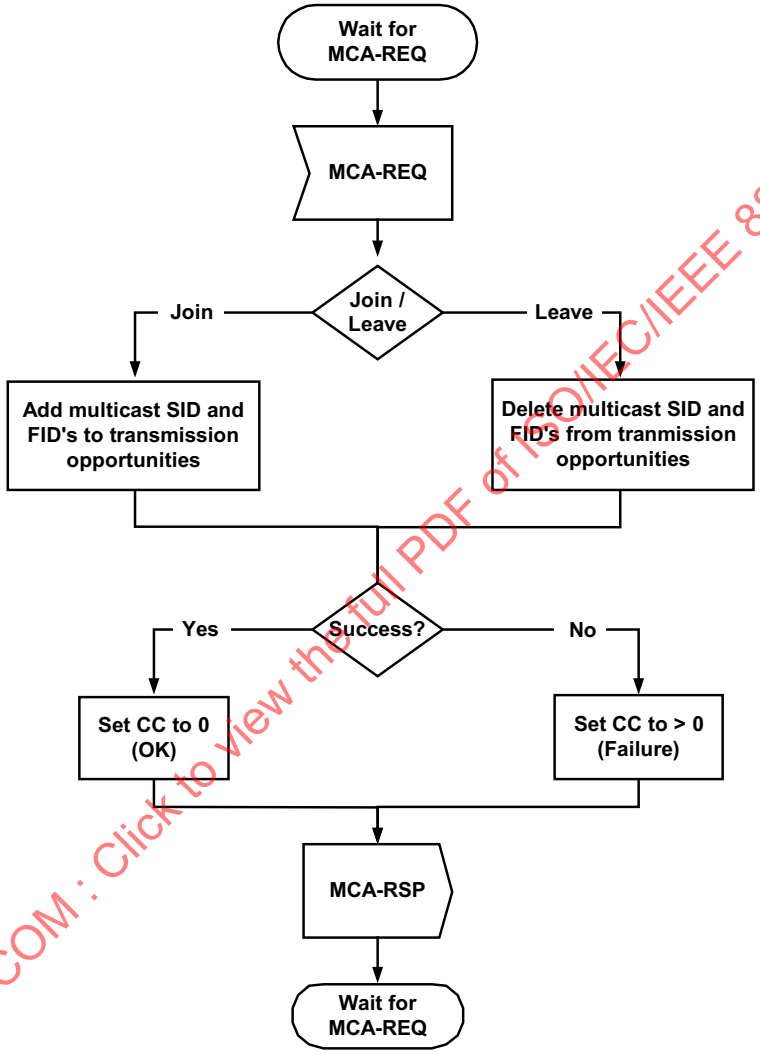

Figure 89—Group management at CPE

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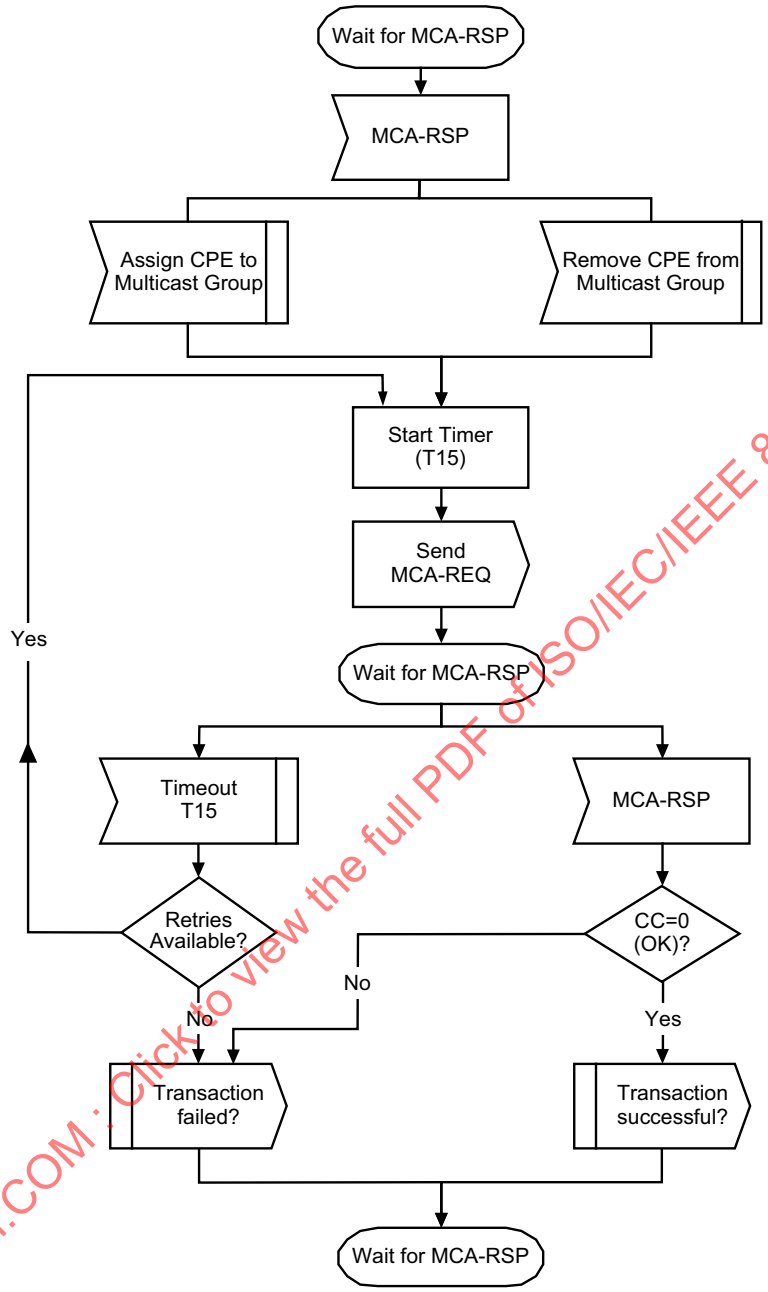

Figure 90—Group management at BS

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7.19.2 Multicast connections

The BS may establish DS multicast service by creating a connection with each CPE to be associated with the service. To provide proper multicast operation, two things shall happen. The FT used for the service as well as the "purpose" (see 7.9.9) shall be the same for all CPEs on the same channel that participate in the multicast group. Except for multicast management FTs, the CPEs need not be aware that the connection is a multicast connection. The data transmitted on the connection with the given FT shall be received and processed by the MAC of each involved CPE. Since a multicast transport connection is associated with a

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service flow, that multicast transport connection is associated with the QoS and traffic parameters for that service flow.

ARQ is not applicable to multicast connections.

Each CPE participating in the multicast group whose "purpose" (see 7.9.9) is configured for multicast management, polling, and/or SCW setup shall have a group security association (GSA), allowing that connection to be encrypted using keys that are independent of those used for other encrypted transmissions between the CPEs and the BS. The GSA shall be established at the CPEs assigned to the multicast group via the SCM GSA This message shall be sent prior to any transmission on the Multicast SID. The SAID of the GSA shall be the Multicast Management SID of the multicast group. The GSA shall remain installed on the CPE until it is asked by the by BS to leave the multicast group and it has received a SCM GSA-Remove message.

No protection shall be afforded for traffic on a DS multicast transport FT. Traffic on multicast transport FTs shall be mapped to the null SAID (i.e., the null SA). Only, management messages that are mapped to a DS multicast management FT (Table 30) are to be encrypted.

7.19.3 Multicast-enabled SCW configuration

Normally, multicast service is used for DS multicast management, polling, or transport traffic. Multicast service, can also be used to configure a group of CPEs for passive SCW monitoring or active SCW for CBP PDU transmission. This can be done by addressing a US-MAP IE to a SID that represents a multicast group and setting the UIUC to either 0 or 1 (see 7.9.4.1).

Prior to transmitting the US-MAP IE, the CPEs shall be added to the multicast group (via MCA-REQ/RSP), which is configured for the 0x03, 0x05, or 0x07 purpose (see 7.9.9).

7.20 Quality of service

The MAC adopts a similar QoS service model as specified in IEEE Std 802.16™-2009, 6.3.14 (see also Kay [B62]). It defines several QoS related concepts, which include the following:

— Service Flow QoS Scheduling
— Dynamic Service Establishment
— Two-phase Activation Model

7.20.1 Theory of operation

The various protocol mechanisms described in this standard may be used to support QoS for both US and DS traffic through the CPE and the BS. This subclause provides an overview of the QoS protocol mechanisms and their part in providing end-to-end QoS.

The requirements for QoS include the following:

— A configuration and registration function for pre-configuring CPE-based QoS service flows and traffic parameters.
— A signaling function for dynamically establishing QoS-enabled service flows and traffic parameters.
— Utilization of MAC scheduling and QoS traffic parameters for US service flows.
— Utilization of QoS traffic parameters for DS service flows.

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— Grouping of service flow properties into named Service Classes, so upper-layer entities and external applications (at both the CPE and BS) may request service flows with desired QoS parameters in a globally consistent way.

The principal mechanism for providing QoS is to associate packets traversing the MAC interface into a service flow as identified by the transport FT assigned to a unicast SID (an individual CPE) or multicast transport FT assigned to a multicast SID (a multicast group of CPEs). A service flow is a unidirectional flow of packets that is provided with a particular QoS. The BS provide this QoS according to the QoS parameter set defined for the service flow.

The primary purpose of the QoS features defined here is to define transmission ordering and scheduling on the air interface. However, these features often need to work in conjunction with mechanisms beyond the air interface in order to provide end-to-end QoS or to police the behavior of CPEs.

Service flows exist in both the US and DS direction and may exist without actually being activated to carry traffic. All service flows have a 32-bit SFID; admitted and active service flows also have a 13-bit transport FT assigned to a unicast SID (an individual CPE) or multicast transport FT assigned to a multicast SID (a multicast group of CPEs).

7.20.2 Service flows

A service flow is a MAC transport service that provides unidirectional transport of packets either to US packets transmitted by the CPE or to DS packets transmitted by the BS.[23] A service flow is characterized by a set of QoS parameters such as latency, jitter, and throughput assurances. In order to standardize operation between the CPE and BS, these attributes include details of how the CPE requests US bandwidth allocations and the expected behavior of the BS US scheduler.

A service flow is partially characterized by the following attributes.[24]

SFID: An SFID is assigned to each existing service flow. The SFID serves as the principal identifier for the service flow in the network. A service flow has at least an SFID and an associated direction.

— FT: Mapping to an SFID that exists only when the connection has an admitted or active service flow.

— ProvisionedQoSParamSet: A QoS parameter set provisioned via means outside of the scope of this standard, such as the network management system.

— AdmittedQoSParamSet: Defines a set of QoS parameters for which the BS (and possibly the CPE) is reserving resources. The principal resource to be reserved is bandwidth, but this also includes any other memory or time-based resource required to subsequently activate the flow.

— ActiveQoSParamSet: Defines a set of QoS parameters defining the service actually being provided to the service flow. Only an Active service flow may forward packets.

— Authorization Module: A logical function within the BS that approves or denies every change to QoS parameters and Classification rules associated with a service flow. As such, it defines an “envelope” that limits the possible values of the AdmittedQoSParamSet and ActiveQoSParamSet.

[23]A service flow, as defined here, has no direct relationship to the concept of a “flow” as defined by the IETF Integrated Services (intserv) Working Group (IETF RFC 2212). An intserv flow is a collection of packets sharing transport-layer endpoints. Multiple intserv flows can be served by a single service flow

[24]Some attributes are derived from the preceding attribute list. The Service Class Name is an attribute of the ProvisionedQoSParamSet. The activation state of the service flow is determined by the ActiveQoSParamSet. If the ActiveQoSParamSet is null, then the service flow is inactive.

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The relationship between the QoS parameter sets is as shown in Figure 91 and Figure 92. The ActiveQoSParamSet is always a subset of the AdmittedQoSParamSet, which is always a subset of the authorized "envelope."[25] In the dynamic authorization model, this envelope is determined by the Authorization Module (labeled as the AuthorizedQoSParamSet). In the provisioned authorization model, this envelope is determined by the ProvisionedQoSParamSet. It is useful to think of the following three types of service flows:

— Provisioned: This type of service flow is known via provisioning by, for example, the network management system. Its AdmittedQoSParamSet and ActiveQoSParamSet are both null.
— Admitted: This type of service flow has resources reserved by the BS for its AdmittedQoSParamSet, but these parameters are not active (i.e., its ActiveQoSParamSet is null). Admitted Service Flows may have been provisioned or may have been signaled by some other mechanism.
— Active: This type of service flow has resources committed by the BS for its ActiveQoSParamSet, (e.g., is actively sending maps containing unsolicited grants for a UGS based service flow). Its ActiveQoSParamSet is non-null.

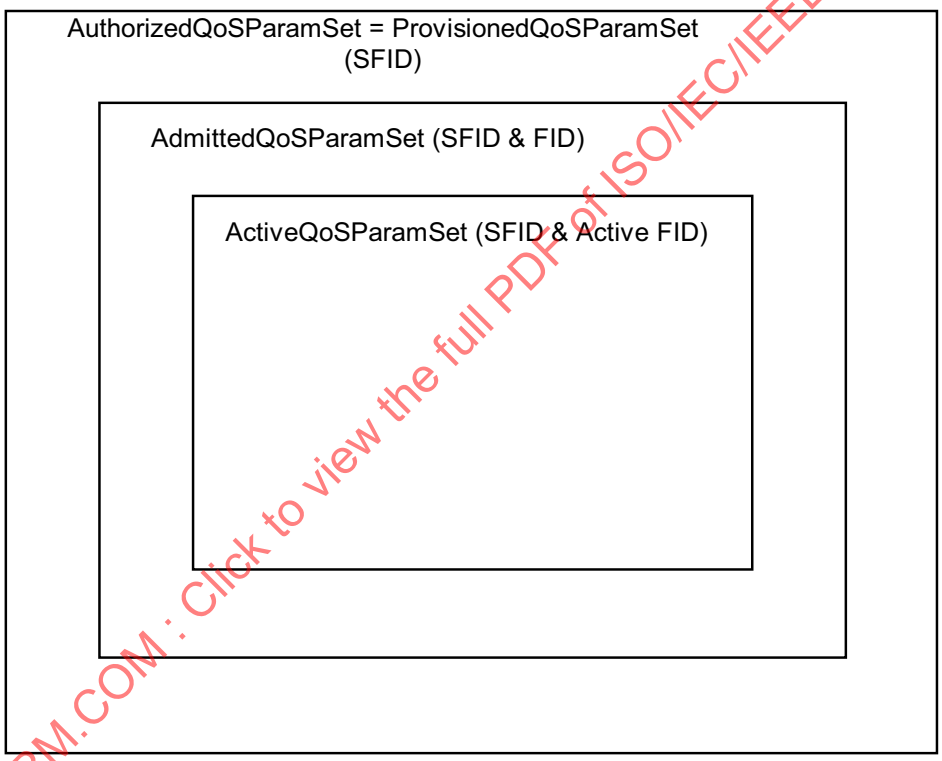

Figure 91—Provisioned authorization model "envelopes"

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[25]To say that QoS Parameter Set A is a subset of QoS Parameter Set B, the following shall be true for all QoS Parameters in A and B: if (a smaller QoS parameter value indicates less resources, e.g., Maximum Traffic Rate); A is a subset of B if the parameter in A is less than or equal to the same parameter in B; if (a larger QoS parameter value indicates less resources, e.g., Tolerated Grant Jitter); A is a subset of B if the parameter in A is greater than or equal to the same parameter in B; if (the QoS parameter is not quantitative, e.g., Service Flow Scheduling Type); A is a subset of B if the parameter in A is equal to the same parameter in B.

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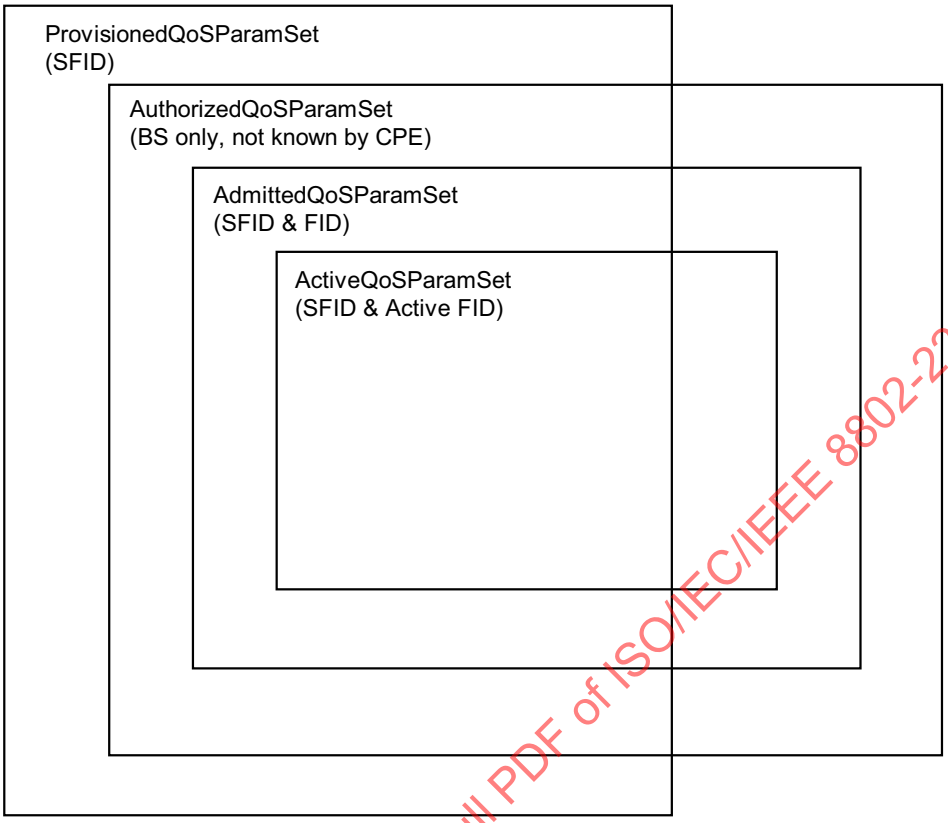

Figure 92—Dynamic authorization model "envelopes"

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7.20.3 Object model

The major objects of the architecture are represented by named rectangles in Figure 93. Each object has a number of attributes; the attribute names that uniquely identify it are marked with an asterisk (*). Optional attributes are denoted with brackets. The relationship between the number of objects is marked at each end of the association line between the objects. For example, a service flow may be associated with from 0 to N (many) PDUs, but a PDU is associated with exactly one service flow. The service flow is the central concept of the MAC protocol. It is uniquely identified by a 32-bit (SFID). Service flows may be in either the US or DS direction. Admitted and active service flows are mapped to one of the 3-bit FTs assigned to each SID (see 13.2).

Outgoing user data is submitted to the MAC SAP by a CS process for transmission on the MAC interface. The information delivered to the MAC SAP includes the SID indicated in the DS- or US-MAP IE (that describes the DS/US allocation for that CPE) and the FT in the GMH of the MAC PDU. The tuple, or concatenation of SID and FT (see 7.2 and 13.2), forms a connection identifier that identifies the connection across which the information is delivered. The service flow for the CPE (SID) is mapped to MAC connection identified by the FT.

The Service Class is an optional object that may be implemented at the BS. It is referenced by an ASCII name, which is intended for provisioning purposes. A Service Class is defined in the BS to have a particular QoS parameter set. The QoS parameter sets of a service flow may contain a reference to the Service Class Name as a "macro" that selects all of the QoS parameters of the Service Class. The service flow QoS parameter sets may augment and even override the QoS parameter settings of the Service Class, subject to authorization by the BS.

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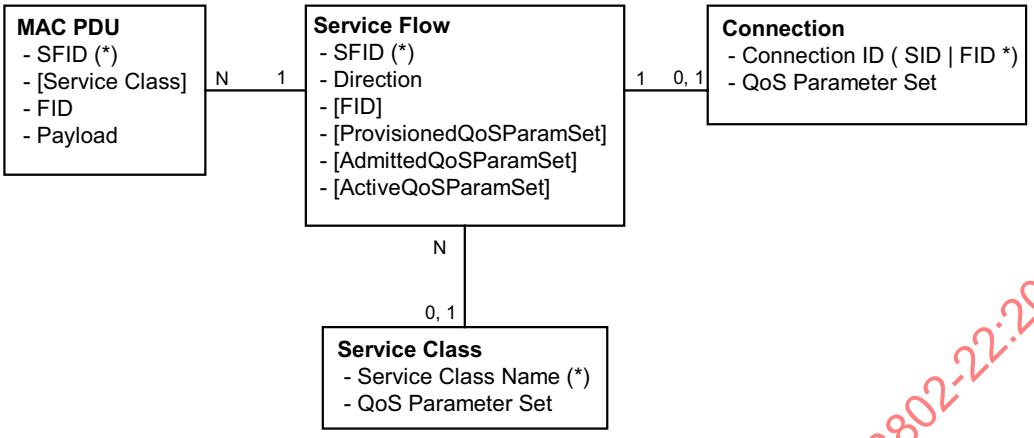

Figure 93—Object model of the QoS service

7.20.4 Service classes

The Service Class serves the following purposes:[26]

— It allows operators, who so wish, to move the burden of configuring service flows from the provisioning server to the BS. Operators provision the CPEs with the Service Class Name; the implementation of the name is configured at the BS. This allows operators to modify the implementation of a given service to local circumstances without changing CPE provisioning. For example, some scheduling parameters may need to be tweaked differently for two different BSs to provide the same service. As another example, service profiles could be changed by time of day.

— It allows higher-layer protocols to create a service flow by its Service Class Name. For example, telephony signaling may direct the CPE to instantiate any available provisioned service flow of class "G711."

Any service flow may have its QoS parameter set specified in any of the following three ways:

— By explicitly including all traffic parameters.

— By indirectly referring to a set of traffic parameters by specifying a Service Class Name.

— By specifying a Service Class Name along with modifying parameters.

The Service Class Name is "expanded" to its defined set of parameters at the time the BS successfully admits the service flow. The Service Class expansion can be contained in the following BS-originated messages: DSA-REQ, DSC-REQ, DSA-RSP, and DSC-RSP. In all of these cases, the BS shall include a service flow encoding that includes the Service Class Name and the QoS parameter set of the Service Class.

When a Service Class name is given in an admission or activation request, it is possible that the returned QoS parameter set may change from activation to activation. This can happen because of administrative changes to the Service Class's QoS parameter set at the BS. If the definition of a Service Class Name is changed at the BS (e.g., its associated QoS parameter set is modified), it has no effect on the QoS parameters of existing service flows associated with that Service Class. A BS may initiate DSC transactions to existing service flows that reference the Service Class Name to affect the changed Service Class definition.

[26]Service classes are merely identifiers for a specific set of QoS parameter set values. Hence, the use of service classes is optional. A service identified by a service class is treated no differently, once established, than a service that has the same QoS parameter set explicitly specified.

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7.20.5 Authorization

An authorization module shall approve every change to the service flow QoS parameters. This includes every DSA-REQ message to create a new service flow and every DSC-REQ message to change a QoS parameter set of an existing service flow. Such changes include requesting an admission control decision (e.g., setting the AdmittedQoSParamSet) and requesting activation of a service flow (e.g., setting the ActiveQoSParamSet). The authorization module also checks reduction requests regarding the resources to be admitted or activated.

In the static authorization model, the authorization module stores the provisioned status of all "deferred" service flows. Admission and activation requests for these provisioned service flows shall be permitted, as long as the Admitted QoS parameter set is a subset of the Provisioned QoS parameter set, and the Active QoS parameter set is a subset of the Admitted QoS parameter set. Requests to change the Provisioned QoS parameter set shall be refused, as shall requests to create new dynamic service flows. This defines a static system where all possible services are defined in the initial configuration of each CPE.

In the dynamic authorization model, the authorization module also communicates through a separate interface to an independent policy server. This policy server may provide the authorization module with advance notice of upcoming admission and activation requests, and it specifies the proper authorization action to be taken on those requests. Admission and activation requests from a CPE are then checked by the Authorization Module to verify that the ActiveQoSParamSet being requested is a subset of the set provided by the policy server.

Prior to initial connection setup, the BS shall retrieve the Provisioned QoS Set for a CPE. This is handed to the Authorization Module within the BS. The BS shall be capable of caching the Provisioned QoS parameter set and shall be able to use this information to authorize dynamic flows that are a subset of the Provisioned QoS parameter set. The BS should implement mechanisms for overriding this automated approval process (such as described in the dynamic authorization model). For example, it could

— Deny all requests whether or not they have been pre-provisioned.
— Define an internal table with a richer policy mechanism but seeded by the Provisioned QoS Set.
— Refer all requests to an external policy server.

7.20.6 Types of service flows

It is useful to think about three basic types of service flows. This subclause describes these three types of service flows in more detail. However, it is important to note that there are more than just these three basic types (see 7.9.8.9.4).

7.20.6.1 Provisioned

A service flow may be provisioned but not immediately activated (sometimes called "deferred"). That is, the description of any such service flow contains an attribute that provisions but defers activation and admission (see 7.9.8.9.4). The network assigns a SFID for such a service flow. The BS may also require an exchange with a policy module prior to admission.

If authorized and resources are available, the BS shall respond by mapping the service flow to a FT.

As a result of external action beyond the scope of this specification, the BS may choose to activate a service flow by passing the SFID as well as the FT and the associated QoS parameter sets to the CPE in the DSC-REQ message. Such a provisioned service flow may be activated and deactivated many times (through DSC exchanges). In all cases, the original SFID shall be used when reactivating the service flow.

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7.20.6.2 Admitted

This protocol supports a two-phase activation model that is often utilized in telephony applications. In the two-phase activation model, the resources for a "call" are first "admitted," and then once the end-to-end negotiation is completed (e.g., called party's gateway generates an "off-hook" event), the resources are "activated." The two-phase model serves the following purposes:

— Conserving network resources until a complete end-to-end connection has been established
— Performing policy checks and admission control on resources as quickly as possible, and in particular, before informing the far end of a connection request
— Preventing several potential theft-of-service scenarios

For example, if an upper-layer service were using UGS, and the addition of upper-layer flows could be adequately provided by increasing the Maximum Sustained Traffic Rate QoS parameter, then the following procedure might be used. When the first higher-layer flow is pending, the BS issues a DSA-REQ with the admitted Maximum Sustained Traffic Rate parameter equal to that required for one higher-layer flow, and the active Maximum Sustained Traffic Rate parameter equal to zero. Later when the higher-layer flow becomes active, it issues a DSC-REQ with the instance of the active Maximum Sustained Traffic Rate parameter equal to that required for one higher-layer flow. Admission control was performed at the time of the reservation, so the later DSC-REQ, having the active parameters within the range of the previous reservation, is guaranteed to succeed. Subsequent higher-layer flows would be handled in the same way. If there were three higher-layer flows establishing connections, with one flow already active, the service flow would have admitted Maximum Sustained Traffic Rate equal to that required for four higher-layer flows, and active Maximum Sustained Traffic Rate equal to that required for one higher-layer flow.

An activation request of a service flow where the new ActiveQoSParamSet is a subset of the AdmittedQoSParamSet shall be allowed, except in the case of catastrophic failure. An admission request where the AdmittedQoSParamSet is a subset of the previous AdmittedQoSParamSet shall succeed, so long as the ActiveQoSParamSet remains a subset of the AdmittedQoSParamSet.

A service flow that has resources assigned to its AdmittedQoSParamSet, but whose resources are not yet completely activated, is in a transient state. It is possible in some applications that a long-term reservation of resources is necessary or desirable. For example, placing a telephone call on hold should allow any resources in use for the call to be temporarily allocated to other purposes, but these resources shall be available for resumption of the call later. The AdmittedQoSParamSet is maintained as "soft state" in the BS; this state shall be maintained without releasing the non-activated resources. Changes may be signaled with a DSC-REQ message.

7.20.6.3 Active

A service flow that has a non-NULL ActiveQoSParamSet is said to be an active service flow. It is requesting (according to its Request/Transmission Policy, as in 7.9.8.9.10) and being granted bandwidth for transport of data packets. An admitted service flow may be activated by providing an ActiveQoSParamSet, signaling the resources actually desired at the current time. This completes the second stage of the two-phase activation model (see 7.20.6.2).

A service flow may be provisioned and immediately activated. Alternatively, a service flow may be created dynamically and immediately activated. In this case, two-phase activation is skipped and the service flow is available for immediate use upon authorization.

7.20.7 Service Flow creation

The provisioning of service flows is done via means outside of the scope of this standard, such as the network management system. During provisioning, a service flow is instantiated, gets a SFID and a

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"provisioned" type. For some service flows it may be specified that DSA procedure shall be activated by Network Entry procedure. Enabling service flows follows the transfer of the operational parameters (see Figure 47). In this case, the service flow type may change to "admitted" or to "active"; in the latter case, the Service Flow is mapped onto a certain connection.

Service flow encodings contain either a full definition of service attributes (omitting defaultable items if desired) or a service class name. A service class name is an ASCII string, which is known at the BS and which indirectly specifies a set of QoS parameters.

Triggers, other than network entry, also may cause creation, admission, or activation of service flows. Such triggers lay outside the scope of the standard.

Capability of handling each specific Service Flow parameter is optional.

7.20.7.1 Dynamic Service Flow creation

7.20.7.1.1 BS-initiated

A DSA-REQ from a BS contains an SFID for either one US or one DS Service flow, possibly its associated FT, and a set of active or admitted QoS parameters. The protocol is illustrated in Figure 94 and is described in detail in 7.20.9. The CPE responds with DSA-RSP indicating acceptance or rejection. In the case when rejection was caused by presence of a non-supported parameter of non-supported value, specific parameter may be included into DSA-RSP.

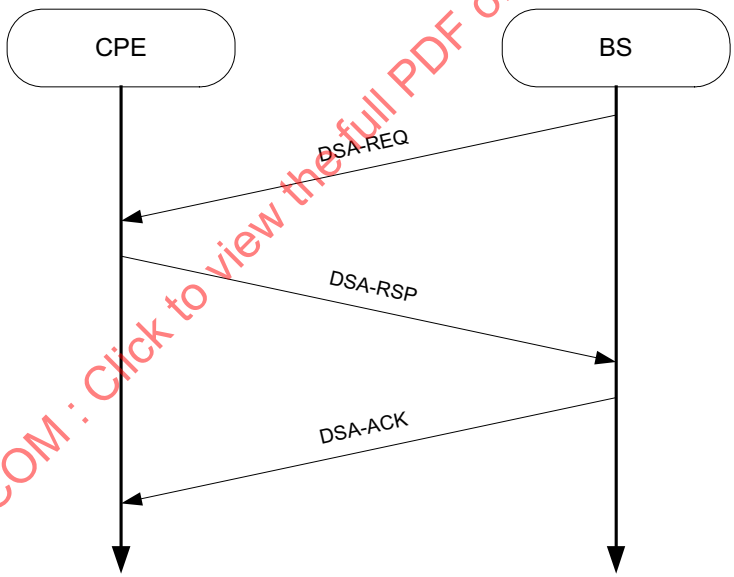

Figure 94—DSA message flow (BS-initiated)

7.20.8 Dynamic Service Flow modification and deletion

In addition to the methods presented in for creating service flows, protocols are defined for modifying and deleting service flows (see 7.20.9).

Both provisioned and dynamically created service flows are modified with the DSC message, which can change the Admitted and Active QoS parameter sets of the flow. A successful DSC transaction changes a service flow's QoS parameters by replacing both the Admitted and Active QoS parameter sets. If the message contains only the Admitted set, the Active set is set to null and the flow is deactivated. If the

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message contains neither set ("000" value used for QoS parameter set type—see 7.9.8.9.4), then both sets are set to null and the flow is de-admitted. When the message contains both QoS parameter sets, the Admitted set is checked first, and if admission control succeeds, the Active set in the message is checked against the Admitted set in the message to verify that it is a subset. If all checks are successful, the QoS parameter sets in the message become the new Admitted and Active QoS parameter sets for the service flow. If either of the checks fails, the DSC transaction fails and the service flow QoS parameter sets remain unchanged.

7.20.9 Service Flow Management

7.20.9.1 Overview

Service flows may be created, changed, or deleted. This is accomplished through a series of MAC management messages referred to as DSA, DSC, and DSD. The DSA messages create a new service flow. The DSC messages change an existing service flow. The DSD messages delete an existing service flow. This is illustrated in Figure 95.

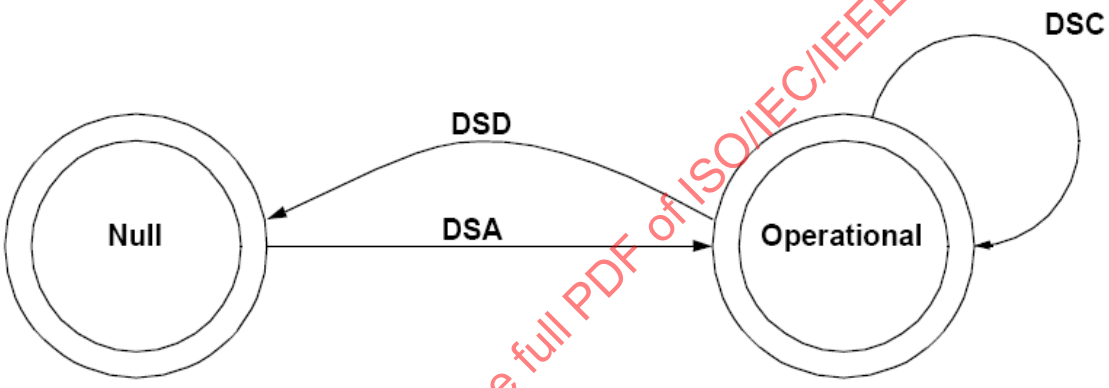

Figure 95—Dynamic service flow overview

The Null state implies that no service flow exists that matches the SFID and/or Transaction ID in a message. Once the service flow exists, it is operational and has an assigned SFID. In steady-state operation, a service flow resides in a Nominal state. When DSx messaging is occurring, the service flow may transition through other states, but remains operational. Since multiple service flows may exist, there may be multiple state machines active, one for every service flow. DSx messages only affect those state machines that match the SFID and/or Transaction ID. Both the CPE and BS shall decrypt and verify the Ciphertext ICV (see 8.4.2) for the PDUs of all DSx messages before processing them, and discard any messages that fail.

Transaction IDs are unique per transaction and are selected by the initiating BS.

Each DSx message sequence is a unique transaction with an associated unique transaction identifier. The DSA/DSC transactions consist of a request/response/acknowledge sequence. The DSD transactions consist of a request/response sequence. The response messages shall return a CC of OK unless some exception condition was detected. The acknowledge messages shall return the CC in the response unless a new exception condition arises. A more detailed state diagram, including transition states, is shown in Figure 96 through Figure 102. The detailed actions for each transaction shall be given in the following subclauses.

7.20.9.2 Dynamic Service Flow state transitions

The Dynamic Service Flow state transition diagram (Figure 96) is the top-level state diagram and controls the general service flow state. As needed, it creates transactions, each represented by a Transaction state transition diagram, to provide the DSA, DSC, and DSD signaling. Each Transaction state transition diagram

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communicates only with the parent Dynamic Service Flow state transition diagram. The top-level state transition diagram filters DSx messages and passes them to the appropriate transaction based on SFID, service flow reference number, and Transaction ID.

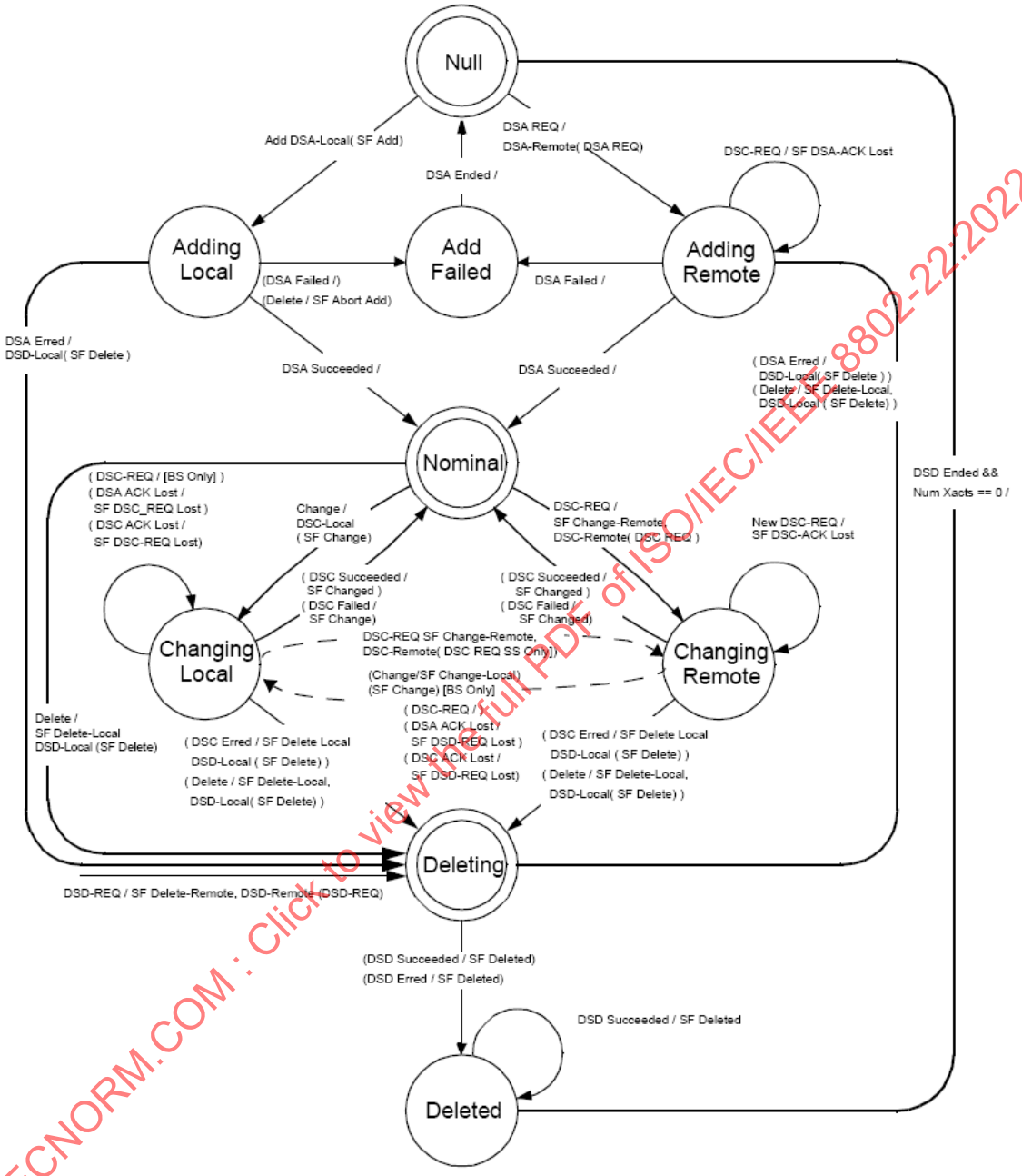

Figure 96—Dynamic Service Flow state transition diagram

There are six different types of transactions, which are locally initiated or remotely initiated for each of the DSA, DSC, and DSD messages (Figure 96 through Figure 102). Most transactions have three basic states—pending, holding, and deleting. The pending state is typically entered after creation and is where the transaction is waiting for a reply. The holding state is typically entered once the reply is received. The purpose of this state is to allow for retransmissions in case of a lost message, even though the local entity has perceived that the transaction has completed. The deleting state is only entered if the service flow is being deleted while a transaction is being processed.

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The flow diagrams provide a detailed representation of each of the states in the Transaction state transition diagrams. All valid transitions are shown. Any inputs not shown should be handled as a severe error condition.

With one exception, these state diagrams apply equally to the BS and CPE. In the Dynamic Service Flow Changing-Local state, the defined behavior is applicable to the BS only. This is called out in the state transition and detailed flow diagrams.

NOTE—The "Num Xacts" variable in the Dynamic Service Flow state transition diagram is incremented every time the top-level state diagram creates a transaction and is decremented every time a transaction terminates. A dynamic service flow should not return to the Null state until it is deleted and all transactions have terminated.

The inputs for the state diagrams are identified as follows.

Dynamic Service Flow state transition diagram inputs from unspecified local, higher level entities:

a) Add
b) Change
c) Delete

Dynamic Service Flow state transition diagram inputs from DSx Transaction state transition diagrams:

a) DSA Succeeded
b) DSA Failed
c) DSA-ACK Lost
d) DSA Erred
e) DSA Ended

a) DSC Succeeded
b) DSC Failed
c) DSC-ACK Lost
d) DSC Erred
e) DSC Ended

a) DSD Succeeded
b) DSD Erred
c) DSD Ended

DSx Transaction state transition diagram inputs from the Dynamic Service Flow state transition diagram:

a) SF Add
b) SF Change
c) SF Delete

a) SF Abort Add
b) SF Change-Remote

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c) SF Delete-Local
d) SF Delete-Remote

a) SF DSA-ACK Lost
b) SF DSC-REQ Lost
c) SF DSC-ACK Lost
d) SF DSC-REQ Lost

a) SF Changed
b) SF Deleted

The creation of DSx transactions by the Dynamic Service Flow state transition diagram is indicated by the notation:

DSx – [Local | Remote] (initial_input)

where initial_input may be SF Add, DSA-REQ, SF Change, DSC-REQ, SF Delete, or DSD-REQ, depending on the transaction type and initiator.

State transitions (i.e., the lines between states) are labeled with <what causes the transition>/<messages and events triggered by the transition>. If there are multiple events or messages before the slash "/" separated by a comma, any of them can cause the transition. If there are multiple events or messages listed after the slash, all of the specified actions shall accompany the transition.

For example, "DSD-REQ/SF Delete Remote, DSD-Remote (DSD-REQ)" should be read as follows: Once DSD-REQ is received, it triggers sending a "SF Delete Remote" event to transactions running for this service flow AND starting the "DSD-Remote" transaction and pass the event DSD-REQ to it.

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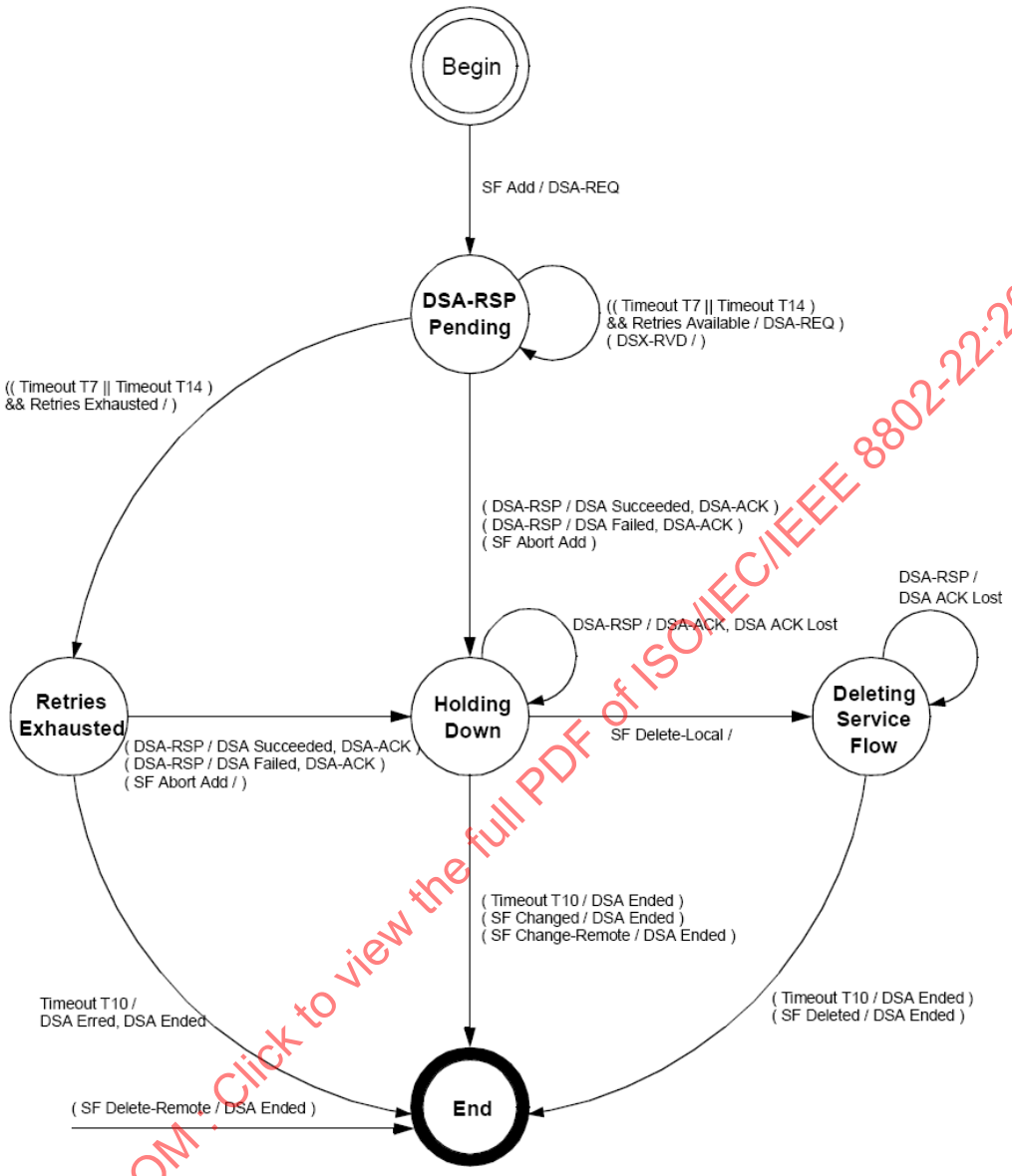

Figure 97—DSA—Locally-Initiated Transaction state transition diagram

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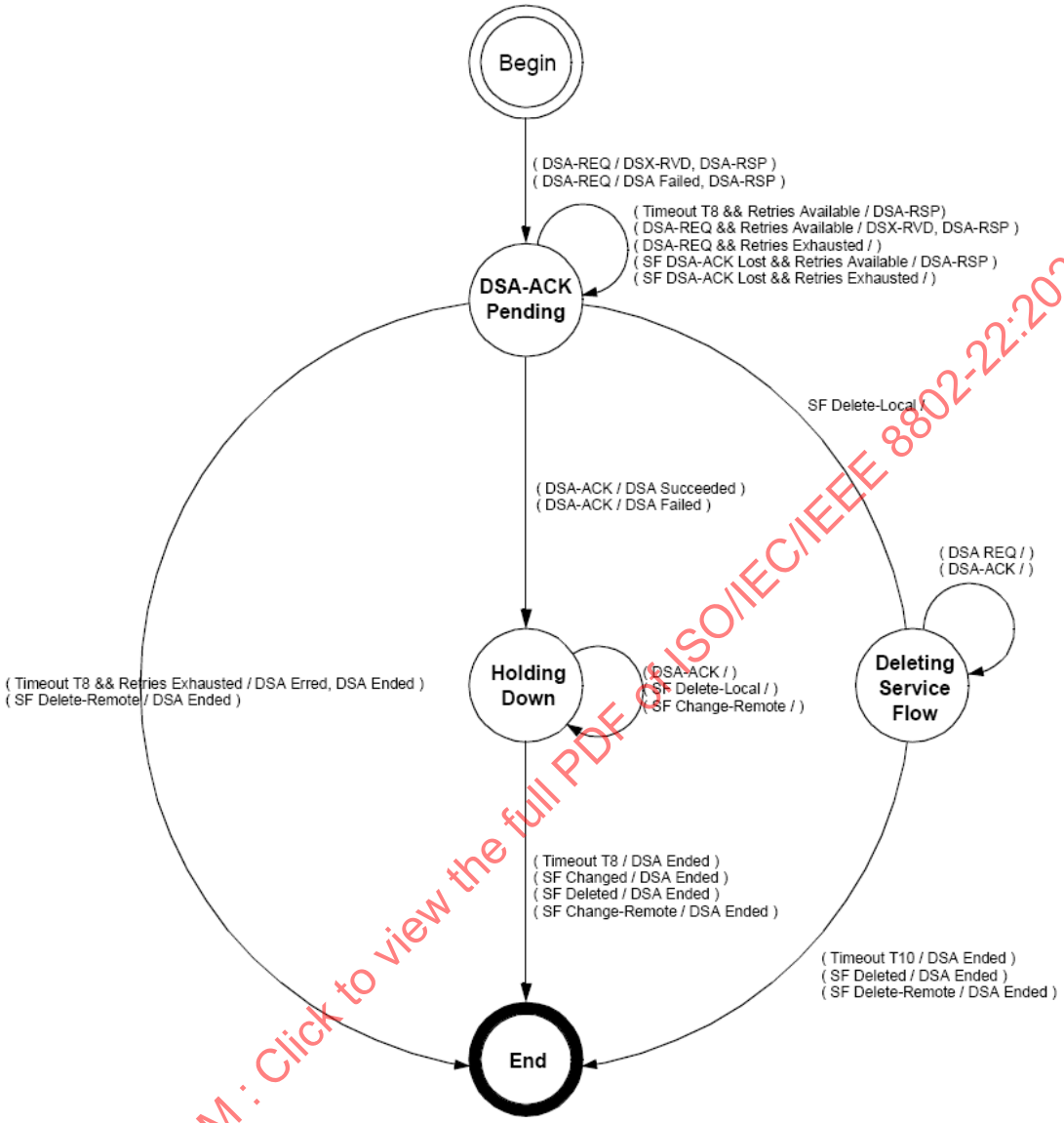

Figure 98—DSA—Remotely-Initiated Transaction State Transition Diagram

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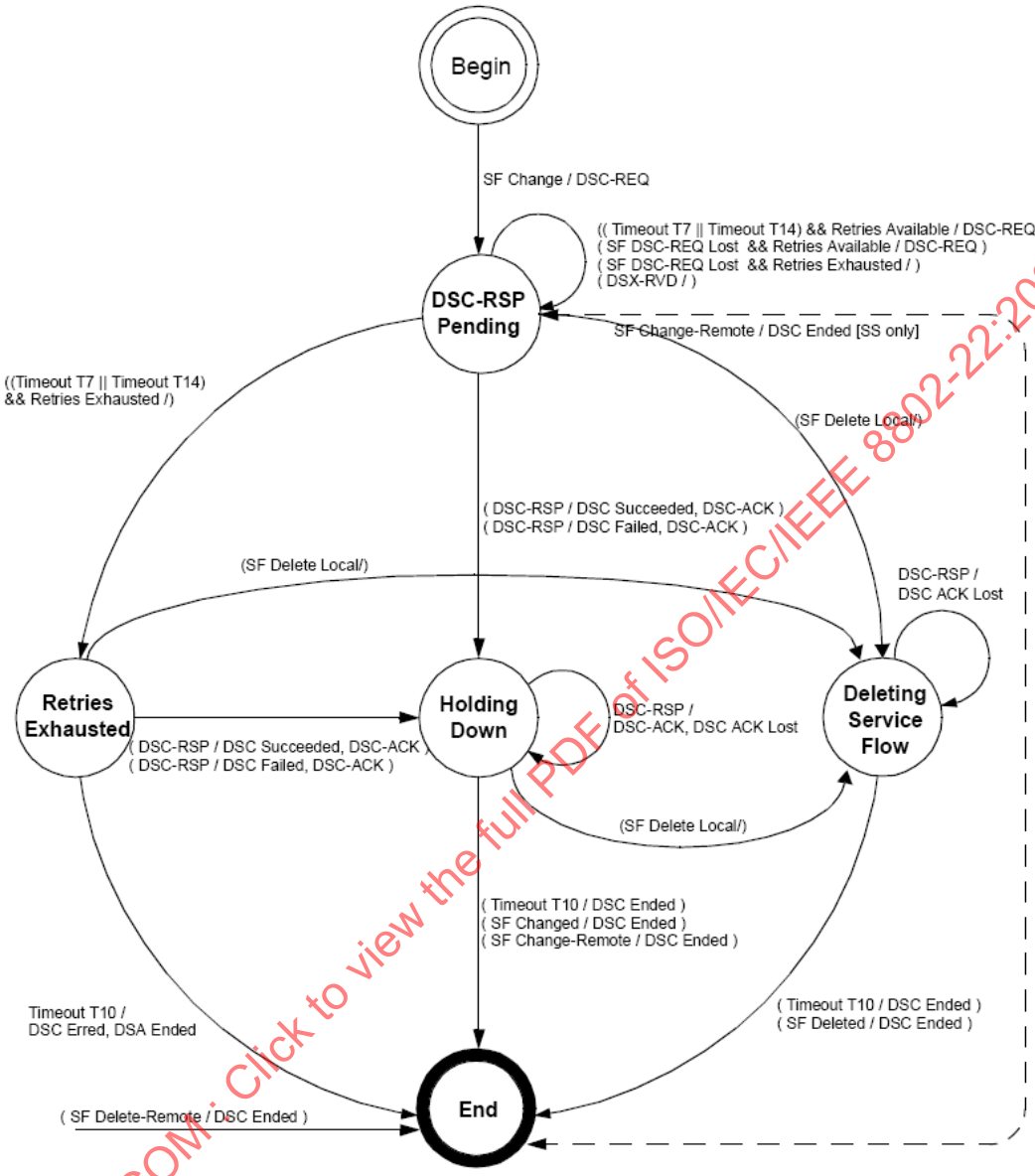

Figure 99—DSC—Locally-Initiated Transaction State Transition Diagram

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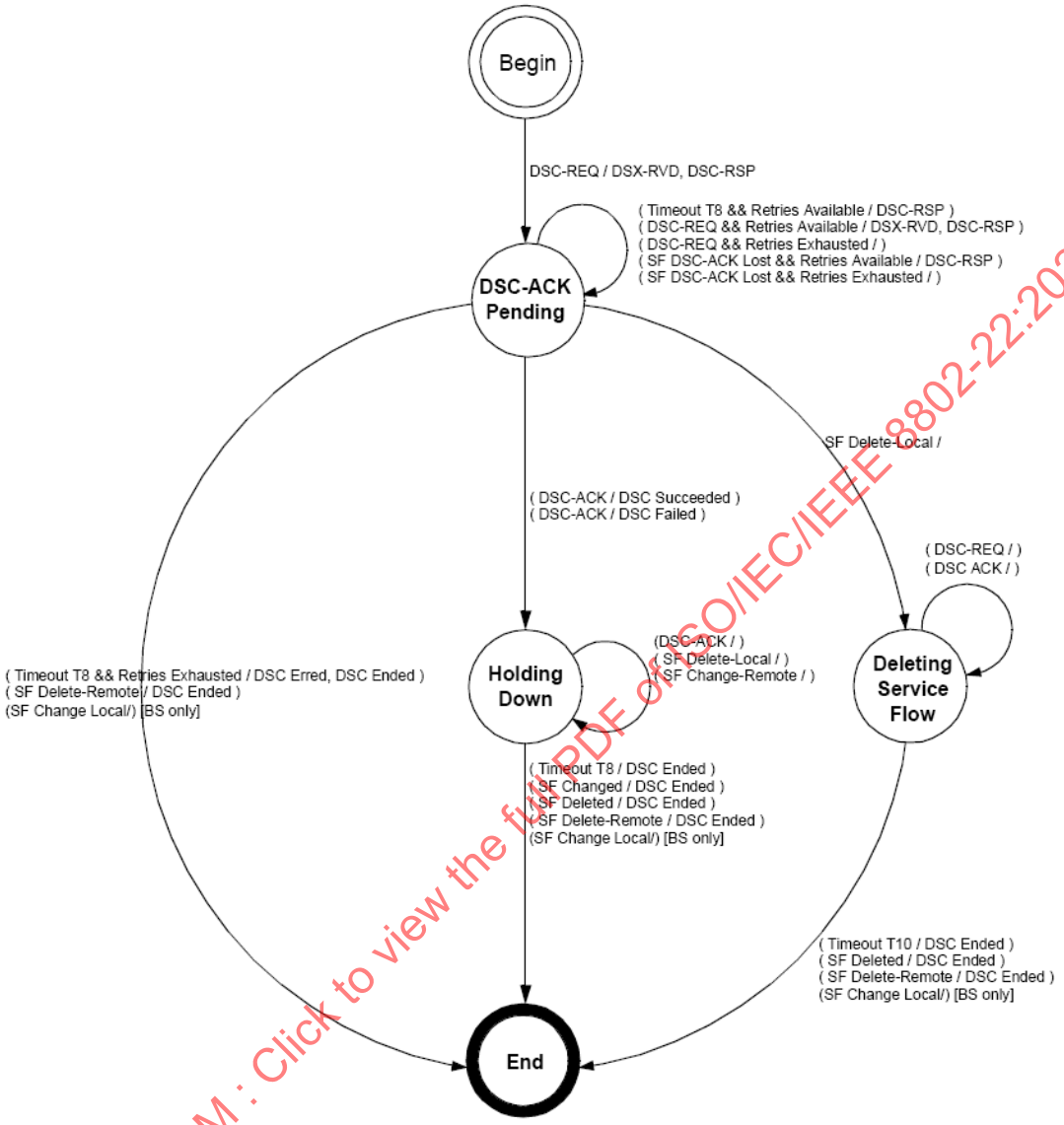

Figure 100—DSC—Remotely-Initiated Transaction State Transition Diagram

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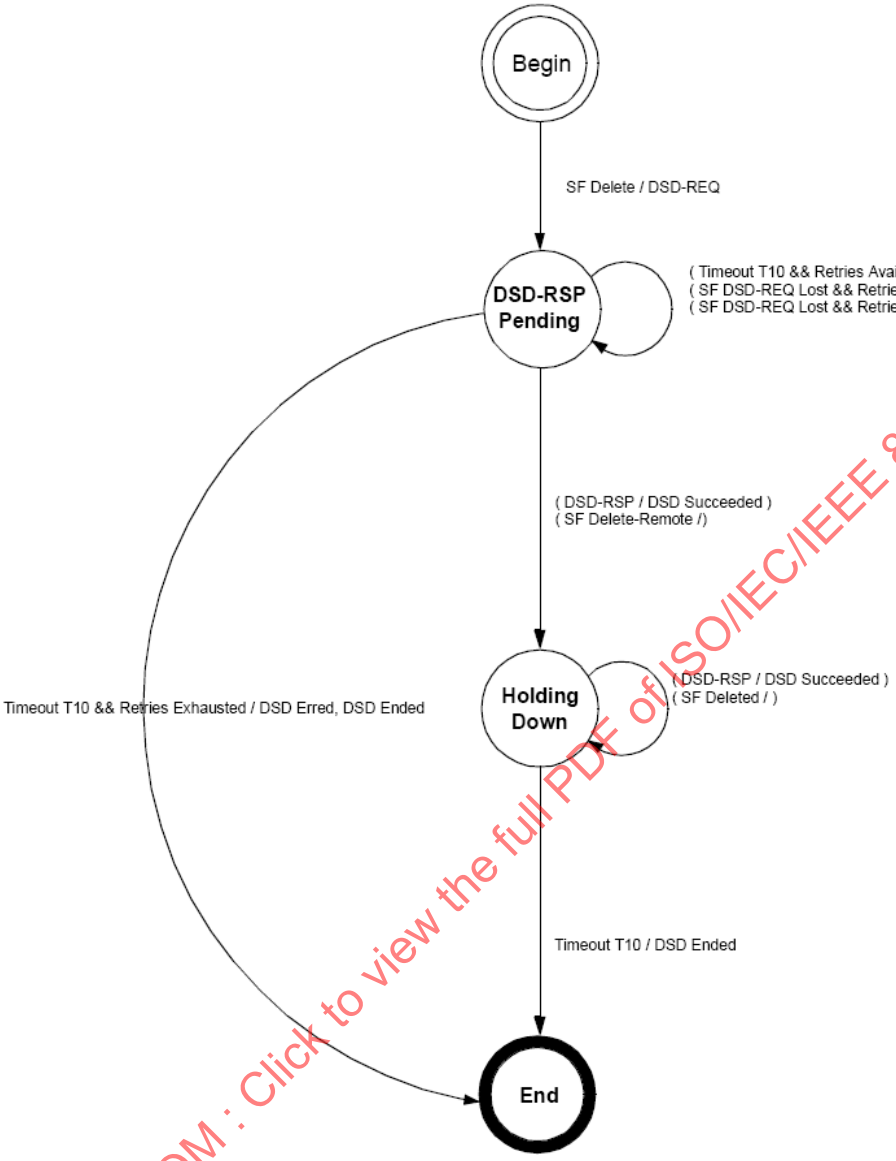

Figure 101—DSD—Locally-Initiated Transaction State Transition Diagram

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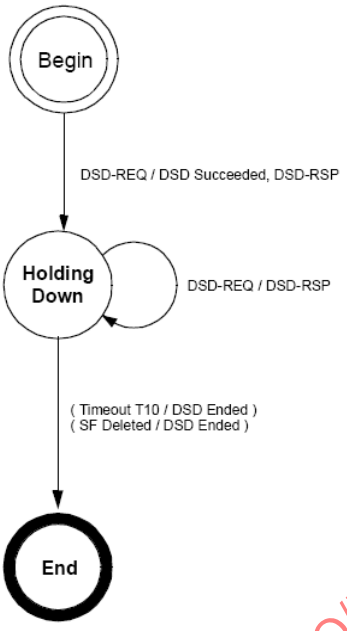

Figure 102—DSD—Remotely-Initiated Transaction State Transition Diagram

7.20.9.3 Dynamic Service Addition

7.20.9.3.1 BS-initiated DSA

A BS wishing to establish either a US or DS dynamic service flow with a CPE performs the following operations. The BS checks the authorization of the destination CPE for the requested CoS and to determine whether the QoS requirements can be supported. If the service can be supported, the BS generates a new SFID with the required CoS and informs the CPE using a DSA-REQ message. If the CPE checks that it can support the service, it responds using a DSA-RSP message. The transaction completes with the BS sending the acknowledge message (DSA-ACK). This process is illustrated in Table 226.

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Table 226—BS-initiated DSA

CPE		BS
		New service flow required for CPE
		Check whether CPE is authorized for service
		Check whether service flow(s) QoS can be supported
		Create SFID
		If AdmittedQoSParamSet is non-null, map service flow to SID
Receive DSA-REQ	<======DSA-REQ======	Send DSA-REQ
Confirm that CPE can support service flow		Set Timer T7
Add Downstream SFID (if present)		
Enable reception on any new downlink service flow		
Send DSA-RSP	======DSA-RSP======>	Receive DSA-RSP
Receive DSA-RSP		Timer T7 stops
Timer T7 Stops		Enable transmission (DS) or reception (US) of data on new service flow
Receive DSA-ACK	<======DSA-ACK======	Send DSA-ACK
Enable transmission on new US service flow		

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7.20.9.3.1.1 A-BS and R-CPE behavior during A-BS-initiated DSA on PHY-OM2

When an A-BS initiates a DSA-REQ message to a CPE via a centralized scheduling R-CPE, the centralized scheduling R-CPE and the A-BS may deal with the message in the following way:

— If the service flow parameters are changed, the A-BS shall send a DSC-REQ to the centralized scheduling R-CPE before sending the DSA-REQ to the A-CPE in the same manner as previously defined.
— The A-BS may include a Per-RS QoS TLV in the DSA-REQ to the centralized scheduling R-CPE. If the centralized scheduling R-C receives the Per-RS QoS TLV, the centralized scheduling R-CPE shall use the values in the Per-RS QoS TLV instead of the ones in the service flow parameters.
— When the centralized scheduling R-CPE can support the requested QoS parameter set, it sends the DSA-REQ to the A-CPE using the primary management CID of the A-CPE.
— When the centralized scheduling R-CPE cannot support the requested QoS parameter set in the DSA-REQ, it sends the DSA-RSP with the CC set to reject-RS-not-supported-parameter-value to the A-BS indicating that it can support the requested QoS parameter set. The DSA-RSP may contain the acceptable QoS parameter set that the centralized scheduling R-CPE can support.

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— The centralized scheduling R-CPE may get the updated SF parameters and confirmation code from the DSA-RSP and DSA-ACK sent from the A-CPE and the A-BS, respectively.

7.20.9.3.2 DSA state transition diagrams

DSA state transition diagrams are shown in Figure 103 through Figure 111.

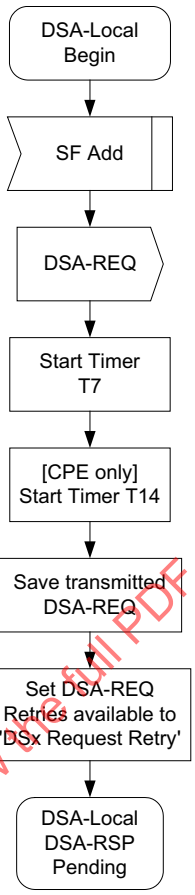

Figure 103—DSA—Locally-Initiated Transaction Begin state flow diagram

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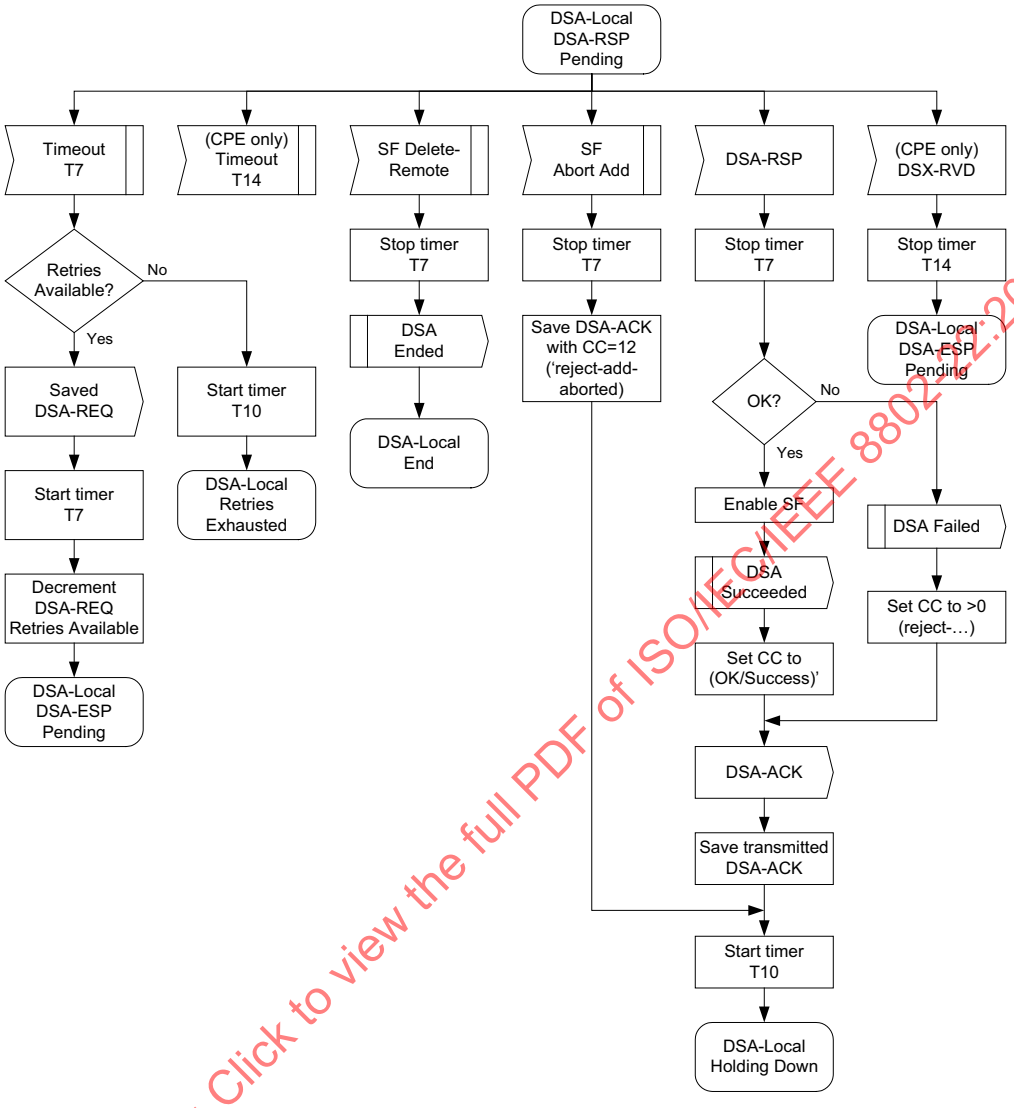

Figure 104—DSA—Locally-Initiated Transaction DSA-RSP Pending state flow diagram

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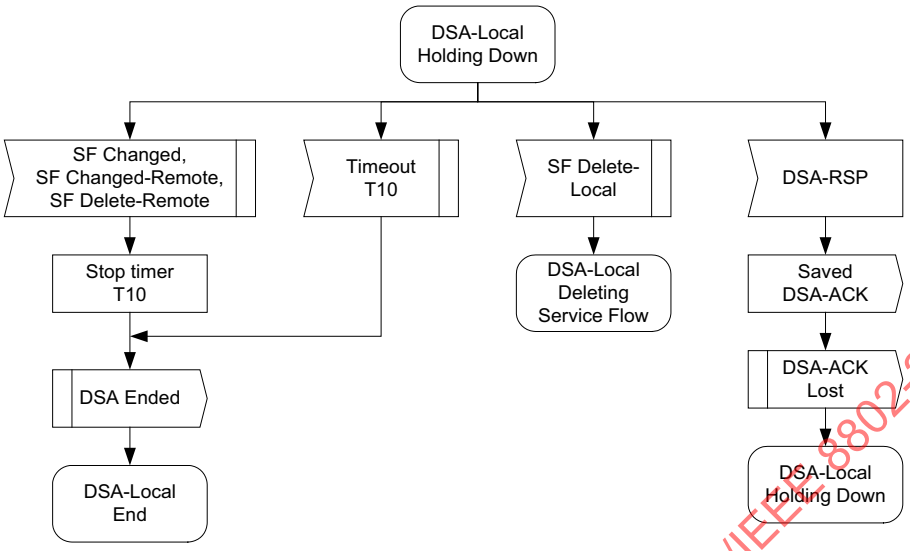

Figure 105—DSA—Locally-Initiated Transaction Holding state flow diagram

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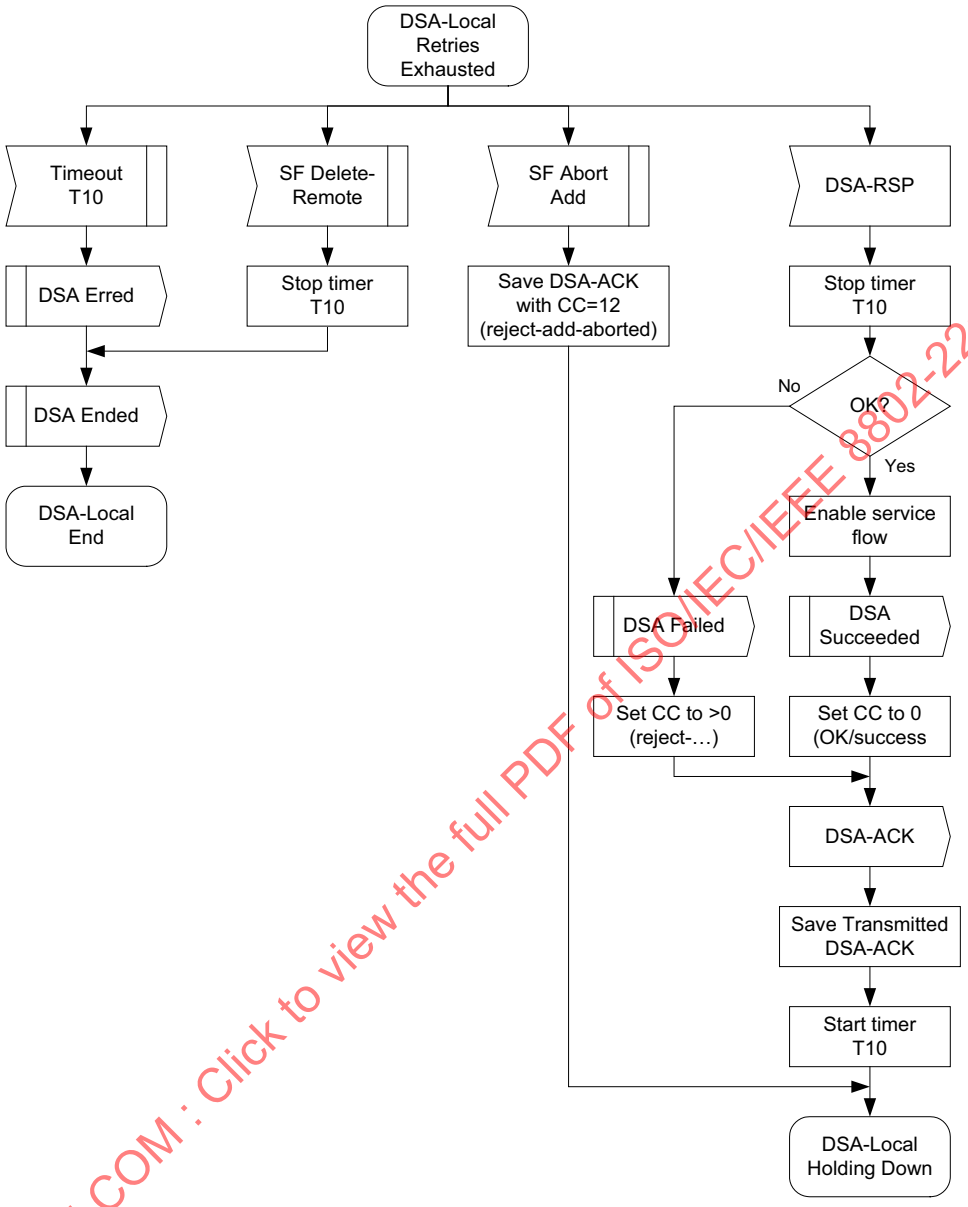

Figure 106—DSA—Locally-Initiated Transaction Retries Exhausted state flow diagram

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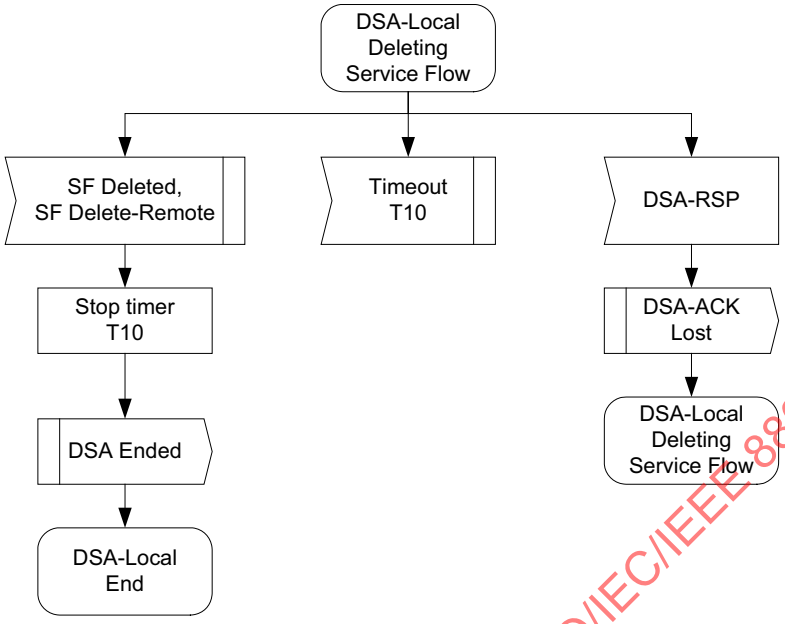

Figure 107—DSA—Locally-Initiated Transaction Deleting Service Flow state flow diagram

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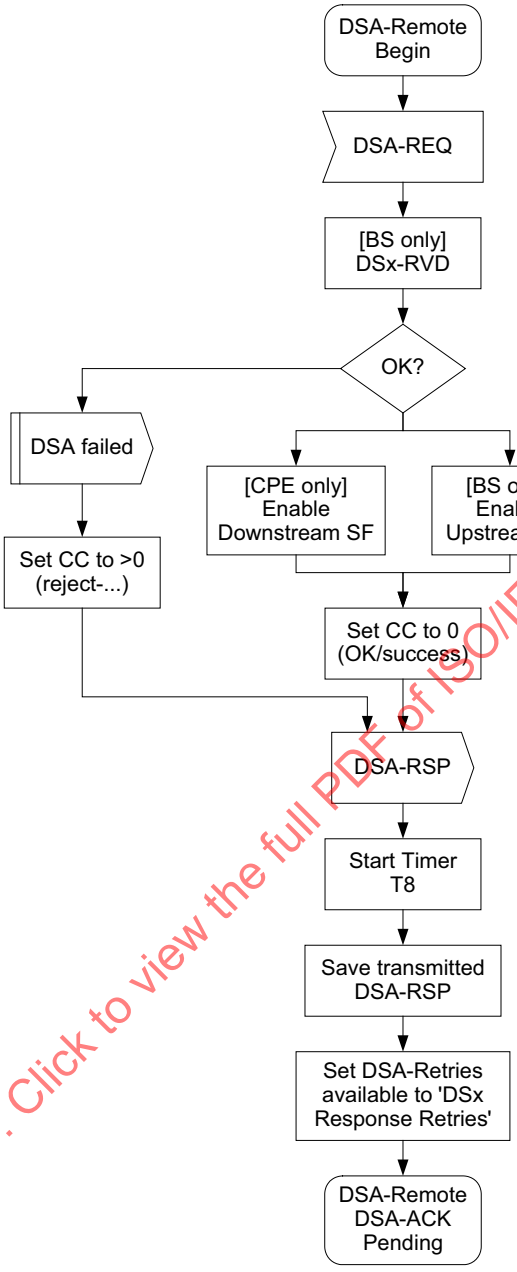

Figure 108—DSA—Remotely-Initiated Transaction Begin state flow diagram

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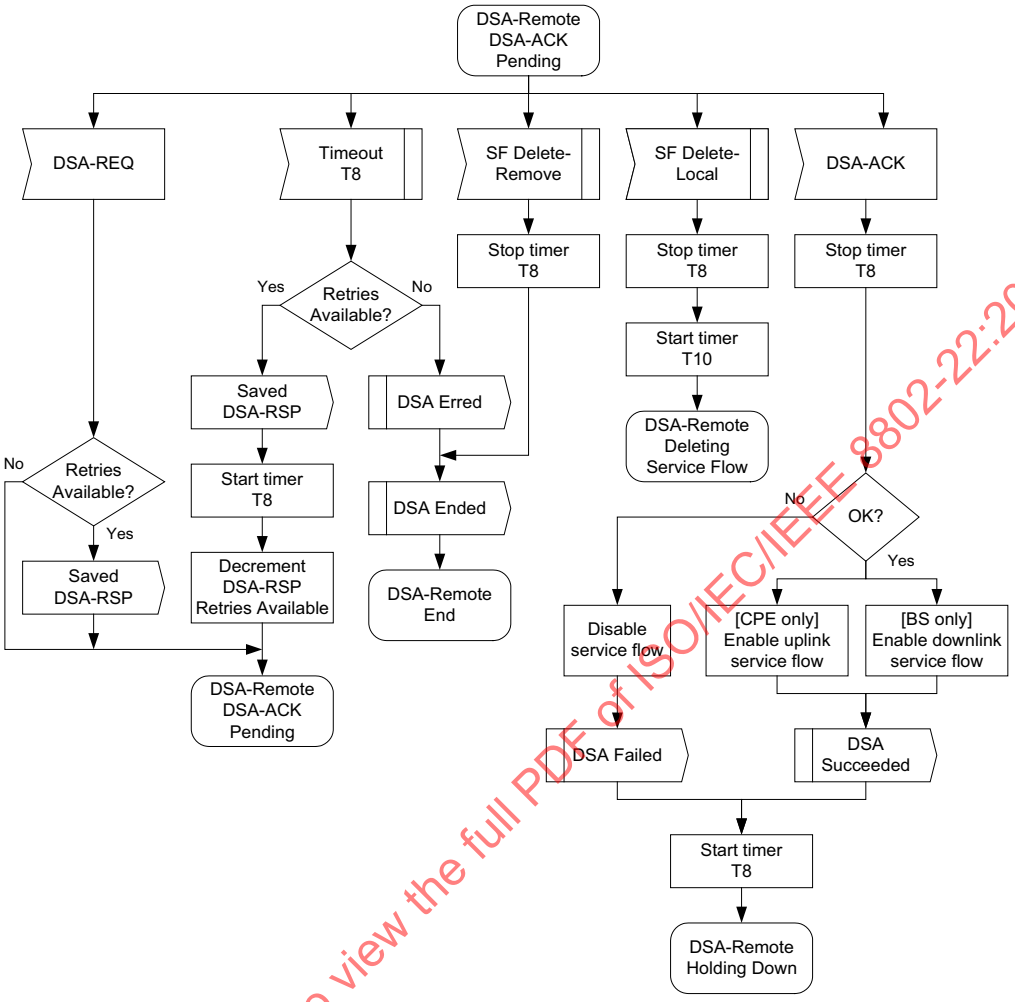

Figure 109—DSA—Remotely Initiated Transaction DSA-ACK Pending state flow diagram

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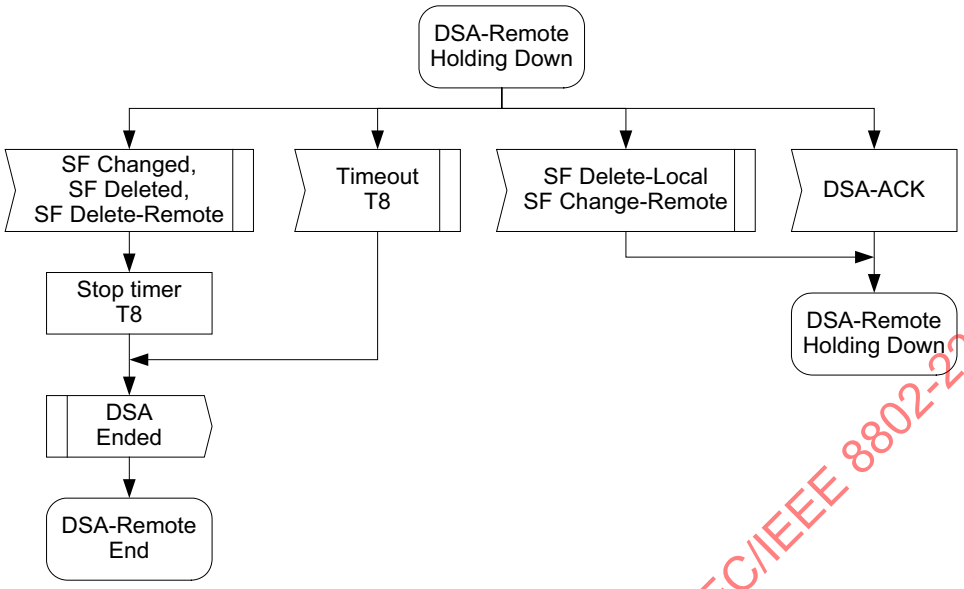

Figure 110—DSA—Remotely-Initiated Transaction Holding Down state flow diagram

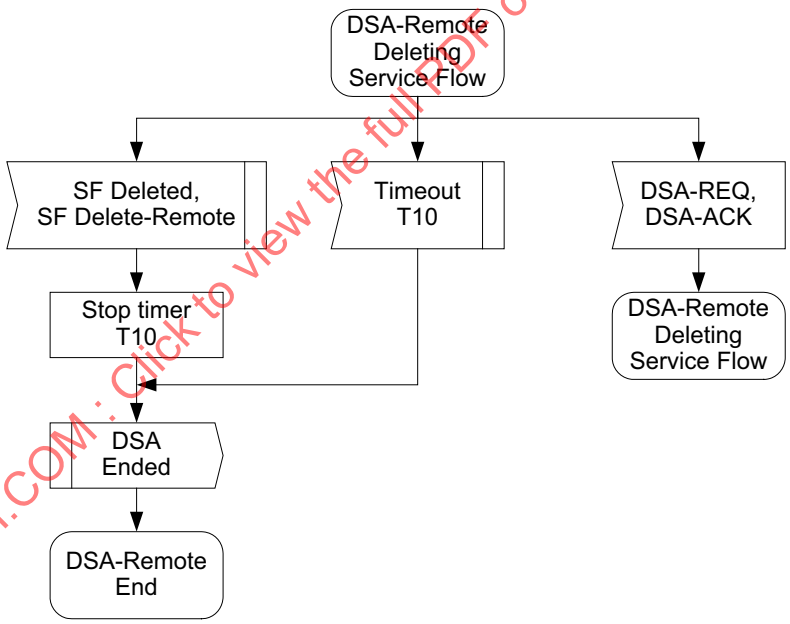

Figure 111—DSA—Remotely-Initiated Transaction Deleting Service state flow diagram

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7.20.9.4 Dynamic Service Change

The DSC set of messages is used to modify the flow parameters associated with a service flow. Specifically, DSC can modify the service flow specification.

A single DSC message exchange can modify the parameters of either one downlink service flow or one US service flow.

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To prevent packet loss, any required bandwidth change is sequenced between the CPE and BS.

The BS controls both US and DS scheduling. The timing of scheduling changes is independent of direction AND whether it is an increase or decrease in bandwidth. The BS always changes scheduling on receipt of a DSC-RSP (BS-initiated transaction).

The BS also controls the DS transmit behavior. The change in DS transmit behavior is always coincident with the change in DS scheduling (i.e., BS controls both and changes both simultaneously).

The CPE controls the US transmit behavior. The timing of CPE transmit behavior changes is a function of which device initiated the transaction and whether the change is an “increase” or “decrease” in bandwidth.

If a US service flow’s bandwidth is being reduced, the CPE reduces its payload bandwidth first and then the BS reduces the bandwidth scheduled for the service flow. If a US service flow’s bandwidth is being increased, the BS increases the bandwidth scheduled for the service flow first and then the CPE increases its payload bandwidth.

Any service flow can be deactivated with a DSC command by sending a DSC-REQ message, referencing the SFID, and including a null ActiveQoSParamSet. However, if a service flow that is mapped to either Basic, Primary Management, or Secondary Management Connection of a CPE is deactivated, that CPE is considered de-registered. The CPE shall attempt an initial entry and re-register with the BS to continue operation. Therefore, care should be taken before deactivating such service flows. If a service flow that was provisioned is deactivated, the provisioning information for that service flow shall be maintained until the service flow is reactivated.

A CPE shall have only one DSC transaction outstanding per service flow. If it detects a second transaction initiated by the BS, the CPE shall abort the transaction it initiated and allow the BS-initiated transaction to complete.

The following service flow parameters may not be changed, and shall not be present in the DSC-REQ or DSC-RSP messages:

— Service Flow Scheduling type
— Request/Transmission Policy
— Convergence Sublayer Specification
— Fixed-length versus variable-length SDU indicator
— SDU size
— ARQ parameters, in accordance with individual TLV definitions
— Target SAID, service flow can only be mapped to one SA while operating

7.20.9.4.1 BS-initiated DSC

A BS that needs to change a service flow definition performs the following operations.

The BS shall decide if the referenced service flow can support this modification. If so, the BS informs the CPE using a DSC-REQ. The CPE checks that it can support the service change, and shall respond using a DSC-RSP indicating acceptance or rejection. In the case when rejection was caused by presence of non-supported parameter of non-supported value, specific parameter may be included into DSC-RSP. The BS reconfigures the service flow if appropriate, and then shall respond with a DSC-ACK. This process is illustrated in Table 227.

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Table 227—BS-initiated DSC

BS		CPE
Service flow requires modifying		
Send DSC-REQ	======DSC-REQ=====>	Receive DSC-REQ
Set Timer T7		
		Validate request
		Modify service flow
		Decrease Payload Bandwidth if required
Receive DSC-RSP	<=====DSC-RSP======	Send DSC-RSP
Timer T7 Stops		
Modify service flow		
Adjust Channel Bandwidth		
Send DSC-ACK	======DSC-ACK=====>	Receive DSC-ACK
		Increase Payload Bandwidth if required

7.20.9.4.1.1 A-BS and centralized scheduling R-CPE behavior during A-BS-initiated DSC on PHY-OM2

When an A-BS initiates a DSC-REQ message to a A-CPE via a centralized scheduling R-CPE, the centralized scheduling R-CPE and the A-BS may deal with the message in the following way:

— If the service flow parameters are changed, the A-BS shall send a DSC-REQ to the centralized scheduling R-CPE before sending the DSC-REQ to the A-CPE.

— The A-BS may include a Per-RS QoS TLV in the DSC-REQ to the centralized scheduling R-CPE. If the centralized scheduling R-CPE receives the Per-RS QoS TLV, the centralized scheduling R-CPE shall use the values in the Per-RS QoS TLV instead of the ones in the service flow parameters.

— When the centralized scheduling R-CPE can support the requested QoS parameter set, it sends the DSC-REQ to the A-CPE using the primary management CID of the CPE.

— When the centralized scheduling R-CPE cannot support the requested QoS parameter set in the DSC-REQ, it sends a DSC-RSP with the CC set to reject-RS-not-supported-parameter-value to the A-BS indicating that it cannot support the requested QoS parameter set. The DSC-RSP may contain the acceptable QoS parameter set that the centralized scheduling R-CPE can support.

— The centralized scheduling R-CPE may get the updated SF parameters and confirmation code from the DSC-RSP and DSC-ACK sent from the A-CPE and the A-BS, respectively.

7.20.9.4.2 DSC state transition diagrams

DSC state transition diagrams are shown in Figure 112 through Figure 120.

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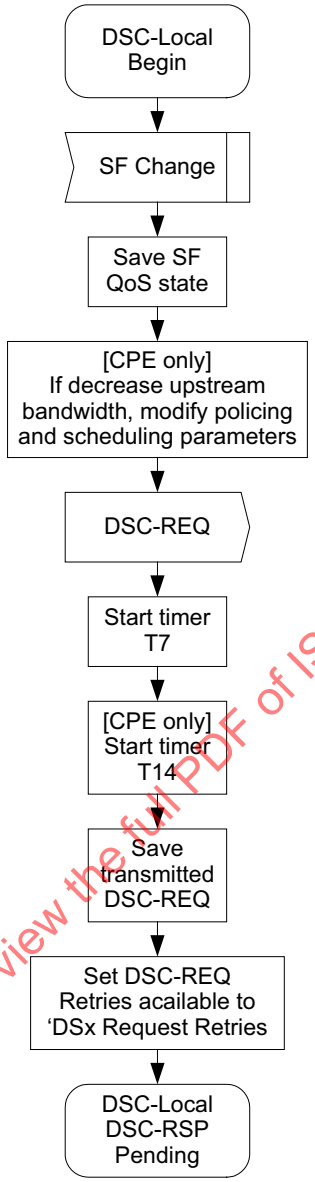

Figure 112—DSC—Locally-Initiated Transaction Begin state flow diagram

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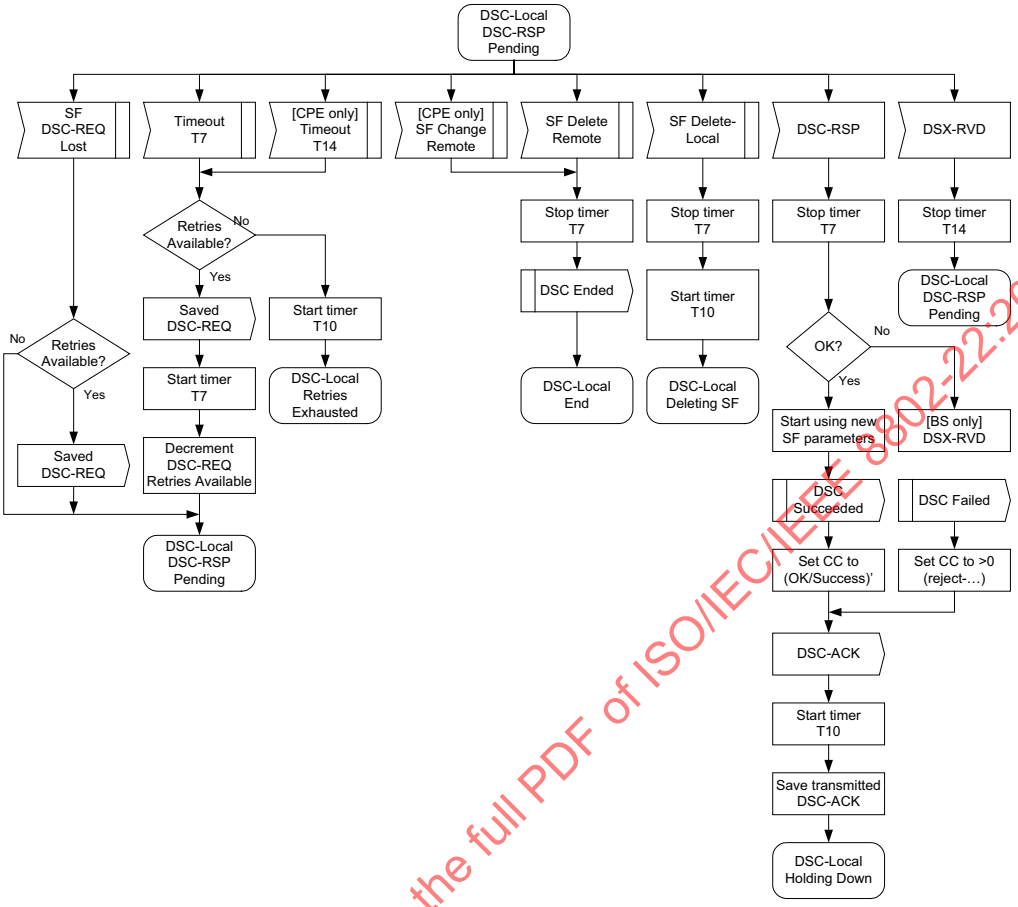

Figure 113—DSC—Locally-Initiated Transaction DSC-RSP Pending state flow diagram

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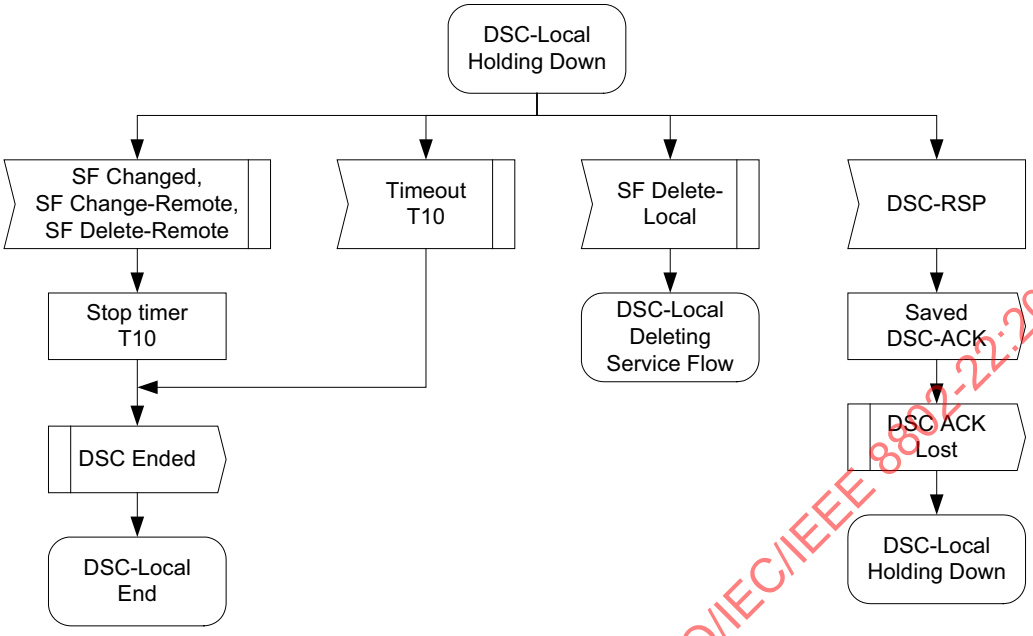

Figure 114—DSC—Locally-Initiated Transaction Holding Down state flow diagram

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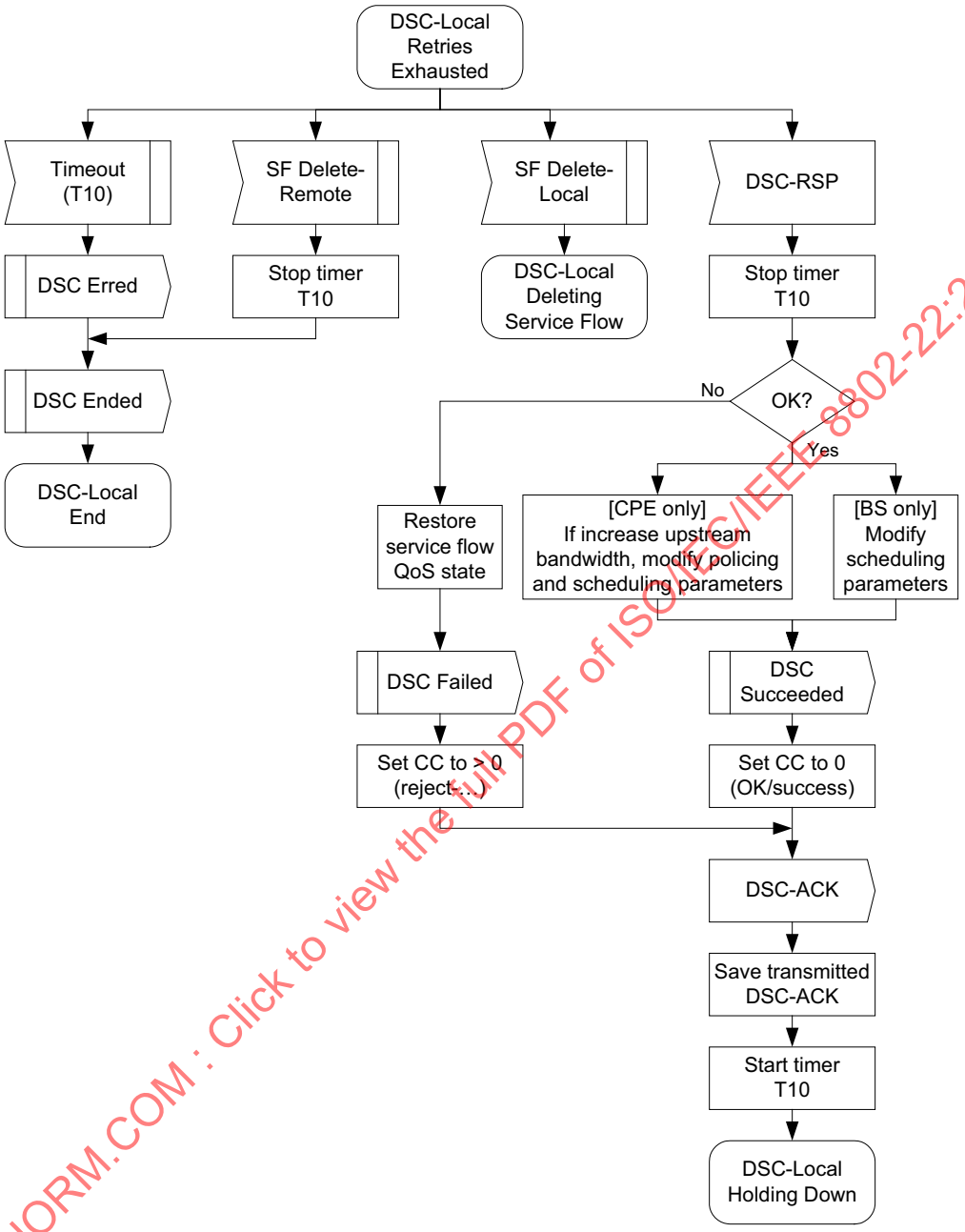

Figure 115—DSC—Locally-Initiated Transaction Retries Exhausted state flow diagram

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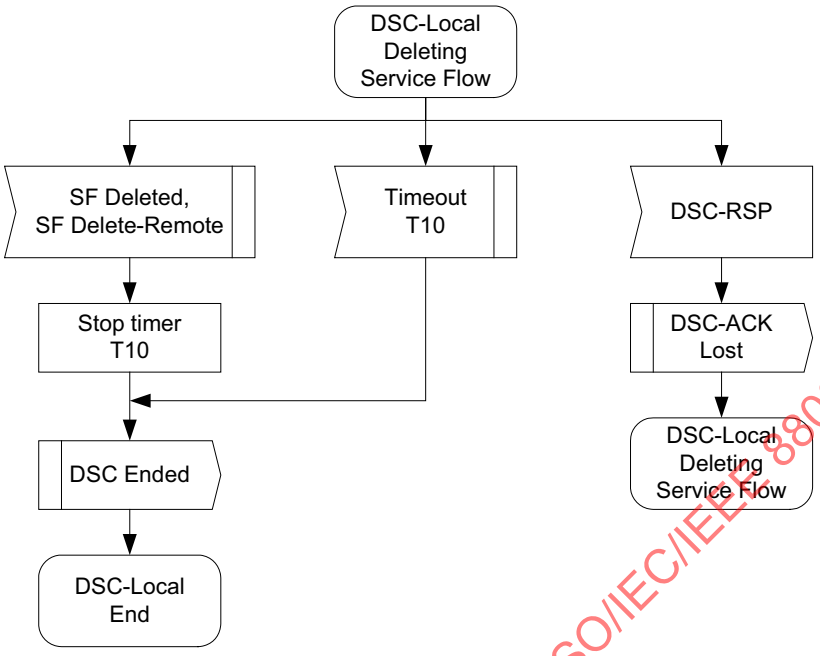

Figure 116—DSC—Locally-Initiated Transaction Deleting Service Flow state flow diagram

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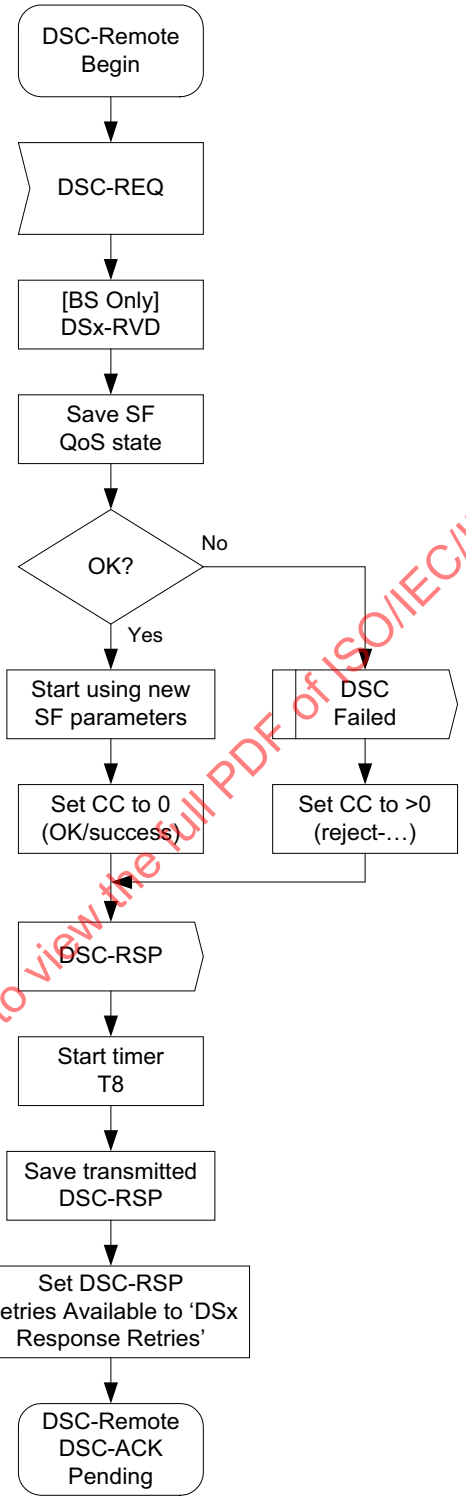

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Figure 117—DSC—Remotely-Initiated Transaction Begin state flow diagram

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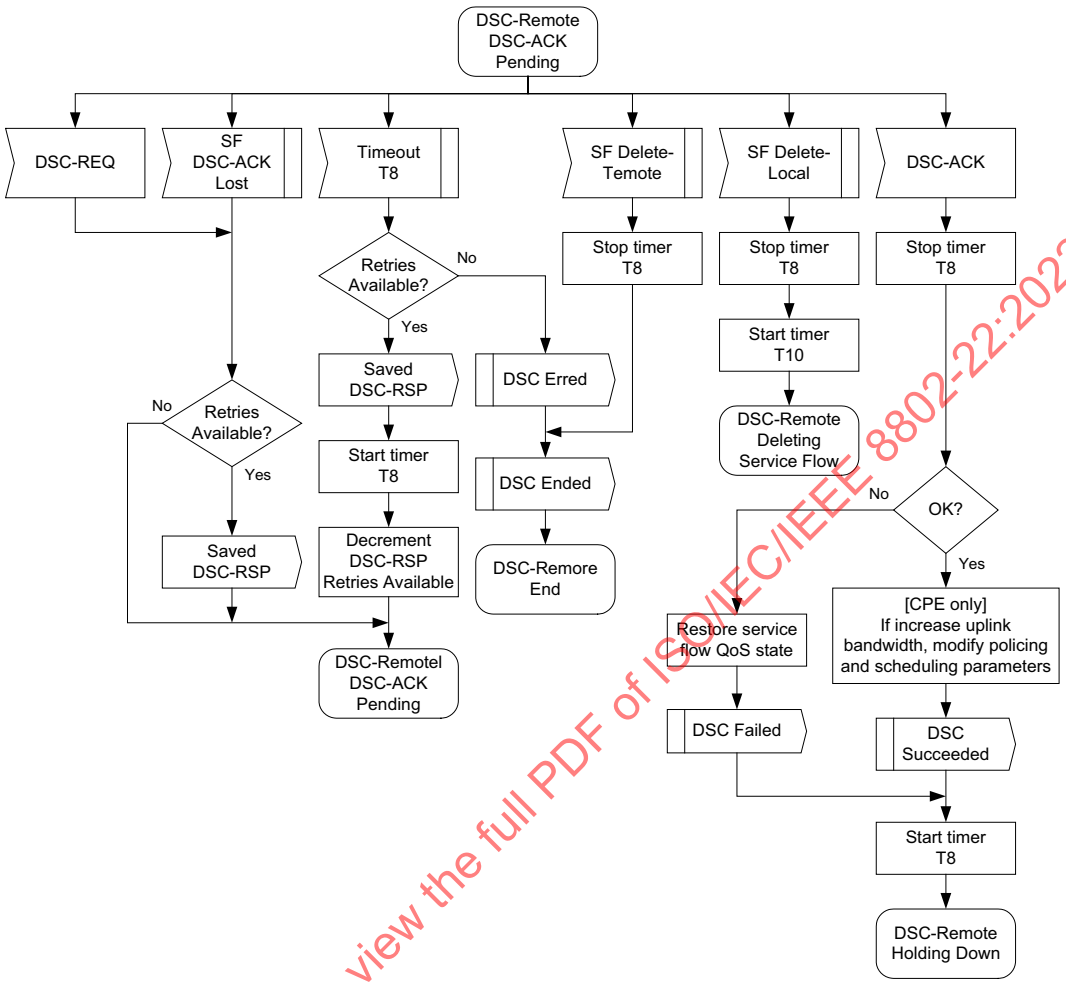

Figure 118—DSC—Remotely-Initiated Transaction DSC-ACK Pending state flow diagram

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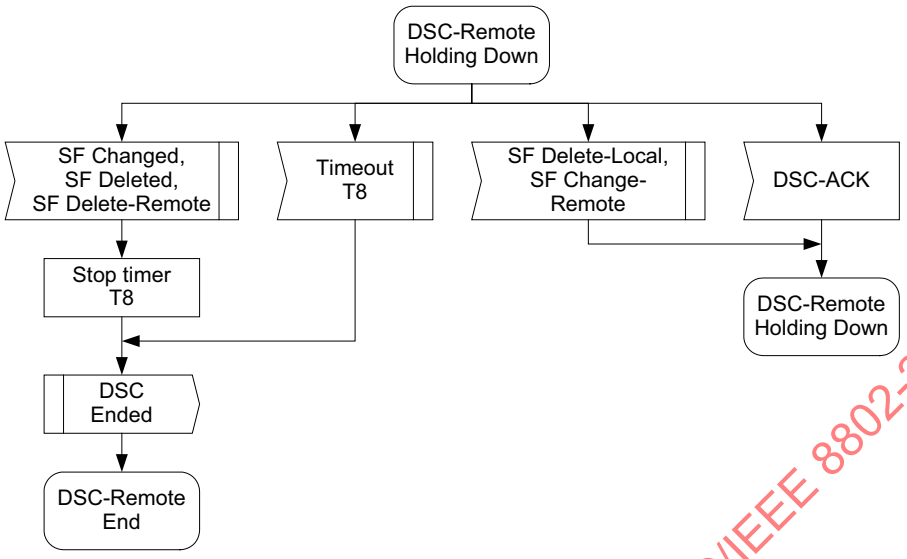

Figure 119—DSC—Remotely-Initiated Transaction Holding Down state flow

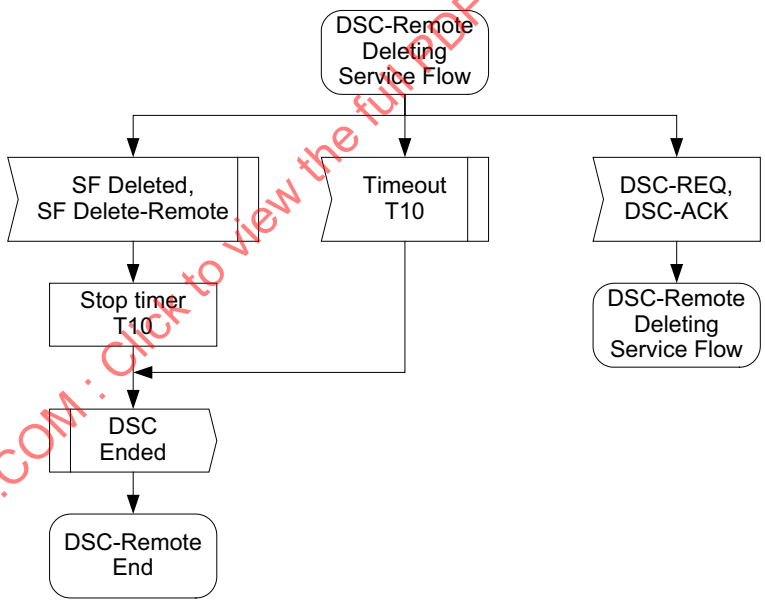

Figure 120—DSC—Remotely-Initiated Transaction Deleting Service Flow state flow diagram

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7.20.9.5 Dynamic Service Deletion

Any service flow can be deleted with the DSD messages. When a service flow is deleted, all resources associated with it are released. If a service flow for a provisioned service is deleted, the ability to re-establish the service flow for that service is network management dependent. Therefore, care should be taken before

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deleting such service flows. However, the deletion of a provisioned service flow shall not cause a CPE to reinitialize.

7.20.9.5.1 BS-initiated DSD

A BS wishing to delete a dynamic service flow generates a delete request to the associated CPE using a DSD-REQ. The CPE removes the service flow and generates a response using a DSD-RSP. This process is illustrated in Table 228. Only one service flow can be deleted per DSD-REQ.

Table 228—DSD-initiated from BS

CPE		BS
		Service flow no longer needed
		Delete service flow
		Determine associated CPE for this service flow
Receive DSD-REQ	<=====DSD-REQ======	Send DSD-REQ
Delete service flow		
		Delete service flow
Send DSD-RSP	======DSD-RSP=====>	Receive DSD-RSP

7.20.9.5.1.1 A-BS and centralized scheduling R-CPE behavior during A-BS-initiated DSD on PHY-OM2

When an A-BS initiates a DSD-REQ message to a A-CPE via a centralized scheduling R-CPE using the primary management CID of the A-CPE, the centralized scheduling R-CPE relays it to the A-CPE using the primary management CID of the A-CPE. When the centralized scheduling R-CPE receives a DSD-RSP sent from the A-CPE, it deletes the service flow information and relays it to the A-BS.

7.20.9.5.2 DSD state transition diagrams

DSD state transition diagrams are shown in Figure 121 through Figure 125.

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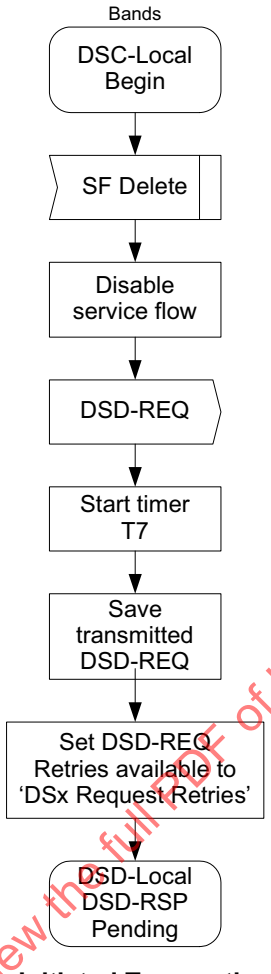

Figure 121—DSD—Locally-Initiated Transaction Begin state flow diagram

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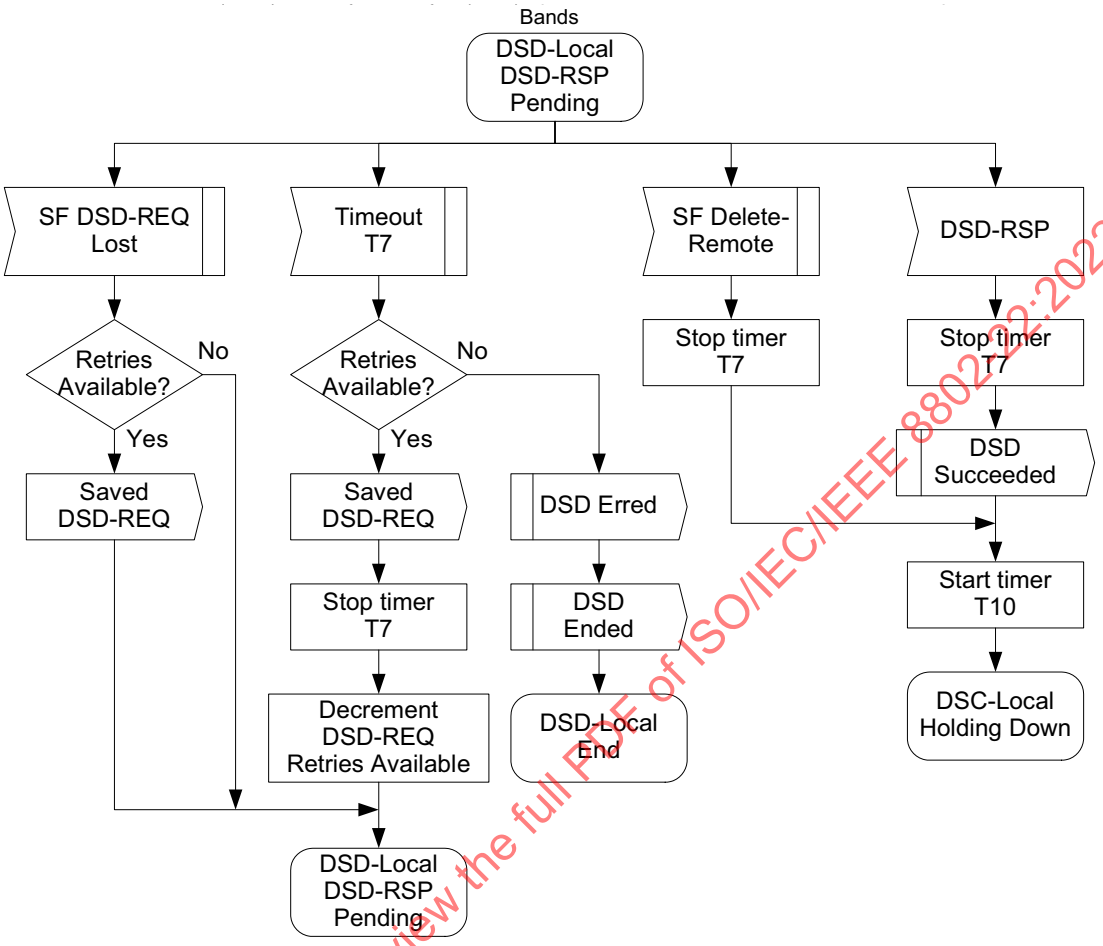

Figure 122—DSD—Locally-initiated Transaction DSD-RSP Pending state flow diagram

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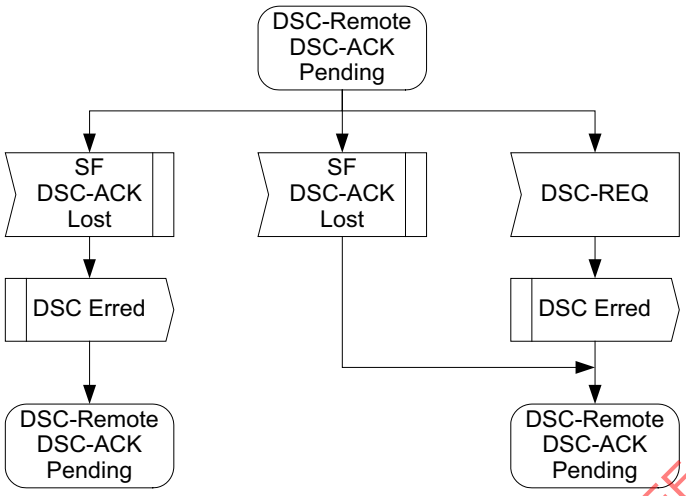

Figure 123—DSD—Locally-initiated Transaction Holding Down state flow diagram

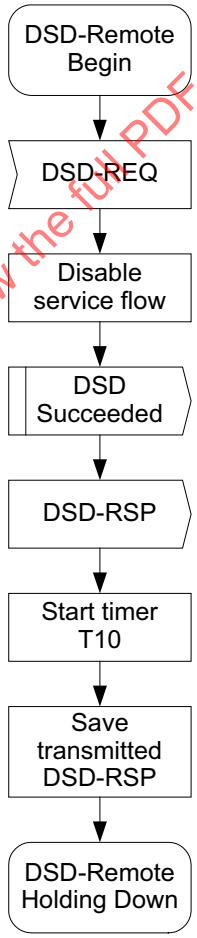

Figure 124—DSD—Remotely-initiated Transaction Begin state flow diagram

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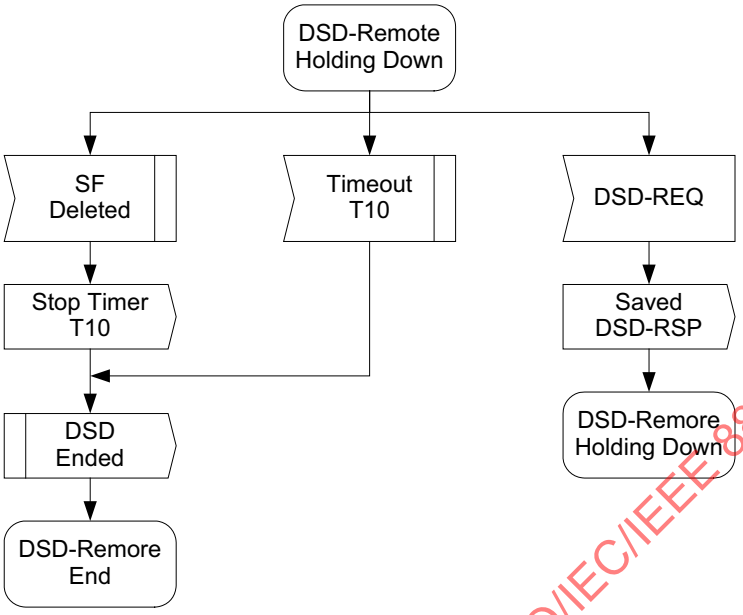

Figure 125—DSD—Remotely-initiated Transaction Holding Down state flow diagram

7.21 Incumbent protection

To address incumbents' detection and protection, numerous techniques are available by means of spectrum management, quiet period management, distributed spectrum sensing, detection algorithms, and measurements. The MAC provides all the capabilities for the effective detection and protection of incumbent services. A comprehensive set of spectrum management and measurement commands is available, which gives the BS the necessary flexibility to manage CPEs and obtain a reliable spectrum occupancy map of its cell and, if needed, change its operating parameters.

An A-WRAN shall support incumbent protection on relay connection between an A-BS and CPEs. The incumbent protection procedures when the direct connection exists between the A-BS and CPEs shall follow the operations described from 7.19.1 to 7.19.3. The measurement management and notification procedures of incumbent protection for a relay network are shown in 7.21.2.1 and 7.21.4.2, respectively

CPEs also have various ways to report measured information to the BS. In addition to a pool of MAC management messages, UCSs can also be reported either through fields located in the generic MAC header itself, or through the UCS contention or CDMA messages. The simplified lifecycle of a single measurement activity is depicted in Figure 126. Each of the phases of this lifecycle requires special handling, and specific protocols and algorithms are described in this subclause and in 11.3 to address their requirements. In the following subclauses, a detailed overview of the mandatory mechanisms available in the MAC for the management of incumbent measurements throughout their lifecycle is provided.

7.21.1 Measurements classification

Measurements can be of the following types: in-band (i.e., measurements made on the operating channel and its first adjacent channels), and out-of-band (i.e., measurements made on other channels than the above three channels).

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7.21.2 Measurements management

Besides the automated sensing measurements that are carried out autonomously by the SSA (see 11.3.3 and 11.3.4), which allow for detection of urgent interference situations for in-band sensing and which allow for clearing a minimum number of channels on the backup list (see 11.3.4) for out-of-band sensing, the MAC also supports a hierarchical measurement philosophy implemented by four management messages, namely, BLM-REQ, BLM-RSP, BLM-REP, and BLM-ACK (see Table 26 and 7.9.18). These management messages are used between the SM at the BS and the SSA at the BS and CPEs to perform a wide range of measurement activities, either related to incumbents or to self-coexistence. With these messages, both in-band and out-of-band specific measurements can be performed.

In a single BLM-REQ command, the BS may simultaneously request SSAs to perform several types of measurements in a number of channels. Thus, a BLM-REQ is formed by a collection of single measurement requests. Each single measurement request specifies several parameters such as the periodicity with which the BS wants SSAs to report back to it or if reports are to be autonomous. Furthermore, single measurement requests also define timing parameters, as illustrated in Figure 23. Upon receiving a BLM-REQ message, the SSA shall examine this message's header and determine whether it is required to respond back with a BLM-RSP message. In all cases, the SSA shall carry out all the measurements as requested by the BS, if these are supported. SSAs shall report back to the BS with a BLM-REP message that contains measurement results of what has been requested by the BS in the corresponding BLM-REQ message. These reports shall be sent with the periodicity specified by the BS in the corresponding BLM-REQ message. Once the measurement report message is successfully received at the BS, the BS shall respond back to the SSA with a BLM-ACK message to acknowledge its reception. In case the SSA does not hear the BLM-ACK message from the BS after some pre-specified timeout T29 (see Table 338), it shall assume that its BLM-REP message was lost and shall initiate retransmission of this BLM-REP message. The SSA shall attempt retransmission of measurement report messages up to the values specified for BLM-REP Retries (see Table 338). Once the BLM-ACK message is successfully received at the SSA, it shall then clear its local statistics to prepare for future measurements. Figure 126 illustrates the measurement message flow between the BS and a SSA.

The nature of the SSA reports received by the SM at the BS can be essentially of two types: regular or urgent. Regular reports refer to the cases where the BS has explicitly requested SSAs to report back to it with a certain periodicity (and so the BS can allocate sufficient US resources beforehand), and also when SSAs are allowed to report autonomously, for example, whenever enough data has been collected (in this case, CPEs may have to request for US resource allocation).

Urgent reports are those that take place as a result of the automated in-band sensing carried out by the SSA (see 11.3.3) whenever an incumbent is detected in the current operating channel of an IEEE 802.22 cell or on either of its adjacent channels. The BS shall provide US UCS contention periods on a regular basis. The CPEs can then notify the BS about potential interference by sending the UCS notification bit in the GMH and sending in its own US allocations or using one of these UCS contention periods.

Subsequent reports can then be requested through the BLM-REQ MAC message immediately after detection of an incumbent to further quantify the situation (see 7.21.4). In this case, the BS shall provide periodic bandwidth request opportunities during which CPEs can report critical measurement results, or else the CPE can use any of its own reservations for this purpose.

In case the CPE uses UCS notification, the BS does not send an acknowledgment. The BS can then send a BLM-REQ message and allocate bandwidth for the CPE to transmit the complete measurement report message (BLM-REP), and the corresponding acknowledgment (BLM-ACK) is sent on the next DS opportunity following the reception of the measurement report.

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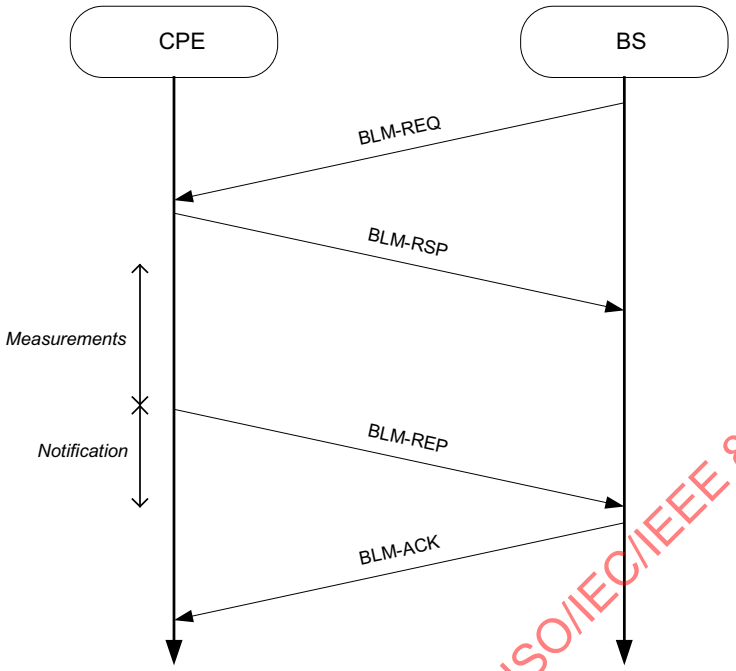

Figure 126—Measurement message flow between BS and CPE

Once the BS receives a UCS notification from its various CPEs, it may wish to take steps to resolve any potential interference situation with incumbents. To this end, a rich set of channel management messages is supported through the Incumbent Detection Recovery Protocol (IDRP) (see Table 26 and 7.9.17) that enables the BS to act promptly and effectively. The IDRP shall also be used as part of the recovery procedure (see 7.21.5). In case of self-coexistence interference situations, other mechanisms available are "spectrum etiquette" and "on-demand frame-based contention," and their use is discussed in 7.22.

In order for the BS to poll measurements from a group of CPEs, the BS shall establish a multicast group and assign said CPEs to the group (see xx), as well as establish a Group Security Association (GSA) and keying mechanism to protect the DS measurement report request messages.

7.21.2.1 Measurements management for a relay network PHY-OM2

Measurement management performs a wide range of measurement activities, either related to incumbent detection or to self-coexistence.

In an A-WRAN network, measurement requests can be performed from the A-BS.

When a centralized scheduling R-CPE receives a BLM-REQ from the A-BS, it shall send it to the destination CPE. The CPE shall report back to the A-BS through the centralized scheduling R-CPE with a BLM-REP message that contains measurement results. Then, the A-BS sends the corresponding acknowledgment (BLM-ACK) on the next DS opportunity following the reception of the measurement report (see Figure 127).

When a distributed scheduling R-CPE receives a BLM-REQ from the A-BS, it shall perform measurement management within the local cell by sending a BLM-REQ to the A-CPE. The A-CPE shall report back to the A-BS through the distributed scheduling R-CPE with the BLM-REP message that contains measurement

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results. Then, the A-BS sends the corresponding acknowledgment (BLM-ACK) on the next DS opportunity following the reception of the measurement report (see Figure 127).

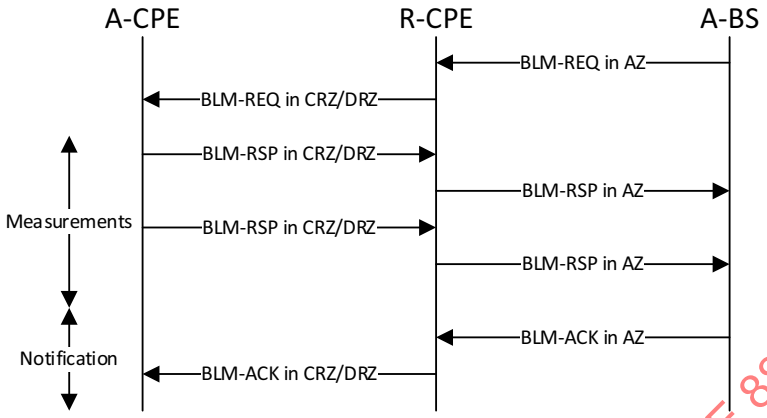

Figure 127—Measurement message flow between A-BS and CPE through A-CP

7.21.3 Incumbent detection

The MAC is able to fully manage periodic sensing of incumbent transmissions. This is done through the quiet period management mechanisms described in 7.23.

7.21.4 Measurement report and notification

Channels occupied by incumbents change over time, and this is the reason why CPEs and BSs shall periodically sense the medium to determine the presence or absence of incumbents. In a situation where an incumbent is operating on the same channel or on adjacent channels relative to the channel used by the IEEE 802.22 cell (i.e., in-band), certain CPEs (or even the BS itself) will detect the incumbent's transmitted signal through the distributed sensing technique. Whenever this happens, the CPE shall immediately notify and report this situation to the BS. The SSAs at both BS and CPEs shall execute automatic algorithms that allow the reliable detection of incumbent signals. The procedure is described in 11.3.3.

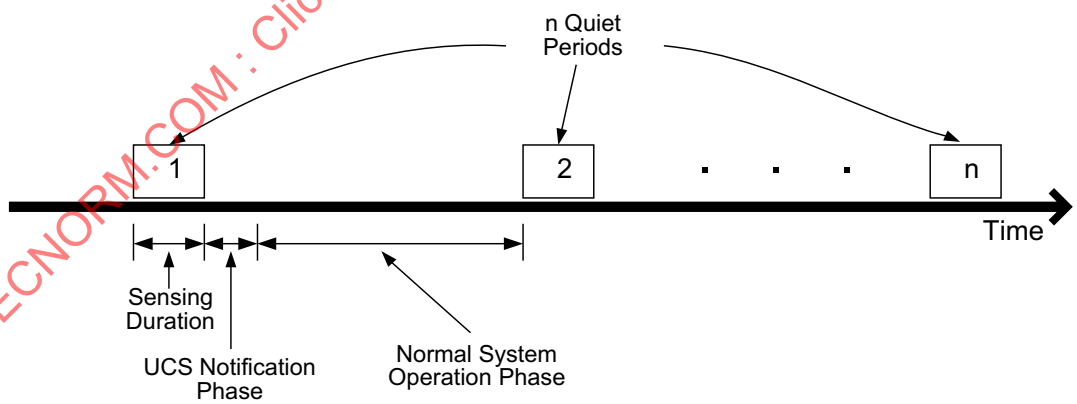

Figure 128—Incumbent notification phases

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7.21.4.1 Notification phase for sensing

After a quiet period, the SSA at both the BS and CPEs will have performed incumbent measurements. If the BS itself detected the presence of an in-band incumbent, it can proceed as discussed in 7.21.2. Regardless of that, in the next frame (and optionally in subsequent frames) right after the end of the quiet period the BS may limit its DS transmissions to the minimum necessary, and devote most of its frame allocation for US traffic.[27]

More specifically, the BS may decide to provide for more US bandwidth allocation for those CPEs that indicated the presence of incumbents, and hence obtain a more comprehensive report.

Those CPEs who have not been allocated dedicated US bandwidth, but who have detected the presence of an incumbent during the quiet period, shall use the UCS notification intervals for the purpose of notifying the BS. If no such UCS notification intervals are available, the CPE shall wait for subsequent frames where the BS will either allocate US bandwidth for this particular CPE or schedule UCS notification intervals. In the case of the contention-based UCS interval, the burst shall contain 7 symbols to allow the pilot carriers to properly correct for the transmission channel distortion.

It is important to note that only those CPEs that have not been allocated US bandwidth in a frame are allowed to use the UCS notification intervals in that frame (see 7.21.4.1.2 for further details). Those CPEs having US bandwidth allocation shall use the UCS flag bit in the generic MAC header of their US transmission (see 7.8.1.1).

To improve the reliability and performance of the system, two types of UCS notification windows are possible (see 7.21.4.1.2). In the case of a contention-based UCS notification, the BS shall allocate the size of a UCS notification interval to be big enough to fit one or a few generic MAC headers (which is the smallest unit of information for incumbent notification purposes—see 7.8.1.1). The CPEs that have detected an incumbent in-band shall then contend for this UCS notification interval to immediately send their MAC header with the UCS flag set.

In the case of a CDMA UCS notification, the CPE shall transmit its CDMA code in the corresponding CDMA UCS opportunistic allocation. This will allow the BS to identify right away that there is an UCS and allow it to take the necessary measures but it will not tell the BS with which CPE this situation occurred. To identify which CPE has detected an incumbent, the BS will need to issue a CDMA_Allocation_IE for the CPE to respond. This bandwidth grant will allow the CPE the opportunity to report on its UCS. The use of both of these types of notification schemes will provide a quick and reliable report from the CPEs to the BS to be made in the first stage, and allow the BS to query for a more detailed report on the UCS, in a second stage, by sending a BLM-REQ message and granting more US bandwidth resources to those CPEs that claim having detected the presence of incumbents.

At any time, the BS should allocate a minimum number of UCS notification intervals for the purpose of incumbent notification. If the detection of an incumbent by a CPE takes place during normal operation, the CPE can notify the BS through its granted US bandwidth allocation in the frame or, if not available, through UCS notification. These are discussed in the subclauses that follow.

7.21.4.1.1 CPEs with upstream bandwidth allocation

In case the CPE has a US bandwidth allocation to send the UCS notification to the BS by setting the UCS flag in the generic MAC header (see Table 6), it shall do so in the first available opportunity. By setting this field, it will indicate to the BS that there is an UCS. Where incumbent protection is concerned, the UCS notification messages take precedence over all other messages. Once the BS receives the UCS notification message, it proceeds as outlined in 7.21.2 and takes any necessary steps to resolve the coexistence situation.

[27] The number of frames will highly depend on the number of CPEs.

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Once the BS is notified through the UCS notification flag in the MAC header, it can proceed in different ways. For example, once it receives this UCS notification, it may query the reporting CPE through the BLM-REQ message and allocate more US resources to this CPE in the following frame so that this CPE can send a more detailed report via a BLM-REP. Alternatively, the BS may set the MRT field in the corresponding allocation of this CPE in the US-MAP message (see Table 46), and this will specifically solicit from this CPE more detailed measurement information that shall be sent in its next US allocation. Another possibility is for the BS to play safe and immediately issue channel management messages for a channel switch in order to resolve the situation. Finally, one last option could be for the BS to delay taking any immediate action and wait for feedback from other CPEs.

7.21.4.1.2 CPEs without upstream bandwidth allocation

Even if the CPE does not have any US bandwidth allocation with its BS, it still needs to report to the BS about the UCS with incumbents. In this case, the CPE shall use the opportunistic US UCS notification intervals in order to reach the BS and indicate the UCS with incumbents. The opportunistic UCS notification intervals shall always be allocated by the BS in the same time/frequency region across frames. This will allow even those CPEs who have suddenly started to experience harmful interference from an incumbent service to reliably notify the BS about the presence of the incumbent service, as the location of the UCS notification intervals is always known. The CPE shall notify the BS in the UCS notification interval immediately after the incumbent service is detected, while it is still synchronized to the BS.

It is important to highlight that the only situation when CPEs are allowed to use UCS notification intervals is when they do not have US bandwidth allocation but yet need to reach the BS and report a UCS with incumbents. There are two possible ways a BS can allocate opportunistic UCS notification windows in its US: Contention-based UCS notification and CDMA UCS notification. The CPEs shall use these intervals in accordance with their specific type.

7.21.4.1.2.1 Contention-based UCS notification

In reporting a UCS through the use of the contention-based UCS notification intervals, the CPE shall transmit only the generic MAC header, typically without any payload. In this MAC header, the CPE shall set the UCS field accordingly so as to allow the BS to be notified of the UCS. Upon receiving the message from the CPE, the BS shall proceed as discussed in 7.21.2. If requested by the BS through either a BLM-REQ message or by the MRT field in the US-MAP (see Table 46), the CPE shall send a single measurement report describing the potential interference situation in a subsequent field (see 7.9.18.3.1.1).

7.21.4.1.2.2 CDMA UCS notification

In addition to the contention-based UCS notification window described previously, the PHY also supports the use of a CDMA mechanism for the purpose of UCS notification.

As specified in 7.9.3.1, the PHY has available a subset of UCS notification codes that shall be used for CDMA UCS notification. The CPE, upon needing to make a UCS notification, shall select, with equal probability, a UCS notification code from the code subset allocated to UCS notification. This UCS notification code shall be modulated onto the specified US opportunistic subchannels and transmitted during the appropriate CDMA UCS notification window (see Table 46 for UIUC=4).

Upon detection, the BS shall grant a US allocation for the CPE. The BS does not respond with an allocation on the CPE's SID and Basic FT since it is not yet known at that time. Instead, it broadcasts a CDMA_Allocation_IE, which specifies the code that was used by the CPE. This allows the CPE to determine whether it has been given an allocation by matching the CDMA code that he used for the CDMA UCS notification message and the code broadcast by the BS. The CPE shall use the allocation to transmit a MAC PDU with the UCS field in the MAC header properly set. In addition, if allowed by the BS, data could also be transmitted in this allocation as indicated by the Usage field—see Table 48.

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If the BS does not issue the CDMA_Allocation_IE described above, the CPE shall assume that the Code transmission resulted in a collision and follow the contention resolution as specified in 7.15.

7.21.4.2 Measurement report and notification for a relay network on PHY-OM2

The A-CPE may have a US bandwidth allocation in a CRZ to send the UCS notification to the centralized scheduling R-CPE or may have a US bandwidth allocation in a DRZ to send UCS notification to the distributed scheduling R-CPE. Those A-CPEs shall relay the UCS notification transmitted by the A-CPE to the A-BS in an AZ by using one of UCS notifications, i.e., US bandwidth allocation, opportunistic UCS notification, and CDMA-based UCS notification.

The A-CPE may use an opportunistic UCS notification interval in a CRZ to send the UCS notification to the centralized scheduling R-CPE, or may use an opportunistic UCS notification interval in a DRZ to send UCS notification to the distributed scheduling R-CPE. Those R-CPEs shall relay UCS notification transmitted by the A-CPE to the A-BS in an AZ by using one of UCS notifications that are US bandwidth allocation, opportunistic UCS notification, and CDMA-based UCS notification.

Upon reception of UCS notification codes from A-CPEs, a centralized scheduling R-CPE shall relay the UCS notification codes to the A-BS. The A-BS does not respond with an allocation on the A-CPE's SID and Basic FT since the allocation is not yet known at this time. Instead, it broadcasts a CDMA_Allocation_IE, which specifies the code and allocation in a CRZ that was used by the A-CPE. This allows the A-CPE to determine whether it has been given an allocation by matching the CDMA code that was used for the CDMA UCS notification message and the code broadcast by the A-BS. The A-CPE shall use the allocation to transmit a MAC PDU to the centralized scheduling R-CPE with the UCS field in the MAC header properly set. The centralized scheduling R-CPE shall send the UCS notification to the A-BS by using any possible way of UCS notification (7.19).

Upon reception of UCS notification codes, a distributed scheduling R-CPE does not respond with an allocation on the CPE′s SID and Basic FT since the allocation is not yet known at that time. Instead, it broadcasts a CDMA_Allocation_IE, which specifies the code that was used by the A-CPE. This allows the CPE to determine whether it has been given an allocation by matching the CDMA code that was used for the CDMA UCS notification message and the code broadcast by the distributed scheduling R-CPE. The A-CPE shall use the allocation to transmit a MAC PDU with the UCS field in the MAC header properly set. The distributed scheduling R-CPE shall send the UCS notification to the A-BS by using any possible way of UCS notification (7.21.4.1.2.1 and 7.21.4.1.2.2).

7.21.5 Incumbent detection recovery

This subclause describes the incumbent detection recovery protocol (IDRP), which is used by the BS and CPEs to restore service under an UCS due to incumbent detection.

The IDRP is executed by BS and CPEs. When the CPE detects and reports an incumbent on the operating channel or its adjacent channels, it expects a notification from the BS. There are two types of notification: explicit and implicit. The explicit notification is used by the BS if it decides to execute a spectrum management command, in which case the BS transmits a spectrum management message to CPEs (e.g., a channel switching request message CHS-REQ) providing a way to notify CPEs and re-establish normal operation in a timely manner on another operating channel. However, if the reporting CPE does not receive the spectrum management message, it uses a timer to identify whether action is needed to protect the detected incumbent and maintain connectivity with the BS. Therefore, after sending the incumbent detection notification, the CPE starts the timer T56 that is preset at the value given in Table 338, and if this timer expires before an explicit notification is received from the BS, the CPE concludes that the operating channel is under interference and immediately switches to the first backup channel on its list. Figure 129 depicts the explicit and implicit notification mechanisms, while Figure 130 and Figure 131 show the details of IDRP for the BS and CPE, respectively.

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Figure 130 describes the detailed procedure executed by the BS, which starts with an incumbent detection event, which can be triggered by an incumbent detection notification received from one or more CPEs, or by the BS's own measurements or external information (e.g., database updates). In such a situation, the BS shall update its local channel status information and if the affected channel is the operating channel, the BS shall notify the CPEs of the action to be taken by sending a spectrum management command. As part of the procedure, the BS shall also update the list of backup channels when needed.

In the case of a CPE (see Figure 131), the first step in IDRP upon detection of a primary radio service is to notify the BS and await further instructions (this can be done a few times up to a predetermined amount of repetitions). In case the CPE does not receive a spectrum management message from the BS, the CPE shall try to find the transmission from the BS and continue its operation on the first backup channel, if not, on the second backup channel and so on. If the CPE cannot re-establish communication with the BS on any of the backup channels, the CPE initialization procedure shall be triggered.

The success of the recovery procedure will depend on the availability of backup channels and in order to maintain a list of available backup channels, CPEs shall use their idle time to perform measurements to keep track of the availability of backup channels as described in 11.3.4. For this purpose, the BS shall provide sufficient idle time to the CPEs for them to "clear" a sufficient number of backup channels (see Figure 159 and 7.9.18.3.1.4). The BS can also request CPEs to sense some backup channels through the BLM-REQ message (see 7.9.18.1). Every CPE shall perform this procedure according to a repetition period of execution as specified by the Channel Monitoring Requirement for acquiring a channel in Table A.13.

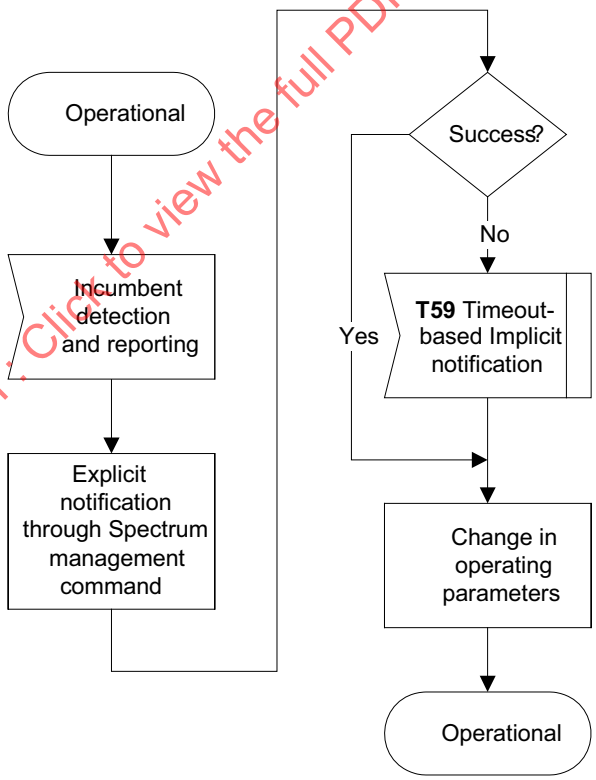

Figure 129—Explicit and implicit notification mechanisms in IDRP

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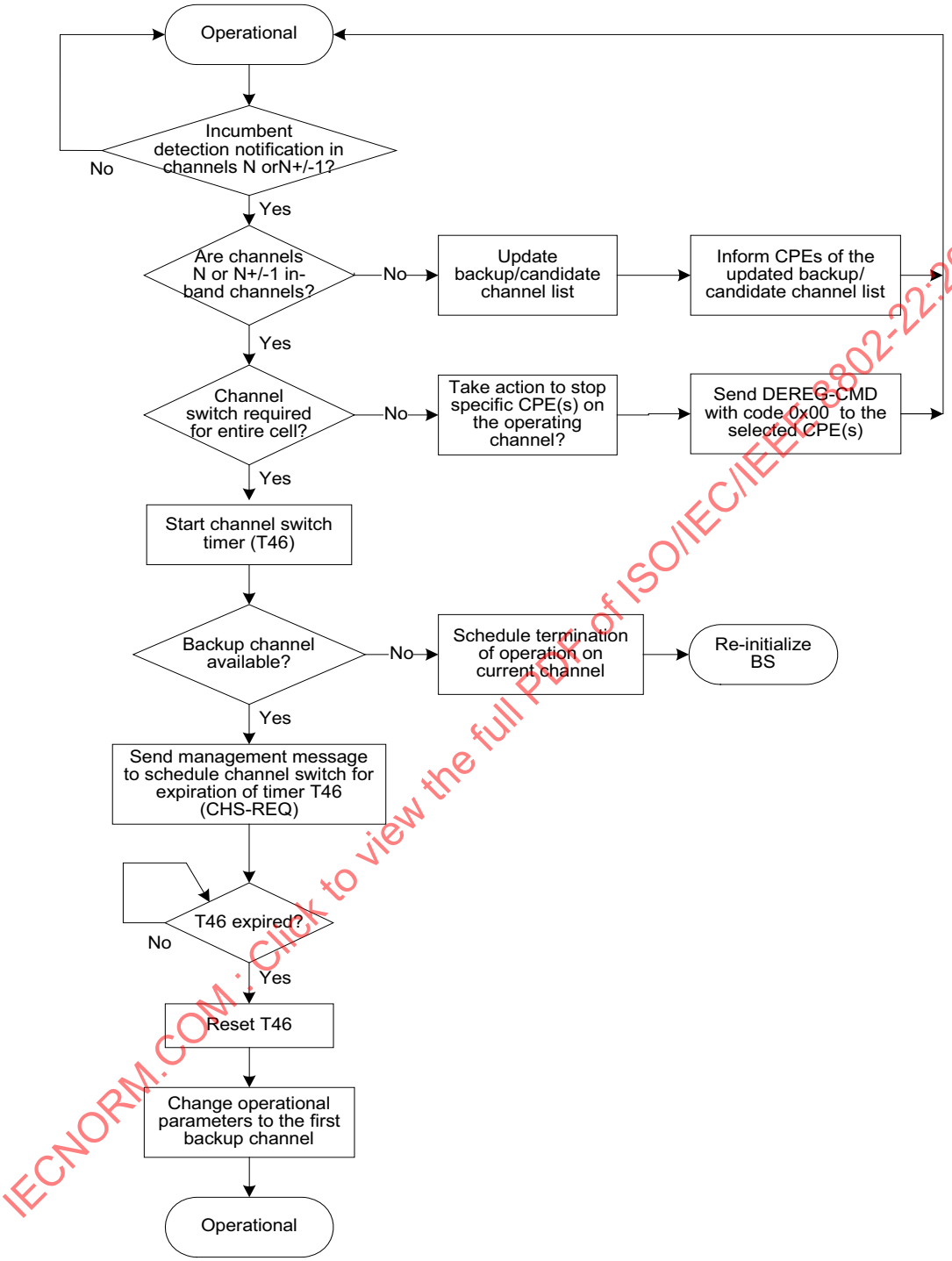

Figure 130—IDRP at BS

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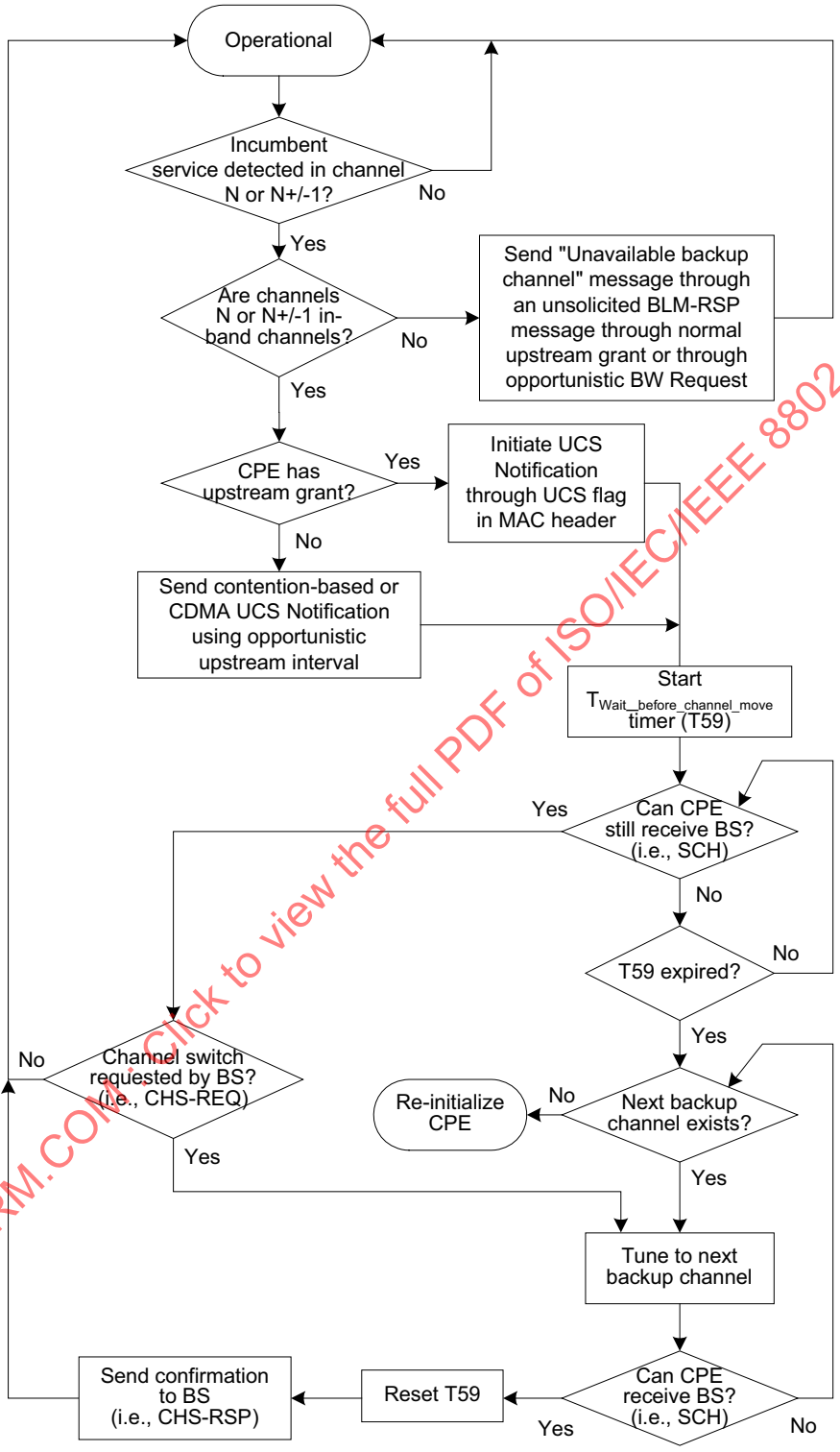

Figure 131—IDRP at CPE

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7.21.6 DFS for incumbent protection

The DFS model is supported through the quiet period management mechanism (see 7.23), measurement messages (see 7.9.18), and channel management messages (see 7.9.17). This framework allows for the BS to control and implement the necessary behavior to sense and protect the incumbent services.

7.22 Self-coexistence

Coexistence is critical for the IEEE 802.22 air interface, which is required to include incumbent detection and protection mechanisms as discussed in as well as self-coexistence measures. With regards to self-coexistence, the CBP protocol is used to exchange coexistence beacons to achieve efficient self-coexistence among overlapping IEEE 802.22 cells. The combination of the incumbent protection and self-coexistence mechanisms forms a MAC layer that is highly flexible and adaptive to the environment, and can react to sudden changes. This subclause discusses the various coexistence aspects available to address self-coexistence.

As depicted in Figure 133, multiple IEEE 802.22 BSs and CPEs may operate in the same vicinity and unless appropriate measures are taken at the air interface level, self-interference may render the IEEE 802.22 system useless. Even if directional antennas are used at the CPEs, self-coexistence issues are not at all overcome due to the fact that CPEs can be in line with more than one BS and also that the CPE antenna discrimination is relatively limited in the TV broadcast bands (see 9.12.1.1). This is further aggravated by the fact that IEEE 802.22 coverage range can potentially go up to 100 km, and hence its interference range and impact on other collocated IEEE 802.22 cells is larger than in any other existing unlicensed technology.

Because of the issues identified in the previous paragraph, the MAC layer shall address self-coexistence using a mandatory mechanism including the two following elements: spectrum etiquette (see 7.22.3.1) and on-demand frame contention (see 7.22.3.2). This self-coexistence mechanism as well as the required inter-WRAN communication architecture is depicted in Figure 132.

The Coexistence Beacon protocol (CBP) is the transport mechanism for the coexistence elements supported in this standard, and CBP packets can be transmitted over the air or through the backhaul. The BSs and CPEs shall be capable of transmitting and receiving CBP packets over the air as specified in 9.5. In order to implement eventual coexistence mechanism over the backhaul, the CBP information from IEEE 802.22 BSs shall be encapsulated in IP packets for transport over the backhaul. A WRAN runs in normal MAC Operational mode by default and transits to self-coexistence MAC Operational mode when the WRAN can detect and decode an SCH or a CBP burst from an adjacent WRAN cell on PHY-OM1. An A-WRAN runs in normal MAC Operational mode by default and transits to self-coexistence MAC Operational mode when the A-WRAN can detect and decode an Advanced Frame Control Header (A-FCH) and/or Extended Frame Control Header (Ex-FCH) or a CBP burst from an adjacent A-WRAN cell on PHY-OM2.

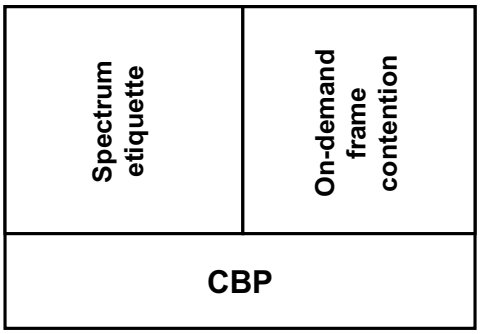

Figure 132—CBP as a transport mechanism for inter-WRAN communications and self-coexistence

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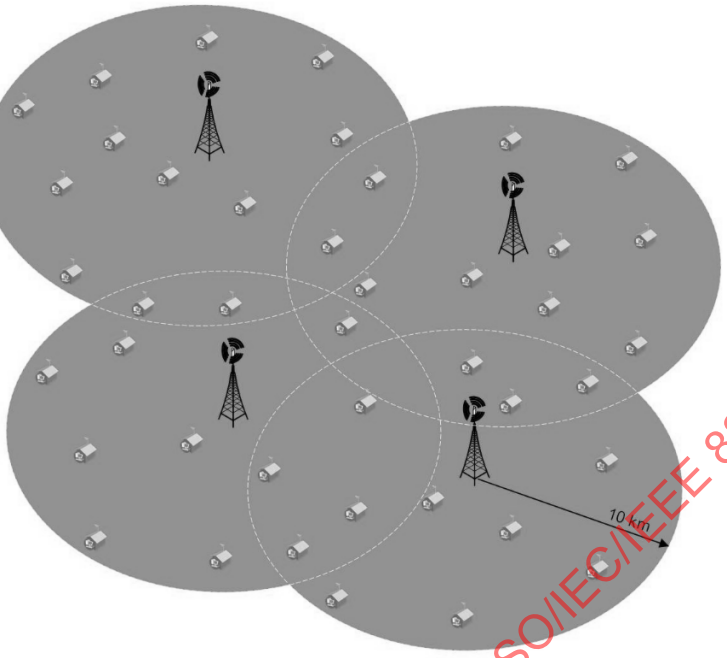

Figure 133—Example of IEEE 802.22 deployment configuration

7.22.1 Coexistence Beacon Protocol (CBP)

To cope with serious self-interference issues that may arise in a real deployment scenario, the CBP protocol shall be employed. The CBP is a best-effort protocol based on coexistence beacon transmissions. Given the mechanism for synchronization of overlapping BSs (see 7.25) and that many CPEs can be used to augment redundancy of the transmission, successful delivery of coexistence beacon transmissions can be made highly reliable.

7.22.1.1 CBP packet structure

The structure of a CBP packet (i.e., CBP PHY PDU) for PHY-OM1 is shown in Figure 134. The burst starts with a CBP preamble that shall be common across all IEEE 802.22 networks on PHY-OM1 (see 9.4.1.1) and that shall be different from the superframe preamble. After the CBP preamble, the CBP MAC PDU as described in Table 8 shall be transmitted. The CBP MAC PDU shall be two OFDM symbols long.

By including the SCH data (which contains information about the IEEE 802.22 cell) as part of the beacon MAC header, the transmitting CPE or BS conveys necessary information to allow neighboring network discovery and coordination of quiet periods and SCWs. Including the SCH is a way to advertise the schedule of QPs and SCWs to CPEs in other neighboring WRAN cells.

The SCH information is needed in situations where WRANs are operating in different channels as well as when they are operating co-channel or on adjacent channels. In the first case, the SCH information obtained through detecting and demodulating the SCH or through reception of the CBPs allows other WRANs to discover the schedule of QPs, which can be used for out-of-band sensing. In case WRANs are operating co-channel or on adjacent channels, the SCH, received through the CBPs, will signal the schedule of QPs and SCWs in addition to containing other IEs that can be used to signal frame allocations, when needed.

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In the A-WRAN, the A-FCH/ExtFCH data is included as part of the beacon MAC header, the transmitting A-CPE or A-BS/distributed scheduling R-CPE conveys necessary information to allow neighboring network discovery and coordination of quiet periods and SCWs (between A-BSs). Including the A-FCH/Ex-FCH is a way to advertise the schedule of QPs and SCWs to A-CPEs of other neighboring A-WRAN cells.

The A-FCH/Ex-FCH information is needed in situations where A-WRANs are operating in different channels as well as when they are operating co-channel or on adjacent channels. In the first case, the A-FCH/Ex-FCH information obtained through detecting and demodulating the A-FCH/Ex-FCH or through reception of the CBPs allows other A-WRANs to discover the schedule of QPs, which can be used for out-of-band sensing. In case A-WRANs are operating co-channel or on adjacent channels, the A-FCH/Ex-FCH, received through the CBPs, will signal the schedule of QPs and SCWs in addition to containing other IEs that can be used to signal frame allocations, when needed.

For communication using CBP over the backhaul, the CBP MAC PDU (see Figure 134) shall be encapsulated into an IP packet.

The structure of a CBP packet (i.e., CBP PHY PDU) for PHY-OM2 is shown in Figure 134. The burst starts with a CBP preamble that shall be common across all IEEE 802.22 networks on PHY-OM2 (see CBP preamble) and that shall be different from the frame preamble. After the CBP preamble, the CBP MAC PDU as described in Table 14 shall be transmitted. The CBP MAC PDU shall be two OFDM symbols long.

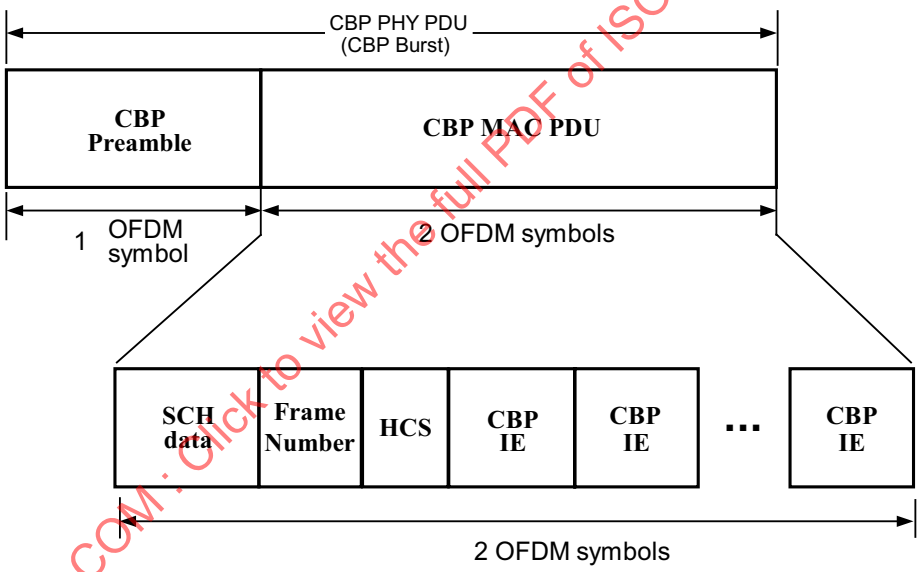

Figure 134—Structure of a CBP packet

The A-BS controls access to the medium within the SCW in an A-WRAN cell. The A-BS shall decide which A-CPEs transmit CBP packets in each scheduled active UIUC=0.

7.22.1.2 SCW schedule and CBP Packet Transmission/Reception scheduling

IEEE 802.22 BSs and CPEs are capable of transmitting coexistence beacons (see 7.8.1.2), which can provide its recipients enough information to achieve reliable self-coexistence among overlapping IEEE 802.22 cells. The CBP also allows for device identification, as may be required by local regulation, for interference resolution as well as enhancement to the terrestrial geolocation process between CPEs within a cell (see 11.5.2.3).

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Coexistence beacons are scheduled by the BS through the use of UIUCs 0 and 1 for Passive and Active modes respectively as indicated by the US-MAP (see Table 47). When selecting a UIUC equal to 0 or 1 for SCW scheduling, the SID contained in the MAP IE indicates which CPEs shall send the beacon, in case of Active mode, or which CPEs shall listen to the medium for detecting a beacon, in case of Passive mode, within the scheduled time of the SCW. This SID is either unicast (for a single CPE) or multicast (for a group of CPEs). The self-coexistence UIUC (see Table 41) can be unicast and multicast in active mode (UIUC=0) and it can be unicast, multicast, as well as broadcast when it is in passive mode (UIUC=1).

CBP packet transmissions shall be performed in the operating channel, but BSs and CPEs shall be capable of receiving CBP packets in any channel in which it is capable of operating. The BS specifies the channel number in which the CPE shall listen to the medium for a coexistence beacon (SCW in Passive mode). The channel number is included in the US-MAP for the UIUC=1. This allows the self-coexistence among IEEE 802.22 systems operating in the same channel and the monitoring of the quiet period scheduling carried by the CBP bursts in different channels for proper RF detection of incumbent signals in those channels that would otherwise be hidden by nearby WRAN transmissions.

The coexistence UIUCs identify the presence of a SCW at the end of the frame during which CBP packets can be exchanged. The SCW, when scheduled, occupies the last 5 symbols of the frame (see 7.9.4.1) and consists in one symbol buffer to absorb the propagation time, 3 symbols for the CBP PHY PDU and one last symbol to absorb propagation time.

The BS controls access to the medium within the SCW. The BS shall decide which CPEs transmit CBP packets in each scheduled active UIUC=0. Example of mechanisms that can be used by the BS for the selection of which CPEs are to transmit in each SCW in Active mode can be based on location information, clustering, or be as simple as selecting all CPEs.

All BSs involved in self-coexistence on the operating channel will need to align their operation with all of the declared SCWs of neighboring WRANs so that none continue its normal operation during these SCWs. All overlapping WRAN cells need to comply with the SCW scheduling either through active or passive use. When a WRAN cell reserves a SCW, this means that only that BS and its CPEs will be able to be active (i.e., transmit CBP bursts) during this SCW. For contention-based SCWs, all neighboring WRAN cells could be active during the SCW. This SCW scheduling takes place and applies only to the operating channel.

The CBP protocol can be used for communication and self-coexistence of WRANs on the same operating channel as well as synchronization to scheduled quiet periods across channels, which is enabled by setting the UIUC=0 in the US-MAP for a CPE or a group of CPEs once the CBP Relay message (7.9.23) has provided these CPEs with the proper content of the CBP burst to be transmitted. Note that different CPEs associated to the same BS can simultaneously communicate using CBP. For example, if two CPEs are associated with the same BS, during the same SCW, both can be transmitting in active mode, one of them can be transmitting a CBP packet on the operating channel while the other could be receiving on the same channel or on another channel. This is controlled by the BS when it schedules the SCWs in the US-MAP. It is assumed that within a cell, the BS will have the intelligence to select the right number and the right location of the “active” CPEs to minimize collisions while trying to maximize the communication redundancy.

In order to facilitate network discovery and to enable self-coexistence with neighboring WRANs, the BS shall maintain a minimal regular pattern of Active CBP transmissions (UIUC=0). Beyond inter-WRAN communication, the BS shall schedule Active and Passive mode SCW operation to enable mandatory CPE identification and optional terrestrial geolocation.

The BS shall schedule SCWs through the SCH when the BS initiates its normal operation and continuously thereafter according to its varying requirement as well as the requirements of the other WRAN cells in the area through coordination of these schedules by exchange of the SCH information through the CBP

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mechanism. If a BS wants to co-own a frame, it will be signaled as “01” whereas a frame that the BS does not want to co-own will be signaled as “00”.

The SCH includes SCW Cycle Length, SCW Cycle Offset, and SCW Cycle Frame Bitmap for the purpose of SCW scheduling, as defined in Table 1. SCW Cycle Length represents the cycle interval length between each successive superframe carrying SCWs, in number of superframes. The SCW Cycle Frame Bitmap specifies which frames (in a scheduled superframe) at the end of which a SCW is scheduled as well as the SCW mode (reservation-based SCW vs. contention-based SCW). The field encoding of SCW Cycle Frame Bitmap is specified in Table 1.

The SCW Cycle Length and SCW Cycle Frame Bitmap parameters should be set according to the requirements for self-coexistence and inter-WRAN communications, and it should be based on a trade-off between the performance of inter-WRAN communications and the overhead represented by these SCWs.

Multiple WRANs operating on the same channel may share the same SCWs via contention or each WRAN may reserve its own SCWs depending on how they set up their regular SCWs patterns. Sharing of SCWs reduces the total overhead in the channel, but on the other hand, reservation of SCWs enables contention-free CBP transmissions. The decision on whether to share or reserve SCWs will depend on the total overhead generated by SCWs and the self-coexistence scenarios (e.g., number of neighboring WRANs on the same channel and number of CPEs in the overlap area that can provide a non-negligible transmission redundancy and, hence, probability of successful CBP transmission using contention-based SCWs). Moreover, the WRANs may change the schedule of their SCWs dynamically and therefore they may adjust the schedule to adapt to the self-coexistence scenarios.

The reservation of SCWs facilitates the contention-free CBP transmissions among the neighboring WRAN cells sharing the same channel, and it can be achieved by scheduling the SCWs such that it does not overlap with those of other neighboring WRANs. The procedure for this type of operation is as follows:

— During the initialization stage, the WRAN monitors the channel for at least 16 superframes (the maximum SCW Cycle Length) to discover neighboring WRANs and identifies their schedule of reservation-based SCWs by capturing and decoding the CBP packets from these neighboring WRANs.
— If a WRAN identifies another WRAN’s schedule of reservation-based SCW (specified in SCW Cycle Frame Bitmap with 2-bit set to 11 or 10 in the corresponding frame, see Table 1), it shall regard these SCWs as reserved and shall set its own schedule of reservation-based SCWs so that it does not overlap with the SCWs reserved by the neighboring WRAN(s).
— With the above mechanism, the reservation conflict is low but it could still happen. To detect a potential conflict after the reservation is done, a WRAN can purposely skip the transmission of CBPs in its reserved SCWs and schedule its associated CPE to listen to the channel (using US-MAP with UIUC=1, passive mode) once in a while (irregularly) during the reserved SCWs. If a reservation conflict is identified, the WRAN will restart the process of scheduling SCWs.
— A WRAN can change its schedule of SCWs by updating SCW related parameters in the SCH.

Contention-based SCWs can be shared by neighboring WRANs. In other words, its neighbors can use these contention-based SCWs (combined with its own scheduled SCWs if available) for the transmission of CBPs following the random backoff mechanism defined later in this subclause. However, the WRAN scheduling those contention-based SCWs has the ownership of those SCWs. Other WRANs cannot use those SCWs for other purposes of transmissions nor can they cancel the schedules of these contention-based SCWs. The WRAN owning the contention based SCWs can reduce the frequency of these contention-based SCWs by canceling some of its occurrences. At least one contention-based SCW shall be scheduled per SCW Cycle.

Co-ownership of these contention-based SCWs would avoid one BS removing the SCW used by other BSs. Hence, two neighboring WRANs can be the co-owners of a certain set of contention-based SCWs by each scheduling them in their SCH. In that case, if one WRAN cancels the schedule, the contention-based SCW

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stays scheduled until all other WRAN cells co-owning this SCW decide to cancel it. These other WRAN cells as well as the neighbor WRANs can still share those contention-based SCWs.

To mitigate collision of contention with neighboring WRANs, access to contention-based SCW shall use random backoff in units of contention-based SCWs. When a BS schedules its associated CPEs to transmit CBPs via contention-based SCWs, it shall wait for a random number (from 0 to 15 with uniform probability) of next available contention-based SCWs. For example, if the random number chosen is 0, the BS shall schedule a CBP transmission via a US-MAP IE by accessing the first available contention based SCW from the transmission of the US-MAP IE. If the random number is 5, the BS shall schedule a CBP transmission via a US-MAP IE by accessing the sixth available contention based SCWs from the transmission of the US-MAP IE. A new BS shall have higher priority to access contention-based SCWs by using smaller backoff window. When a new BS attempts to transmit CBPs via contention-based SCWs, it shall wait for a random number from 0 to 7 with uniform probability (as opposed to 0 to 15 for an in-band/established network) of next available contention-based SCWs.

A BS can schedule CPEs in Passive mode (via US-MAP IEs) during SCWs reserved or shared by other neighboring WRANs in order to receive CBP packets from its own WRAN cell (from the BS and/or CPEs) or from the neighboring WRANs operating on the same channel. A BS can also schedule CPEs in Passive mode to listen to CBP burst on either of the adjacent channels for the purpose of localizing and synchronizing the quiet periods for proper in-band sensing. CPEs executing out-of-band sensing during their idle time shall listen to CBP bursts on other channels for the purpose of localizing the quiet periods for proper out-of-band sensing in coexistence situations in these channels (see 11.3.4). For the SCW in Passive mode, the BS shall define the schedule such that it can capture the required self-coexistence information from neighboring WRANs that may impact the WRAN operation. By definition, no other type of transmission shall be allowed during the SCWs. Therefore, any CPE may be scheduled in Passive mode during SCWs. Note that scheduling SCWs in Passive mode do not increase the overhead in the channel since it only requires listening for other CBP transmissions from neighboring cells.

The BS could also use other information available at the MAC layer to decide when and in which mode to generate a Coexistence UIUC, as long as the above generation rules are satisfied. One example can be found in 7.9.18.3.1.3, where the BS uses the CPE statistics report as the basis for triggering the execution of CBP (see 7.9.18.2).

When configuring an SCW for Active mode, the BS shall form the CBP MAC PDU by selecting which IEs (see Table 15) are to be included in the PDU, then setting the fields for those IEs. If CBP Protection is enabled (see 8.6.2.1), than the signature shall be calculated over the other IEs and fields of the Signature IE as the CBP MAC PDU is being assembled.

Once the CBP MAC PDU is assembled it shall be encapsulated in a CBP Relay message (see 7.9.23), and sent on the Primary Management FT if assigned to a single CPE SID or on the Multicast Management FT when assigned to the SID for a (multicast) group of CPEs. This shall be done no later than one frame prior to the frame for which the CPE is configured to use the SCW in Active mode. Upon receiving the CBP Relay message the CPE or CPEs shall un-encapsulate the CBP MAC PDU and transmit it on their next opportunity (e.g., Active mode SCW).

If the CBP MAC PDU is being transmitted during an Active mode SCW for the purpose of facilitating geolocation, then the CBP Device Identification IE (see 7.8.1.3.1.6) shall be added to the CBP MAC PDU when it is being formulated and sent to each CPE (e.g., unicast by the CBP Relay message on each CPE's Primary Management FT) that is being asked to participate in the current Active mode SCW.

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7.22.1.3 CBP-based Neighboring Network Discovery

In order to achieve self-coexistence, overlapping IEEE 802.22 systems shall first discover the presence of each other, which can be done in two ways depending on the operational state of the BS or CPE: network entry and initialization or normal operation.

7.22.1.3.1 Network Discovery during entry and initialization

During network entry and initialization and before any data transmission takes place, the BS and CPE shall perform a network discovery procedure by scanning the wireless medium for CBP packets or SCH (transmitted in the beginning of every superframe). This discovery procedure is part of the BS and CPE initialization procedures described in 7.16.

In the case of BS initialization (see 7.16.1), this procedure is performed before the selection of the operating channel and it may be performed after or at the same time as the BS performs incumbent detection in all usable channels.

In the case of a CPE, this discovery procedure shall scan, at least, the BS's operating channel (N), its adjacent channels (i.e., N+1, and N–1), and channels N+2 and N–2. This is the minimal requirement so that other IEEE 802.22 cells operating in these channels are discovered and reported to the BS, such that sensing quiet periods are synchronized whenever needed to provide reliable TV sensing on N and N±1 since WRAN systems cannot operate on channels adjacent to TV operation and sensing needs to quiet down WRAN transmissions on the channel that it tries to sense as well as its adjacent channels.

A procedure to discover nearby IEEE 802.22 cells is also performed during normal operation as described in 7.22.1.3.2.

7.22.1.3.2 Network Discovery during normal operation

During normal operation, the BS and CPEs can discover other nearby IEEE 802.22 cells by listening to the medium on the look out for CBP packets from other cells and, possibly, BS SCH transmissions from other IEEE 802.22 cells on different channels. This can be accomplished through the scheduling of the Coexistence UIUC = 1 for passive mode SCW. If a CBP packet or SCH is received by the CPE, it shall package that information and transport it to its BS (see Table 198).

The BS may use these mechanisms to discover other IEEE 802.22 cells operating in any channel, but in order to enable efficient coordination among neighboring IEEE 802.22 cells for self-coexistence and to allow efficient sensing, the BS shall use these mechanisms to discover other IEEE 802.22 cells operating in the same channel, in adjacent channels (N+1 and N–1), and in channels N+2 and N–2, and synchronize its quiet periods for sensing accordingly, using the procedure described in 7.23.2.

7.22.1.3.2.1 Discovery with SCW

The BS can discover other WRAN cells by scheduling SCWs in passive mode, during which, it may request one or more of its CPEs to listen to the current operating channel to look for CBP packets from other WRANs or to listen to other channels for CBP packets or SCH transmissions from other BSs or CPEs associated with other BSs. This mechanism is not only useful to discover new IEEE 802.22 cells, but it is also required to maintain coordination with existing neighboring cells to achieve self-coexistence.

In order to satisfy the requirements for coexistence and reliable and timely on-channel sensing, the BS shall schedule a sufficient number of passive SCWs for scanning for CBP packets on channels N, N+1, and N–1. In order to satisfy the requirements for reliable and timely on-channel sensing on N+1 and N–1, the BS shall schedule a sufficient number of SCW in passive mode to scan for CBP packets on channels N+2 and N–2.

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The specific procedure of selecting the CPEs to receive the CBP packets should take into account location information of the CPEs as well as the reported information by the CPEs during their initialization procedure. Furthermore, operators should make sure that they have reliable CBP communication with their adjacent WRAN cells through either the BSs or by locating CPEs at proper distances.

In case a BS discovers a neighboring IEEE 802.22 cells, given the minimum required frequency of CBP transmissions, the BS will be able to regularly schedule SCWs in passive mode to capture the CBP packets in the corresponding channels.

7.22.1.3.2.2 Discovery during frames not allocated in self-coexistence MAC Operational mode

In self-coexistence MAC Operational mode, both BS and associated CPEs in the WRAN cell can listen to the medium for network discovery during those frames not allocated to the present cell. During these periods, discovery can be facilitated by searching for a coexistence beacon or SCH from neighbor cells.

7.22.2 CBP-based inter-BS communication

Inter-BS communications can be enabled by CBP transmission (as discussed in 7.22.1). The BS and CPEs shall be capable of transmitting CBP packets, and shall also be capable of receiving them during the SCW. With the basic information carried in CBP packets (see 7.8.1.3), the BS would have not only information about channels being used, but also about specific time schedules. This would allow a finer control of self-coexistence, which may be desirable especially in the case where there are no other free channels to which BSs can switch.

7.22.3 Mechanism for inter-BS self-coexistence

The self-coexistence operations among IEEE 802.22 WRAN cells shall follow the top-level procedure illustrated in Figure 135 and described as follows:

1) The BS of an IEEE 802.22 WRAN cell is powered on.
2) The BS performs network discovery, which includes discovering
   - TV channel occupancies of the neighboring WRAN cells
   - Self-coexistence window (SCW) reservations of the neighboring WRAN cells
   - Frame reservation patterns of the neighboring WRAN cells on specific channels (this information can be obtained from the received CBP packets)
3) The BS performs channel acquisition based on the Spectrum Etiquette algorithm (as described in 7.22.3.1).
4) If the BS successfully acquires a channel, it goes to the normal MAC Operational mode of data service operations on the acquired channel [as described in step 5) as follows].

   If the BS fails to acquire any empty channel, it selects a channel occupied by one or more other WRAN cells and identifies whether the potential interference comes directly from the other BSs or from the CPEs belonging to the other WRAN cells, or both. If it comes only from the other BSs, the new BS initiates the DS/US Split adjustment mechanism [i.e., skips step 5) and goes to step 6)]. If the potential interference comes from the CPEs, it performs the Inter-WRAN On-demand Frame Contention operations on the selected channel by accessing a contention-based SCW (see 7.22.1.2) [i.e., skips step 5) and step 6) and goes to step 7)]. Note that since the new BS arriving on the channel does not have a frame for itself yet, it cannot involve its CPEs in this initial contention process. Only CBP bursts transmitted directly from the new BS will be able to support the frame contention process in this initial phase. As a result, the process may go initially to step 6) but then move to step 7) when the CPEs belonging to the new WRAN cell start to operate and report potential interference through their CBP bursts.

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5) The BS enters the normal MAC Operational mode of data service operations (see 7.3).

During the normal service operations, the BS may receive external demands (received from other WRAN cells) for sharing its occupied data frames on the operating channel. When this occurs and when the BS cannot find another empty channel for its operation through the Spectrum Etiquette algorithm, the BS performs the Inter-WRAN On-demand Frame Contention operations on its operating channel [as described in step 6)]. If an empty channel is found, then the BS moves its cell to this new channel and enters the normal MAC Operational mode of data service operations (see 7.3).

6) The BS performs the DS/US Split adjustment mechanism using the relevant parameter exchange carried by the SCH (see Table 1) and/or by the CBP burst received directly from the other BSs. Once it has acquired information on the Current DS/US Split, Claimed DS/US Split and the DS/US Change Offset, it applies the same basic algorithm as used for Quiet Period Scheduling described in Table 229 and transmits its updated parameters to the other BSs so that they do the same and converge towards a common DS/US Split, which will vary depending on the compound traffic requirements for the BSs involved. The adjustment of the DS/US Split through this distributed negotiation process, based on the fact that all BSs have their frames aligned (see 9.10), will allow the concurrent use of the same frames by these BSs while avoiding interference caused by a BS that would be still transmitting while the other BSs have started their US subframe and try to receive signals from their CPEs. Note that this will cover the cases where BSs would interfere with each other even though there is no CPE being interfered (i.e., no CPE in the overlap area). There may also be cases where CPEs will receive interference from various BSs while these BSs do not interfere with each other as a result of clever BS antenna installation that will block the signal path between the BSs. The normal case will however be when both BSs and CPEs are interfered with. For these two latter cases, step 7) will be needed to distribute the frames to the various BSs and, since there would not be concurrent use of these frames, there is then no longer a need to synchronize the DS/US split in these cases (Table 229).

7) The BS performs the On-demand Frame Contention operations with a neighboring WRAN cell on the selected channel, and then goes to the self-coexistence MAC Operational mode of data services operations [as described in step 8)]. A neighboring WRAN cell can contend for some of the frames used by the current BS as long as it occupies a number of frames that is larger that the minimum stated in variable Frame_Contention_Min (see Table 336). The required message flow and the On-Demand Frame Contention Protocol are described in .

8) The BS enters the self-coexistence MAC Operational mode of data services operations (see 7.3).

During the self-coexistence MAC Operational mode of data service operations, the BS may receive either internal demands (received from the inside of the BS's own cell) for additional spectrum resources, or external demands (received from other WRAN cells) for sharing its occupied frames on the operating channel. When either of these events occurs, the BS re-initiates the spectrum acquisition process starting from step 3) (Spectrum Etiquette for channel acquisition).

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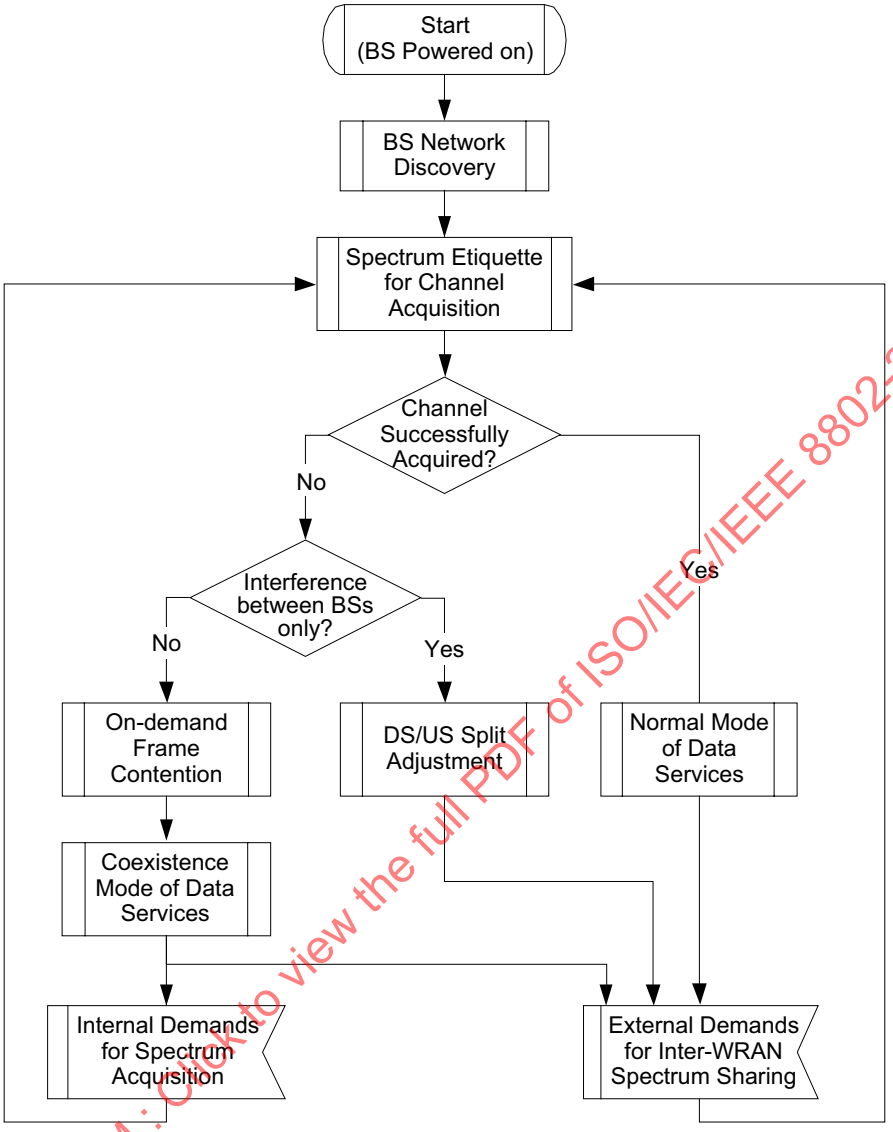

Figure 135—Execution flow of inter-BS self-coexistence mechanisms

7.22.3.1 Spectrum etiquette

The details of the scheme for prioritizing the backup and candidate channels based on spectrum etiquette are given in 11.2.3.2. Once this has taken place, the selection of the next operating channel is done according to the flow chart given in Figure 136.

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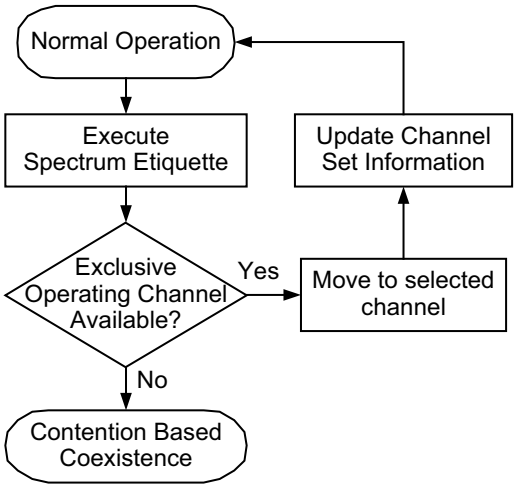

Figure 136—Flow chart of the Spectrum Etiquette process

7.22.3.2 On-demand Frame Contention (ODFC)

7.22.3.2.1 Message Flow of the On-demand Frame Contention protocol

7.22.3.2.1.1 Control messages

Each of the following control messages of the On-demand Frame Contention protocol is encapsulated by one CBP information element (IE).

a) Frame Contention Request (FC_REQ)—This is a unicast request message transmitted by the FC-SRC for initiating the frame contention process. It contains the following information:
   1) The FC-DST's ID as the destination.
   2) The frame index-vector of the data frames claimed by the requesting FC-SRC within a superframe.
   3) The frame contention number (one FCN is used by the requesting FC-SRC for the contention of all the data frames claimed by the requesting FC-SRC as indicated in the frame index vector).

b) Frame Contention Response (FC_RSP)—This is a unicast response message transmitted by the FC-DST responding to a requesting FC-SRC with regard to the contention results. It contains the following information:
   1) The FC-SRC's ID as the destination.
   2) The frame index containing the contention results for each of the claimed data frame within the superframe.

c) Frame Contention Acknowledgment (FC_ACK)—This is a broadcast acknowledgment message transmitted by the winner FC-SRC indicating the confirmation and the scheduling of the frame acquisitions. It contains the following information:
   1) The frame index indicating a confirmation or not of the spectrum acquisition for each of the claimed data frame within the superframe.
   2) The winning FCN (used to resolving possible collisions of frame acquisition).

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3) The ID of the granting FC-DST, which is the FC-DST WRAN cell granting the access to the data frames that are being acquired by the winning FC-SRC (this is used to enable “clear to send”).

d) Frame Contention Release (FC_REL) is a broadcast message transmitted by the granting FC-DST indicating the announcement of the frame releases. It contains the following information:

1) The frame index indicating an announcement of the frame release for each of the granted data frames within the superframe.

2) The FCN of the winning FC-SRC (used to resolving possible collisions of frame acquisition).

3) The ID of the winning FC-SRC, which is the FC-SRC WRAN cell granted the access to the data frame that are being released by the granting FC-DST (this is used to enable efficient frame reuse).

7.22.3.2.1.2 Message flow

The message flow of the On-demand Frame Contention protocol in the time domain is shown in Figure 137.

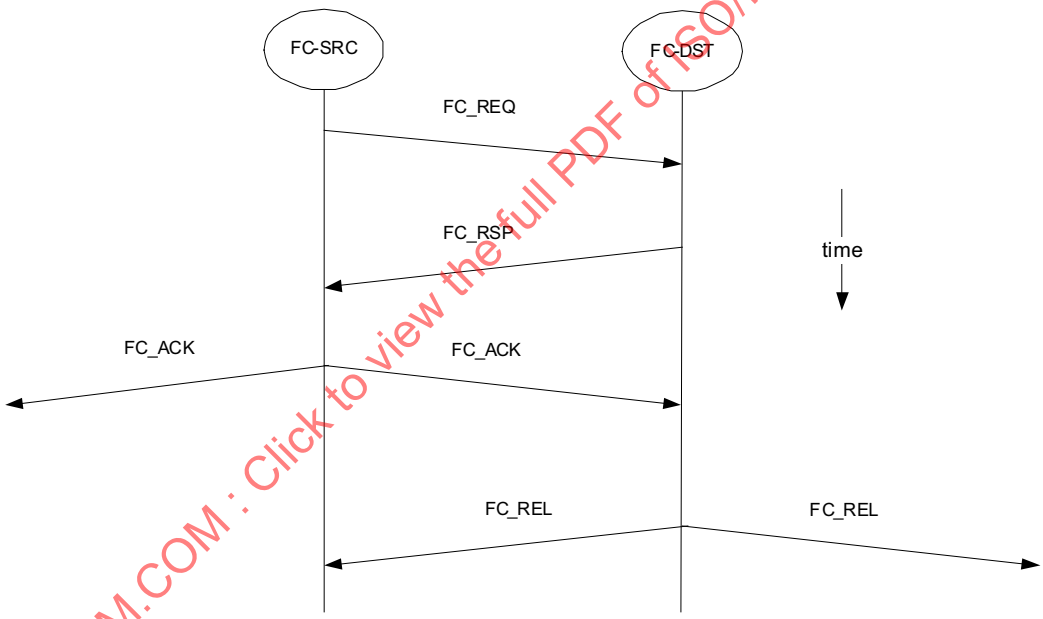

Figure 137—Message Flow of the On-demand Frame Contention protocol

7.22.3.2.2 On-demand Frame Contention protocol

The On-demand Frame Contention protocol is used to resolve contentions of frame resource among the neighboring WRAN cells. It is assumed that when an operating BS switches from the normal MAC Operational mode of operation to the self-coexistence MAC Operational mode of operation, it initially occupies all 16 frames of the superframe. Once in self-coexistence MAC Operational mode, the BS shall schedule at least one contention SCW to monitor potential frame requests from new overlapping WRAN cells. Those WRAN cells will then be able to schedule more SCWs (reservation-based or contention-based) as needed, as described in 7.22.1.2 and contend for frames used by the original WRAN cell by sending the appropriate CBP bursts during these SCWs.

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Once these CBP bursts are received by the original BS or any of its associated CPEs that shall relay it to the BS, the content of these CBP bursts shall be decoded and the On-demand Frame Contention protocol described in this subclause shall be applied to determine whether the distribution of the 16 frames of future superframes should be changed.

7.22.3.2.2.1 Top-level procedure of the On-demand Frame Contention protocol

On an on-going basis, each BS in self-coexistence MAC Operational mode shall execute the ODFC procedure shown in Figure 138 every time it receives an internal (intra-WRAN) or external (inter-WRAN) request for additional frames.

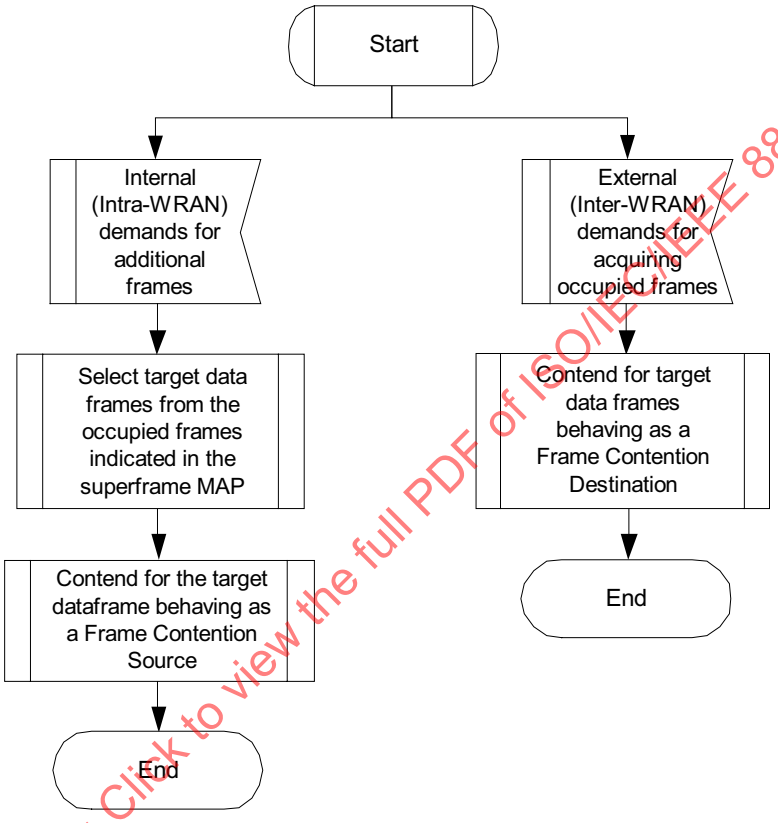

Figure 138—Top-level procedure of the On-demand Frame Contention protocol

7.22.3.2.2.2 Frame contention procedure at the frame contention source

Figure 139 shows the frame contention procedure that is followed by the contention source.

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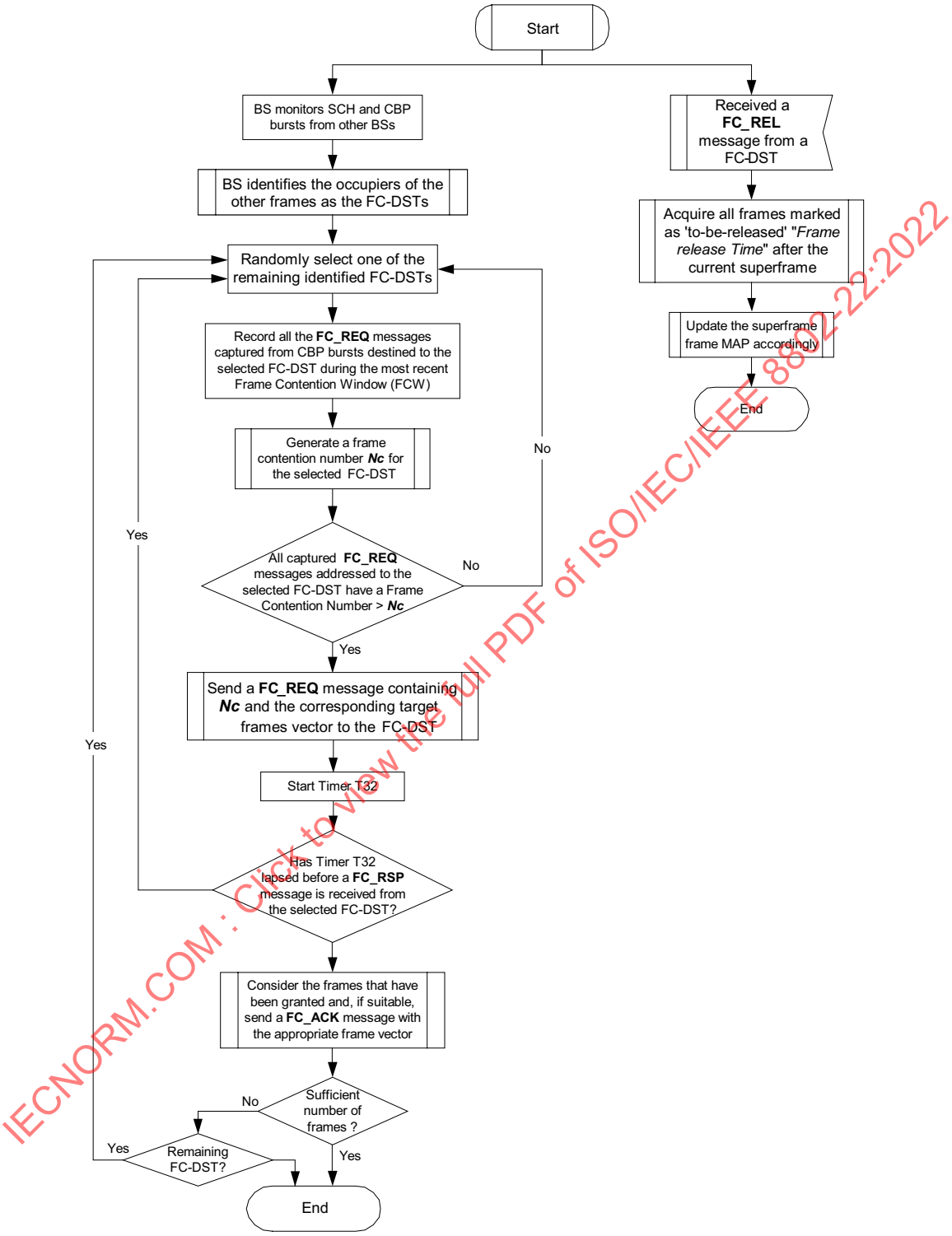

Figure 139—Frame contention procedure at the contention source

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7.22.3.2.2.3 Frame contention procedure at the frame contention destination

Figure 140 shows the frame contention procedure that is followed by the contention destination.

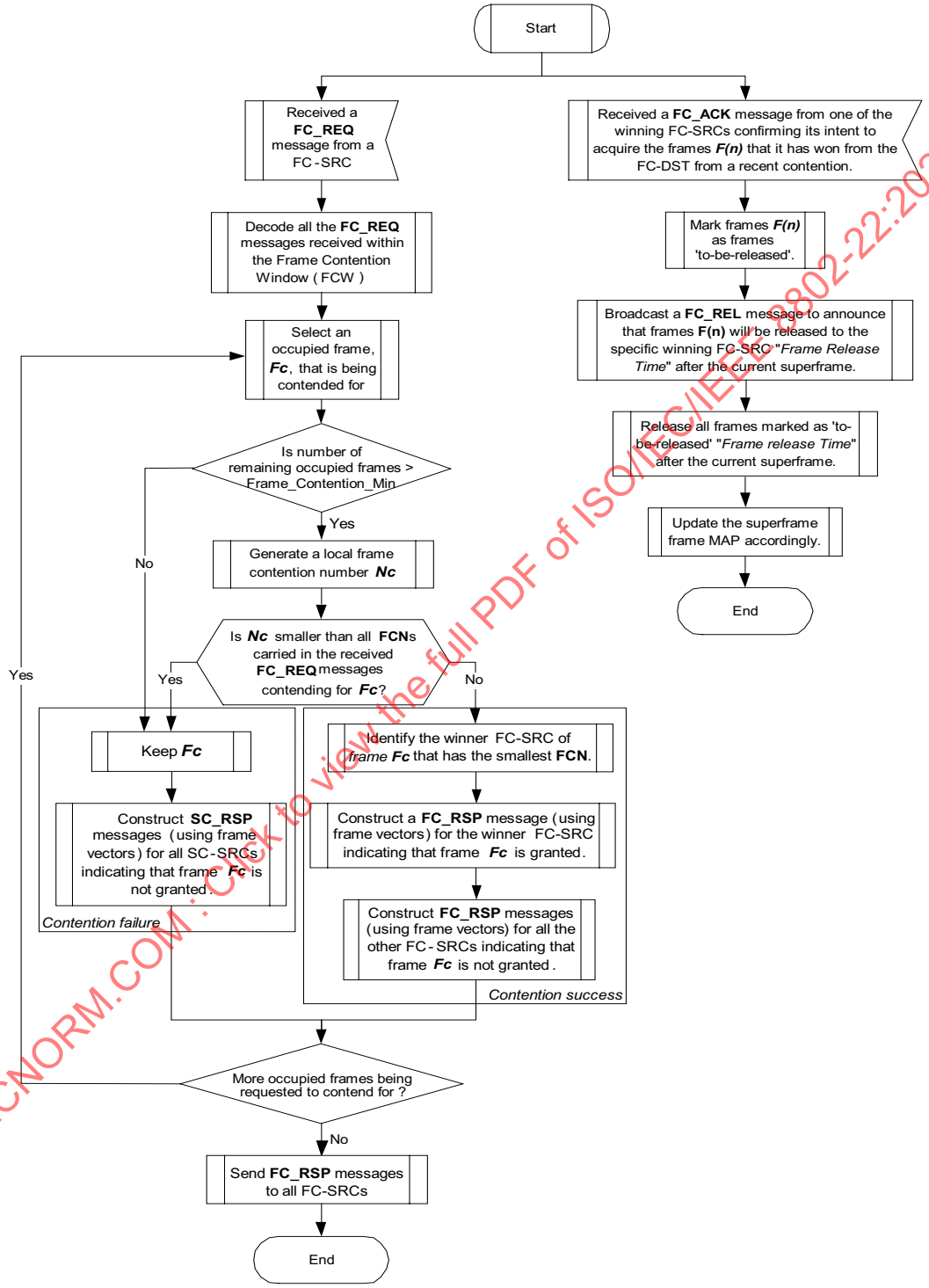

Figure 140—Frame contention procedure at the contention destination

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7.22.3.2.2.4 Algorithm for generation of frame contention number

The frame contention number, indicated in Figure 139 and Figure 140, FCN [i], for WRAN cell *i*, i.e., WRAN [i], shall be generated as follows:

$$FCN\,[i] = \textbf{RANDOM}\,(0, 2^{n}-1)$$

where n = FCN_Range, an adjustable parameter appearing in Table 133.

The random number generator shall generate a uniform distribution from 0 to $2^{n}-1$.

7.22.3.2.2.5 Algorithm to identify the winner FC-SRC

The On-demand Frame Contention algorithm is used to resolve contentions of frame resource among the neighboring WRAN cells when the frame contention number (FCN) of the destination cell is not the smallest one (see Figure 140). For each frame that is contended for, the algorithm shall identify the frame contention source (FC-SRC) that has the smallest frame contention number. The algorithm can be implemented as follows:

On-Demand Frame Contention (*N, WRAN, FCN, Frame*)

1) $FCN_{winner}(Frame) \leftarrow \text{MIN}(FCN\,[1] : FCN\,[N])$
2) **for** $i \leftarrow 1$ **to** N
3) **if** $FCN\,[i] == FCN_{winner}(Frame)$
4) **return** $WRAN_{winner}(Frame) \leftarrow WRAN\,[i]$;
   $FCN_{winner}(Frame)$

where in the algorithm:

N: total number of contending WRAN cells

WRAN: the array of IDs of the contending WRAN cells, *WRAN* [*i*] for $i \leftarrow 1$ to *N*

FCN: the array of frame contention numbers of the contending WRAN cells, in which *FCN* [*i*] is the frame contention number of *WRAN* [*i*] for $i \leftarrow 1$ to *N*

Frame: the data frame (spectrum resource) being contended for;

$FCN_{winner}(Frame)$: the winner frame contention number for accessing the *Frame*

$WRAN_{winner}(Frame)$: *the ID of the winner WRAN cell to access the Frame*

If the algorithm finds more than one smallest frame contention number, it shall select randomly one winner frame contention source among the FC-SRCs represented by these equal frame contention numbers.

7.22.3.2.2.6 Algorithm to prioritize the transmission of frame contention requests

This algorithm allows a reduction of the number of contention request messages required to decide on the winner WRAN in the frame contention protocol. A frame contention source shall monitor the FC_REQ messages related to a specific frame and addressed to a specific FC-DST being broadcast in the area and shall forgo the transmission of its own request for the same frame and toward the same FC-DST if it is to lose the contention at the FC-DST as indicated in Figure 139, given the value of its frame contention number. The algorithm can be implemented as follows:

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Prioritized transmission of Frame Contention Requests (*FC_SRC[i], FCN[i], SCWBackoffMax*)

1) *FC_SRC[i]* generates *FCN[i]*= Random(0,2^{16}–1)
2) Select *SCWBackoffMax[i]* as follows:

$$\mathbf{SCWBackoffMax}[i] = \frac{SCWBackoffMax}{2^{16}-1} FCN[i]$$

3) *FC_SRC[i]* generates a random backoff timer as follows:

$$\mathbf{SCW_Backoff_Timer}[i] = Random(i)$$

where *Random(i)* is an integer uniformly generated over the interval [0, *SCWBackoffMax*[i]] in terms of next upcoming SCW window available opportunities.

4) Before the expiration of the **SCW_Backoff Timer**[i], if *FC_SRC[i]* receives FC_REQ[k] from *FC_SRC[k]* contending for frame s;
   - If *FCN[i]<FCN[k]*, *FC_SRC[i]* make the frame x as a loser frame;
   - Else if *FCN[i]≥FCN[k]*, *FC_SRC[i]* continues to c;
   - Go back to step 4)
5) At the expiration of the **SCW_Backoff_Timer**[i],
   - If there exist frames on the request list not marked as loser frames, terminate the algorithm and proceed to the next step where *FC_SRC[i]* sends FC_REQ[i];
   - Else, terminate the algorithm and exit contention request procedure.

where in the preceding algorithm:

N: the number of frame contention sources (FC_SRCs)
FC_SRC: array of the FC_SRCs IDs
FC_SRC[i]: refers to the BS ID executing this algorithm while *FC_SRC[k]* refers to a neighboring BS of the *FC_SRC[i]*
FCN: array of the frame contention number generated by the WRANs
SCWBackoff_Timer: array of the maximum backoff window for each WRAN
SCWBackoffMax: an integer denoting the maximum backoff window parameter as defined in Table 333

7.22.4 Self-coexistence for a relay network on PHY-OM2

7.22.4.1 General

Self-coexistence in A-WRAN networks shall follow the mechanisms described in 7.20.1, 7.20.2, and 7.20.3, which will be performed by the negotiation of the A-BS and the neighboring A-BSs.

For self-coexistence in A-WRAN networks, the SCW shall be synchronized at all CPEs within an A-WRAN network. For synchronizing SCW, in PHY-OM1 or PHY-OM2, one of the following can be transmitted.

1) BS/A-BS transmits SCH in PHY-OM1.
2) A-BS transmits Frame Control Header in PHY-OM2.
3) A-BS transmits Frame Control Header + Extended Frame Control Header in PHY-OM2.

When a CPE receives one of these transmissions, the CPE forwards it to the A-BS and then synchronizes the SCW within an A-WRAN network. When a distributed scheduling R-CPE receives the SCW schedule information from the A-BS, it shall arrange the SCW schedule within a local cell by sending the same

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information from the respective transmission listed above, which it has received from the A-BS to the CPEs in a local cell.

7.22.4.2 Mechanism for inter-A-BS self-coexistence on a relay network

The self-coexistence operations among A-WRAN cells shall follow the top-level procedure illustrated in Figure 101 and described as follows:

1) The A-BS of an A-WRAN cell is powered on.
2) The A-BS performs network discovery, which includes discovering
   — TV channel occupancies of the neighboring A-WRAN cells
   — SCW reservations of the neighboring A-WRAN cells
   — Frame reservation patterns of the neighboring A-WRAN cells on specific channels (this information can be obtained from the received CBP packets)
3) The A-BS performs channel acquisition based on the Spectrum Etiquette algorithm (as described in 7.20.3).
4) If the A-BS successfully acquires a channel, it goes to the normal MAC Operational mode of data service operations on the acquired channel [as described in step 5) below]. If the A-BS fails to acquire any empty channel, it selects a channel occupied by one or more other A-WRAN cells and identifies whether the potential interference comes directly from the other A-BSs or from the CPEs belonging to the other A-WRAN cells, or both. If it comes only from the other A-BSs, the new A-BS initiates the DS/US Split adjustment mechanism [i.e., skips step 5) and goes to step 6)]. If the potential interference comes from the CPEs, it performs the Inter-WRAN On-demand Frame Contention operations on the selected channel by accessing a contention-based SCW (see 7.20.1) [i.e., skips step 5) and step 6) and goes to step 7)]. Note that since the new A-BS arriving on the channel does not have a frame for itself yet, it cannot involve its CPEs in this initial contention process. Only CBP bursts transmitted directly from the new A-BS will be able to support the frame contention process in this initial phase. As a result, the process may go initially to step 6) but then move to step 7) when the CPEs belonging to the new A-WRAN cell start to operate and report potential interference through their CBP bursts.
5) The A-BS enters the normal MAC Operational mode of data service operations (see 7.3). During the normal service operations, the A-BS may receive external demands (received from other A-WRAN cells) for sharing its occupied data frames on the operating channel. When this occurs and when the A-BS cannot find another empty channel for its operation through the Spectrum Etiquette algorithm, the A-BS performs the Inter-WRAN On-demand Frame Contention operations on its operating channel [as described in step 6)]. If an empty channel is found, then the A-BS moves its cell to this new channel and enters the normal MAC Operational mode of data service operations (see 7.3).
6) The A-BS performs the DS/US Split adjustment mechanism. This can be done only if the CBP burst received directly from the other A-BSs or received by a CPE and forwarded to the A-BS contains information related to transmission 1), 2), and/or 3) listed in 7.22.4.1. Once it has acquired information on the Current DS/US Split, Claimed DS/US Split, and the DS/US Change Offset, it applies the same basic algorithm as used for Quiet Period Scheduling described in Table 184 and transmits its updated parameters to the other A-BSs so that they do the same and converge toward a common DS/US Split, which will vary depending on the compound traffic requirements for the A-BSs involved. The adjustment of the DS/US Split through this distributed negotiation process, based on the fact that all A-BSs have their frames aligned (see 9.10), will allow the concurrent use of the same frames by these A-BSs and avoid interference caused by an A-BS that would be still transmitting while the other A-BSs have started their US subframe and are trying to receive signals from their CPEs. Note that this will cover the cases where A-BSs would interfere with each other even though there is no CPE

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being interfered with (i.e., no CPE in the overlap area). There may also be cases where CPEs will receive interference from various A-BSs while these A-BSs do not interfere with each other as a result of clever A-BS antenna installation that will block the signal path between the A-BSs. The normal case will however be when both A-BSs and CPEs are interfered with. For these two latter cases, step 7) will be needed to distribute the frames to the various A-BSs and, since there would not be concurrent use of these frames, there is then no longer a need to synchronize the DS/US split in these cases.

7) The A-BS performs the On-demand Frame Contention operations with a neighboring A-WRAN cell on the selected channel and then goes to the self-coexistence MAC Operational mode of data services operations [as described in step 8)]. A neighboring A-WRAN cell can contend for some of the frames used by the current A-BS as long as it occupies a number of frames that is larger that the minimum stated in variable Frame_Contention_Min (see Table 274). The required message flow and the On-Demand Frame Contention Protocol are described in 7.20.3.

8) The A-BS enters the self-coexistence MAC Operational mode of data services operations (see 7.3). During the self-coexistence MAC Operational mode of data service operations, the A-BS may receive either internal demands (received from the inside of the A-BS's own cell) for additional spectrum resources or external demands (received from other A-WRAN cells) for sharing its occupied frames on the operating channel. When either of these events occurs, the A-BS re-initiates the spectrum acquisition process starting from step 3) (Spectrum Etiquette for channel acquisition).

7.22.4.3 CBP-based neighboring network discovery

7.22.4.3.1 Overview

During network entry and initialization and before any data transmission takes place, the A-BS and CPE shall perform a network discovery procedure by scanning the wireless medium for CBP packets that contain one of the transmissions listed in 7.22.4.1. This discovery procedure is part of the A-BS and CPE initialization procedures described in 7.14.

During normal operation, the A-BS and CPEs can discover other nearby A-WRAN cells by listening to the medium on the lookout for CBP packets that contain one of the transmissions listed in 7.22.4.1. These transmissions can be received from other cells on the same channel or from cells on different channels. This can be accomplished through the scheduling of the Coexistence UIUC = 1 for passive mode SCW. If a CBP packet containing one of the transmissions listed in 7.22.4.1 is received by the CPE that is managed by the A-BS, it shall package that information and transport it to its A-BS (see Table 172).

7.22.4.3.2 Discovery with SCW

The A-BS can discover other A-WRAN cells by scheduling SCWs in passive mode, during which it may request one or more of its CPEs to listen to the current operating channel to look for CBP packets from other A-WRANs or to listen to other channels for CBP packets. These CBP packets can contain one of the transmissions listed in 7.22.4.1 that originate from other A-BSs or CPEs associated with other A-BSs.

7.23 Quiet periods and sensing

In order to meet the Channel Detection Time for detecting the presence of incumbents in the operating channel, an IEEE 802.22 network shall schedule network-wide quiet periods for sensing. During these quiet periods, all network traffic is suspended and BSs and CPEs shall perform in-band sensing. This process is coordinated by the BS, which is responsible for scheduling the quiet periods.

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The BSs must manage the quiet periods in order to protect the incumbents, while attempting to support the QoS required by IEEE 802.22 users. The two-stage quiet period management mechanism that enables dynamic adjustment of the repetition rate and duration of quiet periods and that shall be supported by the BSs and CPEs are described in 7.23.1. The BS determines the repetition rate and duration of the quiet periods based on the sensing algorithms used and type of signals that the CPEs has to sense. Once this information is determined, the BS can schedule the quiet periods either in the explicit mode, which is done through the use of CHQ-REQ MAC message as described in 7.9.17.3, or in the implicit mode using the sensing related fields in the SCH as specified in Table 1. Subclauses 7.23.1.1 and 7.23.1.2 describe in more details the process of scheduling the quiet periods.

According to the IEEE 802.22 MAC, BSs and CPEs can also perform sensing in channels outside the operating channel and its adjacent channels. However, out-of-band sensing does not require scheduling of network-wide quiet periods in the operating channel and its adjacent channels but it needs to rely on the quiet periods in the channels to be sensed. CPEs can perform out-of-band sensing whenever not engaged in communication with their BS during normal cell operation (see 11.3.4). The BS can also specifically request CPEs to perform out-of-band sensing during normal IEEE 802.22 cell operation in order to keep track of a sufficient number of potential backup channels (see 7.21.5) in case of an UCS. This can be done through BLM management messages (see 7.9.18).

7.23.1 Two-stage sensing mechanism and quiet period management

The mechanism for quiet period management is illustrated in Figure 141and it consists of the following two sensing stages, which are realized through the use of network-wide quiet periods, but which have different time scales:

a) Intra-frame sensing: The intra-frame sensing stage is comprised of one sensing period per frame, during which sensing algorithms that require quiet periods of less than one frame size are employed. Intra-frame sensing allows quiet periods to be scheduled with minimal impact on the QoS for IEEE 802.22 BSs and CPEs. Based on the consolidation of all measurements done during the intra-frame sensing stage over a number of frames, the BS may still decide to schedule an inter-frame quiet period over multiple frames in order to perform longer sensing.

b) Inter-frame sensing: The inter-frame sensing stage is used to support sensing algorithms that require longer sensing durations and is defined as taking longer than one frame size. Since a long quiet period may degrade the performance for QoS sensitive traffic, the allocation and the duration of the inter-frame sensing stage are dynamically adjustable by the BS. In order to meet the QoS requirements of the IEEE 802.22 BSs and CPEs while protecting primary users, the BS can use the feedback obtained during the intra-frame sensing stage to determine whether or not inter-frame sensing is needed.

The intra-frame sensing stage may be able to detect the presence of an incumbent in the measured channel within the required Channel Detection Time without the need of long quiet periods. However, if longer and finer sensing were needed to detect the incumbent, for example, to detect the incumbent signal signature, the inter-frame sensing stage would then be needed. This way, support of better QoS to IEEE 802.22 BSs and CPEs can be provided through this flexible two-stage mechanism.

The implicit quiet period scheduling structure carried by the SCH allows the BS to flexibly schedule quiet periods of any length, whether less than, equal, or larger than one frame size. To implement a quiet period longer than one frame size but that is not an integral number of frames, the BS could allocate an intra-frame quiet period immediately followed by an inter-frame quiet period. For example, if the quiet period duration needs to be one and a half frame long, the BS could allocate an intra-frame quiet period of half a frame followed by an inter-frame quiet period of one frame size. Note that an inter-frame quiet period has precedence over an intra-frame quiet period when both are scheduled in the same frame.

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Note that in-band sensing is done automatically by all CPEs during quiet periods scheduled by the implicit QP scheduling mechanism using the SCH, see 11.3.3. In this case, CPEs only signal the presence of incumbents, when detected, by setting the UCS flag in the generic MAC header sent back to the BS in the granted US packet or, if not available, through the UCS opportunistic burst.

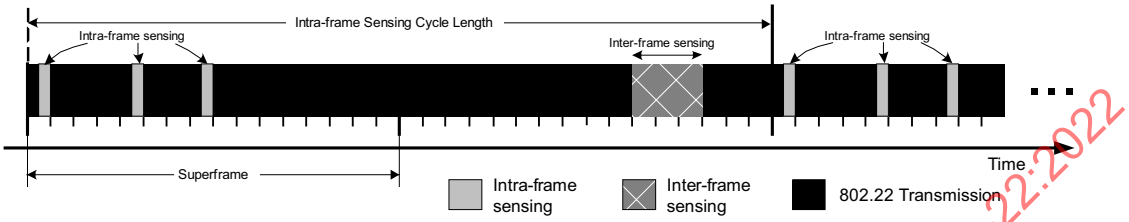

Figure 141—Illustration of the two-stage mechanism for quiet period management

Figure 142 and Figure 143 show in detail how the two-stage mechanism on the operating channel N and two adjacent channels N±1 directed by the BLM-REQ message from the BS shall be implemented at the BS and the CPEs, respectively. Note that the BLM-REQ MAC message can also be used to request sensing of channels other than N and N±1. In such case, the CPE will need to acquire the scheduling of the quiet periods on these channels from their CBP bursts and carry out sensing at the appropriate times.

Inter-frame sensing is needed when acquisition of the payload of the IEEE 802.22.1 beacon is required for authentication purpose (see D.8.3). Unfortunately, inter-frame sensing can substantially impact the WRAN system QoS since the data transmissions may be interrupted for unacceptable long periods. A way to resolve such demanding requirement is by detecting the IEEE 802.22.1 sync burst using intra-frame quiet periods and, when the IEEE 802.22.1 sync burst is detected, the WRAN system can switch to its first backup channel and then, if need be, attempt to acquire the IEEE 802.22.1 payload from its previous operating channel through out-of-band sensing to acquire the beacon payload for additional data such as the location of the beacon and the data needed for its authentication. This special sensing can be signaled to the CPEs by the BLM-REQ message. If the beacon cannot be authenticated, the WRAN system could switch back to its previous channel or, at least add this channel to its list of available backup channels. This process would avoid the requirement for inter-frame sensing, hence preserving the WRAN QoS. If an IEEE 802.22.1 beacon sync burst is detected through intra-frame sensing but the switch to a backup channel is not possible, and then the WRAN system will have to use inter-frame sensing to verify the authenticity of the IEEE 802.22.1 beacon if it wants to continue operating.

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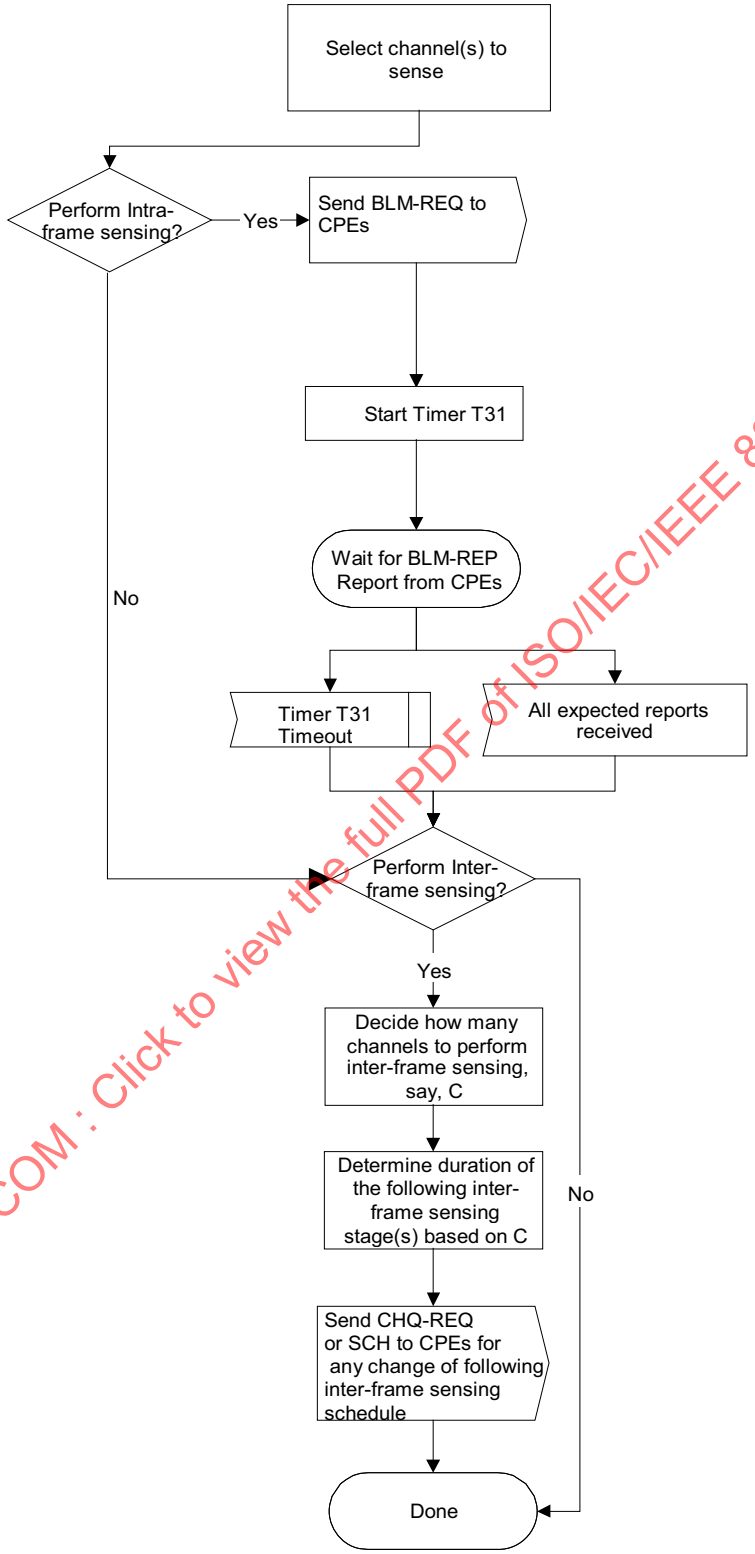

Figure 142—Two-stage directed sensing procedure at the BS

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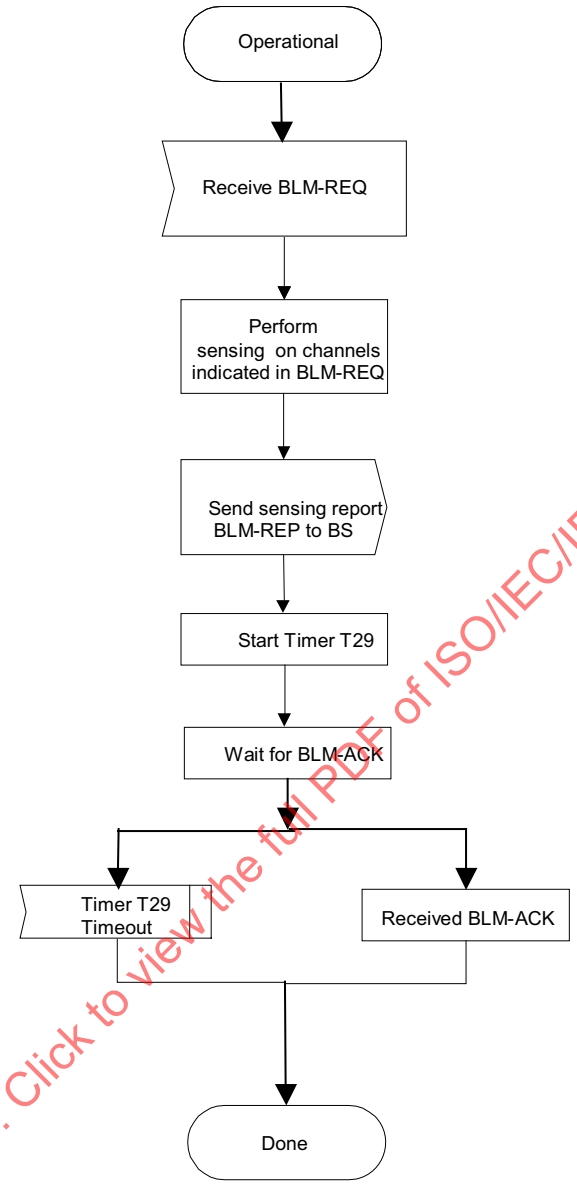

Figure 143—Two-stage directed sensing procedure at the CPE

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7.23.1.1 Intra-frame quiet period allocation

Intra-frame quiet periods shall be scheduled at the end of the MAC frame and they shall not conflict with the SCWs. Since nearby IEEE 802.22 networks are synchronized (see 7.23.2), intra-frame sensing shall be done simultaneously and hence, its effectiveness in detecting incumbent signals will be increased.

The BS shall inform CPEs in which frame intra-frame quiet periods are scheduled and their duration. The BS uses the implicit mode or the explicit mode to indicate the intra-frame quiet period schedule to the CPEs. In the explicit mode, the BS uses the CHQ-REQ MAC message described in 7.9.17.3 to advertise the intra-frame sensing schedule and all the relevant parameters for sensing. This explicit mode should not be used in a self-coexistence operation since the quiet period scheduling information may not be made available to the

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other WRAN systems operating in the area. Only the implicit mode should be used in a self-coexistence situation.

In the implicit mode, this is done using the Current Intra-frame Quiet Period Cycle Length, Current Intra-frame Quiet Period Cycle Offset, Current Intra-frame Quiet Period Cycle Frame Bitmap, and Current Intra-frame Quiet Period Duration fields in the SCH as specified in Table 1. The Intra-frame Quiet Period Cycle Length is the distance in number of superframes between the superframes that contain intra-frame quiet periods assigned to specific frames according to the Intra-frame Quiet Period Cycle Frame Bitmap. Figure 144 illustrates the concept of Intra-frame Quiet Period Cycle and shows an example of a bitmap in which intra-frame quiet periods are scheduled in frames 1, 3, 5, 7, 9, and 11. The duration of the intra-frame quiet period in each frame is specified by the Intra-frame Quiet Period Duration field in the SCH. As shown in Figure 144, the Current Intra-frame Quiet Period Cycle Offset indicates the offset in number of superframes with respect to the next superframe belonging to the current intra-frame quiet period cycle. If the BS decides to change the scheduling of the quiet periods, it shall do so by transmitting a new set of Current Intra-frame Quiet Period scheduling parameters in the SCH in normal operation. If the BS operates in a self-coexistence situation, it shall send this information as a new set of Claimed Intra-frame Quiet Period scheduling parameters in the SCH to allow negotiation among the coexisting WRAN cells to align their quiet periods before declaring the new quiet period schedule as “current” (see 7.23.2.1).

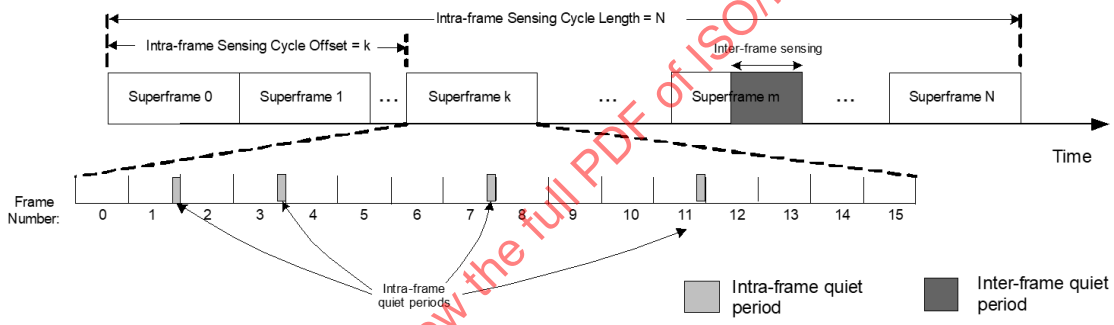

Figure 144—Scheduling of quiet periods for intra-frame and inter-frame sensing using information provided in the SCH

7.23.1.2 Inter-frame quiet period allocation

Once the BS receives the reports from the CPEs about their intra-frame sensing measurement results, it can make a decision with respect to the need for an inter-frame sensing stage. The BS can also decide to perform inter-frame sensing without going through intra-frame sensing. The BS can use either implicit or explicit mode to schedule the quiet periods for inter-frame sensing.

In the explicit mode, the BS uses the measurement frames described in 7.9.17.3 and 7.9.18.1 to adaptively control the quiet periods. In the implicit mode, the BS uses the Inter-frame Quiet Period Duration and Inter-frame Quiet Period Offset fields in the SCH (see Table 1) to schedule or cancel quite periods for inter-frame sensing. Note that the explicit mode does not allow the quiet period scheduling information to be made available to the other WRAN systems operating in the area and should not be used in a self-coexistence operation.

The inter-frame quiet period may last up to an entire superframe. It is especially suited for spectrum sensing algorithms that require longer quiet periods, such as for the detection of the IEEE 802.22.1 beacon payload confirming the presence of wireless microphone operation.

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7.23.1.3 CPE-initiated dynamic quiet period scheduling adjustment

On occasion a CPE may need to request more quiet periods in order to complete its own in-band sensing actions. Quiet period adjustment request is signaled by the CPE by setting the QPA bit in the GMH (Table 6).

If the CPE currently has a US allocation it shall be done immediately and sent in the GMH of the MAC PDU during the next US transmission opportunity.

If the CPE does not currently have a US allocation, CPE shall first request an allocation (see 7.13), and once granted, shall transmit an empty payload MAC PDU with the QPA bit set in the GMH (Table 6).

Upon receiving a MAC PDU with the QPA bit set in the GMH, the BS then determines the new schedule/ configuration.

When the cell is operating in normal mode, the BS shall respond to the quiet period adjustment request by either sending the CPEs a CHQ-REQ message for immediate reaction or modify its SCH accordingly. When the cell is in a self-coexistence situation, the BS shall respond to the request by transmitting the new quiet period schedule in the SCH once the negotiation with the nearby WRAN cells operation on the operating channel and its adjacent channels will have taken place (see 7.23.2).

7.23.2 Synchronization of overlapping quiet periods

Due to the possibility of multiple nearby IEEE 802.22 cells operating on the same channel or adjacent channels, quiet periods of these cells shall be synchronized. This will considerably improve the reliability of detection of incumbent signals, and will also enable better self-coexistence among nearby IEEE 802.22 cells. It is assumed that the BSs will have already synchronized their superframes as discussed in 7.25. Also, the intra-frame sensing quiet periods always start at the end of a frame. This makes the quiet period synchronization procedure described in this subclause considerably simpler.

Hence, in the WRAN BSs shall synchronize their quiet periods with other nearby BSs, while in the A-WRAN A-BSs shall synchronize their quiet periods with other nearby A-BSs. This is done using the fields available in the SCH (see Table 1) or Extended Frame Control Header (see 7.23.1.2) that are used to schedule quiet periods for intra-frame (see 7.23.1.1) and inter-frame sensing (see 7.23.1.2), and which are also carried in CBP packets (see 7.8.1.3.1). The BS/A-BS shall be responsible for setting these fields whenever transmitting an SCH or an Extended Frame Control Header. These QP scheduling fields are sent in the following three sets of parameters in a self-coexistence situation:

— Current Intra-frame Quiet Period Cycle Length, Cycle Offset, Frame Bitmap, and Duration;
— Claimed Intra-frame Quiet Period Cycle Length, Cycle Offset, Frame Bitmap and Duration, Synchronization Counter for Intra-frame Quiet Period repetition rate, and Synchronization Counter for Intra-frame Quiet Period Duration; and
— Inter-frame Quiet Period Duration and Inter-frame Quiet Period Offset.

7.23.2.1 Intra-frame quiet period synchronization

In a WRAN cell, the “current” set of intra-frame quiet period parameters is used by the BS to indicate to its CPEs the quiet periods that are currently scheduled. In the A-WRAN cell, the “current” set of intra-frame quiet period parameters is used by the A-BS to indicate to its’ A-CPEs/R-CPEs the quiet periods that are currently scheduled. Before becoming “current,” this set of QP scheduling parameters has to be confirmed by all coexisting WRAN cells through the CBP mechanism following a negotiation among these WRAN cells. The same applies to all coexisting A-WRAN cells.

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The "claimed" set of intra-frame quiet period parameters is used by each BS in the WRAN or by each A-BS in the WRAN, to announce its new scheduling requirement for quiet periods considering the performance of the sensing techniques used by its CPEs, A-CPEs/R-CPEs respectively. The scheduling requirement is defined as the sensing time needed to meet the required sensing threshold. This "claimed" set is broadcast by the SCH or the Extended Frame Control Header and retransmitted to the other coexisting WRAN cells by the CBP mechanism so that negotiation can take place to arrive at a common quiet period schedule that meets the maximum QP requirement while minimizing the overhead by reducing the non-concurrent quiet periods as much as possible. This "claimed" quiet period schedule, once it has become common to all coexisting WRAN cells, can then be scheduled to become the "current" quiet period parameter set after sufficient time is given for the negotiation to cover for inter-cell propagation.

The BS that receives information about other collocated IEEE 802.22 cells (either directly or reported through the CPEs) shall synchronize with all quiet periods scheduled through negotiation among coexisting BSs. At that time, the common "claimed" intra-frame QP schedule replaces the "current" schedule. The intra-frame QP negotiation mechanism shall be as follows:

In the WRAN, each BS sends its claims to other coexisting BSs through the SCH, which is then carried by the CBP mechanism. In the A-WRAN each A-BS sends its claims to other coexisting A-BSs through the A-FCH/Ex-FCH, which is then carried by the CBP mechanism. Each BS/A-BS that receives a new "claim" shall compare it to its own claim and either replace the incoming claim by its larger claim for the QP repetition rate (i.e., number of 1s in the bitmap/cycle length) and/or QP duration or keep it as is if its own claim is smaller.

If its own claim is larger and the updating results in a new claim that is larger than the "current" QP repetition rate and/or duration, the BS (in the WRAN) or A-BS (in the A-WRAN) shall reset the Claimed Intra-frame Quiet Period Offset to the minimum number of frames required to make sure that all coexisting BSs/A-BSs have received the claim (e.g., 2 hops, that is 2 superframes or frames) before sending it in the SCH (in the WRAN) or the A-FCH/Ex-FCH (in the A-WRAN) and relaying it through the CBP mechanism. If the new claim is smaller than the "current" scheduling, the Claimed QP Offset parameter is repeated unchanged, and the incoming scheduling parameters are also repeated unchanged.

In order to allow the synchronized Intra-frame Quiet Period Duration to adapt to the variation found at different BSs, each BS, denoted as *BS(i)*, should maintain a variable named Synchronization Counter for Intra-frame Quiet Period Duration, denoted as $SC_D(i)$. This value is sent together with the "claimed" Intra-frame Quiet Period Duration, denoted $D^{Claimed}(i)$, in the SCH and CBP. $D^{Claimed}{}_{syn}(i)$ is the latest Intra-frame Quiet Period Duration claimed by *BS(i)* and $D^{Claimed}{}_{min}(i)$ is the minimum required Intra-frame Sensing Duration by *BS(i)*. Initially, SC_{max} is a value predefined and common to all WRAN cells in an area that corresponds to the extent of propagation of the QP scheduling (e.g., 8 hops). This initial value shall be agreed upon and used by all operators in the area and should be updated according to the algorithm described in Table 221. For the values given previously as examples, an increase in QP duration as compared to the "current" value would take place after 2 frames whereas a release of unused quiet period duration as compared to the "current" value would take 8 frames to become "current."

The algorithm described in Table 229 shall be used to come up with a Claimed Intra-frame Quiet Period Duration that will converge to a common value for all overlapping WRAN cells within the given extent of reach (e.g., 8 hops). It will also produce a value for the "claimed" offset, denoted as $Offset^{Claimed}$, in number of superframe, representing the delay required before transferring this "claimed" QP duration into the "current" QP duration, allowing the convergence scheme to stabilize at all BSs involved in the process, thus isolating the "current" QP scheduling values from the temporary instability of the transition on the "claimed" values.

The procedure highlighted in Table 228 is applicable to quiet period scheduling convergence in the A-WRAN. When applying/using this procedure in the A-WRAN, instead of receiving data from SCH, A-BSs receive data from A-FCH/Ex-FCH.

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Table 229—Quiet Period Scheduling Convergence algorithm

% When initializing BS(i) sets: $D^{Current}(i) = 0$ $D^{Claimed}_{syn}(i) = D^{Claimed}_{min}(i)$ $SC_D(i) = SC_{max}$
% For BS(i), before sending out a SCH or CBP packet: if $D^{Claimed}_{syn}(i) < D^{Claimed}_{min}(i)$, then % Case covering increase in QP $D^{Claimed}_{syn}(i) = D^{Claimed}_{min}(i)$ $Offset^{Claimed}(i) = 2$ % 2 superframes for fast reaction time endif % (adjustable) when QP requirement increases

if $D^{Claimed}_{syn}(i) == D^{Claimed}_{min}(i)$, then
$SC_D(i) = SC_{max}$
endif

if $D^{Claimed}_{syn}(i) > D^{Claimed}_{min}(i)$, then % Case covering de-increase in QP
$SC_D(i) = SC_D(i)-1$
if $SD_D(i) == 0$, then
$D^{Claimed}_{syn}(i) = D^{Claimed}_{min}(i)$
$SC_D(i) = SC_{max}$
$Offset^{Claimed}(i) = 9$ % 9 superframes for slow release of QPs (adjustable)
endif
endif

% When BS(i) receives a SCH or CBP packet from BS(j):
if $D^{Claimed}_{syn}(j) > D^{Claimed}_{syn}(i)$, then
$D^{Claimed}_{syn}(i) = D^{Claimed}_{syn}(j)$
$SC_D(i) = SC_D(j)$
else if $D^{Claimed}_{syn}(j) == D^{Claimed}_{syn}(i)$
and $SC_D(j) > SC_D(i)$, then
$SC_D(i) = SC_D(j)$;
endif

% Countdown at every BS in superframe: to fetch 'claimed' value into 'current' value $Offset^{Claimed}(i) = Offset^{Claimed}(i) - 1$ % Offset decremented by 1 if $Offset^{Claimed}(i) == 0$, then % every start of superframe $D^{Current}(i) = D^{Claimed}_{syn}(i)$ endif

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The same algorithm shall be used to converge on a common Claimed Inter-frame Quiet Period repetition rate with the same initial value for SCmax in order to converge on the lowest common quiet period repetition rate where all the Ds (Duration) will be replaced by Rs (Repetition rate). Adjustment of the Claimed Intra-frame Quiet Period Cycle Length and the Claimed Cycle Frame Bitmap shall result from the common repetition rate found.

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7.23.2.2 Inter-frame Quiet Period Synchronization

In the WRAN, the BS that receives information about other collocated IEEE 802.22 WRAN cells (either directly or reported through CPEs) shall synchronize with all quiet periods scheduled by the other cells for the inter-frame QP schedule. In the A-WRAN, the A-BS that receives information about other collocated IEEE 802.22 A-WRAN cells (either directly or reported through A-CPEs) shall synchronize with all quiet periods scheduled by other cells for the inter-frame QP schedule. To synchronize inter-frame sensing quiet periods, the BS uses the information contained in the SCH, while the A-BS uses information in the A-FCH or Ex-FCH. In addition to that, the BS/A-BS shall apply a random mechanism to decide whether to change its quiet period schedule. This mechanism will considerably mitigate the ping-pong effect and it is based on the following rule:

— A BS 1 shall only modify its inter-frame sensing quiet period schedule to synchronize with the inter-frame sensing quiet period of another nearby BS 2 if the remaining time to BS 1's next inter-frame sensing quiet period is larger than the remaining time to BS 2's next inter-frame sensing quiet period.

For example, consider that BS 1 received information on the SCH in the WRAN or A-FCH/Ex-FCH in the A-WRAN transmitted by a collocated BS 2. In this case, BS 1 shall modify its inter-frame quiet period schedule in order to synchronize with that of BS 2 if the Inter-frame Quiet Period Offset of BS1 is larger than that of BS2. If this rule is validated, BS 1 can proceed with the synchronization of its quiet period with that of BS 2. To this end, BS 1 shall schedule the change in its quiet period to take place N frames away, where N = rand(0, Q_{Thresh}) and rand(a, b) is a function that returns an integer number t, where $a \leq t < b$, and Q_{Thresh} is defined in units of superframe. If up until N superframes later BS 1 does not receive any more information regarding the next quiet period of BS 2, it shall proceed with its quiet period change to achieve synchronization. This is done by modifying the values of the Inter-frame Quiet Period Offset and Duration in the SCH (in the WRAN) or A-FCH/Ex-FCH (in the A-WRAN) when initiating the new superframe, or by transmitting an updated CHQ-REQ command.

If, before advertising the change in its quiet period, BS 1 receives information about BS 2, which indicates that BS 2 has already changed its quiet period to align with that of BS 1, BS 1 shall then cancel its scheduled quiet period change. Another possibility is that the new information about the quiet period that BS 1 receives about BS 2 changed since the last notification. In this case, BS 1 shall cancel the current scheduled change of its quiet period and reschedule it if appropriate (using the same procedure as described previously), taking into consideration the new parameters received from BS 2. BS 1 shall proceed with changing its quiet period in all other cases.

In a region with multiple nearby BSs, the synchronization of the superframes (described in 7.25) and the synchronization of the quiet periods using the mechanisms described previously will result in the scenario depicted in Figure 145. The nearby cells will synchronize not only their frames but also their quiet periods. This will render the results of the intra-frame and inter-frame sensing as accurate as can be, since all nearby IEEE 802.22 networks will quiet at the same time and only the signal from the incumbent user, if any, will remain on the channel.

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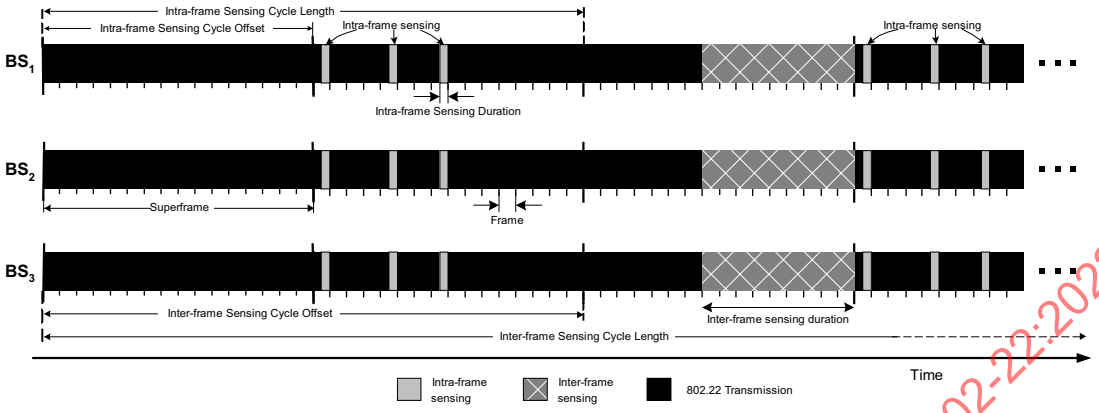

Figure 145—Illustration of the two-stage quiet period mechanism with multiple overlapping cells

7.23.3 CPE report

While intra-frame or inter-frame sensing stages are taking place, the CPE shall report the presence of any incumbent either through the UCS opportunistic burst in the contention window or through the UCS flag in the MAC header if the CPE already has bandwidth granted on its US. Sensing measurement results shall be reported to the BS when requested through the BLM-REQ MAC message. In this case, the CPE shall use the BLM-REP message (see 7.9.18.3) to report to the BS the results of its sensing.

Reporting can be done after each individual sensing interval for sensing mode 2 or once the CPE sensing device has carried out sensing during sufficient time to meet the required sensing threshold for sensing mode 0.

7.23.4 Quiet periods and sensing for a relay network on PHY-OM2

7.23.4.1 Quiet period synchronization for an A-BS's cell

For Quiet period synchronization for an A-BS's cell containing A-CPEs and R-CPEss as shown in Figure 146, the A-BS can schedule the quiet periods either in the explicit mode, which is done through the use of CHQ-REQ MAC message as described in 7.7, or in the implicit mode using the sensing related fields in the SCH on PHY-OM1 or the Extended Frame Control Header on PHY-OM2.

Quiet period allocation shall follow the same mechanisms described in 7.21.1.

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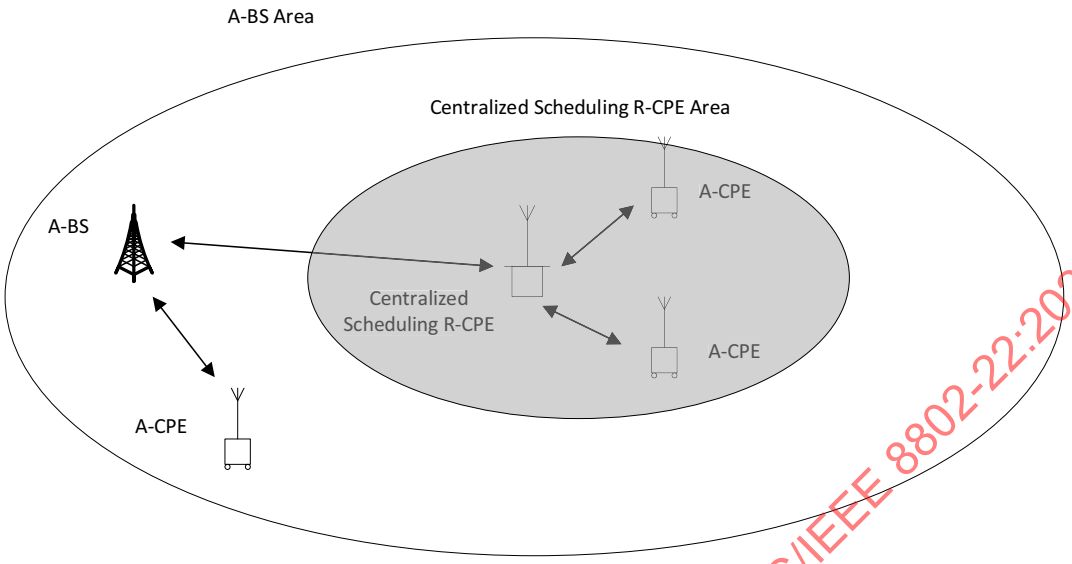

Figure 146—Quiet period synchronization within an A-BS's cell

7.23.4.2 Quiet period synchronization for a local network

The Quiet periods shall be synchronized at all CPEs within an A-WRAN network. Some A-CPEs located in a local cell, which are managed by a distributed scheduling R-CPE, may not be synchronized by the Quiet period scheduling information transmitted from an A-BS because the A-CPEs are outside of the A-BS's cell as shown in Figure 1(c). Instead of the A-BS, the distributed scheduling R-CPE shall transmit the Quiet period scheduling information transmitted from an A-BS to the A-CPE within a local cell.

In the implicit quiet period scheduling, when a distributed scheduling R-CPE receives an Advanced Frame Control Header and/or Extended Frame Control Header from the A-BS, the distributed scheduling R-CPE shall send the Advanced Frame Control Header and/or the Extended Frame Control Header followed by DRZ-FCH to synchronize the quiet period in a local cell.

In the explicit quiet period scheduling, the A-BS uses the CHQ-REQ MAC message described in 7.7 to advertise the intra-frame sensing schedule and all the relevant parameters for sensing. When the distributed scheduling R-CPE receives a CHQ-REQ MAC message from the A-BS, it shall send the CHQ-REQ MAC message to the CPEs within a local cell. This explicit mode should not be used in a self-coexistence operation since the quiet period scheduling information may not be made available to the other A-WRAN systems operating in the area. Only the implicit mode should be used in a self-coexistence situation.

Quiet period allocation shall follow the same mechanisms described in 7.21.1.

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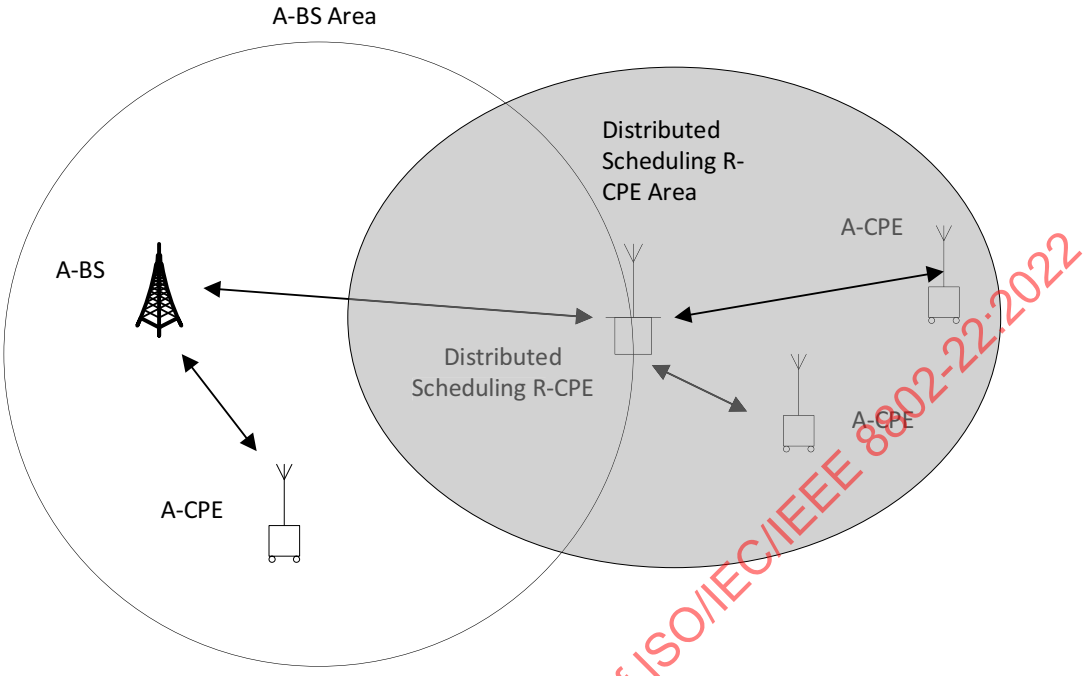

Figure 147—Quiet period synchronization for a local network

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7.24 Channel management

A robust and efficient channel management component is a critical feature. In fact, the channel management component incorporated in the MAC allows IEEE 802.22 systems to efficiently and dynamically use the available channels as the radio environment utilization changes. In the MAC, two modes of channel management are possible: embedded (see 7.9.1.1) and explicit (see 7.9.17). The BS and CPEs shall support both these schemes, while the decision on which one to use and when is at the discretion of the BS.

The embedded mode of channel management has the advantage that individual channel management commands need not be sent (as it is the case in the explicit mode), and hence better spectrum utilization can be achieved. Another advantage of the embedded mode is that it addresses all CPEs in a cell, and hence is an effective way to take corrective actions in case an incumbent user starts operating in a channel occupied by all CPEs in an IEEE 802.22 cell. Similar to all other IEs, the IEs related to the embedded channel management (see 7.9.1.1) scheme shall only be transmitted by the BS when this feature is used.

The explicit approach to channel management, on the other hand, provides greater flexibility and is relatively independent of the MAC protocol used. Furthermore, this allows channel management to be implemented in different granularities, that is, these stand-alone messages could be sent by the BS to CPEs, for example, through unicast (i.e., destined to a single CPE), multicast (i.e., destined to a group of CPEs), or broadcast (i.e., all CPEs in a cell). These messages would also allow the BS to request confirmation of receipt, in case guaranteed delivery is required. In addition, contrary to the embedded mode where the BS has to wait for the next MAC frame in order to send a channel management command, this mode of operation of supporting individual channel management frames allows the MAC to rapidly react to changes in the radio spectrum occupation. This quick reaction is critical especially when we consider incumbent protection.

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Irrespective of the channel management mode, CPEs and BSs shall treat channel management commands with high priority, especially when they refer to the protection of incumbent services. Once the BS detects or receives the report about the presence of an incumbent system on the operating channel (see 7.21.1 and 7.21.3), it should send channel management commands to the effected receivers. Depending of the urgency of the channel management command (the requirements of certain incumbent users may be more strict than others), the BS shall calculate the expected time the channel management message should arrive at the CPEs and appropriately set the scheduling fields (e.g., count, offset, duration, period) in the message header. This will dictate the urgency of the message and how it shall be treated at the receivers.

Also, depending upon the situation, correct reception of channel management frames by all CPEs involved may be required by the BS. In this case, the BS shall set the 'Confirmation Needed' field existing in the header of the channel management frame, which allows for the BS to specifically request the CPEs to send back a confirmation message. If we take the CHS-REQ message, Figure 148 depicts the message flow between BS and CPE when the 'Confirmation Needed' field is set.

Once the destination receives the channel management command from the BS, it shall give higher priority for these types of messages. As such, the receiver shall inspect the message control fields and proceed as instructed by the BS. If a confirmation is needed (in particular, this may be useful in case of transmissions of individual messages as these are unreliable), the receiver shall immediately send back a response message to the BS with the appropriate confirmation code. If a required acknowledgment message is not received within a predetermined timeout, the BS may send another channel management message to the receiver in question. The receivers shall also check the scheduling fields in the management message in order to ascertain how urgent the message is, and how it should be treated internally. The receiver shall then change its operating parameters, at the scheduled time, as instructed by the BS.

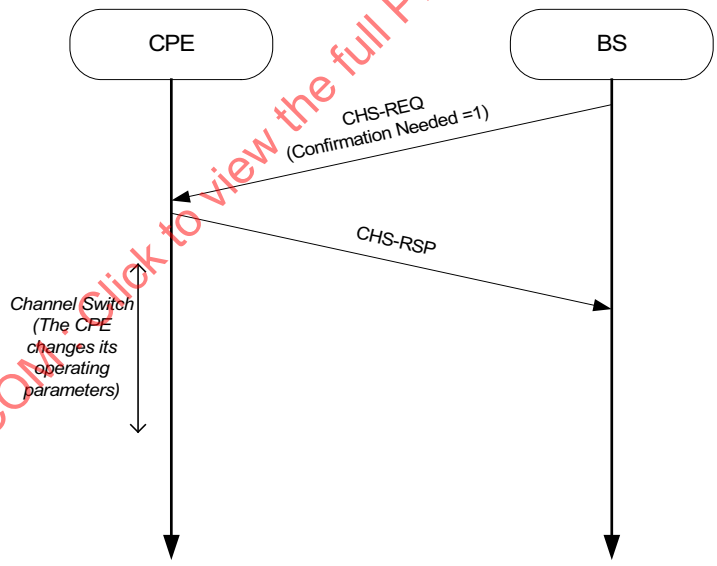

Figure 148—Message flow between BS and CPE when confirmation is required

7.24.1 Initialization and Channel Sets Updating

For efficient channel management, 11.2.3 addresses channel classification and selection rules. In this subclause, procedure of channel list initialization and updating are addressed.

In order to maintain the channel sets, each BS maintains the following available channel sets: Operating, Backup, Candidate, Protected, Occupied, and Unclassified. Each CPE maintains only the first three channel

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sets: Operating, Backup and Candidate. These individual sets have different update steps. For example, on the CPE side, the Operating set is confirmed by every received SCH and the Backup and Candidate sets are updated after receiving the DCD. After synchronization, the BS should send an IPC-UPD message to the CPE to update the set of channels prohibited from incumbent operation for the newly connected CPE to allow skipping these channels to speed up the sensing process. These relations are summarized in Table 230. In the case of the BS, channel sets are updated after each quiet period either at a periodic interval or aperiodic intervals.

Table 230—Update channel set information in CPE

Message	Field	Information
SCH	BS_ID	Operating channel on which the SCH is received
DCD	Number for Backup channels	Number of backup channels
	Backup and candidate channel list	List of backup and candidate channels
IPC-UPD	Incumbent Prohibited Channels Update	Channels that cannot carry incumbent signals since their operation is prohibited (e.g., channel 37 in the USA) and thus do not need to be sensed for the presence of incumbents

When a CPE turns on, it scans the channels to identify the available WRAN operations and proceeds with the selection of one of these services (see 11.3.2). Such selection identifies the operating channel. As part of the CPE initialization, the list of backup and candidate channels is sent in the DCD message by the BS This procedure is closely related with obtaining downlink parameters procedure (see 7.16.2). After association of a new CPE, the BS shall send the IPC-UPD message to indicate the list of channels prohibited from incumbent operation to the CPE so that it can skip incumbent sensing on these channels. Channel sets in the CPE are updated after periodically receiving the DCD message. In the case of the BS, if channel sets are changed as a result of BLM-REP messages, the BS sends the backup and candidate channel list in its DCD message.

7.24.2 Scheduling of channel switching time

When the BS decides to switch channels during normal operation, it shall execute the following procedure to determine when to schedule the channel switching operation.

— The BS selects the first backup channel from its backup/candidate channel list, it shall select a waiting time T46 to make sure that all its CPEs are prepared for the channel switch. The value of T46 is a configuration parameter that could be set by the management interface. The first requirement is that the value of T46 shall be smaller or equal to the maximum allowed channel moving time and the second requirement is that is long enough for the CPEs to recover from an incumbent detection.

— Then, the BS schedules the channel switch using the channel management procedure described in 7.21.5.

7.24.3 Channel management on a relay network on PHY-OM2

7.24.3.1 Overview

Two modes of channel management supported by WRAN, which are an embedded mode and an explicit mode, are also supported in A-WRAN.

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In the embedded mode in A-WRAN, the A-BS shall transmit all IEs related to channel management to all CPEs in the cell. A distributed scheduling R-CPE shall transmit all channel management IEs received from the A-BS to the CPEs managed by the distributed scheduling R-CPE.

In the explicit mode in A-WRAN, the channel management messages could be sent by the A-BS to the specific A-CPEs directly or relayed through a centralized scheduling R-CPE or a distributed scheduling R-CPE. When a R-CPE receives a channel management message not targeted to the R-CPE, the R-CPE shall relay the channel management message to the target A-CPE. In A-WRAN, Figure 149 depicts the message flow between A-BS and A-CPE relayed on R-CPE when the Confirmation Need field is set.

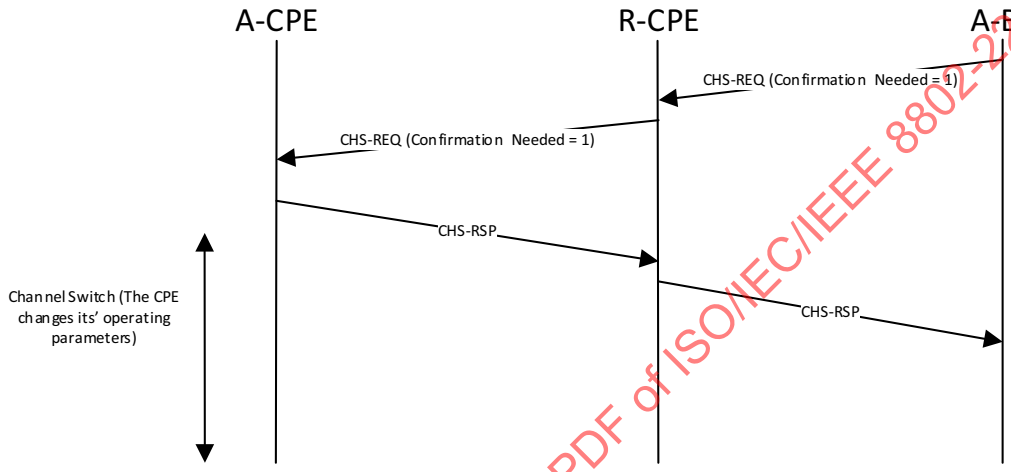

Figure 149—Message flow between A-BS and CPE relayed on R-CPE when confirmation is required

7.24.3.2 Initialization and channel sets updating

In this subclause, procedures of channel list initialization and updating on relay are addressed.

In order to maintain the channel sets, an A-BS maintains the following available channel sets: Operating, Backup, Candidate, Protected, Occupied, and Unclassified. Each A-CPE and centralized scheduling R-CPE within the A-BS's cell maintains only the first three channel sets: Operating, Backup, and Candidate. Each distributed scheduling R-CPE maintains the same channel sets as the A-BS's channel set. These individual sets have different update steps. For example, on the A-CPE side managed by the A-BS, the Operating set is confirmed by every received A-FCH/ExtFCH, and the Backup and Candidate sets are updated after receiving the DCD. On the A-CPE side managed by the distributed scheduling R-CPE, the Operating set is confirmed by every received DRZ-FCH, and the Backup and Candidate sets are updated after receiving the DCD in DRZ. After synchronization, the A-BS should send an IPC-UPD message to the A-CPE to update the set of channels prohibited from incumbent operation for the newly connected A-CPE to allow skipping these channels to speed up the sensing process. These relations are summarized in Table 231 and Table 232. For the A-BS, channel sets are updated after each quiet period either at a periodic interval or at aperiodic intervals. The A-BS shall send all channel sets to the distributed scheduling R-CPE.

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Table 231—Update channel set information in CPE

Message	Field	Information
A-FCH	BS_ID	Operating channel on which the SCH is received on PHY-OM2
DCD	Number for Backup channels	Number of backup channels
	Backup and candidate channel list	List of backup and candidate channels
IPC-UPD	Incumbent Prohibited Channels Update	Channels that cannot carry incumbent signals since their operation is prohibited (e.g., channel 37 in the USA) and thus they can be skipped during the sensing process

Table 232—Update channel set information in CPE for DRZ

Message	Field	Information
DRZ-FCH	BS_ID	Operating channel on which the DRZ-FCH is received
DCD	Number for Backup channels	Number of backup channels
	Backup and candidate channel list	List of backup and candidate channels
IPC-UPD	Incumbent Prohibited Channels Update	Channels that cannot carry incumbent signals since their operation is prohibited (e.g., channel 37 in the USA) and thus they can be skipped during the sensing process

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When a A-CPE turns on, it scans the channels to identify the available A-WRAN operations and proceeds with the selection of one of these services (see 10.3). Such selection identifies the operating channel. As part of the A-CPE initialization, the list of backup and candidate channels is sent in the DCD message by the A-BS or the distributed scheduling R-CPE. This procedure is closely related with obtaining the downlink parameters procedure (see 7.14.2). After association of a new A-CPE, the A-BS or the distributed scheduling A-CPE shall send the IPC-UPD message to indicate the list of channels prohibited from incumbent operation to the A-CPE so that it can skip incumbent sensing on these channels. Channel sets in the A-CPE are updated after periodically receiving the DCD message. For the A-BS, if channel sets are changed as a result of BLM-REP messages, the A-BS sends the backup and candidate channel list in its DCD message. When the distributed scheduling R-CPE receives the updated channel list from the A-BS, the distributed scheduling R-CPE sends the updated backup and candidate channel list in its DCD message in DRZ to the A-CPE.

7.24.3.3 Scheduling of channel switching time

When the A-BS decides to switch channels during normal operation, it shall execute the following procedure to determine when to schedule the channel switching operation:

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— The A-BS selects the first backup channel from its backup/candidate channel list, it shall select a waiting time T46 to make sure that all its A-CPEs are prepared for the channel switch. The value of T46 is a configuration parameter that could be set by the management interface. The first requirement is that the value of T46 shall be smaller or equal to the maximum allowed channel moving time, and the second requirement is that the value is long enough for the A-CPEs to recover from an incumbent detection.

— Then, the A-BS schedules the channel switch using the channel management procedure described in 7.19.

— When the distributed scheduling R-CPE receives the channel switch requirement from the A-BS, the distributed scheduling R-CPE shall make sure that all it's A-CPEs in a local cell are prepared for the channel switch within the available switching time (see switch count in 7.7), which will be transmitted by the A-BS.

7.25 Synchronization of the IEEE 802.22 WRAN BSs and IEEE 802.22 A-BSs

The BSs on PHY-OM1 shall synchronize the absolute local start time of their superframe period, to the start of every minute referenced to UTC to a tolerance of less than or equal to ± 2 µs. The A-BS on PHY-OM2 shall synchronize the absolute local start time of their frame period, to the start of every minute referenced to UTC to a tolerance of less than or equal to ± 2 µs.

All BSs shall use a common clock derived from a global navigational systems such as GPS to synchronize their MAC frames. Every BS upon activation will, as a first step, derive its system clock based on this common clock.

Every BS shall be equipped with a global navigational system receiver capable of receiving a UTC synchronized 1 pps timing signal. The accuracy of the clock pulses derived from the global navigational system are accurate to ± 100 ns and the pulses that are derived typically have rise times within ± 2.5 ns. Although the IEEE 802.22 specification requires the presence of a GPS receiver, other techniques (e.g., IEEE Std 1588™-2008 [B13]) may be considered as long as they meet the required tolerance.

7.26 Multi-channel operation on PHY-OM2

7.26.1 General

This subclause describes the multi-channel operation, which is required to support enhanced broadband services and monitoring applications that require high data throughput. A single channel operation is supported as shown in Figure 150 with maximum date rate of 22.69 Mbps. In Figure 150, each CPE (CPE 1~CPE 5) is using the operating channel f1 to communicate within the service area of BS where the operating channel f1 is assigned by the spectrum manager using the available channel list. Even though several available channels may exist in the list, due to the constraint of the single channel operation of IEEE Std 802.22-2011, those available channels cannot be utilized effectively since multi-channel operation is not supported. Multi-channel operation and Multi-hop relay operation are mutually exclusive. Channel aggregation mode can be configured as Bulk Transmission mode for increasing the transmission throughput or configured as Diversity mode for robust transmission as shown in 7.9.7.3.4.13. Only one type of multi-channel transmission mode shall be in operation at a given time. This is accomplished by an exchange of the CPE Operational Capability IE (7.9.7.3.4.13) in REG-REQ during the A-CPE registration. When the A-BS responds, it selects the multi-channel transmission mode, and then it sets the mode of the A-CPE in the CPE Operational Capability IE in the REG-RSP that it sends back to the A-CPE. Once the A-CPE has been configured to use a multi-channel transmission mode, the procedures used to add, switch, or stop operation can be engaged. When Transmit Diversity mode is selected, the same formatted MAC PDU is transmitted across all allocated channels. When Bulk Transmission mode is selected, a unique MAC PDU is transmitted across each allocated channel.

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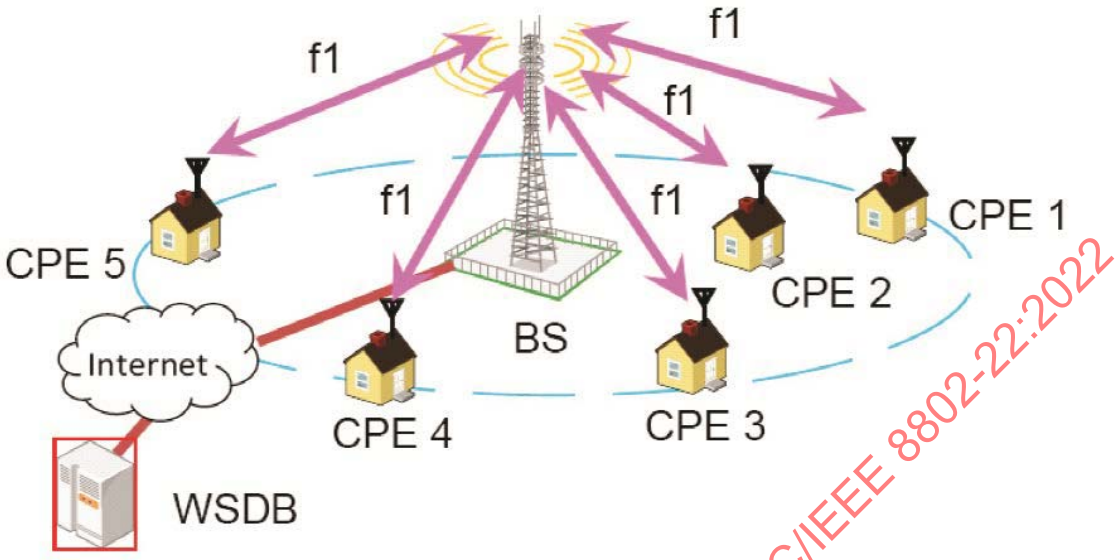

Figure 150—Example of IEEE 802.22 deployment configuration (single channel operation)

The A-WRAN supports aggregate data rates greater than the maximum data rate supported by the IEEE Std 802.22-2011 in order to extend its regional area broadband services to a broader range of applications such as real-time and near real-time monitoring, emergency broadband services, remote medical services, etc. Therefore, multi-channel operation should be considered as a means to achieve throughput greater than the maximum throughput supported by the IEEE Std 802.22-2011.

The examples of multi-channel operation deployment configuration are shown in Figure 1(d) and Figure 1(e), respectively. In Figure 1(d), it is assumed that there are 2 available operating channels within the service area of the A-BS. In this example, multi-channel operation on A-BS is illustrated where only the A-BS is capable of receiving and transmitting over two or more operating channels and responsible for assigning the operating channel to the associated A-CPEs within its service area. By performing the multi-channel operation on A-BS, the A-BS can utilize the available operating channels by distributing the operating channels among the associated A-CPEs. The multi-channel operation on A-BS can improve the individual A-CPE's throughput by decreasing the total number of associated A-CPEs per operating channel. In Figure 1(d), A-CPE 1 and A-CPE 2 are assigned to the operating channel f1 to communicate with the A-BS, and A-CPE 3, A-CPE 4, and A-CPE 5 are assigned to the operating channel f2 to communicate with the A-BS.

In Figure 1(e), it is assumed that there are five available operating channels within the service area of the A-BS. In this example, multi-channel operation on A-BS and A-CPEs is illustrated where both A-BS and associated A-CPEs are capable of receiving and transmitting over two or more operating channels. A-BS is responsible for assigning the operating channel to the associated A-CPEs within the service area for the utilization of available operating channels. In Figure 1(e), A-CPE 1 is assigned to the operating channels f1, f2, and f3 to communicate with the A-BS, and A-CPE 2 is assigned to the operating channels f4 and f5 to communicate with the A-BS. In this example, the A-BS can improve the individual A-CPE's throughput by increasing the number of operating channels assigned to the associated A-CPEs.

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7.26.2 Channel allocation manager

7.26.2.1 General

The channel allocation manager (CAM) shown in Figure 151 is responsible for the basic multi-channel operations such as add new operating channel operation (7.26.2.2), stop operating channel (7.26.2.4), and switch operating channel (7.26.2.5). All of the basic functions described in the CAM are necessary to support the multi-channel operation, which is different from the single channel operation.

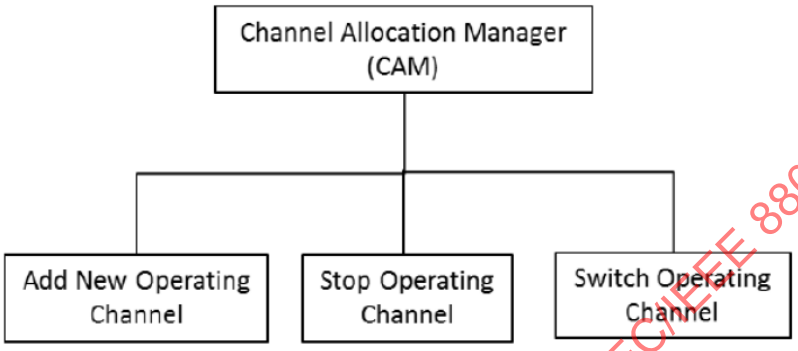

Figure 151—Channel allocation manager

A channel allocation manager is needed to perform multi-channel operations, which are described in 7.26.2.2, 7.26.2.4, and 7.26.2.5.

In 7.26.2.2, detailed operation flow of add new operating channel is discussed. The add new operating channel function is responsible for allocating new operating channel to each available channel transceiver unit (CHU).

In 7.26.2.4, detailed operation flow of stop operating channel is discussed. The stop operating channel function is responsible for stopping the operating channel of the specific CHU.

In 7.26.2.5, detailed operation flow of switch operating channel is discussed. The switch operating channel function is responsible for switching the operating channel of the specific CHU.

A CHU is defined as a transceiver unit that operates in a specific channel operation within its operating frequency which consists of a MAC and a PHY.

7.26.2.2 Add new operating channel operation

7.26.2.2.1 General

When the A-BS is ready to operate under the multi-channel operation, the following procedure of adding new operating channel is performed on both the A-BS and A-CPE, which have the capability of receiving and transmitting over two or more operating channels.

The add new operating channel operation procedure shall consist of the following steps:

a) BS-CAM selects a specific BS-CHU.
b) BS-CAM commences operation request.
c) BS-CHU commences operation acknowledgment.
d) BS-CAM sends management information notification to BS-CHU.

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e) BS-CHU memorizes management information.

f) BS-CHU performs frequency setting.

g) BS-CHU performs synchronization.

h) BS-CHU sends operation preparation completed notification to BS-CAM.

i) BS-CHU broadcasts A-FCH on PHY-OM2.

j) BS-CAM checks unused BS-CHU.

k) CPE-CAM selects a specific CPE-CHU.

l) CPE-CAM sends BS search command (all or specific channel) to the specific CPE-CHU.

m) CPE-CHU performs BS search.

n) CPE-CHU sends BS detected notification to CPE-CAM.

o) CPE-CAM determines other operating CPE-CHU.

p) CPE-CAM performs BSID matching.

q) CPE-CAM sends BSID mismatch notification to CPE-CHU.

r) CPE-CAM sends proceed notification to CPE-CHU.

s) CPE-CHU performs synchronization.

t) CPE-CHU sends synchronization completed notification to CPE-CAM.

u) CPE-CAM checks unused CPE-CHU.

v) CPE-CAM sends registration request to CPE management unit.

w) CPE management unit sends registration completed notification to CPE-CAM.

The add new operating channel operation flow is shown in Figure 152.

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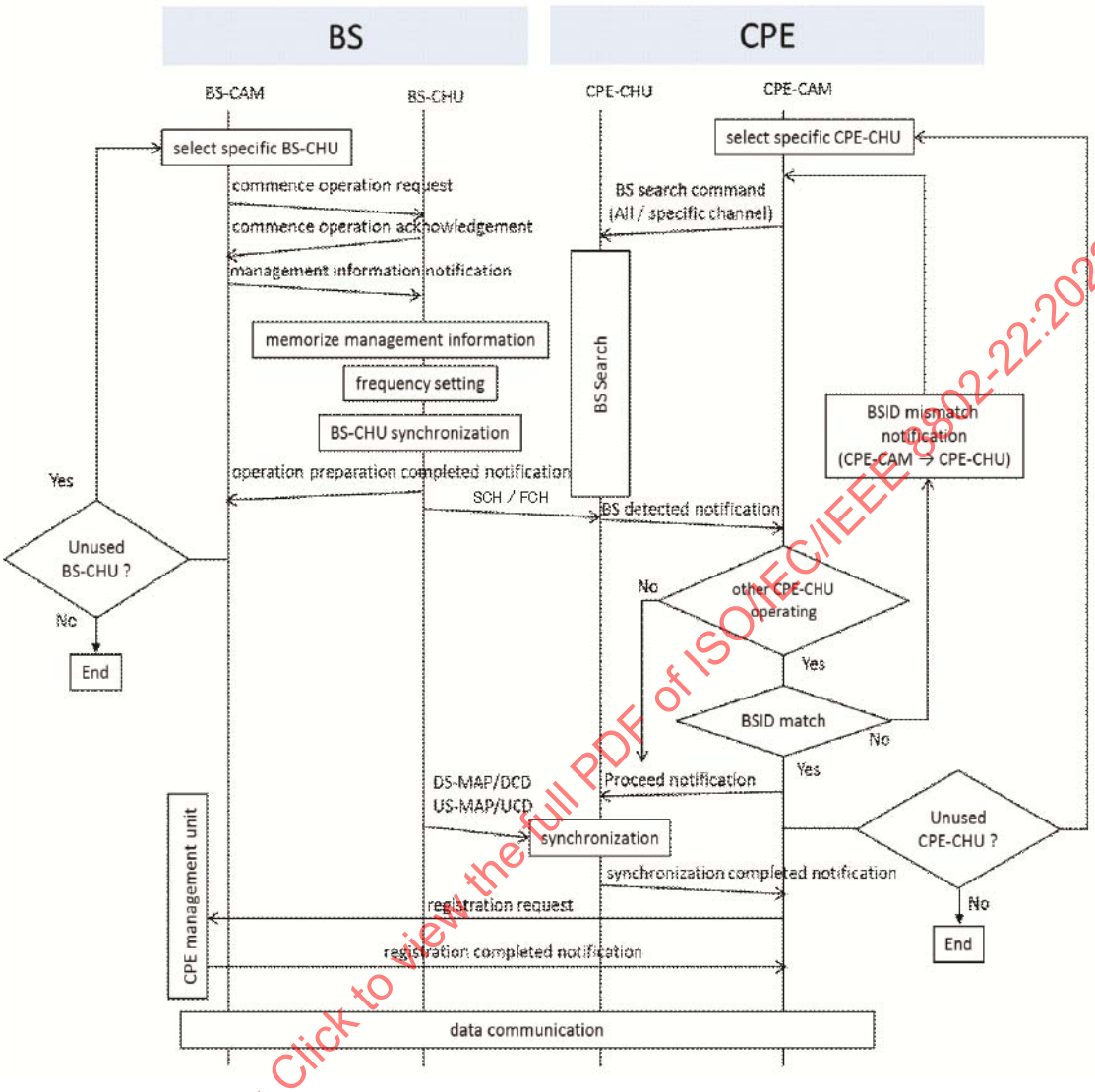

Figure 152—Operation flow for adding new operating channel

7.26.2.2.2 BS-CAM selects a specific BS-CHU

The BS channel allocation manager (BS-CAM) shall select a specific BS channel transceiver unit (BS-CHU) that is the target of the add new operating channel operation. The BS-CAM shall select the BS-CHU that is in the state of unused or unassigned currently and whose hardware corresponds to the new operating channel's frequency. The operating channel selection procedure may be included in this step.

7.26.2.2.3 BS-CAM commences operation request

The BS-CAM shall send a commence operation request to the selected BS-CHU. The commence operation request may include the various parameters in connection with the PHY such as channel center frequency and its offset, etc., and some part of MIB information such as software version information, etc.

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7.26.2.2.4 BS-CHU commences operation acknowledgment

The BS-CHU shall send a commence operation acknowledgment to the BS-CAM. The commence operation acknowledgment may include the specific BS-CHU MIB information that is needed by BS-CAM such as device ID or serial number of the BS-CHU, etc. The BS-CHU shall response with an error when the commence operation request is rejected due to reasons such as mismatch of the software version, etc.

7.26.2.2.5 BS-CAM sends management information notification to BS-CHU

The BS-CAM shall send a management information notification to the BS-CHU. The management information notification may mainly include the MIB information necessary for the BS-CHU and maintained by the BS-CAM such as the ID to identify the connection between BS and CPE (carrier index that is associated with the physical or logical channel), etc. If the BS-CHU has a part of the MAC layer function, then the information on MIB that is used by the MAC layer, such as Station ID, MAC Address of BS, etc., shall be included.

7.26.2.2.6 BS-CHU memorizes management information

The BS-CHU shall memorize the management information from the BS-CAM after the management information notification. Some part of the memorized information (MIB information) shall be immediately reflected on the BS-CHU or reflected as the initial value of the transition state.

7.26.2.2.7 BS-CHU performs frequency setting

The BS-CHU shall perform the frequency setting procedure. The channel center frequency and its offset that were received in the commence operation request or management information notification shall be reflected in the local oscillator of BS-CHU.

7.26.2.2.8 BS-CHU performs synchronization

The BS-CHU shall perform the BS-CHU synchronization procedure. On PHY-OM2, this procedure is intended for network synchronization to synchronize the frame and TDD timing of a number of A-BSs. Basically, this procedure shall synchronize the frame to the start of each minute of the UTC time. As a result, all the operating BS-CHUs shall be synchronized with each other.

7.26.2.2.9 BS-CHU sends operation preparation completed notification to BS-CAM

The BS-CHU shall send an operation preparation completed notification to the BS-CAM. The BS-CHU shall send a response indicating an error when it fails to complete the operation preparation procedure.

7.26.2.2.10 BS-CHU broadcasts A-FCH on PHY-OM2

The BS-CHU shall periodically broadcast a radio frame that includes the A-FCH information on PHY-OM2.

7.26.2.2.11 BS-CAM checks unused BS-CHU

The BS-CAM shall check whether there is any unused BS-CHU. If an unused BS-CHU exists, then the BS-CAM shall proceed to the select specific BS-CHU procedure.

7.26.2.2.12 CPE-CAM selects a specific CPE-CHU

The A-CPE channel allocation manager (CPE-CAM) shall select a specific A-CPE channel transceiver unit (CPE-CHU) that is a target of the add new operating channel operation. The CPE-CAM shall select the

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CPE-CHU that is in the state of unused or unassigned. In many cases, this procedure is triggered when the A-BS lost condition occurs in the ACPE where the CPE-CHU was selected.

7.26.2.2.13 CPE-CAM sends BS search command (All or specific channel) to the specific CPE-CHU

The CPE-CAM shall send an A-BS search command (all or specific channel) to the selected CPE-CHU. The A-BS search command (all or specific channel) shall be performed by searching all the frequency channels that correspond to the selected CPE-CHU or by searching one or more specific frequency channels. The specific channel information shall be indicated by using the extended DCD message or newly defined management message (add new operating channel) to specify the A-BS operating channels that are not connected by any A-CPE or shall be estimated based on the backup channel information. To prevent overlapping with the other CPE-CHU channel, the channel that the other CPE-CHU has already used shall not be searched. Moreover, the channel that the other A-BS has already used and that is identified by a previous BS search command, etc., shall not be searched. The previous A-BS search command is referring to the unsuccessful A-BS search command that did not received a proceed notification from the CPE-CAM due to the BSID mismatch.

7.26.2.2.14 CPE-CHU performs BS search

The CPE-CHU shall perform the BS search command by attempting to detect the radio signal (preamble and A-FCH on PHY-OM2) from the BS at the target frequency of the BS search command.

7.26.2.2.15 CPE-CHU sends BS detected notification to CPE-CAM

The CPE-CHU shall send an A-BS detected notification to the CPE-CAM when it is able to detect the signal strength greater than or equal to a predetermined value that is defined in the BS search procedure. The BS detected notification shall include the BSID, which is obtained by decoding the A-FCH on PHY-OM2.

7.26.2.2.16 CPE-CAM determines other operating CPE-CHU

The CPE-CAM shall determine whether there is any other operating CPE-CHU (connection status with BS). If there is no other operating CPE-CHU at that time, then it does not proceed to add new operating channel procedure (multi-channel operation). The CPE-CHU shall proceed to the synchronization process similarly to the conventional IEEE Std 802.22-2011.

7.26.2.2.17 CPE-CAM performs BSID matching

If another operating CPE-CHU is detected at that time, the CPE-CAM shall determine whether the BSID of the other operating CPE-CHU matches with the BSID obtained by the CPE-CHU during BS detected notification.

7.26.2.2.18 CPE-CAM sends BSID mismatch notification to CPE-CHU

If the BSID mismatch occurred, then the CPE-CAM shall send a BSID mismatch notification to the CPE-CHU, and the CPE-CHU shall resume its BS search process with the rest of the targeted frequency, or the BS-CAM shall send a specific target frequency of BS search command to the CPE-CHU.

7.26.2.2.19 CPE-CAM sends proceed notification to CPE-CHU

If the BSID match is confirmed, then the CPE-CAM shall send a proceed notification to the CPE-CHU to continue with the synchronization procedure.

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7.26.2.2.20 CPE-CHU performs synchronization

The CPE-CHU shall continue with the synchronization procedure with the frequency that is detected in A-FCH on PHY-OM2. In addition to the original synchronization procedure such as detecting and decoding the A-FCH, DS-MAP, etc., to obtain the parameters of the DS, this procedure shall include the reception of UCD message process to obtain the parameters of the US, the ranging process to adjust the TDD timing, etc.

7.26.2.2.21 CPE-CHU sends synchronization completed notification to CPE-CAM

As a response to the proceed notification procedure, the CPE-CHU shall send a synchronization completed notification to the CPE-CAM. By referring to these notifications, the CPE-CAM can recognize the multi-channel operation when two or more CPE-CHUs are connected with the BS.

7.26.2.2.22 CPE-CAM checks unused CPE-CHU

The CPE-CAM shall check whether there is any unused CPE-CHU. If the unused CPE-CHU exists, then the CPE-CAM shall proceed to the select specific CPE-CHU procedure.

7.26.2.2.23 CPE-CAM sends registration request to CPE management unit

The CPE-CAM shall send a registration request to the A-BS for A-CPE registration after completing the multi-channel operation capability. The registration request shall contain the information (carrier index, etc.) that can uniquely identify each channel used in the multi-channel operation. Some management messages may be exchanged only between the BS-CHU and CPE-CHU if necessary.

7.26.2.2.24 CPE management unit sends registration completed notification to CPE-CAM

The A-CPE management unit shall send a registration completed notification to the CPE-CAM.

7.26.2.3 Add new operating channel operation by using BS search command (specific channel)

7.26.2.3.1 General

As described in 7.26.2.2.13, the A-BS search command can be conducted in two modes (all or specific channel). In this subclause, the detailed operation flow for add new operating channel by using ABS search command in specific channel mode is shown. In this operation flow, the BS-CHU and CPE-CHU shall have at least one operating channel to enable the exchange of management messages between the A-BS and A-CPE.

The operation flow for add new operating channel by using BS search command in specific channel mode shall consist of the following steps:

a) BS-CAM sends aggregation information to BS-CHU1.
b) BS-CHU1 forwards aggregation information to CPE-CHU1.
c) CPE-CHU1 forwards aggregation information to CPE-CAM.
d) BS-CAM selects a specific BS-CHU.
e) BS-CAM commences operation request.
f) BS-CHUn commences operation acknowledgment.
g) BS-CAM sends management information notification to BS-CHUn.
h) BS-CHUn memorizes management information.

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i) BS-CHUn performs frequency setting.
j) BS-CHUn performs synchronization.
k) BS-CHUn sends operation preparation completed notification to BS-CAM.
l) BS-CHUn broadcasts A-FCH on PHY-OM2.
m) BS-CAM checks unused BS-CHU.
n) CPE-CAM selects a specific CPE-CHU.
o) CPE-CAM sends BS search command (specific channel) to the specific CPE-CHUn.
p) CPE-CHUn performs BS search.
q) CPE-CHUn sends BS detected notification to CPE-CAM.
r) CPE-CAM determines other operating CPE-CHU.
s) CPE-CAM performs BSID matching.
t) CPE-CAM sends BSID mismatch notification to CPE-CHUn.
u) CPE-CAM sends proceed notification to CPE-CHUn.
v) CPE-CHUn performs synchronization.
w) CPE-CHUn sends synchronization completed notification to CPE-CAM.
x) CPE-CAM checks unused CPE-CHU.
y) CPE-CAM sends registration request to CPE management unit.
z) CPE management unit sends registration completed notification to CPE-CAM.

The operation flow for add new operating channel by using BS search command (specific channel) is shown in Figure 153.

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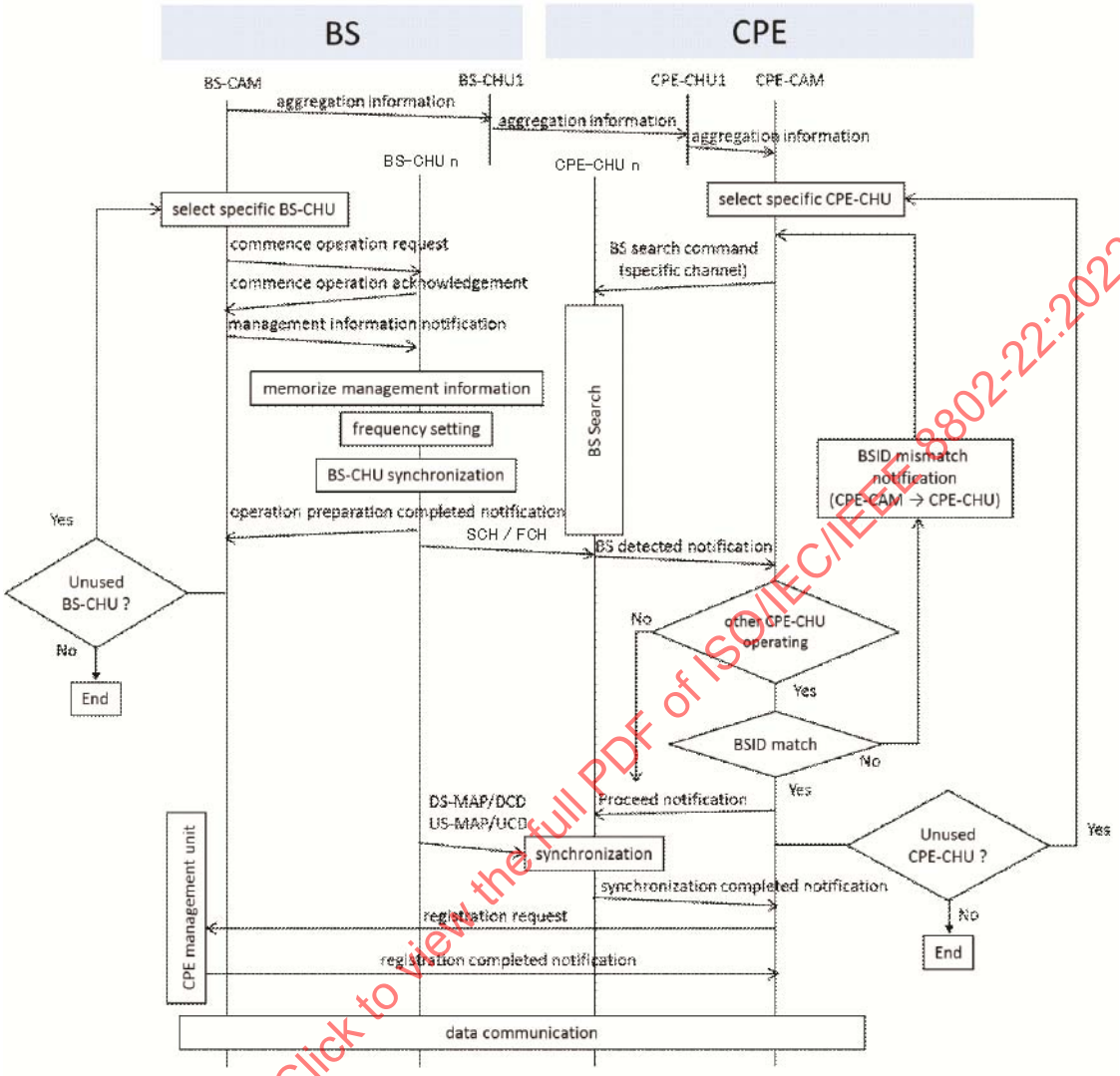

Figure 153—Operation flow for adding new operating channel by using BS search command (specific channel)

7.26.2.3.2 BS-CAM sends aggregation information to BS-CHU1

The BS-CAM shall send the aggregation information (7.9.29.2) to the operating BS-CHU1 periodically during multi-channel operation and the time at which to start a multi-channel operation.

7.26.2.3.3 BS-CHU1 forwards aggregation information to CPE-CHU1

The BS-CHU1 shall forward the aggregation information to the CPE-CHU1 after receiving the information from BS-CAM.

7.26.2.3.4 CPE-CHU1 forwards aggregation information to CPE-CAM

The CPE-CHU1 shall forward the aggregation information to the CPE-CAM after receiving the information from BS-CHU1. The aggregation information shall be designed as a newly defined management message

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from BS-CAM. The details of the management message CAM-ADD are described in 7.9.29.2. The BS-CHU1 and CPE-CHU1 do not need to understand the content of the message when performing the forwarding process.

7.26.2.3.5 BS-CAM selects a specific BS-CHU

The BS-CAM shall select a specific BS-CHU that is the target of the add new operating channel operation. The BS-CAM shall select the BS-CHU that is in the state of unused or unassigned currently and whose hardware corresponds to the new operating channel's frequency. The operating channel selection procedure may be included in this step.

7.26.2.3.6 BS-CAM commences operation request

The BS-CAM shall send a commence operation request to the selected BS-CHU. The commence operation request may include the various parameters in connection with the PHY such as channel center frequency and its offset, etc., and some part of MIB information such as software version information, etc.

7.26.2.3.7 BS-CHUn commences operation acknowledgment

The BS-CHU shall send a commence operation acknowledgment to the BS-CAM. The commence operation acknowledgment may include the specific BS-CHU MIB information that is needed by the BS-CAM such as device ID or serial number of the BS-CHU, etc. The BS-CHU shall response with an error when the commence operation request is rejected due to reasons such as mismatch of the software version, etc.

7.26.2.3.8 BS-CAM sends management information notification to BS-CHUn

The BS-CAM shall send a management information notification to the BS-CHU. The management information notification may mainly include the MIB information necessary for the BS-CHU and maintained by the BS-CAM such as the ID to identify the connection between A-BS and A-CPE (carrier index that is associated with the physical or logical channel), etc. If the BS-CHU has a part of the MAC layer function, then the information on MIB that is used by the MAC layer, such as Station ID, MAC Address of A-BS, etc., shall be included.

7.26.2.3.9 BS-CHUn memorizes management information

The BS-CHU shall memorize the management information from the BS-CAM after the management information notification. Some part of the memorized information (MIB information) shall be immediately reflected on the BS-CHU or reflected as the initial value of the transition state.

7.26.2.3.10 BS-CHUn performs frequency setting

The BS-CHU shall perform the frequency setting procedure. The channel center frequency and its offset that were received in the commence operation request or management information notification shall be reflected in the local oscillator of BS-CHU.

7.26.2.3.11 BS-CHUn performs synchronization

The BS-CHU shall perform the BS-CHU synchronization procedure. This procedure is intended for network synchronization to synchronize the superframe, frame, and TDD timing of a number of A-BS in a wireless communication system. Basically, this procedure shall synchronize the superframe to the start of each minute of the UTC time obtained from a global navigation system such as GPS. As a result, all the operating BS-CHUs shall be synchronized with each other.

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7.26.2.3.12 BS-CHUn sends operation preparation completed notification to BS-CAM

The BS-CHU shall send an operation preparation completed notification to the BS-CAM. The BS-CHU shall send a response indicating an error when it fails to complete the operation preparation procedure.

7.26.2.3.13 BS-CHUn broadcasts A-FCH on PHY-OM2

The BS-CHU shall periodically broadcast a radio frame that includes the A-FCH on PHY-OM2.

7.26.2.3.14 BS-CAM checks unused BS-CHU

The BS-CAM shall check whether there is any unused BS-CHU. If an unused BS-CHU exists, then the BS-CAM shall proceed to the select specific BS-CHU procedure.

7.26.2.3.15 CPE-CAM selects a specific CPE-CHU

The CPE-CAM shall select a specific CPE-CHU that is a target of the add new operating channel operation. The CPE-CAM shall select the CPE-CHU that is in the state of unused or unassigned. In many cases, this procedure is triggered when the BS lost condition occurs in the CPE where the CPE-CHU was selected.

7.26.2.3.16 CPE-CAM sends A-BS search command (specific channel) to the specific CPE-CHUn

The CPE-CAM shall send a A-BS search command (specific channel) to the selected CPE-CHU. The A-BS search command (specific channel) shall be performed by searching one or more specific frequency channels. The specific channel information shall be indicated by using the extended DCD message or newly defined management message (7.9.29.2) to specify the A-BS operating channels that are not connected by any A-CPE or shall be estimated based on the backup channel information. To prevent overlapping with the other CPE-CHU channel, the channel that the other CPE-CHU has already used shall not be searched. Moreover, the channel that the other A-BS has already used and that is identified by a previous A-BS search command, etc., shall not be searched.

7.26.2.3.17 CPE-CHUn performs BS search

The CPE-CHU shall perform the A-BS search command by attempting to detect the radio signal (preamble and A-FCH on PHY-OM2) from the BS at the target frequency of the A-BS search command.

7.26.2.3.18 CPE-CHUn sends A-BS detected notification to CPE-CAM

The CPE-CHU shall send a A-BS detected notification to the CPE-CAM when it is able to detect the signal strength greater than or equal to a predetermined value that is defined in the BS search procedure. The A-BS detected notification shall include the BSID, which is obtained by decoding the A-FCH information on PHY-OM2.

7.26.2.3.19 CPE-CAM determines other operating CPE-CHU

The CPE-CAM shall determine whether there is any other operating CPE-CHU (connection status with A-BS). If there is no other operating CPE-CHU at that time, then it does not proceed to add new operating channel procedure (multi-channel operation). The CPE-CHU shall proceed to the synchronization process similarly to the conventional IEEE Std 802.22-2011.

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7.26.2.3.20 CPE-CAM performs BSID matching

If another operating CPE-CHU is detected at that time, the CPE-CAM shall determine whether the BSID of the other operating CPE-CHU matches with the BSID obtained by the CPE-CHU during A-BS detected notification.

7.26.2.3.21 CPE-CAM sends BSID mismatch notification to CPE-CHUn

If the BSID mismatch occurred, then the BS-CAM shall send a BSID mismatch notification to the CPE-CHU. Then the CPE-CHU shall resume its BS search process with the rest of the targeted frequency, or the BS-CAM shall send a specific target frequency of BS search command to the CPE-CHU.

7.26.2.3.22 CPE-CAM sends proceed notification to CPE-CHUn

If the BSID match is confirmed, then the CPE-CAM shall send a proceed notification to the CPE-CHU to continue with the synchronization procedure.

7.26.2.3.23 CPE-CHUn performs synchronization

The CPE-CHU shall continue with the synchronization procedure with the frequency that is detected in A-FCH on PHY-OM2. In addition to the original synchronization procedure such as detecting and decoding the A-FCH, DS-MAP, etc., to obtain the parameters of the DS, this procedure shall include the reception of UCD message process to obtain the parameters of the US, the ranging process to adjust the TDD timing, etc.

7.26.2.3.24 CPE-CHUn sends synchronization completed notification to CPE-CAM

As a response to the proceed notification procedure, the CPE-CHU shall send a synchronization completed notification to the CPE-CAM. By referring to these notifications, the CPE-CAM can recognize the multi-channel operation when two or more CPE-CHUs are connected with the A-BS.

7.26.2.3.25 CPE-CAM checks unused CPE-CHU

The CPE-CAM shall check whether there is any unused CPE-CHU. If the unused CPE-CHU exists, then the CPE-CAM shall proceed to the select specific CPE-CHU procedure.

7.26.2.3.26 CPE-CAM sends registration request to CPE management unit

The CPE-CAM shall send a registration request to the A-BS for CPE registration after completing the multi-channel operation capability. The registration request shall contain the information (carrier index, etc.) that can uniquely identify each channel used in the multi-channel operation. Some management messages may be exchanged only between the BS-CHU and CPE-CHU if necessary.

7.26.2.3.27 CPE management unit sends registration completed notification to CPE-CAM

The CPE management unit shall send a registration completed notification to the CPE-CAM.

7.26.2.4 Stop operating channel operation

7.26.2.4.1 General

When the BS is operating under the multi-channel operation, the following procedure of stop operating channel is performed on both the A-BS and A-CPE to stop the operating channel that is requested by the A-BS.

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The stop operating channel operation procedure shall consist of the following steps:

a) BS-CAM sends stop operation request to BS-CHU.

b) BS-CHU starts stop operation timer.

c) BS-CHU sends stop operation request acknowledgment to BS-CAM

d) BS-CHU sends stop operation request to CPE-CHU.

e) CPE-CHU starts stop operation timer.

f) CPE-CHU sends stop operation notification to CPE-CAM.

g) CPE-CAM sends stop operation approval/command to CPE-CHU.

h) CPE-CHU sends stop operation request acknowledgment to BS-CHU.

i) CPE-CHU checks stop operation timer expired and stops operation.

j) CPE-CHU sends stop operation completed notification to CPE-CAM.

k) BS-CHU checks stop operation timer expired and stops operation.

l) BS-CHU sends stop operation completed notification to CPE management unit.

The stop operating channel operation flow is shown in Figure 154.

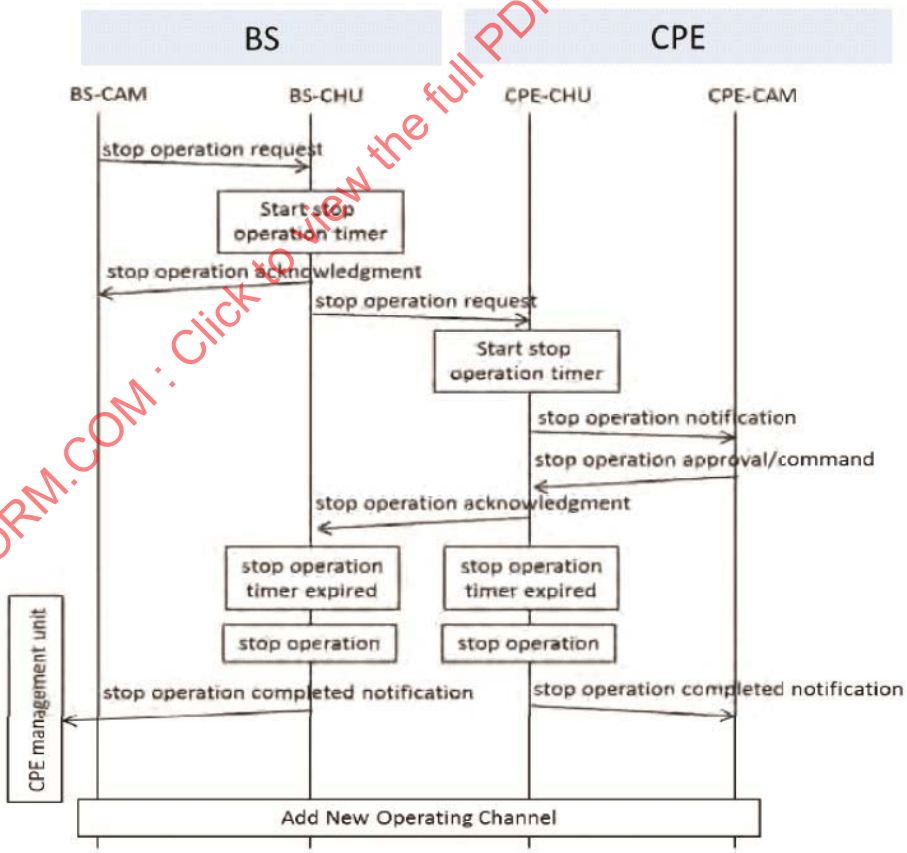

Figure 154—Operation flow for stopping operating channel

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7.26.2.4.2 BS-CAM sends stop operation request to BS-CHU

The BS-CAM shall send the stop operation request to the BS-CHU that is the target of the stop operating channel operation.

7.26.2.4.3 BS-CHU starts stop operation timer

The BS-CHU shall start the stop operation timer (T66) after receiving the stop operation request from the BS-CAM. The start of the stop operation timer shall determine the frame number where the operation is scheduled to stop.

7.26.2.4.4 BS-CHU sends stop operation request acknowledgment to BS-CAM

The BS-CHU shall send the stop operation request acknowledgment to the BS-CAM.

7.26.2.4.5 BS-CHU sends stop operation request to CPE-CHU

The BS-CHU shall send the stop operation request to the CPE-CHU by using the DS transmission. The stop operation request can be sent as a newly defined management message. The details of the management message CAM-STP are described in 7.26.2.4.

7.26.2.4.6 CPE-CHU starts stop operation timer

Based on the information that specifies the target of the stop operation channel, which can be obtained after receiving the stop operation request from the BS-CHU, the CPE-CHU shall confirm the target channel of the request. If the request is addressed to the CPE-CHU, then the CPE-CHU shall start the stop operation timer.

7.26.2.4.7 CPE-CHU sends stop operation notification to CPE-CAM

The CPE-CHU shall send the stop operation notification to the CPE-CAM.

7.26.2.4.8 CPE-CAM sends stop operation approval/command to CPE-CHU

The CPE-CAM shall send the stop operation approval/command to the CPE-CHU after the CPE-CAM is notified that the channel operation of the CPE-CHU will be stopped.

7.26.2.4.9 CPE-CHU sends stop operation request acknowledgment to BS-CHU

The CPE-CHU shall send the stop operation request acknowledgment to the BS-CHU after receiving the stop operation approval/command from the CPE-CAM. The stop operation acknowledgment can be sent as a newly defined management message through the US transmission. The details of the management message CAM-STP are described in 7.26.2.4.

7.26.2.4.10 CPE-CHU checks stop operation timer expired and stops operation

The CPE-CHU shall stop the operation when the stop operation timer expires, i.e., it has reached the frame number that was set during the set stop operation timer procedure. The CPE-CHU shall stop all transmission and reception after the stop operation procedure is performed.

7.26.2.4.11 CPE-CHU sends stop operation completed notification to CPE-CAM

The CPE-CHU shall send the stop operation completed notification to the CPE-CAM after completing the stop operation procedure.

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7.26.2.4.12 BS-CHU checks stop operation timer expired and stops operation

The BS-CHU shall stop the operation when the stop operation timer expires and stop all the transmission and reception after the stop operation procedure is performed.

7.26.2.4.13 BS-CHU sends stop operation completed notification to A-CPE management unit

The BS-CHU shall send the stop operation completed notification to the BS-CAM and A-CPE management unit after completing the stop operation procedure. The BS-CHU and CPE-CHU that have stopped their operation will be the target CHUs for the add new operating channel procedure.

7.26.2.5 Switch operating channel operation

7.26.2.5.1 General

When the BS is operating under the multi-channel operation, the following procedure of switch operating channel is performed on both the A-BS and A-CPE to switch the operating channel that is requested by the A-BS.

The switch operating channel operation procedure shall consist of the following steps:

a) BS-CAM sends channel switch request to BS-CHU.

b) BS-CHU starts channel switch timer.

c) BS-CHU sends channel switch request acknowledgment to BS-CAM.

d) BS-CHU sends channel switch request to CPE-CHU.

e) CPE-CHU starts channel switch timer.

f) CPE-CHU sends channel switch notification to CPE-CAM.

g) CPE-CAM sends channel switch approval/command to CPE-CHU.

h) CPE-CHU sends channel switch request acknowledgment to BS-CHU.

i) BS-CHU checks channel switch timer expired and performs channel switch.

j) CPE-CHU checks channel switch timer expired and performs channel switch.

k) BS-CHU sends channel switch completed notification to BS-CAM.

l) BS-CHU broadcasts A-FCH on PHY-OM2.

m) BS-CHU sends DS-MAP/DCD/US-MAP/UCD to CPE-CHU.

n) CPE-CHU sends channel switch completed notification to CPE-CAM.

o) CPE-CHU sends channel switch completed notification to CPE management unit.

The switch operating channel operation flow is shown in Figure 155.

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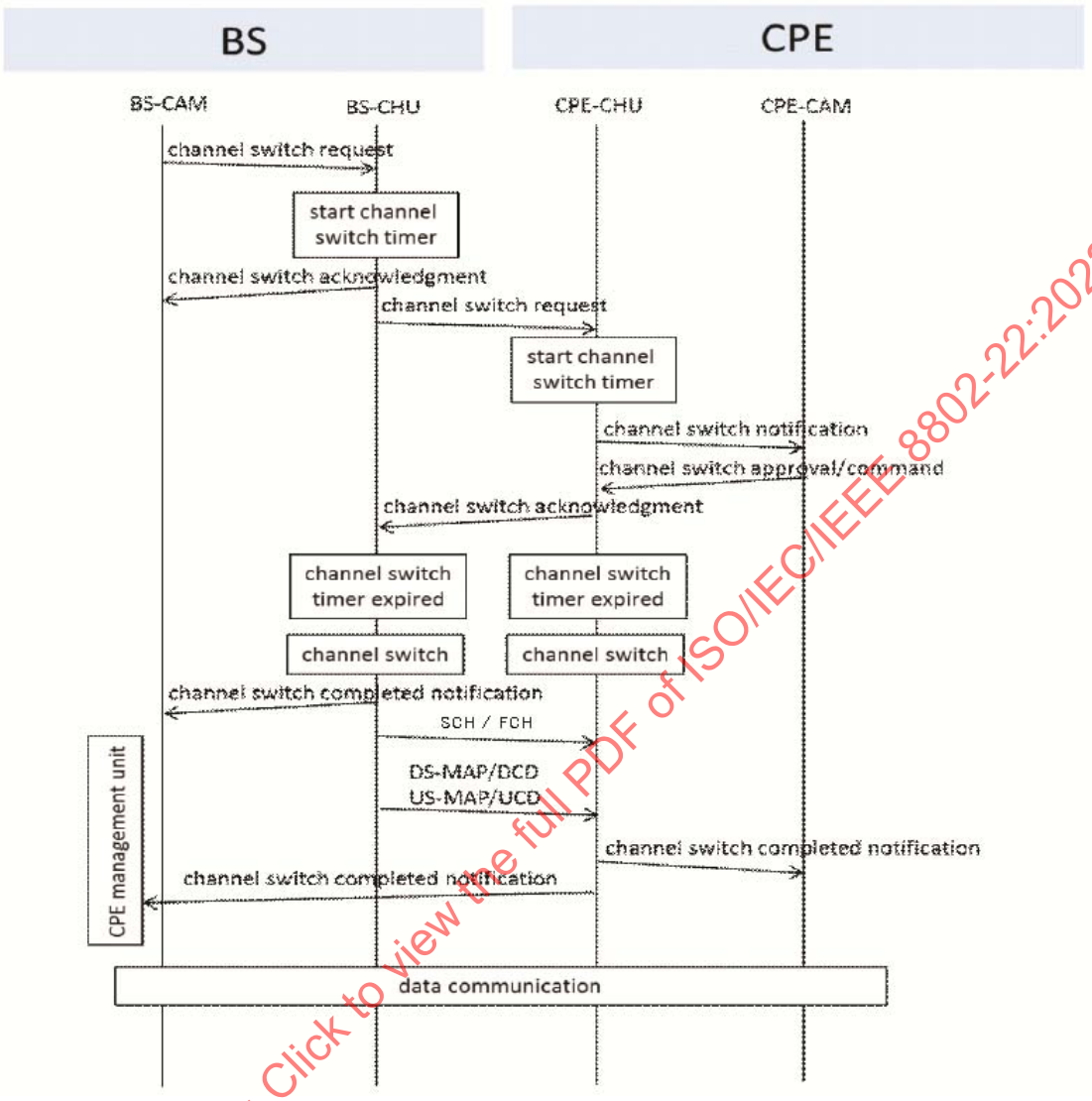

Figure 155—Operation flow for switching operating channel

7.26.2.5.2 BS-CAM sends channel switch request to BS-CHU

The BS-CAM shall send the channel switch request to the BS-CHU that is the target of the switch operating channel operation. The BS-CHU shall correspond to the requested switch operating channel's frequency.

7.26.2.5.3 BS-CHU starts channel switch timer

The BS-CHU shall start the channel switch timer (T67) after receiving the channel switch request from the BS-CAM. The start of the channel switch timer shall determine the frame number where the new operating channel is scheduled to switch.

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7.26.2.5.4 BS-CHU sends channel switch request acknowledgment to BS-CAM

The BS-CHU may send the channel switch request acknowledgment to the BS-CAM after the BS-CHU sent the channel switch request to the CPE-CHU as described in 7.26.2.5.5 for shortening the channel switch time.

7.26.2.5.5 BS-CHU sends channel switch request to CPE-CHU

The BS-CHU shall send the channel switch request to the CPE-CHU by using the DS transmission. The channel switch request can be sent as a newly defined management message. The details of the management message CAM-SWH are described in 7.26.2.5. The management message shall be broadcast to all the A-CPEs, and the A-CPEs shall be able to receive and interpret the content of the management message.

7.26.2.5.6 CPE-CHU starts channel switch timer

The CPE-CHU shall start the channel switch timer after receiving the channel switch request from the BS-CHU.

7.26.2.5.7 CPE-CHU sends channel switch notification to CPE-CAM

The CPE-CHU shall send the channel switch notification to the CPE-CAM in order to acquire channel switch approval/command from the CPE-CAM.

7.26.2.5.8 CPE-CAM sends channel switch approval/command to CPE-CHU

The CPE-CAM shall send the channel switch approval/command to the CPE-CHU after the CPE-CAM is notified that the operating channel of the CPE-CHU will be switched.

7.26.2.5.9 CPE-CHU sends channel switch request acknowledgment to BS-CHU

The CPE-CHU shall send the channel switch request acknowledgment to the BS-CHU after receiving the channel switch approval/command from the CPE-CAM. The channel switch request acknowledgment can be sent as a newly defined management message through the US transmission. The details of the management message CAM-SWH are described in 7.26.2.5.

7.26.2.5.10 BS-CHU checks channel switch timer expired and performs channel switch

The BS-CHU shall switch to a new operating channel when the channel switch timer expires. The channel switch timer expires when it has reached the frame number that was set during the start channel switch timer procedure. The BS-CHU shall modify the operating parameters within the RTG period and shall change the frequency of the local oscillator in order to switch to a new operating channel. In most cases, a channel switch is performed because terminating the current operating channel is necessary; therefore, a channel switch is enforced even if the channel switch acknowledgment is not received from either one of the A-CPEs.

7.26.2.5.11 CPE-CHU checks channel switch timer expired and performs channel switch

The CPE-CHU shall switch to a new operating channel when the channel switch timer expires.

7.26.2.5.12 BS-CHU sends channel switch completed notification to BS-CAM

The BS-CHU shall send the channel switch completed notification to the BS-CAM after completing the channel switch procedure. This shall indicate that the channel switch procedure at the PHY of BS-CHU is completed (such as the frequency of the local oscillator of BS-CHU is locked to the new channel).

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7.26.2.5.13 BS-CHU broadcasts A-FCH on PHY-OM2

The BS-CHU shall broadcast a radio frame that includes the A-FCH on PHY-OM2.

7.26.2.5.14 BS-CHU sends DS-MAP/DCD/US-MAP/UCD to CPE-CHU

The BS-CHU shall send the DS-MAP/DCD/US-MAP/UCD information to CPE-CHU for the synchronization procedure.

7.26.2.5.15 CPE-CHU sends channel switch completed notification to CPE-CAM

The CPE-CHU shall send the channel switch completed notification to the CPE-CAM when the frame containing A-FCH on PHY-OM2, etc., is received correctly. The channel switch completion notification shall indicate that the channel switch has been completed at the MAC layer.

7.26.2.5.16 CPE-CHU sends channel switch completed notification to A-CPE management unit

The CPE-CHU shall send the channel switch completed notification to the CPE management unit. The channel switch completed notification can be sent as a newly defined management message through the US transmission. The details of the management message CAM-SWH are described in 7.26.2.5. Upon receiving the management message, the A-CPE management unit in A-BS shall update the latest information of the A-CPEs.

7.26.3 Multi-channel operation at A-BS

This subclause explains the operation flow of the A-BS's channel allocation manager (BS-CAM) for commencing the multi-channel operation. The operation flow of commencing multi-channel operation at A-BS is shown in Figure 156. In order to perform the multi-channel allocation necessary for multi-channel operation, three basic functions, which are add new operating channel, stop operating channel, and switch operating channel, are defined. The detailed explanation of each function and its operation flow are described in 7.26.2.2, 7.26.2.4, and 7.26.2.5.

In commencing multi-channel operation at the A-BS, the BS-CAM shall play the key role to decide the operating channel and determine the implementation of one of the three basic functions as shown in Figure 156. The triggers for the BS-CAM to decide the operating channel are database access, BS sensing report, CPE sensing report, and BS channel scheduling. The database access trigger shall refer to the database access result that concluded there are changes in the available operating channels after accessing the whitespace database by the database access control in BS. The BS sensing report and CPE sensing report shall refer to the sensing report that concluded there are changes in the available operating channels after performing the sensing process. These are triggers caused by the changes in the available operating channels. The BS channel scheduling is when a particular operating channel is available under specific time scheduling by the BS.

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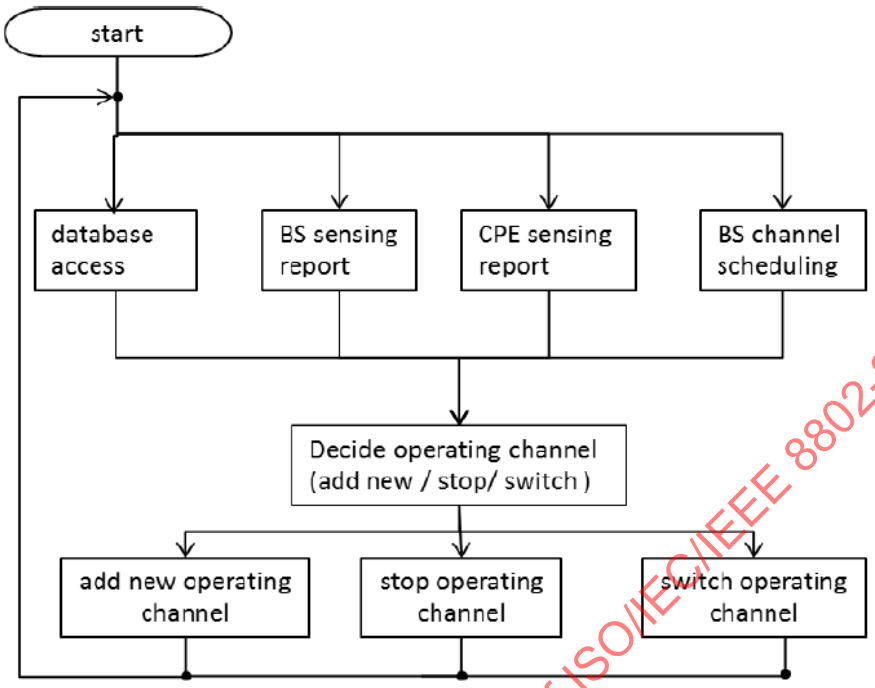

Figure 156—Operation flow of commence multi-channel operation at A-BS

7.26.4 Multi-channel operation at A-CPE

This subclause explains the operation flow of the A-CPE's channel allocation manager (CPE-CAM) for commencing the multi-channel operation. The operation flow of commencing multi-channel operation at A-CPE is shown in Figure 157. In order to perform the multi-channel allocation necessary for multi-channel operation, the CPE-CAM also possesses three basic functions, which are add new operating channel, stop operating channel, and switch operating channel. The detailed explanation of each function and its operation flow are described in 7.26.2.2, 7.26.2.4, and 7.26.2.5.

In commencing multi-channel operation at A-CPE, most of the triggers of the CPE-CAM operation result from the A-BS control messages. The triggers for the CPE-CAM to commence the multi-channel operation are BS control message, A-CPE incumbent sensing report, A-CPE channel scheduling, and the BS lost message. The BS control message includes the switch operating channel and stop operating channel control messages. When the CPE-CAM receives the switch operating channel control message from the BS, it shall proceed to the switch operating channel procedure and switch to the operating channel as stated in the switch operating channel control message. When the CPE-CAM received the stop operating channel control message from the A-BS, it shall proceed to the stop operating channel procedure and stop the operating channel as stated in the stop operating channel control message. When the A-CPE incumbent sensing report shows the detection of incumbent or when the CPE channel scheduling is scheduled to stop the operating channel, the CPE-CAM shall proceed to the stop operating channel procedure as well. The BS lost message, which indicates the lost connection between a CPE-CHU and a A-BS, or the A-CPE channel scheduling for adding a new operating channel shall proceed to the add new operating channel procedure.

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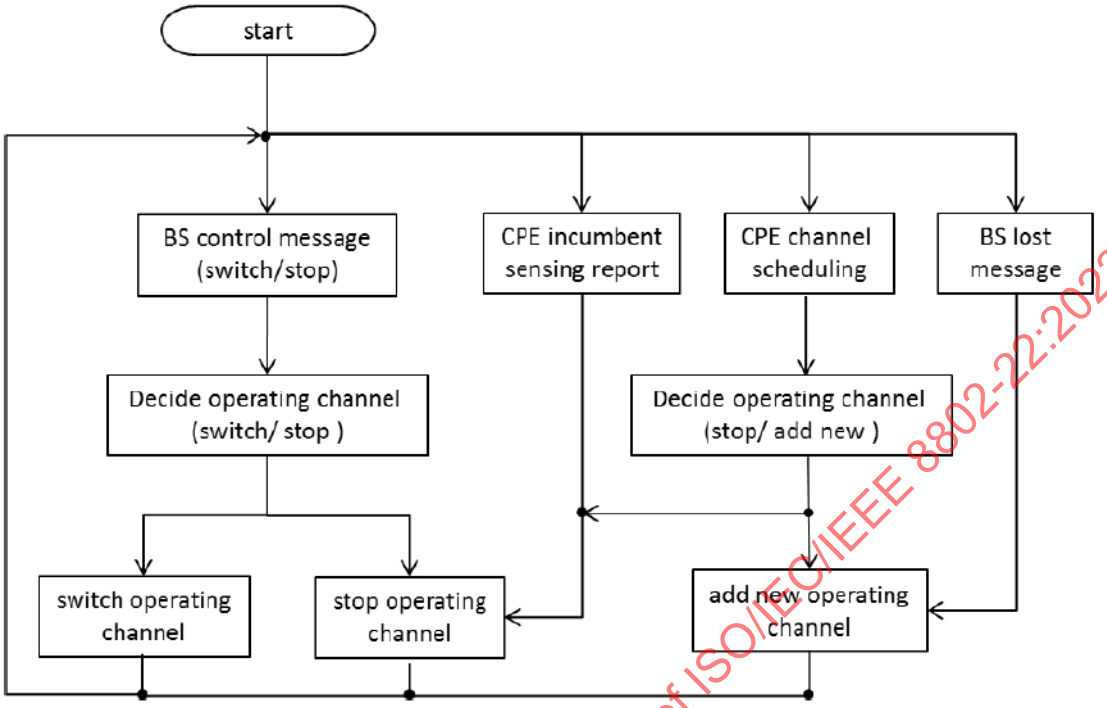

Figure 157—Operation flow for commence multi-channel operation at A-CPE

7.27 Group Resource Allocation on PHY-OM2

A large number of A-CPEs may be connected to the A-BS. Among them, some A-CPEs have similar traffic patterns, such as payload size, traffic period, and data rate (PHY MCS mode), etc. It is a burden of MAP overhead to allocate the resources to all A-CPEs individually. The Group Resource Allocation (GRA) is very efficient for a group of A-CPEs communicating using a same PHY MCS mode and with a fixed payload size. The MAP overhead is significantly reduced by allocating the resources to the group using bitmap format.

The group is composed of one R-CPE and many A-CPEs. Within the group, R-CPE is a controller of a group consisting of many A-CPEs. The R-CPE capabilities include access to the database services, identification of the group, network entry with A-BS, etc. All the A-CPEs within the group are synchronized to the R-CPE.

There are two types of group: fixed group and mobile (or portable) group. The type of group is determined according to the mobility of R-CPE. The R-CPE within a fixed group is fixed on the building, house, tower, etc. The R-CPE within a mobile (or portable) group is mobile (or portable) on the vehicles, etc.

The A-BS configures the group resource allocation by using the Group Resource Allocation Configuration (GRA-CFG) message, as shown in Table 218. The A-BS creates a new group, identifies the devices that belong to the group, and allocates the resources on a group basis. The GRA-CFG message includes the characteristics of the group, such as Device Bitmap Size, Bitmap of Station ID, Group ID, Group Type, and Group Location. The group resource allocation configuration can be updated using the Group Resource Allocation Update (GRA-UPD) message, as shown in Table 219. The A-BS uses a GRA-UPD message to add a device to a group or delete a device from a group. The A-BS also uses a GRA-UPD message to update the location of group. The DS/US-MAP message defines the access to the DS/US resources, as shown in Table 31 and Table 45, respectively. The format of a DS/US-MAP IEs is defined for the Individual

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Resource Allocation (IRA), as shown in Table 26 and Table 35, respectively. And the format of a DS/US-MAP GRA IEs is defined for the Group Resource Allocation (GRA), as shown in Table 41 and Table 57, respectively.

The backup and candidate channels can also be updated on a group basis using Backup and Candidate Channel List IE, as shown in Table 29a. When Group Flag is set to 1, the backup and candidate channels are used locally within a group. Otherwise, when Group Flag is set to 0, the backup and candidate channels are used globally within a cell. The backup and candidate channels are selected using the mobility and the location of R-CPE. The same channel is selected as the backup (or candidate) channel between the fixed groups. But if the groups could overlap, the backup (or candidate) channel shall be different to avoid interference among groups. On the other hand, different channels are selected as the backup (or candidate) channel between the fixed and the mobile group or between the mobile groups. But if the groups could not overlap, the backup (or candidate) channel could be same for frequency reuse. The backup and candidate channel list of each group shall be updated according to the periodic monitoring, which checks whether the groups could overlap each other or a new group appears. Therefore, when a mobile group moves into other group, or when a new group or incumbent user appears within a cell, the A-BS and A-CPEs can reduce the signaling overhead and can prevent QoS degradation by avoiding frequent channel switching.

Figure 158 shows an example of how the backup channel is selected. There are three fixed groups and a single mobile group. The R-CPE of the fixed groups is installed at the fixed object, such as a farmhouse, building, tower, etc. The R-CPE of the mobile group is installed at the mobile or portable object, such as a car, train, ship, etc. In a relationship between group 1 and group 2, there are two fixed groups, which are overlapping each other; thus the A-BS may allocate different backup channels, for example, backup channel #2 and backup channel #3, to group 1 and group 2, respectively. In a relationship between group 1 and group 3, there are two fixed groups, which are not overlapping each other; thus the A-BS may allocate the same backup channel, for example, backup channel #2, to both group 1 and group 3. In a relationship between group 3 and group 4, there are fixed and mobile groups, which are overlapping each other; thus the A-BS may allocate different backup channels, for example, backup channel #2 and backup channel #3, to group 3 and group 4, respectively. In a relationship between group 2 and group 4, there are fixed and mobile groups, which are not overlapping each other; thus the A-BS may allocate the same backup channel, for example, backup channel #3, to both group 2 and group 4.

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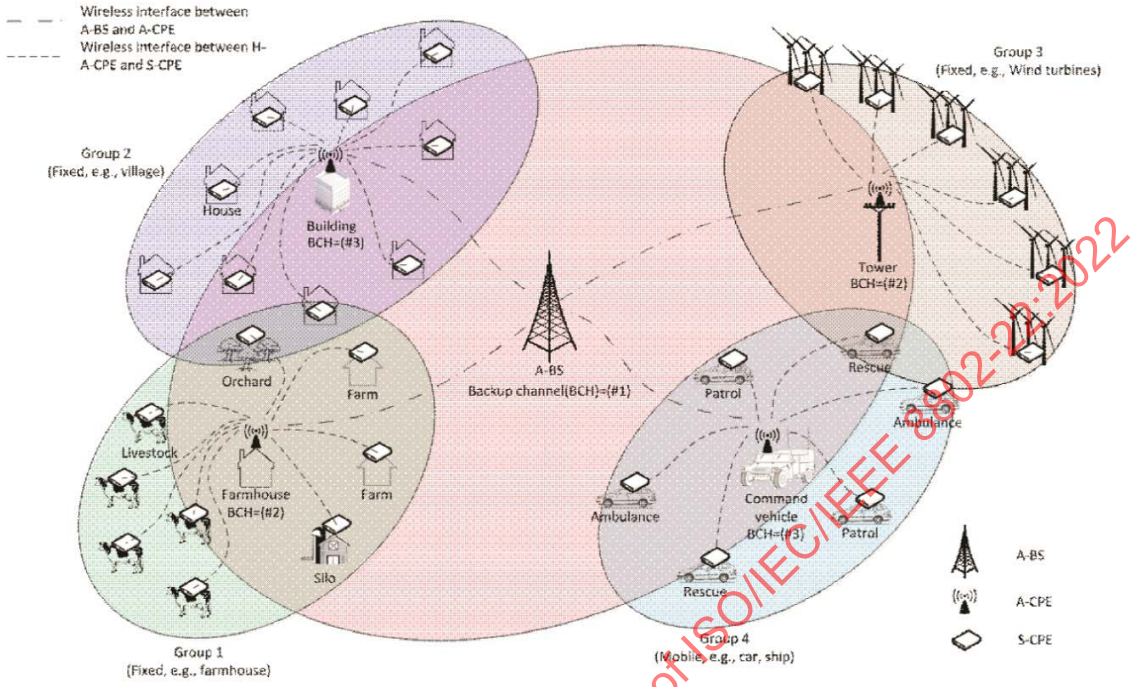

Figure 158—Example of backup channel selection

Figure 159 shows an example of how the backup channel is decided. When any idle backup channels are not being allocated to other groups, the A-BS allocates the idle backup channels to the target group (1). When there are no idle backup channels to be allocated, the A-BS may first check if any backup channels are allocated to a fixed group. When any backup channels are being allocated to fixed groups, and the target group and fixed group do not overlap, the A-BS allocates the backup channels allocated to the fixed group, to the target group (2). A presence of a backup channel allocated to the fixed group may be first checked since a burden of changing the backup channels may exist when a state of a backup channel being currently allocated to a mobile group is changed to an unavailable backup channel, due to mobility of the mobile group, although it is determined that the allocated backup channel is available. When no backup channels are being allocated to fixed groups, or when any backup channels are being allocated to fixed groups but the target group and the fixed group overlap, the A-BS may check if any backup channels are allocated to a mobile group. When backup channels are being allocated to mobile groups, and the target group and the mobile group do not overlap, the A-BS allocates the backup channels allocated to the mobile group (3). Although backup channels are being allocated to the mobile group, but the mobile group and the target group also overlap, the A-BS allocates the backup channels allocated to the fixed group or the mobile group (4). When also no backup channels are being allocated to mobile groups, the A-BS allocates the backup channels allocated to the A-BS, to the target group (5). When at least two overlapping groups share the backup channels or when the A-BS and some groups share the backup channels, the A-BS may use a mechanism for proper resources sharing between the overlapping groups or the A-BS and some groups after channel switching.

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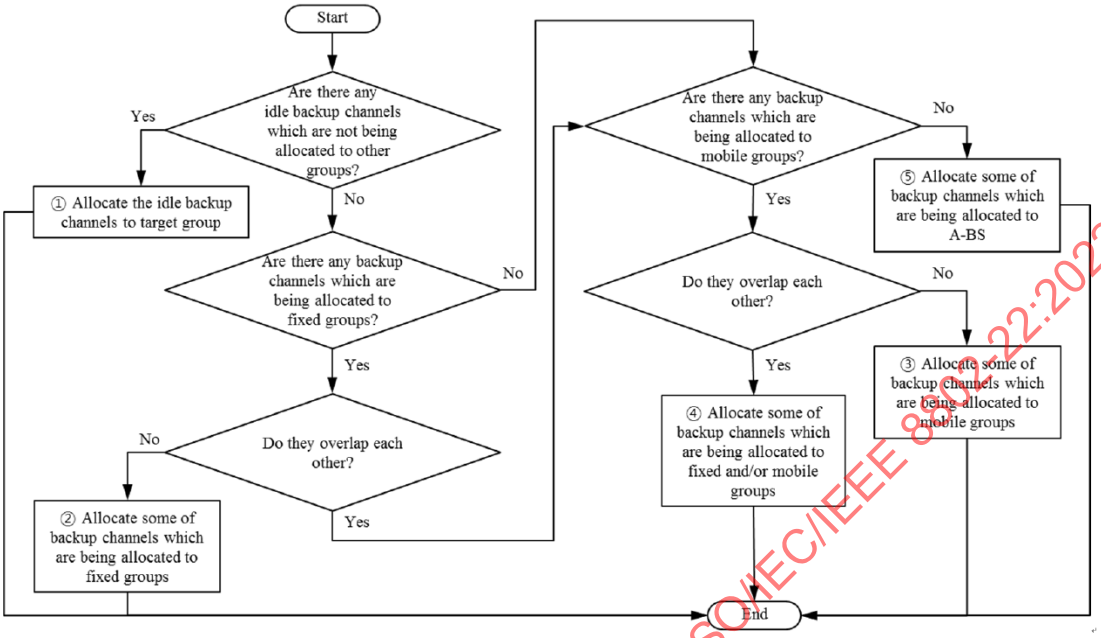

Figure 159—Example of backup channel decision

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8. Security mechanism in IEEE 802.22

Security features defined in this clause provide protection for the IEEE 802.22 users, service providers, and most importantly, the incumbents, who are the primary users of the spectrum. As a result, the protection mechanisms in IEEE 802.22 are divided into two security sublayers that target non-cognitive as well as cognitive functionality of the system and the interactions between the two. This clause does not discuss methods to protect the access to the IEEE 802.22 system and the ability to configure it. Required methods for protecting the hardware and software running on BSs and CPEs are discussed in Clause 12.

The security sublayer 1 provides subscribers with authentication, or confidentiality for user data and MAC management messages transmitted across the broadband wireless network. It does this by applying cryptographic transforms to MAC PDUs carried across connections between CPE and BS. In addition, these security sublayers provide operators with strong protection from theft of service.

The security sublayers employ an authenticated client/server key management protocol in which the BS operator controls distribution of keying material to client CPE. This material is used to protect MAC management messages, and may be optionally used to protect user data. The basic security mechanisms are strengthened by adding EAP-based CPE device authentication to the key management protocol.

All CPEs attempting access to the network shall be authenticated. If the authentication exchange is successfully completed, the BS shall consider the CPE to be authenticated, and proceed to authorize (via registration, see 7.16.2.11) the CPE to access the network. If the authentication exchange is not successfully completed, the BS shall deny the CPE access (via de-registering the CPE, see 7.16.2.11) to the network. In this case, the CPE may attempt access on one of the other WRAN services it detected during initialization (see 7.16.2). If during authentication exchange, the CPE specifies that it does not support IEEE 802.22 security for protection of user data, then after successful completion of authentication, the key exchange used to setup protection of user data shall be skipped.

In cognitive radio systems, confidentiality and privacy mechanisms need to protect data and sensitive spectrum occupancy information from the competitors, as well as the spectrum management information used by the BS to configure the operation of the CPEs. The standard attempts to protect against unauthorized access to these data transport services by securing the associated service flows over the air.

To enhance the security for the cognitive functionality in IEEE 802.22, security sublayer 2 is introduced. The security mechanisms validate the availability of spectrum for the primary and the secondary users by employing mechanisms such as distributed sensing and decision making. This includes authentication of the incumbent sensing information to avoid Denial of Service (DoS) attacks, authentication of the IEEE 802.22.1 beacon frame utilizing the security features that are already embedded in it, authentication of the geolocation and co-existence information, etc. Some cognitive plane security related mechanisms are an integral part of other cognitive functions required for the system implementation such as Spectrum Sensing Function, geolocation, spectrum manager, Spectrum Automaton, Management Plane procedures and functions.

The security concepts that are enabled by security sublayers 1 and 2 are also extended to the relay network for both R-CPEs and A-CPEs. The security model in the relay network is end-to-end. Authentication of MAC management and user data sent between the A-BS and A-CPE is handled at each end of the connection, i.e., by the A-BS and A-CPE. Centralized and distributed scheduling R-CPEs are responsible only for authentication of MAC management messages exchanged between them and the A-BS. Centralized and distributed scheduling R-CPEs shall not be involved in initial authentication or reauthentication or keying of attached A-CPEs, other than to forward SCM-REQ/RSP messages between any attached A-CPEs and the A-BS. Centralized and distributed scheduling R-CPEs do not maintain or store any of the authentication information (e.g., AK Context) related to any attached A-CPEs.

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The authentication phase of the security sublayer is started after the CBC-REQ/RSP exchange, when the "SCM Capability Support" IE (7.7) has, at a minimum, the "Null SA" and "Unicast Management SA" support bits set to 1. If the "Unicast Management SA" support bit is set to 1, in addition to the "Unicast Transport SA" and/or "Group SA" support bits are set to 1, the "PN Window Size" (7.7) and "SCM Flow Control" (7.7) shall be included in the CBC-REQ/RSP. The authentication phase can also be started if the "SCM Capability Support" IE is omitted during the CBC-REQ/RSP exchange. If this happens the BS assumes the CPE supports the "Unicast Management SA" and sets default values for the "PN Window Size" and "SCM Flow Control" IEs.

8.1 Security Architecture for the Data/Control and Management Planes

Privacy has two component protocols as follows:

a) An encapsulation protocol for securing packet data over the air. This protocol defines a set of supported *cryptographic suites*, i.e., pairings of data encryption and authentication algorithms, and the rules for applying those algorithms to a MAC PDU payload.

b) A Security for Control and Management (SCM) protocol providing the secure distribution of keying data from the BS to the CPE. Through this key management protocol, the CPE and the BS synchronize keying data; in addition, the BS uses the protocol to enforce conditional access to network services.

The protocol stack for the security components of the system are shown in Figure 160.

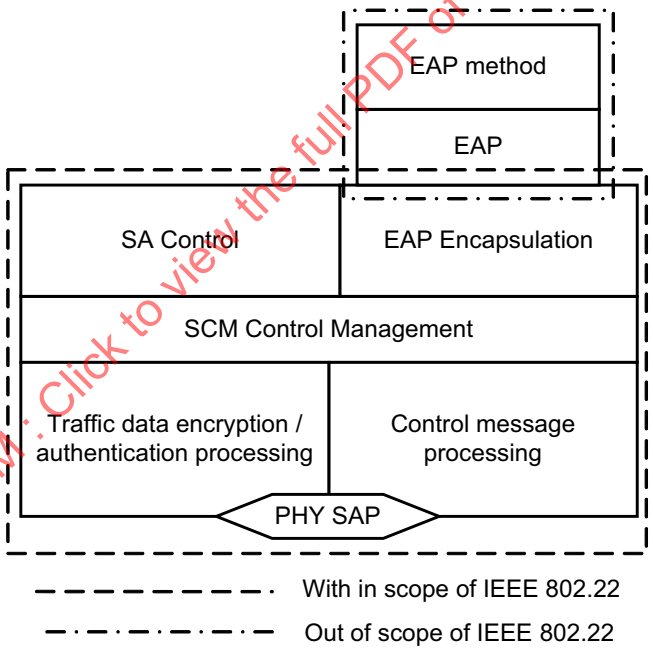

Figure 160—Security sublayer 1

— SCM Control Management: This stack controls all security components. Various keys are derived and generated in this stack.

— Traffic Data Processing: This stack encrypts or decrypts the traffic data and executes the authentication function for the traffic data.

— Control Message Processing: This stack processes the various SCM-related MAC messages, and provides either authentication and/or encryption of such messages.

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8.1.1 Secure encapsulation of MAC PDUs

Encryption services are defined as a set of capabilities within the MAC security sublayer. MAC header information specific to encryption is allocated in the generic MAC header format.

Encryption is always applied to the MAC PDU payload when required by the selected ciphersuite; the generic MAC header is not encrypted. MAC management messages sent to the cell SID for broadcast and initial ranging, as well as the basic FT for a CPE SID, shall be sent in the clear to facilitate such functions as network entry, basic capability negotiation, and authentication exchange. All other management messages shall be protected by the MMP_Key that is setup during the authentication exchange. Multicast MAC management messages shall be protected by the GTEK setup for the GSA. Data messages are protected by the TEKs when "Unicast Transport SA" is enabled.

The format of MAC PDUs carrying encrypted or unencrypted packet data payloads is specified in 8.4.2.1.

8.1.2 Key management and authentication overview

The SCM protocol allows for mutual authentication where both the network and CPEs authenticate each other. It also supports periodic reauthentication and key refresh. It uses strong encryption algorithms to perform key exchanges between a CPE and BS.

The SCM's authentication protocol establishes a shared secret (i.e., the AK) between the CPE and the BS. The shared secret is then used to secure subsequent SCM exchanges of TEKs, if the "Unicast Transport" SA is enabled. This two-tiered mechanism for key distribution permits refreshing of TEKs without incurring the overhead of computation-intensive operations.

EAP-based authentication uses Extensible Authentication Protocol framework (IETF RFC 3748 [B30]). EAP offers the operator to select an EAP Method (e.g., EAP-TLS; IETF RFC 2716 [B25]) to execute the authentication. Each EAP Method specifies a credential that is used to perform authentication and verify the device's/user's identity. For example, EAP-TLS uses a X.509 certificate, while EAP-SIM uses a Subscriber Identity Module.

EAP-TLS or EAP-TTLS shall be used; 8.5 defines the profile for the X.509 credential. In order to avoid security vulnerabilities, the EAP Method implemented in an IEEE 802.22 network shall comply with the mandatory requirements stated in 2.2 of IETF RFC 4017 [B33].

During initial authentication EAP transfer messages are not protected. For reauthentication, the EAP transfer messages are protected (encrypted and authenticated) using the MMP_Key (8.2.4.6.2). If EAP reauthentication messages fail their authentication verification (8.3.2) or are not protected, they shall be ignored by the BS and CPE.

The AAA server and a client CPE authenticate each other during the initial authentication exchange. The AAA and CPE present their credentials to each other. Since the AAA and CPE mutually authenticate each other, there is protection against an attacker employing a cloned CPE that masquerades as a legitimate subscriber's CPE. Once authentication is completed, the BS and CPE have keying that is used to protect management messages (e.g., MMP_Key) and keying used in transportation of keys for protection of user data (e.g., KEK). The process related to setting up and maintaining keying to protect user data is known as the TEK Exchange (see 8.2.3) process. During authentication exchange, protection of user data is configured for the CPE. The TEK Exchange process shall be engaged by a CPE only if protection of user data has been configured during the authentication exchange.

If an R-CPE is configured to support operation as a distributed or centralized scheduling R-CPE, it shall not initiate TEK Exchange process. Distributed and centralized scheduling R-CPEs shall also not be capable of maintaining/storing the keying material related to A-CPEs that are attached to the A-BS through them.

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The traffic key management portion of the SCM protocol adheres to a client/server model, where the CPE (a SCM "client") requests keying material and the AAA server (a SCM "server") responds to those requests. This model provides for an individual CPE to receive keying material for security associations (SAs), for which they are configured.

The SCM protocol uses MAC management messaging, i.e., SCM-REQ and SCM-RSP messages defined in 7.9.21. The SCM protocol is defined in detail in .

8.1.3 Mapping of connections to SAs

The following rules for mapping connections to SAs apply:

a) All transport connections shall be mapped to the "Unicast Transport" SA.

b) Multicast management connections shall be mapped to any GSAs.

c) The primary and secondary management connection shall be mapped to the "Unicast Management" SA.

d) Mulitcast data connections are mapped to the Null SA

The actual mapping for transport connections is achieved by including the SAID of an existing SA in the DSA-REQ/RSP and DSC-REQ/RSP messages together with the FT.

8.1.4 Cryptographic suite

A cryptographic suite is the SA's set of methods for data encryption, data authentication, and TEK exchange. The available cryptographic suites are specified as described in 8.4.1. The cryptographic suite shall be one of the ones listed in Table 240. Of the suites defined in Table 193, only one of them is usable by A-CPEs.

8.2 SCM protocol

8.2.1 Security associations (SAs)

A security association (SA) is the set of security information a BS and one or more of its client CPEs share in order to support secure communications across the IEEE 802.22 network. There are four basic types of SAs: Null, Unicast Management, Unicast Transport, and Group, that can be defined. The Null SA and Unicast SAs shall only be static, i.e., they remain persistent for as long as the CPE is operational. Group SAs shall be either static or dynamic. GSAs are made dynamic by use of the SCM GSA Remove message.

Each CPE establishes the Null SA. The SAs that are to be used are negotiated during the basic capabilities exchange and/or during the registration exchange. If the BS configures the CPE for no other SAs besides the Null SA, then no Unicast and Group SAs shall be setup on the CPE.

The Unicast Management SA has been installed, the cryptographic suite using the 3byte PN (see 8.4.1 and 8.4.2) is are selected for the CPE/A-CPE/R-CPE to use for protecting MAC management messages. If the Unicast Transport SA has been installed on the CPE, the cryptographic suite to be used by the CPE shall be configured during the authentication exchange. CPEs shall only be capable of being configured to use the 3-byte PN suite, where as A-CPEs can be configured for either the 3byte PN or 4byte PN suites (see 8.4.1 and 8.4.2). For complete description of the cryptographic suites, refer to 8.2.2.5. All of the unicast data traffic to/from the CPE/A-CPE shall be protected by the keying material provided by the Unicast Transport SA. All of the unicast management traffic, e.g., on the primary/secondary management FTs, shall be protected by the Unicast Management SA.

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Establishment of Group SAs (GSAs) is optional. Group SAs are to be used for providing keying material for multicast transmission of management message traffic. GSAs are installed on a CPE/A-CPE using the SCM GSA Add message. A CPE/A-CPE is configured for a GSA, when the BS transmits the GSA add message to it. After assigning a CPE/A-CPE or group of CPEs/A-CPE to a multicast group (see 7.19), the BS/A-BS may transmit the SCM GSA Add message to those CPEs/A-CPEs to install the GSA on them. The SCM GSA message shall only be transmitted to the multicast group if the group was configured to support multicast via the Multicast Group Type parameter of the MCA-REQ (see 7.9.9).

Only after the GSA is established at the CPE/A-CPE, is it allowed to receive DS traffic on the multicast management FT mapped to the multicast group associated with the GSA. A GSA will only be established after the process to join a multicast group (see 7.19.1) has concluded. After the BS issues a MCA-REQ asking the CPE/A-CPE to leave the multicast group, it shall send a SCM GSA Remove message to CPE/A-CPE, requiring the CPE/A-CPE to delete any context information relating to the GSA associated with multicast group it was previously asked to leave.

An SA's shared information shall include the cryptographic suite employed within the SA. The shared information may include TEKs. The exact content of the SA is dependent on the SA's cryptographic suite.

SAs are identified using SAIDs. SAID value assignments are defined in 8.2.7.

Using the SCM protocol, a CPE/A-CPE requests from its BS/A-BS an SA's keying material.

The BS/A-BS shall allow access by each client CPE/A-CPE to the SAs for which it is configured.

An SA's keying material has a limited lifetime. When the BS/A-BS delivers SA keying material to a CPE/A-CPE, it also provides the CPE/A-CPE with that material's remaining lifetime. It is the responsibility of the CPE/A-CPE to request new keying material from the BS/A-BS before the set of keying material that the CPE/A-CPE currently holds expires at the BS/A-BS. Should the current keying material expire before a new set of keying material is received, the CPEA-CPE shall perform reauthentication as described in 8.2.2. If a CPE/ACPE is being shutdown or attempting affiliation with another BS/A-BS, it shall stop any current authentication and TEK state machines, and delete any SAs for which it is currently configured.

In all cryptographic suites, key lifetime may be limited by the exhaustion rate of a number space, e.g., the PN of AES in GCM. In this case, the key ends either at the expiry of the key lifetime or the exhaustion of the number space, which ever is earliest. Note that in this case, security is not determined by the key lifetime.

SAs are not applicable to the protection of CBP bursts. CBP bursts will not be encrypted and/or authenticated by the methods and materials that are configured in a CPE's SAs. CBP protection mechanism only provides authentication. The CBP protection mechanism is defined in detail in 8.6.2.

8.2.1.1 Dynamic Creation of GSA

The BS/A-BS may dynamically establish GSAs by issuing a GSA Add message/Remove message (via SCM-REQ/RSP). Upon receiving a GSA Add message, the CPE/A-CPE shall start a TEK state machine to establish and maintain GTEKs for each GSA listed in the message. Upon receiving a GSA Remove message, the CPE shall stop the GTEK state machine as well as delete the GKEK context (see 8.2.8.2). If a CPE/A-CPE is being shutdown or attempting association with another BS/A-CPE, it shall stop any TEK state machines associated with GSAs it is configured for and delete those GSAs.

8.2.1.2 Mapping of DS Multicast Traffic to SAs

When creating a new DS multicast service flow for a multicast transport connection, the BS/A-BS shall map this traffic to the Null SA. When scheduling traffic on a DS multicast connection (see 7.17), the BS checks the CPEs/A-CPEs authentication context for the GSA that is assigned to the multicast group.

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8.2.2 Authentication state machine

The Authentication state machine (ASM) adopts an authentication framework similar to the model specified in IEEE Std 802.16-2009. The ASM incorporates EAP authentication and is made up of four states and thirteen events and messages that are used to communicate with other aspects of the SCM framework. The ASM has to interoperate with the TEK state machine (TSM) (8.2.3) and the EAP Process. In 8.2.2.1 through 8.2.2.7, the term "CPE" refers to CPEs, A-CPEs, R-CPEs.

8.2.2.1 ASM Flow Diagram and State Transition Table

The ASM interacts with the EAP Process component of the CPE, known as the Supplicant. On the network side, the AAA service that the CPE authenticates to interacts with a component of the EAP Process known as the Authenticator. Specifications of most aspects related to the configuration, as well as operation of the EAP Process is out of scope of this standard. For details on how to operate and configure either the Supplicant or the Authenticator, refer to IETF RFC 3748 [B30], IETF RFC 4072 [B35], as well as IEEE Std 802.1X-2010 [B10].

Figure 161 presents the ASM as a state flow diagram, while Table 233 presents the ASM in a state transition table. In Figure 161 transitions are defined by the following format: 'Trigger'/'Action.' Shaded states in Figure 161 represent states whereby message exchanges (e.g., SCM EAP-Start and EAP-Transfer) shall be protected by the MMP_Key derived from the currently active AK. Shaded fields of Table 233 represent non-valid state transitions that are not allowed or described in Figure 161.

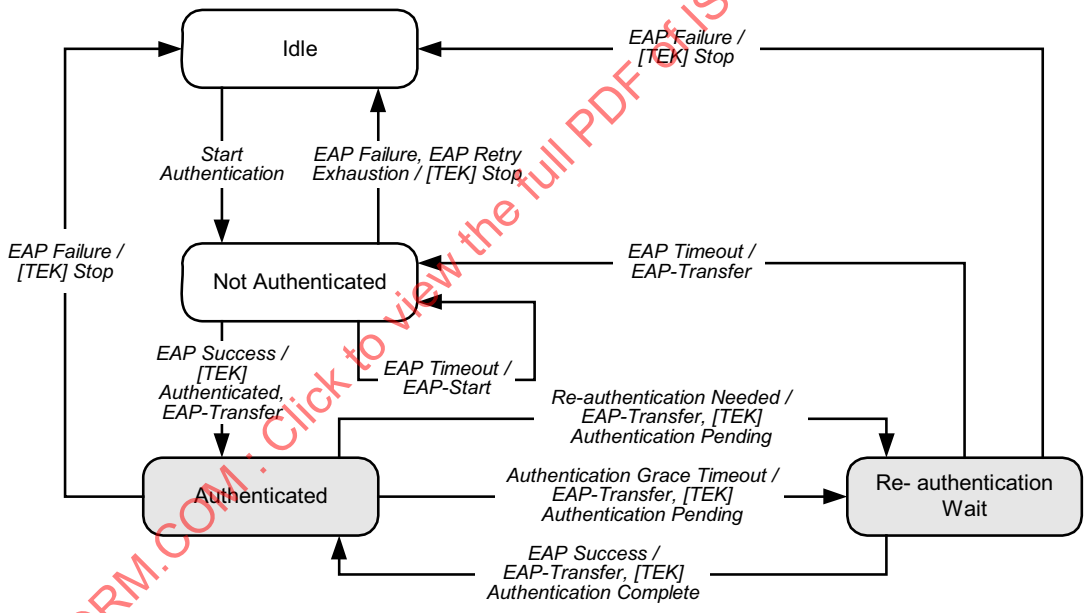

Figure 161—Authentication state machine—Flow diagram

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Table 233—Authentication state machine—State transition matrix

State Event or receive message	(A) Idle	(B) Not Authenticated	(C) Reauthentication Wait	(D) Authenticated
(1) Start Authentication	Not Authenticated			
(2) EAP Timeout		Not Authenticated	Not Authenticated	
(3) EAP Failure		Idle	Idle	Idle
(4) EAP Retry Exhaustion		Idle		
(5) EAP Success		Authenticated	Authenticated	
(6) Reauthentication Needed				Reauthentication Wait
(7) Authentication Grace Timeout				Reauthentication Wait

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8.2.2.2 States

Idle: Initial state of the ASM.

Not Authenticated: The ASM, thus the CPE, is not authenticated. The CPE is awaiting an indication from the EAP Process that EAP authentication. The EAP Process accomplishes this with signaling an *EAP Success* event, and transferring the MSK to the BS and CPE. This state is only left when an EAP Success or EAP Failure event is signaled by the EAP Process, as well as exhaustion of the 'Max # EAP Authentication Attempts.' If entering this state from the Reauthentication Wait state, the CPE shall protect the SCM EAP-Start/Transfer messages with the MMP_Key of the current AK.

Reauthentication Wait: The ASM is halted, pending a reauthentication request. This state is entered when the operator triggers reauthentication or the current authentication is about to expire. SCM EAP-Start/ Transfer messages shall be protected with the MMP_Key of the current AK.

Authenticated: The ASM has completed the EAP authentication. The EAP process has delivered the MSK to the CPE and BS. Both have then subsequently derived the PMK from the MSK. If this state was entered from the Reauthentication Wait state, all subsequent SCM EAP-Start/Transfer messages, as well as the SCM Key-Request/Reply messages shall be protected by the MMP_Key of the current active AK. While in this state, two active AK contexts can be maintained at the CPE. This process is described further in 8.3.1.1 to 8.3.1.3.

8.2.2.3 Messages

SCM EAP-Start: The Supplicant on the CPE uses this message is used to start authentication. The Supplicant on the CPE may also use this message to start reauthentication. When used during reauthentication, this message shall be protected using the MMP_Key of the currently active AK.

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SCM EAP-Transfer: The Supplicant (CPE) and Authenticator (AAA) use this message to exchange EAP data packets to conduct the EAP authentication exchange. In the Not Authenticated state, this message is not protected. During reauthentication this message is protected using the MMP_Key of the currently active AK.

8.2.2.4 Events

Start Authentication: This event is generated to start the ASM after the conclusion of the basic capabilities exchange (CBC-REQ/RSP) during network entry.

EAP Timeout: ASM generates this event when 'EAP Authentication Timer' has expired prior to reception of SCM EAP-Start/Transfer messages during initial authentication or reauthentication. When this happens, the 'Current # of Authentication Attempts' is incremented and the 'EAP Authentication Timer' is restarted.

EAP Failure: The EAP Process generates this message to tell the ASM that the EAP Process has not resulted in successful authentication being verified.

EAP Retry Exhaustion: This event is generated by the ASM when the 'Max # EAP Authentication Attempts' has been reached without successful completion of authentication or reauthentication.

EAP Success: The EAP Process generates this even to tell ASM that EAP Process, during initial authentication or reauthentication, has completed successfully. The 'Current # of Authentication Attempts' is set to zero upon indication of this event.

Reauthentication Needed: Generated when the network operator or AAA service decides to force reauthentication prior to expiration of current AK or to update successive/concurrent AK contexts (see 8.3.1.1 to 8.3.1.3) that are operating on the CPE. Reception of an (unsolicited) SCM EAP-Start/Transfer message prior to expiration of current AK, while in the Authenticated state, can trigger this event.

Authentication Grace Timeout: When 'Authentication Grace Timer' expires, reauthentication process is automatically restarted.

The ASM also sends the following events to the TEK state machine:

— *[TEK] Stop*: Sent by the ASM to stop the TEK state machine governing the key management for Unicast Transport SAs, as well as GSAs set up on the CPE.

— *[TEK] Authentication Complete*: Sent by ASM to TEK state machine to tell TEK state machine to continue operation from the Op Reauth Wait and Rekey Reauth Wait states, when authentication is pending.

— *[TEK] Authentication Pending*: Sent by ASM to TEK state machine to halt TEK state machine while ASM conducts reauthentication. This event is sent to the Op Reauth Wait and Rekey Reauth Wait states when reauthentication is initiated.

— *[TEK] Authenticated*: Sent by ASM to start a TEK state machine for either the Unicast Transport SA, as well as any configured GSA.

8.2.2.5 Parameters

EAP Authentication Timer: Time period between 1) sending SCM EAP-Start message after not receiving an EAP-Transfer or *EAP Success* indication during initial authentication (e.g., while in Not Authenticated state) or 2) between resending SCM EAP-Transfer or *EAP Success* indication during reauthentication (e.g., while in Reauthentication Wait state).

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Authentication Grace Timer: Amount of time after authentication is complete that shall pass before reauthentication is triggered.

Max # EAP Authentication Attempts: Maximum number times a CPE is allowed to attempt EAP authentication.

Current # EAP Authentication Attempts: Current count of attempts to complete EAP authentication.

8.2.2.6 Actions

1-A: Idle (Start Authentication) → Not Authenticated

a) Enable SCM EAP-Start or EAP-Transfer messages to be transferred between 'Supplicant' and 'Authenticator'

2-B: Not Authenticated (EAP Timeout) → Not Authenticated

a) Enable SCM EAP-Start message to be transferred between 'Supplicant' and 'Authenticator'
b) Increment 'Current # of EAP Authentication Attempts'
c) Reset 'EAP Authentication Timer'

2-C: Not Authenticated (EAP Timeout) → Not Authenticated

a) Enable SCM EAP-Transfer message to be transferred between 'Supplicant' and 'Authenticator'
b) Increment 'Current # of EAP Authentication Attempts'
c) Reset 'EAP Authentication Timer'

3-B: Not Authenticated (EAP Failure) → Idle

a) Stop ASM

3-C: Reauthentication Wait (EAP Failure) → Idle

a) Stop all TEK state machines
b) Stop ASM

3-D: Authenticated (EAP Failure) → Idle

a) Stop all TEK state machines
b) Stop ASM

4-B: Not Authenticated (EAP Retry Exhaustion) → Idle

a) Stop ASM (e.g., 'Current # of EAP Authentication Attempts' should be ≥ 'Max # of EAP Authentication Attempts')

5-B: Not Authenticated (EAP Success) → Authenticated

a) Start TEK state machine
b) Start 'Authentication Grace Timer'

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c) Follow procedures in 8.3.1 to manage successive/concurrent AKs
d) Reset 'Current # of EAP Authentication Attempts'

5-C: Reauthentication Wait (EAP Success) → Authenticated

a) Start 'Authentication Grace Timer'
b) Follow procedures in 8.3.1 to manage successive/concurrent AKs
c) Reset 'Current # of EAP Authentication Attempts'
d) Continue operation of TEK state machine

6-D: Authenticated (Reauthentication Needed) → Reauthentication Wait

a) Enable SCM EAP-Transfer message to be transferred between 'Supplicant' and 'Authenticator'
b) Reset 'Current # of EAP Authentication Attempts'
c) Reset 'EAP Authentication Timer'
d) Halt operation of TEK state machine

7-D: Authenticated (Authentication Grace Timeout) → Reauthentication Wait

a) Enable SCM EAP-Transfer message to be transferred between 'Supplicant' and 'Authenticator'
b) Reset 'Current # of EAP Authentication Attempts'
c) Reset 'EAP Authentication Timer'

8.2.2.7 Security capabilities negotiation

As part of their EAP Process, the Supplicant (CPE) provides the BS and Authenticator (AAA service) with a list of all the cryptographic suites (pairing of data encryption and data authentication algorithms) the CPE supports during initiation of initial authentication or reauthentication. The Supplicant may also provide the Authenticator negotiate values for SCM-related parameters (Table 234) that it will use. This information is carried in Attribute Value Pairs (AVPs) of EAP packets encapsulated in either an SCM EAP-Start or EAP-Transfer message.

The format of the data that is exchanged between the Supplicant and the Authenticator shall conform to the methods specified by the AAA service (e.g., RADIUS/RFC 2865 [B26] or DIAMETER/RFC 3588 [B29]) that operator will deploy. The parameters that describe the cryptographic suite options are in 8.4.1. Other SCM-related parameters are described in Table 235. If these items are not negotiated during the authentication procedure, then the default are used.

Upon verifying the Supplicant's credential (e.g., *EAP Success* event), the Authenticator sets the default cryptographic suite for the Unicast Management, the default cryptographic suite for GSA, and configures the cryptographic suite for Unicast Transport SA (see 8.4.1). Cryptographic suites are set for SAs whose support was indicated during basic capability and/or registration exchange. This information will be carried in the SCM EAP-Transfer message that carries the MSK to the BS and CPE (upon completion of EAP authentication). Table 236 defines the format of the CPE's SCM configuration information that the Authenticator provides to the Supplicant. The Authenticator shall reject the authentication request if it determines that there is a mismatch between the SA support setup during basic capability or registration exchange and SA support configuration being requested during authentication exchange.

Each static SA-Descriptor identifies the cryptographic suite employed within the SA. The selection of a static SA's cryptographic suite is typically made independent of the requesting CPE's cryptographic capabilities. An Authenticator may include in its EAP-Transfer message, SA-Descriptors identifying the

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cryptographic suites for SAs for which the AAA authenticates the CPE. The CPE shall not start TEK/GTEK state machines for the Unicast Transport SA or GSAs, unless Unicast Transport SA or GSA was previously configured.

SA-Descriptors for the Unicast Management and/or Unicast Transport SAs shall only be provided in EAP-Transfer messages. SA-Descriptors for GSAs shall not be provided for in EAP-Transfer messages. Only the default cryptographic suite to be employed by GSAs shall be sent in an EAP-Transfer message. One or more GSAs may be installed on the CPE via the SCM GSA-Add message, following addition of that CPE to a multicast group (see 7.19).

If the Unicast Management SA is the only SA that a CPE supports, then neither the Unicast Transport SA or any GSAs shall be configured for the CPE, and no TEK/GTEK state machines shall be started and any traffic that the CPE transmits will be mapped to the Null SA when a service flow is defined.

Table 234 gives an example of how the list of cryptographic suites and SCM-related parameters that the IEEE 802.22-based Supplicant supports can be signaled to the Authenticator.

Table 234—CPE SCM configuration request

Syntax	Size	Notes
CPE Type	8 bits	0x00: CPE 0x01: A-CPE 0x02: Distributed Scheduling R-CPE 0x03: Centralized Scheduling R-CPE 0x04-0xFF: *Reserved*
SA Support Bitmap	8 bits	Value of SCM Capability Setup IE (see 7.9.11.3.3.1)
If “Unicast Transport SA” bit==1 {		
Cryptographic Suite for Unicast Transport SA	8 bits	See 8.4.1
}		
EAP Authentication Timer	24 bits	Timeout period between sending SCM EAP-Start or EAP-Transfer, in seconds (see 8.2.2.5).
Authentication Grace Timer	24 bits	Amount of time after authentication is complete that shall pass before reauthentication is complete, in seconds (see 8.2.2.5).
Max # of EAP Authentication attempts	8 bits	Maximum # of attempts a CPE can attempt EAP authentication (see 8.2.2.5).
Operational Wait Timeout	24 bits	Timeout between sending of Key Request messages from the Op Wait state, in seconds (see 8.2.3.2.4).
Rekey Wait Timeout	24 bits	Timeout between sending of Key Request messages from the Rekey Wait state, in seconds (see 8.2.3.2.4).
GTEK/TEK Grace Time	24 bits	Time interval, in seconds, before the estimated expiration of a GTEK/TEK that the CPE starts rekeying for a new GTEK/TEK.
SCM Flow Control	8 bits	Number of ongoing SCM transactions the CPE will allow.
PN Window Size	8 bits	Size of PN_WINDOW (see 8.4).

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Table 235 gives an example of how the Authenticator can signal the Supplicant with the values for SCM parameters as well as the cryptographic suite configuration for any SAs for which the CPE is configured.

Table 235—CPE SCM configuration reply

Syntax	Size	Notes
CPE Type	8 bits	0x00: CPE 0x01: A-CPE 0x02: Distributed Scheduling R-CPE 0x03: Centralized Scheduling R-CPE 0x04-0xFF: *Reserved*
Num_SA_Descriptors	8 bits	Number of SAs being configured
for (*i*=0; *i* < Num_SA_Descriptors; *i*++){		
SAID	16 bits	SAID of SA
SA-Type	2 bits	Type of SA: 0x00: Null SA 0x01: Unicast Management SA 0x02: Unicast Transport SA 0x03: GSA
Cryptographic Suite	8 bits	Cryptographic Suite to be employed by the SA, see Table 240.
}		
EAP Authentication Timer	24 bits	Timeout period between sending SCM EAP-Start or EAP-Transfer, in seconds (see 8.2.2.5).
Authentication Grace Timer	24 bits	Amount of time after authentication is complete that shall pass before reauthentication is complete, in seconds (see 8.2.2.5).
Max # of EAP Authentication attempts	8 bits	Maximum number of attempts a CPE can attempt EAP authentication (see 8.2.2.5).
Operational Wait Timeout	24 bits	Timeout between sending of Key Request messages from the Op Wait state, in seconds (see 8.2.3.2.4).
Rekey Wait Timeout	24 bits	Timeout between sending of Key Request messages from the Rekey Wait state, in seconds (see 8.2.3.2.4).
GTEK/TEK Grace Time	24 bits	Time interval, in seconds, before the estimated expiration of a GTEK/TEK that the CPE starts rekeying for a new GTEK/TEK.
Max # of Key Request Attempts	8 bits	Max number of attempts a CPE can attempt a Key Request.
SCM Flow Control	8 bits	Number of ongoing SCM transactions the CPE will allow.
PN Window Size	8 bits	Size of PN_WINDOW (see 8.4).

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For the Null SA, all MAC PDUs sent with FTs linked to this SA shall have the EC bit set to ‘0’ in the generic MAC header. For unicast/multicast MAC management traffic mapped to the Unicast Management SA and GSAs, and unicast transport connections mapped to the Unicast Transport SA, the EC bit shall be set to ‘1’ in the generic MAC header. Other combinations are not allowed; MAC PDUs presenting other combinations should be discarded.

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The capabilities defined in an SA are not applicable to management messages transmitted on the Initial Ranging, Basic, as well as Broadcast connections. Only data traffic mapped to the Null SA will be allowed to be transmitted without any authentication or encryption information.

Some rules should be taken under consideration when configuring SAs and cryptographic suites for CPEs:

— Legacy CPEs shall not be capable of being cryptographic Suites that use a 4-byte PN value, e.g., suites 0x01–0x02.
— All CPEs shall make use of the 3-byte PN value suite (e.g., 0x00) related to DS multicast GSA MAC management messages sent on the Multicast Management FT.
— All CPEs shall make use of 3-byte PN value suite (e.g., 0x00) related to Unicast Management SA for MAC management messages sent on the Primary/Secondary Management FTs.

8.2.3 TEK exchange overview

8.2.3.1 TEK exchange overview for PMP topology

The CPE and BS shall not perform the Key Request/Key Reply handshake in either of the following cases:

— If support for the Unicast Transport SA has not been configured.
— The A-CPE is configured to operate as a distributed or centralized scheduling R-CPE.

In the first case, target SAID value, which may be included in DSA-REQ/RSP messages, shall be Null SA's SAID.

Upon achieving authentication, if the CPE has been configured to use the Unicast Transport SA, a CPE starts a separate TEK state machine for the Unicast Transport SA's SAID identified in the Authentication Reply message. Configuration of support for GSAs does not immediately trigger the start of a TEK state machine. A unique TEK state machine for a multicast group's GSA is started when the CPE is added to a multicast group via the SCM GSA-Add during setup of the multicast group. Each TEK state machine operating within the CPE is responsible for managing the keying material associated with its respective SAID. TEK state machines periodically send Key Request messages to the BS, requesting a refresh of keying material for their respective SAIDs.

TEK state machines periodically cause the CPE to send Key Request messages to the BS, requesting a refresh of keying material for their respective SAIDs. The BS responds to a Key Request with a Key Reply message, containing the BS's active keying material for a specific SAID.

The TEK is encrypted using appropriate KEK derived from the AK. For AES-GCM, the TEK is a 128-bit key and the KEK is derived from the AK using a 128-bit key and 128-bit block size.

For the Unicast Transport SA and GSAs, both of which AES-GCM mode, note that at all times the BS maintains two active sets of keying material per SAID. The lifetimes of the two generations overlap so that each generation becomes active halfway through the life of its predecessor and expires halfway through the life of its successor. A BS includes in its Key Replies *both* of an SAID's active generations of keying material.

The Key Reply provides the requesting CPE, in addition to the TEK, the remaining lifetime of each of the two sets of keying material. The receiving CPE uses these remaining lifetimes to estimate when the BS will invalidate a particular TEK and, therefore, when to schedule future Key Requests so that the CPE requests and receives new keying material before the BS expires the keying material the CPE currently holds. For AES-GCM mode, when more than half the available PN numbers in the 24-bit or 32-bit PN number space are exhausted, the CPE shall schedule a future Key Request in the same fashion as if the key lifetime was approaching expiry.

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The operation of the TEK state machine's Key Request scheduling algorithm, combined with the BS's regimen for updating and using an SAID's keying material (see Figure 162 and Table 236), provides for the CPE to be able to continually exchange encrypted traffic with the BS.

A TEK state machine remains active as long as

1) The CPE is authenticated and allowed to operate in the BS's security domain, i.e., it has a valid AK, and
2) The CPE is configured to participate in that particular SA, i.e., the BS continues to provide fresh keying material during rekey cycles.

The parent Authentication state machine stops *all* of its child TEK state machines when the TEK state machine sends a *[TEK] Stop* message during a reauthentication cycle. Individual TEK state machines can be started or stopped during a reauthentication cycle if a CPE's Static SAID authentications changed between successive reauthentications.

Communication between Authentication and TEK state machines occurs through the passing of events and protocol messaging. The Authentication state machine generates events (i.e., Stop, Authenticated, Authentication Pending, and Authentication Complete events) that are targeted at its child TEK state machines. TEK state machines do not target events at their parent Authentication state machine. The TEK state machine affects the Authentication state machine indirectly through the messaging a BS sends in response to a CPE's requests: a BS may respond to a TEK machine's Key Requests with a failure response (i.e., Stop or Authentication Pending events) to be handled by the Authentication state machine.

8.2.3.2 TEK state machine

The TEK state machine consists of seven states and eleven events (including receipt of messages) that may trigger state transitions. Like the Authentication state machine, the TEK state machine is presented in both a state flow diagram (Figure 162) and a state transition matrix (Table 237). As was the case for the Authentication state machine, the state transition matrix shall be used as the definitive specification of protocol actions associated with each state transition.

Shaded states in Figure 162 (Operational, Rekey Wait, Rekey Reauthenticate Wait, and Multicast Rekey Interim Wait) have valid keying material and encrypted traffic may be sent. Shaded blocks in Table 234 highlight transitions that shall not be allowed.

The SAID may be replaced by the GSAID for the multicast service. And, the TEK may be also replaced by the GTEK for the multicast service.

The Authentication state machine starts an independent TEK state machine for each SA for which a CPE is configured. As mentioned in 8.2.2, the BS maintains two active TEKs/GTEKs per SA. Each SA is uniquely identified by its security association identifier (SAID).

For the unicast service, the BS includes in its Key Replies both of these TEKs, along with their remaining lifetimes. For the multicast service, the BS includes in its Key Replies both of the GTEKs, along with their remaining lifetimes.

The BS encrypts downlink traffic with the older of its two TEKs and decrypts uplink traffic with either the older or newer TEK, depending upon which of the two keys the CPE was using at the time. The CPE encrypts uplink traffic with the newer of its two TEKs and decrypts downlink traffic with either the older or newer TEK, depending upon which of the two keys the BS was using at the time. See for details on CPE and BS key usage requirements.

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For the multicast service, the BS shall install a GSA on the CPEs prior to transmitting traffic if any multicast management connections are to be mapped to the GSA using the SCM GSA Add message. The SCM GSA Add message (see Table 194) contains the SAID of the GSA, the GKEK, and the remaining lifetime of the GKEK. When a CPE receives this message it shall issue a Key Request message to the BS. The BS will respond with a Key-Reply, which uses the GKEK to protect both generations of GTEKs. The BS shall update the GKEK by sending another SCM GSA Add message to the CPE, prior to expiration of the amount of "Remaining GKEK Lifetime" as specified in the last SCM GSA Add message. If an amount of time greater than the "Remaining GKEK Lifetime" of the SCM GSA Add message has passed, it shall not start any key exchange transaction (e.g., Key-Request/Reply) until a SCM GSA Add message is sent by the BS. The CPE verifies and/or decrypts downlink traffic with either the older or newer GTEK, depending upon which of the two keys the BS is using at the time. See 8.3 for details on CPE and BS key usage requirements.

Through operation of a TEK state machine, the CPE attempts to keep its copies of SAID's TEKs synchronized with those of its BS. A TEK state machine issues Key Requests to refresh copies of its SAID's keying material soon after the scheduled expiration time of the older of its two TEKs and before the expiration of its newer TEK. To accommodate for CPE/BS clock skew and other system processing and transmission delays, the CPE schedules its Key Requests a configurable number of seconds before the newer TEK's estimated expiration occurs at the BS. With the receipt of the Key Reply, the CPE shall always update its records with the TEK parameters from both TEKs/GTEKs contained in the Key Reply message.

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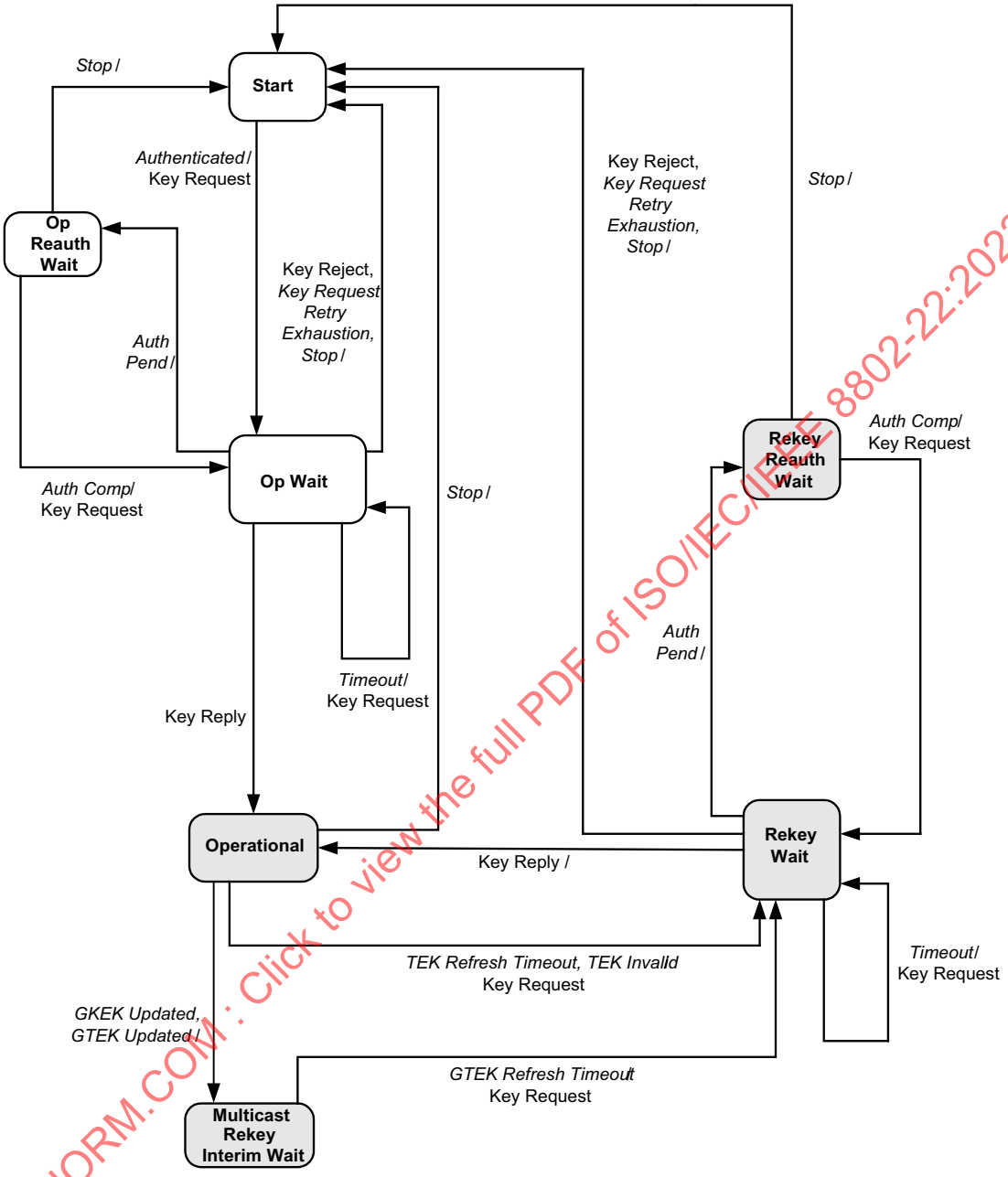

Figure 162—TEK state machine flow diagram

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Table 236—TEK State Transition Finite state machine

State / Event or Received Msg	(A) Start	(B) Op Wait	(C) Op Reauth Wait	(D) Op	(E) Rekey Wait	(F) Rekey Reauth Wait	(G) Multicast Rekey Interim Wait
(1) Stop		Start	Start	Start	Start	Start	
(2) Authenticated	Op Wait						
(3) Auth Pend		Op Reauth Wait			Rekey Reauth Wait		
(4) Auth Comp			Op Wait			Rekey Wait	
(5) TEK Invalid				Rekey Wait			
(6) Timeout		Op Wait			Rekey Wait		
(7) TEK Refresh Timeout				Rekey Wait			
(8) GTEK Refresh Timeout							Rekey Wait
(9) Key Reply		Operational			Operational		
(10) Key Reject		Start			Start		
(11) GKEK Updated				Multicast Rekey Interim Wait			
(12) GTEK Updated				Multicast Rekey Interim Wait			
(13) Key Request Retry Exhaustion		Start			Start		

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In 8.2.3.2.1 through 8.2.3.2.5, the term "CPE" refers to CPEs, and A-CPEs. R-CPEs (distributed or centralized scheduling) shall not make use of TEKs, therefore they shall not make use of the TEK state machine.

8.2.3.2.1 States

Start: This is the initial state of the FSM. No resources are assigned to or used by the FSM in this state—e.g., all timers are off, and no processing is scheduled.

Operational Wait (Op Wait): The TEK state machine has sent its initial request (Key Request) for its SAID's keying material (TEK), and is waiting for a reply from the BS.

Operational Reauthenticate Wait (Op Reauth Wait): The wait state the TEK state machine is placed in if it does not have valid keying material while the Authentication state machine is in the middle of a reauthentication cycle.

Operational: The CPE has valid keying material for the associated SAID.

Rekey Wait: The TEK Refresh Timeout has expired or the TEK Invalid message has been received and the CPE has requested a key update for this SAID. Note that the newer of its two TEKs has not expired and may still be used for both encrypting and decrypting data traffic.

Rekey Reauthenticate Wait (Rekey Reauth Wait): The wait state the TEK state machine is placed in if the TEK state machine has valid traffic keying material, has an outstanding request for the latest keying material, and the Authentication state machine initiates a reauthentication cycle.

Multicast Rekey Interim Wait (Multicast Rekey Interim Wait): This state is defined only for the multicast service. This state is the wait state the TEK state machine is placed in if the TEK state machine has valid traffic keying material and receives the new GKEK from the BS after receiving a SCM GSA Add message.

8.2.3.2.2 Messages

Note that the message formats are defined in detail in 7.9.21.

Key Request: Request a TEK for this SAID. Sent by the CPE to the BS and authenticated with keyed message digest. The message authentication key used to do this, the MMP_KEY, is derived from the AK.

Key Reply: Response from the BS carrying the two diversity sets of traffic keying material for this SAID. Sent by the BS to the CPE, it includes the SAID's TEKs, encrypted with a KEK derived from the AK or the GSAID's GTEK, encrypted with a GSA's GKEK. The Key Reply message is authenticated with a keyed message digest; the MMP_KEY used to do this is key is derived from the AK.

Key Reject: Response from the BS to the CPE to indicate this SAID is no longer valid and no key will be sent. The Key Reject message is authenticated with a keyed message digest; the MMP_KEY used to do this, is derived from the AK.

TEK Invalid: The BS sends this message to the CPE if it determines that the CPE encrypted an uplink PDU with an invalid TEK, i.e., an SAID's TEK key sequence number, contained within the received PDU's MAC Header, is out of the BS's range of known, valid sequence numbers for that SAID.

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8.2.3.2.3 Events

Stop: Sent by the Authentication state machine to an active (non-START state) TEK state machine to terminate TEK state machine and remove the corresponding SAID's keying material from the CPE key table. See Figure 163.

Authenticated: Sent by the Authentication state machine to a non-active (START state) TEK state machine to notify TEK state machine of successful authentication. See Figure 162.

Authentication Pending (Auth Pend): Sent by the Authentication FSM to TEK FSM to place TEK FSM in a wait state while Authentication FSM completes reauthentication. See Figure 162.

Authentication Complete (Auth Comp): Sent by the Authentication state machine to a TEK state machine in the Operational Reauthenticate Wait or Rekey Reauthenticate Wait states to clear the wait state begun by the prior Authentication Pending event. See Figure 162.

TEK Invalid: This event is triggered by either a CPE's data packet decryption logic or by the receipt of a TEK Invalid message from the BS.

A CPE's data packet decryption logic triggers a TEK Invalid event if it recognizes a loss of TEK key synchronization between itself and the encrypting BS. For example, an SAID's TEK key sequence number, contained within the received downlink MAC PDU header, is out of the CPE's range of known sequence numbers for that SAID.

A BS sends a TEK Invalid message to the CPE, triggering a TEK Invalid event within the CPE, if the BS's decryption logic recognizes a loss of TEK key synchronization between itself and the CPE.

Timeout: A retry timer timeout. Generally, when either the *Operational Wait Timeout* expires while in the *Op Wait* state or when the *Rekey Wait Timeout* expires while in the *Rekey Wait* state. Whenever this happens, a counter tracking the current number of Key Request attempts is incremented.

GTEK/TEK Refresh Timeout: The TEK refresh timer timed out. This timer event signals the TEK state machine to issue a new Key Request in order to refresh its keying material. The refresh timer is set to fire a configurable duration of time (GTEK/TEK Grace Time) before the expiration of the newer TEK the CPE currently holds. This is configured via the BS to occur after the scheduled expiration of the older of the two TEKs.

GKEK Updated: This event is triggered when the CPE receives the new GKEK through the SCM GSA Add.

TEK/GTEK Updated: This event is triggered when the CPE receives the new TEK or GTEK and traffic keying material through the Key Reply message.

Key Request Retry Exhaustion: This event is triggered when the number of Key Request attempts after the *Timeout* event while in the "Op Wait" or "Rekey Wait" has been exhausted. When this even is triggered, the count of current number of Key Request attempts is reset.

8.2.3.2.4 Parameters

All configuration parameter values take the default values from Table 333 or may be specified in Auth Reply message. Theses value shall be 4 octets long.

Operational Wait Timeout: Timeout period between sending of Key Request messages from the Op Wait state (see Table 333).

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Rekey Wait Timeout: Timeout period between sending of Key Request messages from the Rekey Wait state (see Table 337).

GTEK/TEK Grace Time: Time interval, in seconds, before the estimated expiration of a GTEK/TEK that the CPE starts rekeying for a new GTEK/TEK. GTEK/TEK Grace Time takes the default value from Table 337 or may be specified in a configuration setting within the Auth Reply message and is the same across all SAIDs (see Table 337).

Max # Key Request Attempts: Maximum number times a CPE is allowed to attempt Key Request transaction while in the *Op Wait* or *Rekey Wait* states.

Current # Key Request Attempts: Current count of attempts to complete a Key Request transaction.

8.2.3.2.5 Actions

Actions taken in association with state transitions are listed by <event> (<rcvd message>) → <state>:

1-B Op Wait *(Stop)* → Start

a) Clear Key Request retry timer
b) Terminate TEK FSM

1-C Op Reauth Wait *(Stop)* → Start

a) Terminate TEK FSM

1-D Operational *(Stop)* → Start

a) Clear TEK refresh timer, which is timer set to go off "GTEK/TEK Grace Time" seconds prior to the TEK's scheduled expiration time
b) Terminate TEK FSM
c) Remove SAID keying material from key table

1-E Rekey Wait *(Stop)* → Start

a) Clear Key Request retry timer
b) Terminate TEK FSM
c) Remove SAID keying material from key table

1-F Rekey Reauth Wait *(Stop)* → Start

a) Terminate TEK FSM
b) Remove SAID keying material from key table

2-A Start *(Authenticated)* → Op Wait

a) Send Key Request message to BS
b) Set Key Request retry timer to Operational Wait Timeout

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3-B Op Wait *(Auth Pend)* → Op Reauth Wait

a) Clear Key Request retry timer

3-E Rekey Wait *(Auth Pend)* → Rekey Reauth Wait

a) Clear Key Request retry timer

4-C Op Reauth Wait *(Auth Comp)* → Op Wait

a) Send Key Request message to BS
b) Set Key Request retry timer to Operational Wait Timeout

4-F Rekey Reauth Wait *(Auth Comp)* → Rekey Wait

a) Send Key Request message to BS
b) Set Key Request retry timer to Rekey Wait Timeout

5-D Operational *(TEK Invalid)* → Rekey Wait

a) Clear TEK refresh timer
b) Send Key Request message to BS
c) Set Key Request retry timer to Rekey Wait Timeout
d) Remove SAID keying material from key table

6-B Op Wait *(Timeout)* → Op Wait

a) Send Key Request message to BS
b) Set Key Request retry timer to Operational Wait Timeout

6-E Rekey Wait *(Timeout)* → Rekey Wait

a) Send Key Request message to BS
b) Set Key Request retry timer to Rekey Wait Timeout

7-D Operational *(TEK Refresh Timeout or TEK Invalid message)* → Rekey Wait

a) Send Key Request message to BS
b) Set Key Request retry timer to Rekey Wait Timeout

8-G Multicast Rekey Interim Wait *(TEK Refresh Timeout)* → Rekey Wait

a) Send Key Request message to BS
b) Set Key Request retry timer to Rekey Wait Timeout

9-B Op Wait *(Key Reply)* → Operational

a) Clear Key Request retry timer
b) Process contents of Key Reply message and incorporate new keying material into key database

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c) Set the TEK refresh timer to go off "GTEK/TEK Grace Time" seconds prior to the newer key's scheduled expiration

9-E Rekey Wait *(Key Reply)* → Operational

a) Clear Key Request retry timer
b) Process contents of Key Reply message and incorporate new keying material into key database
c) Set the TEK refresh timer to go off "GTEK/TEK Grace Time" seconds prior to the newer key's scheduled expiration

10-B Op Wait *(Key Reject)* → Start

a) a) Clear Key Request retry timer
b) b) Terminate TEK FSM

10-E Rekey Wait *(Key Reject)* → Start

a) a) Clear Key Request retry timer
b) b) Terminate TEK FSM
c) c) Remove SAID keying material from key table

11-D Operational *(GKEK Updated)* → M&B Rekey Interim Wait

a) Process contents of the received GSA Add message, and incorporate new GKEK into key database

12-G Operational *(GTEK Updated)* → M&B Rekey Interim Wait

a) Process contents of the Key Reply message, and incorporate new traffic keying material into key database
b) Set the GTEK refresh timer to go off "GTEK/TEK Grace Time" seconds prior to the key's scheduled expiration.

13-B Op Wait *(Key Request Retry Exhaustion)* → Start

a) Clear Key Request retry timer
b) Clear count of current Key Request attempts
c) Terminate TEK FSM
d) Remove SAID keying material from key table

13-E Rekey Wait *(Key Request Retry Exhaustion)* → Start

a) Clear Key Request retry timer
b) Clear count of current Key Request attempts
c) Terminate TEK FSM
d) Remove SAID keying material from key table

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8.2.4 Key derivation

The SCM key hierarchy defines what keys are present in the system and how the keys are generated. IEEE 802.22 systems shall use either EAP-TLS or EAP-TTLS EAP-based, authentication schemes. The keys used to protect management message integrity and transport the TEKs are derived from source key material generated by the authentication process. The EAP authentication process yields the Pairwise Master Key (PMK). All SCM key derivations are based on the Dot22KDF algorithm as defined in8.2.4.7.

8.2.4.1 AK derivation

The AK will be derived by the BS and the CPE from the PMK, when the EAP-based authentication procedure has concluded.

After the authentication procedure has been performed, the CPE and BS will both posses the PMK. The derivation of the AK is based on the following:

AK = Dot22KDF (PMK, CPE MAC Address | BSID | “AK”, 160)

8.2.4.2 KEK derivation

The KEK is derived directly from the AK. It is used to encrypt the TEKs, GKEK and all other keys sent by the BS to the CPE in Key Reply message.

8.2.4.3 GKEK derivation

The GKEK is randomly generated at the BS or a network entity (for example, an ASA server) and transmitted to the CPE encrypted with the KEK. There is one GKEK per Group Security Association. GKEK is used to encrypt the GTEKs sent in the Key Reply message by the BS to the CPEs in the same multicast group.

8.2.4.4 Traffic encryption key (TEK)

The TEK is generated as a random number in the BS and is encrypted using the corresponding TEK encryption algorithm (e.g., AES key wrap [IETF RFC 5649]), keyed with the KEK and transferred between BS and CPE in the TEK exchange.

8.2.4.5 Group traffic encryption key (GTEK)

The GTEK is used to encrypt data packets of the multicast management service and it is shared among all CPEs that belong to the multicast group. There are two GTEKs per GSA. Just as with TEKs, GTEKs will have overlapping lifetimes. The GTEK is randomly generated by the BS. The GTEK is encrypted by the GKEK using same algorithms applied to encryption for TEK and transmitted to the CPE in Key Request/ Key Reply messages.

8.2.4.6 Management Message Protection key and KEK derivation

8.2.4.6.1 MMP_PN management

The CPE shall maintain a MMP_PN counter for each AK. The BS is assumed to maintain a MMP_PN counter for each AK context as well. This is done to keep the MMP_PN value synchronized with the corresponding counter at the CPE. The value of this counter maintained by the CPE is denoted as MMP_PN_C and the value maintained by the BS is denoted as MMP_PN_B.

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8.2.4.6.1.1 Maintenance of MMP_PN$_C$ by the CPE

Upon successful completion of the SCM initial authentication or reauthentication, and establishment of a new AK, the CPE shall instantiate a new MMP_PN counter and set its value to 1. The CPE shall initiate reauthentication before the MMP_PN$_C$ expires, e.g., reaches the half of the counter space (0x7FFFFF). The AK Lifetime (see 8.3.1.1) shall not be set to a value less than the expected amount of time required to for the MMP_PN to be exhausted. The CPE shall manage a separate MMP_PN$_C$ counter for every active AK context. Specifically, during reauthentication, but before the activation of the new AK, the old MMP_PN$_C$ (corresponding to the old AK) shall be used signing and/or encryption of MAC control messages, while the new MMP_PN$_C$ shall be used for signing and/or encrypting of SCM Key Request messages. If CPE should lose its AK context, then CPE shall restart the authentication process.

The CPE may optionally check to see if the MMP_PN$_C$ is synchronized by adding the "MMP_PN" and "Ciphertext ICV" IEs to the RNG-REQ. The "Ciphertext ICV" is calculated over the RNG-REQ message (excluding the MMP_PN IE), according the process defined in 8.4. The MMP_PN value that is sent in the IE shall be the MMP_PN for the active AK context. If the MMP_PN$_C$ does not match (see 8.2.4.6.1.2) MMP_PN$_B$, then the CPE shall be instructed reauthenticate by sending the RNG-CMD with Ranging Status set to "Reauthenticate."

8.2.4.6.1.2 Processing of MMP_PN$_B$ by the BS

The BS may possess one or more AK contexts associated with the CPE, each of which includes the value of MMP_PN$_B$. This value shall be maintained as specified in subsequent paragraphs of this subclause.

Upon successful completion of the SCM initial Authentication and Reauthentication, and establishment of a new AK context, the BS shall set MMP_PN$_B$ of the corresponding newly instantiated AK context to 1. The BS shall manage a separate MMP_PN$_B$ for every AK context it is maintaining. Specifically, during reauthentication, but before the activation of the new AK, the old MMP_PN$_B$ (corresponding to the old AK context) shall be used for signing and/or encryption of MAC control messages, while the new MMP_PN$_B$ shall be used for signing and/or encrypting of SCM Key Reply messages.

During periodic ranging, the CPE can optionally transmit the RNG-REQ containing the MMP_PN parameter using the "MMP_PN" and "Ciphertext ICV" (see 7.9.6). If this is done, the BS shall compare the received MMP_PN value, which is MMP_PN$_C$, with MMP_PN$_B$ (i.e., the value of MMP_PN counter maintained by the BS for the corresponding AK context). If MMP_PN$_C$ < MMP_PN$_B$, the BS shall process the message as being invalid and send a RNG-CMD message requesting the CPE to reauthenticate. This can happen when either the BS or CPE loses the AK context.

8.2.4.6.2 Derivation of Management Message Protection (MMP) keys and KEKs

MMP keys are used to encrypt and sign management messages in order to validate the authenticity of the messages as well as provide confidentiality for the contents of these messages.

There is a single key for US and DS messages.

The MMP_KEY and KEK are derived as follows:

MMP_PREKEY | KEK = Dot22KDF(AK, CPE MAC Address | BSID | "MMP_KEY+KEK", 256)

MMP_KEY = AES$_{MMP_PREKEY}$ (MMP_PN)

For a fixed CPE, the MMP_PN shall be set to 0 in the derivation of the MMP_KEY at the BS and the CPE. Specifically, the preprocessed value of MMP_PREKEY is treated as the Cipher Key of the Advanced

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Encryption Standard (AES) algorithm AES128 [FIPS 197]. The MMP_PN is treated as the Input Block Plain Text of this algorithm. The AES128 algorithm is executed once. The Output Block Cipher Text of this algorithm is treated as the resulting MMP_KEY. When MMP_PN is used as an input of AES128 algorithm, 104 zero bits are pre-padded before the 24-bit MMP_PN where the MMP_PN is regarded as most-significant-bit first order.

8.2.4.7 Key Derivation function

The Dot22KDF algorithm is a CTR mode construction that may be used to derive an arbitrary amount of keying material from source keying material.

```
Dot22KDF(key, astring, keylength)
  {
    result = null;
    Kin = Truncate (key, 128);
    for (i = 0; i < ceil((keylength-1)/128); i++) {
      result = result | AES_Kin(i | astring | keylength | result);
    }
    return Truncate (result, keylength);
  }
```

8.2.5 Key hierarchy

Figure 163 outlines the process to calculate the AK when the EAP-based authentication process has taken place.

Figure 164 outlines the unicast key hierarchy starting from the AK.

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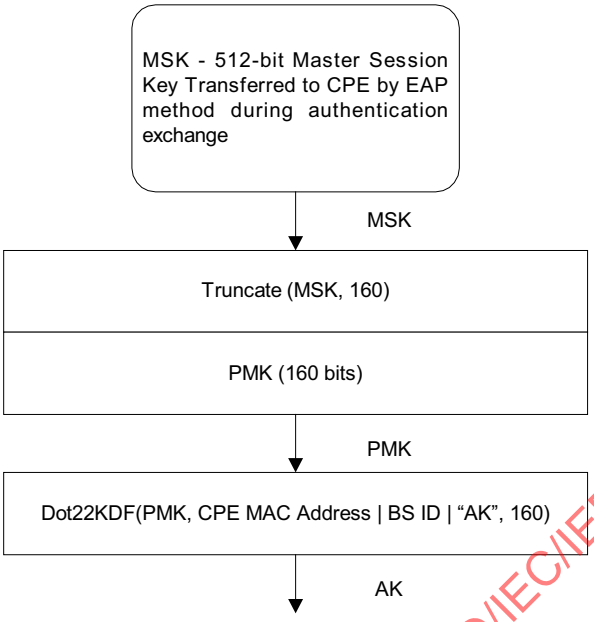

Figure 163—AK from PMK

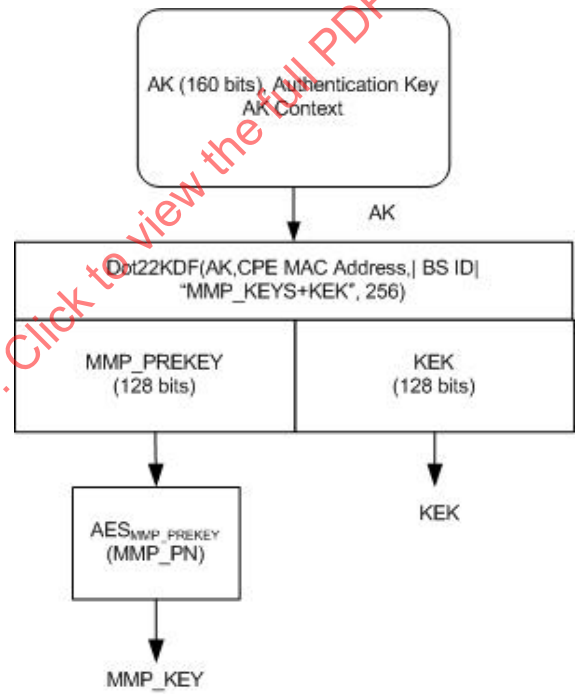

Figure 164—MMP/KEK derivation from AK

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8.2.6 Maintenance of AK

The BS and CPE maintain cached PMK and AK as follows:

1) *PMK Maintenance:* Successful completion of the SCM EAP-based Authentication and establishment of a new PMK causes the activation of all the AK associated with the new PMK on the CPE. The Authenticator (e.g., AAA) shall delete the old PMK and any AKs that are associated with the old PMK for that CPE. During reauthentication, the procedures defined in 8.3 for switching AKs shall govern when the old PMK context is to be deleted.
2) *AK Maintenance:* If the packet counter belonging to MMP key reaches its maximum value, the associated AK becomes permanently deactivated. If protection of user traffic is not enabled (see 8.2.2.7 and 8.4.1), then new AK becomes active immediately after the old one expires. If protection of user transport traffic is enabled (see 8.2.2.7 and 8.4.1), then old AK and MMP_Key shall be used to protect management messages, while the new AK (MMP_Key and KEK derived from new AK) is used to complete the SCM Key-Request/Reply handshake for establishing keys for either the Primary or Secondary SA. Once the old AK expires, the MMP_Key and KEK associated with the new AK are used for protection of subsequent management message and SCM Key-Request/Reply handshakes. The BS and CPE shall maintain the context of an AK (counters, timers, etc.) as long as they both retain the AK. The AK switching process is described in 8.3.

8.2.7 Security associations

Keying material is held within associations. There are four types of association: Null, Unicast Management, Unicast Transport, and Group Security associations (GSA). If CPE and BS do not configure support for the Unicast Transport SA, the Null SA SAID shall be used as the target SAID field in DSA-REQ/RSP messages.

8.2.7.1 Null security association

The Null SA is the default SA that shall be established when the CPE enters the network. This security association does not contain any keying material. Unicast management and transport connections are mapped to this SA when the Unicast Management and Unicast Transport SAs (respectively) are not selected for operation on the CPE. The contents of an SA are as follows:

— The SAID (a 16-bit identifier for the SA): 000|CPE SID. The SAID shall be unique within a BS.

8.2.7.2 Unicast Management security association

The Unicast Management SA is the SA that shall be established when the CPE enters the network, and both the CPE and BS/NMS support CPE authentication services. This security association contains keying material (e.g., MMP_Key) that is used to protect uincast management connections. The contest of the SA are as follows:

— The SAID (a 16-bit identifier for the SA): 001|CPE SID. The SAID shall be unique within a BS.

— The KEK, a 128-bit key encryption key, derived from the AK.

— MMP_Key, for encryption of US and DS management traffic

— MMP_PN, 24-bit packet numbers for use by link cipher to protect US and DS management messages

— RxMMP_PN, 24-bit receive sequence counter, for use by link cipher to protect US and DS management messages

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8.2.7.3 Unicast Transport security association

A security association contains keying material that is used to protect unicast connections. The contents of an SA are as follows:

— The SAID (a 16-bit identifier for the SA): 010|CPE SID. The SAID shall be unique within a BS.
— TEK0 and TEK1, 128-bit traffic encryption keys, generated within the BS and transferred from the BS to the CPE using a secure key exchange.
— The TEK Lifetimes TEK0 and TEK1, a key aging lifetime value.
— PN0 and PN1, packet numbers for use by the link cipher. CPEs shall use a 24-bit packet number, while A -CPEs may be configured to use a 24- or 32-bit packet number.
— RxPN0 and RxPN1, receive sequence counter, for use by the link cipher. CPEs shall use a 24-bit sequence counter, while A -CPEs may be configured to used 24- or 32-bit sequence numbers.
— Size of PN/sequence counter, 24-bit if suite 0x01 or 32-bit if suite 0x03 is configured for this SA (see Table 193)

8.2.7.4 Group security association

The Group Security Association (GSA) contains keying material used to secure multicast transmissions. These are defined separately from SAs since GSA offer a lower security bound than unicast security associations, since keying material is shared between all members of the group, allowing any member of the group to forge traffic as if it came from any other member of the group.

The contents of a GSA are as follows:

— The SAID (GSAID), a 16-bit identifier for the GSA: 011|Multicast Group SID. The SAID shall be unique within the BS
— The Group Key Encryption Key (GKEK). Serves the same function as a KEK but for a GSA.
— The Group Traffic Encryption Key (GTEK). Served the same function as an SA TEK but for a GSA.
— GTEK0 and GTEK1, 128-bit traffic encryption keys.
— The GTEK Lifetimes for GTEK0 and GTEK1, a key aging lifetime value.
— GPN0 and GPN1, 24-bit packet numbers for use by the link cipher.
— RxGPN0 and RxGPN1, 24-bit receive sequence counter, for use by the link cipher.

8.2.8 Security context

The security context is a set of parameters linked to a key in each hierarchy that defines the scope while the key usage is considered to be secure. Examples of these parameters are key lifetime and counters ensuring the same encryption will not be used more than once. When the context of the key expires, a new key should be obtained to continue working.

The purpose of this subclause is to define the context that belongs to each key, how it is obtained and the scope of its usage.

The context described in 8.2.8.1 to 8.2.8.3, shall only be maintained if either one of two conditions are met. One, the BS and CPE have detected that they are no longer connected to each other. Two, the CPE detects that it has moved. If the CPE is being asked to shutdown or it is attempting affiliation with another BS, it shall stop any current state machines, remove any SAs, as well as delete any security context prior to affiliation with a new BS.

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8.2.8.1 AK context

The AK key has two phases of lifetime: the first begins at AK creation and the second begins after validation by the SCM Key-Request/Reply handshake.

Hence, when the PKM is created, it is created with a specific lifetime.

If the (current) cached AK and associated context is lost either by the BS or the CPE, now new TEKs can be transported to the CPE using the KEK derived from that AK. Reauthentication shall be required to establish a new PKM, which allows for a new AK to be derived. From the AK, the MMP_KEY and KEK are derived. The MMP_KEY is used to protect management messages, while the KEK is to be used to transport new TEKs to the CPE.

The AK context is described in Table 237.

Table 237—AK Context in SCM

Parameter	Size (bits)	Usage
AK	160	The authentication key, calculated as defined in 8.2.4.1.
AK Lifetime	32	This is the time this key is valid; it is calculated AK lifetime = PMK lifetime = Authentication Grace Time. When this expires, reauthentication is needed.
AK Sequence Number	4	The sequence number of the PMK from which this AK is derived.
KEK	128	Used to encrypt transport keys from the BS to the CPE.
MMP_KEY	128	The key which is used for signing and/or encrypting DS/US management messages.
MMP_PN	24	Used to avoid DS/US replay attack on management connection. When this expires reauthentication is needed.

8.2.8.2 GKEK context

The GKEK is the head of the group key hierarchy. There is a separate GKEK for each group (each GSA).

This key is randomly generated by the BS and transferred to the CPE encrypted with KEK. It is used to encrypt group TEKs (GTEK) when broadcasting them to all CPEs. The GKEK context is described in Table 238.

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Table 238—GKEK context

Parameter	Size (bits)	Usage
GKEK	128	Used to encrypt transport keys from the BS to the CPE.
GKEK Sequence Number	4	The sequence number of the GKEK. The new GKEK sequence number shall be one greater than the preceding GKEK sequence number.
GKEK Lifetime	32	This is the time this key is valid; prior to expiration a new GKEK should be obtained.
GTEK0	128	Older of two keys used to sign and/or encrypt multicast/broadcast management and data traffic messages.
GTEK1	128	Newer of two keys used to sign and/or encrypt multicast/broadcast management and data traffic messages.
GPN0	24	Packet number counter associate with older of two keys used to sign and/or encrypt multicast/broadcast management and data traffic messages. Used to avoid DS/US replay attack on multicast/broadcast connection. When this expires re-keying is needed.
GPN1	24	Packet number counter associate with older of two keys used to sign and/or encrypt multicast/broadcast management and data traffic messages. Used to avoid DS/US replay attack on multicast/broadcast connection. When this expires re-keying is needed.

8.2.8.3 PMK context

The PMK context includes all parameters associated with the PMK. This context is created when EAP-based Authentication completes.

The PMK context is described in Table 239.

Table 239—PMK Context

Parameter	Size (bits)	Usage
PMK	160	A key yielded from EAP-based authentication
PMK Sequence Number	4	PMK sequence number, when the EAP-based authentication is achieved and a key is generated. The MSB 2 bits are the sequence counter, and the least significant bits are set to 0.

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8.3 Key usage

8.3.1 BS key usage

The BS is responsible for maintaining keying information for all SAs. The SCM protocol defined in this specification describes a mechanism for synchronizing this keying information between a BS and its client CPE.

8.3.1.1 AK lifetime

At initial network entry, if the security is enabled during the basic capabilities negotiation, the authentication procedure shall be initiated. The authentication procedure activates a new AK. This AK shall remain active until it expires according to its predefined *Authentication Grace Time*, a BS system configuration parameter. In SCM, AK lifetime is determined the PAK lifetime or by the expiration of the MMP_PN.

A CPE will initiate reauthentication before the expiration of its current AK. This leads the CPE to have two active sets of keying material. If a CPE fails to reauthenticate before the expiration of its current AK, the BS shall hold no active AKs for the CPE and shall consider the CPE *unauthenticated*. A BS shall remove from its keying tables all TEKs associated with an unauthenticated CPEs SA.

8.3.1.2 AK transition period on BS

The BS shall always be prepared to start reauthentication upon request. The BS shall be able to support two simultaneously active AKs for each client CPE. The BS has two active AKs during an AK transition period; the two active keys have overlapping lifetimes.

In SCM, an AK transition period begins when the BS receives an SCM EAP-Transfer or EAP-Start message from a CPE to start reauthentication and the BS has a single active AK for that CPE. In response to this request for reauthentication, the BS activates a second AK [see point (a) and (d) in Figure 165], which shall have a key sequence number one greater (modulo 16) than that of the existing AK and shall be sent back to the requesting CPE in an SCM EAP-Transfer message during reauthentication. The BS shall set the active lifetime of this second AK to be the remaining lifetime of the first AK [between points (a) and (c) in Figure 165], plus the predefined *AK Lifetime*; thus, the second, “newer” key shall remain active for one *AK Lifetime* beyond the expiration of the first, “older” key.

As long as the BS is in the midst of a CPE AK transition period, and thus is holding two active AKs for that CPE, it shall respond to the SCM EAP-Transfer messages with the newer of the two active keys. Once the older key expires, an SCM EAP-Transfer transmission sent to start reauthentication shall trigger the activation of a new AK, and the start of a new key transition period indicated at point (b) in Figure 165.

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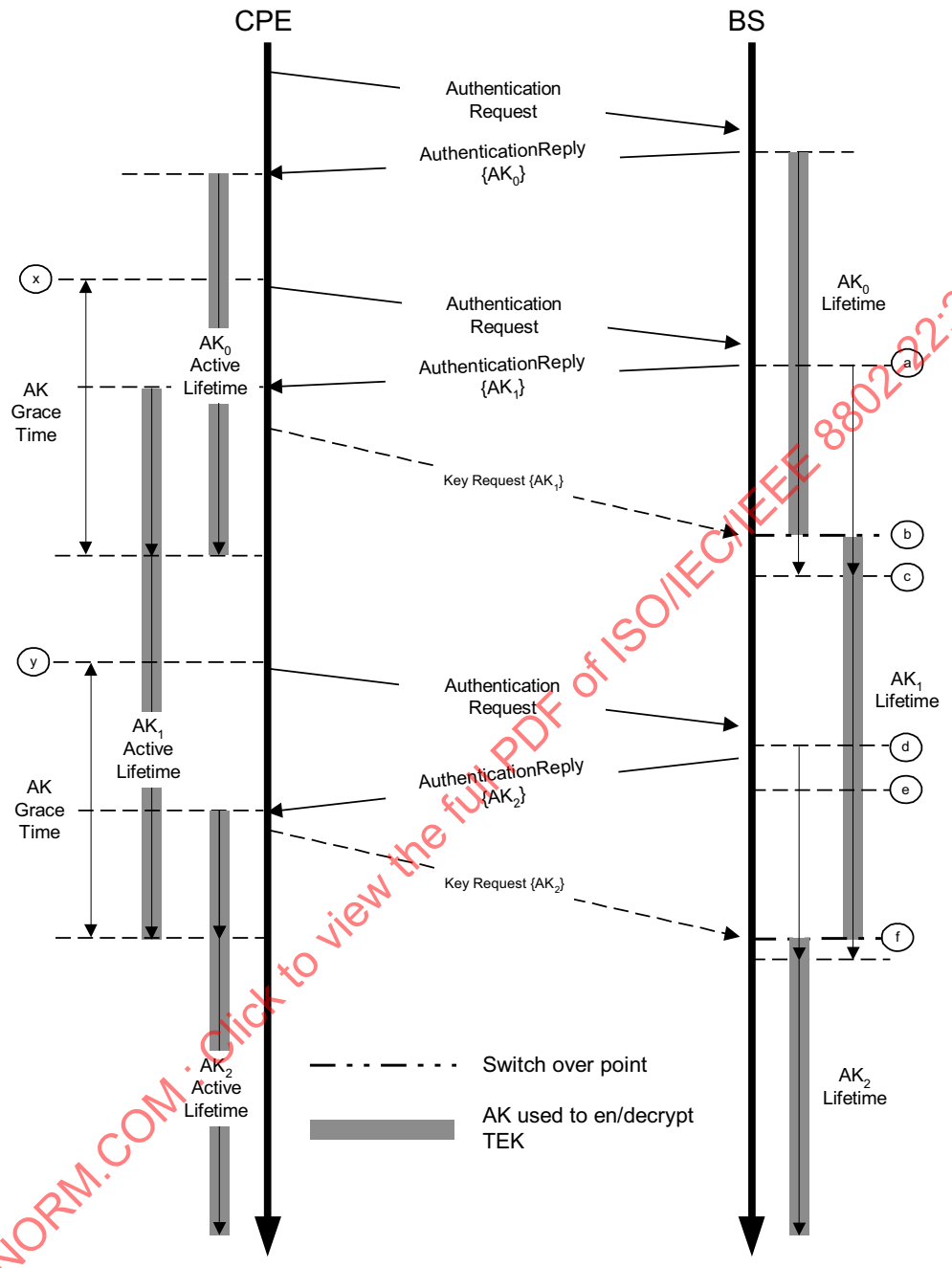

Figure 165—AK management in BS and CPE

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8.3.1.3 BS usage of AK

The BS shall make use of keys derived from the CPE's AK for the following purposes:

a) Verify MAC-Digests and decrypt (see 8.4) of SCM Key Request messages as well as all other non-SCM related management messages received from CPE

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b) Calculate MAC-Digests and encrypt (see 8.4) for SCM Key Reply messages as well as other non-SCM related management messages sent to CPE

c) Encrypting TEK when it is sent to CPE in the Key Reply message

The MMP_KEY is used to verify MAC Digests and decrypt (see 8.4) of SCM Key Request messages as well as other non-SCM related management messages received from CPE. The PN used in this operation is MMP_PN (see 8.2.4.6.1.2). When a CPE issues an SCM Key Request message, it shall include the AK Sequence Number, to indicate that it is using the newer of the two AKs that it is assigned.

The MMP_KEY is used to verify MAC Digests and decrypt (see) of SCM Key Reply messages as well as other non-SCM related management messages sent to the CPE. The PN used in this operation is MMP_PN (see 8.2.4.6.1.1). If the BS has been informed by the CPE that the Key Request issued by the CPE was issued with the newer AK, then BS shall use the MMP_KEY derived from the new AK and initialize MMP_PN associated with the new AK to 0. If the BS has no knowledge that the CPE is using the new AK, then it will use the MMP_KEY derived from the old AK and use the current value of MMP_PN associated with the older AK. The CPE indicates which AK is being used by including the AK Sequence Number of that AK in the Key Request message.

Prior to expiration of the MMP_PN, when half the key space (2^{23}) has been used up, the CPE conduct reauthentication.

8.3.1.4 TEK/GTEK lifetime

The BS maintains two, active TEKs per SA or GTEKs per GSA. Both TEKs/GTEKs will have overlapping lifetimes. *TEK/GTEK Lifetime* is a system parameter that determines the length of time for which the TEK/GTEK is valid. *TEK/GTEK Lifetime* is only invalidated when the PN associated with that TEK is about to expire. The *TEK/GTEK Lifetime* is communicated to the CPE, along with both generations of TEKs, from the BS in the SCM Key Reply message.

In the generic MAC header (GMH), the usage of the newer TEK/GTEK is indicated in the value of the EKS field. For the newer TEK/GTEK, the EKS field is 1 greater (modulo 4) than that of the older TEK/GTEK.

8.3.1.5 BS usage of TEK and GTEK

Two generations of TEKs shall be maintained per SA, and two generations of GTEKs shall be maintained per GSA. Transitioning between both generations of TEKs/GTEKs and how they are used are dependent on whether or not the TEK/GTEK is used for DS or US traffic.

The BS transitions from using the older generation to the newer generation (for each of its SAs) based on the following rules:

a) At the expiration of the older TEK/GTEK, the BS shall immediately transition to using the newer TEK/GTEK for encryption.

b) The transitional period for the encrypting US traffic begins when the BS issues the newer TEK/GTEK to the CPE in the SCM Key Reply message and concludes that the older TEK/GTEK has expired (i.e., its PN has expired).

The BS makes use of both generations of TEKs/GTEKs, based on the following rules:

a) BS shall use the older TEK/GTEK for encrypting DS traffic.

b) BS shall be able to decrypt US traffic using either of the two TEK.

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It is the responsibility of the CPE to update its keys in a timely fashion; the BS shall transition to a new DS encryption key regardless of whether a client CPE has retrieved a copy of that TEK/GTEK.

Note that the BS encrypts with a given TEK/GTEK for only the second half of that TEK's total lifetime (see Figure 166). The BS is able, however, to decrypt with a TEK/GTEK for the TEKs/GTEKs entire lifetime.

In Figure 166, "CPE" refers to CPEs and A-CPEs.

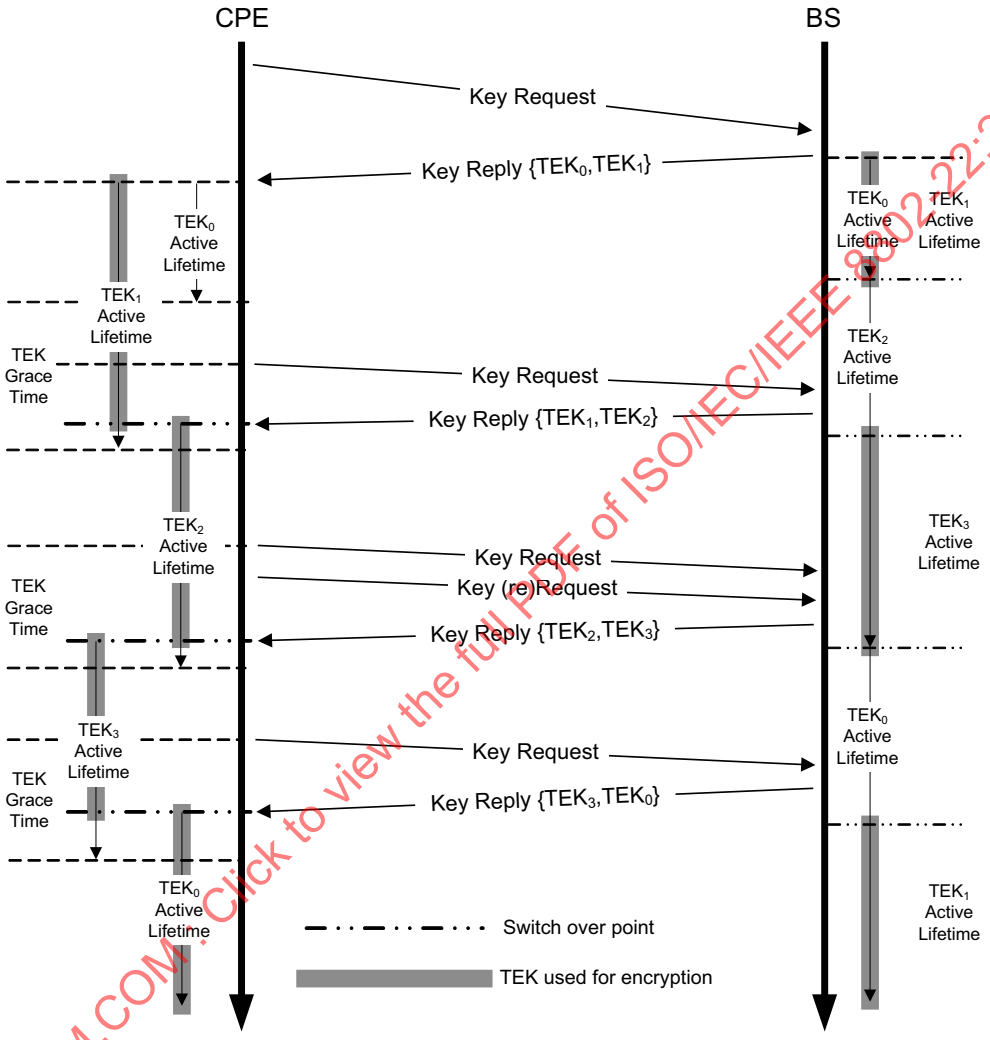

Figure 166—TEK Management in BS and CPE

8.3.2 CPE Key Usage

CPEs shall maintain an active AK and stay authenticated with the BS. This requires the CPE to initiate reauthentication periodically. Upon completing authentication and reauthentication, the CPE shall also be responsible for maintaining active keying material (e.g., TEKs) for encrypting DS and US traffic.

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8.3.2.1 CPE reauthentication

AKs have a limited lifetime and shall be periodically refreshed. The Authentication state machine (see Figure 161) manages the scheduling of reauthentication attempts for refreshing AKs. In SCM EAP-based authentication, the CPE refreshes its AK by issuing a SCM EAP-Request message.

In SCM, a CPE's Authentication state machine schedules the beginning of reauthentication a configurable duration of time, the *Authentication Grace Time*, [see points (x) and (y) in Figure 165], before the CPE's latest AK is scheduled to expire. The *Authentication Grace Time* is configured to provide a CPE with an authentication retry period that is sufficiently long to allow for system delays and provide adequate time for the CPE to successfully complete an Authentication exchange before the expiration of its most current AK. The *Authentication Grace Time* should be set at a value that does not expire for the MMP_PN expires.

Note that the BS does not require knowledge of the *Authentication Grace Time*. The BS, however, shall track the lifetimes of its AKs and shall deactivate a key once it has expired.

8.3.2.2 CPE usage of AK

A CPE shall use the MMP_KEY/KEK derived from the newer of the two AKs it has when calculating MAC Digests and encryption of SCM Key Request, and other SCM-related messages. A CPE shall use the MMP_KEY derived from the older of the two AKs to protect non-SCM related management messages that are transmitted to the BS.

The CPE shall be capable of using the MMP_KEY/KEK derived from the newer one of its AKs to verify and decrypt SCM Key Reply, SCM TEK Invalid, as well as other SCM-related messages. A CPE shall use the MMP_KEY derived from the older of the two AKs to protect non-SCM related management messages that are received from the BS.

8.3.2.3 CPE usage of TEK and GTEK

Through operation of its TEK state machines, a CPE shall maintain two, successive sets of keying material for encrypting traffic per SA. The CPE schedules requests for a new set of traffic keying material, based a configurable amount of time, the *TEK/GTEK Lifetime* [see points (x) and (y) in Figure 165], before the CPE's latest TEK is scheduled to expire.

For each SA for which the CPE is configured, the CPE

- Shall use the newer of its two TEKs to encrypt US traffic
- Shall be able to decrypt DS traffic encrypted with either of the TEKs.

The left-hand side of Figure 165 illustrates the CPE's maintenance and usage of an SA's TEK, where the shaded portion of a TEK's lifetime indicates the time period during which that TEK shall be used to encrypt MAC PDU payloads.

GTEKs shall be treated in the same manner as TEKs, with regard to how they are managed (see Figure 165).

8.4 Cryptographic methods

This subclause specifies the cryptographic algorithms and key sizes used by the SCM protocol. All CPE and BS implementations shall support the method of packet data encryption and authentication defined in 8.4.2, using the cryptographic suites specified in 8.4.1.

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All inputs to key derivation and other supporting functions shall be byte aligned. Furthermore, each byte shall be in canonical form as defined in IEEE Std 802-2001 where the leftmost bit in each byte is the most significant bit and the rightmost bit is the least significant bit.

8.4.1 Selection of Data Encryption and Authentication methods

Only one Data Encryption and Authentication algorithm is supported in IEEE 802.22, AES in GCM mode, therefore no specific configuration item is required to define the use of AES GCM. The parameters in Table 333 are associated with how AES GCM is to be applied in order to provide authentication and/or encryption for MAC PDU payloads. The cryptographic suite configuration for an SA takes into account the purpose of the SA and the type of CPE the SA is being configured for. Cryptographic suite configuration for an SA is negotiated during initial authentication and reauthentication via the exchange of SCM EAP-Transfer messages (see 8.2.2.7).

The cryptographic suite types are defined in Table 240.

Table 240—Cryptographic Suite Applicability and Description

Cryptographic Suite Identifier	PN Value Size (Byte)	ICV Value Size (Byte)	SA's Suite is used in	CPE Type
0x00	0	0	Null SA	All CPEs
0x01	3	8	Unicast Management SA, Unicast Transport SA, GSA	CPE, A-CPE
0x02	3	8	Unicast Management SA, GSA	Distributed Scheduling R-CPE, Centralized Scheduling R-CPE
0x03	4	8	Unicast Transport SA	A-CPE
0x04–0xFF	*Reserved*	*Reserved*	*Reserved*	

In Table 333, a configuration parameter for the list of SA's supported will be transmitted to the AAA through the BS by the CPE in the SCM EAP-Start and/or EAP-Transfer messages.

8.4.2 Data Encryption and Authentication with AES GCM

For all cryptographic suites (see Table 240) selected for operation during the Authentication, AES in GCM (NIST Special Publication 800-38D and FIPS 197) mode is used to provide authentication and/or encryption of MAC PDUs.

8.4.2.1 PDU format

8.4.2.1.1 Packet number (PN)

8.4.2.1.1.1 PN Overview

A PN is prepended to a MAC PDU payload when a CPE is configured for a cryptographic suite other than 0x00. The PN value associated with a cryptographic suite selected for an SA can be 3 bytes or 4 bytes. An advanced S-CPE cannot be configured for a multiple cryptographic suites that support both 3-byte and 4-byte PNs simultaneously across the Unicast Transport SA. Subclause 8.4.2.1.1.2 describes how the CPE

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an BS handle the operation of a 3-byte PN, and 8.4.2.1.1.3 describes how the CPE and BS handle the operation of a 4-byte PN..

8.4.2.1.1.2 3-byte PN procedure

The MAC PDU payload shall be prefixed with a 3-byte PN, when the cryptographic suite 0x01 or 0x02 is being used. The PN shall be encoded in the MAC PDU least significant byte first. The PN shall not be encrypted.

The PN associated with an SA shall be set to 1 when the SA is established and when a new TEK is installed. Upon completion of initial authentication or reauthentication and after the MMP_KEY has been derived, the MMP_PN is set to 1. After each PDU transmission made during single channel operation or each PDU transmission to be copied across all active BS/CPE-CHUs during multi-channel operation in Transmit Diversity mode, the PN and MMP_PN shall be incremented by 1. After each unique PDU transmission made on each active BS/CPE-CHU during multi-channel operation in Bulk Transmission mode, the PN and MMP_PN shall be incremented by 1 on each active CHU in succession.

When admitting a CPE to an existing multicast/broadcast group, the BS will take the current value of the PN related to the newest generation of material for that GSA, and increment by 1 when establishing. The maximum number of CPEs that can be admitted to a multicast/broadcast group simultaneously is one half the PN_WINDOW_SIZE (see 8.4.2.3).

On DS connections, the PN shall be XORed with 0x800000 prior to encryption and transmission. This effectively splits the PN space into two ranges for DS (0x000000–0x7FFFFF) and DU (0x800001–0xFFFFFF); thereby avoiding collision of PN values when using a single PN for DS and DU. On DS connections, the PN shall be used without such modification.

Any tuple value of {PN, KEY} shall be handled as per the receive processing rules for treating the PN value as described in 8.4.2.3. These measures are a known protection against replay attacks.

A new TEK shall be requested and transferred before the PN on either the CPE or BS reaches 0x7FFFFF. If the PN in either the CPE or BS reaches 0x7FFFFF without new keys being installed, transport communications on that SA shall be halted until new TEKs are installed. In the case of the MMP_KEY, if MMP_PN expires, then the current AK is invalidated and shall start Reauthentication.

8.4.2.1.1.3 4-byte PN procedure

The MAC PDU payload shall be prefixed with a 4-byte PN, when the cryptographic suite selected for the SA is 0x03. The PN shall be encoded in the MAC PDU least significant byte first. The PN shall not be encrypted.

The PN associated with an SA shall be set to 1 when the SA is established and when a new TEK is installed. Upon completion of initial authentication or reauthentication and after the MMP_KEY has been derived, the MMP_PN is set to 1. After each PDU transmission made during single channel operation or each PDU transmission to be copied across all active BS/CPE-CHUs during multi-channel operation in Transmit Diversity mode, the PN and MMP_PN shall be incremented by 1. After each unique PDU transmission made on each active BS/CPE-CHU during multi-channel operation in Bulk Transmission mode, the PN and MMP_PN shall be incremented by 1 on each active CHU in succession.

When admitting a CPE to an existing multicast/broadcast group, the BS will take the current value of the PN related to the newest generation of material for that GSA, and increment by 1 when establishing. The maximum number of CPEs that can be admitted to a multicast/broadcast group simultaneously is one half the PN_WINDOW_SIZE (see 8.4.2.3).

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On DS connections, the PN shall be XORed with 0x80000000 prior to encryption and transmission. This effectively splits the PN space into two ranges for DS (0x00000000–0x7FFFFFFF) and DU (0x80000001–0xFFFFFFFF); thereby avoiding collision of PN values when using a single PN for DS and DU. On DS connections, the PN shall be used without such modification.

Any tuple value of {PN, KEY} shall be handled as per the receive processing rules for treating the PN value as described in 8.4.2.3. These measures are a known protection against replay attacks.

A new TEK shall be requested and transferred before the PN on either the CPE or BS reaches 0x7FFFFFFF. If the PN in either the CPE or BS reaches 0x7FFFFFFF without new keys being installed, transport communications on that SA shall be halted until new TEKs are installed. In the case of the MMP_KEY, if MMP_PN expires, then the current AK is invalidated and shall start Reauthentication.

8.4.2.1.2 PDU format—No Protection (Suite 0x00)

When this cryptographic suite is used the PDU format shall follow the format already defined in 7.6. PDUs using this suite shall have the EC bit set to 0 in the GMH.

8.4.2.1.3 PDU format—Authentication and Encryption, 3-byte PN (Suites 0x01-0x02)

The ciphersuites allow for authentication and/or encryption of MAC PDUs. If suite 0x01 or 0x02 is assigned to the SA, then authentication and encryption are provided for any MAC PDUs transmitted on service flows that are mapped to these SAs.

The AES in GCM protocol is applied in the following manner:

1) The Plaintext Payload is processed, generating an Integrity Check Value (ICV) that is 8 bytes long.
2) Then the ICV is encrypted using the active TEK/GTEK, generating the Ciphertext ICV.
3) Then the Plaintext Payload is encrypted with AES using the active TEK/GTEK, generating a Ciphertext Payload.
4) The encrypted PDU is formed by prepending the proper PN value to the Ciphertext Payload and appending the Ciphertext ICV to the Ciphertext Payload.

This requires the EC bit in the GMH to be set to 1. If EC bit is not set to 1, the PDU shall be discarded, as this would indicate a conflict between the configured cryptographic suite and how it is being applied.

Figure 167 illustrates how MAC PDUs are processed and formatted when suite 0x01 or 0x02 is configured and the EC bit in GMH is set to 1. The Ciphertext ICV is transmitted so that byte index 0 (as enumerated in NIST Special Publication 800-38D) is transmitted first and byte index 7 is transmitted last (i.e., LSB first).

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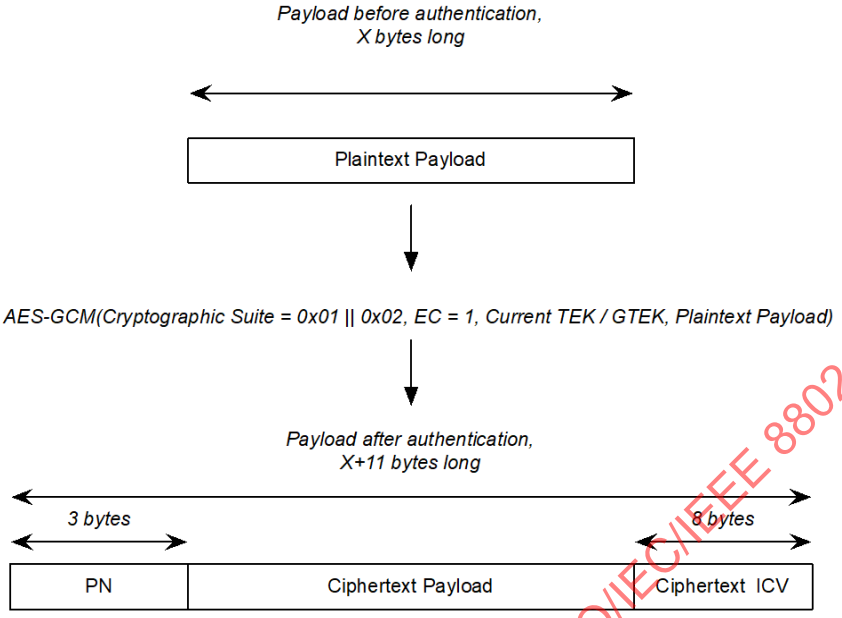

Figure 167—Authentication and Encryption, 3-byte PN PDU format

8.4.2.2 PDU format—Authentication and Encryption only, 4-byte PN (Suite 0x03)

If suite 0x03 is assigned to an SA, then MAC PDUs associated with service flows mapped to this SA shall be protected by authentication and encryption, and no other cipher suites can be mapped to this SA.

The AES in GCM protocol is applied in the following manner:

1) The Plaintext Payload is processed, generating the Integrity Check Value (ICV) that is 8 bytes long.
2) Then the ICV is encrypted using the active TEK, generating the Ciphertext ICV.
3) Then the Plaintext Payload is encrypted with AES using the active TEK, generating a Ciphertext Payload.
4) The encrypted PDU is formed by prepending the proper PN value to the Ciphertext Payload, and appending the Ciphertext ICV to the Ciphertext Payload.

This requires the EC bit in the GMH to be set to 1. If the EC bit is not set to 1, the PDU shall be discarded, as this would indicate a conflict between the configured cryptographic suite and how it is being applied.

Figure 168 illustrates how MAC PDUs are processed and formatted when suite 0x10 is configured and the EC bit in GMH is set to 1.

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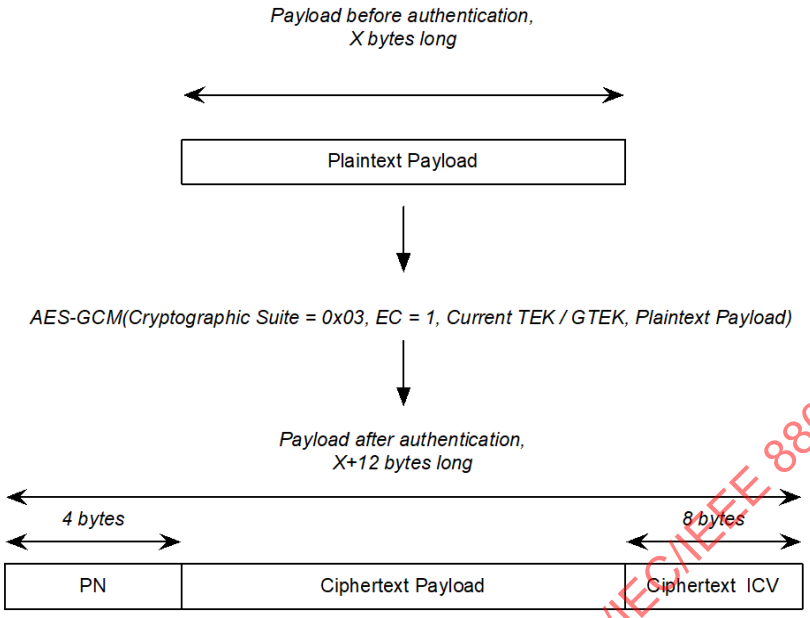

Figure 168—Authentication and Encryption, 4-byte PN PDU format

The GCM specification (NIST SP 800-38D) defines specific values for several parameters.

The additional authenticated data (AAD) to be used in the GCM process shall be the GMH.

T represents the ICV (otherwise known as Message Authentication Code, MAC). This value, as stated in 8.4.2.1, shall be 64 bits (8 octets) long for suites 0x08, 0x09, 0x0A, 0x0B, 0x11, 0x12, 0x13, and 0x14. This value, as stated in 8.4.2.1, shall be 32 bits (4 octets) long for suites 0x01, 0x02, 0x03, 0x04, 0x0C, 0x0D, 0x0E, and 0x0F.

Consistent with the GCM specification, the IV or Initialization Vector is used to initialize the Authenticated Encryption function of GCM. The IV shall be 128 bits (16 octets) long for suites (0x01 and 0x02) that use a 3-byte PN or 136 bits (17 octets) for suites (0x03) that use a 4-byte PN. The IV shall be constructed according to the procedure defined 8.2.1 of NIST Special Publication 800-38D. The IV for suites using the 3-byte PN is described in Table 241. The IV for suites using the 4-byte PN is described in Table 242.

IV construction for suites using the 3-byte PN is ordered as follows:

— The IV shall be 16 bytes long.
— Bytes 0 through 3 shall be set to the first 4 bytes of the generic MAC header (thus excluding the HCS). The HCS of the generic MAC header is not included in the IV since it is redundant.
— Bytes 4 through 12 are reserved and shall be set to 0x000000000000.
— Bytes 13 through 15 shall be set to the value of the PN. The PN bytes shall be ordered so that byte 13 shall take the least significant byte and byte 15 shall take the most significant byte.

IV construction for suites using the 4-byte PN is ordered as follows:

— The IV shall be 17 bytes long.
— Bytes 0 through 3 shall be set to the first 4 bytes of the generic MAC header (thus excluding the HCS). The HCS of the generic MAC header is not included in the IV since it is redundant.

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— Bytes 4 through 12 are reserved and shall be set to 0x000000000000.

— Bytes 13 through 16 shall be set to the value of the PN. The PN bytes shall be ordered so that byte 13 shall take the least significant byte and byte 16 shall take the most significant byte.

Table 241—IV construction for suites with 3-byte PN

Field	Fixed Field		Invocation Field
Byte	0 3	4 12	13 15
Data	GMH	*Reserved*	PN
Contents	GMH (without HCS)	0x00 00000 0000 000 0000	3bytePNfield from Payload

Table 242—IV construction for suites with 4-byte PN

Field	Fixed Field		Invocation Field
Byte	0 3	4 12	13 16
Data	GMH	*Reserved*	PN
Contents	GMH (without HCS)	0x000000000000000000	4bytePNfield from Payload

Consistent with the GCM specification, pre-counter block J_0 is generated using the equations defined in Section 7 of NIST Special Publication 800-38D.

Consistent with the NIST GCM specification, the counter blocks CB_j are formatted as shown in 6.5 of NIST Special Publication 800-38D.

8.4.2.3 Receive processing rules

On receipt of a PDU the receiving CPE or BS shall decrypt and authenticate the PDU consistent with the NIST GCM specification configured as specified in 8.4.2.2.

Packets that are found to be not authentic shall be discarded.

Receiving BS or CPEs shall maintain a record of the highest value PN and MMP_PN received for each SA. The receiver shall maintain a PN window whose size is specified by the PN_WINDOW_SIZE parameter for SAs and management connections as defined in Table 272. The setting of PN_WINDOW_SIZE shall take into account the number of active CPE-CHUs when the network is configured to work in multi-channel operation with Bulk Transmission mode.

When single or multi-channel operation is engaged, any received PDU with a PN lower than the beginning of the PN window shall be discarded as a replay attempt. The receiver shall track PNs within the PN window.

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When the network is configured for single-channel operation, any PN that is received more than once shall be discarded as a replay attempt. When the network is configured for multi-channel operation in Transmit Diversity mode, any PN that is received more than once on all active CHUs shall be discarded as a replay attempt. When the network is configured for multi-channel operation in Bulk Transmission mode, any PN that is received more than once on one or more of the active CHUs shall be discarded as a replay attempt. Upon reception of a PN, which is greater than the end of the PN window, the PN window shall be advanced to cover this PN.

8.4.3 Requirements for EAP-TLS/TTLS

IEEE 802.22 devices shall use EAP-TLS or EAP-TTLS to support device authentication. IEEE 802.22 BSs shall use EAP-based techniques for the authentication of the database service. Implementation of authentication services (e.g., key agreement and digital signature processed) based on EAP-TLS or EAP-TTLS shall conform to the specifications as defined in the following IETF RFCs:

— IETF RFC 5246
— IETF RFC 5216
— IETF RFC 5281
— IETF RFC 4492

Note that implementation of IETF RFC 5246 may include updates/extension to TLS as defined in IETF RFC 5746 [B39] and IETF RFC 5878 [B42]

8.5 Certificate profile

This standard mandates use of EAP-TLS or EAP-TTLS as the authentication mechanism. The certificate profile defined in this subclause provides a description of the credentials to be used for device authentication of IEEE 802.22 networks. This certificate profile is also used to develop credentials for database service access.

8.5.1 Certificate format

This subclause describes the X.509 Version 3 certificate format and certificate extensions used in IEEE 802.22-compliant CPEs. The X.509 Version 3 format is defined in IETF RFC 2459. ASN.1 encoding of algorithm identifiers are also further described in IETF RFC 3279 (as updated by RFC 4055 [B34], RFC 5480 [B38], RFC 5756 [B40], and RFC 5758 [B41]) and IETF RFC 5280. The basic X.509 Version 3 certificate format is retained from the reference system. Table 243 highlights the fields of an X.509v3 certificate.

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Table 243—Fields of X.509 Version 3 Certificates

X.509 Version 3 Field	Description
tbsCertificate.version	Indicates X.509 certificate version. Always set to 3.
tbsCertificate.serialNumber	Unique integer the issuing CA assigns to the certificate.
tbsCertificate.signature	Object identifier (OID) and optional parameters defining algorithm used to sign the certificate. This field shall contain the same algorithm identifier as the signature Algorithm field.
tbsCertificate.issuer	Distinguished Name of the CA that issued the certificate.
tbsCertificate.validity	Specifies when the certificate becomes active and when it expires.
tbsCertificate.subject	Distinguished Name identifying the entity whose public key is certified in the subject public key information field.
tbsCertificate.subjectPublicKeyInfo	Field contains the public key material (public key and parameters) and the identifier of the algorithm with which the key is used.
tbsCertificate.issuerUniqueID	Optional field to allow reuse of issuer names over time.
tbsCertificate.subjectUnique ID	Optional field to allow reuse of subject names over time.
tbsCertificate.extensions	The extension data.
signatureAlgorithm	OID and optional parameters defining algorithm used to sign the certificate. This field shall contain the same algorithm identifier as the signature field in tbsCertificate.
signatureValue	Digital signature computed upon the ASN.1 DER encoded tbsCertificate.

All certificates described in this specification shall be based on RSA or ECC. With RSA, the RSA signature algorithm SHA-256 is used as the one-way hash function. The RSA signature algorithm is described in PKCS #1 (IETF RFC 2437); SHA-256 is described in FIPS 180-3.

For ECC certificates elliptic curve domain parameters can be generated according to procedures defined in A.3 of ANSI X9.62-2005. Example parameters sets of parameters can be found in FIPS 186-3 and ANSI X9.63-2001.

8.5.1.1 tbsCertificate.validity.notBefore and tbsCertificate.validity.notAfter

CPE certificates shall not be renewable and shall thus have a validity period greater than the operational lifetime of the CPE. A Manufacturer/Service Provider CA certificate's validity period should exceed that of the CPE certificates it issues. The validity period of a CPE certificate shall begin with the date of generation of the device's certificate; the validity period should extend out to at least 10 years after that manufacturing date. Validity periods shall be encoded as UTC Time. UTC Time values shall be expressed Greenwich Mean Time (Zulu) and shall include seconds (i.e., times are YYMMDDHHMMSSZ), even where the number of seconds is zero.

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8.5.1.2 tbsCertificate.serialNumber

Serial numbers for CPE certificates signed by a particular issuer shall be assigned by the manufacturer in increasing order. Thus, if the tbsCertificate.validity.notBefore field of one certificate is greater than the tbsCertificate.validity.notBefore field of another certificate, then the serial number of the first certificate shall be greater than the serial number of the second certificate.

8.5.1.3 tbsCertificate.signature and signatureAlgorithm

Certificates can be signed with the RSA or ECDSA (ANSI X9.62-2005) algorithms. ECDSA is the elliptic curve analog of the DSA signature algorithm. The following two subclauses define OIDs that represent values for tbsCertificate.signature and signatureAlgorithm fields of the X.509v3 certificate to describe each algorithm.

8.5.1.3.1 RSA signature & signatureAlgorithm

The RSA signature algorithm (PKCS #1, IETF RFC 2437), which makes use of SHA-256 is described in FIPS 180-3) as the one-way hash algorithm. The ASN.1 OID used to describe the RSA signature algorithm using SHA-256 is as follows:

sha-256WithRSAEncryption OBJECT IDENTIFIER ::=

{ iso(1) member-body(2) us(840) rsadsi(113549) pkcs(1) pkcs-1(1) 11}

The calculation and encoding of the signature value is described in PKCS #1 (IETF RFC 2437) specification. The signature value is calculated over the rest of ASN.1 encoded certificate, then inserted in the signatureValue field of the certificate.

8.5.1.3.2 ECC signature & signatureAlgorithm

ECDSA itself is identified by OIDs arranged in the following manner:

ansi-X9-62 OBJECT IDENTIFIER ::= {

iso(1) member-body(2) us(840) 10045 }

id-ecSigType OBJECT IDENTIFIER ::= {

ansi-X9-62 signatures(4) }

ECDSA also uses SHA-256 as the one-way hash function. The ASN.1 OID used to describe the ECDSA signature algorithm using SHA-256 is as follows:

ecdsa-with-SHA-256 OBJECT IDENTIFIER ::= { iso(1) member-body(2)

us(840) ansi-X9-62(10045) signatures(4) ecdsa-with-SHA2(3) 1

}

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The calculation and encoding of the signature value is described in ANSI X9.62-2005. This process outputs two values (r and s). The signature value is calculated over the rest of ASN.1 encoded certificate, then inserted in the signatureValue field of the certificate using the following ASN.1 encoded data structure:

```
Ecdsa-Sig-Value ::= SEQUENCE {

    r   INTEGER,

    s   INTEGER }
```

When the ephemeral public key R:=(x1,y1):=kG that is generated during the ECDSA signature generation algorithm has an odd valued “y-” coordinate “y1,” the ECDSA signature component “s” *shall* be changed towards the integer “-s” (modulo n), where “n” is the prime order of the cyclic subgroup of the elliptic curve in question. Note that this extra post-processing step can be executed by any party and that using accelerated methods for signature verification is (of course) entirely optional.

8.5.1.4 tbsCertificate.issuer and tbsCertificate.subject

X.509 Names are SEQUENCES of RelativeDistinguishedNames, which are in turn SETs of AttributeTypeAndValue. AttributeTypeAndValue is a SEQUENCE of an AttributeType (an OBJECT IDENTIFIER) and an AttributeValue. The value of the countryName attribute shall be a two-character PrintableString, chosen from ISO 3166 [B44]; all other AttributeValues shall be encoded as either T.61/ TeletexString or PrintableString character strings. The PrintableString encoding shall be used if the character string contains only characters from the PrintableString set. Specifically:

```
abcdefghijklmnopqrstuvwxyz

ABCDEFGHIJKLMNOPQRSTUVWXYZ

0123456789

’()+,–./:=? and space
```

The T.61/TeletexString shall be used if the character string contains other characters. The following OIDs are needed for defining issuer and subject Names in SCM certificates:

```
id-at OBJECT IDENTIFIER ::= {joint-iso-ccitt(2) ds(5) 4}

id-at-commonName OBJECT IDENTIFIER ::= {id-at 3}

id-at-countryName OBJECT IDENTIFIER ::= {id-at 6}

id-at-localityName OBJECT IDENTIFIER ::= {id-at 7}

id-at-stateOrProvinceName OBJECT IDENTIFIER ::= {id-at 8}

id-at-organizationName OBJECT IDENTIFIER ::= {id-at 10}

id-at-organizationalUnitName OBJECT IDENTIFIER ::= {id-at 11}
```

The following subclauses describe the attributes that comprise the subject Name forms for each type of SCM certificate. Note that the issuer name form is the same as the subject of the issuing certificate. Additional

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attribute values that are present but unspecified in the following forms should not cause a device to reject the certificate.

8.5.1.4.1 Manufacturer/ServiceProvider certificate

countryName=<Country of Manufacturer/ServiceProvider>

[stateOrProvinceName=<state/province>]

[localityName=<City>]

organizationName=<Company Name>

organizationalUnitName=WirelessRAN

[organizationalUnitName=<Manufacturing Location>]

commonName=<Company Name> <Certificate Authority>

The countryName, organizationName, and commonName attributes shall be included and shall have the values shown. The organizationalUnitName having the value "WirelessRAN" shall be included. The organizationalUnitName representing manufacturing location should be included. If included, it shall be preceded by the organizationalUnitName having value "WirelessRAN." The stateOrProvinceName and localityName may be included. Other attributes are not allowed and shall not be included.

8.5.1.4.2 CPE certificate

countryName=<Country of Manufacturer/ServiceProvider>

organizationName=<Company Name>

organizationalUnitName=<manufacturing location>

commonName=<MAC Address>

commonName=<Device Id>

commonName=<Serial Number>

The "Device Id" and "Serial Number" shall be formatted as alpha-numeric strings with 17 and 12 characters, respectively.

The MAC address shall be the CPE's MAC address. It is expressed as six pairs of hexadecimal digits 20 separated by colons (:), e.g., "C4:2C:03:32:B2:A1". The Alpha HEX characters (A–F) shall be expressed as 21 uppercase letters.

The organizationalUnitName in a CPE certificate, which describes the modem's manufacturing location, should be the same as the organizationalUnitName in the issuer Name describing a manufacturing location.

The countryName, organizationName, organizationalUnitName, and commonName attributes shall be included. Other attributes are not allowed and shall not be included.

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8.5.1.4.3 BS certificate

countryName=<Country of Operation>

organizationName=< Name of Infrastructure Operator>

organizationalUnitName=<WirelessRAN>

commonName=<MAC Address>

commonName=<Serial Number>

commonName=<FCC Id>

The “Serial Number” and “FCC Id” shall be formatted as alpha-numeric strings.

The MAC address shall be the BS's MAC address. It is expressed as six pairs of hexadecimal digits 20 separated by colons (:), e.g., “C4:2C:03:32:B2:A1.” The Alpha HEX characters (A–F) shall be expressed as 21 uppercase letters.

8.5.1.5 tbsCertificate.subjectPublicKeyInfo

The tbsCertificate.subjectPublicKeyInfo field contains the public key and the public key algorithm identifier. The following two subclauses describe OIDs used to encode this information for RSA public keys (8.5.1.5.1) and ECDSA/ECDH public keys (8.5.1.5.2).

8.5.1.5.1 RSA public keys

The OID that identify RSA encryption for a certificate are defined as follows:

```
pkcs-1 OBJECT IDENTIFIER ::= { iso(1) member-body(2) us(840)
        rsadsi(113549) pkcs(1) 1}

rsaEncryption OBJECT IDENTIFIER ::= { pkcs-1 1}
```

The OID that identifies RSA public keys in a certificate is defined as follows:

```
RSAPublicKey ::= SEQUENCE {
        modulus     INTEGER,  -- n
        publicExponent   INTEGER } -- e
```

8.5.1.5.2 ECDSA/ECDH public keys

ECDH (ANSI X9.63-2001) is the elliptic curve analog of Diffie-Hellman agreement. The OIDs and parameters used to encode information are similar for ECDSA signatures and ECDH encryption, and arranged in the following manner:

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```
ansi-X9-62 OBJECT IDENTIFIER ::=

{ iso(1) member-body(2) us(840) 10045 }


id-public-key-type OBJECT IDENTIFIER ::= { ansi-X9.62 2 }


id-ecPublicKey OBJECT IDENTIFIER ::= { id-publicKeyType 1 }
```

Each elliptic curve public key is associated with a set of elliptic curve parameters. The OIDs that define the elliptic curve parameters are arranged as follows:

```
EcpkParameters ::= CHOICE {
        ecParameters ECParameters,
        namedCurve  OBJECT IDENTIFIER,
        implicitlyCA NULL }
```

If ecParameters are inherited from the certificate authority, then the implicitlyCA value is included in EcpkParameters and is set to NULL. ecParameters and its components are defined as follows:

```
ECParameters ::= SEQUENCE {
        version  ECPVer,     -- version is always 1
        fieldID  FieldID,    -- identifies the finite field over
            -- which the curve is defined
        curve    Curve,      -- coefficients a and b of the
            -- elliptic curve
        base   ECPoint,      -- specifies the base point P
            -- on the elliptic curve
        order   INTEGER,     -- the order n of the base point
        cofactor INTEGER OPTIONAL -- The integer h = #E(Fq)/n
}


ECPVer ::= INTEGER {ecpVer1(1)}
```

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```
Curve ::= SEQUENCE {
        a    FieldElement,
        b    FieldElement,
        seed   BIT STRING OPTIONAL }

FieldElement ::= OCTET STRING

ECPoint ::= OCTET STRING
```

ECPoint represents the base point of an elliptic curve and can take on two forms, compressed and uncompressed (defined in ANSI X9.62-2005). For certificates the encoding of ECPoint shall be supported by the uncompressed form. The compressed form may (optionally) be used instead.

The elliptic curve domain parameters can be generated according to procedures defined in A.3 of ANSI X9.62-2005. Example parameters sets of parameters can be found in FIPS 186-3 and ANSI X9.63-2001.

8.5.1.6 tbsCertificate.issuerUniqueID and tbsCertificate.subjectUniqueID

The issuerUniqueID and subjectUniqueID fields shall be omitted for all of the SCM's certificate types.

8.5.1.7 tbsCertificate.extensions

8.5.1.7.1 CPE certificates

CPE certificates may contain noncritical extensions; they shall not contain critical extensions. If the KeyUsage extension is present, the keyAgreement and keyEncipherment bits shall be turned on, keyCertSign and cRLSign bits shall be turned off, and all other bits should be turned off.

8.5.1.7.2 BS certificates

Manufacturer/ServiceProvider certificates may contain the Basic Constraints extension. If included, the Basic Constraints extension may appear as a critical extension or as a noncritical extension. Manufacturer/ ServiceProvider certificates may contain noncritical extensions; they shall not contain critical extensions other than, possibly, the Basic Constraints extension. If the KeyUsage extension is present in a Manufacturer/ServiceProvider certificate, the keyCertSign bit shall be turned on and all other bits should be turned off.

8.5.1.8 signatureValue

In all three SCM certificate types, the signatureValue can contain either the RSA (with SHA-256) or ECDSA signature computed over the ASN.1 DER encoded tbsCertificate. The ASN.1 DER encoded tbsCertificate is used as input to the RSA signature function. The resulting signature value is ASN.1 encoded as a bit string and included in the Certificate's signatureValue field.

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8.5.2 Certificate storage and management

8.5.2.1 Certificate storage and management in CPE

Manufacturer/ServiceProvider-issued CPE certificates shall be stored in (e.g., pre-installed) CPE permanent, write-once memory. CPEs that have pre-installed RSA private/public key pairs shall also have factory-installed CPE certificates. CPEs that rely on internal algorithms to generate an RSA key pair shall support a mechanism for installing a manufacturer-issued CPE certificate following key generation. The CA certificate of the Manufacturer/ServiceProvider CA that signed the CPE certificate shall be embedded into the CPE software. If a manufacturer issues CPE certificates with multiple Manufacturer/ServiceProvider CA certificates, the CPE software shall include ALL of that manufacturer's CA certificates. The specific Manufacturer/ServiceProvider CA certificate installed by the CPE shall be that identifying the issuer of that modem's CPE certificate.

8.5.2.2 Certificate storage and management in the BS

SCM employs digital certificates to allow BSs to verify the binding between an identity (encoded in an X.509 digital certificate's subject names) and its public key for both a CPE and a database service. The BS does this by validating the CPE or database service certificate's certification path or chain. Validating the chain means verifying the Manufacturer/ServiceProvider CA Certificate through some means.

8.6 Security sublayer 2—Security mechanisms for the cognitive functions

Unlike other standards where devices operate in the licensed spectrum, cognitive radio based WRANs need to operate in the unlicensed spectrum or *white spaces* as secondary occupiers of the spectrum. Mechanisms have been defined in various clauses of IEEE Std 802.22 to protect the incumbents who are the primary occupiers of the spectrum (spectrum sensing, geolocation, spectrum management, spectrum etiquette etc.). This subclause provides further details on how to protect the incumbents as well as the IEEE 802.22 systems against various types of Denial of Service (DoS) attacks targeted at the cognitive functions of the IEEE 802.22 systems. As a result, the security sublayer 2 has been introduced in the *cognitive plane* of the IEEE 802.22 entity. The *cognitive plane* consists of a Spectrum Sensing Function (SSF), a Geolocation Function and an SM at the BS or the Spectrum Automaton at the CPE.

Figure 3 shows the IEEE 802.22 Protocol Reference Model (PRM) with its Cognitive Plane functions containing security sublayer 2 at the BS. Figure 4 shows the IEEE 802.22 PRM with its Cognitive Plane functions containing security sublayer 2 at the CPE. Details on the PRM itself can be found in 5.1.

Organization—Subclause 8.6.1 defines detailed attributes and mechanisms that IEEE 802.22 systems are required to provide for securing and protecting the cognitive functions. Some cognitive plane security related mechanisms are an integral part of other cognitive functions required for the IEEE 802.22 system implementation such as Spectrum Sensing Function, geolocation, spectrum manager, Spectrum Automaton, Management Plane procedures and functions etc. Since these functions are described in clauses other than Clause 8, 8.6, briefly describes the required security features and provides references as to where in IEEE 802.22 mechanisms or the messaging for the same can be found. These security mechanisms are related to availability, authentication, authorization, identification, integrity, confidentiality, and privacy. Subclause 8.6.1 describes distributed sensing, and decision making to enhance security for WRAN systems and the incumbents. The information fusion and decision making mechanism are explained in greater detail in Clause 11 on Cognitive Radio Capability. The theoretical background for collaborative sensing and decision making is provide in Annex E related to Collaborative Sensing and Decision Making to Provide Protection against the Spurious Signals. Some other security mechanisms related to the cognitive capability are also defined in greater detail in this subclause. Subclause 8.6.2 is related to the CBP Authentication Mechanisms and 8.6.3 is related to the IEEE 802.22.1 Wireless Microphone Beacon Authentication.

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Some of the basic security functions of this layer and the remediation measures required to protect these functions are described in Annex F.

8.6.1 Signal type determination, distributed sensing, and policy enforcement

8.6.1.1 General

The essential functions of the security sublayer 2 at the cognitive plane shall be to provide protection for the incumbents as well as protection to the IEEE 802.22 systems against DoS attacks of various types. Figure 169 shows the security sublayer architecture for the Cognitive Plane. This security sublayer is responsible for distributed spectrum sensing, signal type determination, correlation with geolocation information from various sensors (CPEs) located in the network and policy enforcement. This information from various sensors shall be combined in a certain way, which is referred to as information fusion followed by policy enforcement. These steps enable the IEEE 802.22 systems to provide protection against some types of DoS attacks. Since this functionality is essentially a part of the Spectrum Manager (SM), the signal type determination, information fusion, and policies are defined in Clause 11; however a brief description is provided in 8.6.1.2 and 8.6.1.3..

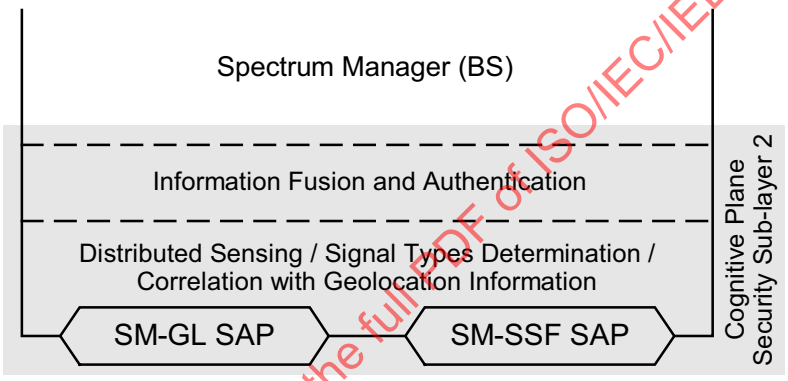

Figure 169—Security sublayer 2 at the Cognitive Plane

8.6.1.2 Signal type determination

IEEE 802.22 systems shall have the capability to determine the signal types that have been detected as an outcome of spectrum sensing. The signal type determination is dependent on the regulatory domain requirements and has been specified in Clause 11 and Annex A. In some regulatory domains, the signal type determination through the use of spectrum sensing may be necessary since it determines the radio transmission behavioral control using various policies and procedures.

8.6.1.3 Distributed sensing mechanisms

Distributed spectrum sensing is a scheme wherein *more than one* Radio Frequency (RF) sensors are used to sense the spectrum. This local sensing information shall be made available at the BS that makes a decision on whether to make opportunistic usage of the spectrum.

Annex F shows some comparisons of distributed spectrum sensing and information fusion to improve security in a network consisting of cognitive radios such as the one being considered for IEEE 802.22 systems. In Annex E, various rules are considered for information fusion where it has been shown that rather than using simple OR or AND type rules, *Voting based rules* provide flexibility and accuracy needed to provide security protection in cognitive radio systems. However, in certain regulatory domains such as the US, only 'OR' rule based distributed sensing is allowed wherein even if one sensor detects and determines the signal type, the policies defined in Clause 11 for such a detected signal need to be enforced.

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Distributed sensing may take into account the knowledge on the geographic location of the specific sensing devices providing sensing reports. Sensing related information exchange for distributed sensing scheme may utilize available interfaces and data structures (IEEE Std 1900.6™ [B16]). The correlation of the reports of the sensing devices that may have sent an urgent coexistence situation (UCS) message to the BS and their respective geographic location may provide means to identify the characteristics of the sensed signal. This may improve the decision making to determine the presence of an incumbent and its type versus presence of other devices based on their expected extent of coverage.

In the case of DTV detection, there will be larger area where the sensors will detect the presence of the signal. In the case of a wireless microphone, the detection will be over a limited area. This is also true in the case of the detection of an IEEE 802.22.1 beacon. This information is useful in determining the signal type and, in the case of an IEEE 802.22.1 beacon, it reduces the need to rely on the full PPDU decoding.

Since all the information may be available at the BS, based on what is allowed in the regulatory domain requirements, it will be up to the manufacturers to implement various levels of complexity in fusing the sensing reports and the geographic location of the sensing devices to come up with a reliable assessment of the presence of incumbents, that is true positives, while minimizing the probability of false positives. Incumbents shall be protected in all cases and in case of doubt; action shall be taken to avoid interference to incumbents. More advanced data fusion and decision processes may have the advantage of avoiding false positives and false alarms and therefore reducing cases where WRAN systems would have to change frequency while it is not necessary.

Distributed sensing will help provide protection to the primary users of the spectrum since the probability of missed detection reduces with the number of sensors. Signal type determination and distributed sensing provides protection to the WRAN systems of the spectrum against DoS attacks. Distributed sensing helps to protect the WRAN systems against DoS attacks since it is easy to fool one sensor into believing the state of the spectrum, however, it is difficult to fool many sensors located in proximal, but disparate geographical locations. However, the data fusion rule for the distributed sensing shall be used in accordance with the specified regulatory domain requirements. (See Annex A.)

8.6.1.4 Policy enforcement and radio transmission behavior control

The IEEE 802.22 SM shall control the radio transmission behavior of the BS and the CPEs via policy sets as defined in 11.5.2.

8.6.2 CBP Authentication mechanisms

This subclause discusses a method to provide protection over CBP bursts. The CBP authentication works through direct transmissions of CBPs between BSs over-the-air, through CPEs in overlap areas that will just blindly relay the received CBP burst, or via a network backhaul mechanism. This method provides authentication and integrity protection for CBPs by using certificates to facilitate calculation of a signature over the CBPs. The calculation of the signature does not hide, modify or transform the data in anyway. This signature is then added to the CBPs as an IE. CBP bursts that include the signature IE can be decoded and processed by BSs that do not support the CBP protection mechanism. If the receiving BS supports the CBP protection, and has the key that can be used to verify the signature, the signature verification process is started. If verification is successful the CBP burst is processed, if verification fails the CBP burst is dropped.

This method was derived from the method used to protect beacon messages transmitted by low-powered licensed devices operating in television broadcast bands as defined in the current IEEE Std 802.22.1-2010. The receiving station (CPE or BS) uses the certificate information to verify the signature. CBP Protection can be provided using one of two options. Figure 170 and Figure 171 describe the process by which certificates used in CBP Protection are distributed for each option. Subclauses 8.6.2.1 to 8.6.2.5 describe the options in detail. A process by which BSs can exchange their implicit certificates is described in 8.6.2.6.

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CBP Authentication relies on certificates based on the Elliptic Curve Qu-Vanstone Implicit Certificate Scheme (ECQV) as defined in SEC 4. Traditional certificates bind the identity of the device to a public key and a signature. The implicit certificate scheme defines a more compact certificate by binding the identity to public reconstruction data. The tuple of the "device identity || public reconstruction data || certificate authority public key" is fed into a know function to generate a public key for the device.

CBP Authentication makes use of implicit certificates given their smaller size and faster processing advantages. Given these advantages, it must be noted that there is one drawback. Any set of random data for the public reconstruction data and the certificate authority public key can be used with a device identity to generate a public key. This can be mitigated in one of two ways. First, if a device can provide knowledge of the private key that is bound to the reconstructed public key, it assures that the certificate authority has bound that public reconstruction data to that device's identity. Second, if a malicious user makes use of random data to generate a public key, it is not feasible to recompute the associated private key.

Throughout this subclause "BS" refers to BS operating on PHY-OM1, as well as distributed scheduling R-CPE and A-BS operating on PHY-OM2. Throughout this subclause, "MAC Address" refers to IEEE 48-bit MAC address that identifies the BS in PHY-OM1, as well as the distributed scheduling R-CPE and the A-BS in PHY-OM2.

The organization of this sublcause is a follows:

- 8.6.2.1: Process for executing CBP Authentication Mode 1
- 8.6.2.2: Process for executing CBP Authentication Mode 2
- 8.6.2.3: Describes the format of implicit certificates and Signature IEs that are in CBP bursts
- 8.6.2.4: Prerequisites for and execution of certificate generation/verification processes
- 8.6.2.5: Prerequisites for and execution of Signature generation/verification processes
- 8.6.2.6: BS implicit certificate Exchange

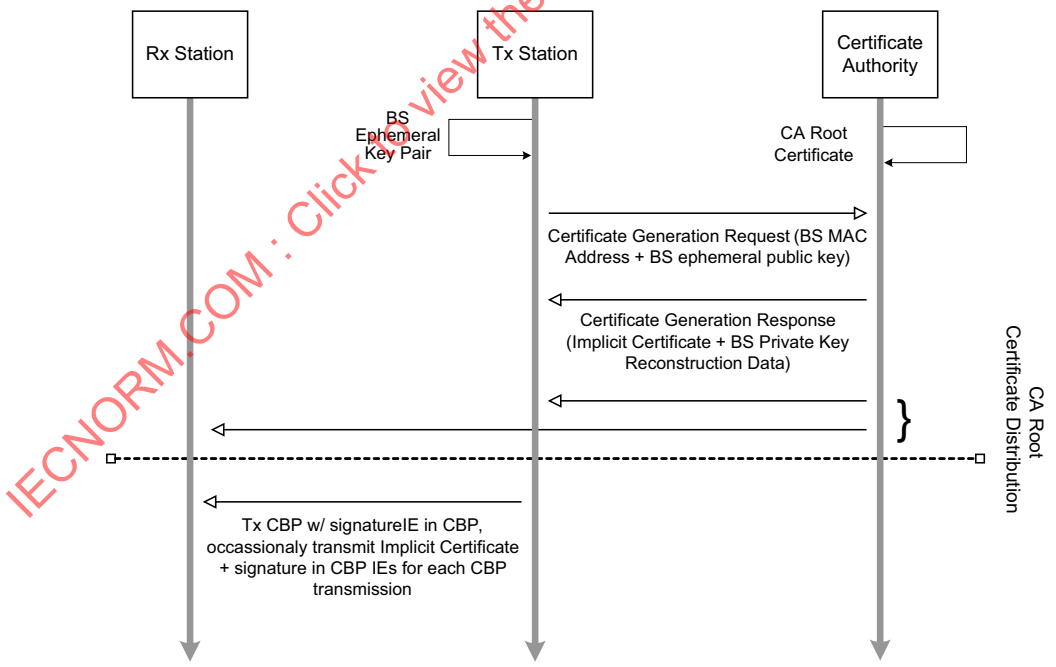

Figure 170—CBP Authentication Mechanisms for Mode 1

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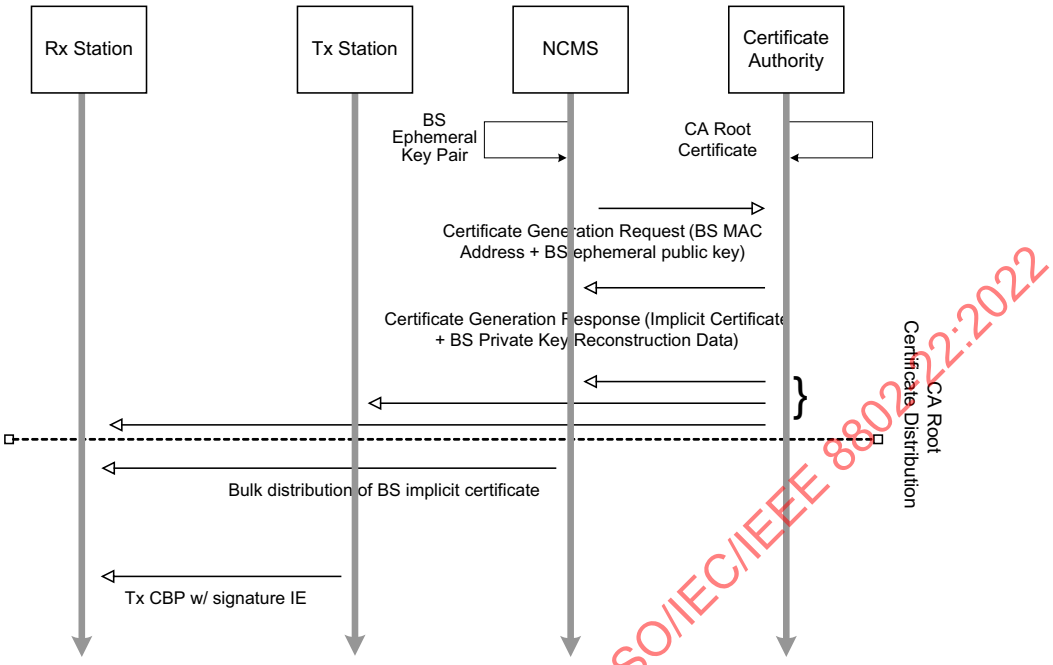

Figure 171—CBP Authentication Mechanisms for Mode 2

8.6.2.1 CBP Protection Mode 1

Mode 1 of CBP Protection entails transmission of BS ECC implicit certificates in CBP bursts on a regular basis, and inclusion of the signatures to be transmitted every CBP bursts. The format of the BS certificate and signature data is described in 8.6.2.3. Option 1 is executed in the following manner:

1) The BS uses the procedure in 8.6.2.4 to obtain an implicit certificate for the BS.
2) BS adds its implicit certificate to CBP as an IE. This may happen only via a periodic broadcast or during a certificate request/response (CERT-REQ/RSP, see 8.6.2.6).
3) BS implicit certificate private key is used directly to calculate an ECSSR-PV signature over the CBP burst data (see 8.6.2.5.2).
4) Receiving station receives a CBP burst with certificate and signature IEs. If the receiving station already has cached the implicit certificate from a transmitting station, it can skip ahead to verifying the signature. The receiving station then validates the BS implicit certificate's public key, Key Validity Date (Not Before), and Key Validity Time Period fields (see 8.6.2.4.3). If this validation fails, the receiving station drops the CBP. If successful, the receiving stations attempts to verify the signature (see 8.6.2.5.3). If this fails, receiving station will drop the CBP.

8.6.2.2 CBP Protection Mode 2

Mode 2 of CBP Protection entails pre-distribution of BS ECC implicit certificates to receiving station. This can be done when the CPE is activated, or via NCMS (for periodic certificate updates). BS calculates the signature value in the same manner as described in steps 3 of the execution of Mode 1. The format of the of the BS certificate data that is pre-distributed the signature are defined in 8.6.2.3. Mode 2 is executed in the following manner:

1) The operator (via the NCMS) uses the procedures defined in 8.6.2.4.2 to obtain an implicit certificate and private key reconstruction data for each BS under its control. Each BS receives its

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own implicit certificate and private key reconstruction data. The NCMS verifies each BSs implicit certificate public key, Key Validity Date (Not Before), and Key Validity Time Period fields.

2) The operator (via the NCMS) then distributes implicit certificates of BSs to each BS that it controls in the network.
3) BS implicit certificate private key is used directly to calculate an ECSSR-PV signature over the CBP burst data (see 8.6.2.5.2).
4) Receiving station receives a CBP burst with the Signature IEs. The receiving station attempts to verify the Signature (see 8.6.2.5.3). If this fails, receiving station will drop the CBP.

8.6.2.3 CBP Protection Certificate and Signature structures

The following subclauses describe the structures of the certificate and signature information. For either mode, the Certificate Authority's root certificate (CARC) in Table 246 is exchanged only between the BS or operator NCMS, and the Certificate authority itself. For Mode 1, BS implicit certificates (BSIC) are exchanged between BS (via an IE in CBP burst) in order to facilitate CBP authentication. For Mode 2, the BS IC is not transmitted over the air. For either mode, the signature structure is included in an IE whenever a CBP burst is transmitted. The certificate and signature structures defined in this subclause are encoded as IEs that are defined in 7.8.1.3.1.7.

Table 244—Mode 1 and Mode 2 BS Implicit Certificate (BSIC)

Item	Size	Description
CA ID	8 bits	ID of CA that issued implicit certificate to BS
Key ID	9 bits	Identifier of public key associated with certificate as assigned by CA. This identifier is generated by the Certificate Authority (CA) when the certificate is created.
Key Validity Date (Not Before)	31 bits	Derived from ZDA NMEA 0183 string (each letter represents a digit encoded by different number of bits): — X: year = 2010+X, X is 6 bits — M: month, e.g., 01–12, total is 4 bits — D: day, e.g., 01–31, total 5 bits — H: hour, e.g., 00–23, total 5 bits — m: minute, e.g., 00–59, total 6 bits — s: seconds, assumed to be 00, not actually encoded — zZ: hours off of GMT; z is 1 bit ± indication, 2nd Z is number hours 1–13 4 bits, total 5 bits
Key Validity Time Period	7 bits	Amount of time in 6 month increments that the certificate is valid.

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Table 244—Mode 1 and Mode 2 BS Implicit Certificate (BSIC) *(continued)*

Item	Size	Description
Version	5 bit	00000: ECQV implicit certificates, ECSSR-PV signature scheme, K-233 EC Domain parameters in compressed form and 233-bit keys 00001: ECQV implicit certificates, ECSSR-PV signature scheme, B-233 EC Domain parameters in compressed form and 233-bit keys 00010: ECQV implicit certificates, ECSSR-PV signature scheme, sect233k1 EC Domain parameters in compressed form and 233-bit keys 00011: ECQV implicit certificates, ECSSR-PV signature scheme, sect233r1 EC Domain parameters in compressed form and 233-bit keys 00100–11111: *Reserved*
Padding	4 bits	All bit shall be set to 0.
BS Public Key Reconstruction Data	31 byte	Key data used to reconstruct public key: — 31 bytes for 233 bit ECC keys

Table 245—Mode 1 and Mode 2 Signature structure

Item	Size	Description
Key ID	9 bits	Identifier of the key associated with the BS implicit certificate used to generate the signature. This identifier is generated by the Certificate Authority (CA) when the certificate is created.
Time Stamp	44 bits	Derived from ZDA NMEA 0183 string (each letter represents a digit encoded by different number of bits): — X: year = 2010+X, X is 6 bits — M: month, e.g., 01–12, total is 4 bits — D: day, e.g., 01–31, total 5 bits — H: hour, e.g., 00–23, total 5 bits — m: minute, e.g., 00–59, total 6 bits — ss: seconds, 00–59, 6 bits — .ss: 10 ms boundary, 0.000–.99, 7 bits — zZ: hours off of GMT; z is 1bit ± indication, 2nd Z is number hours 1–13 4 bits, total 5 bits
Version	5 bit	00000: ECQV implicit certificates, ECSSR-PV signature scheme, K-233 EC Domain parameters in compressed form and 233-bit keys 00001: ECQV implicit certificates, ECSSR-PV signature scheme, B-233 EC Domain parameters in compressed form and 233-bit keys 00010: ECQV implicit certificates, ECSSR-PV signature scheme, sect233k1 EC Domain parameters in compressed form and 233-bit keys 00011: ECQV implicit certificates, ECSSR-PV signature scheme, sect233r1 EC Domain parameters in compressed form and 233-bit keys 00100–11111: *Reserved*

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Table 245—Mode 1 and Mode 2 Signature structure *(continued)*

Item	Size	Description
Padding	6 bits	All bits shall be set to 0.
Signature	Variable	Output of signature process. This includes the *RecoverableMessage* part (*C*) and the Signature Data (*d*) as described in 8.6.2.5.3. The signature process is detailed in 8.6.2.5.2. The signature calculated over the entire CBP MAC PDU. If Version==00000 or 00010, Size= 43 bytes If Version==00001 or 00011, Size= 44 bytes

Table 246—CA Root Certificate (CARC)

Item	Size	Description
CA ID	8 bits	Unique identifier of the CA
Key ID	9 bits	Identifier of CA Root certificate as assigned by CA
Key Validity Date (Not Before)	31 bits	Derived from ZDA NMEA 0183 string (each letter represents a digit encoded by different number of bits): — X: year–2010 + X, X is 6 bits — M: month, e.g., 01–12, total is 4 bits — D: day, e.g., 01–31, total 5 bits — H: hour, e.g., 00–23, total 5 bits — m: minute, e.g., 00–59, total 6 bits — s: seconds, assumed to be 00, not actually encoded — zZ: hours off of GMT; z is 1bit ± indication, 2nd Z is number hours 1–13 4 bits, total 5 bits
Key Validity Time Period	7 bits	Amount of time in 6-month increments, that the certificate is valid.
Version	5 bit	00000: ECQV implicit certificates, ECSSR-PV signature scheme, K233 EC Domain parameters in compressed form & 233 bit keys 00001: ECQV implicit certificates, ECSSR-PV signature scheme, B-233 EC Domain parameters in compressed form & 233 bit keys 00010: ECQV implicit certificates, ECSSR-PV signature scheme, sect233k1 EC Domain parameters in compressed form & 233 bit keys 00011: ECQV implicit certificates, ECSSR-PV signature scheme, sect233r1 EC Domain parameters in compressed form & 233 bit keys 00100–11111: *Reserved*

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Table 246—CA Root Certificate (CARC) *(continued)*

Item	Size	Description
EC Domain Parameters	4 bits	form0x0: Parameters for K-233 in FIPS 186-3 0x1: Parameters for B-233 in FIPS 186-3 0x2: Parameters for sect233k1 in SEC2 [B69] 0x3: Parameters for sect233r1 in SEC2 [B69] 0x4–0xF: *Reserved*
CA Public Key Reconstruction Data	31 bytes	Data used to reconstruct CA public key

8.6.2.4 ECQV implicit certificate generation, processing, and validation requirements

Certificate generation requirements, as well the certificate validation and generation processes shall follow the process as described in 2.2, 2.3, and 2.4 of SEC 4. Throughout this subclause "BS" refers to BS operating on PHY-OM1, as well as distributed scheduling R-CPE and A-BS operating on PHY-OM2.

8.6.2.4.1 ECQV certificate generation requirements

1) Infrastructure as described in Figure 170 for certificate generation and distribution
2) Recommended EC domain parameters to be used shall be for binary fields on either 223-bit random or Koblitz curves. Example domain parameters can be found in:
   i) K-233 or B-233 elliptic curves defined in FIPS 186-3,
   ii) sect233k1 and sect233r1 curves defined in SEC2 [B69]
   iii) In the EC domain parameters, elliptic curve points shall be represented in compressed form
3) BS/A-BS/Distributed scheduling R-CPE shall be identified by its 48-bit MAC Address.
4) 'to -be-signed certificate data', IU construction is as follows:
   — For BSIC: BSIC = I_U || BEU, where I_U = KeyID || BS/A-BS/Distributed Scheduling R-CPE MAC Address || CA ID || Key Validity Date (Not Before) || Key Validity Date (Not After) || Version, and BEU = BS/A-BS/Distributed Scheduling R-CPE Public Key Reconstruction Data.
   — For CARC: CARC = I_U || BEU, where I_U = KeyID || MAC Address || CA ID || Key Validity Date (Not Before) || Key Validity Date (Not After) || Version || EC Domain Parameters, and BEU = CA Public Key Reconstruction Data.
   — NOTE—BS MAC Address comes from the BS, the operator NCMS, or the SCH data in the CBP burst, respectively. In addition the A-BS MAC address comes from the A-FCH PHY-OM2. The Key ID, Key Validity Date (Not Before), and Key Validity Time Period are assigned by the CA and are contained in the Implicit Certificate.
5) The CA shall have a public-key pair that is selected from the EC domain parameters in Requirement 2 and bound to the CA ID. Entities shall have access to the CA implicit certificate (with the CA's public key reconstruction data), but not the private key associated with the implicit certificate.
6) SHA-256 shall be used as a Hash function.
7) If each operator is allowed to maintain its own BS implicit certificates (i.e., act as its own Certificate Authority),
   — Operator will register its Certificate Authority ID when registering its Operator ID. The mechanism for registration is outside the scope of the standard.

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— Operators may share their own CA Root certificate with other operators that have BSs/A-BSs that border or overlap with BSs/A-BSs in their own network. The mechanism for CA Root Certificate sharing is outside the scope of the standard.

8.6.2.4.2 ECQV Certificate generation process

1) In order to start certificate generation process (see Figure 170) a request from the BS/A-BS (for Mode 1, or on behalf of BS/A-BS (by the NCMS) for Mode 2, shall be made to CA. Along with the request an ephemeral public key is transmitted to the CA. (Step 1 of 2.4.1 of SEC 4.)
   — This process requires that an 'ephemeral' key pair using established ECC domain parameters. ECC domain parameters used for 'ephemeral' key pair generation shall be the same parameters used by CA for its own certificate and BS/A-BS implicit certificate generation. An ephemeral key pair generated for this step shall never be re-used.
2) The CA processes this request according to the procedures outline in 2.4.2 of SEC 4.
   — This process requires that CA generate its own 'ephemeral' key pair using established ECC domain parameters. ECC domain parameters used for 'ephemeral' key pair generation shall be the same parameters it uses for its own certificate and BS/A-BS implicit certificate generation. An ephemeral key pair shall never be reused.
3) The BS/A-BS or operator NCMS receives a response from the CA and proceeds with the generation of the implicit certificate according to the steps 2–12 in 2.4.1 of SEC 4.

8.6.2.4.3 ECQV Implicit Certificate Validation requirements

1) Whether certificate information for a BS/A-BS is received in Certificate IE or is distributed through the NCMS, a BS/A-BS received that certificate shall validate it or obtain proof of validation from the NCMS.
   — BS/A-BS or NCMS operator may check a CA's CRL during installation and validation of other BS/A-BSs implicit certificates
2) The Certificate/License authority shall have its own certificate with its own EC key pair, that is generated from the EC domain parameters that are selected
3) ECC domain parameters that CA uses for generation of its own certificate shall be same as parameters used for BS/A-BS implicit certificates and 'ephemeral' key pair generation
4) The CA certificate and its associated KeyId shall be delivered to BS/A-BS through NCMS, and stored in a MIB entry, which happens offline and not part of WRAN operation
5) Certificates for all CA's and a CA's associated ECC domain parameters shall be shared between operator's and distributed to all BS/A-BSs within an operator's network. The mechanism by which this is done is outside the scope of the standard.

8.6.2.4.4 ECQV Implicit Certificate Validation process

1) BS implicit certificates are validated according to the procedure defined in 2.3.1 of SEC 4. This implies checking the validity of the implicit certificate's public key, as well as the Key Validity Date (Not Before) and Key Validity Time Period fields of the certificate.
2) If a certificate fails validation when received in a Certificate IE of a CBP burst, the CBP burst shall be dropped. In this case the operator may either continue to attempt coexistence operation with the transmitter of the CBP burst (in the future) or discontinue coexistence operation with the transmitter of the CBP burst.
3) If a certificate fails validation during installing on a BS/A-BS, then the certificate shall not be installed on that BS/A-BS.

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— BS/A-BS or NCMS operator may check a CA's CRL during installation and validation of other BS/A-BS s implicit certificates. Procedures describing the maintenance of a CRL for implicit certificates are out of the scope of the standard.

8.6.2.5 Signature generation, processing, and validation requirements

Throughout this subclause "BS" refers to BS operating on PHY-OM1, as well as distributed scheduling R-CPE and A-BS operating on PHY-OM2.

8.6.2.5.1 Signature generation requirements

1) The ECSSR-PV signature scheme that is used to generated the signature, is based on the same scheme as used calculate signatures for the wireless microphone beacon (IEEE 802.22.1-2010). Requirements for the Elliptic Curve Signature Scheme with Recovery, Pinstov-Vanstone (ECSSR-PV) as applied to wireless microphone beacon authentication are defined in 7.5.4.1 of IEEE Std 802.22.1-2010. ECSSR-PV requirements for CBP authentication differ in the following manner:
   i) EMSR2 shall be used as the message encoding method
   ii) The *padLen* parameter for the EMSR2 encoding method shall be 14 octets
   iii) The message representative of the *RecoverableMessage* (C) portion of the output of the signature in step 4 of 8.6.2.5.2, is an octet string of the octet 'E0' repeated *padLen* times (e.g., "E0 E0 E0 E0 E0 E0 E0 E0 E0 E0 E0 E0 E0 E0").
   iv) ECPSP-NR2/PV, ECSP-PV, ECVP-PV shall be used as the pre-signature, signature, and verification primitives respectively to be used in the application of the ECSSR-PV scheme
2) Prior to applying the ECSSR-PV signature scheme that is used to generate a signature, a BS/A-BS transmitting the message shall use the Private Key Reconstruction Data (s) to reconstruct the private key associated with its BS/A-BS implicit certificate. This is done according to the process as defined in 2.4.1 of SEC 4.
3) Prior to applying the ECSSR-PV signature scheme to verify a signature in a received CBP MAC PDU (see Table 13 for BS using PHY-OM1 or Table 14 for A-BS/distributed scheduling R-CPE using PHY-OM2), that receives messages shall use the Public Key Reconstruction Data (*BEU*, see 8.6.2.4.1) to reconstruct the public key of each BS/A-BS implicit certificate that it has installed.
4) The transmitting BS/A-BS uses system clock (synchronized to GPS), to get time (to millisecond) for "Time" field of Signature IE.
5) In this subclause, the "CBP MAC PDU header" can take on different data depending on the PHY Operational mode on which the CBP MAC PDU burst is being transmitted. For CBP MAC PDU transmitted on PHY-OM1 (BS), the CBP MAC PDU header includes the Length, SCH Data Index, SCH Data, Frame Number, and HCS fields defined in Table 8. For CBP MAC PDU transmitted on PHY-OM2 (A-BS/distributed scheduling R-CPE), the CBP MAC PDU header includes the Length, Advanced FCH and Extended FCH Index, A-FCH and Extended FCH Data, Frame Number, and HCS fields as defined in Table 14.

8.6.2.5.2 Signature generation process

1) The M_1 input into the signature process shall be an empty, null string.
2) The M_2 input into the signature process shall be constructed as follows:
   i) M_2 = CBP MAC PDU header || CBP IE_1 || CBP IE_2 … || CBP IE_n || EID || KID || Timestamp || V
   ii) CBP IE_1 – CBP IE_n refer to the CBP IEs to be included in CBP

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iii) EID refers to the Element ID field of the Signature IE, which is equal to 0x06

iv) KID refers to the 9-bit Key ID field of the Signature IE

v) V refers to the 5-bit Version field of the Signature IE

3) The ECSSR-PV signature scheme is applied (see 10.5.2 of IEEE 1363a-2004 [B12]), using the private key of the BS/A-BS implicit certificate to generate *RecoverableMessage* Portion (*C*) and the Signature part (*d*) of the 'to-be-sent signature data', 'to-be-sent signature data' = $C \parallel d$.

4) The 'to-be-sent signature data' value is inserted into the Signature field of the Signature IE, prior to transmission of the CBP burst.

8.6.2.5.3 Signature verification process

1) The M_1 input into the ECSSR-PV scheme is an empty, null string.

2) The M_2 input into the ECSSR-PV scheme are derived from the fields in the received CBP burst as described in step 2) in 8.6.2.5.2.

3) Execute the ECSSR-PV signature verification process (see 10.5.3 of IEEE 1363a-2004 [B12]), using the public key associated with the BS/A-BS implicit certificate of the BS/A-BS that transmitted the CBP burst [see requirement 3) in 8.6.2.5.1].

i) If signature verification succeeds, the CBP burst is then processed.

ii) If not, then the CBP burst is dropped. BS/A-BS may attempt to re-acquire CBPs from the transmitting BS/A-BS or may discontinue coexistence operation with the transmitting BS/A-BS.

8.6.2.6 BS Implicit Certificate Exchange

CBP Authentication Mode 1 requires that BS/A-BSs exchange their implicit certificates in order to facilitate verification of CBP transmissions. CBP Protection Mode 2 allows for pre-distribution of CA Root and BS/A-BS Implicit certificates between all BS/A-BSs within an operator's network. This would be accomplished using the NCMS. This may not be possible when BS/A-BSs from different operators border/overlap with each other. This subclause defines a certificate exchange process to handle this case, which allows BS/A-BSs to share their implicit certificates via CBP transmission during SCWs.

If there is a single CA, then the CA Root certificate and single set of EC domain parameters are available to all operators. If each operator is allowed to sign/create their own certificates, then operators shall make available their CA Root Certificate and EC domain parameters available to other operators.

If a BS/A-BS receives a CBP from a BS/A-BS, for whom it does not have the BS/A-BS implicit certificate, it cannot verify the signature in the 2nd symbol (1st data symbol) of CBP and shall drop the CBP packet. Upon doing this the BS/A-BS (Certificate Requestor) will initiate a Certificate Request directed towards the source BS/A-BS (Certificate Responder) of the unverifiable CBP. The Certificate Requestor BS does this by adding a CERT-REQ IE (see 7.8.1.3.1.9), with its own BS/A-BS implicit certificate, as an IE in the CBP MAC PDU.

When the Certificate Responder receives a CBP with a CERT-REQ IE from a Certificate Requestor it verifies the certificate and Signature data in the Signature IE of the CBP MAC PDU. If both BS/A-BSs are under the same CA then the Certificate Responder already has the CA Root certificate and EC domain parameters it needs to verify the BS/A-BS implicit certificate from Certificate Requestor. If they are not, e.g., each operator has its own CA or CAs exist on a regional basis, than the Certificate Responder shall use a mechanism to request the CA Root certificate and EC domain parameters of another CA. This mechanism shall be provided. The definition of this mechanism is outside the scope of the standard.

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After verifying the Certificate Requestor's certificate and signature over CBP in which CERT-REQ IE was received, the Certificate Responder initiates a Certificate Response directed towards the Certificate Requestor. The Certificate Responder does this by adding a CERT-RSP IE (see 7.8.1.3.1.10), with its own BS/A-BS implicit certificate to the CBP MAC PDU.

When Certificate Requestor receives the CBP with the Certificate Response, it verifies it in the same manner that Certificate Responder verifies the Certificate Request. After this, any pending self-coexistence signaling (e.g., Channel Contention) can proceed. Figure 172 illustrates the BS/A-BS Implicit Certificate Exchange. For certificate exchange between BS/A-BSs operating in the same area, the requester makes use of an optimally selected CPE for reliable CBP burst transmission. If the destination BS/A-BS does not respond, the certificate requestor assumes that the destination BS/A-BS does not support self-coexistence and normal operation will continue.

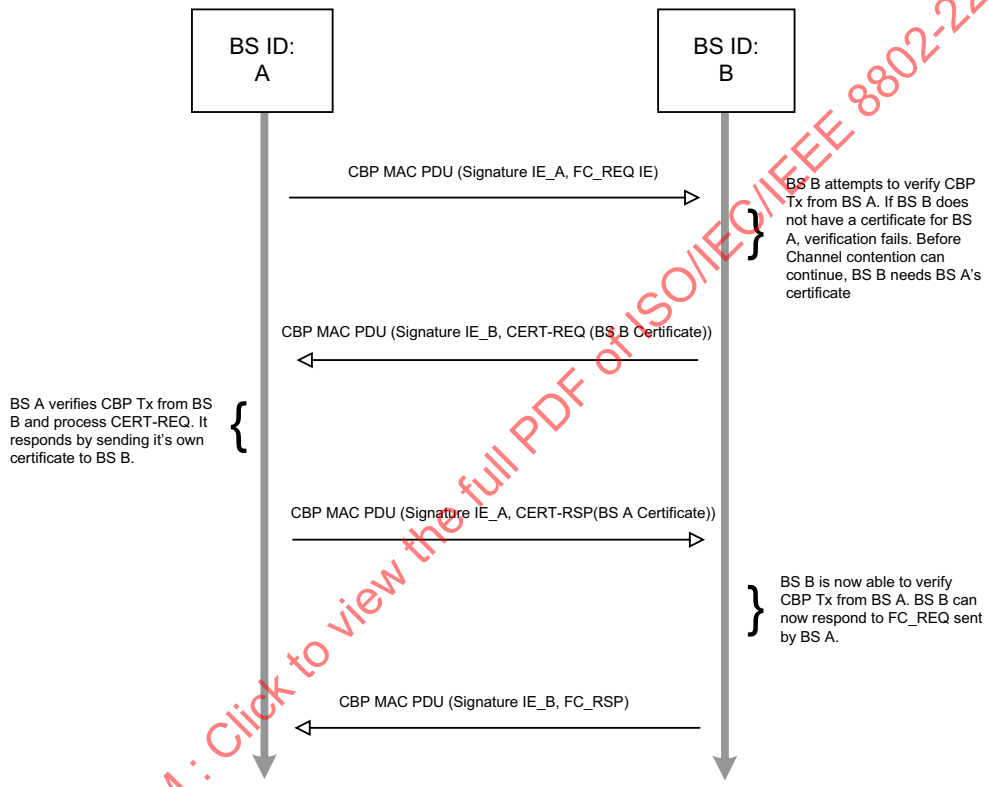

Figure 172—BS Implicit Certificate Exchange

8.6.3 IEEE 802.22.1 beacon authentication

The *beacon*, as defined in IEEE Std 802.22.1-2010, is used to afford protection to devices that fall under FCC Part 74 in the USA from harmful interference from license-exempt devices in the television bands. Authentication information has been added to the beacon to allow IEEE 802.22 BSs to verify the authenticity of the transmission of the beacon. Without this verification, it may be possible for a rogue device/operator to send out an illegitimate beacon in an effort to cause the receiver of the beacon to vacate that particular channel.

D.8.2 defines 10 modes for sensing and decoding the IEEE 802.22.1 beacon. Sensing Types 1–8 are not adequate for sensing and decoding enough of the IEEE 802.22.1 Beacon Frame to provide the receiving device with the information to authenticate the IEEE 802.22.1 beacon. To authenticate the beacon, Sensing Types 9 and 10 shall be used.

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If Sensing Type 9 (see D.8.2.9) is used, then MSF1 and MSF2 of the IEEE 802.22.1 beacon frame is captured and decoded. If the CRC verification on both MSF1 and MSF2 passes, the CPE relays the payloads to the BS. The signature calculated over the IEEE 802.22.1 beacon frame is contained with the Signature field of MSF2. To verify the signature, the public key of the certificate used to generate the signature is required. In this case, the certificate and public key shall be obtained by the BS via some off-line method (see 5.6.1 and 7.5.5, IEEE Std 802.22.1-2010) and installed at the IEEE 802.22 BS via a MIB.

If Sensing Type 10 (see D.8.2.10) is used, then MSF1, MSF2, and MSF3 of the IEEE 802.22.1 beacon frame is captured and decoded. If the CRC verification on all three MSFs passes, the CPE relays the payloads to the BS. With this method the receiving device has all of the information it needs to verify the signature.

The process for verifying the signature in the IEEE 802.22.1 beacon frame is detailed in 7.5.4 of IEEE Std 802.22.1-2010. If the signature is processed, and verified as being authentic, the receiving device has knowledge that the originator of the beacon is an authentic PPD as defined by IEEE Std 802.22.1-2010. Under this circumstance, the IEEE 802.22 device shall vacate the channel after following the procedures as defined by the policy in Clause 11. If the signature is not verified as being authentic, then no action is taken (see policy 3b in Table 315).

8.7 CPE privacy

CPE SID and MAC Address are sent in the clear during the Ranging procedure. This can allow malicious users to track an individual CPE in the network, which is both a security concern and may (in some regulatory domains) violate laws regarding privacy of user information.

The following process details a procedure that can be used to help ensure user privacy:

a) Upon receiving the CDMA Allocation IE, CPE selects a locally administered MAC Address using the Administratively Assigned Identifier (AAI)-type Structured Local Address Plan (SLAP) as defined in 8.4.4.3 of IEEE Std 802-2014.

   1) This entails setting the I/G, U/L, Y, Z bits of MAC Address to 0100.

   2) Remaining 44 bits shall be assigned randomly.

b) The CPE then transmits this locally administered MAC address in the RNG-REQ.

c) BS receives the RNG-REQ and selects a (permanent) SID for the CPE. It sends the permanent SID along with the locally administered MAC address received in the RNG-REQ to the CPE in the RNG-CMD message.

d) The CPE and BS proceed with the Authorization process to setup keying on the CPE.

The CPE and BS “hold” onto the locally administered MAC Address over the course of the association. No other CPE can enter the network utilizing the same temporary MAC. Use of this procedure is optional and at the discretion of the operator.

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9. Operation Mode 1 (PHY-OM1)

This clause specifies the basic technologies for the standardization of the physical (PHY) layer for WRAN systems. The specification is for a system that uses vacant channels to provide wireless communication over a distance of up to 100 km, the propagation time over the first 30 km range being absorbed by the TTG at the PHY layer, and the propagation time beyond 30 km being absorbed by proper MAC packet scheduling at the BS, as well as time buffers before and after the opportunistic bursts (ranging, BW request, and UCS notification) and before and after the CBP burst.

PHY Operation Mode 1 (PHY-OM1) and PHY Operation Mode 2 (PHY-OM2) are designed to meet the needs required by channel models A and B in IEEE 802.22 Working Group on Wireless Regional Area Networks [B7]. In the rare cases where propagation conditions are as severe as those expressed by channel models C and D in IEEE 802.22 Working Group on Wireless Regional Area Networks [B7], PHY-OM2 (Clause 10) may be required to revert to PHY specifications in PHY-OM1 (Clause 9).

The system reference frequency is the center frequency of the channel in which the transmitter and the receiver equipment operates. Annex A lists the frequencies corresponding to the channels used for WRAN operation in various regulatory domains.

More flexible variation of the regular frequency raster (*the FCC currently only uses channels 2 to 51 for broadcasting*) is possible if the occupied channel of a WRAN system is defined by the two channel edge frequencies. This way, the WRAN can operate anywhere within a regular channel in the case of a system using a scaled sampling frequency (see 9.1.2), or overlapping two regular channels, allowing, for example, a separation of a fraction of a regular channel from a DTV or from another WRAN channel to precisely control the adjacent channel interference while maximizing the use of the RF spectrum. Channel designations, mostly exceeding current channel designations (*outside those used by local regulatory bodies*) may be redefined for the BS to use these flexible channel extensions.

The PHY specification is based on an orthogonal frequency division multiple access (OFDMA) scheme where information to downstream (DS) or from upstream (US) multiple CPEs are modulated on orthogonal subcarriers using Inverse Fourier Transforms. The main system parameters are provided in Table 250.

Table 247—Nominal system parameters for WRAN

Parameters	Specification	Remark
Frequency range	54~862 MHz[a]	
Channel bandwidth	6, 7, or 8 MHz	According to regulatory domain (see Annex A).
Data rate (6 MHz case, 1/16 CP case)	4.54 to 22.69 Mbits/s	See Table 251
Spectral efficiency (6 MHz case, 1/16 CP case)	0.76 to 3.78 bits/(s Hz)	See Table 251
Payload modulation	QPSK, 16-QAM, 64-QAM	BPSK used for preambles, pilots, and CDMA codes.
Transmit EIRP	4 W maximum for CPEs. 4 W maximum for BSs in the USA regulatory domain.	Maximum EIRP for BSs may vary in other regulatory domains.
Multiple Access	OFDMA	

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Table 247—Nominal system parameters for WRAN *(continued)*

Parameters	Specification	Remark
FFT size (N_{FFT})	2048	
Cyclic prefix modes	1/4, 1/8, 1/16, 1/32	
Duplex	TDD	

[a] Frequency range allocated to the Television Broadcasting Service in various parts of the world (see Annex A for further details).

The following subclauses provide details on the various aspects of the PHY specifications.

9.1 Symbol description

9.1.1 OFDM symbol mathematical representation

The RF signal transmitted during any OFDM symbol duration can be represented mathematically as shown in Equation (8):

$$s(t) = \mathrm{Re}\left\{ e^{j2\pi f_c t} \sum_{\substack{k=-N_T/2 \\ k\neq 0}}^{N_T/2} c_k e^{j2\pi k\Delta f (t-T_{CP})} \right\} \tag{8}$$

where

t is the time elapsed since the beginning of the current symbol, with $0<t<T_{SYM}$
T_{SYM} is the symbol duration, including cyclic prefix duration
$Re(.)$ real part of the signal
f_c is the carrier frequency
c_k is a complex number; the data to be transmitted on the subcarrier whose frequency offset index is k, during the current symbol. It specifies a point in a QAM constellation.
Δf is the subcarrier frequency spacing
T_{CP} is the time duration of cyclic prefix
N_T is the number of used subcarriers (not including DC subcarrier)

9.1.1.1 Time domain description

The time-domain signal is generated by taking the inverse Fourier transform of the length N_{FFT} vector. The vector is formed by taking the constellation mapper output and inserting pilot and guard tones. At the receiver, the time domain signal is transformed to the frequency domain representation by using a Fourier transform.

Let T_{FFT} represent the time duration of the IFFT output signal. The OFDM symbol is formed by inserting a cyclic prefix of time duration T_{CP} (shown in Figure 173), resulting in a symbol duration of $T_{SYM} = T_{FFT} + T_{CP}$.

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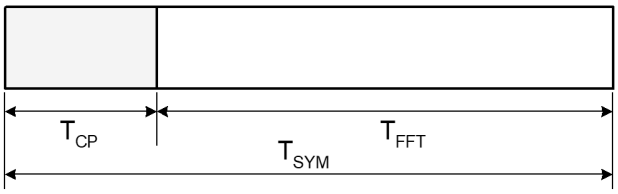

Figure 173—OFDM symbol format

The specific values for T_{FFT}, T_{CP} and T_{SYM} are given in 9.1.2. The BS determines these parameters and conveys the T_{CP} to T_{FFT} ratio to the CPEs using the SCH (see Table 1).

The time at which the FFT window starts within the symbol period for reception at the CPE is determined by the local synchronization strategy to minimize inter-symbol interference due to pre- and post-echoes and any synchronization error, and is implementation dependent.

9.1.1.2 Frequency domain description

In the frequency domain, an OFDM symbol is defined in terms of its subcarriers. The subcarriers are classified as: 1) data subcarriers, 2) pilot subcarriers, 3) guard and Null (including DC) subcarriers. The classification is based on the functionality of the subcarriers. The DS and US may have different allocations of subcarriers. The total number of subcarriers is determined by the FFT/IFFT size. The pilot subcarriers are distributed across the bandwidth. The exact location of the pilot and data subcarriers and the symbol's subchannel allocation is determined by the particular configuration used. All the remaining guard/Null subcarriers carry no energy and are located at the center frequency of the channel (DC subcarrier) and at both edges of the channel (guard subcarriers).

9.1.2 Symbol parameters

The modulation parameter nominal specifications detailed in this standard of the WRAN signal are examples selected to fit in the three broadly used broadcast channel bandwidths present in different parts of the world, which are 6, 7, and 8 MHz channels. A nominal set of modulation parameters is specified in the present subclause as well as in 9.4 for each channel bandwidth. These nominal parameter sets may be extended to other sets of parameters developed around different sampling frequencies to either ease the filter rejection at the edge of the channel or to occupy a different portion of the spectrum. Such variations result in their corresponding transmission throughput, all the other system parameters being kept the same.

When such variation from the nominal sets described below is used, the specification of the basic sampling frequency shall be a pre-shared value between the BS and CPE. This pre-shared "Fs" value shall then be used to compute the resultant values in Table 247, Table 248, and Table 250.

9.1.2.1 Subcarrier spacing

The BS and CPEs shall use the 2048 FFT mode with the subcarriers spacing specified in Table 248.

The subcarrier spacing, ΔF, is dependent on the bandwidth of the channel (6 MHz, 7 MHz, or 8 MHz). Table 247 shows the subcarrier spacing and the corresponding FFT/IFFT period (T_{FFT}) values for the different channel bandwidth options.

The inter-carrier spacing in Table 119 is obtained by dividing the basic sampling frequency by the size of the FFT/IFFT, i.e., 2048 (**$\Delta f(Hz) = 10^6 * F_S / 2048$**). The FFT/IFFT period is the reciprocal of the inter-carrier

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spacing ($\mathbf{T_{FFT}}$ **(µs)=10**^{6}**/Δf**). The Time Unit (TU) is obtained by dividing the FFT/IFFT period by 2048 (**TU(ns)=10**^{3}***T**$_{FFT}$**/2048**).

Table 248—Subcarrier spacing and FFT/IFFT period values for three nominal bandwidth options based on sampling frequency equivalent to 8/7 channel bandwidth

	6 MHz based channels	7 MHz based channels	8 MHz based channels
Basic sampling frequency, F_S (MHz)	6.8 (34/5)	7.9375 (127/16)	9.0625 (145/16)
Inter-carrier spacing, Δf (Hz) = F_S/2048	3.320…	3.875…	4.425…
FFT/IFFT period, T_{FFT} (µs)=1/Δf	301.176…	258.015…	225.986…
Time Unit (ns) TU=T_{FFT}/2048	147.058…	125.984…	110.344…

9.1.2.2 Symbol duration for different cyclic prefix modes

The cyclic prefix duration T_{CP} could be one of the following derived values: $T_{FFT}/32$, $T_{FFT}/16$, $T_{FFT}/8$, and $T_{FFT}/4$. The OFDM symbol duration for different values of cyclic prefix ($\mathbf{T_{SYM}}$ **(µs)** = $\mathbf{T_{FFT}}$ + $\mathbf{T_{CP}}$) is given in Table 249.

Table 249—Symbol duration for different cyclic prefixes and three nominal bandwidth options

		CP = T_{FFT}/32	CP = T_{FFT}/16	CP = T_{FFT}/8	CP = T_{FFT}/4
	6 MHz	310.588…	320	338.823…	376.470…
	7 MHz	266.078…	274.141…	290.267…	322.519…
	8 MHz	233.048…	240.110…	254.234…	282.482…

9.1.2.3 Transmission parameters

Table 250 shows the different parameters and their values for the three bandwidths.

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Table 250—OFDM parameters for the three nominal channel bandwidths

TV channel bandwidth (MHz)	6	7	8
Total number of subcarriers, N_{FFT}	2048		
Number of guard subcarriers, N_G (L, DC, R)	368 (184, 1, 183)		
Number of used subcarriers, $N_T = N_D + N_P$	1680		
Number of data subcarriers, N_D	1440		
Number of pilot subcarriers, N_P	240		

9.2 Data rates

Table 251 defines the different PHY modulation and encoding modes with their associated parameters along with an example of the resulting gross data rates in the case of the 6 MHz channel bandwidth.

Table 251—PHY MCS modes and their related modulations, coding rates and nominal data rates for $T_{CP} = T_{FFT}/16$

PHY MCS mode	Modulation	Coding rate	Data rate (Mb/s)	Spectral efficiency[e] (for 6 MHz bandwidth)
1 [a]	BPSK	Uncoded	f	f
2 [b]	QPSK	1/2 Repetition: 4	f	f
3 [c]	QPSK	1/2 Repetition: 3	f	f
4 [d]	QPSK	1/2 Repetition: 2	f	f
5	QPSK	1/2	4.54	0.76
6	QPSK	2/3	6.05	1.01
7	QPSK	3/4	6.81	1.13
8	QPSK	5/6	7.56	1.26
9	16-QAM	1/2	9.08	1.51
10	16-QAM	2/3	12.10	2.02
11	16-QAM	3/4	13.61	2.27
12	16-QAM	5/6	15.13	2.52

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Table 251—PHY MCS modes and their related modulations, coding rates and nominal data rates for $T_{CP} = T_{FFT}/16$ *(continued)*

PHY MCS mode	Modulation	Coding rate	Data rate (Mb/s)	Spectral efficiency[e] (for 6 MHz bandwidth)
13	64-QAM	1/2	13.61	2.27
14	64-QAM	2/3	18.15	3.03
15	64-QAM	3/4	20.42	3.40
16	64-QAM	5/6	22.69	3.78

[a] Mode 1 is only used for CDMA opportunistic bursts.
[b]Mode 2 is only used for SCH packet transmission.
[c] Mode 3 is only used for CBP transmission.
[d]Mode 4 is only used for FCH transmission.
[e]Spectral efficiency informative values are calculated assuming continuous stream of 1440 data subcarriers for the given modulation and FEC modes (i.e., assuming no TTG, RTG and superframe and frame headers).
[f]These modes are for control signal transmissions and there is no need to specify data rate or spectral efficiency.

9.3 Functional block diagram applicable to the PHY layer

The functional block diagram of the transmitter and receiver for the PHY layer is shown in Figure 174. This subclause describes the general processing of the WRAN baseband signal. The binary data intended for transmission is supplied to the PHY layer from the MAC layer. This input is sent to a channel coding processor that includes a data scrambler, encoder, puncturer (except for LDPC and SBTC) as specified in 9.7, and a bit interleaver specified in 9.6.5. The interleaved data is mapped to data constellations as described in according to the modulation schemes specified as shown in Table 251. The subcarrier allocator assigns the data constellations to the corresponding subchannels according to the subcarrier allocation methods described in 9.6.3 and 9.6.4.

A frame may have its first OFDM symbol occupied by the frame preamble or have its first and second OFDM symbols occupied by the superframe preamble and the frame preamble as specified in 9.4.1. The pilot subcarriers are transmitted at fixed positions in the frequency domain within each OFDM data symbol as specified in 9.6.1. Preambles and pilots can support the synchronization, channel estimation, and tracking process. In the frequency domain, an OFDM symbol contains the data, pilot, and null subcarriers, as defined in Table 250. The resultant stream of constellations is subsequently input to an inverse Discrete Fourier Transform after a serial-to-parallel conversion. The inverse Fast Fourier Transform (IFFT) is the expected means of performing the inverse Discrete Fourier Transform. In order to prevent inter-symbol interference (ISI) eventually caused by the channel delay spread, the OFDM symbol is extended by a cyclic prefix that contains the same waveform as the corresponding ending part of the symbol. Finally, the OFDM signal is transferred to the RF transmission modules via a digital-to-analog converter.

The OFDM receiver roughly implements the same operations as performed by the transmitter but in reverse order. In addition to the data processing, synchronization and channel estimation shall be performed at the receiver.

The CBP packet can also be generated through the same process as that used for the data transmission. The only difference is in the subcarrier allocator and the preamble and pilot inserters. The subcarrier allocation of CBP data is similar to a spreading process because each QPSK symbol is transmitted on three different spread subcarriers. The CBP packet subcarrier allocation, preamble and pilot patterns are described in 9.5.

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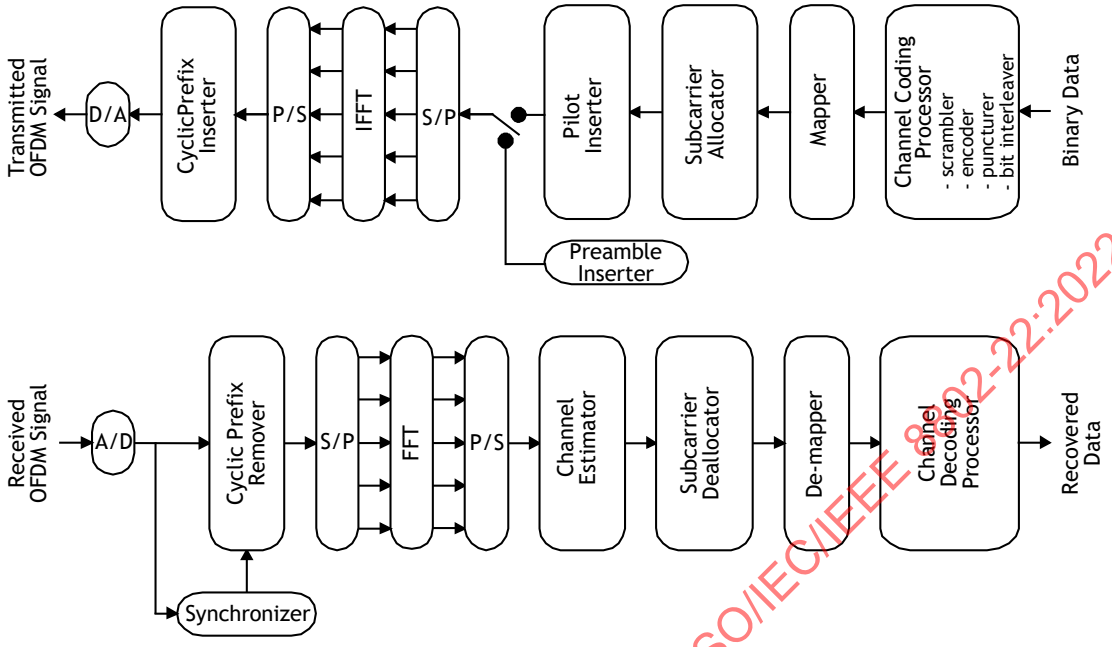

Figure 174—Transmitter and receiver block diagram for the OFDMA PHY

9.4 Superframe and frame structures

The basic superframe structure and frame structure are shown in Figure 10, Figure 11, and Figure 12. See 7.3 and 7.3.2 for a full description of the superframe and frame structures.

The superframe shall consist of 16 frames of 10 ms each. Each frame contains a preamble, header, and data bursts.

For both normal and self-coexistence operational modes, in the first allocated frame, the first symbol shall be the superframe preamble, followed by a frame preamble symbol. The third symbol shall be the SCH, and the fourth symbol shall contain the FCH and, when needed, DS-MAP, US-MAP, DCD and UCD, and data bursts if there is some room left. The SCH is transmitted to provide protection to incumbents through the scheduling of quiet periods and self-coexistence through the mapping of the frames belonging to the appropriate WRAN cell, and so on (see 7.3). The FCH specifies the length of the first MAP that will immediately follow the FCH. The first frame allocated to a BS in a superframe shall contain two fewer symbols than normal frames to keep the length to 10 ms.

The other allocated frames of the superframe shall contain successively a frame preamble, the FCH and the DS-MAP, US-MAP, DCD, and UCD messages when needed, and the data bursts.

In each frame, a TTG shall be inserted between the DS and US bursts to allow the CPE to switch between the receive mode and transmit mode and to absorb the signal propagation time for a distance of up to 30 km (note that the propagation time for CPEs beyond this distance will be accommodated by proper scheduling of the DS bursts and US grants). A RTG shall be inserted at the end of each frame to allow the BS to switch between its receiving mode and transmit mode (see Figure 13). The values indicated in Table 252 for the TTG and RTG shall be used for the specified cyclic prefixes and channel bandwidth options.

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Table 252—WRAN frame parameters for the three nominal sampling frequencies

Cyclic prefix	Number of symbols per frame [a]			Transmit-receive turnaround gap [b] (TTG)			Receive-transmit turnaround gap [c] (RTG)		
BW	6 MHz	7 MHz	8 MHz	6 MHz	7 MHz	8 MHz	6 MHz	7 MHz	8 MHz
1/4	24	29	33	1428 TU	1666 TU	1903 TU	2572 TU	909 TU	1682 TU
1/8	27	32	37	1428 TU	1666 TU	1903 TU	1548 TU	1165 TU	658 TU
1/16	29	34	39	1428 TU	1666 TU	1903 TU	524 TU	781 TU	914 TU
1/32	30	35	40	1428 TU	1666 TU	1903 TU	204 TU	781 TU	1234 TU

[a] Indicates the DS/US payload symbols only. Here, one frame preamble symbol and one header symbol carrying the FCH, DS/US-MAP and DCD/UCD are assumed. Different values may apply when the frame carries more header symbols using 1/4 cyclic prefix such as the superframe preamble and SCH.

[b] Example of TTG set to absorb the propagation delay for up to 30 km and a CPE turnaround time of 10 μs. For larger distances, proper scheduling at the BS will allow for absorption of longer propagation delay.

[c] Portion of symbol left over to arrive at the 10 ms frame period. There is also the possibility of superframe realignement (~+/–25 TU) at the top of the minute with the master clock.

9.4.1 Preamble

9.4.1.1 Preamble definition

Two types of frequency domain sequences are defined in order to facilitate burst detection, synchronization, and channel estimation at a WRAN receiver, as follows:

1) Short Training Sequence (STS): This sequence is made of 512 bits producing a binary bipolar sequence (+1, –1) applied to every 4th subcarrier of an OFDM symbol. Thus, in the time domain, this will result in 4 repetitions of a 512-sample sequence for each OFDM symbol modulated by the STS.
2) Long Training Sequence (LTS): This sequence is made of 1024 bits producing a binary bipolar sequence (+1, –1) applied to every 2nd subcarrier of an OFDM symbol. Thus, in the time domain, this will result in 2 repetitions of a 1024-sample sequence for each OFDM symbol modulated by the LTS.

The STS is used to form the superframe and CBP preambles while the LTS is used to form the frame preamble. Each sequence element is associated with one OFDM subcarrier (BPSK modulated) in the frequency domain. The sequence element values (+1, –1) are generated in an algorithmic way to provide for low peak-to-average-power-ratio (PAPR).

These sequences shall be generated by the method described in the 9.4.1.1.1 and 9.4.1.1.2.

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9.4.1.1.1 Generation of STS

First, a periodic sequence P_{REF}^{ST} with a period of 512 is generated using a pseudo-noise (PN) sequence generator with the following polynomial: $X^9 + X^8 + X^6 + X^5 + X^3 + X^2 + 1$. Figure 175 depicts an implementation of this PN sequence generator using a Linear Feedback Shift Register.

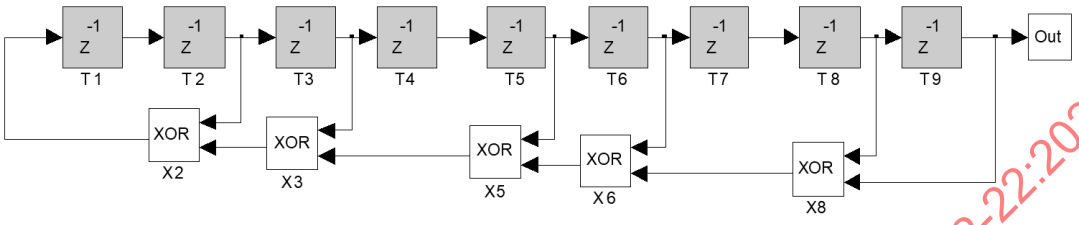

Figure 175—Structure of a Linear Feedback Shift Register implementation for the given STS polynomial

The STS sequence generator is initialized to a value of 1 1111 1111. The resultant P_{REF}^{ST} sequence of 511 samples (using BPSK mapping as shown in Figure 198) is given as follows:

$P_{REF}^{ST}(0:510) = \{1, 1, 1, 1, 1, 1, 1, 1, 1, -1, -1, 1, -1, 1, -1, 1, -1, 1, -1, 1, \ldots, -1, -1, -1, -1, -1, -1, -1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, -1, -1, 1, -1\}$

Second, define $S_{277}(0:209) = P_{REF}^{ST}(277:486)$. The elements of sequence $\{S_{277}\}$ may be obtained by clocking the STS generator, without resetting it, 487 times consecutively, and storing only the last 210 samples (out of the BPSK modulator, see Figure 175). Moreover, define $S_{488}(0:209) = P_{REF}^{ST}(488:697)$. The elements of sequence $\{S_{488}\}$ may be obtained by continuing to clock the STS generator, without resetting it, for an extra 211 clocks, after S_{277} has been stored. The last 210 samples form the elements of S_{488} taken from the BPSK modulator. Therefore, a total of 698 clocks are necessary to obtain one pair of sequences $\{S_{277}, S_{488}\}$ (see Figure 176).

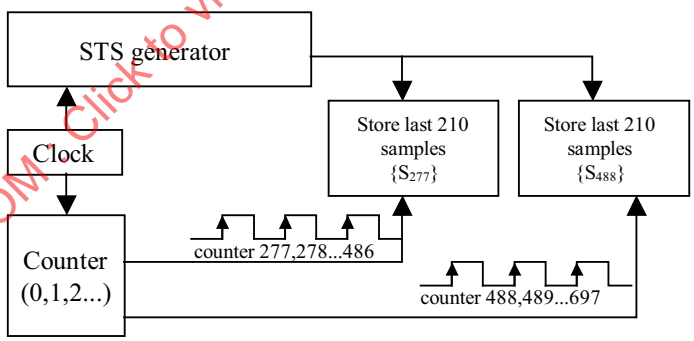

Figure 176—Scheme for the generation of sequences $\{S_{277}, S_{488}\}$

After resetting the clock, the first 210 symbols of these sequences are as follows:

$S_{277}(0:209) = \{1, 1, -1, -1, -1, 1, -1, 1, -1, 1, 1, -1, 1, 1, 1, 1, -1, -1, 1, 1, \ldots, 1, 1, -1, 1, -1, -1, -1, -1, -1, 1, 1, -1, 1, 1, -1, -1, -1, -1, -1, -1\}$, and

$S_{488}(0:209) = \{-1, -1, 1, -1, -1, -1, -1, -1, -1, -1, -1, 1, 1, 1, -1, -1, -1, -1, -1, -1, -1, \ldots, -1, -1, -1, -1, -1, 1, -1, 1, -1, 1, -1, -1, -1, -1, -1, -1, 1, 1, 1, -1, -1\}$

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For illustration only, consider that after resetting the STS generator, the pair of sequences $\{S_{277},S_{488}\}$ can be represented in Hexadecimal format where the elements with amplitude value of –1 are mapped to bit0 (bit zero) and the elements with value of +1 are mapped to bit1 (bit one). These sequences can therefore be represented in hex format after appending 2 dummy zero bits at the end (bit ordering from left to right) as follows:

$\{S_{277}\text{hex}\}$= C56F36BB65B724B8E5E8D6137C4AF1942307BF5AB264770B41B00

$\{S_{488}\text{hex}\}$= 203805FF2AB99A227875F4D4ECE9163C851F3D4530C410FC15030

The coefficients of the 2048 frequency elements to be presented at the input of the inverse DFT are then formed from the preceding two sequences using the Equation (9) where N_T represents the number of used subcarriers (see Table 250):

$$P_{ST}(k) = \begin{cases} \sqrt{\frac{1680}{N_T}} S_{277}\left(\frac{k+840}{4}\right), -840 \le k \le -4, k \bmod 4 = 0 \\ \sqrt{\frac{1680}{N_T}} S_{488}\left(\frac{k-4}{4}\right), 4 \le k \le 840, k \bmod 4 = 0 \\ 0 \qquad\qquad\qquad\qquad , \text{otherwise} \end{cases} \tag{9}$$

And results in the short training sequence (STS) as follows:

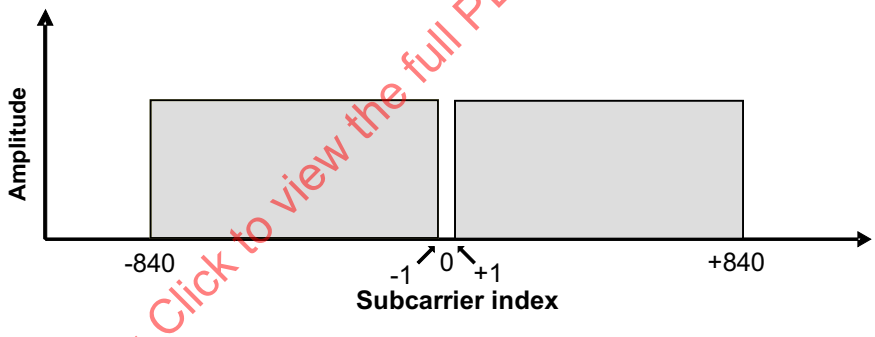

Figure 177—Subcarrier numbering scheme

P_{ST} (–1024:–841) = {0, 0, 0, 0, 0, …, 0, 0, 0, 0, 0}

P_{ST} (–840:–1) = $\sqrt{1680/NT}${1, 0, 0, 0, 1, 0, 0, 0, –1, 0, 0, 0, –1, 0, 0, 0, –1, 0, 0, 0, …, –1, 0, 0, 0, –1, 0, 0, 0, –1, 0, 0, 0, –1, 0, 0, 0, –1, 0, 0, 0}

$P_{ST}(0)$ = 0

P_{ST}(1:840) = $\sqrt{1680/NT}${0, 0, 0, –1, 0, 0, 0, –1, 0, 0, 0, 1, 0, 0, 0, –1, 0, 0, 0, …, 0, 0, 0, –1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, –1, 0, 0, 0, –1}

P_{ST} (841:1023) = {0, 0, 0, 0, 0, …, 0, 0, 0, 0, 0}

Taking the inverse DFT of the above sequence will generate 4 repetitions of a 512-sample sequence in the time domain. The factor $\sqrt{1680/NT}$ is used to normalize the signal energy, where N_T represents the number of used subcarriers.

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9.4.1.1.2 Generation of LTS

First, a periodic sequence P_{REF}^{LT} with a period of 1024 is generated using a pseudo-noise (PN) sequence generator with a polynomial of $X^{10}+X^{9}+X^{7}+X^{5}+X^{4}+X^{2}+1$. Figure 178 depicts an implementation of this PN sequence generator using a Linear Feedback Shift Register.

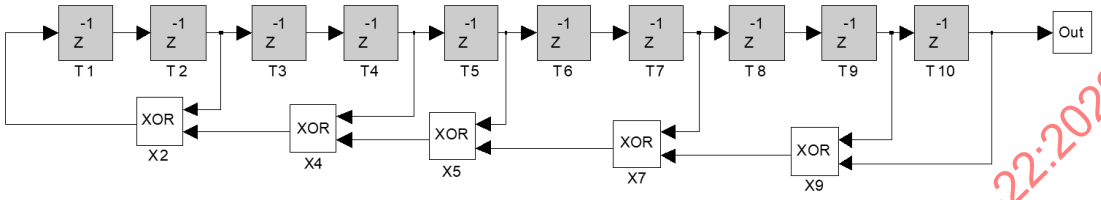

Figure 178—Structure of a Linear Feedback Shift Register implementation for the given LTS polynomial

The LTS sequence generator is initialized to a value of 11 1111 1111. The resultant P_{REF}^{LT} sequence of 1023 samples (using BPSK mapping) is given as follows:

$P_{REF}^{LT}(0:1022)$ = {1, 1, 1, 1, 1, 1, 1, 1, 1, 1, –1, –1, 1, 1, 1, –1, 1, –1, 1, 1, … , 1, –1, 1, 1, –1, –1, –1, 1, –1, –1, –1, –1, 1, 1, –1, 1, –1, –1, 1, –1}

Second, define $S_{115}(0:419)=P^{LT}{}_{REF}(115:534)$ and $S_{536}(0:419)=P_{REF}^{LT}(536:955)$, respectively. The first 420 binary values of these sequences are as follows:

$S_{115}(0:419)$ = {1, –1, 1, –1, 1, –1, –1, –1, –1, 1, 1, –1, 1, 1, 1, 1, 1, 1, 1, …, 1, 1, –1, 1, –1, 1, 1, 1, –1, 1, 1, –1, –1, 1, –1, –1, 1, 1, 1, 1}, and

$S_{536}(0:419)$ = {1, 1, 1, 1, –1, –1, 1, 1, 1, 1, –1, –1, –1, 1, –1, –1, –1, 1, 1, –1, …, 1, –1, –1, 1, –1, –1, 1, 1, 1, –1, –1, –1, 1, 1, –1, 1, 1, 1, 1}

For illustration only, consider that after resetting the LTS generator, the pair of sequences $\{S_{536},S_{115}\}$ can be represented in Hexadecimal format where the elements with amplitude value of –1 are mapped to bit0 (bit zero) and the elements with value of +1 are mapped to bit1 (bit one). These sequences can therefore be represented in hex format (bit ordering from left to right) as follows:

$\{S_{115}hex\}$=
A877F40C94889D20B91E7FB49616CB714A17845A62EE00A795947CC27EFBBD3E32F5B7E0FE2607056F6669D872C8A0376E8ED764F

$\{S_{536}hex\}$=
F1C4677539900F45F5E42A3418663A12B8F6C1081350487D8D55D344BACF02CD9C9BCD68C4932A67D2AC0473878B1F970A2A938DF

The coefficients of the 2048 frequency elements to be presented at the input of the inverse DFT are then formed from the preceding two sequences using Equation (10) where N_T represents the number of used subcarriers:

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$$P_{LT}(k) = \begin{cases} \sqrt{\frac{1680}{N_T}} S_{115}\left(\frac{k+840}{2}\right), -840 \le k \le -2, k \bmod 2 = 0 \\ \sqrt{\frac{1680}{N_T}} S_{536}\left(\frac{k-2}{2}\right), 2 \le k \le 840, k \bmod 2 = 0 \\ 0, \text{otherwise} \end{cases} \quad (10)$$

And results in the long training (LT) sequence as follows:

P_{LT} (–1024:–841) = {0, 0, 0, 0, 0, …, 0, 0, 0, 0, 0}

P_{LT} (–840:–1) = $\sqrt{\frac{1680}{N_T}}$ {1, 0, –1, 0, 1, 0, –1, 0, 1, 0, –1, 0, –1, 0, –1, 0, –1, 0, 1, 0, …, 1, 0, –1, 0, –1, 0, 1, 0, –1, 0, –1, 0, 1, 0, 1, 0, 1, 0, 1, 0}

$P_{LT}(0) = 0$

P_{LT}(1:840) = $\sqrt{\frac{1680}{N_T}}$ {0, 1, 0, 1, 0, 1, 0, 1, 0, –1, 0, –1, 0, –1, 0, 1, 0, 1, 0, …, 0, –1, 0, –1, 0, 1, 0, 1, 0, –1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1}

P_{LT} (841:1023) = {0, 0, 0, 0, 0, …, 0, 0, 0, 0, 0}

Taking the inverse DFT of P_{LT} will result in 2 repetitions of a 1024-sample vector in the time domain. The factor $\sqrt{\frac{1680}{N_T}}$ is used to normalize the signal energy, where N_T represents the number of used subcarriers..

9.4.1.2 Superframe preamble

The superframe preamble is used by the receiver for frequency and time synchronization. The format of the superframe preamble is shown in Figure 178. The superframe preamble shall be 1 OFDM symbol in duration and shall consist of 4 repetitions of the STS in the time domain preceded by a cyclic prefix of length 1/4 (T_{CP}= 1/4 T_{FFT}), which shall also consist of an STS.

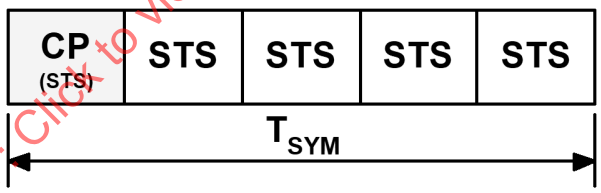

Figure 179—Superframe preamble format using the short training sequence

9.4.1.3 Frame preamble

The format of the frame preamble is shown in Figure 180. The frame preamble shall use the T_{CP} = 1/4 T_{FFT}, which shall consist of the second half of the LTS.

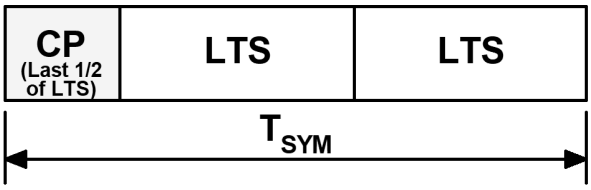

Figure 180—Frame preamble format using LTS

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9.4.1.4 CBP preamble

The CBP preamble shall have a duration of 1 OFDM symbol and it shall be composed of five short training sequences (STS_{CBP}). The STS_{CBP} is generated as described in 9.4.1.1.1 with $S_{233}(0:209) = P_{REF}^{ST}(233:442)$ and $S_{22}(0:209) = P_{REF}^{ST}(22:231)$. These shifts generate a preamble that has low cross-correlation with the superframe preamble. The sequences $S_{233}(0:209)$ and $S_{22}(0:209)$ are the first 210 bits of the following sequences in hex format (bit order from left to right):

$S_{233}(0:209)$= 2939C5D0D3EC56F36BB65B724B8E5E8D6137C4AF1942307BF5AB0

$S_{22}(0:209)$= 33444F0EBE9A9D9D22C790A3E7A8A618821F82A067F754B31BBD8

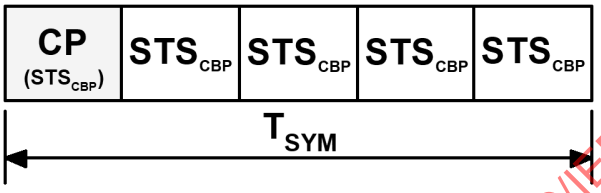

Figure 181—CBP preamble format using a short training sequence

The coefficients of the 2048 frequency elements to be presented at the input of the inverse DFT are then formed from the preceding two sequences using Equation (11), where N_T represents the number of used subcarriers (see Table 250):

$$P_{ST}(k) = \begin{cases} \sqrt{\frac{N_T}{420}} S_{233}\left(\frac{k+840}{4}\right), -840 \le k \le -4, k \bmod 4 = 0 \\ \sqrt{\frac{N_T}{420}} S_{22}\left(\frac{k-4}{4}\right), 4 \le k \le 840, k \bmod 4 = 0 \\ 0 \quad \text{, otherwise} \end{cases} \tag{11}$$

And results in the short training sequence (STS_{CBP}) as follows:

P_{ST} (–1024:–841) = {0, 0, 0, 0, 0, …, 0, 0, 0, 0, 0}

P_{ST} (–840:–1) = $\sqrt{\frac{N_T}{420}}$ {–1, 0, 0, 0, –1, 0, 0, 0, 1, 0, 0, 0, –1, 0, 0, 0, 1, 0, 0, 0, …, 1, 0, 0, 0, –1, 0, 0, 0, –1, 0, 0, 0, –1, 0, 0, 0, –1, 0, 0, 0}

$P_{ST}(0) = 0$

$P_{ST}(1:840) = \sqrt{\frac{N_T}{420}}$ {0, 0, 0, –1, 0, 0, 0, –1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, …, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 0, –1, 0, 0, 0, –1, 0, 0, 0, –1}

P_{ST} (841:1023) = {0, 0, 0, 0, 0, …, 0, 0, 0, 0, 0}

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Taking the inverse DFT of the above sequence will generate 4 repetitions of a 512–sample sequence in the time domain. The factor $\sqrt{\frac{N_T}{420}}$ is used to normalize the signal energy, where NT represents the number of used subcarriers.

9.4.2 Control header and MAP definitions

9.4.2.1 Superframe Control header (SCH)

The field definitions of the SCH are provided in 7.7.1. The length shall be one OFDM symbol.

The SCH field definition are transmitted using the PHY MCS mode 2 (seeTable 251) and T_{CP}= 1/4T_{FFT}. The SCH shall be decoded by all the CPEs associated with that BS (or in the region of that BS).

The SCH is transmitted over all 60 subchannels using all 1440 data subcarriers. The 240 pilot subcarrier indices of the SCH shall be: {–840, –833, –826, …. –21, –14, –7, 1,8,15, …, 820, 827, 834} for the first symbol of the frame (i.e., the FCH symbol or the SCH of the first frame of the superframe belonging to the WRAN cell). The pilot pattern is defined in 9.6.1. The rest of the active subcarriers are then designated as data subcarriers.

The length of the SCH is 45 bytes and is encoded by a rate: 1/2 convolutional coder to give 720 coded bits. These coded bits are then interleaved according to Table 255. The output of the interleaver is mapped to 360 QPSK symbols, D_1 to D_{360}. These 360 symbols are then mapped to the 1440 data carriers, skipping the pilot subcarriers, as follows:

D_1:D_6 = S_{-839}:S_{-834} = S_{-419}:S_{-414} = S_2:S_7 = S_{422}:S_{427}

D_7:D_{12} = S_{-832}:S_{-827} = S_{-412}:S_{-407} = S_9:S_{14} = S_{429}:S_{434}

D_{13}:D_{18} = S_{-825}:S_{-820} = S_{-405}:S_{-400} = S_{16}:S_{21} = S_{436}:S_{441}

. . .

D_{355}:D_{360} = S_{-426}:S_{-421} = S_{-6}:S_{-1} = S_{415}:S_{420} = S_{835}:S_{840}

S_k represents the symbol on k^{th} data subcarrier. Thus each data symbol D_k is spread over four data subcarriers for added robustness.

9.4.2.2 Frame control header (FCH)

The frame control header is transmitted as part of the DS PDU in the DS subframe. The length of the FCH shall be 3 bytes and contain information as specified in 7.7.2. The FCH shall be sent in the first subchannel of the symbol immediately following the frame preamble symbol except when it is the first frame of a superframe belonging to a specific BS where this symbol will follow the SCH. This second symbol of the frame carrying the FCH shall use a cyclic prefix T_{CP}=1/4 T_{FFT}.

The FCH shall be encoded using the binary convolutional channel coding specified in 9.7.2.1.1. The FCH shall be transmitted using the PHY MCS mode 5 listed in Table 251. The 15-bit randomizer is initialized using the 15 LSBs of the BS ID. The BS ID is transmitted as part of the SCH and is thus available to the CPEs for decoding. The 24 FCH bits are encoded and mapped onto 24 data subcarriers (note that the subcarrier allocation for FCH is as defined in 9.6.2). In order to increase the robustness of the FCH, as signaled in the SCH, the encoded and mapped FCH data may be transmitted using the PHY MCS mode 4 listed in Table 251. The FCH then occupies the first two OFDM slots.

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9.4.2.3 DS-MAP, US-MAP, DCD, and UCD

The length of the DS-MAP PDU is variable and is defined in the FCH (7.7.2). Note that if the DS-MAP PDU is not present, this length will be that of the US-MAP PDU. This PDU shall be encoded using the binary convolutional channel coding specified in 9.7.2.1.1 and transmitted using the PHY MCS mode 5 listed in Table 251 in the logical subchannel immediately following the FCH. If the DS-MAP is present, the length of the US-MAP, DCD and UCD, when present, shall be specified at the beginning of the DS-MAP in that order. The number of subchannels required to transmit these fields shall be determined by their respective lengths in number of OFDM slots. These fields shall be transmitted using PHY MCS mode 5. If this number exceeds the number of subchannels allocated per symbol, the transmission of these PDUs will continue in the next symbol starting with the first logical subchannel. The unused subchannels in the last symbol of the frame header shall be used for DS transmissions.

9.5 CBP packet format

The format of the CBP packet is shown in Figure 182. The CBP packet consists of a preamble portion and a data portion. The CBP preamble is one OFDM symbol in duration and is generated as described in 9.4.1.4. The CBP data portion can be either one or two OFDM symbols in duration. The length field in the first symbol enables a receiver to determine the presence or absence of the second data symbol.

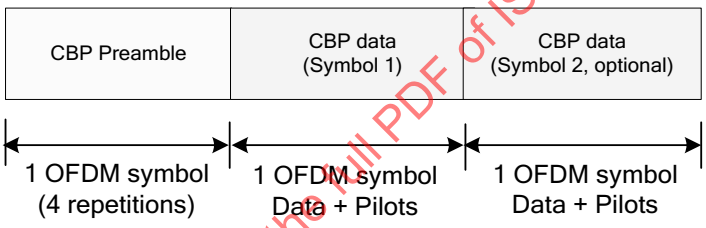

Figure 182—CBP packet format

The CBP preamble consists of four repetitions of a short training sequence. A receiver may use the first two short training sequences in this field for acquisition and AGC setting and the next two short training sequences for frequency offset estimation. The CBP data symbols consist of the data and the pilot subcarriers. From the 1680 used subcarriers, 426 subcarriers are designated as pilot subcarriers and the remaining 1254 subcarriers are designated as data subcarriers.

The location of the non-zero subcarriers in the CBP preamble and the location of pilot and data subcarriers in the CBP data symbols are given below and shown pictorially in Figure 183.

Location of non-zero subcarriers in the CBP preamble symbol: (–840, –836, –832, -828, …, –12, –8, –4, 4, 8, 12, 16, ... , 832, 836, 840)

Location of 426 pilot subcarriers in the data portion: (–840, –839, –838, –834, –830, –826, …, –10, –6, –2, –1, 1, 2, 6, 10, …, 830, 834, 838, 839, 840)

Location of 1254 data subcarriers in the data portion: (–837, –836, –835), (–833, –832, –831), (–829, –828, –827), …, (–9, –8, –7), (–5, –4, –3), (3, 4, 5), (7, 8, 9), (11, 12, 13), … (831, 832, 833), (835, 836, 837).

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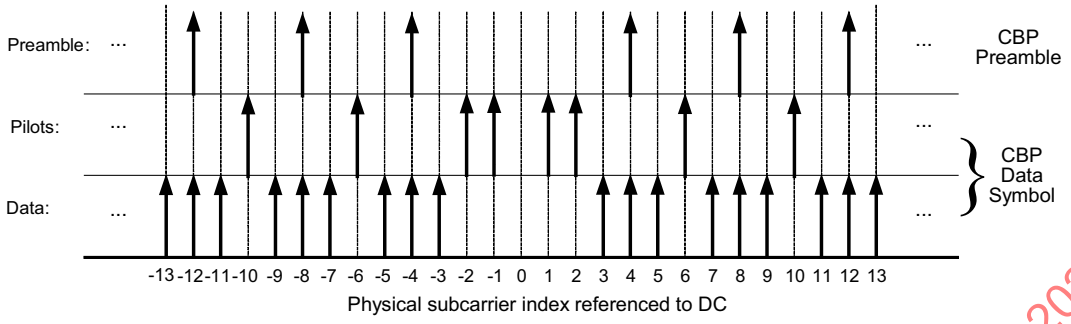

Figure 183—Subcarrier definition for CBP preamble and data symbols

The pilot signals in the CBP packet shall be BPSK modulated, as described in 9.8.2, by a pseudo random binary sequence to avoid the generation of spectral line frequencies. The polynomial for the PRBS generator shall be the same as that used for the data scrambler, as defined in 9.7.1. The PRBS generator shall be initialized by the same seed value, 0 1 1 0 1 1 1 0 0 0 1 0 1 0 1, starting with the MSB on the left. The first 426 bits of the sequence shall be used for pilot modulation in the first OFDMA symbol, while the next 426 bits shall be used for pilot modulation in the second OFDMA symbol. The first OFDMA symbol starts after the preamble in every CBP packet.

9.5.1 Encoding of CBP data

Figure 184 shows a simplified block diagram of the CBP data encoder and mapper.

Figure 184—Encoding steps for CBP data

The CBP payload is first processed by the scrambler, which is functionally the same as the data scrambler (see 9.8.2). The scrambler shall be initialized for each CBP payload with the same initialization vector as for the PSDU data (see 9.7.1). The scrambled CBP payload is divided into blocks of 418 bits before encoding and mapping. Unlike for a data burst, OFDM slot concatenation (see 9.7.2.1.3) is not used for the CBP payload. Each block of 418 bits shall be first encoded using a rate: 1/2 convolutional code (see 9.7.2.1.1) with tail biting resulting in 836 encoded bits. To do this, the convolutional coder has to be initialized with the last 6 bits of each block to be encoded. After interleaving of the encoded bits by a bit interleaver with interleaving size of 836 bits (see Figure 9.6.5), the bits are then mapped using the QPSK constellation (see Figure 195), resulting in 418 QPSK symbols. Each of these QPSK symbols is transmitted on three subcarriers in order to provide additional frequency diversity. The spreading function is described by Equation (12):

$$\begin{bmatrix} S_i \\ S_{i+418} \\ S_{i+836} \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} [D_i] \quad i = 0,1,2,...,417 \tag{12}$$

Where D_i represents the i^{th} QPSK symbol and S_k represents the symbol on the k^{th} data subcarrier. The 1254 spread symbols are inserted in their corresponding locations as described above. This will result in symbol S_0 being inserted in frequency bin –837, symbol S_1 in frequency bin –836, symbol S_2 in frequency bin –835,

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symbol S_3 in frequency bin –833, etc. The 426 pilot symbols are then inserted in their designated frequency bins. The resultant vector is then transformed into the time domain using an IFFT module. The length of cyclic prefix for the CBP packet symbols is $T_{CP} = 1/4\ T_{FFT}$.

A WRAN receiver can combine the pilot subcarriers of the CBP data symbols with those of the preamble symbols to perform better interpolation to derive channel estimates. These channel estimates can then be used to equalize the CBP data symbols. The receiver can also use maximal ratio combining (MRC) to de-spread the data symbols. The use of soft-decision Viterbi decoding is recommended.

9.6 OFDM subcarrier allocation

Among the 2048 subcarriers in each OFDM symbol, 384 subcarriers are null subcarriers (left guard band, right guard band and DC subcarriers) with 0 amplitude and 0 phase. The remaining 1680 subcarriers, which are partitioned into 60 subchannels, are for pilot and data. A subchannel is composed of 28 subcarriers (24 data and 4 pilot subcarriers). A subchannel is the basic unit used for subcarrier allocation in both DS and US.

In the DS, the 240 pilot values are allocated first. A sequence of 1440 complex data values generated by the constellation mapper is interleaved using the interleaving algorithm described in 9.6.2. These interleaved values are then allocated to the 1440 data subcarriers.

In the US, the first six logical subchannels, which are usually reserved for opportunistic or scheduled control signaling, use a set of regularly spaced subcarriers with physical mapping as specified in 9.6.4. The US-MAP may also assign up to 10 additional subchannels for such opportunistic signaling (see Table 46). Among the remaining subchannels, the subchannels allocated to a CPE are assigned with pilot values and data from the constellation mapper. Other subchannels are assigned with 0 amplitude and 0 phase at the CPE. The 1512 assigned values are interleaved using the interleaving algorithm described in 9.6.2. These interleaved values are then allocated to the 1512 remaining subcarriers.

9.6.1 Pilot pattern

The pilot insertion pattern is shown in Figure 185. The pilot pattern shall be repeated every 7 OFDM symbols and 7 subcarriers in the time and frequency domains, respectively. The pilot pattern is always the same, independent of the channel bandwidth. The pilot pattern shall also be the same for the DS and US. In the DS, the pilots do not participate in the interleaving procedure, and the physical representation of the pilots in the time and frequency domains follows the same pattern as shown in Figure 185 except for the subcarrier index. The following physical pilot indices, P_k, after the last frame preamble in every DS subframe, shall be used instead of the logical indices 0, 1, … , 6. See Equation (13).

$$P_k = -840 + 7k + pilot_subcarrier_offset + DC_flag \quad k = 0,1,2,...,239 \tag{13}$$

where

k is the running subcarrier index from 0 to 239

pilot_subcarrier_offset is the subcarrier offset to control the beginning of first pilot subcarrier within each OFDM symbol. The *pilot_subcarrier_offset* is 0, 3, 5, 1, 4, 6, and 2 for *(OFDMA_symbol_index mod 7)* = 0, 1, 2, 3, 4, 5, and 6, respectively. The OFDMA symbol of index 0 should be the first OFDMA symbol in every DS or US subframes.

DC_flag is used to count the DC subcarrier in the calculation of pilot subcarrier index. When *k* is equal or larger than 120, the value is set to 1.

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In the US, the pilots participate in the interleaving procedure, they will not have the same spacing after the interleaving process, and their physical representation will be different from Figure 185. These pilot subcarriers should be used by both BS and CPE for robust channel estimation and tracking against frequency offset and phase noise. Note that the pattern described in this subclause does not apply to the CBP packet.

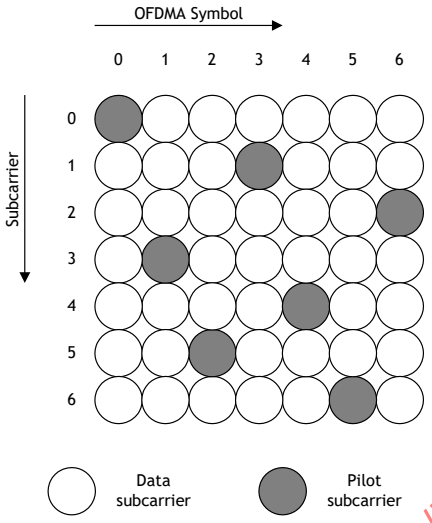

Figure 185—Repetition unit of the pilot pattern (in the logical domain before interleaving)

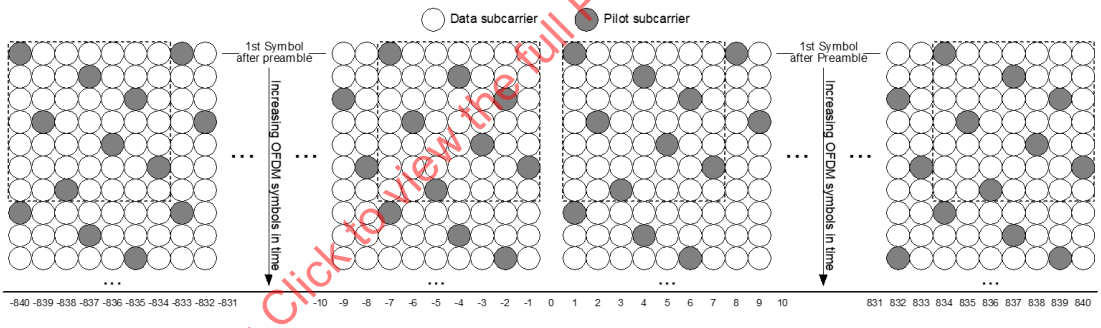

Figure 186—Physical location of the downstream pilot subcarriers

In both DS and US, the pilot subcarriers shall be BPSK modulated, as described 9.8.2., by a pseudo random binary sequence to avoid the generation of line spectral frequencies. The polynomial for the PRBS generator shall be the same as that used for the data scrambler, as defined in 9.7.1. The PRBS generator shall be initialized at the beginning of each frame by the same seed value, 0 1 1 0 1 1 1 0 0 0 1 0 1 0 1, starting with the MSB on the left. The first 240 bits of the sequence shall be used for pilot modulation in the first OFDM symbol, while the next 240 bits shall be used for pilot modulation in the second OFDM symbol, and so on. The first OFDM symbol starts after the frame preamble in every DS subframe, while the first OFDMA symbol starts from the initial OFDMA symbol in every US burst.

9.6.2 Interleaving algorithm

The interleaving algorithm uses two parameters (Increment and Offset) to generate a permutation rule L(k). The values of these two parameters are within the range of the interleaving block size indicated by K.

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"Increment" denotes the jump in value between two adjacent interleaved indices, and "Offset" denotes the initial index of the interleaved pattern.

For both subcarrier interleaving and bit interleaving, the sequence [k=0, … ,(K–1)] is interleaved to generate the sequence L(k). In the case of the subcarrier allocator, after interleaving, the value at index L(k) in the input subcarrier sequence coming from the constellation mapper is relocated to index k in the output subcarrier sequence going to the pilot inserter. For the bit interleaver, the value at index L(k) in the input data sequence is relocated to index k in the output sequence going to the data encoder.

The permutation rule is defined in Equation (14) (for k = 0 to K–1):

$$L(k) = \mathrm{mod}(k*\mathrm{Increment}+\mathrm{Offset},K) \quad (14)$$

The performance of the L(k) permutation rule is characterized by the interleaving spreading depth, which corresponds to the sum of the distance between two permutated indices and the distance between their related unpermutated indices, as shown in Equation (15):

$$\text{Spreading Depth} = |\Delta L|+|\Delta k| = |L(k+\Delta k)-L(k)|+|\Delta k| \quad (15)$$

For any indices k and k+Δk in the unpermutated sequence, ΔL represents the distance between the corresponding indices L(k) and L(k+Δk) in the permutated sequence. The spreading depth can then be calculated for all values of k and k+Δk.

The best interleaving parameters {Increment, Offset} are the ones that can maximize the minimum spreading depth and minimize the number of occurrences of the smaller spreading depths.

9.6.3 Downstream subcarrier allocation

For each symbol in the DS, every 4 pilot values and every 24 complex data from the constellation mapper are assigned to a subchannel. For example, subchannel 1 is constituted of pilot values at indices 0, … , 3 and complex data values at indices 0, … , 23; subchannel 2 is constituted of pilot values at indices 4, … , 7 and complex data values at indices 24, … , 47, and so on (for the following subchannels).

The pilot values shall be directly allocated (without interleaving) to pilot subcarriers following the pilot pattern defined in 9.6.1. A sequence of 1440 complex data from the constellation mapper shall first be interleaved, and then the interleaved data sequence shall be allocated to the data subcarriers sequentially.

The permutation rule L(k) used for interleaving is as described in 9.6.2 with the parameters {K,Increment,Offset}={1440,1153,672} in the case of the legacy interleaving option A or {1440, 437,153} in the case of interleaving option B provide the best spreading depth (as specified in Table 255). Index L(k) in the constellation mapper output data sequence shall correspond to index k in the interleaved subcarrier sequence. For illustration, Table 253 shows the relationship between the input and output sequences of the interleaving process for subchannels 1, 2, and 3 for the parameters {1440,1153,672}. In the table, the interleaved subcarrier sequence corresponds to the input indices whereas the constellation mapper output sequence corresponds to the output indices.

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Table 253—Interleaving patterns for subchannels 1, 2, and 3 in the downstream

Subchannel 1		Subchannel 2		Subchannel 3	
Input index	Output index	Input index	Output index	Input index	Output index
0	672	24	984	48	1296
1	385	25	697	49	1009
2	98	26	410	50	722
3	1251	27	123	51	435
4	964	28	1276	52	148
5	677	29	989	53	1301
6	390	30	702	54	1014
7	103	31	415	55	727
8	1256	32	128	56	440
9	969	33	1281	57	153
10	682	34	994	58	1306
11	395	35	707	59	1019
12	108	36	420	60	732
13	1261	37	133	61	445
14	974	38	1286	62	158
15	687	39	999	63	1311
16	400	40	712	64	1024
17	113	41	425	65	737
18	1266	42	138	66	450
19	979	43	1291	67	163
20	692	44	1004	68	1316
21	405	45	717	69	1029
22	118	46	430	70	742
23	1271	47	143	71	455

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The subcarrier allocation in the DS is performed using the following procedure:

a) All null subcarriers are first allocated.
b) The pilot values are allocated to the pilot subcarriers following the pilot pattern described in 9.6.1.

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c) K=1440 complex values from the constellation mapper are interleaved using the algorithm described in 9.6.2 with parameters {K,Increment, Offset}={1440,1153,672} for the legacy interleaving option A or {1440,437,153} for the option B that provides the best spreading depth (see Table 254).

The interleaved data sequence is allocated sequentially to the remaining subcarriers.

Figure 187 shows an example allocation for the first OFDM symbol in a burst, where P is a pilot subcarrier, and L(x) represents an index in the constellation mapper output data sequence.

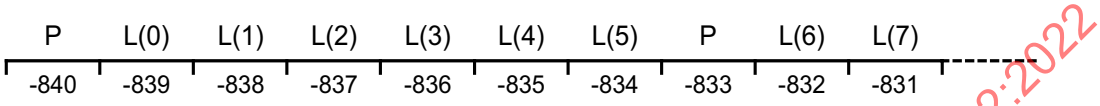

Figure 187—Example allocation for the first OFDMA symbol in a burst

9.6.4 Upstream Subcarrier allocation

In the US, the first six subchannels, which are usually reserved for opportunistic or scheduled control signaling (i.e., Ranging/BW request/UCS notification bursts, see 9.9.3), use the predetermined regular subcarrier indices specified below. When these subchannels are not used for control signaling, they can be used for data. In such case, the pilot subcarriers are logically allocated as shown in Figure 185. The remaining regularly spaced subcarriers are then sequentially assigned with data values from the constellation mapper.

All the subcarriers in the subchannels not assigned to the CPE shall be assigned 0 amplitude and 0 phase at the CPE. For each subchannel assigned to the CPE, 4 associated pilot values shall be assigned and 24 complex data from the constellation mapper shall be assigned following the pattern specified in 9.6.1.

Among the 240 pilot values, every 4 pilot values are associated with a subchannel. For example, pilot values at indices 0, … , 3 are associated with subchannel 1, pilot values at indices 4, … , 7 are associated with subchannel 2, and so on. However, if a subchannel is used for CDMA opportunistic signaling, its pilot values normally associated with this subchannel are not used. Every 24 complex data values from the constellation mapper are assigned to a subchannel. The assignment follows the pattern specified in 9.6.1.

Within each subchannel assigned to the CPE, the 4 pilot values shall be inserted following the pilot pattern described in 9.6.1. Then complex data values shall be sequentially allocated to the remaining 24 logical subcarriers.

While the logical subcarriers in the six first subchannels are allocated to regularly spaced physical subcarriers after interleaving among these 168 subcarriers as indicated in Table 255, interleaving shall be performed on the subcarriers in the remaining 54 subchannels, that is for the remaining 1512 subcarriers as indicated in Table 255. The interleaved sequence shall be allocated sequentially to the 1512 remaining physical subcarriers in the symbol. In other words, each subchannel is mapped to a group of 28 physical subcarriers following the interleaving scheme described below.

The permutation rule L(k) used for interleaving is described in 9.6.2 with the parameters {K,Increment,Offset}={1512,1123,478} for the legacy interleaving option A or {1512,1231,1311} for interleaving option B that provides the best spreading depth (as indicated in Table 255). Index L(k) in the constellation mapper output sequence shall correspond to index k in the interleaved subcarrier sequence. Table 254 shows the relationship between the interleaver input and output sequences for parameters {1512,1123,478} for subchannels 7 and 8 with the pilot allocation shown for the first symbol of the US subframe. In the table, the interleaved subcarrier sequence corresponds to the input indices whereas the constellation mapper output corresponds to the output indices. $\boldsymbol{P_i}$ represents the i^{th} pilot value, $\boldsymbol{D_{j,k}}$

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represents the k^{th} data value in the group of 24 data values (obtained from the constellation mapper) allocated to subchannel j.

Table 254—Example of interleaving patterns in the upstream for the first symbol of the interleaved subchannels 7 and 8

Subchannel 7			Subchannel 8		
Input index	**Value**	**Output index**	**Input index**	**Value**	**Output index**
0	$\mathbf{P_0}$	478	28	$\mathbf{P_4}$	170
1	$\mathbf{D_{3,0}}$	89	29	$\mathbf{D_{4,0}}$	1293
2	$\mathbf{D_{3,1}}$	1212	30	$\mathbf{D_{4,1}}$	904
3	$\mathbf{D_{3,2}}$	823	31	$\mathbf{D_{4,2}}$	515
4	$\mathbf{D_{3,3}}$	434	32	$\mathbf{D_{4,3}}$	126
5	$\mathbf{D_{3,4}}$	45	33	$\mathbf{D_{4,4}}$	1249
6	$\mathbf{D_{3,5}}$	1168	34	$\mathbf{D_{4,5}}$	860
7	$\mathbf{P_1}$	779	35	$\mathbf{P_5}$	471
8	$\mathbf{D_{3,6}}$	390	36	$\mathbf{D_{4,6}}$	82
9	D3,7	1	37	$\mathbf{D_{4,7}}$	1205
10	$\mathbf{D_{3,8}}$	1124	38	$\mathbf{D_{4,8}}$	816
11	$\mathbf{D_{3,9}}$	735	39	$\mathbf{D_{4,9}}$	427
12	$\mathbf{D_{3,10}}$	346	40	$\mathbf{D_{4,10}}$	38
13	$\mathbf{D_{3,11}}$	1469	41	$\mathbf{D_{4,11}}$	1161
14	$\mathbf{P_2}$	1080	42	$\mathbf{P_6}$	772
15	$\mathbf{D_{3,12}}$	691	43	$\mathbf{D_{4,12}}$	383
16	$\mathbf{D_{3,13}}$	302	44	$\mathbf{D_{4,13}}$	1506
17	$\mathbf{D_{3,14}}$	1425	45	$\mathbf{D_{4,14}}$	1117
18	$\mathbf{D_{3,15}}$	1036	46	$\mathbf{D_{4,15}}$	728
19	$\mathbf{D_{3,16}}$	647	47	$\mathbf{D_{4,16}}$	339
20	$\mathbf{D_{3,17}}$	258	48	$\mathbf{D_{4,17}}$	1462
21	$\mathbf{P_3}$	1381	49	$\mathbf{P_7}$	1073
22	$\mathbf{D_{3,18}}$	992	50	$\mathbf{D_{4,18}}$	684
23	$\mathbf{D_{3,19}}$	603	51	$\mathbf{D_{4,19}}$	295
24	$\boldsymbol{D_{3,20}}$	214	52	$\boldsymbol{D_{4,20}}$	1418
25	$\boldsymbol{D_{3,21}}$	1337	53	$\boldsymbol{D_{4,21}}$	1029
26	$\boldsymbol{D_{3,22}}$	948	54	$\boldsymbol{D_{4,22}}$	640
27	$\boldsymbol{D_{3,23}}$	559	55	$\boldsymbol{D_{4,23}}$	251

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The subcarrier allocation in the US shall be performed using the following procedure:

1) All null subcarriers and the DC subcarrier are first allocated with 0 amplitude and 0 phase.

2) The 168 subcarriers of the six first subchannels, which are usually reserved for “Ranging/BW requests/UCS notification,” are allocated using the following subcarrier indices: {–840, –830, –820, … , –20, –10, 10, 20, … , 820, 830, 840}. In the case where the US-MAP indicates that any of these six first subchannels are assigned to the CPE for data transmission, the pilot subcarriers are logically allocated as shown in 9.6.1 as a function of the symbol order in the US subframe. The remaining regularly spaced subcarriers are then sequentially assigned with data values from the constellation mapper.

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3) For each subchannel allocated to the CPE among the remaining 54 subchannels, the 4 associated pilot values are logically inserted following the pilot pattern described in 9.6.1 as a function of the symbol order in the US subframe. Complex data values from the constellation mapper are then sequentially allocated to the remaining 24 logical subcarriers. Note that in the US, a CPE is assigned 7 or more symbols that can span one or more subchannels, and data values are inserted into the same subchannel on a symbol by symbol basis (over all assigned symbols) before the next subchannel is used. If the US-MAP indicates that more than 6 subchannels are assigned for "Ranging/BW request/ UCS notification," the logical subcarriers for these subchannels shall be allocated accordingly.

4) All the subcarriers of the remaining subchannels are allocated with 0 amplitude and 0 phase.

5) The 168 logical subcarriers assigned to the first 6 subchannels are interleaved using the algorithm described in 540[9.6.2] with parameters {K,p,q,j}={168,137,148} for the legacy interleaving option A or {168,65,19} for the interleaving option B that provides the best spreading depth.

6) The 1512 assigned logical subcarriers are interleaved using the algorithm described in 9.6.2 with parameters {K,p,q,j}={1512,1123,478} for the legacy interleaving option A or {1512,1231,1311} for the interleaving option B that provides the best spreading depth.

7) The interleaved sequence is allocated sequentially to the remaining 1512 subcarriers.

Table 255—Interleaving parameters for the downstream and upstream subcarrier mapping allocation

	Interleaving depth	Option A Interleaving parameters		Minimum spreading depth	Option B Interleaving parameters		Minimum spreading depth
	K	Increment	Offset	|ΔL|+|Δk|	Increment	Offset	|ΔL|+|Δk|
DS	1440	1153	672	10	437	153	52
US	1512	1123	478	42	1231	1311	54
SCH	168	137	148	16	65	19	16
	720	169	588	24	199	258	36
CBP burst	836	705	506	38	655	19	40

9.6.5 Bit interleaving

The interleaving algorithm described in 9.6.2 shall be used to interleave the data bits at the output of the channel coding procedure to generate an interleaved bit sequence. The index L(k) in the bit sequence at the output of the channel coding procedure shall correspond to the index k in the interleaved bit sequence.

Table 256 provides the block sizes and interleaving parameters {K,Increment,Offset} for all supported block sizes as well as information on the resulting minimum interleaving spreading depth |ΔL|+|Δk|, which is indicative of the strength of the interleaving process for each block size and for both sets of interleaving parameters.

Only the block size where K= 288 shall be supported in the DS and K= 96, 192, and 288 in the US for the binary convolutional coding (see 9.7.2.1).

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Table 256—Interleaving pattern description

Coded block	Legacy Option A interleaving parameters		Minimum spreading depth	Optimum Option B interleaving parameters		Minimum spreading depth
K (bits)	Increment	Offset	|ΔL|+|Δk|	Increment	Offset	|ΔL|+|Δk|
48	17	16	6	11	29	8
96	73	33	8	79	5	12
144	85	78	12	89	99	16
192	73	33	16	139	42	18
240	229	222	12	71	106	20
288	169	129	24	121	35	24
336	145	192	14	139	292	24
384	133	174	18	31	207	24
432	253	234	24	77	14	28
480	289	432	10	127	298	30
528	421	30	12	223	43	30
576	361	324	16	107	341	32
672	649	501	24	107	48	36
720	169	588	24	199	258	36
768	265	609	30	541	156	36
836	705	506	38	655	19	40
864	97	336	18	713	128	40
960	709	942	36	403	478	42
1008	793	324	28	95	307	42
1056	—	—	—	815	937	44
1152	937	324	32	529	164	48
1248	1129	1077	24	571	598	48
1344	1093	942	32	727	248	48
1440	881	520	36	457	156	48
1536	133	558	36	199	367	54
1632	745	705	46	787	74	54
1680	1121	280	46	299	387	56

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Table 256—Interleaving pattern description *(continued)*

Coded block	Legacy Option A interleaving parameters		Minimum spreading depth	Optimum Option B interleaving parameters		Minimum spreading depth
K (bits)	Increment	Offset	|ΔL|+|Δk|	Increment	Offset	|ΔL|+|Δk|
1728	937	900	48	137	247	56
1824	1537	816	38	1051	28	60
1920	1633	1584	40	1471	222	60
2016	481	1200	42	277	16	60
2112	—	—	—	1121	230	64
2208	841	1761	24	593	291	64
2304	1057	2064	48	499	36	66

9.7 Channel coding

Channel coding includes data scrambling, binary convolutional coding or advanced coding, puncturing in the case of BCC and CTC, bit interleaving and constellation mapping. Figure 188 shows the mandatory channel coding process. The channel coder processes the control headers and the PSDU portion of the PPDU. The channel coder shall not process the preamble part of the PPDU.

For the purpose of channel coding, each data burst is further subdivided into data blocks as shown in Figure 189. Each block of encoded data will be mapped and transmitted on one or more OFDM slots.

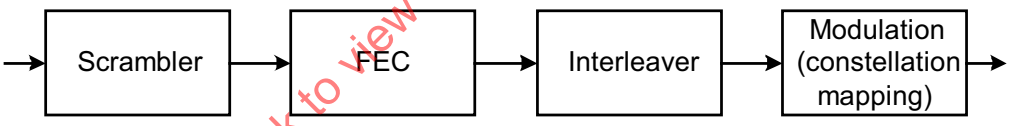

Figure 188—Channel coding process

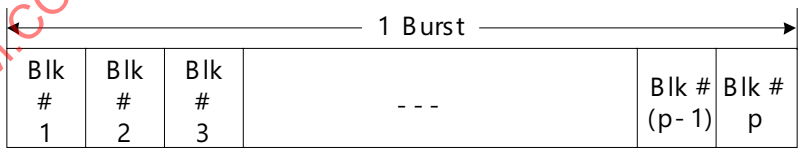

Figure 189—Partitioning of a data burst into data blocks

9.7.1 Data scrambling

The PSDU data is first processed by the data scrambler using a pseudo random binary sequence (PRBS) generator. The PRBS generator polynomial is $1+X^{14}+X^{15}$ and is shown in Figure 190. The preamble and the control header fields of the PPDU shall not be scrambled. The data scrambler is initialized on each burst with 011011100010101, starting with the MSB on the left. The generation of the initialization vector for control headers is described in 9.4.2. The pad bits, if present, shall be scrambled.

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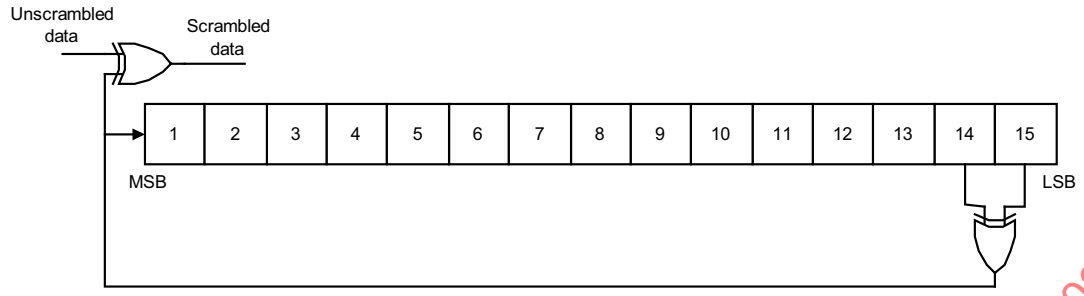

Figure 190—Pseudo random binary sequence generator for data scrambler

9.7.2 Forward Error Correction (FEC)

The binary convolutional code is mandatory and there are three additional optional modes.

9.7.2.1 Binary Convolutional code (BCC) mode (mandatory)

9.7.2.1.1 Binary convolutional coding

The data burst is encoded using a rate: 1/2 binary convolutional encoder. The constraint length of this coder is equal to 7 and its generator polynomials are 171_o and 133_o for outputs A and B, respectively. Figure 191 is a graphical description of the generator polynomials. Output A and output B represent the first and second output bits respectively of this encoder.

The convolutional coder shall be initialized at the beginning of the control headers and at the beginning of each PSDU data block. Tail biting shall be used with both control headers and the PSDU data. This implies that for the case of control headers, the encoder memory is initialized with the last 6 bits in the headers and for the case of PSDU data, the encoder memory is initialized with the last 6 bits in each PSDU data block.

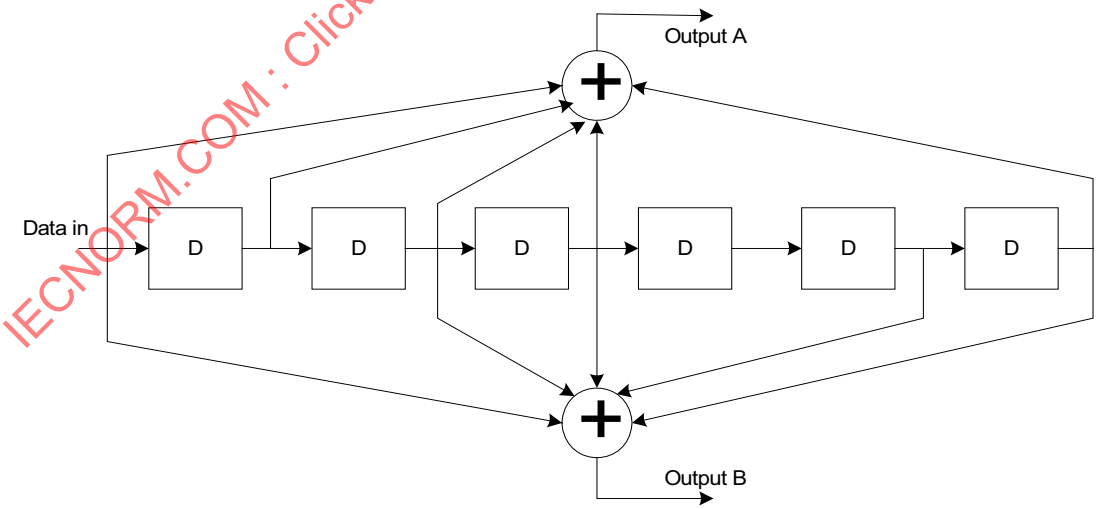

Figure 191—Rate: 1/2 convolutional coder with generator polynomials 171o, 133p (the delay element represents a delay of 1 bit)

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9.7.2.1.2 Puncturing

Different coding rates can be obtained by puncturing the output of the convolutional coder. Table 257 shows the different rates that can be derived from the output of the rate: 1/2 convolutional coder and the associated puncturing patterns.

Decoding by using Viterbi algorithm is recommended. At the receiver, zeros are inserted in the locations of the punctured bits before the Viterbi decoder.

Table 257—Puncturing and bit insertion for the different coding rates

Code rate	1/2	2/3	3/4	5/6
Convolutional coder output	A_1B_1	$A_1B_1B_2$	$A_1B_1B_2A_3$	$A_1B_1B_2A_3B_4A_5$
Puncturer output/ bit-inserter input	A_1B_1	$A_1B_1B_2$	$A_1B_1B_2A_3$	$A_1B_1B_2A_3B_4A_5$
Decoder input	A_1B_1	$A_1B_10B_2$	$A_1B_10B_2A_30$	$A_1B_10B_2A_300B_4A_50$

9.7.2.1.3 OFDM slot concatenation

Before the slot concatenation rule described below can be applied, the last slot on each PSDU should be padded with zeros in case the encoded data from the payload does not completely fill it.

The encoding block size shall depend on the number of OFDM slots allocated, the FEC coding rate and the modulation specified for the current transmission. The allowed coded block sizes shall be 48 bytes for the FCH and 288 bytes for all other DS burst transmissions. The coded block sizes for the US burst transmissions shall be 96 bit for QPSK modulation, 192 bits for 16-QAM modulation and 288 bits for 64-QAM modulation, and the number of symbols assigned to the US subframe shall be even.[28]

Concatenation of a number of OFDM slots shall be performed in order to allow for transmission of these coded blocks. Table 258 specifies the concatenation index for different modulations and coding.

For any modulation and coding, the following parameters are defined:

— j: index dependent on the modulation level and FEC rate
— n: number of allocated OFDM slots
— k: floor (n / j)
— m: n mod j

Table 259 shows the rules used for OFDM slot concatenation.

[28] In IEEE Std 802.22-2011, it was found that, for a given burst listed in the DS-MAP or US-MAP, the specification of the length of this burst in number of OFDM slots was not sufficient for the receiver to unambiguously deduce the size of the encoded block and subsequently the size of the encoding block resulting from the coding rate used as specified by the DIUC or UIUC contained in the corresponding DS-MAP or US-MAP for the given burst. This results from the fact that there could be a number of arrangements of multiple blocks of given size constituting the burst that fits in the specified length. The receiver would not be able to know which of these arrangements is being used for the burst. In order to avoid such ambiguity and not having to modify the DS-MAP to specify the block size, it is proposed to limit the encoded block size to 48 bytes for the FCH and 288 bytes for all other DS transmissions

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Table 258—Concatenation index for different modulations and coding

Block size (encoded bits)>	**288**
Modulation	j
QPSK	6
16-QAM	3
64-QAM	2
Modulation and rate	**j**
QPSK 1/2	12
QPSK 2/3	9
QPSK 3/4	8
QPSK 5/6	7
16-QAM 1/2	6
16-QAM 2/3	4
16-QAM 3/4	4
16-QAM 5/6	3
64-QAM 1/2	4
64-QAM 2/3	3
64-QAM 3/4	2
64-QAM 5/6	2
256-QAM 1/2	3
256-QAM 2/3	2
256-QAM 3/4	2
256-QAM 5/6	1
256-QAM 7/8	1
4D-TCM 48QAM	2
4D-TCM 192QAM	1

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Table 259—OFDM slot concatenation rule

Number of OFDM slots	Concatenated slots
n ≤ j	1 block of n slots

n > j	If (n mod j =0)
	k blocks of j slots
	else
	(k–1) blocks of j slots
	1 block of ceil((m+j)/2) slots
	1 block of floor((m+j)/2) slots

Table 260 defines the basic sizes of the useful data payloads (in bytes) to be encoded in relation with the selected modulation type, encoding rate, and concatenation rule.

Table 260—Useful data payload in bytes for an FEC block

QPSK				16-QAM				64-QAM				256-QAM				
R= 1/2	R= 2/3	R= 3/4	R= 5/6	R= 1/2	R= 2/3	R= 3/4	R= 5/6	R= 1/2	R= 2/3	R= 3/4	R= 5/6	R= 1/2	R= 2/3	R= 3/4	R= 5/6	R= 7/8
3																
	4															
			5													
6				6												
	8				8											
9		9				9		9								
			10				10									
12	12			12					12			12				
15			15								15					
	16				16								16			
18		18		18		18		18						18		
	20		20				20								20	
21																21
24	24			24	24				24			24				
			25													
27		27				27		27		27						
	28															
30			30	30			30				30					

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Table 260—Useful data payload in bytes for an FEC block *(continued)*

QPSK				16-QAM				64-QAM				256-QAM				
R= 1/2	R= 2/3	R= 3/4	R= 5/6	R= 1/2	R= 2/3	R= 3/4	R= 5/6	R= 1/2	R= 2/3	R= 3/4	R= 5/6	R= 1/2	R= 2/3	R= 3/4	R= 5/6	R= 7/8
	32				32								32			
33																
			35													
36	36	36		36		36		36	36			36		36		
	8				8											

9.7.2.2 Duo-binary convolutional Turbo code (CTC) mode (optional)

9.7.2.2.1 Duo-binary convolutional turbo coding

The Duo-binary Turbo Code is illustrated in Figure 192. It uses a Circular Recursive Systematic Convolutional (CRSC) Code as component codes, with double-binary input.

The bits of the data to be encoded are alternately fed to inputs A and B, starting with the MSB of the first byte being fed to A. The encoding system is fed by blocks of k bits or N couples (k=2×N). N is a multiple of 4 (k is a multiple of 8).

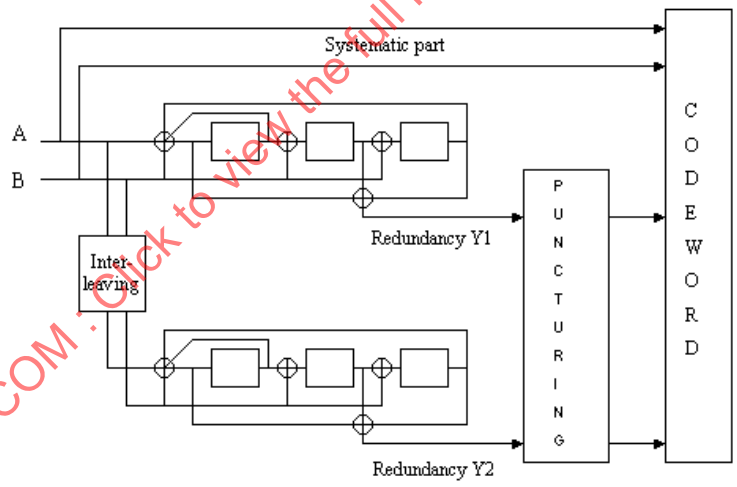

Figure 192—Duo-binary convolutional turbo code: Encoding scheme

The polynomials, which shall be used for the connections, are described in octal and symbolic notations as follows:

— For the feedback branch: 15 (in octal), equivalently $1+D+D^3$ (in symbolic notation)

— For the Y1 and Y2 parity bits, 13, equivalently $1+D^2+D^3$

The input A shall be connected to tap "1" of the shift register and the input "B" shall be connected to the input taps "1," D, and D^2.

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This first encoding is called *C1 encoding*. After initialization by the circulation state S_{c_1}, the encoder shall be fed by the sequence in the natural order with incremental address i = 0, …, *N*–1.

This second encoding is called *C2 encoding*. After initialization by the circulation state S_{c_2}, the encoder shall be fed by the interleaved sequence with incremental address j = 0, …, *N*–1.

The permuting function that gives the natural address *i* of the considered couple, when reading it at place *j* for the second encoding, is given in 9.7.2.2.2.

9.7.2.2.2 CTC interleaver

In the CTC interleaver, the permutation shall be done on two levels:

— The first one inside the couples (**level 1**)
— The second one between couples (**level 2**)

The permutation is described in the following algorithm:

— Set the permutation parameters P_0, P_1, P_2 and P_3. These parameters depend on the size of the sequence to be encoded. Table 261 gives the block size, code rates, and code parameters for the different modulation and coding schemes. Optimized code parameters are given for data block sizes up to 240 bytes.
— $j = 0, \ldots, N-1$.
— **level 1**
  —if j mod. 2 = 0, let (A,B) = (B,A) (invert the couple)
— **level 2**
  — if j mod. 4 = 0, then P = 0;
  — if j mod. 4 = 1, then $P = N/2 + P_1$;
  — if j mod. 4 = 2, then $P = P_2$;
  — if j mod. 4 = 3, then $P = N/2 + P_3$.
  — $i = P_0 \cdot j + P + 1$ mod. N

Table 261—Code parameters for the different modulation and coding schemes

Data block size (byte)	Encoded data block size (bytes)								N	P0	P1	P2	P3
	QPSK		16-QAM		64-QAM								
	1/2	3/4	1/2	3/4	1/2	2/3	3/4	5/6					
6	12	—	—	—	—	—	—	—	24	5	0	0	0
9	—	12	—	—	—	—	—	—	36	11	18	0	18
12	24	—	24	—	—	—	—	—	48	13	24	0	24
18	36	24	—	24	36	—	—	—	72	11	6	0	6
20		—		—		—	—	—	80	13	4	40	20
24	48	—	48	—	—	36	—	—	96	7	48	24	72
27	—	36	—	—	—	—	36	—	108	11	54	56	2

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Table 261—Code parameters for the different modulation and coding schemes *(continued)*

Data block size (byte)	Encoded data block size (bytes)								N	P0	P1	P2	P3
	QPSK		16-QAM		64-QAM								
	1/2	3/4	1/2	3/4	1/2	2/3	3/4	5/6					
30	60	—	—	—	—	—	—	36	120	13	60	0	60
36	72	48	72	48	72	—	—	—	144	17	74	72	2
41		—		—		—	—	—	164	19	18	20	122
45	—	60	—	—	—	—	—	—	180	11	90	0	90
48	96	—	96	—	—	72	—	—	192	11	96	48	144
54	108	72	—	72	108	—	72	—	216	13	108	0	108
60	120	—	120	—	—	—	—	72	240	13	120	60	180
66	132	—	—	—	—	—	—	—	264	23	2	160	30
72	144	96	144	96	144	108	—	—	288	23	50	188	50
78	156	—	—	—	—	—	—	—	312	23	102	64	38
81	—	108	—	—	—	—	108	—	324	11	172	164	16
83		—		—		—	—	—	332	23	96	160	32
90	180	120	—	120	180	—	—	108	360	29	56	0	68
96	192	—	192	—	—	144	—	—	384	29	68	140	56
99	—	132	—	—	—	—	—	—	396	29	36	128	76
102	204	—	—	—	—	—	—	—	408	29	124	204	40
108	216	144	216	144	216	—	144	—	432	13	0	4	8
114	228	—	—	—	—	—	—	—	456	31	100	224	104
117	—	156	—	—	—	—	—	—	468	31	98	220	98
120	240	—	240	—	—	180	—	144	480	31	52	240	52
132	264	—	264	—	—	—	—	—	528	31	24	36	104
135	—	180	—	—	—	—	180	—	540	31	42	248	34
138	276	—	—	—	—	—	—	—	552	35	14	136	6
144	288	192	288	192	288	216	—	—	576	31	42	232	18
150	300	—	—	—	—	—	—	180	600	37	20	152	0
153	—	204	—	—	—	—	—	—	612	37	6	164	14
156	312	—	312	—	—	—	—	—	624	37	312	156	468
162	324	216	—	216	324	—	216	—	648	37	62	160	34
171	—	228	—	—	—	—	—	—	684	37	108	136	8

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Table 261—Code parameters for the different modulation and coding schemes *(continued)*

Data block size (byte)	Encoded data block size (bytes)								N	P0	P1	P2	P3
	QPSK		16-QAM		64-QAM								
	1/2	3/4	1/2	3/4	1/2	2/3	3/4	5/6					
174	348	—	—	—	—	—	—	—	696	37	0	128	12
180	360	240	360	240	360	—	—	216	720	37	92	100	68
186	372	—	—	—	—	—	—	—	744	37	54	196	50
192	384	—	384	—	—	288	—	—	768	19	384	216	600
198	396	264	—	264	396	—	—	—	792	41	0	228	24
204	408	—	408	—	—	—	—	—	816	37	408	204	612
207	—	276	—	—	—	—	—	—	828	41	136	288	192
216	432	288	432	288	432	324	288	—	864	19	2	16	6
222	444	—	—	—	—	—	—	—	888	43	10	220	18
225	—	300	—	—	—	—	—	—	900	43	8	56	20
228	456	—	456	—	—	—	—	—	912	43	96	8	124
234	468	312	—	312	468	—	—	—	936	43	120	140	124
240	480	—	480	—	—	360	—	288	960	43	52	120	28

9.7.2.2.3 Determination of the circulation states

The state of the encoder is denoted S ($0 \le S \le 7$) with $S = 4 \cdot s_1 + 2 \cdot s_2 + s_3$ (see Table 262). The circulation states S_{c_1} and S_{c_2} shall be determined by the following operations:

— Initialize the encoder with state 0. Encode the sequence in the natural order for the determination of S_{c_1} or in the interleaved order for the determination of S_{c_2} (without producing redundancy). In both cases, the final state of the encoder is denoted S_{N-1}^{0}.

— According to the length N of the sequence, the following correspondence shall be used to find S_{c_1} and S_{c_2} (see Table 262).

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Table 262—Circulation state correspondence table

S_{N-1}^{0} *N*mod.7	0	1	2	3	4	5	6	7
1	Sc=0	Sc=6	Sc=4	Sc=2	Sc=7	Sc=1	Sc=3	Sc=5
2	Sc=0	Sc=3	Sc=7	Sc=4	Sc=5	Sc=6	Sc=2	Sc=1
3	Sc=0	Sc=5	Sc=3	Sc=6	Sc=2	Sc=7	Sc=1	Sc=4
4	Sc=0	Sc=4	Sc=1	Sc=5	Sc=6	Sc=2	Sc=7	Sc=3
5	Sc=0	Sc=2	Sc=5	Sc=7	Sc=1	Sc=3	Sc=4	Sc=6
6	Sc=0	Sc=7	Sc=6	Sc=1	Sc=3	Sc=4	Sc=5	Sc=2

9.7.2.2.4 Code rate and puncturing

Four code rates are defined to match those defined for the convolution code: R = 1/2, 2/3, 3/4 and 5/6. These rates shall be achieved through selectively deleting or puncturing the parity bits. The puncturing pattern defined in Table 263 shall be applied to the outputs of both codes C1 and C2 (in parallel). The puncturing algorithm holds even when the number of couples is not a multiple of 10, for rate: 5/6, or a multiple of 12 for rates: 1/2, 2/3, and 3/4. This is illustrated more specifically in the following example. A two-byte input (16 bits) to the encoder would produce 16 redundancy bits, 8 bits from Y1, and 8 bits from Y2 (refer to Figure 192). These two sets of 8 bits are punctured separately. Using a rate of 3/4 puncturing vector would yield 2 sets of 3 bits, totaling 6 redundancy bits. Thus the output would be 16 + 6 = 22 coded bits. Using a rate: 5/6, the puncturing vector would yield two sets of 2 bits, totaling in 4 redundancy bits. Thus the output would be 16 + 4 = 20 coded bits.

Table 263—Puncturing patterns for turbo codes (“1”= keep, “0”= puncture)

Code rate	Puncturing vector
1/2	Y = [1 1 1 1 1 1]
2/3	Y = [1 0 1 0 1 0]
3/4	Y = [1 0 0 1 0 0]
5/6	Y = [1 0 0 0 0]

9.7.2.2.5 Block concatenation

The concatenation scheme of the CTC blocks is defined to allow data block sizes of up to 240 bytes. The rules to be used with the concatenation scheme are defined fully in Table 264, Table 265, and Table 266. This is used for OFDM subchannelization with QPSK, 16-QAM, and 64-QAM. Table 266 defines shortening and puncturing patterns needed for supporting block sizes with a multiplicative factor of 7. Table 266 shall be used when the number of allocated OFDM slots, n, corresponds to transmitted blocks of size 336, 672, 1008, 1344, 1680, and 2016 bits.

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Table 264—CTC Encoding subchannel concatenation

Modulation and rate	j	L
QPSK, rate: 1/2	j = 80	L =1
QPSK, rate: 3/4	j = 52	L=1
16-QAM, rate: 1/2	j = 40	L=2
16-QAM, rate: 3/4	j = 26	L=2
64-QAM, rate: 1/2	j = 26	L=3
64-QAM, rate: 2/3	j = 20	L=3
64-QAM, rate: 3/4	j = 16	L=3
64-QAM, rate: 5/6	j = 16	L=3

Table 265—Block fitting for n (number OFDM slots) equal to a multiple of 7

Rate	Trans-mitted (bits)	Ideal data Size (bits)	Ideal data Size (bytes)	Sup-ported block size (bytes)	Input size to encoder (bits)	Data Pay-load (bits)	After en-coder (bits)	Short-ened (bits)	Pad-ding (bits)	Punc-turing (bits)	Data pay-load (bytes)
1/2	336	168	21	20	160	160	320	0	16	0	20
2/3	336	224	28	27	216	216	324	0	12	0	27
3/4	336	252	31.5	31	248	248	332	0	4	0	31
5/6	336	280	35	36	288	280	346	8	0	2	35
1/2	672	336	42	41	328	328	656	0	16	0	41
2/3	672	448	56	55	440	440	660	0	12	0	55
3/4	672	504	63	64	512	504	684	8	0	4	63
5/6	672	560	70	69	552	552	664	0	8	0	69
1/2	1008	504	63	64	512	504	1024	8	0	8	63
2/3	1008	672	84	83	664	664	996	0	12	0	83
3/4	1008	756	94.5	96	768	752	1024	16	0	0	94
5/6	1008	840	105	106	848	840	1018	8	0	2	105
1/2	1344	672	84	83	664	664	1328	0	16	0	83
2/3	1344	896	112	110	880	880	1320	0	24	0	110
3/4	1344	1008	126	128	1024	1008	1366	16	0	6	126
5/6	1344	1120	140	138	1104	1104	1326	0	18	0	138
1/2	1680	840	105	106	848	840	1696	8	0	8	105
2/3	1680	1120	140	138	1104	1104	1656	0	24	0	138

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Table 265—Block fitting for n (number OFDM slots) equal to a multiple of 7 *(continued)*

Rate	Transmitted (bits)	Ideal data Size (bits)	Ideal data Size (bytes)	Supported block size (bytes)	Input size to encoder (bits)	Data payload (bits)	After encoder (bits)	Shortened (bits)	Padding (bits)	Puncturing (bits)	Data payload (bytes)
3/4	1680	1260	157.5	156	1248	1248	1664	0	16	0	156
5/6	1680	1400	175	174	1392	1392	1672	0	8	0	174
1/2	2016	1008	126	128	1024	1008	2048	16	0	16	126
2/3	2016	1344	168	171	1368	1344	2052	24	0	12	168
3/4	2016	1512	189	190	1520	1512	2028	8	0	4	189
5/6	2016	1680	210	212	1696	1680	2036	16	0	4	210

Table 266—Subchannel concatenation rule for CTC

Number of OFDM slots	Subchannels concatenated
$n \leq j$ AND $n \bmod 7 \neq 0$	1 block of n slots
$n \leq j$ AND $n \bmod 7 = 0$, AND $n > 42/L$	1 block of $4n/7$ slots 1 block of $3n/7$ slots
$n > j$	If $(n \bmod j = 0)$ q blocks of j slots else $(q-1)$ blocks of j slots 1 block of L_{b1} slots 1 block of L_{b2} slots Where $q = n \operatorname{div} j$ $L_{b1} = \text{ceil}((n-(q-1)\cdot j)/2)$ $L_{b2} = \text{floor}((n-(q-1)\cdot j)/2)$ If $(L_{b1} \bmod 7 = 0)$ or $(L_{b2} \bmod 7 = 0)$ $L_{b1} = L_{b1} + 1$; $L_{b2} = L_{b2} - 1$

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9.7.2.3 Low-density parity check codes (LDPC) mode (optional)

9.7.2.3.1 Code description

The LDPC code is based on a set of fundamental LDPC codes. Each of the fundamental codes is a systematic linear block code. Using the methods described in 9.7.2.3.2, the fundamental codes can accommodate various code rates and packet sizes.

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Each LDPC code in the set of LDPC codes is defined by a parity-check matrix **H** of size *m*-by-*n*, where *n* is the length of the code and *m* is the number of parity check bits in the code. The number of systematic bits is $k = n - m$.

The matrix **H** is defined as

$$\mathbf{H} = \begin{bmatrix} \mathbf{P}_{0,0} & \mathbf{P}_{0,1} & \mathbf{P}_{0,2} & \cdots & \mathbf{P}_{0,n_b-2} & \mathbf{P}_{0,n_b-1} \\ \mathbf{P}_{1,0} & \mathbf{P}_{1,1} & \mathbf{P}_{1,2} & \cdots & \mathbf{P}_{1,n_b-2} & \mathbf{P}_{1,n_b-1} \\ \mathbf{P}_{2,0} & \mathbf{P}_{2,1} & \mathbf{P}_{2,2} & \cdots & \mathbf{P}_{2,n_b-2} & \mathbf{P}_{2,n_b-1} \\ \vdots & \vdots & \vdots & \cdots & \vdots & \vdots \\ \mathbf{P}_{m_b-1,0} & \mathbf{P}_{m_b-1,1} & \mathbf{P}_{m_b-1,2} & \cdots & \mathbf{P}_{m_b-1,n_b-2} & \mathbf{P}_{m_b-1,n_b-1} \end{bmatrix} = \mathbf{P}^{H_b}$$

where $\mathbf{P}_{i,j}$ is one of a set of *z*-by-*z* permutation matrices or a *z*-by-*z* zero matrix. The matrix **H** is expanded from a binary base matrix $\mathbf{H}_b$ of size m_b-by-n_b, where $n = z \times n_b$ and $m = z \times m_b$, with integer $z \geq 1$. The base matrix is expanded by replacing each 1 in the base matrix with a *z*-by-*z* permutation matrix, and each 0 with a *z*-by-*z* zero matrix. The base matrix size n_b is equal to 24.

The permutations used are circular right shifts, and the set of permutation matrices contains the *z*×*z* identity matrix and circular right shifted versions of the identity matrix. Because each permutation matrix is specified by a single circular right shift, the binary base matrix information and permutation replacement information can be combined into a single compact model matrix $\mathbf{H}_{bm}$. The model matrix $\mathbf{H}_{bm}$ has the same size as the binary base matrix $\mathbf{H}_b$, with each binary entry (*i*,*j*) of the base matrix $\mathbf{H}_b$ replaced to create the model matrix $\mathbf{H}_{bm}$. Each 0 in $\mathbf{H}_b$ is replaced by a blank or negative value (e.g., by –1) to denote a *zz* all-zero matrix, and each 1 in $\mathbf{H}_b$ is replaced by a circular shift size $p(i,j) \geq 0$. The model matrix $\mathbf{H}_{bm}$ can then be directly expanded to **H**.

$\mathbf{H}_b$ is partitioned into two sections, where $\mathbf{H}_{b1}$ corresponds to the systematic bits and $\mathbf{H}_{b2}$ corresponds to the parity-check bits, such that $\mathbf{H}_b = \left[\left(\mathbf{H}_{b1}\right)_{m_b \times k_b} \middle| \left(\mathbf{H}_{b2}\right)_{m_b \times m_b} \right]$.

Section $\mathbf{H}_{b2}$ is further partitioned into two sections, where vector $\mathbf{h}_b$ has odd weight, and $\mathbf{H}'_{b2}$ has a dual-diagonal structure with matrix elements at row *i*, column *j* equal to 1 for *i*=*j*, 1 for *i*=*j*+1, and 0 elsewhere [see Equation (16)]:

$$\mathbf{H}_{b2} = \left[\mathbf{h}_b \middle| \mathbf{H}'_{b2} \right] = \left[\begin{array}{c|cccc} h_b(0) & 1 & & & \\ h_b(1) & 1 & 1 & & \mathbf{0} \\ . & & 1 & \ddots & \\ . & & & \ddots & 1 \\ . & & \mathbf{0} & & 1 & 1 \\ h_b(m_b-1) & & & & & 1 \end{array} \right] \tag{16}$$

The base matrix has $h_b(0) = 1$, $h_b(m_b-1) = 1$, and a third value $h_b(j)$, $0 < j < (m_b - 1)$ equals to 1. The base matrix structure avoids having columns with multiple weights of value 1 in the expanded matrix.

In particular, the non-zero sub-matrices are circularly right shifted by a particular circular shift value. Each "1" in $\mathbf{H}'_{b2}$ is assigned a shift size of 0, and is replaced by a *z*×*z* identity matrix when expanding to **H**. The

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two 1s located at the top and the bottom of $\mathbf{h}_b$ are assigned shift sizes equal to 0, and the third 1 in the middle of $\mathbf{h}_b$ is given an unpaired shift size greater than 0.

A base model matrix is defined for the largest code length (n = 2304) of each code rate. The set of shifts $\{p(i,j)\}$ in the base model matrix are used to determine the shift sizes for all other code lengths of the same code rate. Each base model matrix has $n_b = 24$ columns, and the expansion factor z_f is equal to $n/24$ for code length n. Here f is the index of the code lengths for a given code rate, $f = 0, 1, 2, \ldots, 20$. For code length n = 2304 the expansion factor is designated $z_0 = 96$.

For each code rate, the shift sizes $\{p(f, i, j)\}$ for a code size corresponding to expansion factor z_f are derived from $\{p(i,j)\}$ by scaling $p(i,j)$ proportionally, as shown in Equation (17):

$$p(f,i,j) = \begin{cases} p(i,j), & p(i,j) \le 0 \\ \left\lfloor \dfrac{p(i,j) z_f}{z_0} \right\rfloor, & p(i,j) > 0 \end{cases} \tag{17}$$

where $\lfloor x$ denotes the flooring function that gives the nearest integer towards $-\infty$.

Rate 1/2 code:

–1 94 73 –1 –1 –1 –1 –1 55 83 –1 –1 7 0 –1 –1 –1 –1 –1 –1 –1 –1 –1 –1 –1
–1 27 –1 –1 –1 22 79 9 –1 –1 –1 12 –1 0 0 –1 –1 –1 –1 –1 –1 –1 –1 –1 –1
–1 –1 –1 24 22 81 –1 33 –1 –1 –1 0 –1 –1 0 0 –1 –1 –1 –1 –1 –1 –1 –1 –1
61 –1 47 –1 –1 –1 –1 –1 65 25 –1 –1 –1 –1 0 0 –1 –1 –1 –1 –1 –1 –1 –1 –1
–1 –1 39 –1 –1 –1 84 –1 –1 41 72 –1 –1 –1 –1 –1 0 0 –1 –1 –1 –1 –1 –1 –1
–1 –1 –1 –1 46 40 –1 82 –1 –1 –1 79 0 –1 –1 –1 –1 0 0 –1 –1 –1 –1 –1 –1
–1 –1 95 53 –1 –1 –1 –1 –1 14 18 –1 –1 –1 –1 –1 –1 –1 –1 0 0 –1 –1 –1 –1
–1 11 73 –1 –1 –1 2 –1 –1 47 –1 –1 –1 –1 –1 –1 –1 –1 –1 –1 0 0 –1 –1 –1
12 –1 –1 –1 83 24 –1 43 –1 –1 –1 51 –1 –1 –1 –1 –1 –1 –1 –1 0 0 –1 –1
–1 –1 –1 –1 –1 94 –1 59 –1 –1 70 72 –1 –1 –1 –1 –1 –1 –1 –1 –1 0 0 –1
–1 –1 7 65 –1 –1 –1 –1 39 49 –1 –1 –1 –1 –1 –1 –1 –1 –1 –1 –1 –1 0 0
43 –1 –1 –1 –1 66 –1 41 –1 –1 –1 26 7 –1 –1 –1 –1 –1 –1 –1 –1 –1 –1 0

Note that the R=1/2 code is designed such that after a model matrix row permutation of [0, 2, 4, 11, 6, 8, 10, 1, 3, 5, 7, 9], consecutive rows do not intersect. This may be used to increase decoding throughput in some layered decoding architectures.

Rate 2/3 code:

2 –1 19 –1 47 –1 48 –1 36 –1 82 –1 47 –1 15 –1 95 0 –1 –1 –1 –1 –1 –1
–1 69 –1 88 –1 33 –1 3 –1 16 –1 37 –1 40 –1 48 –1 0 0 –1 –1 –1 –1 –1 –1
10 –1 86 –1 62 –1 28 –1 85 –1 16 –1 34 –1 73 –1 –1 –1 0 0 –1 –1 –1 –1
–1 28 –1 32 –1 81 –1 27 –1 88 –1 5 –1 56 –1 37 –1 –1 –1 0 0 –1 –1 –1
23 –1 29 –1 15 –1 30 –1 66 –1 24 –1 50 –1 62 –1 –1 –1 –1 –1 0 0 –1 –1
–1 30 –1 65 –1 54 –1 14 –1 0 –1 30 –1 74 –1 0 –1 –1 –1 –1 –1 0 0 –1
32 –1 0 –1 15 –1 56 –1 85 –1 5 –1 6 –1 52 –1 0 –1 –1 –1 –1 –1 0 0
–1 0 –1 47 –1 13 –1 61 –1 84 –1 55 –1 78 –1 41 95 –1 –1 –1 –1 –1 –1 0

Note that the R=2/3 code is designed such that after a model matrix row permutation of [0, 3, 6, 1, 4, 7, 2, 5],

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consecutive rows do not intersect. This may be used to increase decoding throughput in some layered decoding architectures.

Rate 3/4 code:

6 38 3 93 –1 –1 –1 30 70 –1 86 –1 37 38 4 11 –1 46 48 0 –1 –1 –1 –1
62 94 19 84 –1 92 78 –1 15 –1 –1 92 –1 45 24 32 30 –1 –1 0 0 –1 –1 –1
71 –1 55 –1 12 66 45 79 –1 78 –1 –1 10 –1 22 55 70 82 –1 –1 0 0 –1 –1
38 61 –1 66 9 73 47 64 –1 39 61 43 –1 –1 –1 –1 95 32 0 –1 –1 0 0 –1
–1 –1 –1 –1 32 52 55 80 95 22 6 51 24 90 44 20 –1 –1 –1 –1 –1 –1 0 0
–1 63 31 88 20 –1 –1 –1 6 40 56 16 71 53 –1 –1 27 26 48 –1 –1 –1 –1 0

Rate 5/6 code:

1 25 55 –1 47 4 –1 91 84 8 86 52 82 33 5 0 36 20 4 77 80 0 –1 –1
–1 6 –1 36 40 47 12 79 47 –1 41 21 12 71 14 72 0 44 49 0 0 0 0 –1
51 81 83 4 67 –1 21 –1 31 24 91 61 81 9 86 78 60 88 67 15 –1 –1 0 0
50 –1 50 15 –1 36 13 10 11 20 53 90 29 92 57 30 84 92 11 66 80 –1 –1 0

9.7.2.3.2 Code rate and block size adjustment

The LDPC code flexibly supports different block sizes for each code rate through the use of an expansion factor as shown in Table 267. Each base model matrix has $n_b = 24$ columns and the expansion factor (z factor) is equal to $n/3$ for code length n. In each case, the number of information bits is equal to the code rate times the coded length n.

Table 267—LDPC encoded block sizes, Z factor, and code rates

n encoded bits)	Encoded bytes	*z* factor	*k* (data bytes)				Number of OFDM slots		
			R=1/2	R=2/3	R=3/4	R=5/6	QPSK	16-QAM	64-QAM
384	48	16	24	32	36	40	8	4	—
480	60	20	30	40	45	50	10	5	—
576	72	24	36	48	54	60	12	6	4
672	84	28	42	56	63	70	14	7	—
768	96	32	48	64	72	80	16	8	—
864	108	36	54	72	81	90	18	9	6
960	120	40	60	80	90	100	20	10	—
1056	132	44	66	88	99	110	22	11	—
1152	144	48	72	96	108	120	24	12	8
1248	156	52	78	104	117	130	26	13	—
1344	168	56	84	112	126	140	28	14	—
1440	180	60	90	120	135	150	30	15	10

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Table 267—LDPC encoded block sizes, Z factor, and code rates *(continued)*

n encoded bits)	Encoded bytes	*z* factor	*k* (data bytes)				Number of OFDM slots		
			R=1/2	R=2/3	R=3/4	R=5/6	QPSK	16-QAM	64-QAM
1536	192	64	96	128	144	160	32	16	—
1632	204	68	102	136	153	170	34	17	—
1728	216	72	108	144	162	180	36	18	12
1824	228	76	114	152	171	190	38	19	—
1920	240	80	120	160	180	200	40	20	—
2016	252	84	126	168	189	210	42	21	14
2112	264	88	132	176	198	220	44	22	—
2208	276	92	138	184	207	230	46	23	—
2304	288	96	144	192	216	240	48	24	16

9.7.2.3.3 Packet encoding

The encoding block size *k* shall depend on the number of OFDM slots allocated and the modulation specified for the current transmission. Concatenation of a number of OFDM slots shall be performed in order to make larger blocks of coding where it is possible, with the limitation of not exceeding the largest block under the same coding rate (the block defined by the 64-QAM modulation). Table 268 and Table 269 specify the concatenation of OFDM slots for different allocations and modulations.

For any modulation and FEC rate, given an allocation of N_{slot} OFDM slots, the following parameters can be defined:

j: modulation-dependent parameter

N_{slot}: number of allocated OFDM slots

F: floor(N_{slot} *j*)

M: N_{slot} mod *j*

The parameter *j* for LDPC is determined as shown in Table 268.

Table 268—Parameter "j" for LDPC

j	Modulation
48	QPSK
24	16-QAM
16	64-QAM

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Table 269—OFDM slot concatenation

N_{SLOT}	OFDM slots concatenated
$N_{SLOT} \leq j$	1 block of N_{SLOT} OFDM slots
$N_{SLOT} > j$, M=0	F blocks of j OFDM slot
$N_{SLOT} > j$, M>0	(F – 1) blocks of j OFDM slots 1 block of ceil((M+j)/2) OFDM slots 1 block of floor((M+j)/2) OFDM slots

Control information and packets that result in a codeword size n of less than 384 bits are encoded using BCC, with appropriate code rates and modulation orders, as described in 9.7.2.1.

9.7.2.4 Shortened block turbo codes (SBTC) mode (optional)

The BTC is constructed by the product of two simple component codes, which are binary Hamming codes with a special design or parity check codes. Table 270 specifies the parity check matrix for the Hamming codes. Actually, all the columns of the parity check matrix for n = 7 are the binary representation of integers 1 to 7 (the topmost part corresponds to the least-significant bit in the binary representation of an integer). Similarly, all the columns of the parity check matrix for n = 15, 31 and 63 are the binary representation of integers 1 to 15, 1 to 31, and 1 to 63, respectively. Note that with this encoding scheme, the parity check bits are no longer located together at the end of the code word. In general, for a (2^m–1, 2^m–1–m) Hamming code with integer m larger than 2, the parity-check positions are located in columns numbered 1, 2, 4 … 2^{m-1} of the parity check matrix. Both Hamming codes and extended Hamming codes may be used as component codes. To create extended Hamming codes, the overall even parity check bit is added at the end of each code word.

Table 270—Parity check matrix for the Hamming codes

n'	K'	Parity check matrix
7	4	$\begin{bmatrix} 1 & 0 & 1 & 0 & 1 & 0 & 1 \\ 0 & 1 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 & 1 & 1 & 1 \end{bmatrix}_{3\times 7}$
15	11	$\begin{bmatrix} 1 & 0 & 1 & \cdots & 1 & 0 & 1 \\ 0 & 1 & 1 & \cdots & 0 & 1 & 1 \\ 0 & 0 & 0 & \cdots & 1 & 1 & 1 \\ 0 & 0 & 0 & \cdots & 1 & 1 & 1 \end{bmatrix}_{4\times 15}$

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Table 270—Parity check matrix for the Hamming codes *(continued)*

n'	K'	Parity check matrix
31	26	$\begin{bmatrix} 1 & 0 & 1 & \cdots & 1 & 0 & 1 \\ 0 & 1 & 1 & \cdots & 0 & 1 & 1 \\ 0 & 0 & 0 & \cdots & 1 & 1 & 1 \\ 0 & 0 & 0 & \cdots & 1 & 1 & 1 \\ 0 & 0 & 0 & \cdots & 1 & 1 & 1 \end{bmatrix}_{5\times 31}$
63	57	$\begin{bmatrix} 1 & 0 & 1 & \cdots & 1 & 0 & 1 \\ 0 & 1 & 1 & \cdots & 0 & 1 & 1 \\ 0 & 0 & 0 & \cdots & 1 & 1 & 1 \\ 0 & 0 & 0 & \cdots & 1 & 1 & 1 \\ 0 & 0 & 0 & \cdots & 1 & 1 & 1 \\ 0 & 0 & 0 & \cdots & 1 & 1 & 1 \end{bmatrix}_{6\times 63}$

Several parameters are used to describe the BTC encoder. k_y, n_y and k_x, n_x are the number of information bits and codeword lengths for the vertical component code and the horizontal component code, respectively. I_x, I_y, and D, as defined in Table 272, are used to construct the shortened BTC codes. With the aid of Figure 193, the procedure to construct BTC is listed as follows:

- Place (k_y k_x) information bits in information area (the blank area in Figure 193). The information bits may be placed in columns with indexes from 1 to n_x–1, except for columns 2^i with i = 0, 1, 2, …, n_x–k_x–2 (n_x–k_x–1 parity check bits). Similarly, information bits may be located in rows with indexes 1 to n_y except for rows with indexes 2^j with j = 0, 1, 2, … , n_y–k_y–2 (n_y–k_y–1 parity check bits).
- Compute the parity check bits of k_y rows using the corresponding parity check matrix in Table 270 and inserting them in the corresponding positions signed by □ .
- Compute the parity check bits of k_x columns using the corresponding parity check matrix in Table 270 and inserting them in the corresponding positions signed by ○ and ◎ .
- Calculate and append the extended parity check bits to the corresponding rows and columns, if the component code of the row (or column) is an extended Hamming code.
- The overall block size of such a product code is n = n_x × n_y, the total number of information bits k = k_x × k_y, and the code rate is R = R_x × R_y, where R_i = k_i/n_i, i = x, y. The Hamming distance of the product code is d = d_x × d_y. Data bit ordering for the composite BTC block is the first bit in the first row is the LSB and the last data bit in the last data row is the MSB.

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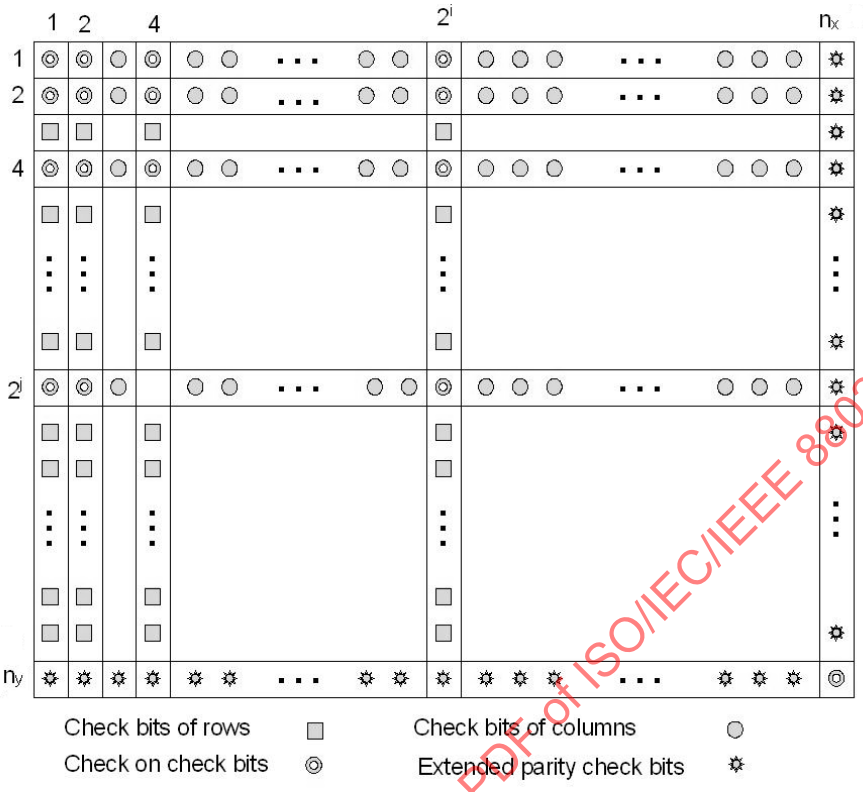

Figure 193—Block turbo code (BTC) structure

Transmission of the block over the channel shall occur in a linear fashion, with all bits of the first row transmitted left to right followed by the second row, etc. To match a required packet size, BTC may be shortened by removing symbols from the BTC array. In the two-dimensional case, rows, columns, or parts thereof can be removed until the appropriate size is reached. There are two steps in the process of shortening product codes:

— Step 1) Remove I_x rows and I_y columns from the two-dimensional code. This is equivalent to shortening the component codes that make up the BTC.

— Step 2) Use if the size of data field of SBTC specified from Step 1) above is larger than the expected size. In this case, the D right LSBs are zero-filled by the encoder. After decoding at the receive end, the decoder shall strip off these unused bits and only the specified data payload is passed to the next higher level in the PHY. The same general method is used for shortening the last code word in a message where the available data bytes do not fill the available data bytes in a code block.

These two processes of code shortening are depicted in Figure 194. The new coded block length of the code is $(n_x - I_x)(n_y - I_y)$. The corresponding information length is given as $(k_x - I_x)(k_y - I_y) - D$. Consequently, the code rate is given by Equation (18).

$$R = \frac{(k_x - I_x)(k_y - I_y) - D}{(n_x - I_x)(n_y - I_y)} \tag{18}$$

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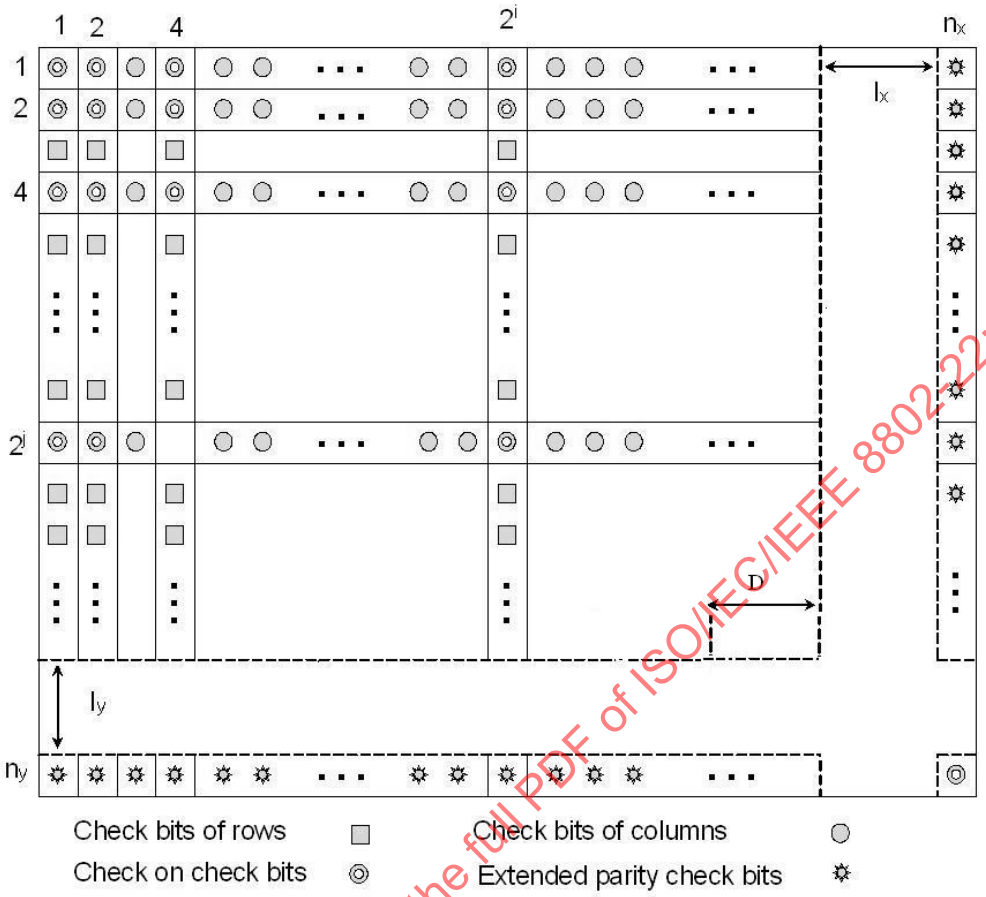

Figure 194—Shortened BTC (SBTC) structure

The basic sizes of the useful data payloads for different modulation types and encoding rates are displayed in Table 271. Table 272 gives the code parameters of SBTC for different data payload and coded block sizes.

The encoding block size shall depend on the number of OFDM slots allocated and the modulation specified for the current transmission. Concatenation of a number of OFDM slots shall be performed in order to allow for transmission of larger blocks of coding where it is possible, with the limitation of not going beyond the largest block under the same coding rate. Table 273 specifies the concatenation of OFDM slots for different allocations and modulations. The parameters in Table 273 and Table 274 shall apply to the SBTC encoding scheme.

For any modulation and FEC rate, given an allocation of n OFDM slots, the following parameters are defined:

- j: parameter dependent on the modulation and FEC rates
- n: number of allocated OFDM slots
- k: floor (n/j)
- m: n mod j

The rules used for OFDM slot concatenation are showed in Table 273.

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Table 271—Useful data payload for one or multiple OFDM slots

Modulation scheme	QPSK		16-QAM		64-QAM				Coded bytes
Encoding rate	1/2	3/4	1/2	3/4	1/2	2/3	3/4	5/6	
Allowed data (bytes)	3	—	—	—	—	—	—	—	6
	6	9	6	9	—	—	—	—	12
	9	—	—	—	9	12	—	15	18
	12	18	12	18	—	—	—	—	24
	15	—	—	—	—	—	—	—	30
	18	27	18	27	18	24	27	30	36
	21	—	—	—	—	—	—	—	42
	24	36	24	36	—	—	—	—	48
	27	—	—	—	27	36	—	45	54
	30	45	30	45	—	—	—	—	60
	33	—	—	—	—	—	—	—	66
	36	54	36	54	36	48	54	60	72

Table 272—Code parameters for different data payload coded block sizes

Data bytes	Coded bytes	Constituent	Code parameters		
			I_x	I_y	D
3	6	(15,11)(8,7)	3	4	0
6	12	(16,11) (8,7)	4	0	1
9	12	(16,15) (16,15)	10	0	3
9	18	(16,11) (16,15)	4	4	5
12	18	(8,7) (64,63)	4	28	9
15	18	(16,15) (16,15)	7	0	0
12	24	(16,11) (16,15)	4	0	9
18	24	(8,7) (32,31)	2	0	11
15	30	(15,11) (31,26)	3	11	0
18	36	(15,11) (31,26)	3	7	8

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Table 272—Code parameters for different data payload coded block sizes *(continued)*

Data bytes	Coded bytes	Constituent	Code parameters		
			I_x	I_y	D
24	36	(16,15) (32,26)	4	8	6
27	36	(8,7) (64,63)	2	16	19
30	36	(16,15) (32,31)	7	0	8
21	42	(7,4) (63,57)	0	15	0
24	48	(16,11) (32,26)	0	8	6
36	48	(16,15) (63,57)	8	15	6
27	54	(32,26) (32,26)	14	8	0
36	54	(32,31) (31,26)	8	13	11
45	54	(8,7) (64,63)	0	10	11
30	60	(32,26) (32,26)	2	16	0
45	60	(16,15) (32,26)	0	2	0
33	66	(32,26) (32,26)	8	10	24
36	72	(32,26) (32,26)	14	0	24
48	72	(16,11) (64,63)	0	28	1
54	72	(16,15) (64,57)	0	28	3
60	72	(16,15) (64,63)	7	0	24

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Table 273—Subchannel concatenation rule

Number of OFDM slots	OFDM slots concatenated	
$n \leq j$	One block of n OFDM slots	
$n > j$	$m = 0$	k blocks of j OFDM slots
	$m \neq 0$	(k–l) blocks of j OFDM slots One block of ceil ((m+j)/2) OFDM slots One block of floor ((m+j)/2) OFDM slots

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Table 274—Encoding OFDM slots concatenation for different allocations and modulations

Modulation and rate	J
QPSK 1/2	12
QPSK 3/4	6
16-QAM 1/2	6
16-QAM 3/4	6
64-QAM 1/2	4
64-QAM 2/3	4
64-QAM 3/4	2
64-QAM 5/6	4

9.8 Constellation mapping and modulation

9.8.1 Data modulation

The output of the bit interleaver is entered serially to the constellation mapper. The input data to the mapper is first divided into groups of number of coded bits per carrier, i.e., NCBPC bits and then converted into complex numbers representing QPSK, 16-QAM, or 64-QAM constellation points. The mapping for QPSK, 16-QAM, or 64-QAM is performed according to Gray-coding constellation mapping, as shown in Figure 195, Figure 196, and Figure 197, respectively, where b_0 represents the most significant modulation bit for all constellations.

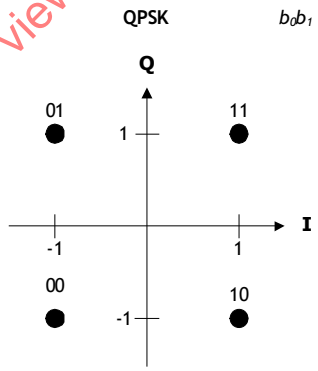

Figure 195—Gray mapping for QPSK

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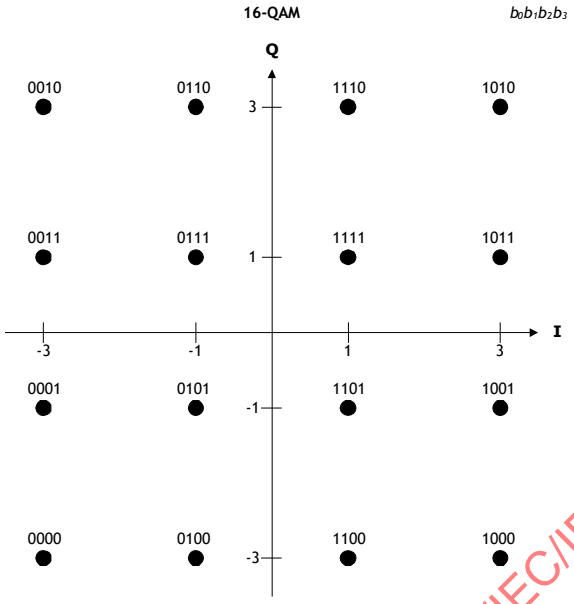

Figure 196—Gray mapping for 16-QAM

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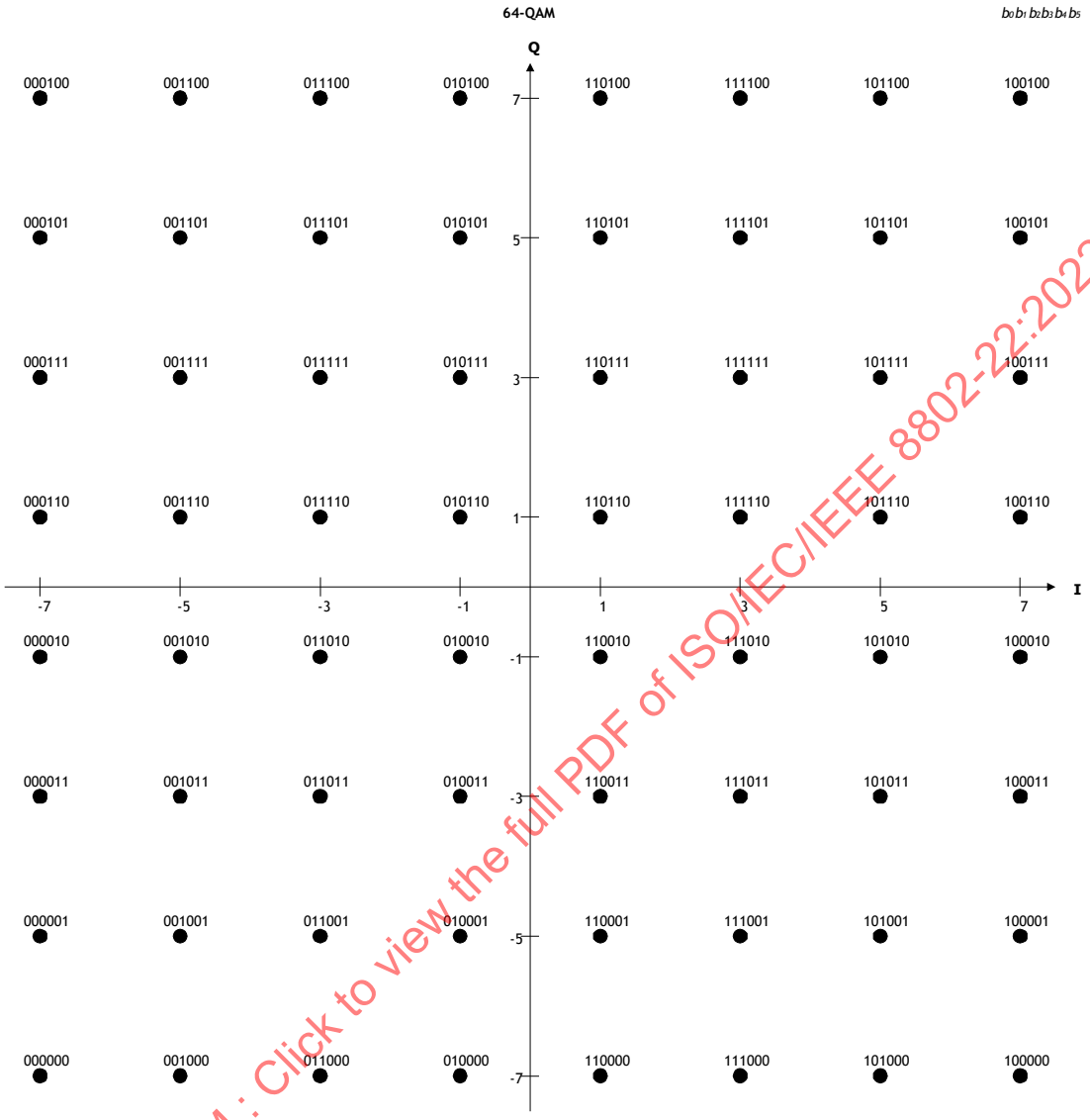

Figure 197—Gray mapping for 64-QAM

The complex value number is scaled by a modulation dependent normalization factor K_{MOD}. Table 275 shows the K_{MOD} values for the different modulation types defined in this subclause. The number of coded bits per slot (N_{CBPS}) and the number of data bits per slot for the different modulation constellation and coding rate combinations are summarized in Table 276. Note that an OFDM slot corresponds to one OFDM symbol by one subchannel).

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Table 275—Number of coded bit per carrier and normalization factor for different modulation constellations

Modulation type	N_{CBPC}	K_{MOD}
QPSK	2	$1/\sqrt{2}$
16-QAM	4	$1/\sqrt{10}$
64-QAM	6	$1/\sqrt{42}$

Table 276—Number of coded bits per OFDM slot (N_{CBPS}) and corresponding number of data bits for different modulation constellation and coding rate combinations

Constellation type	Coding rate	N_{CBPS}	Corresponding number of data bits
QPSK	1/2	48	24
QPSK	2/3	48	32
QPSK	3/4	48	36
QPSK	5/6	48	40
16-QAM	1/2	96	48
16-QAM	2/3	96	64
16-QAM	3/4	96	72
16-QAM	5/6	96	80
64-QAM	½	144	72
64-QAM	2/3	144	96
64-QAM	3/4	144	108
64-QAM	5/6	144	120

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9.8.2 Pilot modulation

The pilot subcarriers shall be modulated according to the BPSK modulation, as shown in Figure 198. In the BPSK modulation, the modulation-dependent normalization factor, K_{MOD}, is 1.

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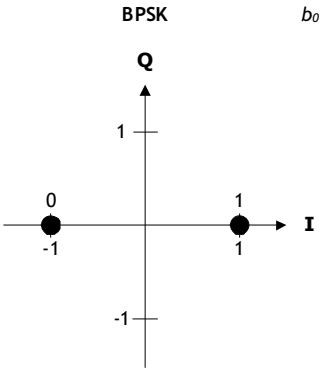

Figure 198—BPSK constellation bit encoding

9.8.3 Normalized carrier amplitude levels

The carrier amplitude scaling factors specified for various modulations (9.8.1) and Subcarrier Power Control (SPC) levels (7.9.2.1) result in many cases in irrational numbers that are difficult to represent by simple binary coded values. In order to avoid the excessive number of bits that would be required in practice to approximate these irrational numbers and the likelihood of systemic errors that would result due to different approximations used by different manufacturers in their implementation, specific normalized values are given in Table 277 to simplify the coding of these carrier amplitudes and avoid any such systemic errors.

Table 277—Normalized carrier amplitude values for all modulation and SPC levels used in the standard

Subcarrier Power Control (SPC)		BPSK STS	BPSK LTS	BPSK Pilots	QPSK Data	16-QAM Data		64-QAM Data			
Reserved		*Reserved*	*Reserved*	*Reserved*	*Reserved*	*Reserved*		*Reserved*			
1 0 0	1	156	117	78	54	24	72	12	36	60	84
0 1 1	2/3	—	—	—	36	16	48	8	24	40	56
0 1 0	1/2	—	—	—	27	12	36	6	18	30	42
0 0 1	1/3	—	—	—	18	8	24	4	12	20	28
0 0 0	0	—	—	—	0	0	0	0	0	0	0

9.9 Control mechanisms

9.9.1 Downstream synchronization

A DS synchronization process shall be performed by each CPE. All the CPEs shall be synchronized with the BS.

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The superframe and frame preambles may be used to perform the DS synchronization. This process shall provide a CPE with sufficient time and frequency accuracy (i.e., to synchronize the CPE's local clock to the reference clock at the BS) to allow it to correctly receive DS information from the BS. Such DS information includes, among other things, the timing of the next US transmission opportunities for the CPE.

9.9.2 Upstream synchronization

US synchronization shall be achieved through initial ranging and periodic ranging processes. The initial ranging transmission burst is specified in 9.9.3.1.2 . The periodic ranging transmission burst is specified in 9.9.3.1.3. US synchronization shall ensure that all US transmissions are received at the BS with which the CPEs are associated within ±25% of the shortest cyclic prefix as given in Table 247, i.e., ±2.333 μs or ±16 sampling periods.

9.9.3 Opportunistic upstream bursts

Some transmission capacity shall be reserved in the US subframe, when needed, for CDMA ranging, CDMA or contention-based BW request, and CDMA or contention-based UCS notification. In the time domain, capacity shall be assigned over the width of the US subframe. In the frequency domain, the transmitted signal shall consist in the first six subchannels using the regularly spaced subcarrier pattern described in 9.6.4, which is optimized for the terrestrial-based geolocation ranging (see 11.5.2), and up to 10 additional subchannels using the regular US subcarrier interleaving scheme described in 9.6.4. The group of 168 regularly spaced subcarriers constituting the first six subchannels and the additional subchannels mentioned above are collectively called the ranging channel.

9.9.3.1 CDMA bursts

The number of subchannels for the ranging channel and the number of symbols for each transmission (CDMA initial ranging, CDMA periodic ranging, CDMA BW request and CDMA UCS notification) are specified in the US-MAP_IE

CPEs are allowed to collide on the ranging channel. To still provide reliable transmission, each CPE randomly chooses one ranging code from the subgroup of specified binary codes that is defined in . These codes are then BPSK modulated onto the subcarriers in the ranging channel. The length of these binary codes is the same as the number of subcarriers in the ranging channel.

9.9.3.1.1 CDMA codes

The binary codes shall be the pseudo-noise codes produced by the PRBS generator described in Figure 199, which illustrates the following polynomial generator: $1 + x^1 + x^4 + x^7 + x^{15}$. The PRBS generator shall be initialized by the seed b15...b1 = 0,0,1,0,1,0,1,1,s0,s1,s2,s3,s4,s5,s6 where s6 is the LSB of the PRBS seed, and s6:s0 are the least significant 7 bits of the *BS_ID*, where s6 is the LSB of the *BS_ID* (see Table 1).

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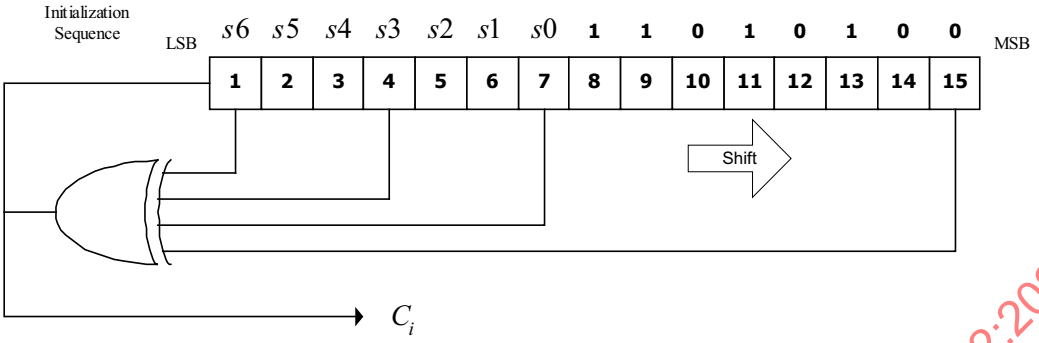

Figure 199—PRBS generator for ranging code generation

The binary ranging codes shall be subsequences of the pseudo-noise sequence appearing at its output C_i. The length of each ranging code is N_{code} bits, which is defined by the number of subchannels on the US_MAP_IE and shall always be multiple of 28 to satisfy the number of subcarriers per subchannel. These bits are used to modulate the subcarriers in the ranging channel and are mapped to the subcarriers in increasing frequency order of the logical subcarriers, such that the lowest indexed bit modulates the subcarrier with the lowest subcarrier index and the highest indexed bit modulates the subcarrier with the highest index.

For example, the first N_{code} bit code block is obtained by clocking the PN generator as specified, with *BS_ID* = 0, the first code shall be 00110000010001... The next code block is produced by taking the output of the $(N_{code}+1)^{th}$ to $(2\times N_{code})^{th}$ clock of the PRBS generator, etc.

Each BS uses a subset of these codes. Let "p" point within the array of code blocks, each code block being N_{code} bits long. For example, if p = 200 and N_{code} = 28, the code block 200 located from bits 5600 to 5627 will be used. A set of variables called S, N, M, L and I shall be sent from the BS to the CPE to indicate the beginning code block in the code stream. For example, if S = 202, we will start using the code block p=202, namely bits 5656 to 5683. The code blocks to be used shall be consecutive. Starting from code block S, the first N code blocks shall be used for initial ranging. The next M code blocks shall be used for periodic ranging. The next L code blocks shall be used for BW-request. The next I code blocks shall be used for UCS notification. The end of the bit structure shall be truncated to align with the last complete code block. If the end of the last complete block is reached in the process, the bit usage will continue by wrapping to code block 0.

The BS shall separate colliding codes and extract timing (ranging) and power information by using a correlation function. The time (ranging) and power measurements shall be used by the system to compensate for the various BS-CPE-BS propagation distances. In the process of CPE code detection, the BS will also get the Channel Impulse Response (CIR) for the transmission link from the specific CPE. The precise timing offset shall be estimated by terrestrial ranging (see 11.5.2).

9.9.3.1.2 Initial-ranging transmission

The initial ranging transmission shall be used by all CPEs to synchronize to the system when attempting to associate. The initial ranging transmission will be used for detecting and adjusting the timing offset and adjusting the transmission EIRP level. The initial-ranging transmission is performed using three consecutive symbols starting, as indicated in the US-MAP for the CPE, on the first symbol after the TTG. To allow for absorption of the signal propagation delay for the forward and return paths from a CPE located at a distance of up to a maximum of 100 km, 2 more buffer symbols are needed at the BS for this initial ranging burst to avoid spilling onto other signals received from synchronized CPEs. The window for the initial-ranging transmission shall therefore always occupy the first 5 OFDM symbols of the US subframe.

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The same ranging code shall be repeated on the ranging channel of these three OFDM symbols and this code shall be BPSK modulated with phase rotation according to the symbol index and the subcarrier index in order to maintain the phase continuity between two contiguous symbols after the CP is inserted in front of each OFDM symbol. These symbols shall be generated according to Equation (19). A time-domain illustration of the three consecutive symbols used for the initial-ranging transmission is shown in Figure 200.

$$s(n,l) = \sum_{k=0}^{N_{FFT}-1} \left[b_k \cdot e^{j2\pi \frac{k \cdot l \cdot N_{CP}}{N_{FFT}}} \right] \cdot e^{j2\pi \frac{k \cdot n}{N_{FFT}}} = \sum_{k=0}^{N_{FFT}-1} b_k \cdot e^{j2\pi \frac{k \cdot (n+l \cdot N_{CP})}{N_{FFT}}} \quad (19)$$

$$b_k = \begin{cases} 2 \cdot \left(\frac{1}{2} - C_i \right), & i=i+1, k \in R \\ 0, & k \notin R \end{cases}$$

where

$s(n,l)$ is the l^{th} OFDM symbol for initial ranging with the sample index n. l is [0,1,2]

k is the subcarrier index in the channel

C_i is the ranging code defined in 9.9.3.1.1. $i = [0 \sim N_{code}-1]$ where N_{code} is the length of the CDMA code.

R is the set of index of subcarriers within the ranging subchannel

N_{FFT} is the size of 2K FFT, 2048

N_{CP} is the size of the cyclic prefix

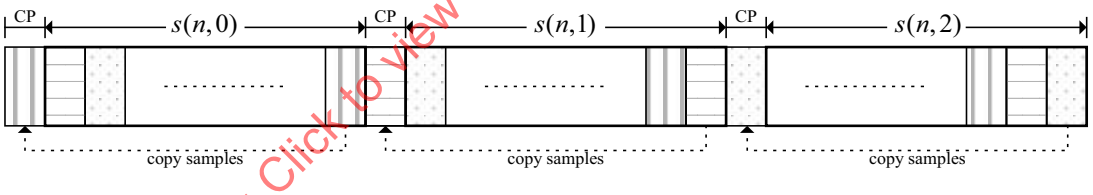

Figure 200—Initial-ranging transmission using three consecutive OFDM symbols

9.9.3.1.3 CDMA periodic-ranging, BW-request, and UCS notification transmission

Periodic-ranging transmissions shall be sent periodically by CPEs identified by the BS for system periodic ranging. Bandwidth-request transmissions shall be for requesting US allocations from the BS. UCS notification transmissions shall be used for reporting detection of an incumbent. These transmissions shall be sent only by CPEs that have already associated with the BS. To perform periodic-ranging, bandwidth-request or UCS notification transmission, the CPE can send a transmission in the following manner.

Modulate one ranging code on the ranging channel for a period of one OFDM symbol. Ranging channels shall be dynamically allocated by the MAC layer at the BS and indicated by the number of subchannels in the US-MAP_IE (see Table 46). A time domain illustration of the periodic-ranging, bandwidth-request or UCS notification transmission is shown in Figure 201, where $s(n,0)$ follows Equation (19) in 9.9.3.1.2 for $l = 0$.

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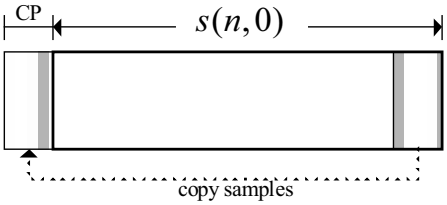

Figure 201—Periodic ranging/bandwidth-request/UCS notification transmission

9.9.3.1.4 Ranging, BW request, and UCS notification opportunity windows

The opportunity window for each type of CDMA burst shall be assigned to some or all of the first six subchannels containing the 168 regularly spaced subcarriers normally used for terrestrial geolocation ranging and to a number of additional subchannels if needed, over the entire US subframe. Initial ranging, periodic ranging, BW-request, and UCS notification CDMA bursts, if present, shall be allocated to a number of symbols in successive portions of the total opportunity window as indicated by the US_MAP_IE (see Table 46) and illustrated in Figure 202. N_1 denotes the number of subchannels over which concatenated initial ranging, periodic ranging, BW-request, and UCS notification codes will be transmitted. The initial ranging, when scheduled, shall occupy the first 5 symbols of the ranging window. These symbols should be excluded from the scheduling of the other opportunity windows. It is assumed that, except for the initial ranging, the CDMA bursts will be transmitted by the CPEs such that they arrive at the BS with the proper timing within the cyclic prefix.

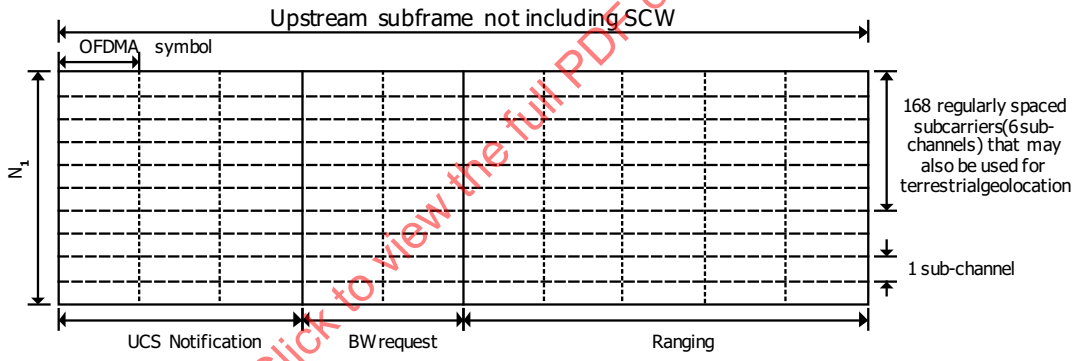

Figure 202—Example of Ranging/BW request/UCS notification opportunities windows

9.9.3.2 Contention-based BW Request and UCS notification

The contention-based BW Request and UCS notification opportunity window shall be assigned to some or all of the first six subchannels containing the 168 regularly spaced subcarriers that are normally used for terrestrial geolocation ranging and to a number of additional subchannels if needed, over the entire US subframe as specified in Table 46. In order to avoid excessive number of collisions, each contention-based burst will be transmitted with a random back-off uniformly selected within the range specified in Table 42. The allowed size for these contention-based bursts is specified by the BS in its US-MAP (see Table 43). The Contention-based BW Request and UCS Notification shall use PHY MCS mode 5 for their transmission.

9.9.4 Power control

The WRAN system standard shall support Transmit Power Control (TPC) on a link-by-link basis to allow a reduction of the transmit EIRP at the CPEs to the lowest levels possible to minimize interference to

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incumbents while still maintaining the fastest possible reliable connection. CPE transmit EIRP is also controlled by the coarse ranging process (see 7.16.2.8.2) to minimize the dynamic range between carriers received at the BS from the near and far CPEs.

9.9.4.1 Transmit power control boundaries and EIRP limits

The transmitter shall support monotonic power level control over a range of at least 60 dB, with a resolution (step size) of 0.5 dB. The EIRP accuracy shall be ± 1.5 dB when the level is at least 10 dB below the maximum regulatory power limit and ±0.5 dB elsewhere.

A compliant implementation shall limit the device's maximum operating EIRP by 0.5 dB from the maximum allowed EIRP obtained from the database service or from the regulated EIRP limit (see Annex A) to assure that the regulated EIRP and power constraints are not exceeded.

The relationship between the transmitted EIRP and the conducted power going to the antenna will be established at the device with the knowledge of the maximum antenna gain for each channel on which the device can operate.

$EIRP_{MAX}$ (dBm) = maximum transmit power (dBm) + maximum antenna gain for the specified channel (dBi).

Such antenna gain shall be available under the following requirements:

— Non-integrated antennas shall be required to store their maximum directional gain, in dBi, for each channel and report values in response of the device request (see 15.2.1.6).
— CPEs employing non-integrated antennas shall query their antenna for the maximum gain per channel at start-up as part of the self-test prior to association using the M-ANTENNA-INFORMATION primitive structure described in 15.2.1.6.3.
— In the case of an antenna integrated to the CPE, indicated by using the M-ANTENNA-INTEGRATED primitive structure described in 15.2.1.6.1, the maximum antenna gain per channel shall be recorded in the CPE by the manufacturer.

The conservative assumption is made that there is 0 dB loss due to antenna coupling and cable loss between the CPE and its antenna. Such losses should be minimized in practice to allow the CPE to reach the maximum EIRP (e.g., 4 W), which would be reduced by the amount of these losses since the BS will not go beyond this maximum assuming that there is 0 dB coupling and cable loss.

9.9.4.2 Transmit power control mechanism

A power control algorithm shall be supported for the US channel with both an initialization procedure through initial ranging and a periodic adjustment procedure to be carried out without loss of data. The BS shall be capable of providing accurate power measurements of the received burst signal. This value shall then be compared against a reference level, and the resulting EIRP level per subcarrier to be used by the CPE shall be fed back to the CPE through the RNG-CMD MAC message (see 7.9.6). The power control algorithm shall support EIRP adjustment as required (due to propagation loss and power fluctuations) at rates of up to 6 dB/s. The CPE shall adjust its transmit EIRP in response to a TPC command in the next scheduled US burst following receipt of the command. The power control algorithm at the BS shall take into account the various SNR requirements resulting from the different burst profiles while preventing violation of the emission masks (see 9.13) and maximum EIRP levels (see Annex A).

A transmitting CPE shall maintain the same transmitted EIRP density (EIRP per OFDMA subcarrier) regardless of the number of subchannels assigned, unless the maximum allowable total EIRP level (EIRP per subcarrier multiplied by the number of subcarriers used at any particular time) is reached. In other words, when the number of active subchannels allocated to a user is reduced, the total transmitted EIRP shall

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be reduced proportionally by the CPE, without additional power control messages (i.e., the gain of the RF transmission path is kept constant). When the number of subchannels is increased, the total transmitted EIRP shall also be increased proportionally. However, the transmitted EIRP level shall not exceed the maximum allowable EIRP level in an entire channel as dictated by regulatory requirements (see Annex A). The CPE shall interpret power control messages as the required transmitted EIRP density (EIRP per OFDMA subcarrier) as previously described.

To maintain at the BS a received power density [received signal strength level (RSSL) per subcarrier] consistent with the modulation and FEC rate used by each CPE, the BS may change the EIRP density transmitted by the CPE, through the RNG-CMD message (see 7.9.6), as well as the CPE-assigned modulation and FEC rate. There are, however, situations where the CPE should automatically update its transmitted EIRP density without being explicitly instructed by the BS. This happens when the CPE transmits in the region marked by UIUC = 2 to 7 (see Table 47). In all these situations, the CPE shall use a new transmitted EIRP density value set according to Equation (20) (in dBm).

$$
\begin{aligned}
P_{tmp} &= P_{last} + (CNR_{new} - CNR_{last}) + Offset \\
P_{Tot} &= P_{tmp} + 10 \cdot \log(N_{new}) \\
P_{new} &= \begin{cases} P_{tmp} & if \ P_{Tot} \le P_{Max} \\ P_{Max} - 10 \cdot \log(N_{new}) & if \ P_{Tot} > P_{Max} \end{cases}
\end{aligned}
\tag{20}
$$

where

P_{Max} is the maximum allowable transmitted EIRP on the current operating channel
P_{tmp} is the temporary transmitted EIRP density (per subcarrier)
P_{Tot} is the temporary total transmitted EIRP
CNR_{new} is the normalized CNR of new modulation/FEC rate instructed by the UIUC
CNR_{last} is the normalized CNR of the last used modulation/FEC rate
P_{range} is the EIRP density (per subcarrier) indicated by the BS by the RNG-CMD MAC message
P_{last} is the P_{range} specified by the RNG-CMD MAC message for the last used modulation/FEC rate
P_{new} is the EIRP density (per subcarrier) to be used for the current burst transmission

Note that the “normalized CNR” corresponds to the subcarrier power over the noise power present in the subcarrier nominal bandwidth that corresponds numerically to the subcarrier spacing as indicated in Table 248, expressed in dB. In other words, the “normalized CNR” corresponds to the subcarrier power density over the noise power density expressed in dB.

In all other situations, the CPE shall use the EIRP density value set according to Equation (21) (in dBm).

$$P_{new} = P_{range} \tag{21}$$

This resulting value P_{new} is updated based on the value P_{range} transmitted regularly to the CPE by the BS through the RNG-CMD MAC message (see 7.9.6) to keep the TPC of the RF link up-to-date. The CPE shall be calibrated by the manufacturer so that the actual EIRP density per subcarrier transmitted by the CPE corresponds to the level indicated by the P_{range} variable resulting from the RNG-CMD message (within 0.5 dB). The default normalized CNR values per modulation for the binary convolutional code (BCC), except for the CDMA code, are given in Table 228. These values may be overridden by the BS by using a dedicated UCD message (see Table 46). The second column is the default value and third column is informative and indicative of the modulation performance in a multipath channel.

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Table 278—Normalized CNR per modulation for BER = 2 × 10^{-4}

Modulation—FEC rate	Normalized CNR (dB)	
	AWGN (default)	Multipath channel [a]
CDMA code	1.2	5
QPSK, rate: 1/2	4.3	8.1
QPSK, rate: 2/3	6.1	11.6
QPSK, rate: 3/4	7.1	14.0
QPSK, rate: 5/6	8.1	17.8
16-QAM, rate: 1/2	10.2	14.8
16-QAM, rate: 2/3	12.4	20.3
16-QAM, rate: 3/4	13.5	24.6
16-QAM, rate: 5/6	14.8	28.6
64-QAM, rate: 1/2	15.6	20.5
64-QAM, rate: 2/3	18.3	26.2
64-QAM, rate: 3/4	19.7	31.8
64-QAM, rate: 5/6	20.9	40.4

[a] The multipath channel used for the calculations is defined on 6 paths as follows: excess delay: –3, 0, 2, 4, 7 and 11 μsec; relative amplitude: –6, 0, –7, –22, –16, and –20 dB; the phase for each path is random. The delay, amplitude, and phase are assumed to be constant over the period of one symbol.

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The CPE shall report, at registration, the maximum EIRP that it can achieve in the case of the transmission of a full multiplex (60 subchannels) while still meeting the required RF mask (see 9.13) and other performance limits set by the manufacturer. The maximum EIRP achievable at the CPE (see 7.9.11.3.2.1) may be reported in the CBC-REQ MAC message (see 7.9.11.1). This parameter may be used by the BS to determine the maximum EIRP density per subcarrier achievable as a function of the number of used subchannels allocated to the CPE for its US burst, noting that the PAPR tends to increase with the number of transmitted subcarriers in the burst. This parameter may also be used by the BS for optimal assignment of coding schemes and modulations and also for optimal allocation of subchannels. These algorithms are vendor-specific.

For the periodic ranging, once a CPE sends a periodic ranging code and fails to receive a RNG-CMD (7.9.6) the CPE may adjust its EIRP for the transmission of subsequent periodic ranging codes up to $EIRP_{IR_MAX}$ (7.16.2.8.1).

9.10 Network synchronization

For multiple WRAN cells implementation, it is required that all BSs be time synchronized within a tolerance of ±8 TU (equivalent to 1.167 μs for 6 MHz, 1 μs for 7 MHz BW and 0.875 μs for 8 MHz BW). It should be

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noted that any filtering at the output of the OFDM modulator to help meeting the rejection required by the RF mask (see 9.13) will create temporal dispersion that will consume part of the cyclic prefix capability provided for alleviating channel time spreading.

In the event of a loss of synchronization with the common clock or with nearby WRAN BSs, the BS shall continue to operate and shall automatically resynchronize through the synchronization process described in 7.25.

For multiple WRAN cells implementation, frequency references derived from a common timing reference shall be used to control the frequency accuracy of Base-Stations as specified in xx, provided that they meet the frequency accuracy requirements of 9.11. This applies during normal operation and during loss of timing reference.

9.11 Frequency Control requirements

At the BS, the transmitted center frequency and the symbol clock frequency shall be derived from the same reference oscillator. At the BS, the reference frequency tolerance shall be better than ±2 ppm.

At the CPE, the transmitted center frequency and the symbol clock frequency shall be derived from the same reference oscillator. Thereby, the transmit center frequency shall be synchronized and locked to the frequency transmitted from the BS with a maximum tolerance of 2% of the subcarrier spacing.

During the synchronization period, the CPE shall acquire frequency synchronization within the specified tolerance before attempting any US transmission. During normal operation, the CPE shall track the frequency changes and shall defer any transmission if synchronization is lost.

9.12 Antenna

9.12.1 Antenna reference patterns

9.12.1.1 CPE transmit/receive antenna reference pattern

The WRAN transmit/receive antenna at the CPE shall meet the reference antenna pattern depicted in Figure 203. The backlobe rejection level of 17 dB shall be met for all elevation angles in the range of ±20 degrees from the horizontal plane. This pattern was developed assuming a typical antenna gain of 12 dBi and is described by Equation (22):

$$\text{Maximum relative gain (dB)} = \begin{cases} 10 \cdot \log_{10}(\cos^4 \theta), & |\theta| \le 68^{\circ} \quad \text{(main lobe)} \\ -17, & 68^{\circ} < |\theta| < 180^{\circ} \quad \text{(side/back lobe)} \end{cases} \tag{22}$$

In the case where the WRAN transmit and receive functions of the CPE use separate antennas, the gain of these antennas shall track within 0.5 dB of each other in all azimuths of the main lobe. Outside the main lobe, both antennas shall meet the specified front-to-back ratio.

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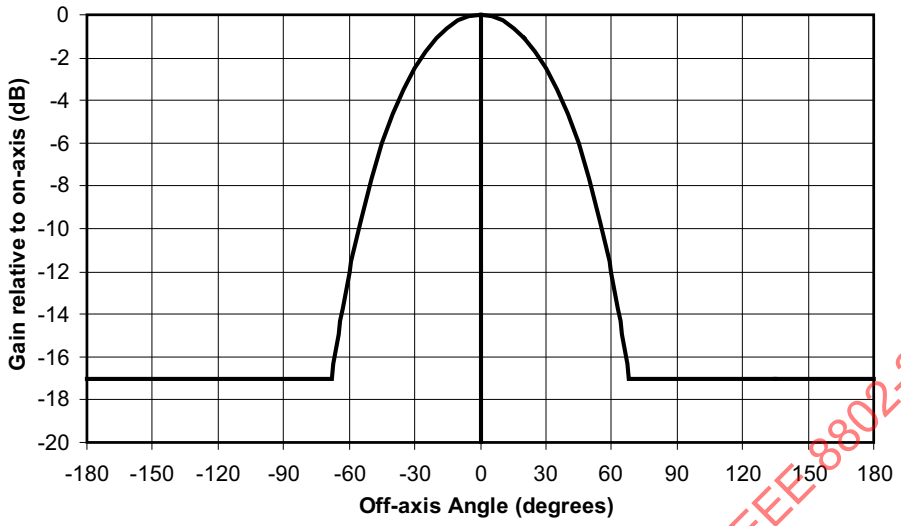

Figure 203—CPE TX/RX reference antenna pattern

9.12.1.2 Sensing antenna reference pattern

The gain of the sensing antenna in the horizontal azimuthal plane shall be equivalent to an omni-directional antenna. The deviation from this nominal gain shall be no worse than –1 dB. Such maximum deviation from this nominal gain should be kept over ±20 degrees in the vertical pattern in all azimuths.

9.12.1.2.1 BS transmit/receive antennas

The BS shall use the same antenna for transmission and reception. This allows the assumption of reciprocal transmit and receive path used in the equations in this standard for the calculation of the power levels.

9.12.2 Antenna interface

9.12.2.1 TRU/AU physical interface

The IEEE 802.22 BS and CPE may be implemented as separate TRUs and AUs or integrated into a single unit. In the case where they are separate units, the TRU and the AU shall have a coaxial interface to convey the radio signals to be transmitted and received by the antenna as well as ancillary signals to be transferred between the TRU and AU such as data, clock, and power supply.

An integrated unit is defined as one where removal or disconnection of the RF antenna or GPS antenna shall only be possible through tampering with the unit in such a way as to trigger the tamper proof mechanisms (see Clause 12). Any other implementation will result in separate CPE and AUs to which the following specification shall apply.

When implemented as separate units, interfaces shall exist on both the AU and the TRU. The transceiver unit shall be connected to the AU via a 50 Ω coaxial cable. The AU shall consist of the antenna and, where required, the integrated GPS receiver. The TRU interface shall be a female “N” type connector. The AU interface shall be a female “N” type connector. The coaxial cable shall have a male standard or corrugated type “N” connector at both the TRU and the AU ends. The length of the coaxial cable shall be less than 50 m for cables fitted with standard type “N” connectors and be less than 250 m for cables fitted with corrugated type “N” connectors. These connectors shall comply with MIL-PRF-39012E [B63] with Amendment 1 and

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MIL-STD-348 [B64]. Table 279 summarizes the technical requirements for the "N" connectors and Figure 204 illustrates typical TRU and AU interfaces and the coaxial cable linking them.

Table 279—Type "N" connector requirements

Impedance	50 Ω
Frequency range	0 to 11 GHz
Voltage rating	1500 Vpeak
VSWR	1.35 maximum over 0 to 11 GHz
Dielectric withstanding voltage	2500 V rms
Insulation resistance	5000 MΩ minimum
Center contact resistance	1.0 mΩ
Outer contact resistance	0.2 mΩ
RF leakage	–90 dB minimum at 3 GHz
Insertion loss	0.15 dB maximum at 10 GHz
Mating	5/8-24 threaded coupling MIL-STD-348
Weatherproof	All connectors exposed to outside conditions shall be weatherproof

Figure 204—RF interface between an IEEE 802.22 transceiver and its antenna

The TRU and AU interfaces and the coaxial cable linking them shall convey the following multiplex of signal components:

1) TX-RF: the transmit RF signal generated by the TRU. The AU shall not change the frequency or amplify this signal.
2) RX-RF: the RF signal received over the air by the AU. The AU shall not change the frequency of this signal.
3) COAX-DC: a temporary dc power applied by the TRU. When applied, its voltage shall be maintained at 5 ± 0.25 V and it shall support any dc load up to 0.5 ± 0.1 A. If the dc load present on the "N" connector is below 10 Ω, the TRU shall remove the COAX-DC signal and report the "short detected" event. The AU may use this dc as power supply and shall not present a load of more than 0.4 A any time.
4) UP-LINK: signaling generated by the TRU, superimposed to the COAX-DC and destined for the AU. The UP-LINK shall consist of a binary signal encoded as a 2.0 ± 0.01 MHz amplitude-switched carrier. This carrier shall have an amplitude of 0.3 ±0.03 Vpk-pk to represent a binary 0 and an amplitude of 0.03 ± 0.03 V to represent a binary 1.
5) DN-LINK: signaling generated by the AU, superimposed to the COAX-DC and destined for the TRU. The DN-LINK shall consist of a binary signal encoded as a 1.0 ± 0.005 MHz amplitude

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switched carrier. This carrier shall have an amplitude of 0.3 ± 0.03 Vpk-pk to represent a binary 0 and an amplitude of 0.03 ± 0.03V to represent a binary 1.

The TRU shall apply and maintain COAX-DC at least 0.5 s before applying the UP-LINK signal. The AU shall be ready to receive the UP-LINK signal and transmit the DN-LINK signal within 0.4 s after the application of COAX-DC.

When data is transmitted on either UP-LINK or DN-LINK, the rate of transmission shall be 9600 bits per second. The asynchronous data communication method used for the UP-LINK and DN-LINK shall consist of a bit-by-bit transmission on the physical channel. The information shall be broken into 8-bit data words. Each data word, starting with the least significant bit (LSB), shall be preceded by one start bit (binary 0), augmented with one parity bit generated from the 8-bit data word with even parity, and followed by one stop bit (binary 1). When the transmission link is idle, it shall be at binary state 1. Figure 205 illustrates the structure of the bit stream for two successively transmitted octets.

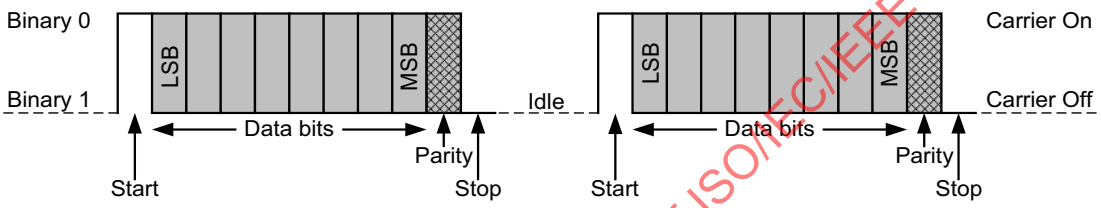

Figure 205—Structure of the UP-LINK and DN-LINK bit stream

9.12.2.2 TRU/AU messaging interface

The following message codes shall be used to signal communication between the TRU and AU:

Instructions are formatted as follows: 1 byte of opcode followed by data or control code bytes.

TRU-HELLO:

I. This message shall be sent if the TRU has not received an AU-HELLO message within 4 s after applying power to the AU.
II. Purpose: for the TRU to initiate handshaking with the AU to verify that the AU is available for query. If the AU does not respond within 4 s after this message transmission, the TRU shall declare the antenna non-operational and abort its operation.
III. Format:
    a) Opcode: 0x0000
    b) Data: none

AU-HELLO:

I. Sent by the AU upon power-on or in response to the TRU-HELLO message.
II. Purpose: for the AU to announce that it is available for query. The AU shall respond within 4 s after the transmission of the TRU-HELLO message,
III. Format:
    a) Opcode: 0x1YYY, where YYY is the amount of data (antenna model and antenna gain) that is stored in the AU (maximum length= 2k octets).
    b) Data: none

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AU-REQ:

I. Sent by the TRU after setup of serial communication and indication of AU availability (i.e., after reception of AU-HELLO).
II. Purpose: for the TRU to request transfer of antenna information from the AU.
III. Format:
    a) Opcode: 0x2000
    b) Data: none

AU-RSP:

I. Sent by the AU after receiving an AU-REQ from the TRU.
II. Purpose: for the AU to transfer the antenna model and gain information.
III. Format:
    a) Opcode: 0x3YYY, where 0xYYY is the length of the data string that is to be sent to the TRU (maximum length= 2k octets).
    b) Data: string of octets that contains the antenna model and gain information according to the format specified below (2k octets maximum). Once received, this string of octets shall be parsed by the TRU and stored in the appropriate MIBs (see 7.9.7.3.4.8 and 7.9.7.3.4.9).

GPS-REQ:

I. Sent by the TRU after setup of serial communication and indication of AU availability (i.e., after reception of AU-HELLO)
II. Purpose: for the TRU to request delivery of geolocation data from the GPS receiver.
III. Format:
    a) Opcode: 0x4YYY, where 0xYYY is the length of the data string that is to be relayed transparently to the GPS receiver (maximum length = 2k octets).
    b) Data: Character string to be relayed transparently to the GPS receiver.

GPS-RSP:

I. Sent by the AU after receiving data from the GPS receiver.
II. Purpose: forwarding the NMEA string received from the GPS receiver to the TRU.
III. Format:
    a) Opcode: 0x5YYY, where 0xYYY is the length of the data string that is being relayed transparently to the TRU.
    b) Data: Character string received from the GPS receiver (2k octets maximum).

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9.12.2.3 AU antenna information mapping

Table 280 presents the mapping of the information to be stored at the AU. It is defined by segments that contain the type of information (3 octets), the length of the segment (1 octet), and the information, followed by a CRC-16 to protect the information contained in the segment during transmission.

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Table 280—Example of data segments stored at the AU (to be read vertically)

MDL	**USA**	**GBR**	**—**
Length 0xYY	**Length 56=0x38**	**Length 55=0x37**	**Length 0xYY**
—	$Gain_2$	$Gain_{21}$	—
—	$Gain_3$	$Gain_{22}$	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	—	—
—	—	$Gain_{68}$	—
—	$Gain_{50}$	$Gain_{69}$	CRC-16
CRC-16	$Gain_{51}$	CRC-16	
	CRC-16		

Each data segment shall begin with a 3 ASCII characters long code contained in the following 3 octets:

- MDL: Antenna model segment. These 3 first octets are followed by one octet indicating the length of data to follow before the closing 2 CRC octets. The data shall contain the antenna model and serial number stored in a character string assigned by the AU manufacturer.
- USA, GBR, etc.: Regulatory domain ISO 3166 [B44] code included as the first 3 octets followed by one octet indicating the length of data to follow before the closing 2 CRC octets. The data portion shall contain one octet per channel indicating the on-axis gain of the antenna at the center frequency. The channels correspond to those listed in Annex A and are ordered the same way as shown in Annex A (see Table A.17 for the USA and Table A.18 for European countries). Additional segments can be added for further regulatory domains up to 2k octets.
- $Gain_n$: Maximum on-axis antenna gain in the specific channel in 0.25 dB units ranging from -22.0 dBi (0x01) to 41.0 dBi (0xFD). Code 0x00 shall be assigned to channels for which the antenna is not intended to be used. Code 0x01 shall also be used for antenna gain smaller than –22.0 dBi. Code 0xFB shall be used for antenna gain higher than 41.0 dBi. Code 0xFF is not allowed. (See Table 75.).

9.13 RF mask

IEEE 802.22 devices shall comply with the RF mask specified for the appropriate regulatory domain as indicated in Annex A. Where such requirements have not been specified, the IEEE 802.22 devices shall meet at least one of the RF masks included in Annex A. The power spectrum density (PSD) measurement shall be done over a measurement bandwidth of 100 kHz and a video bandwidth of 100 kHz with an average detector.

In order to meet the various RF masks specified in Annex A, there may be a need to shape the transmission signal with either filtering in the frequency domain or windowing in the time domain. This is implementation dependent.

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9.14 Receiver requirements

9.14.1 Receiver minimum sensitivity

The receiver minimum sensitivity level, R_{SS}, is defined as the minimum power, measured at the antenna port, at which the bit error rate performance is equal to the required limit. The equation is given as follows:

R_{SS} (dBm) = Reference thermal noise density level
+ Noise figure
+ Effective channel bandwidth
+ Required signal-to-noise ratio
+ Receiver implementation margin
+ Interference allowance

where

Reference thermal noise density level = Boltzman Constant + 10×log(reference noise temperature) with Boltzman Constant = –138.6 dB(mW/(K × MHz)) and reference noise temperature = 290 K (degrees Kelvin)

Noise figure = 3 dB for the BS and 6 dB for the CPE

Effective channel bandwidth = 10 log [signal bandwidth (MHz)] with signal bandwidth values as in Table 250)

Required signal-to-noise ratio = the reference normalized SNR as shown in Table 228 for a BER performance of $2x10^{-4}$ where the values include 1.1 dB, 1.3 dB, 1.5 dB, and 1.7 dB decoder implementation margins for QPSK, 16-QAM, 64-QAM, and 256-QAM modulations, respectively

Receiver implementation margin = 1.9 dB and 2.1 dB for BS and CPE respectively, accounting for the coupling loss, pre-amplification filter loss, assuming that a low-noise pre-amplifier is located at the antenna

Interference allowance = 1 dB for either BS or CPE to cover for the impact of local interference at the receiver

The BS and CPE minimum receiver sensitivity for the three channel bandwidths shall at least meet the values given in Table 281.

Table 281—Minimum receiver sensitivity requirement for QPSK rate: 1/2 BER= $2×10^{-4}$

TV channel bandwidth (MHz)	6	7	8
BS receiver sensitivity (dBm)	–94.5	–93.8	–93.2
CPE receiver sensitivity (dBm)	–91.3	–90.6	–90.0

9.14.2 Receiver selectivity

The receiver selectivity is a measure of the ability of the receiver to reject signals from adjacent channels, while receiving a wanted signal on the selected frequency. It is defined as the ratio of the selected channel signal power to the power of the signal in the adjacent channel, subject to the target BER of $2×10^{-4}$.

For IEEE 802.22 WRAN systems, the minimum receiver selectivity shall be

D/U_{adj} = 50.7 dB for the most robust modulation: QPSK, rate: 1/2

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corresponding to the 55 dBr (72.5 dBc) rejection in the first adjacent channel of a transmitted WRAN signal (consistent with what is specified in the FCC R&O 08-260).

9.14.3 Receiver tolerance to interference overload

The receiver tolerance to interference overload (also known as the *receiver blocking level* or *maximum input level*) refers to the effect of strong RF signals in channels other than the channel of interest and its two adjacent channels on the ability of the receiver to decode a wanted signal in the selected channel.

The receiver tolerance to interference overload (i.e., maximum input level) for both the BS and CPE shall be –8 dBm.

9.15 Multiple-input, multiple-output (MIMO)

9.15.1 Overview

The multiple-input, multiple-output (MIMO) system has attracted a great deal of attention since the mid-1990s. It consists of multiple antennas at both transmitter and receiver and is a breakthrough in wireless communication system design. Not limited to time and frequency dimensions, MIMO exploits the spatial dimension created by multiple antennas to achieve improvements in capacity and reliability. Moreover, the improvements come with neither addition of bandwidth nor increment of power, therefore, making MIMO a highly spectral efficient and reliable technique.

The MIMO channel can be made more robust against fading channels than each of its single-input-single-output (SISO) components by exploiting spatial diversity. Furthermore, MIMO channel creates the possibility to increase the transmission rate compared to SISO channel through spatial multiplexing; however, these two features cannot be fully exploited at the same time. A fundamental trade-off between rate increment and robustness against fading exists and must be decided according to the users needs.

The MIMO technique described as follows is more appropriate for the link between A-BS and A-CPEs existing in the wireless network backbone of A-WRAN systems. On the other hand, implementing MIMO on the links between A-BS and S-CPEs or A-CPEs and S-CPEs is technically more challenging. This is due to the fact that the lower operating frequencies inherent to the TVWS bands require antennas with bigger physical sizes than the ones required by existing wireless communication systems operating at higher parts of the frequency spectrum.

9.15.2 MIMO pilot allocation

9.15.2.1 Overview

The pilot insertion pattern for two antennas and four antennas is shown in Figure 206 and Figure 207, respectively. The pilot pattern shall be repeated every 7 OFDM symbols and 7 subcarriers in the time and frequency domains, respectively. The pilot pattern is always the same, independent of the channel bandwidth. The pilot pattern shall also be the same for the DS and US.

9.15.2.2 Pilot allocation for two antennas

The pilot insertion pattern for two antennas is shown in Figure 206. The following physical pilot indices, P_k, after the last frame preamble in every DS subframe, shall be used instead of the logical indices 0, 1, …, 6.

$$P_k = -840 + 7k + pilot_subcarrier_offset + DC_flag, \quad k = 0,1,2,...,239$$

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where

k is the running subcarrier index from 0 to 239.

pilot_subcarrier_offset is the subcarrier offset to control the beginning of first pilot subcarrier within each OFDM symbol. The *pilot_subcarrier_offset* for antenna 0 is 0, 3, 5, and 1 for (*OFDM_symbol_index mod 7*) = 0, 2, 4, and 6, respectively. The *pilot_subcarrier_offset* for antenna 1 is 2, 6, and 4 for (*OFDM_symbol_index mod 7*) = 1, 3, and 5, respectively. The OFDMA symbol of index 0 should be the first OFDMA symbol in every DS or US subframes.

DC_flag is used to count the DC subcarrier in the calculation of pilot subcarrier index. When *k* is equal or larger than 120, the value is set to 1.

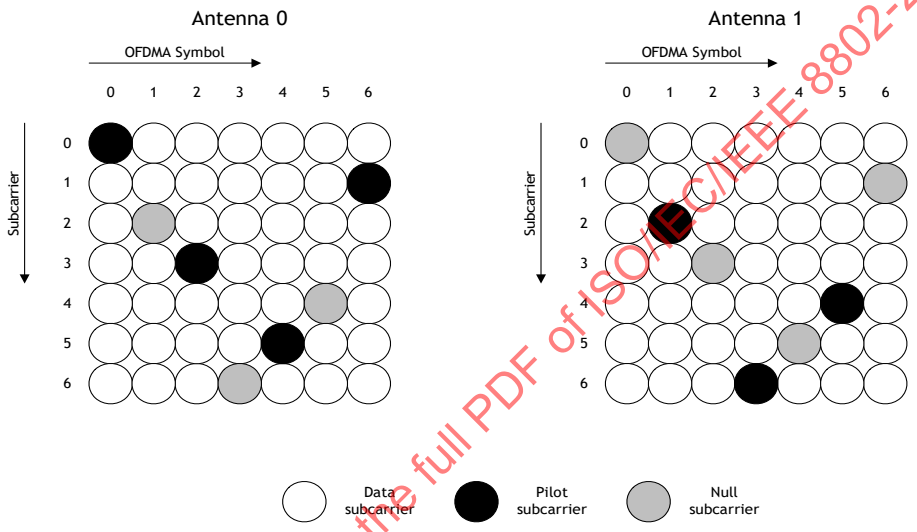

Figure 206—Pilot pattern for two TX antennas

9.15.2.3 Pilot allocation for four antennas

The pilot insertion pattern for four antennas is shown in Figure 207. The following physical pilot indices, P_k, after the last frame preamble in every DS subframe, shall be used instead of the logical indices 0, 1, …, 6.

$$P_k = -840 + 7k + pilot_subcarrier_offset + DC_flag, \quad k = 0,1,2,...,239$$

where

k is the running subcarrier index from 0 to 239.

pilot_subcarrier_offset is the subcarrier offset to control the beginning of first pilot subcarrier within each OFDM symbol. The *pilot_subcarrier_offset* for antenna 0 is 0 and 3 for (*OFDM_symbol_index mod 7*)= 0 and 4, respectively. The *pilot_subcarrier_offset* for antenna 1 is 1 and 4 for (*OFDM_symbol_index mod 7*) = 1 and 5, respectively. The *pilot_subcarrier_offset* for antenna 2 is 2 and 5 for (*OFDM_symbol_index mod 7*) = 2 and 6, respectively. The OFDMA symbol of index 0 should be the first OFDMA symbol in every DS or US subframes.

DC_flag is used to count the DC subcarrier in the calculation of pilot subcarrier index.When k is equal or larger than 120, the value is set to 1.

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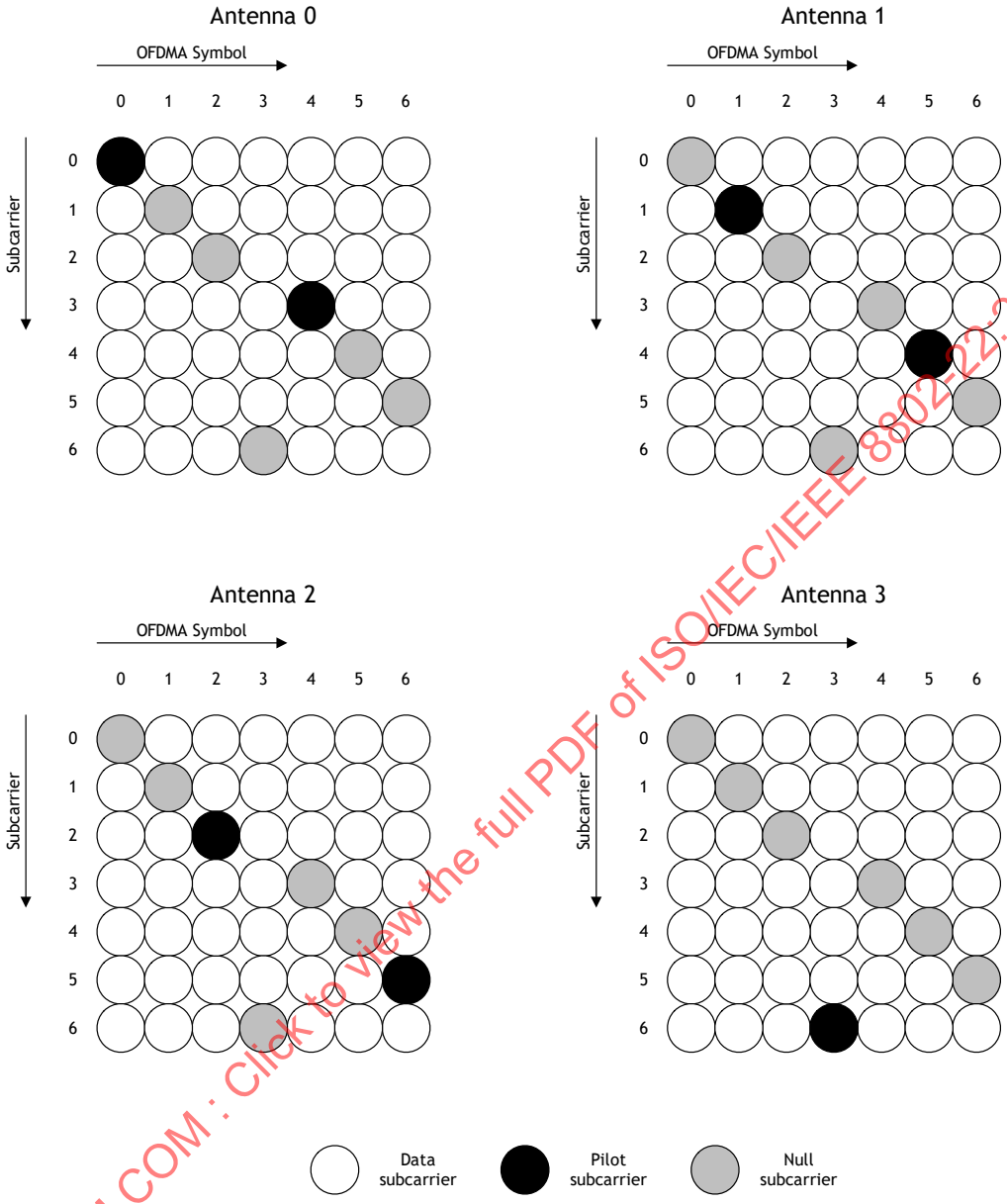

Figure 207—Pilot pattern for four TX antennas

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9.15.3 Space time coding (STC)

9.15.3.1 Overview

The MIMO technique described in this clause is common to both PHY-OM1 (Clause 9) and PHY-OM2 (Clause 10) of the PHY considered in this standard.

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9.15.3.2 Transmit diversity using two antennas (Alamouti O-STBC)

Improvement in wireless link robustness against the deleterious effects of fading is achieved by the use of Orthogonal Space-Time Block Codes (O-STBCs) through exploitation of the extra degrees of freedom provided by the multi-input, multi-output (MIMO) channel.

Let us consider a wireless communications system with two antennas at the transmitter side and a single antenna at the receiver side. Additionally, let both transmit antennas, namely antenna one and two, be spaced at least half-wave length from each other and from which two symbols s_1 and s_2 are respectively transmitted (simultaneously) at a given symbol period T. If during the following symbol period $-s_2^*$ and s_1^*, where $*$ represents complex conjugation operation, are now transmitted respectively from antenna one and two, we can represent the encoding scheme as shown in Equation (23):

$$G_2 = \begin{bmatrix} s_1 & s_2 \\ -s_2^* & s_1^* \end{bmatrix} \tag{23}$$

where the columns of the above encoding matrix represent the transmit antennas, the rows correspond to the symbol periods and s_n is the symbol taken from a complex constellation C with $n \in \{1,2\}$.

Considering that the channel remains constant across two consecutive symbol periods, i.e., a block fading channel, we can write, as shown in Equation (24):

$$h_1(t) = h_1(t+T) = h_1 \tag{24}$$

$$h_2(t) = h_2(t+T) = h_2$$

where

T is the symbol period
h_1 and h_2 are the channel paths between the transmit antenna and the receive antenna

Thus received signals are expressed by

$$r_1 = h_1 s_1 + h_2 s_2 + n_1$$

$$r_2 = h_1 s_2 + h_2 s_1 + n_2$$

Here, n_1 and n_2 are zero-mean white complex Gaussian distributed noise values with variance $\sigma^2_n/2$ per dimension.

9.15.3.3 Transmit diversity with array-interference gain

9.15.3.3.1 Overview

The technique disclosed in this subclause is full rate based on array-interference constructive aggregation. Its objective is to improve the link reliability over conventional transmit diversity, i.e., Space-Time Block Codes (STBC). This technique intentionally creates aligned array interference so as to exploit its energy in the form of added array gain. As a result, the overall gain (diversity gain + array gain) reduces the bit-error probability (BEP) as compared to the diversity gain only yielded by conventional STBCs based systems.

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9.15.3.3.2 Transmit diversity with array-interference gain for two antennas

9.15.3.3.2.1 Overview

In this subclause we describe the structure of a 2 transmit (TX) antennas ($n_t = 2$) transmit diversity TDD system exploiting transmit array interference. Since the system is based on TDD, both transmitter and receiver operate in the same frequency channel, however, in different time slots. In addition, in a TDD communication system, transmitter and receiver alternate their roles, i.e., the transmitter in time "T_n" is the receiver in the consecutive time "T_{n+1}". A direct consequence of the aforementioned is that both transmitter and receiver can estimate the wireless channel **H** during the time in which they are acting as receiver.

The vector $\mathbf{H} = [h_1\ h_2]$ represents the multiple-input-single-output (MISO) channel between the base station and the single antennae receiver (RX) white-space device. In the analyses presented hereafter, **H** is considered to be quasi-static.

Symbols vectors are transmitted through **H**, and noise is added at the receiver as shown in Figure 208. The transmitter is composed of two blocks, namely, "array gain maximization" and "transmit vector selector." The aforementioned blocks are described in the following subclauses.

In two TX antenna systems, a total of two unique transmit vectors G_m, for $m \in \{0,1\}$ exists. Each G_m yields a single interference, which is aligned to the original signal thus improving system robustness towards fading. The total interference has components coming from all antennas in the array thus it is hereafter called aligned array interference I_{Am}. It should be noted that I_{Am}, where $m \in \{0,1\}$, are functions of the fading channel **H**, and both TX and RX can estimate **H** due to the reciprocity of uplink/downlink.

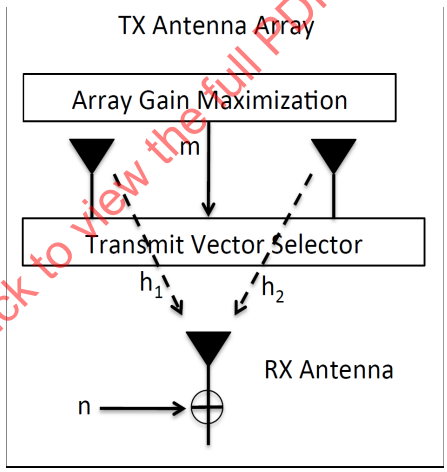

Figure 208—Transmit diversity with array-interference gain for two TX antennas (TX side)

Channel estimation is performed by the channel estimator block (see G.1.2 for implementation of the receiver side) based on pilots. The estimation is then provided to the array gain maximization block.

The array gain maximization block in TX performs

$$\arg\max_{m}(I_{Am}), \forall m \in \{0,1\}$$

in order to compare all the I_{Am} and selects the one that has the maximum value.

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Then, the array gain maximization block at the transmitter sends m inherent to the maximum array interference to the transmit vector selector block, which selects G_m to be transmitted over the channel **H** since G_m will yield the maximum array gain.

9.15.3.3.2.2 Array gain maximization block

In the array gain maximization block, the array interference I_{Am} is stored as a function of **H.**

— Array Interference I_{A0}

$$I_{A0} = h_1^* h_2 + h_1 h_2^*$$

— Array Interference I_{A1}

$$I_{A1} = -h_1^* h_2 - h_1 h_2^*$$

In order to select the most aligned interference, the array gain maximization block performs

$$\arg\max_m (I_{Am}), \forall m \in \{0,1\}$$

The array gain maximization block at the TX directly sends m to the collocated transmit vector selector block. For the following implementation examples, consider that m is represented by 3 bits.

9.15.3.3.2.3 Transmit vector selector block

— Transmit $G_0 = [\ s\ \ s]$ if m is '000'

— Transmit $G_1 = [\ s\ -s]$ if m is '001'

where

s is a symbol taken from a complex constellation C

9.15.3.3.3 Transmit diversity with array-interference gain for four antennas

9.15.3.3.3.1 Array gain maximization block

For four TX antennas, there are eight unique G_m together with their respective I_{Am} as well as w_m, m {0,1,2,3,4,5,6,7}.

$$I_{A0} = h_1^* h_2 + h_1 h_2^* + h_1^* h_3 + h_1 h_3^* + h_1^* h_4 + h_1 h_4^* + h_2^* h_3 + h_2 h_3^* + h_2^* h_4 + h_2 h_4^* + h_3^* h_4 + h_3 h_4^*$$

$$I_{A1} = -h_1^* h_2 - h_1 h_2^* - h_1^* h_4 - h_1 h_4^* - h_2^* h_3 - h_2 h_3^* - h_3^* h_4 - h_3 h_4^* + h_1^* h_3 + h_1 h_3^* + h_2^* h_4 + h_2 h_4^*$$

$$I_{A2} = -h_1^* h_3 - h_1 h_3^* - h_1^* h_4 - h_1 h_4^* - h_2^* h_3 - h_2 h_3^* - h_2^* h_4 - h_2 h_4^* + h_1^* h_2 + h_1 h_2^* + h_3^* h_4 + h_3 h_4^*$$

$$I_{A3} = -h_1^* h_2 - h_1 h_2^* - h_1^* h_3 - h_1 h_3^* - h_2^* h_4 - h_2 h_4^* - h_3^* h_4 - h_3 h_4^* + h_1^* h_4 + h_1 h_4^* + h_2^* h_3 + h_2 h_3^*$$

$$I_{A4} = -h_1^* h_4 - h_1 h_4^* - h_2^* h_4 - h_2 h_4^* - h_3^* h_4 - h_3 h_4^* + h_1^* h_2 + h_1 h_2^* + h_1^* h_3 + h_1 h_3^* + h_2^* h_3 + h_2 h_3^*$$

$$I_{A5} = -h_1^* h_3 - h_1 h_3^* - h_2^* h_3 - h_2 h_3^* - h_3^* h_4 - h_3 h_4^* + h_1^* h_2 + h_1 h_2^* + h_1^* h_4 + h_1 h_4^* + h_2^* h_4 + h_2 h_4^*$$

$$I_{A6} = -h_1^* h_2 - h_1 h_2^* - h_2^* h_3 - h_2 h_3^* - h_2^* h_4 - h_2 h_4^* + h_1^* h_3 + h_1 h_3^* + h_1^* h_4 + h_1 h_4^* + h_3^* h_4 + h_3 h_4^*$$

$$I_{A7} = -h_1^* h_2 - h_1 h_2^* - h_1^* h_3 - h_1 h_3^* - h_1^* h_4 - h_1 h_4^* + h_2^* h_3 + h_2 h_3^* + h_2^* h_4 + h_2 h_4^* + h_3^* h_4 + h_3 h_4^*$$

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In order to select the most aligned interference, the array gain maximization block performs

$$\arg\max_{m}(I_{Am}), \forall m \in \{0,1,2,3,4,5,6,7\}$$

The array gain maximization block at the transmitter sends m to the transmit vector selector block collocated at the transmitter.

9.15.3.3.3.2 Transmit vector selector block

- Transmit $G_0 = [\ s\ \ s\ \ s\ \ s]$ if m is '000';
- Transmit $G_1 = [\ s\ -s\ \ s\ -s]$ if m is '001';
- Transmit $G_2 = [\ s\ \ s\ -s\ -s]$ if m is '010';
- Transmit $G_3 = [\ s\ -s\ -s\ \ s]$ if m is '011';
- Transmit $G_4 = [\ s\ \ s\ \ s\ -s]$ if m is '100';
- Transmit $G_5 = [\ s\ \ s\ -s\ \ s]$ if m is '101';
- Transmit $G_6 = [\ s\ -s\ \ s\ \ s]$ if m is '110';
- Transmit $G|_7 = [-s\ \ s\ \ s\ \ s]$ if m is '111';

The preceding procedure partially (transmitter side only) describes how to obtain diversity added with array gain for systems with multiple antennas at the transmitter side. Note that the transmitter steps described here must be followed by the receiver steps described in G.1.2.

If more than one antenna is available in the receiver terminal, maximum ratio combining (MRC) can be utilized to significantly enhance link reliability. For simplicity, in the following example consider that the number of antennas available at the receiver is 2. The technique, however, can be utilized for any number of receive antennas.

In order to use MRC, little modification is necessary to what has been presented. The array gain maximization block, now, performs

$$\arg\max_{m}(I_{Am} + I'_{Am}), \forall m \in \{0,1\}$$

for two TX antennas, and

$$\arg\max_{m}(I_{Am} + I'_{Am}), \forall m \in \{0,1,2,3,4,5,6,7\}$$

for four TX antennas. Here, I_{Am} is the array interference in the first RX antenna, given in the previous clauses and I'_{Am} represents the array interferences in the second RX antenna. Since the channel to the second RX antenna is given by $\mathbf{H} = [h_3\ h_4]$, for two TX antennas, and $\mathbf{H} = [h_5\ h_6\ h_7\ h_8]$, for four TX antennas, I'_{Am} becomes

$$I_{A0} = h_3^* h_4 + h_3 h_4^*$$

$$I_{A1} = -h_3^* h_4 - h_3 h_4^*$$

or

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$$I_{A0} = h_5^* h_6 + h_5 h_6^* + h_5^* h_7 + h_5 h_7^* + h_5^* h_8 + h_5 h_8^* + h_6^* h_7 + h_6 h_7^* + h_6^* h_8 + h_6 h_8^* + h_7^* h_8 + h_7 h_8^*$$

$$I_{A1} = -h_5^* h_6 - h_5 h_6^* - h_5^* h_8 - h_5 h_8^* - h_6^* h_7 - h_6 h_7^* - h_7^* h_8 - h_7 h_8^* + h_5^* h_7 + h_5 h_7^* + h_6^* h_8 + h_6 h_8^*$$

$$I_{A2} = -h_5^* h_7 - h_5 h_7^* - h_5^* h_8 - h_5 h_8^* - h_6^* h_7 - h_6 h_7^* - h_6^* h_8 - h_6 h_8^* + h_5^* h_6 + h_5 h_6^* + h_7^* h_8 + h_7 h_8^*$$

$$I_{A3} = -h_5^* h_6 - h_5 h_6^* - h_5^* h_7 - h_5 h_7^* - h_6^* h_8 - h_6 h_8^* - h_7^* h_8 - h_7 h_8^* + h_5^* h_8 + h_5 h_8^* + h_6^* h_7 + h_6 h_7^*$$

$$I_{A4} = -h_5^* h_8 - h_5 h_8^* - h_6^* h_8 - h_6 h_8^* - h_7^* h_8 - h_7 h_8^* + h_5^* h_6 + h_5 h_6^* + h_5^* h_7 + h_5 h_7^* + h_6^* h_7 + h_6 h_7^*$$

$$I_{A5} = -h_5^* h_7 - h_5 h_7^* - h_6^* h_7 - h_6 h_7^* - h_7^* h_8 - h_7 h_8^* + h_5^* h_6 + h_5 h_6^* + h_5^* h_8 + h_5 h_8^* + h_6^* h_8 + h_6 h_8^*$$

$$I_{A6} = -h_5^* h_6 - h_5 h_6^* - h_6^* h_7 - h_6 h_7^* - h_6^* h_8 - h_6 h_8^* + h_5^* h_7 + h_5 h_7^* + h_5^* h_8 + h_5 h_8^* + h_7^* h_8 + h_7 h_8^*$$

$$I_{A7} = -h_5^* h_6 - h_5 h_6^* - h_5^* h_7 - h_5 h_7^* - h_5^* h_8 - h_5 h_8^* + h_6^* h_7 + h_6 h_7^* + h_6^* h_8 + h_6 h_8^* + h_7^* h_8 + h_7 h_8^*$$

The array gain maximization block at the transmitter sends m to the collocated transmit vector selector block.

9.15.4 Spatial multiplexing

9.15.4.1 Overview

The MIMO technique described in this clause is common to both Mode 1 (Clause 9) and PHY-OM2 (Clause 10) of the PHY considered in this standard.

9.15.4.2 Spatial multiplexing using two antennas

Previous subclauses have described methods to improve wireless link robustness against the deleterious effects of fading. Two spatial diversity techniques were described, namely Alamouti Code and a form of transmit diversity, which exploits the antenna array interference to obtain extra diversity gain. One application example of the aforementioned techniques is link-range extension between CPEs in order to service a wider geographical area. This is fundamental whenever the antennas of both CPEs are positioned relatively low due to the strong signal attenuation characteristic to near ground wave propagation.

This subclause, however, describes a highly spectral efficient technique that significantly enhances the A-WRAN system throughput. Spatial multiplexing transmits independent and separately encoded signals, i.e., streams, from each transmit antenna, therefore reusing (or multiplexing) the space dimension. In A-WRAN systems, enhanced data rate enables CPEs with bandwidth-hungry applications, e.g., such as wireless video transmissions for monitoring purposes, or it can increase the density of CPEs with data rate comparable to legacy IEEE 802.22 standard.

Let us consider the 2x2 wireless communications depicted in Figure 209. The channel gains between the ith transmit antenna and the jth receive antenna $h_{j,i}$ is represented by the MIMO channel matrix

$$\boldsymbol{H} = \begin{bmatrix} h_{1,1} & h_{1,2} \\ h_{2,1} & h_{2,2} \end{bmatrix}.$$

Additionally, let both transmit antennas, namely antenna one and two, be spaced at least half-wave length from each other and from which two symbols s_1 and s_2, taken from an arbitrary complex constellation C, are simultaneously transmitted. Representing the transmitted symbols by the vector $\boldsymbol{s} = [s_1\ s_2]^T$ and the noise at the receive antennas by $\boldsymbol{n} = [n_1\ n_2]^T$, also illustrated in Figure 209, we can represent the received signals as shown in Equation (25)

$$\begin{bmatrix} y_1 \\ y_2 \end{bmatrix} = \begin{bmatrix} h_{1,1} & h_{1,2} \\ h_{2,1} & h_{2,2} \end{bmatrix} \cdot \begin{bmatrix} s_1 \\ s_2 \end{bmatrix} + \begin{bmatrix} n_1 \\ n_2 \end{bmatrix} \quad (25)$$

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or Equation (26)

$$\mathbf{y} = \mathbf{H}^{*}\mathbf{s} + \mathbf{n} \tag{26}$$

Here, n_j is the zero-mean white complex Gaussian distributed noise with variance $\sigma^2_n/2$ per dimension and ^{T} denotes transpose operation.

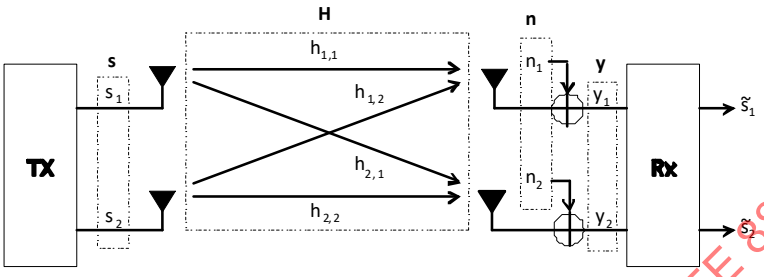

Figure 209—Schematic representation of spatial multiplexing technique

9.15.4.3 Spatial multiplexing using four antennas

Previous subclauses have described spatial multiplexing with two Tx and two RX antennas. This subclause illustrates the same technique, however, for four Tx and four RX antennas.

Consider a 4x4 wireless communications system. The channel gains between the ith transmit antenna and the jth receive antenna $h_{j,i}$ is represented by the MIMO channel matrix:

$$\boldsymbol{H} = \begin{bmatrix} h_{1,1} & h_{1,2} & h_{1,3} & h_{1,4} \\ h_{2,1} & h_{2,2} & h_{2,3} & h_{2,4} \\ h_{3,1} & h_{3,2} & h_{3,3} & h_{3,4} \\ h_{4,1} & h_{4,2} & h_{4,3} & h_{4,4} \end{bmatrix}$$

Similarly to the 2x2 case, let all antennas be spaced at least half-wave length from each other from where four symbols s_1, s_2, s_3, s_4, taken from the arbitrary complex constellation C, are simultaneously transmitted. The transmitted symbols vector is $\boldsymbol{s} = [s_1\ s_2\ s_3\ s_4]^T$ and the noise at the receive antennas is $\boldsymbol{n} = [w_1\ w_2\ w_3\ w_4]^T$ with the received signals also given by $\boldsymbol{y} = \boldsymbol{H}^{*}\boldsymbol{s} + \boldsymbol{n}$.

9.16 Using PHY-OM1 in non-TV whitespace frequency bands

The possibility of operating a technology based on IEEE Std 802.22 in the frequency bands such as 1.3 GHz to 1.75 GHz and 2.7 GHz to 3.7 GHz, etc., opens interesting possibilities and challenges. Since the IEEE 802.22 system defines an OFDMA-based operation, the US transmission from various CPEs requires very tight tolerance in order for successful demodulation of the signals at the BS. Subclause 9.11 specifies a 2% error relative to the OFDM subcarrier spacing, corresponding to 60 Hz as the maximum frequency error permissible for acceptable OFDM inter-carrier leakage. This is essentially related to the fact that the US bursts from multiple CPE transmissions need to be received at the BS as a coherent frequency multiplex. This means that additional techniques may be needed to improve the stability/VCO hunting/tracking at the CPEs in order to utilize the IEEE 802.22 system at these higher carrier frequencies, or IEEE 802.22 systems can potentially operate with a higher instantaneous bandwidth (e.g., 18 MHz instead of 6 MHz) in order to alleviate the tight frequency tolerance requirements.

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10. PHY Operation Mode 2 (PHY-OM2)

This clause specifies the basic technologies for the standardization of the PHY for A-WRAN systems. The specification is for a system that uses vacant channels to provide wireless communication.

The system reference frequency is the center frequency of the channel in which the transmitter and the receiver equipment operates. Annex A lists the frequencies corresponding to the channels used for A-WRAN operation in various regulatory domains.

The PHY specification is based on an OFDMA scheme where information to downstream (DS) or from upstream (US) multiple CPEs are modulated on orthogonal subcarriers using Inverse Fourier Transforms. The main system parameters are provided in Table 282.

Table 282—System parameters for A-WRAN

Parameters	Specifications	Remark
Frequency range	54~862 MHz	
Channel bandwidth	6, 7, or 8 MHz	According to regulatory domain (see Annex A).
Data rate (6 MHz case, 1/16 CP case)	3.61 to 18.05 up to 25.27 Mbit/s for SISO and single channel operation case 57.77 to 288.85 up to 404.39 Mbit/s for 4 stream MIMO and 4 channel operation case	See Table 286. The single channel and single spatial stream is mandatory. Others cases should be optional.
Spectral Efficiency (6 MHz case, 1/16 CP case)	0.60 to 3.01 up to 4.21 bit/(s·Hz) for SISO and single channel operation case 2.41 to 12.05 up to 16.85 bit/(s·Hz) for 4 stream MIMO and 4 channel operation case	See Table 286.
Payload modulation	QPSK, 16-QAM, 64-QAM, 256-QAM (optional), MD-TCM (optional)	BPSK used for preambles, pilots, and CDMA codes.
Transmit EIRP	4 W maximum for CPEs. 4 W maximum for BSs in the USA regulatory domain.	Maximum EIRP for BSs may vary in other regulatory domains.
Multiple access	OFDMA	
FFT Size (N_{FFT})	1024	
Cyclic prefix modes	1/4, 1/8, 1/16, 1/32	
Duplex	TDD	

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The following subclauses provide details on the various aspects of the PHY specifications.

10.1 Symbol description

10.1.1 OFDM symbol mathematical representation

The RF signal transmitted during any OFDM symbol duration can be represented mathematically as shown in Equation (27):

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(27)

$$s(t) = \mathrm{Re}\left\{ e^{j2\pi f_c t} \sum_{\substack{k=-N_T/2 \\ k\neq 0}}^{N_T/2} c_k e^{j2\pi k\Delta f (t-T_{CP})} \right\}$$

where

t is the time elapsed since the beginning of the current symbol, with $0<t<T_{SYM}$
T_{SYM} is the symbol duration, including cyclic prefix duration
$Re(.)$ is the real part of the signal
f_c is the carrier frequency
C_k is a complex number; the data to be transmitted on the subcarrier whose frequency offset index is k, during the current symbol. It specifies a point in a QAM constellation
Δf is the subcarrier frequency spacing
T_{CP} is the time duration of cyclic prefix
N_T is the number of used subcarriers (not including dc subcarrier)

10.1.1.1 Time domain description

The time domain signal is generated by taking the inverse Fourier transform of the length NFFT vector. The vector is formed by taking the constellation mapper output and inserting pilot and guard tones. At the receiver, the time domain signal is transformed to the frequency domain representation by using a Fourier transform.

Let T_{FFT} represent the time duration of the IFFT output signal. The OFDM symbol is formed by inserting a cyclic prefix of time duration T_{CP} (shown in Figure 210), resulting in a symbol duration of $T_{SYM} = T_{FFT} + T_{CP}$.

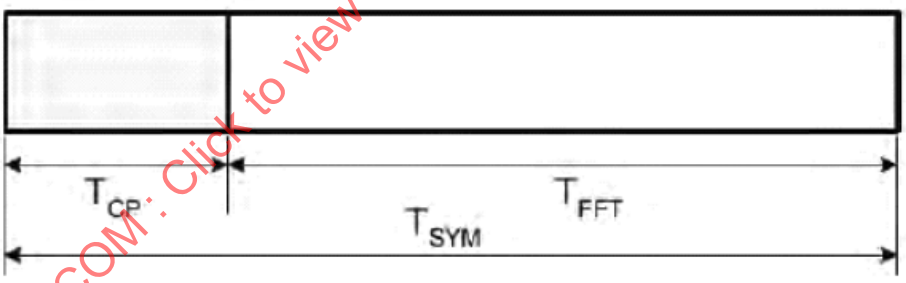

Figure 210—OFDM symbol format

The specific values for T_{FFT}, T_{CP}, and T_{SYM} are given in 10.1.2. The BS determines these parameters and conveys the T_{CP}-to-T_{FFT} ratio to the CPEs using the FCH.

The time at which the FFT window starts within the symbol period for reception at the CPE is determined by the local synchronization strategy to minimize inter-symbol interference due to pre- and post-echoes and any synchronization error; therefore, it is implementation dependent.

10.1.1.2 Frequency domain description

In the frequency domain, an OFDM symbol is defined in terms of its subcarriers, which are classified as follows: data subcarriers, pilot subcarriers, and guard and null (including dc) subcarriers. The classification is based on the functionality of the subcarriers. The DS and US may have different allocations of subcarriers.

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The total number of subcarriers is determined by the FFT/IFFT size. The pilot subcarriers are distributed across the bandwidth. The exact location of the pilot and data subcarriers and the symbol's subchannel allocation is determined by the particular configuration used. All the remaining guard/null subcarriers carry no energy and are located at the center frequency of the channel (dc subcarrier) and at both edges of the channel (guard subcarriers).

10.1.2 Symbol parameters

10.1.2.1 Subcarrier spacing

The BS and CPEs shall use the 1024 FFT mode with the subcarriers spacing specified in Table 283. The subcarrier spacing, ΔF, is dependent on the bandwidth of the channel (6 MHz, 7 MHz, or 8 MHz). Table 283 shows the subcarrier spacing and the corresponding FFT/IFFT period (T_{FFT}) values for the different channel bandwidth options.

Table 283—Subcarrier spacing and FFT/IFFT period values for different bandwidth options

	6 MHz based channels	7 MHz based channels	8 MHz based channels
Basic sampling frequency, F_s (MHz)	5.6	6.53	7.46
Inter-carrier spacing ΔF (Hz)= F_s /1024	5468.75	6380.208…	7291.6…
FFT/IFFT period, T_{FFT}(μs)=1/ ΔF	182.857…	156.734…	137.142…
Time Unit (ns) TU=T_{FFT}/1024	178.571…	153.061…	133.928…

10.1.2.2 Symbol duration for different cyclic prefix modes

The cyclic prefix duration, T_{CP}, could be one of the following derived values: $T_{FFT}/32$, $T_{FFT}/16$, $T_{FFT}/8$, and $T_{FFT}/4$. The OFDM symbol duration for different values of cyclic prefix is given in Table 284.

Table 284—Symbol duration for different cyclic prefixes and bandwidth options

		CP=T_{FFT}/32	CP=T_{FFT}/16	CP=T_{FFT}/8	CP=T_{FFT}/4
T_{SYM} =T_{FFT}+T_{CP} (μs)	6 MHz	188.571…	194.285…	205.714…	228.571…
	7 MHz	161.632…	166.530…	176.326…	195.918…
	8 MHz	141.428…	145.714…	154.285…	171.428..

10.1.2.3 Transmission parameters

Table 285 shows the different parameters and their values for the three bandwidths.

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Table 285—OFDM parameters for the three channel bandwidths

TV channel bandwidth (MHz)	6	7	8
Total number of subcarriers, N_{FFT}	1024		
Number of guard subcarriers, N_G (L, DC, R)	192 (96,1,95) for DS 184 (92,1,91) for US		
Number of used subcarriers $N_T = N_D + N_P$	832 for DS 840 for US		
Number of data subcarriers, N_D	832 or 416 for DS 840 or 420 for US		
Number of pilot subcarriers, N_P	0 or 416 for DS 0 or 420 for US		

10.1.3 OFDMA basic terms definition

10.1.3.1 Tile, slot, and data region

In DS, a tile consists of 4 successive active subcarriers and 4 OFDM symbols as shown in Figure 211. In US, a tile consists of 4 successive active subcarriers and 7 OFDM symbols as shown in Figure 212.

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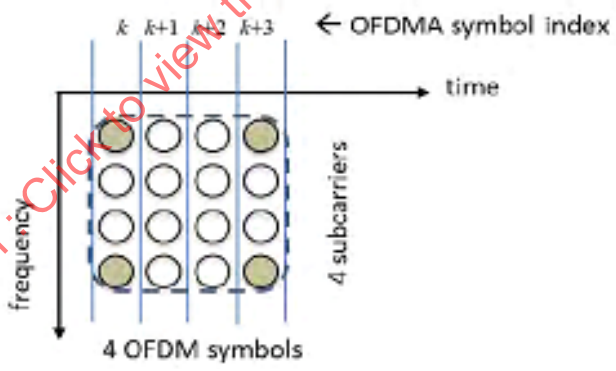

Figure 211—Tile configuration for DS

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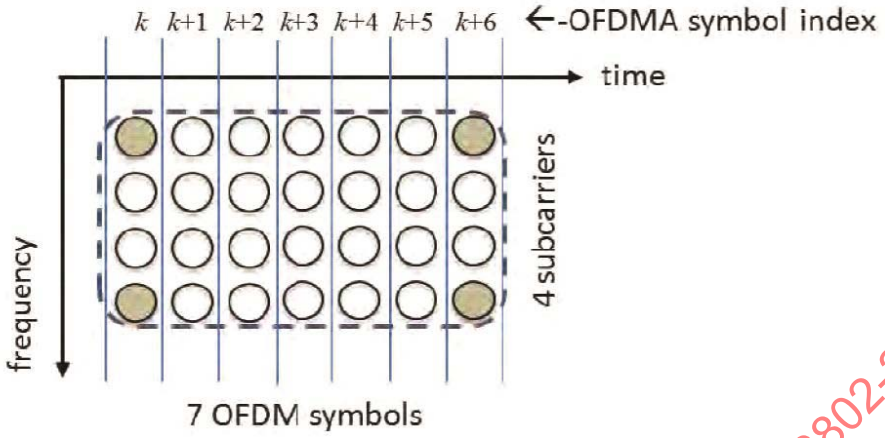

Figure 212—Tile configuration for US

A slot is the minimum possible data allocation unit. A slot requires both a time and subchannel dimension. In DS, a slot consists of 16 subcarriers and 4 OFDM symbols (or 4 DS tiles) as shown in Figure 213. In US, a tile consists of 8 subcarriers and 7 OFDM symbols (or 2 US tiles) as shown in Figure 214.

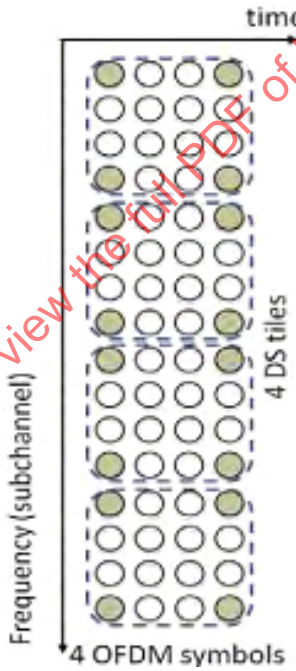

Figure 213—Slot configuration for DS

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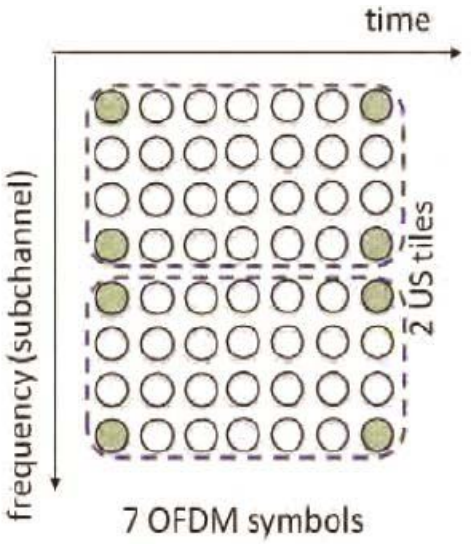

Figure 214—Slot configuration for US

A data region is a 2D allocation of a group of contiguous subchannels, in a group of contiguous OFDMA symbols. All the allocations refer to logical subchannels. A 2D allocation may be visualized as a rectangle, such as the 8x5 rectangles shown in Figure 215.

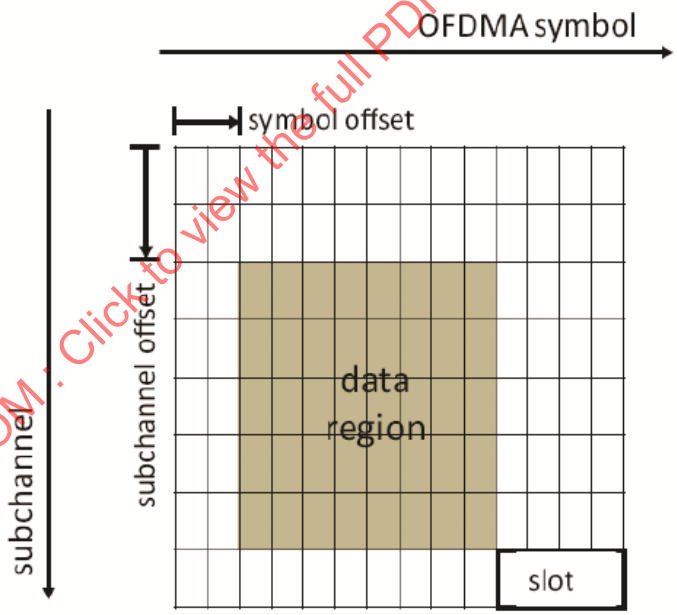

Figure 215—Example of a data region that defines an OFDMA allocation (DS)

10.1.3.2 Data mapping

MAC data shall be processed as described in 10.7 and shall be mapped to a data region (see 10.1.3.1) for DS and US using the algorithms defined as follows:

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a) **DS:**

1) Segment the data into blocks sized to fit into one slot.

2) Each slot shall span one subchannel in the subchannel axis and 4 OFDM symbols in the time axis, as per the slot definition in 10.1.3.1. Map the slots so that the lowest numbered slot occupies the lowest numbered subchannel in the lowest numbered symbol.

3) Continue the mapping so that the subchannel index is increased. When the edge of the data region is reached, continue the mapping from the lowest numbered subchannel in the next available symbol.

Figure 216 illustrates the order in which OFDMA slots are mapped to subchannels and OFDMA symbols in DS.

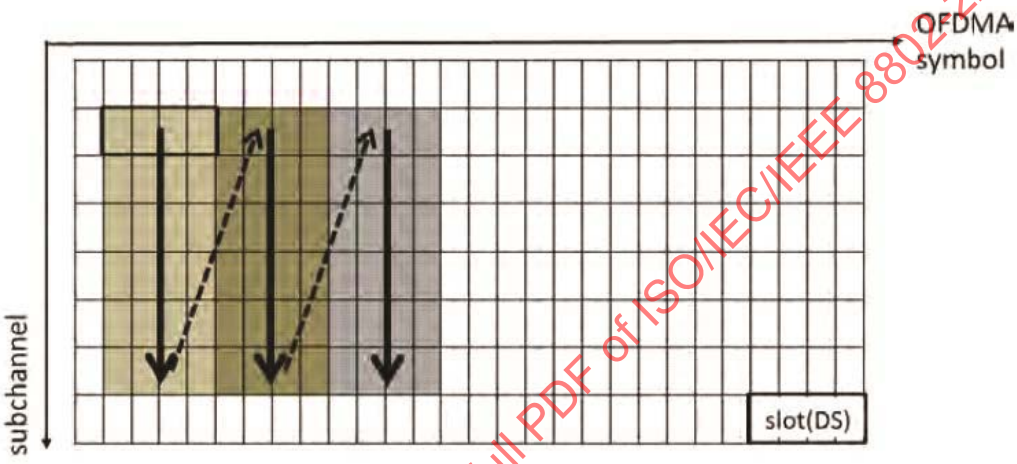

Figure 216—Procedure of slot allocation to the burst (data region) in DS

b) **US:** The US mapping consists of two steps. In the first step, the slots allocated to each burst (a data region) are selected. In the second step, the allocated slots are mapped.

1) Allocate slots to bursts.

i) Segment the data into blocks sized to fit into one slot.

ii) Each slot shall span one subchannel in the subchannel axis and 7 OFDM symbols in the time axis, as per the slot definition in Figure 214. Allocate the slots so that the lowest numbered slot occupies the lowest numbered symbol in the lowest numbered subchannel.

iii) Continue allocating so that the OFDMA symbol index is increased. When the edge of the allocated data region is reached, continue allocating from the lowest numbered symbol in the next available subchannel.

iv) A US allocation is created by selecting an integer number of contiguous slots, according to the ordering of substeps i) through iii). This results in the general burst structure shown by the gray area in Figure 217.

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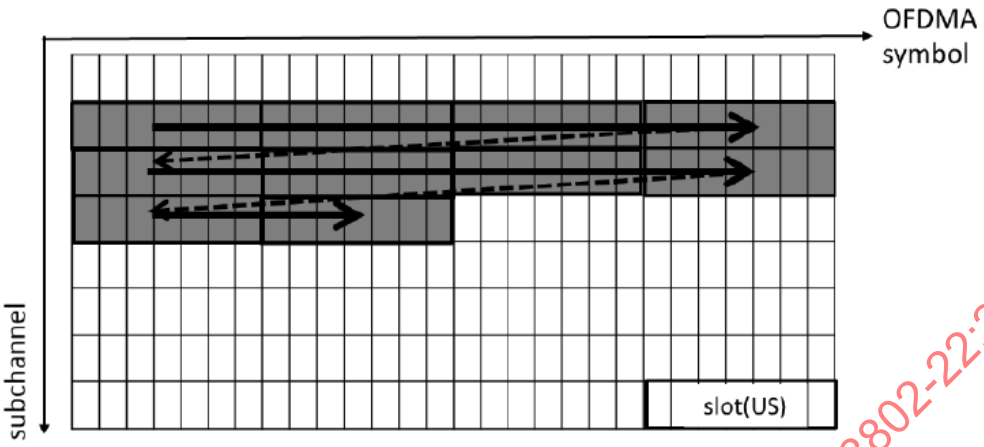

Figure 217—Slot allocation to the allocated data region (burst) in US

2) Map slots within the UL allocation.

   i) Map the slots so that the lowest numbered slot occupies the lowest numbered subchannel in the lowest numbered OFDMA symbol.

   ii) Continue the mapping so that the subchannel index is increased. When the last subchannel is reached, continue the mapping from the lowest numbered subchannel in the next OFDMA symbol that belongs to the UL allocation. The resulting order is shown by the arrows in Figure 231.

Figure 218 illustrates the order in which OFDMA slots are mapped to subchannels and OFDMA symbols in US.

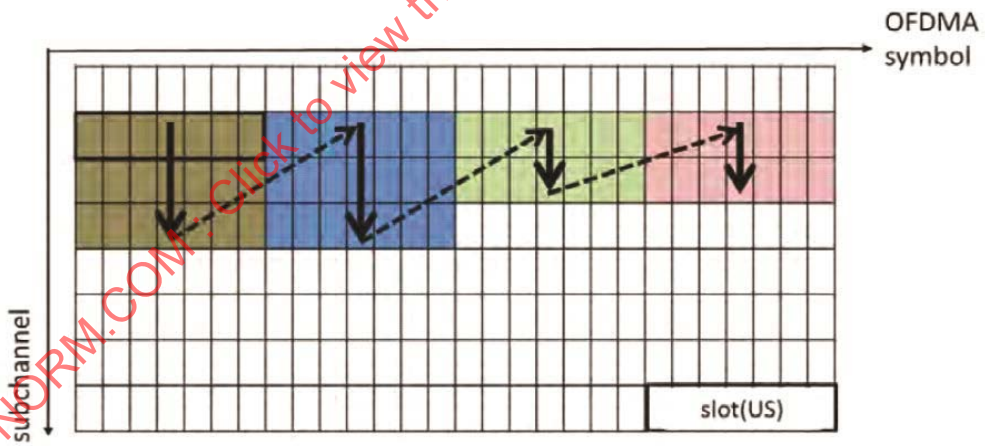

Figure 218—Example of mapping slots to subchannels and symbols in the US

The subchannels referred to in this subclause are logical subchannels.

10.2 Data rates

Table 286 defines the different PHY modulation and encoding modes with their associated parameters along with an example of the resulting gross data rates for the 6 MHz channel bandwidth.

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Table 286—PHY MCS modes and their related modulations, coding rates, and data rates for $T_{CP}=T_{FFT}/16$

PHY MCS mode	Modulation	Coding rate	Data rate (Mb/s)	Spectral efficiency[a] (for 6 MHz bandwidth)
1[b]	BPSK	Uncoded	4	4
2[c]	QPSK	1/2 repetition: 4	4	4
3	QPSK	1/2	3.61	0.60
4	QPSK	2/3	4.81	0.80
5	QPSK	3/4	5.42	0.90
6	QPSK	5/6	6.02	1.00
7	16-QAM	1/2	7.22	1.20
8	16-QAM	2/3	9.63	1.60
9	16-QAM	3/4	10.83	1.81
10	16-QAM	5/6	12.04	2.01
11	64-QAM	1/2	10.83	1.81
12	64-QAM	2/3	14.44	2.41
13	64-QAM	3/4	16.25	2.71
14	64-QAM	5/6	18.05	3.01
15	256-QAM	1/2	14.44	2.41
16	256-QAM	2/3	19.26	3.21
17	256-QAM	3/4	21.66	3.61
18	256-QAM	5/6	24.07	4.01
19	256-QAM	7/8	25.27	4.21
20	4D-TCM 48 QAM	10/11	18.05	3.01
21	4D-TCM 192 QAM	14/15	25.27	4.21

NOTE—These modes are for control signal transmissions, and there is no need to specify data rate or spectral efficiency.

[a]Spectral efficiency informative values are calculated assuming continuous stream for the given modulation and FEC modes (i.e., assuming no TTG, RTG, or frame headers).
[b]Mode 1 is used only for CDMA opportunistic bursts.
[c]Mode 2 is used only for A-FCH and DRZ-FCH transmission.

Table 287 through Table 298 give the data rates for the various channel and spatial stream combinations.

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Table 287—Data rate for 1 channel and 1 spatial stream

MODE	Modulation	Coding rate	Data rate (Mbits/s)				Data rate (Mbits/s)				Data rate (Mbits/s)			
			6 MHz BW				7 MHz BW				8 MHz BW			
			1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP
3	QPSK	1/2	3.07	3.41	3.61	3.72	3.58	3.98	4.21	4.34	4.09	4.55	4.81	4.96
4	QPSK	2/3	4.09	4.55	4.81	4.96	4.77	5.30	5.62	5.79	5.46	6.06	6.42	6.61
5	QPSK	3/4	4.60	5.11	5.42	5.58	5.37	5.97	6.32	6.51	6.14	6.82	7.22	7.44
6	QPSK	5/6	5.11	5.68	6.02	6.20	5.97	6.63	7.02	7.23	6.82	7.58	8.02	8.27
7	16-QAM	1/2	6.14	6.82	7.22	7.44	7.16	7.96	8.42	8.68	8.18	9.09	9.63	9.92
8	16-QAM	2/3	8.18	9.09	9.63	9.92	9.55	10.61	11.23	11.57	10.91	12.12	12.84	13.23
9	16-QAM	3/4	9.21	10.23	10.83	11.16	10.74	11.93	12.64	13.02	12.28	13.64	14.44	14.88
10	16-QAM	5/6	10.23	11.37	12.04	12.40	11.93	13.26	14.04	14.47	13.64	15.16	16.05	16.53
11	64-QAM	1/2	9.21	10.23	10.83	11.16	10.74	11.93	12.64	13.02	12.28	13.64	14.44	14.88
12	64-QAM	2/3	12.28	13.64	14.44	14.88	14.32	15.91	16.85	17.36	16.37	18.19	19.26	19.84
13	64-QAM	3/4	13.81	15.34	16.25	16.74	16.11	17.90	18.96	19.53	18.41	20.46	21.66	22.32
14	64-QAM	5/6	15.34	17.05	18.05	18.60	17.90	19.89	21.06	21.70	20.46	22.73	24.07	24.80
15	256-QAM	1/2	12.28	13.64	14.44	14.88	14.32	15.91	16.85	17.36	16.37	18.19	19.26	19.84
16	256-QAM	2/3	16.37	18.19	19.26	19.84	19.10	21.22	22.47	23.15	21.82	24.25	25.68	26.45
17	256-QAM	3/4	18.41	20.46	21.66	22.32	21.48	23.87	25.27	26.04	24.55	27.28	28.88	29.76
18	256-QAM	5/6	20.46	22.73	24.07	24.80	23.87	26.52	28.08	28.93	27.28	30.31	32.09	33.07
19	256-QAM	7/8	21.48	23.87	25.27	26.04	25.06	27.85	29.49	30.38	28.64	31.83	33.70	34.72
20	4D-TCM 48QAM	10/11	15.34	17.05	18.05	18.60	17.90	19.89	21.06	21.70	20.46	22.73	24.07	24.80
21	4D-TCM 192QAM	14/15	21.48	23.87	25.27	26.04	25.06	27.85	29.49	30.38	28.64	31.83	33.70	34.72

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Table 288—Data rate for 1 channel and 2 spatial streams

MODE	Modulation	Coding rate	Data rate (Mbits/s)											
			6 MHz BW				7 MHz BW				8 MHz BW			
			1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP
3	QPSK	1/2	6.14	6.82	7.22	7.44	7.16	7.96	8.42	8.68	8.18	9.09	9.63	9.92
4	QPSK	2/3	8.18	9.09	9.63	9.92	9.55	10.61	11.23	11.57	10.91	12.12	12.84	13.23
5	QPSK	3/4	9.21	10.23	10.83	11.16	10.74	11.93	12.64	13.02	12.28	13.64	14.44	14.88
6	QPSK	5/6	10.23	11.37	12.04	12.40	11.93	13.26	14.04	14.47	13.64	15.16	16.05	16.53
7	16-QAM	1/2	12.28	13.64	14.44	14.88	14.32	15.91	16.85	17.36	16.37	18.19	19.26	19.84
8	16-QAM	2/3	16.37	18.19	19.26	19.84	19.10	21.22	22.47	23.15	21.82	24.25	25.68	26.45
9	16-QAM	3/4	18.41	20.46	21.66	22.32	21.48	23.87	25.27	26.04	24.55	27.28	28.88	29.76
10	16-QAM	5/6	20.46	22.73	24.07	24.80	23.87	26.52	28.08	28.93	27.28	30.31	32.09	33.07
11	64-QAM	1/2	18.41	20.46	21.66	22.32	21.48	23.87	25.27	26.04	24.55	27.28	28.88	29.76
12	64-QAM	2/3	24.55	27.28	28.88	29.76	28.64	31.83	33.70	34.72	32.74	36.37	38.51	39.68
13	64-QAM	3/4	27.62	30.69	32.50	33.48	32.22	35.80	37.91	39.06	36.83	40.92	43.33	44.64
14	64-QAM	5/6	30.69	34.10	36.11	37.20	35.80	39.78	42.12	43.40	40.92	45.47	48.14	49.60
15	256-QAM	1/2	24.55	27.28	28.88	29.76	28.64	31.83	33.70	34.72	32.74	36.37	38.51	39.68
16	256-QAM	2/3	32.74	36.37	38.51	39.68	38.19	42.44	44.93	46.29	43.65	48.50	51.35	52.91
17	256-QAM	3/4	36.83	40.92	43.33	44.64	42.97	47.74	50.55	52.08	49.10	54.56	57.77	59.52
18	256-QAM	5/6	40.92	45.47	48.14	49.60	47.74	53.04	56.16	57.87	54.56	60.62	64.19	66.13
19	256-QAM	7/8	42.97	47.74	50.55	52.08	50.13	55.70	58.97	60.76	57.29	63.65	67.40	69.44
20	4D-TCM 48QAM	10/11	30.69	34.10	36.11	37.20	35.80	39.78	42.12	43.40	40.92	45.47	48.14	49.60
21	4D-TCM 192QAM	14/15	42.97	47.74	50.55	52.08	50.13	55.70	58.97	60.76	57.29	63.65	67.40	69.44

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Table 289—Data rate for 1 channel and 4 spatial streams

MODE	Modulation	Coding rate	Data rate (Mbits/s)											
			6 MHz BW				7 MHz BW				8 MHz BW			
			1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP
3	QPSK	1/2	12.28	13.64	14.44	14.88	14.32	15.91	16.85	17.36	16.37	18.19	19.26	19.84
4	QPSK	2/3	16.37	18.19	19.26	19.84	19.10	21.22	22.47	23.15	21.82	24.25	25.68	26.45
5	QPSK	3/4	18.41	20.46	21.66	22.32	21.48	23.87	25.27	26.04	24.55	27.28	28.88	29.76
6	QPSK	5/6	20.46	22.73	24.07	24.80	23.87	26.52	28.08	28.93	27.28	30.31	32.09	33.07
7	16-QAM	1/2	24.55	27.28	28.88	29.76	28.64	31.83	33.70	34.72	32.74	36.37	38.51	39.68
8	16-QAM	2/3	32.74	36.37	38.51	39.68	38.19	42.44	44.93	46.29	43.65	48.50	51.35	52.91
9	16-QAM	3/4	36.83	40.92	43.33	44.64	42.97	47.74	50.55	52.08	49.10	54.56	57.77	59.52
10	16-QAM	5/6	40.92	45.47	48.14	49.60	47.74	53.04	56.16	57.87	54.56	60.62	64.19	66.13
11	64-QAM	1/2	36.83	40.92	43.33	44.64	42.97	47.74	50.55	52.08	49.10	54.56	57.77	59.52
12	64-QAM	2/3	49.10	54.56	57.77	59.52	57.29	63.65	67.40	69.44	65.47	72.75	77.03	79.36
13	64-QAM	3/4	55.24	61.38	64.99	66.96	64.45	71.61	75.82	78.12	73.66	81.84	86.65	89.28
14	64-QAM	5/6	61.38	68.20	72.21	74.40	71.61	79.57	84.25	86.80	81.84	90.93	96.28	99.20
15	256-QAM	1/2	49.10	54.56	57.77	59.52	57.29	63.65	67.40	69.44	65.47	72.75	77.03	79.36
16	256-QAM	2/3	65.47	72.75	77.03	79.36	76.38	84.87	89.86	92.59	87.30	97.00	102.70	105.81
17	256-QAM	3/4	73.66	81.84	86.65	89.28	85.93	95.48	101.10	104.16	98.21	109.12	115.54	119.04
18	256-QAM	5/6	81.84	90.93	96.28	99.20	95.48	106.09	112.33	115.73	109.12	121.24	128.38	132.27
19	256-QAM	7/8	85.93	95.48	101.10	104.16	100.25	111.39	117.95	121.52	114.58	127.31	134.80	138.88
20	4D-TCM 48QAM	10/11	61.38	68.20	72.21	74.40	71.61	79.57	84.25	86.80	81.84	90.93	96.28	99.20
21	4D-TCM 192QAM	14/15	85.93	95.48	101.10	104.16	100.25	111.39	117.95	121.52	114.58	127.31	134.80	138.88

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Table 290—Data rate for 2 channels and 1 spatial stream

MODE	Modulation	Coding rate	Data rate (Mbits/s)											
			6 MHz BW				7 MHz BW				8 MHz BW			
			1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP
3	QPSK	1/2	6.14	6.82	7.22	7.44	7.16	7.96	8.42	8.68	8.18	9.09	9.63	9.92
4	QPSK	2/3	8.18	9.09	9.63	9.92	9.55	10.61	11.23	11.57	10.91	12.12	12.84	13.23
5	QPSK	3/4	9.21	10.23	10.83	11.16	10.74	11.93	12.64	13.02	12.28	13.64	14.44	14.88
6	QPSK	5/6	10.23	11.37	12.04	12.40	11.93	13.26	14.04	14.47	13.64	15.16	16.05	16.53
7	16-QAM	1/2	12.28	13.64	14.44	14.88	14.32	15.91	16.85	17.36	16.37	18.19	19.26	19.84
8	16-QAM	2/3	16.37	18.19	19.26	19.84	19.10	21.22	22.47	23.15	21.82	24.25	25.68	26.45
9	16-QAM	3/4	18.41	20.46	21.66	22.32	21.48	23.87	25.27	26.04	24.55	27.28	28.88	29.76
10	16-QAM	5/6	20.46	22.73	24.07	24.80	23.87	26.52	28.08	28.93	27.28	30.31	32.09	33.07
11	64-QAM	1/2	18.41	20.46	21.66	22.32	21.48	23.87	25.27	26.04	24.55	27.28	28.88	29.76
12	64-QAM	2/3	24.55	27.28	28.88	29.76	28.64	31.83	33.70	34.72	32.74	36.37	38.51	39.68
13	64-QAM	3/4	27.62	30.69	32.50	33.48	32.22	35.80	37.91	39.06	36.83	40.92	43.33	44.64
14	64-QAM	5/6	30.69	34.10	36.11	37.20	35.80	39.78	42.12	43.40	40.92	45.47	48.14	49.60
15	256-QAM	1/2	24.55	27.28	28.88	29.76	28.64	31.83	33.70	34.72	32.74	36.37	38.51	39.68
16	256-QAM	2/3	32.74	36.37	38.51	39.68	38.19	42.44	44.93	46.29	43.65	48.50	51.35	52.91
17	256-QAM	3/4	36.83	40.92	43.33	44.64	42.97	47.74	50.55	52.08	49.10	54.56	57.77	59.52
18	256-QAM	5/6	40.92	45.47	48.14	49.60	47.74	53.04	56.16	57.87	54.56	60.62	64.19	66.13
19	256-QAM	7/8	42.97	47.74	50.55	52.08	50.13	55.70	58.97	60.76	57.29	63.65	67.40	69.44
20	4D-TCM 48QAM	10/11	30.69	34.10	36.11	37.20	35.80	39.78	42.12	43.40	40.92	45.47	48.14	49.60
21	4D-TCM 192QAM	14/15	42.97	47.74	50.55	52.08	50.13	55.70	58.97	60.76	57.29	63.65	67.40	69.44

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Table 291—Data rate for 2 channels and 2 spatial streams

MODE	Modulation	Coding rate	Data rate (Mbits/s)											
			6 MHz BW				7 MHz BW				8 MHz BW			
			1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP
3	QPSK	1/2	12.28	13.64	14.44	14.88	14.32	15.91	16.85	17.36	16.37	18.19	19.26	19.84
4	QPSK	2/3	16.37	18.19	19.26	19.84	19.10	21.22	22.47	23.15	21.82	24.25	25.68	26.45
5	QPSK	3/4	18.41	20.46	21.66	22.32	21.48	23.87	25.27	26.04	24.55	27.28	28.88	29.76
6	QPSK	5/6	20.46	22.73	24.07	24.80	23.87	26.52	28.08	28.93	27.28	30.31	32.09	33.07
7	16-QAM	1/2	24.55	27.28	28.88	29.76	28.64	31.83	33.70	34.72	32.74	36.37	38.51	39.68
8	16-QAM	2/3	32.74	36.37	38.51	39.68	38.19	42.44	44.93	46.29	43.65	48.50	51.35	52.91
9	16-QAM	3/4	36.83	40.92	43.33	44.64	42.97	47.74	50.55	52.08	49.10	54.56	57.77	59.52
10	16-QAM	5/6	40.92	45.47	48.14	49.60	47.74	53.04	56.16	57.87	54.56	60.62	64.19	66.13
11	64-QAM	1/2	36.83	40.92	43.33	44.64	42.97	47.74	50.55	52.08	49.10	54.56	57.77	59.52
12	64-QAM	2/3	49.10	54.56	57.77	59.52	57.29	63.65	67.40	69.44	65.47	72.75	77.03	79.36
13	64-QAM	3/4	55.24	61.38	64.99	66.96	64.45	71.61	75.82	78.12	73.66	81.84	86.65	89.28
14	64-QAM	5/6	61.38	68.20	72.21	74.40	71.61	79.57	84.25	86.80	81.84	90.93	96.28	99.20
15	256-QAM	1/2	49.10	54.56	57.77	59.52	57.29	63.65	67.40	69.44	65.47	72.75	77.03	79.36
16	256-QAM	2/3	65.47	72.75	77.03	79.36	76.38	84.87	89.86	92.59	87.30	97.00	102.70	105.81
17	256-QAM	3/4	73.66	81.84	86.65	89.28	85.93	95.48	101.10	104.16	98.21	109.12	115.54	119.04
18	256-QAM	5/6	81.84	90.93	96.28	99.20	95.48	106.09	112.33	115.73	109.12	121.24	128.38	132.27
19	256-QAM	7/8	85.93	95.48	101.10	104.16	100.25	111.39	117.95	121.52	114.58	127.31	134.80	138.88
20	4D-TCM 48QAM	10/11	61.38	68.20	72.21	74.40	71.61	79.57	84.25	86.80	81.84	90.93	96.28	99.20
21	4D-TCM 192QAM	14/15	85.93	95.48	101.10	104.16	100.25	111.39	117.95	121.52	114.58	127.31	134.80	138.88

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Table 292—Data rate for 2 channels and 4 spatial streams

MODE	Modulation	Coding rate	Data rate (Mbits/s)											
			6 MHz BW				7 MHz BW				8 MHz BW			
			1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP
3	QPSK	1/2	24.55	27.28	28.88	29.76	28.64	31.83	33.70	34.72	32.74	36.37	38.51	39.68
4	QPSK	2/3	32.74	36.37	38.51	39.68	38.19	42.44	44.93	46.29	43.65	48.50	51.35	52.91
5	QPSK	3/4	36.83	40.92	43.33	44.64	42.97	47.74	50.55	52.08	49.10	54.56	57.77	59.52
6	QPSK	5/6	40.92	45.47	48.14	49.60	47.74	53.04	56.16	57.87	54.56	60.62	64.19	66.13
7	16-QAM	1/2	49.10	54.56	57.77	59.52	57.29	63.65	67.40	69.44	65.47	72.75	77.03	79.36
8	16-QAM	2/3	65.47	72.75	77.03	79.36	76.38	84.87	89.86	92.59	87.30	97.00	102.70	105.81
9	16-QAM	3/4	73.66	81.84	86.65	89.28	85.93	95.48	101.10	104.16	98.21	109.12	115.54	119.04
10	16-QAM	5/6	81.84	90.93	96.28	99.20	95.48	106.09	112.33	115.73	109.12	121.24	128.38	132.27
11	64-QAM	1/2	73.66	81.84	86.65	89.28	85.93	95.48	101.10	104.16	98.21	109.12	115.54	119.04
12	64-QAM	2/3	98.21	109.12	115.54	119.04	114.58	127.31	134.80	138.88	130.94	145.49	154.05	158.72
13	64-QAM	3/4	110.48	122.76	129.98	133.92	128.90	143.22	151.64	156.24	147.31	163.68	173.31	178.56
14	64-QAM	5/6	122.76	136.40	144.42	148.80	143.22	159.13	168.49	173.60	163.68	181.87	192.56	198.40
15	256-QAM	1/2	98.21	109.12	115.54	119.04	114.58	127.31	134.80	138.88	130.94	145.49	154.05	158.72
16	256-QAM	2/3	130.94	145.49	154.05	158.72	152.77	169.74	179.73	185.17	174.59	193.99	205.40	211.63
17	256-QAM	3/4	147.31	163.68	173.31	178.56	171.86	190.96	202.19	208.32	196.42	218.24	231.08	238.08
18	256-QAM	5/6	163.68	181.87	192.56	198.40	190.96	212.18	224.66	231.47	218.24	242.49	256.75	264.53
19	256-QAM	7/8	171.86	190.96	202.19	208.32	200.51	222.79	235.89	243.04	229.15	254.61	269.59	277.76
20	4D-TCM 48QAM	10/11	122.76	136.40	144.42	148.80	143.22	159.13	168.49	173.60	163.68	181.87	192.56	198.40
21	4D-TCM 192QAM	14/15	171.86	190.96	202.19	208.32	200.51	222.79	235.89	243.04	229.15	254.61	269.59	277.76

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Table 293—Data rate for 3 channels and 1 spatial stream

MODE	Modulation	Coding rate	Data rate (Mbits/s)											
			6 MHz BW				7 MHz BW				8 MHz BW			
			1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP
3	QPSK	1/2	9.21	10.23	10.83	11.16	10.74	11.93	12.64	13.02	12.28	13.64	14.44	14.88
4	QPSK	2/3	12.28	13.64	14.44	14.88	14.32	15.91	16.85	17.36	16.37	18.19	19.26	19.84
5	QPSK	3/4	13.81	15.34	16.25	16.74	16.11	17.90	18.96	19.53	18.41	20.46	21.66	22.32
6	QPSK	5/6	15.34	17.05	18.05	18.60	17.90	19.89	21.06	21.70	20.46	22.73	24.07	24.80
7	16-QAM	1/2	18.41	20.46	21.66	22.32	21.48	23.87	25.27	26.04	24.55	27.28	28.88	29.76
8	16-QAM	2/3	24.55	27.28	28.88	29.76	28.64	31.83	33.70	34.72	32.74	36.37	38.51	39.68
9	16-QAM	3/4	27.62	30.69	32.50	33.48	32.22	35.80	37.91	39.06	36.83	40.92	43.33	44.64
10	16-QAM	5/6	30.69	34.10	36.11	37.20	35.80	39.78	42.12	43.40	40.92	45.47	48.14	49.60
11	64-QAM	1/2	27.62	30.69	32.50	33.48	32.22	35.80	37.91	39.06	36.83	40.92	43.33	44.64
12	64-QAM	2/3	36.83	40.92	43.33	44.64	42.97	47.74	50.55	52.08	49.10	54.56	57.77	59.52
13	64-QAM	3/4	41.43	46.03	48.74	50.22	48.34	53.71	56.87	58.59	55.24	61.38	64.99	66.96
14	64-QAM	5/6	46.03	51.15	54.16	55.80	53.71	59.67	63.19	65.10	61.38	68.20	72.21	74.40
15	256-QAM	1/2	36.83	40.92	43.33	44.64	42.97	47.74	50.55	52.08	49.10	54.56	57.77	59.52
16	256-QAM	2/3	49.10	54.56	57.77	59.52	57.29	63.65	67.40	69.44	65.47	72.75	77.03	79.36
17	256-QAM	3/4	55.24	61.38	64.99	66.96	64.45	71.61	75.82	78.12	73.66	81.84	86.65	89.28
18	256-QAM	5/6	61.38	68.20	72.21	74.40	71.61	79.57	84.25	86.80	81.84	90.93	96.28	99.20
19	256-QAM	7/8	64.45	71.61	75.82	78.12	75.19	83.54	88.46	91.14	85.93	95.48	101.10	104.16
20	4D-TCM 48QAM	10/11	46.03	51.15	54.16	55.80	53.71	59.67	63.19	65.10	61.38	68.20	72.21	74.40
21	4D-TCM 192QAM	14/15	64.45	71.61	75.82	78.12	75.19	83.54	88.46	91.14	85.93	95.48	101.10	104.16

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Table 294—Data rate for 3 channels and 2 spatial streams

MODE	Modulation	Coding rate	Data rate (Mbits/s)											
			6 MHz BW				7 MHz BW				8 MHz BW			
			1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP
3	QPSK	1/2	18.41	20.46	21.66	22.32	21.48	23.87	25.27	26.04	24.55	27.28	28.88	29.76
4	QPSK	2/3	24.55	27.28	28.88	29.76	28.64	31.83	33.70	34.72	32.74	36.37	38.51	39.68
5	QPSK	3/4	27.62	30.69	32.50	33.48	32.22	35.80	37.91	39.06	36.83	40.92	43.33	44.64
6	QPSK	5/6	30.69	34.10	36.11	37.20	35.80	39.78	42.12	43.40	40.92	45.47	48.14	49.60
7	16-QAM	1/2	36.83	40.92	43.33	44.64	42.97	47.74	50.55	52.08	49.10	54.56	57.77	59.52
8	16-QAM	2/3	49.10	54.56	57.77	59.52	57.29	63.65	67.40	69.44	65.47	72.75	77.03	79.36
9	16-QAM	3/4	55.24	61.38	64.99	66.96	64.45	71.61	75.82	78.12	73.66	81.84	86.65	89.28
10	16-QAM	5/6	61.38	68.20	72.21	74.40	71.61	79.57	84.25	86.80	81.84	90.93	96.28	99.20
11	64-QAM	1/2	55.24	61.38	64.99	66.96	64.45	71.61	75.82	78.12	73.66	81.84	86.65	89.28
12	64-QAM	2/3	73.66	81.84	86.65	89.28	85.93	95.48	101.10	104.16	98.21	109.12	115.54	119.04
13	64-QAM	3/4	82.86	92.07	97.49	100.44	96.67	107.41	113.73	117.18	110.48	122.76	129.98	133.92
14	64-QAM	5/6	92.07	102.30	108.32	111.60	107.41	119.35	126.37	130.20	122.76	136.40	144.42	148.80
15	256-QAM	1/2	73.66	81.84	86.65	89.28	85.93	95.48	101.10	104.16	98.21	109.12	115.54	119.04
16	256-QAM	2/3	98.21	109.12	115.54	119.04	114.58	127.31	134.80	138.88	130.94	145.49	154.05	158.72
17	256-QAM	3/4	110.48	122.76	129.98	133.92	128.90	143.22	151.64	156.24	147.31	163.68	173.31	178.56
18	256-QAM	5/6	122.76	136.40	144.42	148.80	143.22	159.13	168.49	173.60	163.68	181.87	192.56	198.40
19	256-QAM	7/8	128.90	143.22	151.64	156.24	150.38	167.09	176.92	182.28	171.86	190.96	202.19	208.32
20	4D-TCM 48QAM	10/11	92.07	102.30	108.32	111.60	107.41	119.35	126.37	130.20	122.76	136.40	144.42	148.80
21	4D-TCM 192QAM	14/15	128.90	143.22	151.64	156.24	150.38	167.09	176.92	182.28	171.86	190.96	202.19	208.32

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Table 295—Data rate for 3 channels and 4 spatial streams

MODE	Modulation	Coding rate	Data rate (Mbits/s)											
			6 MHz BW				7 MHz BW				8 MHz BW			
			1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP
3	QPSK	1/2	36.83	40.92	43.33	44.64	42.97	47.74	50.55	52.08	49.10	54.56	57.77	59.52
4	QPSK	2/3	49.10	54.56	57.77	59.52	57.29	63.65	67.40	69.44	65.47	72.75	77.03	79.36
5	QPSK	3/4	55.24	61.38	64.99	66.96	64.45	71.61	75.82	78.12	73.66	81.84	86.65	89.28
6	QPSK	5/6	61.38	68.20	72.21	74.40	71.61	79.57	84.25	86.80	81.84	90.93	96.28	99.20
7	16-QAM	1/2	73.66	81.84	86.65	89.28	85.93	95.48	101.10	104.16	98.21	109.12	115.54	119.04
8	16-QAM	2/3	98.21	109.12	115.54	119.04	114.58	127.31	134.80	138.88	130.94	145.49	154.05	158.72
9	16-QAM	3/4	110.48	122.76	129.98	133.92	128.90	143.22	151.64	156.24	147.31	163.68	173.31	178.56
10	16-QAM	5/6	122.76	136.40	144.42	148.80	143.22	159.13	168.49	173.60	163.68	181.87	192.56	198.40
11	64-QAM	1/2	110.48	122.76	129.98	133.92	128.90	143.22	151.64	156.24	147.31	163.68	173.31	178.56
12	64-QAM	2/3	147.31	163.68	173.31	178.56	171.86	190.96	202.19	208.32	196.42	218.24	231.08	238.08
13	64-QAM	3/4	165.73	184.14	194.97	200.88	193.35	214.83	227.47	234.36	220.97	245.52	259.96	267.84
14	64-QAM	5/6	184.14	204.60	216.63	223.20	214.83	238.70	252.74	260.40	245.52	272.80	288.85	297.60
15	256-QAM	1/2	147.31	163.68	173.31	178.56	171.86	190.96	202.19	208.32	196.42	218.24	231.08	238.08
16	256-QAM	2/3	196.42	218.24	231.08	238.08	229.15	254.61	269.59	277.76	261.89	290.99	308.10	317.44
17	256-QAM	3/4	220.97	245.52	259.96	267.84	257.80	286.44	303.29	312.48	294.62	327.36	346.62	357.12
18	256-QAM	5/6	245.52	272.80	288.85	297.60	286.44	318.27	336.99	347.20	327.36	363.73	385.13	396.80
19	256-QAM	7/8	257.80	286.44	303.29	312.48	300.76	334.18	353.84	364.56	343.73	381.92	404.39	416.64
20	4D-TCM 48QAM	10/11	184.14	204.60	216.63	223.20	214.83	238.70	252.74	260.40	245.52	272.80	288.85	297.60
21	4D-TCM 192QAM	14/15	257.80	286.44	303.29	312.48	300.76	334.18	353.84	364.56	343.73	381.92	404.39	416.64

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Table 296—Data rate for 4 channels and 1 spatial stream

MODE	Modulation	Coding Rate	Data rate (Mbits/s)											
			6 MHz BW				7 MHz BW				8 MHz BW			
			1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP
3	QPSK	1/2	12.28	13.64	14.44	14.88	14.32	15.91	16.85	17.36	16.37	18.19	19.26	19.84
4	QPSK	2/3	16.37	18.19	19.26	19.84	19.10	21.22	22.47	23.15	21.82	24.25	25.68	26.45
5	QPSK	3/4	18.41	20.46	21.66	22.32	21.48	23.87	25.27	26.04	24.55	27.28	28.88	29.76
6	QPSK	5/6	20.46	22.73	24.07	24.80	23.87	26.52	28.08	28.93	27.28	30.31	32.09	33.07
7	16-QAM	1/2	24.55	27.28	28.88	29.76	28.64	31.83	33.70	34.72	32.74	36.37	38.51	39.68
8	16-QAM	2/3	32.74	36.37	38.51	39.68	38.19	42.44	44.93	46.29	43.65	48.50	51.35	52.91
9	16-QAM	3/4	36.83	40.92	43.33	44.64	42.97	47.74	50.55	52.08	49.10	54.56	57.77	59.52
10	16-QAM	5/6	40.92	45.47	48.14	49.60	47.74	53.04	56.16	57.87	54.56	60.62	64.19	66.13
11	64-QAM	1/2	36.83	40.92	43.33	44.64	42.97	47.74	50.55	52.08	49.10	54.56	57.77	59.52
12	64-QAM	2/3	49.10	54.56	57.77	59.52	57.29	63.65	67.40	69.44	65.47	72.75	77.03	79.36
13	64-QAM	3/4	55.24	61.38	64.99	66.96	64.45	71.61	75.82	78.12	73.66	81.84	86.65	89.28
14	64-QAM	5/6	61.38	68.20	72.21	74.40	71.61	79.57	84.25	86.80	81.84	90.93	96.28	99.20
15	256-QAM	1/2	49.10	54.56	57.77	59.52	57.29	63.65	67.40	69.44	65.47	72.75	77.03	79.36
16	256-QAM	2/3	65.47	72.75	77.03	79.36	76.38	84.87	89.86	92.59	87.30	97.00	102.70	105.81
17	256-QAM	3/4	73.66	81.84	86.65	89.28	85.93	95.48	101.10	104.16	98.21	109.12	115.54	119.04
18	256-QAM	5/6	81.84	90.93	96.28	99.20	95.48	106.09	112.33	115.73	109.12	121.24	128.38	132.27
19	256-QAM	7/8	85.93	95.48	101.10	104.16	100.25	111.39	117.95	121.52	114.58	127.31	134.80	138.88
20	4D-TCM 48QAM	10/11	61.38	68.20	72.21	74.40	71.61	79.57	84.25	86.80	81.84	90.93	96.28	99.20
21	4D-TCM 192QAM	14/15	85.93	95.48	101.10	104.16	100.25	111.39	117.95	121.52	114.58	127.31	134.80	138.88

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Table 297—Data rate for 4 channels and 2 spatial streams

MODE	Modulation	Coding rate	Data rate (Mbits/s)											
			6 MHz BW				7 MHz BW				8 MHz BW			
			1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP
3	QPSK	1/2	24.55	27.28	28.88	29.76	28.64	31.83	33.70	34.72	32.74	36.37	38.51	39.68
4	QPSK	2/3	32.74	36.37	38.51	39.68	38.19	42.44	44.93	46.29	43.65	48.50	51.35	52.91
5	QPSK	3/4	36.83	40.92	43.33	44.64	42.97	47.74	50.55	52.08	49.10	54.56	57.77	59.52
6	QPSK	5/6	40.92	45.47	48.14	49.60	47.74	53.04	56.16	57.87	54.56	60.62	64.19	66.13
7	16-QAM	1/2	49.10	54.56	57.77	59.52	57.29	63.65	67.40	69.44	65.47	72.75	77.03	79.36
8	16-QAM	2/3	65.47	72.75	77.03	79.36	76.38	84.87	89.86	92.59	87.30	97.00	102.70	105.81
9	16-QAM	3/4	73.66	81.84	86.65	89.28	85.93	95.48	101.10	104.16	98.21	109.12	115.54	119.04
10	16-QAM	5/6	81.84	90.93	96.28	99.20	95.48	106.09	112.33	115.73	109.12	121.24	128.38	132.27
11	64-QAM	1/2	73.66	81.84	86.65	89.28	85.93	95.48	101.10	104.16	98.21	109.12	115.54	119.04
12	64-QAM	2/3	98.21	109.12	115.54	119.04	114.58	127.31	134.80	138.88	130.94	145.49	154.05	158.72
13	64-QAM	3/4	110.48	122.76	129.98	133.92	128.90	143.22	151.64	156.24	147.31	163.68	173.31	178.56
14	64-QAM	5/6	122.76	136.40	144.42	148.80	143.22	159.13	168.49	173.60	163.68	181.87	192.56	198.40
15	256-QAM	1/2	98.21	109.12	115.54	119.04	114.58	127.31	134.80	138.88	130.94	145.49	154.05	158.72
16	256-QAM	2/3	130.94	145.49	154.05	158.72	152.77	169.74	179.73	185.17	174.59	193.99	205.40	211.63
17	256-QAM	3/4	147.31	163.68	173.31	178.56	171.86	190.96	202.19	208.32	196.42	218.24	231.08	238.08
18	256-QAM	5/6	163.68	181.87	192.56	198.40	190.96	212.18	224.66	231.47	218.24	242.49	256.75	264.53
19	256-QAM	7/8	171.86	190.96	202.19	208.32	200.51	222.79	235.89	243.04	229.15	254.61	269.59	277.76
20	4D-TCM 48QAM	10/11	122.76	136.40	144.42	148.80	143.22	159.13	168.49	173.60	163.68	181.87	192.56	198.40
21	4D-TCM 192QAM	14/15	171.86	190.96	202.19	208.32	200.51	222.79	235.89	243.04	229.15	254.61	269.59	277.76

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Table 298—Data rate for 4 channels and 4 spatial streams

MODE	Modulation	Coding rate	Data rate (Mbits/s)											
			6 MHz BW				7 MHz BW				8 MHz BW			
			1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP	1/4 CP	1/8 CP	1/16 CP	1/32 CP
3	QPSK	1/2	49.10	54.56	57.77	59.52	57.29	63.65	67.40	69.44	65.47	72.75	77.03	79.36
4	QPSK	2/3	65.47	72.75	77.03	79.36	76.38	84.87	89.86	92.59	87.30	97.00	102.70	105.81
5	QPSK	3/4	73.66	81.84	86.65	89.28	85.93	95.48	101.10	104.16	98.21	109.12	115.54	119.04
6	QPSK	5/6	81.84	90.93	96.28	99.20	95.48	106.09	112.33	115.73	109.12	121.24	128.38	132.27
7	16-QAM	1/2	98.21	109.12	115.54	119.04	114.58	127.31	134.80	138.88	130.94	145.49	154.05	158.72
8	16-QAM	2/3	130.94	145.49	154.05	158.72	152.77	169.74	179.73	185.17	174.59	193.99	205.40	211.63
9	16-QAM	3/4	147.31	163.68	173.31	178.56	171.86	190.96	202.19	208.32	196.42	218.24	231.08	238.08
10	16-QAM	5/6	163.68	181.87	192.56	198.40	190.96	212.18	224.66	231.47	218.24	242.49	256.75	264.53
11	64-QAM	1/2	147.31	163.68	173.31	178.56	171.86	190.96	202.19	208.32	196.42	218.24	231.08	238.08
12	64-QAM	2/3	196.42	218.24	231.08	238.08	229.15	254.61	269.59	277.76	261.89	290.99	308.10	317.44
13	64-QAM	3/4	220.97	245.52	259.96	267.84	257.80	286.44	303.29	312.48	294.62	327.36	346.62	357.12
14	64-QAM	5/6	245.52	272.80	288.85	297.60	286.44	318.27	336.99	347.20	327.36	363.73	385.13	396.80
15	256-QAM	1/2	196.42	218.24	231.08	238.08	229.15	254.61	269.59	277.76	261.89	290.99	308.10	317.44
16	256-QAM	2/3	261.89	290.99	308.10	317.44	305.54	339.48	359.45	370.35	349.18	387.98	410.80	423.25
17	256-QAM	3/4	294.62	327.36	346.62	357.12	343.73	381.92	404.39	416.64	392.83	436.48	462.15	476.16
18	256-QAM	5/6	327.36	363.73	385.13	396.80	381.92	424.35	449.32	462.93	436.48	484.98	513.50	529.07
19	256-QAM	7/8	343.73	381.92	404.39	416.64	401.02	445.57	471.78	486.08	458.30	509.23	539.18	555.52
20	4D-TCM 48QAM	10/11	245.52	272.80	288.85	297.60	286.44	318.27	336.99	347.20	327.36	363.73	385.13	396.80
21	4D-TCM 192QAM	14/15	343.73	381.92	404.39	416.64	401.02	445.57	471.78	486.08	458.30	509.23	539.18	555.52

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10.3 Functional block diagram applicable to the PHY

The functional block diagram of the transmitter and receiver for the PHY is shown in Figure 219. This subclause describes the general processing of the A-WRAN baseband signal. The binary data intended for transmission is supplied to the PHY from the MAC layer. This input is sent to a channel coding processor, which includes a data scrambler, encoder, puncturer, and a bit interleaver specified in 10.6.4. The interleaved data is mapped to data constellations as described in according to the modulation schemes specified as shown in Table 286. The subcarrier allocator assigns the data constellations to the corresponding subchannels according to the subcarrier allocation methods described in 10.6.2 and 10.6.3.

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A frame has its first OFDM symbol occupied by the frame preamble in 10.4.1.1. The pilot subcarriers are transmitted at fixed positions in the frequency domain within each OFDM data symbol as specified in 10.6.1. Preambles and pilots can support the synchronization, channel estimation, and tracking process. In the frequency domain, an OFDM symbol contains the data, pilot, and null subcarriers, as defined in Table 285. The resultant stream of constellations is subsequently input to an inverse Discrete Fourier Transform after a serial-to-parallel conversion. The inverse Fast Fourier Transform (IFFT) is the expected means of performing the inverse Discrete Fourier Transform. In order to prevent inter-symbol interference eventually caused by the channel delay spread, the OFDM symbol is extended by a cyclic prefix that contains the same waveform as the corresponding ending part of the symbol. Finally, the OFDM signal is transferred to the RF transmission modules via a digital-to-analog converter.

The OFDM receiver roughly implements the same operations as performed by the transmitter but in reverse order. In addition to the data processing, synchronization and channel estimation shall be performed at the receiver.

The CBP packet can also be generated through the same process as that used for the data transmission. The CBP packet subcarrier allocation, preamble, and pilot patterns are described in 10.5.

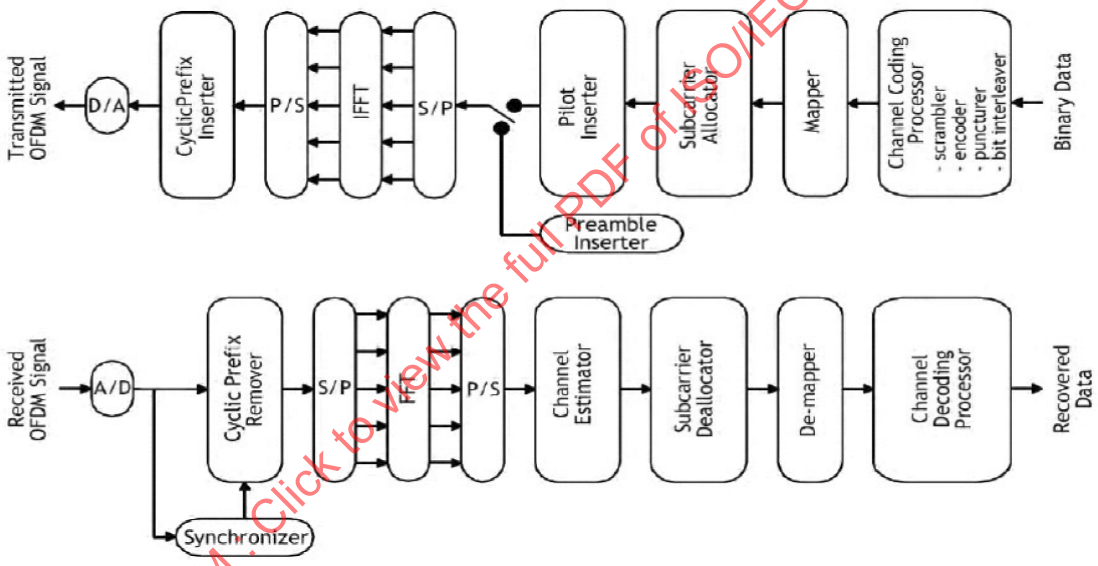

Figure 219—Transmitter and receiver block diagram for the OFDMA PHY

10.4 Frame structure

The basic frame structure is shown in Figure 12. See 7.5 for a full description of the frame structure.

Each frame contains a preamble, header, and data bursts.

For both normal and self-coexistence operational modes, the first symbol shall be the frame preamble. The second to fifth symbols shall contain the A-FCH, and DS-MAP, US-MAP, when needed, DCD and UCD, and data bursts if there is some room left. The A-FCH specifies the length of the first MAP that will immediately follow the A-FCH.

In each frame, a TTG shall be inserted between the DS and US bursts to allow the CPE to switch between the receive mode and transmit mode and to absorb the signal propagation time. An RTG shall be inserted at

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the end of each frame to allow the BS to switch between its receiving mode and transmit mode (see Figure 15).

The values indicated in Table 299 for the TTG and RTG shall be used for the specified cyclic prefixes and channel bandwidth options.

Table 299—A-WRAN frame parameters

Cyclic prefix	Number of symbols per frame[a]			Transmit-receive turnaround gap[b] (TTG)			Receive-transmit turnaround gap[c] (RTG)		
BW	**6 MHz**	**7MH**	**8MHz**	**6 MHz**	**7MH**	**8MHz**	**6 MHz**	**7MH**	**8MHz**
1/4	41	48	55	1185 TU	1382 TU	1579 TU	1056 TU	1232 TU	1408 TU
1/8	46	54	61	1185 TU	1382 TU	1579 TU	672 TU	592 TU	1665 TU
1/16	48	57	65	1185 TU	1382 TU	1579 TU	1504 TU	848 TU	1280 TU
1/32	50	59	67	1185 TU	1382 TU	1579 TU	960 TU	592 TU	1280 TU

[a]Indicates the DS/US payload symbols and symbols for A-FCH, DS/US MAP, and DCD/UCD. Here, one frame preamble symbol is assumed. Different values may apply when the frame carries more header symbols.
[b]Example of TTG set to absorb the propagation delay.
[c]Portion of symbol left over to arrive at the 10 ms frame period.

10.4.1 Preamble

10.4.1.1 Frame preamble and local frame preamble

The first symbol of the DS transmission is the preamble. Three different preamble carrier sets are defined, differing in the allocation of subcarriers. Those subcarriers are modulated using a boosted BPSK modulation with a specific pseudo-noise (PN) code.

The preamble carrier sets are defined using Equation (28):

$$PreambleCarrierSet_n = n + 3k \tag{28}$$

where

$PreambleCarrierSet_n$	specifies all subcarriers allocated to the specific preamble
n	is the designating number of the preamble carrier set indexed 0, 1, and 2
k	is a running index. 0...283

Each segment uses a preamble composed of a single carrier set in the following manner:

— Start position of segment 0 uses preamble carrier set 0 (n =0).

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— Start position of segment 1 uses preamble carrier set 1 (n =1).

— Start position of segment 2 uses preamble carrier set 2 (n =2).

For the start position of segment 0, the dc carrier will not be modulated at all, and the appropriate PN will be discarded. Therefore, the dc carrier shall always be zeroed.

Each start position of segment eventually modulates each third subcarrier. As an example, Figure 220 depicts the preamble of start position of segment 0. In this figure, subcarrier 0 corresponds to the first subcarrier used in the preamble symbol.

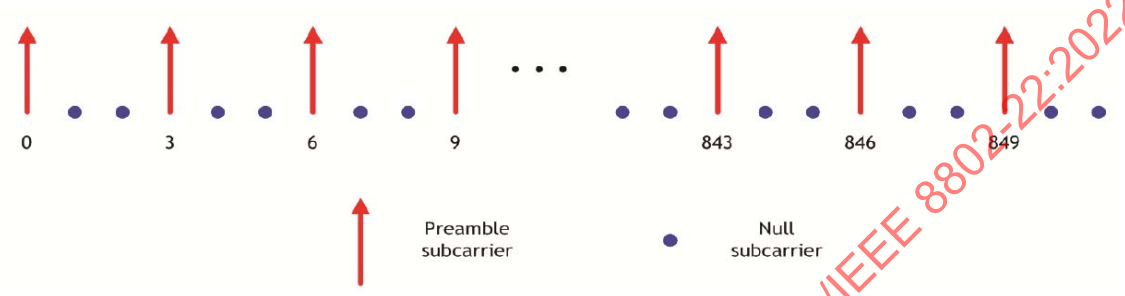

Figure 220—Example of basic structure of preamble (for the case of *n*=0)

The PN series modulating the preamble carrier set is defined in Table 300. The series modulated depends on the start position of segment and segment bandwidth used. The defined series shall be mapped onto the preamble subcarriers in ascending order. Table 300 includes the PN sequence in an hexadecimal format. The value of the PN is obtained by converting the series to a binary series (W_k) and mapping the PN starting from the MSB of each symbol to the LSB (0 mapped to +1 and 1 mapped to –1). For example, for Frame Preamble (the first row of Table 300), W_k = 101001101111..., and the mapping shall follow: +1 –1 +1 –1 –1 +1 +1 –1 +1 +1 +1 +1....

Table 300—Frame preamble and local frame preamble modulation series

Preamble type	Start position of segment	Segment bandwidth	Series to modulate (W_k)
Frame Preamble	—	—	0xA6F294537B285E1844677D133E4D53CCB1F182DE0 0489E53E6B6E77065C7EE7D0ADBEAF
Local Frame Preamble 0	0	1 segment	0x668321CBBE7F462E6C2A07E8BBDA2C7F7946D5F6 9E35AC8ACF7D64AB4A33C467001F3B2
Local Frame Preamble 1	0	2 segments	0x1C75D30B2DF72CEC9117A0BD8EAF8E0502461FC 07456AC906ADE03E9B5AB5E1D3F98C6E
Local Frame Preamble 2	0	3 segments	0x5F9A2E5CA7CC69A5227104FB1CC2262809F3B10D 0542B9BDFDA4A73A7046096DF0E8D3D
Local Frame Preamble 3	1	1 segment	0x82F8A0AB918138D84BB86224F6C342D81BC8BFE7 91CA9EB54096159D672E91C6E13032F
Local Frame Preamble 4	1	2 segments	0xEE27E59B84CCF15BB1565EF90D478CD2C49EE8A 70DE368EED7C9420B0C6FFAF9AF035FC
Local Frame Preamble 5	2	1 segment	0xC1DF5AE28D1CA6A8917BCDAF4E73BD93F931C4 4F93C3F12F0132FB643EFD5885C8B2BC

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For the preamble symbol, there will be 86 guard band subcarriers on each side of the spectrum.

The symbols in the DS preamble shall be modulated according to Equation (29):

$$Re(PreambleModulated) - 2 \cdot \sqrt{3} - \left(\langle \frac{1}{2} - W_k \rangle\right)(ImPreambleModulated) - 0 \quad (29)$$

10.4.1.2 CBP preamble

The CBP preamble shall have a duration of 1 OFDM symbol. The PN series modulating the CBP preamble carrier set is defined in Table 301. The series modulated depends on the start of segment and segment bandwidth used. The defined series shall be mapped onto the CBP preamble subcarriers in ascending order. Table 301 includes the PN sequence in a hexadecimal format. The value of the PN is obtained as described in 10.4.1.1.

Table 301—CBP preamble and local CBP preamble modulation series

Preamble type	Start position of segment	Segment bandwidth	Series to modulate (W_k)
CBP Preamble	—	—	0x61AF26BD39A9FFF52826625E04ADA299385A373F A946D837D754E6CFEBB26F5C03B87CF
Local CBP Preamble 0	0	1 segment	0xD77D97CDB93DBEAA65CAFA146F40D72B5E8094 4F750E07325DC164ED60F32434BC7187D
Local CBP Preamble 1	0	2 segments	0x4529D9CA65AF49C1C39BDC18CFAB87E03FE4DA FC0A48FF1457D46B0DF66B414A23ACDDB
Local CBP Preamble 2	0	3 segments	0x33AC0261DAA57C1D611EBA1C730D50AFEE5BE3 E849030A4E891BC8C5F4C78DCDDFEA263
Local CBP Preamble 3	1	1 segment	0xBED48C704F02A84F03BCD299D919DA56F7B71ED F8A0F8A25E8F8496F95A44CE2B9F74C9
Local CBP Preamble 4	1	2 segments	0x0ECCBE0902EBF4B4C29506014A3706622784B7B2 D5153E10AD3112DC5E45277A32E79DE
Local CBP Preamble 5	2	1 segment	0x7CB4937889C7DFD9AA2D37235E06F993D3D4F5D5 15B39CA652F62397C08457D66BC5A36

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10.4.2 Control header and MAP definitions

10.4.2.1 Advanced Frame control header (A-FCH)

The frame control header is transmitted as part of the DS PDU in the DS subframe. The length of the A-A-FCH shall be 3 bytes and contain information as specified in Table 3. The A-FCH shall be sent in the first subchannel of the symbol immediately following the frame preamble symbol. The A-FCH shall be encoded using QPSK rate 1/2 with four repetitions using the binary convolutional channel coding (i.e., the A-FCH information shall be sent on four subchannels with successive logical subchannel numbers). The A-FCH contains the DS frame prefix as described in 7.5.3 and specifies the length of the DS-MAP message that immediately follows the DS frame prefix and the repetition coding used for the DS-MAP message.

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10.4.2.2 DS-MAP, US-MAP, DCD, and UCD

The length of the DS-MAP PDU is variable and is defined in the A-FCH (10.4.2.1). This PDU shall be encoded using the binary convolutional channel coding specified in 10.7.2.1 and transmitted using the PHY MCS mode 3 listed in Table 286 in the logical subchannel immediately following the A-FCH. The length of the US-MAP, DCD, and UCD, when present, shall be specified at the beginning of the DS-MAP in that order. The number of subchannels required to transmit these fields shall be determined by their respective lengths in number of OFDM slots. These fields shall be transmitted using PHY MCS mode 4. If this number exceeds the number of subchannels, the transmission of these PDUs will continue in the next slot starting with the first logical subchannel. The unused subchannels in the last slot of the frame header shall be used for DS transmissions.

10.5 CBP packet format

The format of the CBP packet is shown in Figure 221. The CBP packet consists of a preamble portion and a data portion. The CBP preamble is one OFDM symbol in duration and is generated as described in 9a.4.1.2. The format of the CBP data portion is the same as the data portion of the normal zone.

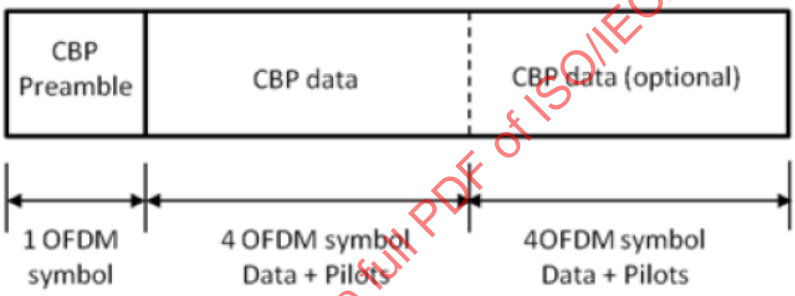

Figure 221—CBP packet format

10.6 OFDM subcarrier allocation

Sampling frequencies are F_s =5.6 MHz, 6.53 MHz, and 7.47 MHz for the channel bandwidth of 6 MHz, 7 MHz, and 8 MHz, respectively. Subtracting the guard subcarriers from N_{FFT} (=1024), one obtains the set of used subcarriers which consists of both pilot subcarriers and data subcarriers. In the DS, the pilot subcarriers are allocated first; then data subcarriers are divided into subchannels. In the US, the set of used subcarriers is first partitioned into subchannels, and then the pilot subcarriers are allocated from within each subchannel.

10.6.1 Pilot pattern

10.6.1.1 Downstream (DS)

A slot (or a subchannel) in the DS is composed of 4 OFDMA symbols and 16 subcarriers as shown in Figure 213. Within each slot, there are 48 data subcarriers and 16 fixed-position pilots. The subchannel is constructed from four DS tiles. Each tile has four successive active subcarriers, and its configuration is illustrated in Figure 222.

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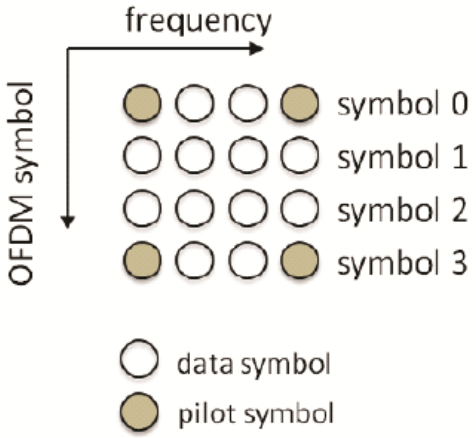

Figure 222—Pilot pattern for DS

10.6.1.2 Upstream (US)

A slot (or a subchannel) in the US is composed of 7 OFDMA symbols and 8 subcarriers as shown in Figure 214. Within each slot, there are 48 data subcarriers and 8 fixed-position pilots. The subchannel is constructed from two US tiles. Each tile has four successive active subcarriers, and its configuration is illustrated in Figure 223.

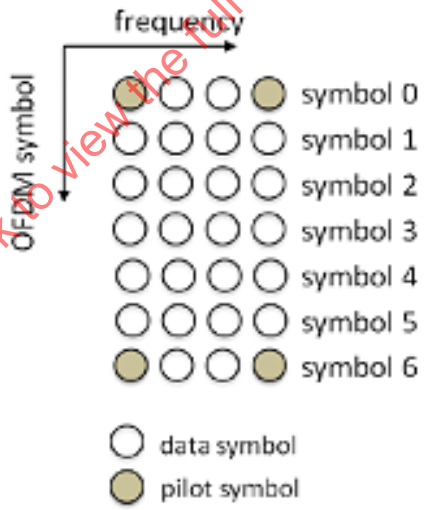

Figure 223—Pilot pattern for US

10.6.2 DS subcarrier allocation

10.6.2.1 Symbol structure for subchannel in the DS

The symbol structure is constructed using pilot, data, and null subcarriers. The symbol is first divided into basic tiles and null carriers are allocated. Pilot and data subcarriers are allocated within each tile. Table 302 summarizes the parameters of the symbol structure in the DS.

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Table 302—Symbol structure parameters in the downstream

Parameters	Value	Comments
FFT size	1024	
Number of DC subcarriers	1	Index 512 (counting from 0)
Number of Guard subcarriers, left	96	—
Number of Guard subcarriers, right	95	—
Number of used subcarriers (N_{used})	833	Number of total subcarriers including dc, data, and pilot
Number of subchannels ($N_{subchannels}$)	52	—
Number of tiles (N_{tiles})	208	—
Number of tiles per subchannel (or slot)	4	—
Number of pilot subcarriers per slot	16	—
Number of data subcarriers per slot	48	—
Number of OFDM symbols per slot	4	—
Number of subcarriers per tile	4	—
Sequence for DS tile permutation (P_t)	6, 48, 37, 21, 31, 40, 42, 32, 47, 30, 33, 18, 10, 15, 50, 51, 46, 23, 45, 16, 39, 35, 7, 25, 11, 22, 38, 28, 19, 17, 3, 27, 12, 29, 26, 5, 41, 49, 44, 9, 8, 1, 13, 36, 14, 43, 2, 20, 24, 4,34, 0	Used to allocate tiles to subchannel

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10.6.2.2 Subcarrier allocation and data mapping onto subcarriers

The carrier allocation to subchannels is performed using the following procedure:

a) Subcarriers shall be divided into the number of tiles (N_{tiles}) containing 4 adjacent subcarriers each (starting from carrier 0). The number of tiles (N_{tiles}) in the DS is 208.

b) Logical tiles are mapped to physical tiles in the FFT using Equation (30).

$$Tiles(s, n) = N_{subchannels} \bullet n + (P_t[(s+n) \bmod N_{subchannels}] + \text{DS_PermBase}) \bmod N_{subchannels} \quad (30)$$

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where

$Tiles(s, n)$ is the physical tile index in the FFT with tiles being ordered consecutively from the most negative to the most positive used subcarrier (0 is the starting tile index)

n is the tile index 0,1,2,3 in a subchannel

$N_{subchannels}$ is the number of subchannels: 52

s is the index number of a subchannel:0…$N_{subchannels}$–1

P_t is the sequence for the DS tile permutation shown below DS_PermBase is an integer ranging from 0 to 31, which is set to preamble-Cell ID in the first zone

P_t= {6, 48, 37, 21, 31, 40, 42, 32, 47, 30, 33, 18, 10, 15, 50, 51, 46, 23, 45, 16, 39, 35, 7, 25, 11, 22, 38, 28, 19, 17, 3, 27, 12, 29, 26, 5, 41, 49, 44, 9, 8, 1, 13, 36, 14, 43, 2, 20, 24, 4,34, 0}

DS_PermBase is an integer ranging from 0 to 31, which is set to preamble Cell ID in the first zone.

Example of the logical tile mapping to the physical tile is provided below to clarify the operation of Equation (30). In this example, tiles used for subchannel s = 2 in DS_PermBase = 1 are computed.

— Apply the permutation due to the selection of the subchannel (s = 2), rotate times: {37, 21, 31, 40, 42, 32, 47, 30, 33, 18, 10, 15, 50, 51, 46, 23, 45, 16, 39, 35, 7, 25, 11, 22, 38, 28, 19, 17, 3, 27, 12, 29, 26, 5, 41, 49, 44, 9, 8, 1, 13, 36, 14, 43, 2, 20, 24, 4,34, 0, 6, 48}.

— Take the first 4 numbers, and add the DS_PermBase (perform modulo operation if needed): {38, 22, 32, 41}.

— Finally, add the appropriate shift: {38, 74, 136, 197}.

c) After allocating the pilot subcarriers within each tile, indexing of the data subcarriers within each slot is performed starting from the first symbol at the lowest indexed subcarrier of the lowest indexed tile, continuing in an ascending manner through the subcarriers in the same symbol, then going to the next symbol at the lowest indexed data subcarrier, and so on. Data subcarriers shall be indexed from 0 to 47. The indexing of the data subcarriers (48 data subcarriers) in one subchannel in DS is shown in Figure 224.

Figure 224—DS data subcarrier index in one subchannel

d) The mapping of data onto the subcarriers shall follow Equation (31). This equation calculates the subcarrier index to which the data constellation point is to be mapped.

$$Subcarrier(n, s) = (n + 13 \cdot s) \bmod N_{subcarriers} \quad (31)$$

where

$Subcarrier(n, s)$ is the permutated subcarrier index corresponding to data subcarrier.

n is a running index 0…47, indicating the data constellation point

s is the subchannel number 0…51

$N_{subcarriers}$ is the number of data subcarriers per slot: 48

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10.6.3 Upstream subcarrier allocation

10.6.3.1 Symbol structure for subchannel in the upstream

The symbol structure is constructed using pilot, data, and null subcarriers. The symbol is first divided into basic tiles and null carriers are allocated. Pilot and data subcarriers are allocated within each tile. Table 303 summarizes the parameters of the symbol structure in the US.

Table 303—Symbol structure parameters in the upstream

Parameters	Value	Comments
Number of DC subcarriers	1	Index 512 (counting from 0)
Number of Guard subcarriers, left	92	—
Number of Guard subcarriers, right	91	—
Number of used subcarriers (N_{used})	841	Number of all subcarriers including DC, data and pilots used within a symbol
Number of subchannels ($N_{subchannels}$)	105	—
Number of tiles (N_{tiles})	210	—
Number of tiles per subchannel	2	—
Number of pilot subcarriers per slot	8	—
Number of data subcarriers per slot	48	—
Number of OFDM symbols per slot	7	—
Number of subcarriers per tile	4	—
Sequence for US tile permutation (P_t)	33, 52, 35, 67, 94, 13, 80, 6, 34, 45, 43, 68, 84, 66, 7, 37, 71, 89, 55, 101, 27, 60, 51, 14, 21, 17, 93, 72, 95, 73, 81, 24, 103, 86, 39, 29, 56, 62, 70, 64, 23, 22, 54, 15, 90, 76, 100, 33, 36, 18, 9, 91, 19, 26, 12, 92, 48, 25, 87, 74, 5, 31, 85, 40, 104, 2, 102, 69, 57, 50, 1, 44, 0, 20, 88, 79, 16, 28, 46, 42, 41, 59, 96, 97, 99, 82, 30, 49, 65, 77, 63, 11, 8, 75, 98, 38, 32, 83, 4, 47, 58, 61, 78, 10, 53	Used to allocate tiles to subchannel

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10.6.3.2 Subcarrier allocation and data mapping onto subcarriers

The carrier allocation to subchannels is performed using the following procedure:

a) The usable subcarriers in the allocated frequency band shall be divided into N_{tiles} physical tiles with parameters specified by Table 303. The number of tiles (N_{tiles}) in the US is 210.

b) Logical tiles are mapped to physical tiles in the FFT using Equation (32).

$$Tiles(s, n) = N_{subchannels} \bullet n + (P_t[(s+n) \bmod N_{subchannels}] + \text{US_PermBase}) \bmod N_{subchannels} \quad (32)$$

where

$Tiles(s, n)$ is the physical tile index in the FFT with tiles being ordered consecutively from the most negative to the most positive used subcarrier (0 is the starting tile index)

n is the tile index 0,1 in a subchannel

$N_{subchannels}$ is the number of subchannels: 105

s is the index number of a subchannel: $0 \ldots N_{subchannels}-1$

P_t is the sequence for the US tile permutation shown below

P_t= {33, 52, 35, 67, 94, 13, 80, 6, 34, 45, 43, 68, 84, 66, 7, 37, 71, 89, 55, 101, 27, 60, 51, 14, 21, 17, 93, 72, 95, 73, 81, 24, 103, 86, 39, 29, 56, 62, 70, 64, 23, 22, 54, 15, 90, 76, 100, 33, 36, 18, 9, 91, 19, 26, 12, 92, 48, 25, 87, 74, 5, 31, 85, 40, 104, 2, 102, 69, 57, 50, 1, 44, 0, 20, 88, 79, 16, 28, 46, 42, 41, 59, 96, 97, 99, 82, 30, 49, 65, 77, 63, 11, 8, 75, 98, 38, 32, 83, 4, 47, 58, 61, 78, 10, 53}

US_PermBase is an integer value which is assigned by a management entity

Example of the logical tile mapping to the physical tile is provided below to clarify the operation of Equation (32). In this example, tiles used for subchannel s = 3 in US_PermBase = 2 are computed.

— Apply the permutation due to the selection of the subchannel (s = 3), rotate three times: {67, 94, 13, 80, 6, 34, 45, 43, 68, 84, 66, 7, 37, 71, 89, 55, 101, 27, 60, 51, 14, 21, 17, 93, 72, 95, 73, 81, 24, 103, 86, 39, 29, 56, 62, 70, 64, 23, 22, 54, 15, 90, 76, 100, 33, 36, 18, 9, 91, 19, 26, 12, 92, 48, 25, 87, 74, 5, 31, 85, 40, 104, 2, 102, 69, 57, 50, 1, 44, 0, 20, 88, 79, 16, 28, 46, 42, 41, 59, 96, 97, 99, 82, 30, 49, 65, 77, 63, 11, 8, 75, 98, 38, 32, 83, 4, 47, 58, 61, 78,10, 53, 33, 52, 35}.

— Take the first 2 numbers, and add the US_PermBase (perform modulo operation if needed): {69, 96}.

— Finally, add the appropriate shift: {69, 201}.

c) After allocating the pilot subcarriers within each tile, indexing of the data subcarriers within each slot is performed starting from the first symbol at the lowest indexed subcarrier of the lowest indexed tile, continuing in an ascending manner through the subcarriers in the same symbol, then going to the next symbol at the lowest indexed data subcarrier, and so on. Data subcarriers shall be indexed from 0 to 47. The indexing of the data subcarrier (48 data subcarriers) in one subchannel in US is shown in Figure 225.

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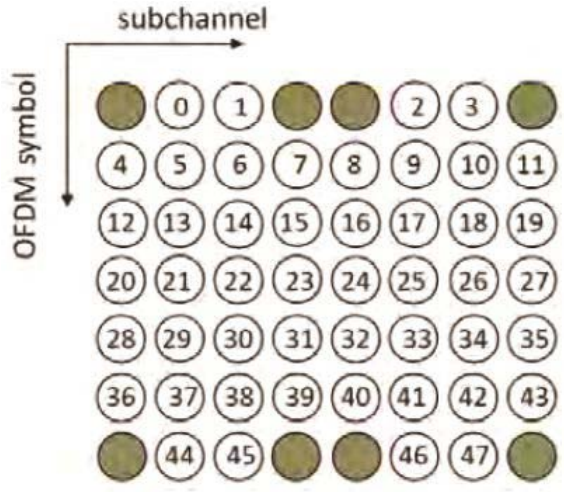

Figure 225—US data subcarrier index in one subchannel

d) The mapping of data onto the subcarriers shall follow Equation (33). This equation calculates the subcarrier index to which the data constellation point is to be mapped.

$$Subcarrier(n, s) = (n + 13 \cdot s) \bmod N_{subcarriers} \quad (33)$$

where

$Subcarrier(n, s)$	is the permutated subcarrier index corresponding to data subcarrier
n	is a running index 0…47, indicating the data constellation point
s	is the subchannel number 0…104
$N_{subcarriers}$	is the number of data subcarriers per slot: 48

For example, for subchannel 1 (s = 1), the first data constellation point (n = 0) is mapped onto *Subcarrier* (0,1) = 13 shown in Figure 226, where 13 is the subcarrier with index 13 according to step a) in this subclause. Considering the US tile structure (4 subcarriers by 7 OFDM symbols), it can be seen that this is the second indexed subcarrier on the third symbol within the slot.

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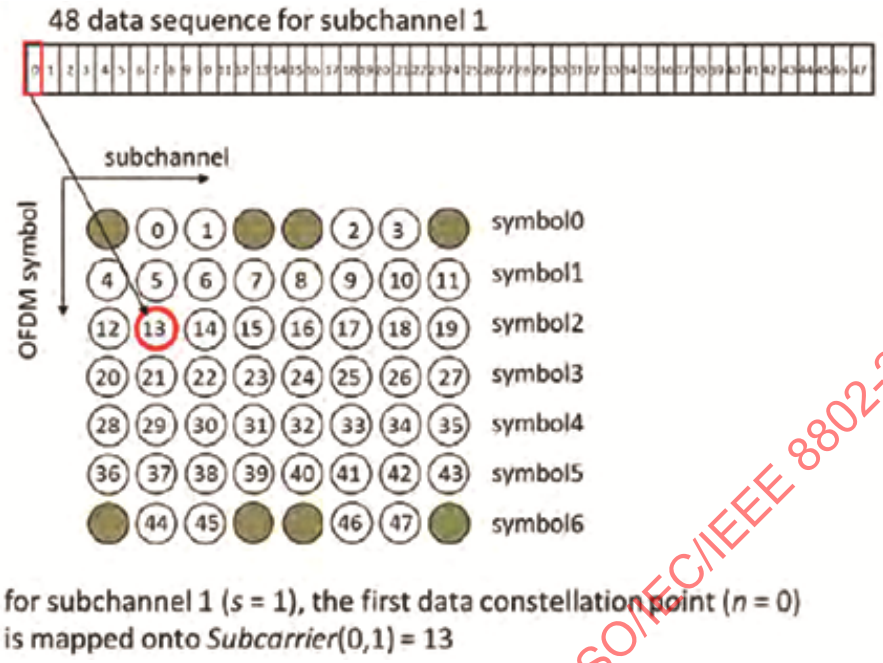

Figure 226—Example of data mapping onto subcarrier (*s*=1, *n*=0)

Similarly, for subchannel 3, the ninth data constellation point ($n = 8$) is mapped onto *Subcarrier* (8, 3) = 47 shown in Figure 227. According to step a), this is the last indexed subcarrier of the seventh symbol within the slot.

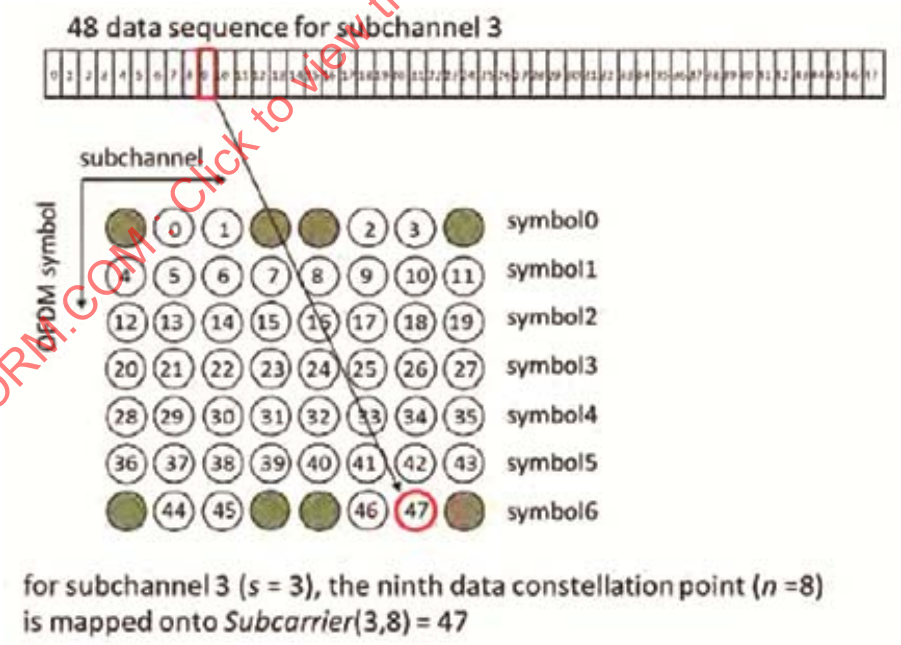

Figure 227—Example of data mapping onto subcarrier (*s*=3, *n*=8)

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10.6.3.3 Data subchannel rotation scheme

In the US, a rotation scheme shall be applied per OFDMA slot duration. On each slot duration, the rotation scheme shall be applied to all US subchannels that belong to the normal data burst. The rotation scheme is defined by applying the following rules:

a) Per OFDMA slot duration, pick the subchannels that are used for the normal data burst. Renumber these subchannels contiguously so that the lowest numbered physical subchannel is renumbered with 0. The total number of subchannels picked shall be designated N_{subchn}.

b) The mapping function defined by rule a) shall define a function, f, so that temp1_subchannel_number = f (old_subchannel_number).

c) Mark the first US OFDMA slot duration with the slot index $S_{idx} = 0$. Increase S_{idx} by 1 in every slot duration so that subsequent slots are numbered 1, 2, 3..., etc.

d) Apply the following formula:

temp2_subchannel_number = (temp1_subchannel_number + 13 · $\boldsymbol{S_{idx}}$) mod $\boldsymbol{N_{subchn}}$

e) To get the new subchannel number, apply the following formula:

new_subchannel_number = f^{-1}(temp2_subchannel_number), where f^{-1} (.) is the inverse mapping of the mapping defined in rule b).

f) For subchannels that are used for control burst (for the UIUC value less than 14), new_subchannel_number = old_subchannel_number.

g) The new_subchannel_number shall replace the old_subchannel_number in each allocation defined by 10.1.3.2 data mapping where the new_subchannel_number is the output of the rotation scheme and the old_subchannel_number is the input of the rotation scheme.

10.6.4 Bit interleaving

All encoded data bits shall be interleaved by a block interleaver with a block size corresponding to the number of coded bits per the encoded block size N_{cbps}. (Possible values of N_{cbps} for each MCS are specified later.) The interleaver is defined by a two-step permutation. The first ensures that adjacent coded bits are mapped onto nonadjacent subcarriers. The second permutation ensures that adjacent coded bits are mapped alternately onto less or more significant bits of the constellation, thus avoiding long runs of lowly reliable bits.

Let N_{cpc} be the number of coded bits per subcarrier, i.e., 2, 4, or 6 for QPSK, 16-QAM, or 64-QAM, respectively. Let $s = N_{cpc}/2$. Within a block of N_{cbps} bits at transmission, let k be the index of the coded bit before the first permutation, m_k be the index of that coded bit after the first and before the second permutation and let j_k be the index after the second permutation, just prior to modulation mapping, and d be the modulo used for the permutation.

The first permutation is defined by Equation (34):

$$m_k = (N\text{cbps}/d) \bullet k \bmod d + \mathit{floor}(k/d) \quad k = 0, 1, \ldots, N\text{cbps} - 1 \quad d = 16 \tag{34}$$

The second permutation is defined by Equation (35).

$$j_k = s \bullet \mathit{floor}(m_k / s) + (m_k + N_{cbps} - \mathit{floor}(d \bullet m_k / N_{cbps}))_{mod(s)} \quad k = 0, 1, \ldots, N\text{cbps} - 1 \quad d = 16 \tag{35}$$

The de-interleaver, which performs the inverse operation, is also defined by two permutations. Within a received block of N_{cbps} bits, let j be the index of a received bit before the first permutation; m_j be the index

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of that bit after the first and before the second permutation; and let k_j be the index of that bit after the second permutation, just prior to delivering the block to the decoder.

The first permutation is defined by Equation (36).

$$m_j = s \bullet floor(j/s) + (j + floor(d \bullet j / N\text{cbps}))mod(s)\ j = 0, 1, \ldots, N\text{cbps} - 1\ d = 16 \quad (36)$$

The second permutation is defined by Equation (37).

$$k_j = d \bullet mj - (N\text{cbps} - 1) \bullet floor(d \bullet mj / N\text{cbps})\ j = 0, 1, \ldots, N\text{cbps} - 1\ d = 16 \quad (37)$$

The first permutation in the de-interleaver is the inverse of the second permutation in the interleaver, and conversely.

10.7 Channel coding

10.7.1 Data scrambling

The data scrambling of PHY-OM1 (9.7.1) is used for PHY-OM2.

10.7.2 Forward error correction (FEC)

The BCC mode is mandatory (10.7.2.1), and there is another optional mode (10.7.2.2).

10.7.2.1 BCC mode (mandatory)

10.7.2.1.1 Binary convolutional coding

The BCC mode of PHY-OM1 (9.7.2.1.1) is used for PHY-OM2.

10.7.2.1.2 Puncturing

The puncturing procedure of PHY-OM1 (9.7.2.1.2) is used for PHY-OM2.

10.7.2.1.3 OFDM slot concatenation

The encoding block size shall depend on the number of OFDM slots allocated and the modulation specified for the current transmission. Concatenation of a number of OFDM slots shall be performed in order to allow for transmission of larger blocks of coding where it is possible, with the limitation of not exceeding the largest block size for the corresponding modulation and coding. Table 304 specifies the concatenation index for different modulations and coding.

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Table 304—Concatenation index for different modulations and coding

Modulation and rate	j
QPSK 1/2	6
QPSK 2/3	4
QPSK 3/4	4
QPSK 5/6	2
16-QAM 1/2	3
16-QAM 2/3	2
16-QAM 3/4	2
16-QAM 5/6	1
64-QAM 1/2	2
64-QAM 2/3	1
64-QAM 3/4	1
64-QAM 5/6	1
256-QAM 1/2	1
256-QAM 2/3	1
256-QAM 3/4	1
256-QAM 5/6	1
256-QAM 7/8	1
4D-TCM 48QAM 10/11	1
4D-TCM 192QAM 14/15	1

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For any modulation and coding, the following parameters are defined:

— j: index dependent on the modulation level and FEC rate
— n: number of allocated OFDM slots
— k: floor (n / j)
— m: n mod j

Table 305 shows the rules used for OFDM slot concatenation.

Table 306 defines the basic sizes of the useful data payloads (in bytes) to be encoded in relation with the selected modulation type, encoding rate (**R** in table), and concatenation rule.

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Table 305—OFDM slot concatenation rule

Number of slots	Slots concatenated
$n \leq j$	1 block of n slots

$n > j$	If (n mod j = 0) k blocks of j slots
	else
	(k – 1) blocks of j slots
	1 block of ceil ((m + 1) / 2) slots
	1 block of floor ((m + j) / 2) slots

Table 306—Useful data payload (in bytes) for an FEC block

QPSK				16-QAM				64-QAM				256-QAM					4D-TCM	
R= 1/2	R= 2/3	R= 3/4	R= 5/6	R= 1/2	R= 2/3	R= 3/4	R= 5/6	R= 1/2	R= 2/3	R= 3/4	R= 5/6	R= 1/2	R= 2/3	R= 3/4	R= 5/6	R= 7/8	R= 10/ 11	R= 14/ 15
6																		
	8																	
		9																
			10															
12				12														
	16				16													
18		18				18		18										
			20				20											
24	24			24					24			24						
		27								27								
30											30						30	
	32				32								32					
36		36		36		36		36						36				
															40			
																42		42

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10.7.2.2 Duo-binary convolutional Turbo code (CTC) mode (optional

The CTC for PHY-OM1 (9.7.2.2) is used for PHY-OM2.

10.7.2.3 Low-density parity check codes (LDPC) mode (optional)

The LDPC for PHY-OM1 (9.7.2.3) is used for PHY-OM2.

10.7.2.4 Shortened Block Turbo Codes (SBTC) modes (Optional)

The SBTC for PHY-OM1 (9.7.2.4) is sued for PHY-OM2.

10.7.2.5 Multidimensional trellis coded modulation (MD-TCM) mode (optional)

10.7.2.5.1 Overview of multidimensional trellis codded modulation (MD-TCM)

Multidimensional trellis coded modulation (MD-TCM) is a combined coding and modulation for band-limited channels by using multiple 2D symbols. In this subclause, four-dimensional TCM (4D-TCM) is applied to achieve additional higher data rate option and peak-to-average power ratio (PAPR) reduction at data mapping. The functional block of the 4D-TCM encoder is illustrated in Figure 228. 4D-TCM encoder contains the following functions:

— Coset selection
— Region pair selection
— Symbol selection

For 4D-TCM 48QAM, a 4D symbol (equal to two 2D symbols) contains 3 bits for coset selection, 3 bits for region pair selection, and 2x2 bits for symbol selection. In total, it contains 10 bits per 4D symbol, which is equal to 5 bits per 2D symbol (also equal to 5/6-coded 64QAM). For 4D-TCM 48QAM, a 4D symbol (equal to two 2D symbols) contains 3 bits for coset selection, 3 bits for region pair selection, and 2x4 bits for symbol selection. In total, it contains 14 bits per 4D symbol, which is equal to 7 bits per 2D symbol (also equal to 7/8-coded 256 QAM).

Detail structure of each component is described in the following subclauses.

10.7.2.5.2 Coset selection

Two bits enter the rate 2/3 convolutional encoder. This encoder generates three-bit output. With one additional bit, a total of four bits are used to choose a pair of signal points illustrated in Figure 229 among the following pairs of signal points:

(A, A), (A, B),(A, C),(A, D),(B, A),(B, B),(B, C),(B, D),(C, A),(C, B),(C, C),(C, D),
(D, A),(D, B),(D, C),(D, D).

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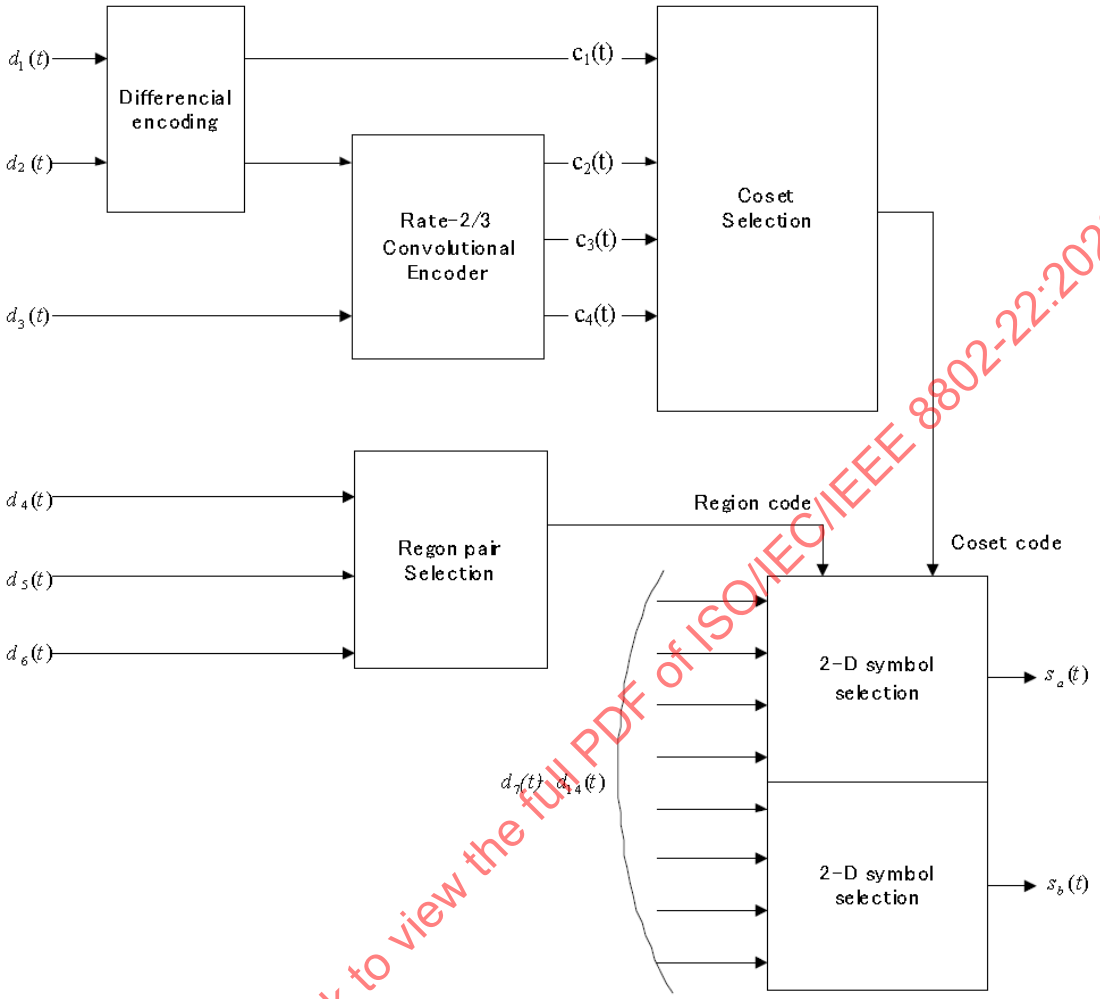

Figure 228—Structures of multidimensional trellis encoder

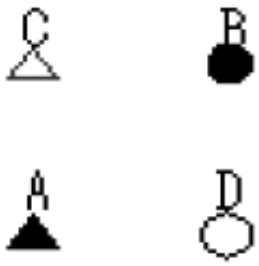

Figure 229—Signal constellation for coset selection

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Bit assignment for coset selection is listed in Table 307.

Table 307—Bit assignment for coset selection

Input of coset selection $c_1(t)c_2(t)$ $c_3(t)$ $c_4(t)$	Output of coset at $s_a(t)$ / $s_b(t)$
0000	A/A
0001	A/C
0010	A/B
0011	A/D
0100	C/A
0101	C/C
0110	C/ B
0111	C/D
1000	B/A
1001	B/C
1010	B/B
1011	B/D
1100	D/A
1101	D/C
1110	D/B
1111	D/D

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10.7.2.5.3 Region pair selection

Three bits enter a Region pair selector to select a pair of regions over two 2D symbols. Figure 230 illustrates the sketch of regions. One 2D symbol contains three regions, say I_0, I_1, and O illustrated in Figure 230. According to the contents of entered three bits, one region pair (R_1, R_2) shall be chosen among the following region pairs:

(I_0, I_0), (I_0, I_1), (I_0, O),(I_1, I_0), (I_1, I_1), (I_1, O), (O, I_0), (O, I_1),

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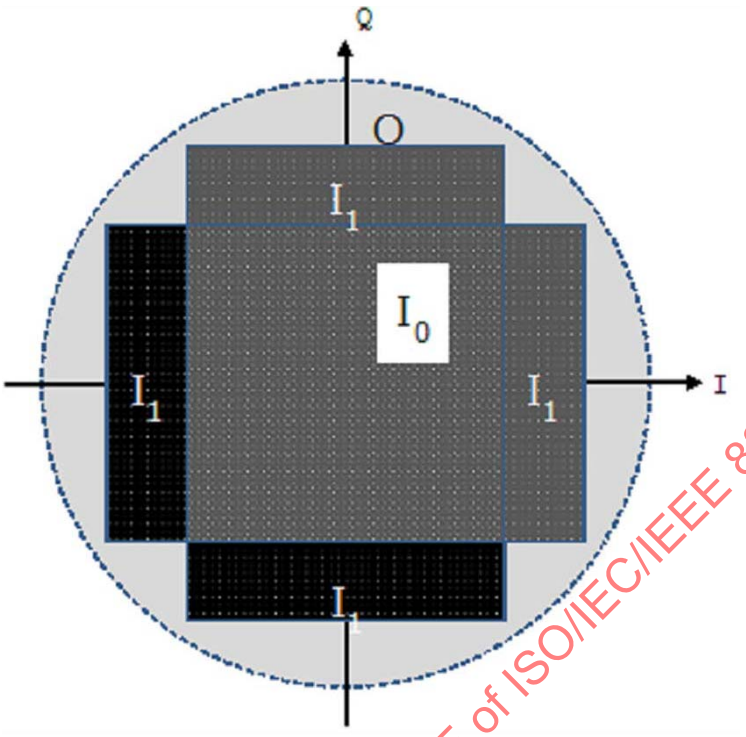

Figure 230—Sketch of "region" in MD-TCM

Bit assignment of region pair selection is listed in Table 308.

Table 308—Region pair selection

$d_4(t)d_5(t)d_6(t)$	Region at $s_a(t)$	Region at $s_b(t)$
000	I_0	I_0
001	I_0	I_1
010	I_0	O
011	I_1	I_0
100	I_1	I_1
101	I_1	O
110	O	I_0
111	O	I_1

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10.7.2.5.4 Symbol selection

For MD-TCM 48 QAM, 2-D symbol selection contains QPSK mapper with constellation mapping in Figure 195. For MD-TCM 192 QAM, 2D symbol selection contains 16-QAM mapper with constellation mapping in Figure 196.

10.8 Constellation mapping and modulation

10.8.1 Data modulation

The data modulation procedures for PHY-OM1 (9.8, except for the information in Table 227) are used for PHY-OM2. See Table 309 for the number of coded bits per slot (NCBPS) and the number of data bits per slot for the different modulation constellation and coding rate combinations for PHY-OM2.

Table 309—Number of coded bits per OFDM slot (N_{CBPS}) and corresponding number of data bits for different modulation constellation and coding rate combinations

Constellation type	Coding rate	N_{CBPS}	Corresponding number of data bits
QPSK	1/2	96	48
QPSK	2/3	96	64
QPSK	3/4	96	72
QPSK	5/6	96	80
16-QAM	1/2	192	96
16-QAM	2/3	192	128
16-QAM	3/4	192	144
16-QAM	5/6	192	160
64-QAM	1/2	288	144
64-QAM	2/3	288	192
64-QAM	3/4	288	216
64-QAM	5/6	288	240
256-QAM	1/2	384	192
256-QAM	2/3	384	256
256-QAM	3/4	384	288
256-QAM	5/6	384	320
256-QAM	7/8	384	336
4D-TCM 48QAM	10/11 for 4D symbol	264	240
4D-TCM 192QAM	14/15 for 4D symbol	360	336

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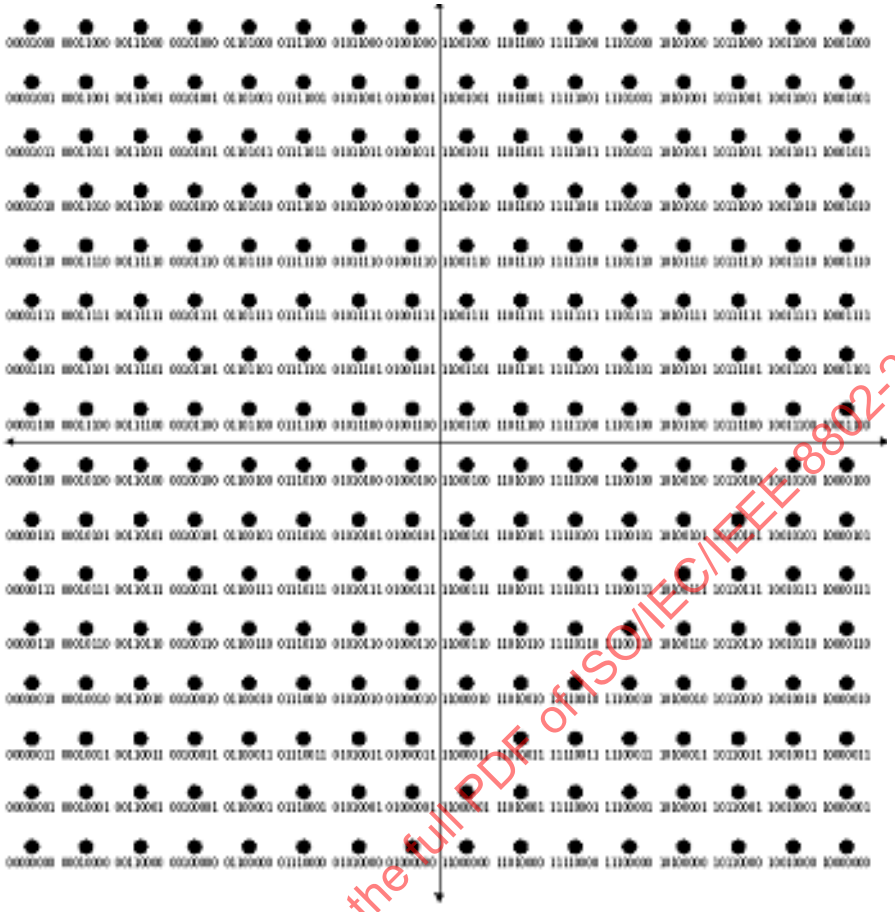

Figure 231—Gray mapping for 256-QAM

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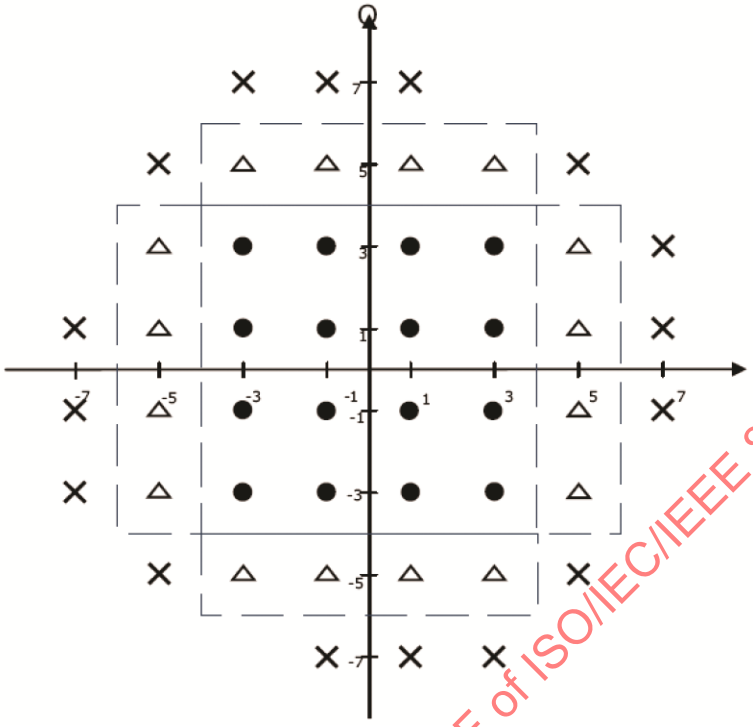

Figure 232—Constellation of one 2D symbol for MD-TCM 48 QAM

Table 310—Number of coded bit per carrier and normalization factor for 256-QAM/4D-TCM modulation constellations

Modulation Type	N_{CBPC}	K_{MOD}
256-QAM	8	1/sqrt(170)
4D-TCM 48QAM	5.5	1/sqrt(31.33)
4D-TCM 192QAM	7.5	1/sqrt(122.33)

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Table 311—Number of coded bits per OFDM slot (N_{CBPS}) and corresponding number of data bits for 256-QAM/4D-TCM modulation constellation and coding rate combinations

Constellation type	Coding rate	N_{CBPS}	Corresponding number of data bits
256-QAM	½	192	96
256-QAM	2/3	192	128
256-QAM	3/4	192	144
256-QAM	2/3	192	60
256-QAM	¾	192	168
256-QAM	5/6	192	120
256-QAM	7/8	192	168
4D-TCM 48QAM	10/11 for 4D symbol	132	120
4D-TCM 192QAM	14/15 for 4D symbol	180	168

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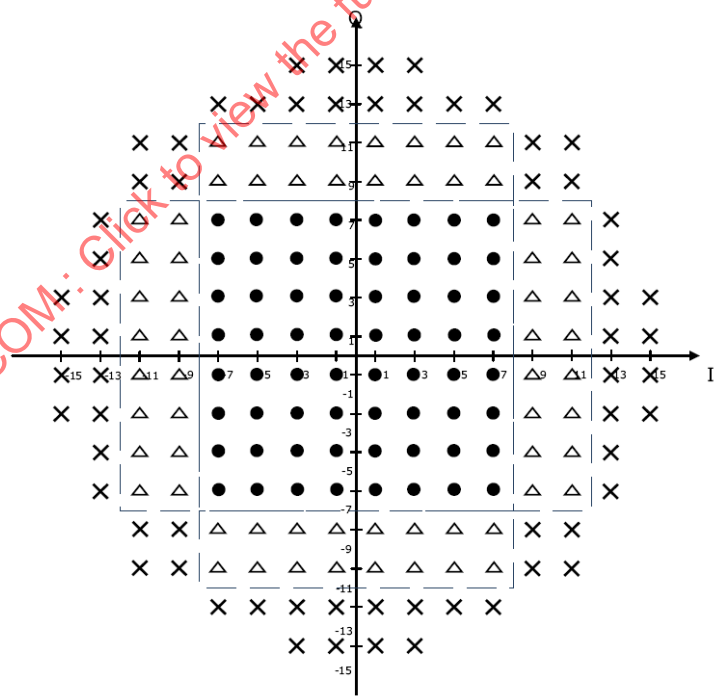

Figure 233—Constellation of one 2D symbol for MD-TCM 192 QAM

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10.8.2 Pilot modulation

The pilot modulation procedures for PHY-OM1 (9.8.2) are used for PHY-OM2.

10.9 Control mechanisms

10.9.1 DS synchronization

The DS synchronization procedures for PHY-OM1 (9.9.1) are used for PHY-OM2. A DS synchronization process shall be performed by each A-CPE. All the A-CPEs shall be synchronized with the A-BS or a distributed scheduling R-CPE.

10.9.2 US synchronization

US synchronization shall be achieved through initial ranging and periodic ranging processes. The initial ranging transmission burst is specified 10.9.3.1.2. The periodic ranging transmission burst is specified in 10.9.3.1.1. US synchronization shall ensure that all US transmissions are received at the BS with which the CPEs are associated within ± 25% of the shortest cyclic prefix as given in Table 282, i.e., ± 1.429 ms or ± 8 sampling periods.

10.9.3 Opportunistic US bursts

A ranging channel is composed of one or more groups of six adjacent subchannels, using the symbol structure defined in 10.6.3.1, where the groups are defined starting from the first subchannel. Subchannels are considered adjacent if they have successive logical subchannel numbers. The indices of the subchannels that compose the ranging channel are specified in the US-MAP message. BS shall allocate ranging, bandwidth (BW) request, or UCS notification allocation as a multiple of subchannels.

10.9.3.1 CDMA bursts

The number of subchannels for the ranging channel and the number of symbols for each transmission (CDMA initial ranging, CDMA periodic ranging, CDMA BW request, and CDMA UCS notification) are specified in the US-MAP_IE.

CPEs are allowed to collide on the ranging channel. To still provide reliable transmission, each CPE randomly chooses one ranging code from the subgroup of specified binary codes that is defined in 10.9.3.1.1. These codes are then BPSK modulated onto the subcarriers in the ranging channel. The length of these binary codes is the same as the number of subcarriers in the ranging channel.

10.9.3.1.1 CDMA codes

The binary codes shall be the pseudo-noise codes produced by the PRBS generator described in Figure 234, which illustrates the following polynomial generator: 1+ x1 + x4+ x7+ x15. The PRBS generator shall be initialized by the seed b15...b1 = 0,0,1,0,1,0,1,1,s0,s1,s2,s3,s4,s5,s6 where s6 is the LSB of the PRBS seed, and s6:s0=US_PermBase, where s6 is the MSB of the US_PermBase.

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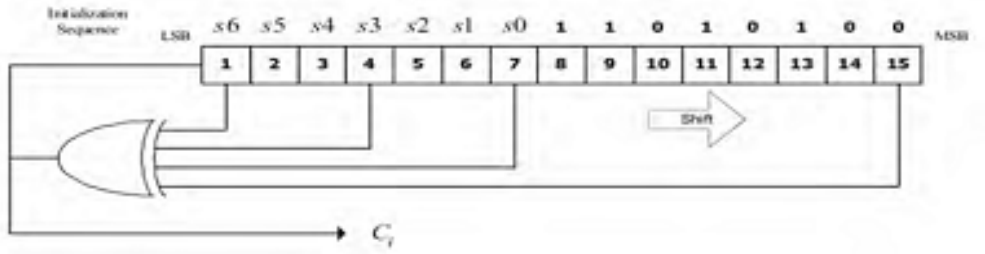

Figure 234—PRBS generator for ranging code generation

The binary ranging codes shall be subsequences of the pseudo-noise sequence appearing at its output Ci. The length of each ranging code is 144 bits. These bits are used to modulate the subcarriers in a group of six adjacent subchannels. The bits are mapped to the subcarriers in increasing frequency order of the logical subcarriers, such that the lowest indexed bit modulates the subcarrier with the lowest subcarrier index and the highest indexed bit modulates the subcarrier with the highest index. The index of the lowest numbered subchannel in the six shall be an integer multiple of six.

For example, the first 144 bit obtained by clocking the PN generator as specified and by setting US_PermBase = 0, the first code shall be 00110000010001... . The next ranging code is produced by taking the output of the 145th to 288th clock of the PRBS generator, etc.

The number of available codes is 256, numbered 0...255. Each BS uses a subset of these codes, where the subgroup is defined by a number S, 0<S<255. The group of codes shall be between S and (S+O+N+M+L) mod 256:

— The first N codes produced are for initial ranging. Clock the PRBS generator 144 × (S mod 256) times to 144 × ((S + N) mod 256) – 1 times.

— The next M codes produced are for periodic ranging. Clock the PRBS generator 144 × ((N + S) mod 256) times to 144 × ((N + M + S) mod 256) – 1 times.

— The next L codes produced are for BW request. Clock the PRBS generator 144 × ((N + M + S) mod 256) times to 144 × ((N + M + L + S) mod 256) – 1 times.

— The next O codes produced are for UCS notification. Clock the PRBS generator 144 × ((N + M + L + S) mod 256) times to 144 × ((N + M + L + O + S) mod 256) – 1 times.

The BS shall separate colliding codes and extract timing (ranging) and power information by using a correlation function. The time (ranging) and power measurements shall be used by the system to compensate for the various BS-CPE-BS propagation distances. In the process of CPE code detection, the BS will also get the Channel Impulse Response (CIR) for the transmission link from the specific CPE. The precise timing offset shall be estimated by terrestrial ranging (see 10.5).

10.9.3.1.2 Initial-ranging transmission

The initial ranging transmission shall be used by all CPEs to synchronize to the system when attempting to associate. The initial ranging transmission will be used for detecting and adjusting the timing offset and adjusting the transmission EIRP level. The initial-ranging transmission is performed using two or four consecutive symbols starting, as indicated in the US-MAP for the CPE, on the first symbol after the TTG.

These symbols shall be generated according to Equation (38), except that $0 \leq t \leq 2T_s$. A time domain illustration used for the initial-ranging transmission is shown in Figure 235.

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$$s(t) = \mathrm{Re}\left\{ e^{j2\pi f_c t} \sum_{k=-\frac{N_{used}-1}{2}, k\neq 0}^{\frac{N_{used}-1}{2}} c_k \cdot e^{j2\pi k\Delta f(t-T_g)} \right\} \quad (38)$$

where

t is the time, elapsed since the beginning of the subject OFDMA symbol

c_k is a complex number; the data to be transmitted on the subcarrier whose frequency offset index is k, during the subject OFDMA symbol. It specifies a point in a QAM constellation.

T_g is the guard time

T_s is the OFDMA symbol duration, including guard time

Δf is the subcarrier frequency spacing

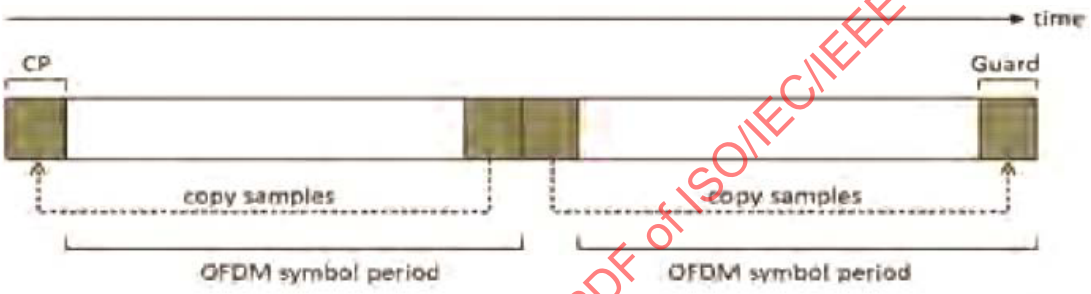

Figure 235—Initial-ranging transmission

The BS can allocate two consecutive initial ranging slots; onto those slots, the CPE shall transmit the two consecutive initial ranging codes (starting code shall always be a multiple of 2), as illustrated in Figure 236.

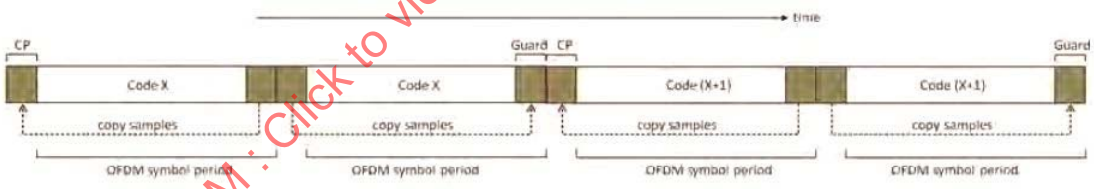

Figure 236—Initial-ranging transmission, using two consecutive initial ranging codes

10.9.3.1.3 CDMA periodic-ranging, BW-request, and UCS notification transmission

Periodic-ranging transmissions shall be sent periodically by CPEs identified by the BS for system periodic ranging. Bandwidth-request transmissions shall be for requesting US allocations from the BS. UCS notification transmissions shall be used for reporting detection of an incumbent. These transmissions shall be sent only by CPEs that have already associated with the BS. To perform periodic-ranging, bandwidth-request or UCS notification transmission, the CPE can send a transmission in one of the following manners:

a) Modulate one ranging code on the ranging subchannel for a period of one OFDM symbol. Ranging subchannels shall be dynamically allocated by the MAC layer at the BS and indicated by the number of subchannels in the US-MAP_IE. A time domain illustration of the periodic-ranging, bandwidth-request, or UCS notification transmission is shown in Figure 237.

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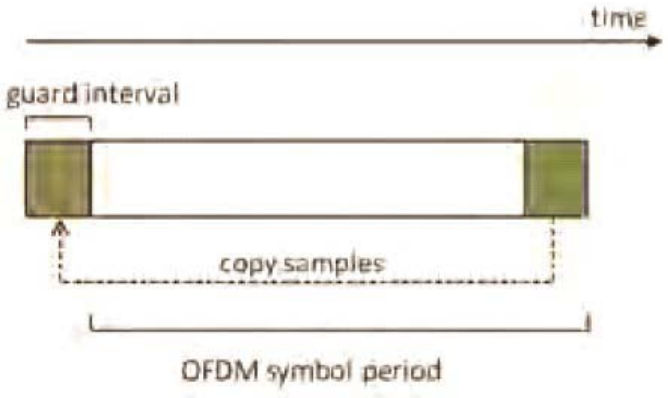

Figure 237—Periodic-ranging/Bandwidth-request/UCS notification transmission using one code

b) Modulate three consecutive ranging codes (starting code shall always be a multiple of three) on the ranging subchannel for a period of three OFDMA symbols (one code per symbol). Ranging subchannels are dynamically allocated by the MAC and indicated in the US-MAP. A time domain illustration of the periodic ranging, BW request, or UCS notification transmission is shown in Figure 238.

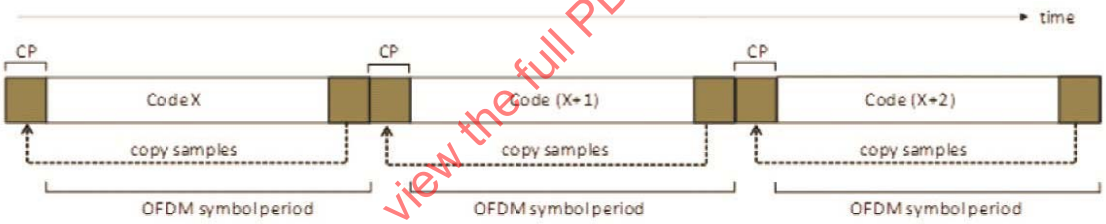

Figure 238—Periodic-ranging/bandwidth-request/UCS notification transmission using three consecutive codes

10.9.3.1.4 Ranging, BW request, and UCS notification opportunity windows

For CDMA ranging, BW request, and UCS notification transmission, the ranging opportunity size is the number of symbols required to transmit the appropriate ranging/BW-request/UCS notification code (1, 2, 3, or 4 symbols) and is denoted N1. N2 denotes the number of subchannels required to transmit a ranging code. In each allocation of ranging/BW-request/UCS notification, the opportunity size (N1) is fixed and conveyed by the corresponding US-MAP IE that defines the allocation.

The ranging allocation is subdivided into slots of N1 OFDMA symbols by N2 subchannels, in a time first order, i.e., the first opportunity begins on the first symbol of the first subchannel of the ranging allocation, the next opportunities appear in ascending order in the same subchannel, until the end of the ranging/BW-request/UCS notification (or until there are less than N1 symbols in the current subchannel), and then the number of subchannel is incremented by N2. The ranging allocation is not required to be a whole multiple of N1 symbols, so a gap may be formed (that can be used to mitigate interference between ranging and data transmissions). Each CDMA code shall be transmitted at the beginning of the corresponding slot. See Figure 239.

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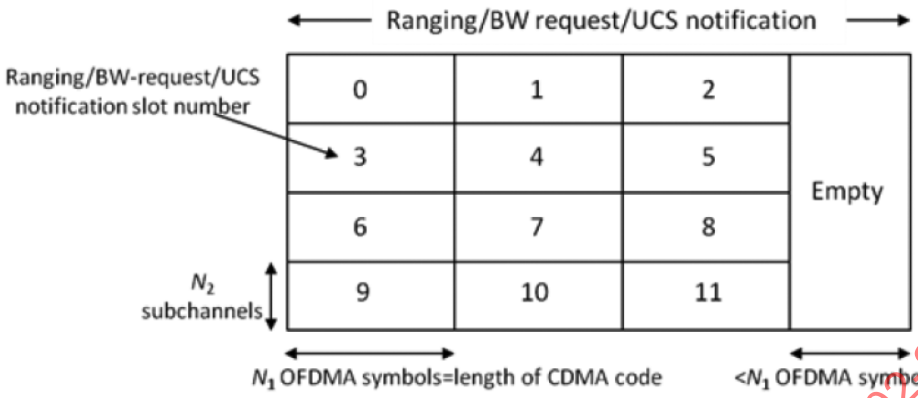

Figure 239—Example of Ranging/BW request/UCS notification opportunities windows

10.9.4 Power control

The power control procedures for PHY-OM1 (9.9.4) are used for PHY-OM2.

10.9.4.1 Transmit power control boundaries and EIRP limits

The transmit power control boundaries and EIRP limits for PHY-OM1 (9.9.4.1) are used for PHY-OM2.

10.9.4.2 Transmit power control mechanism

The transmit power control procedures for PHY-OM1 (9.9.4.2, except for the information in Table 228) are used for PHY-OM2. See Table 312 for the default normalized CNR values per modulation for the BCC for PHY-OM2.

Table 312—Normalized CNR per modulation for BER = 2×10^{-4}

Modulation - FEC rate	Normalized CNR (dB)
	AWGN (default)
CDMA code	1.9
QPSK, rate: 1/2	4.7
QPSK, rate: 2/3	6.4
QPSK, rate: 3/4	7.3
QPSK, rate: 5/6	8.4
16-QAM, rate: 1/2	10.5
16-QAM, rate: 2/3	12.6
16-QAM, rate: 3/4	13.8
16-QAM, rate: 5/6	15.1
64-QAM, rate: 1/2	15.4

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Table 312—Normalized CNR per modulation for BER = 2×10^{-4} *(continued)*

Modulation - FEC rate	Normalized CNR (dB)
	AWGN (default)
64-QAM, rate: 2/3	18.3
64-QAM, rate: 3/4	19.7
64-QAM, rate: 5/6	21.2
256-QAM, rate: 1/2	19.6
256-QAM, rate: 2/3	23.3
256-QAM, rate: 3/4	25.1
256-QAM, rate: 5/6	26.9
256-QAM, rate: 7/8	28.2

10.10 Network synchronization

For multiple A-WRAN cells implementation, it is required that all BSs be time synchronized within a tolerance of ± 8 TU (equivalent to 1.429 μs for 6 MHz, 1.224 μs for 7 MHz BW and 1.071 μs for 8 MHz BW). It should be noted that any filtering at the output of the OFDM modulator to help meeting the rejection required by the RF mask (see 10.13) will create temporal dispersion that will consume part of the cyclic prefix capability provided for alleviating channel time spreading.

In the event of a loss of synchronization with the common clock or with nearby A-WRAN BSs, the BS shall continue to operate and shall automatically resynchronize through the synchronization process described in 7.23.

For multiple A-WRAN cells implementation, frequency references derived from a common timing reference shall be used to control the frequency accuracy of BSs as specified in 7.23, provided that they meet the frequency accuracy requirements of 10.11. This applies during normal operation and during loss of timing reference.

10.11 Frequency control requirements

The frequency control requirements of PHY-OM1 (9.11) are used for PHY-OM2.

10.12 Antenna

The antenna procedures of PHY-OM1 (9.12) are used for PHY-OM2.

10.13 RF mask

The RF mask requirements of PHY-OM1 (9.13) are used for PHY-OM2.

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10.14 Receiver requirements

The receiver requirements of PHY-OM1 (9.14) are used for PHY-OM2.

10.15 MIMO pilot allocation

10.15.1 Overview

Multiple-input, multiple-output (MIMO) system has attracted a great deal of attention since the mid-1990s. It consists of multiple antennas at both transmitter and receiver, and are a breakthrough in wireless communication system design. Not limited to time and frequency dimensions, MIMO exploits the spatial dimension created by multiple antennas to achieve improvements in capacity and reliability. Moreover, the improvements come with neither addition of bandwidth nor increment of power, therefore, making MIMO a highly spectral efficient and reliable technique.

The MIMO channel can be made more robust against fading channels than each of its single-input-single-output (SISO) components by exploiting spatial diversity. Furthermore, MIMO channel creates the possibility to increase the transmission rate compared to SISO channel through spatial multiplexing; however, these two features cannot be fully exploited at the same time. A fundamental trade-off between rate increment and robustness against fading exists and shall be decided according to the users needs.

The MIMO technique described hereafter is more appropriate for the link between A-BS and R-CPEs existing in the wireless network backbone of A-WRAN systems. On the other hand, implementing MIMO on the links between A-BS and A-CPEs or R-CPEs and A-CPEs is technically more challenging. This is due to the fact that the lower operating frequencies inherent to the TVWS bands require antennas with bigger physical sizes than the ones required by existing wireless communication systems operating at higher parts of the frequency spectrum.

When using MIMO scheme for PHY-OM2, the data allocation to tile is changed to accommodate multiple antennas transmission for the channel estimation. MIMO pilot allocations for the cases of two TX antennas and four TX antennas are described in 10.15.2.2 and Figure 241, respectively. Each subclause includes both DS and US pilot allocations for multiple transmit antennas.

10.15.2 MIMO Pilot allocation

10.15.2.1 Overview

The pilot insertion pattern for two antennas and four antennas is shown in 10.15.2.2 and 10.15.2.3, respectively. The pilot pattern shall be repeated every 7 OFDM symbols and 7 subcarriers in the time and frequency domains, respectively. The pilot pattern is always the same, independent of the channel bandwidth. The pilot pattern shall also be the same for the DS and US.

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10.15.2.2 Pilot allocation for two antennas

For two transmit BS antennas, the DS data allocation to tile is changed (Figure 240) to accommodate two antennas transmission for channel estimation. Figure 240 replaces Figure 222 in 10.6.1.1 when MIMO is enabled.

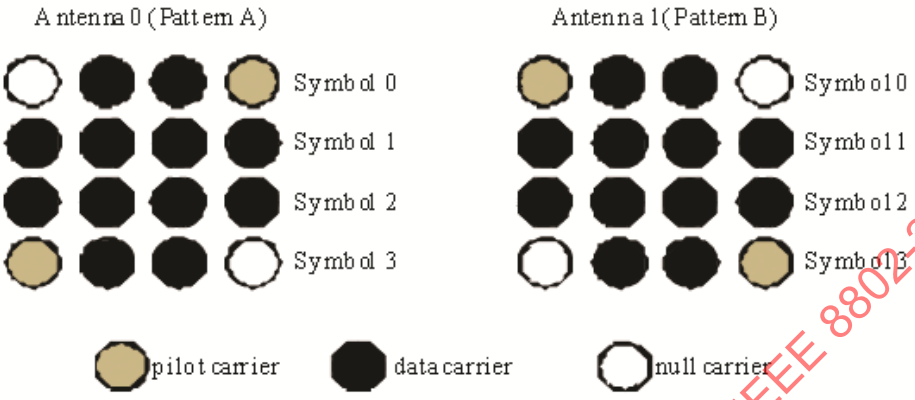

Figure 240—DS tile structure for two TX antennas

For two transmit CPE antennas, the US data allocation to tile is changed (Figure 241) to accommodate two antennas transmission for channel estimation. Figure 241 replaces Figure 223 in 10.6.1.2 when MIMO is enabled.

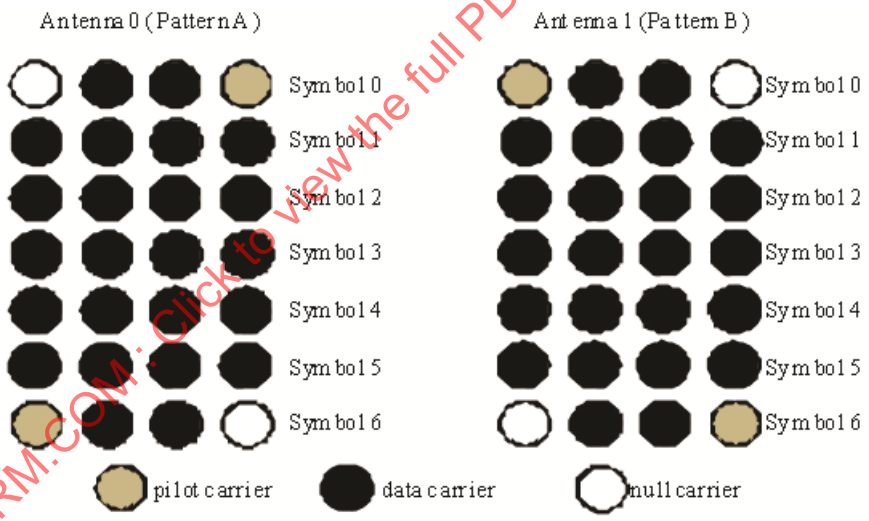

Figure 241—US tile structure for two TX antennas

10.15.2.3 Pilot allocation for four antennas

For four transmit BS antennas, the DS data allocation to tile is changed (Figure 242) to accommodate four antennas transmission for channel estimation. Figure 242 replaces Figure 222 in 10.6.1.1 when MIMO is enabled.

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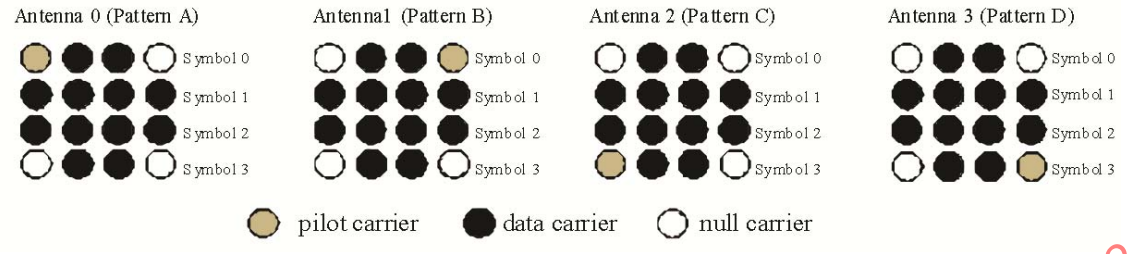

Figure 242—DS tile structure for four TX antennas

For four transmit CPE antennas, the US data allocation to tile is changed (Figure 243) to accommodate four antennas transmission for channel estimation. Figure 243 replaces Figure 223 in 10.6.1.2 when MIMO is enabled.

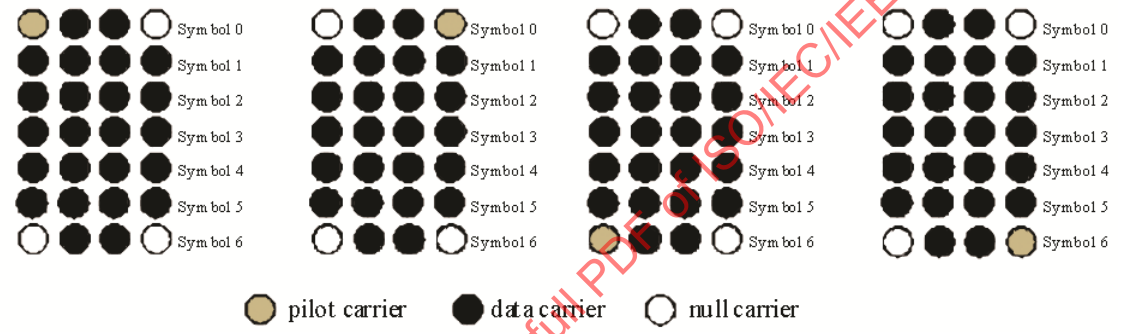

Figure 243—US tile structure for four TX antennas

10.15.3 Space time coding (STC)

The MIMO technique is common to PHY-OM1 and PHY-OM2. The procedures for PHY-OM1 (9.15.3) are used for PHY-OM2.

10.16 Using PHY-OM2 in non-TV Whitespace Frequency Bands

The possibility of operating the IEEE 802.22 system in the frequency bands such as 1.3 GHz to 1.75 GHz and 2.7 GHz to 3.7 GHz, etc., opens interesting possibilities and challenges. Since IEEE Std 802.22 defines an OFDMA-based operation, the upstream transmission from various CPEs requires very tight tolerance in order for successful demodulation of the signals at the BS. Subclause 9.11 specifies a 2% error relative to the OFDM subcarrier spacing, corresponding to 60 Hz as the maximum frequency error permissible for acceptable OFDM inter-carrier leakage. This is essentially related to the fact that the upstream bursts from multiple CPE transmissions need to be received at the BS as a coherent frequency multiplex. This means that additional techniques may be needed to improve the stability/VCO hunting/tracking at the CPEs in order to utilize the IEEE 802.22 system at these higher carrier frequencies, or IEEE 802.22 systems can potentially operate with a higher instantaneous bandwidth (e.g., 18 MHz instead of 6 MHz) in order to alleviate the tight frequency tolerance requirements.

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11. Cognitive radio capability

11.1 General

This clause describes the cognitive radio capabilities supported by IEEE Std 802.22, which are required to meet regulatory requirements for protection of incumbents as well as to provide for efficient operation of IEEE 802.22 networks. The cognitive radio capabilities include: BSs SM, spectrum sensing automaton (SSA), access to the database services, channel set management, policy (Table 315 and Annex A), CPE registration and tracking, spectrum sensing services, and geolocation services.

IEEE 802.22 devices shall employ cognitive radio capability, which shall enable them to make decisions about their radio operating behavior based on information from various sources such as sensing, geolocation, and the database service, policy, etc. The information should be obtained through communication with the database service, or through direct sensing for incumbents on channels that would be impacted by operation of the IEEE 802.22 device, or both. The information may also be the result of rules governing the particular regulatory domain where the device intends to operate (e.g., certain channels may be “off limits” because they were allocated for some other specific use). This clause defines the IEEE 802.22 functional entities, information elements, and procedures related to obtaining and managing this information.

If a database service is present in the domain where the IEEE 802.22 device would operate, the IEEE 802.22 device shall retrieve appropriate spectrum availability information based on the geographic coordinates of its intended operating location from the database service, as described by procedures defined in this clause.

An IEEE 802.22 device shall also sense for the presence of incumbents in areas where the IEEE 802.22 device intends to operate, both prior to, and during operation. This includes sensing the prospective channels of operation as well as any other channels that might be subjected to harmful interference as a result of the operation of the IEEE 802.22 device. Signals that the IEEE 802.22 device shall sense are as follows:

— Television broadcasts
— Wireless microphone transmissions
— Transmissions from protecting devices, such as the IEEE 802.22.1 wireless beacon
— Other incumbent devices such as medical telemetry devices that may need to be protected in the local regulatory domain (see Footnote 20 of the FCC R&O 08-260)

The IEEE 802.22 systems shall select their operating, backup, and candidate channel sets based on the procedures that are described in 11.2.3. The IEEE 802.22 transmission shall be controlled by various policies that are defined in 11.2.5 related to the SM Policies. The SM operation is described in detail in 11.2.

Note that IEEE 802.22 devices shall also sense for other IEEE 802.22 systems that may be present and operating in their area. If such systems are discovered, the devices shall follow the self-coexistence procedures defined in 7.22.

The organization of this clause is as follows: 11.2 describes the Spectrum Manager operation; 11.3 describes the Spectrum Sensing Automaton; 11.4 describes the Spectrum Sensing Function; 11.5 describes the Geolocation; 11.6 describes the database service. Management primitives and messaging associated with the functions described in this clause are discussed in 15.2.1.3.

A-WRAN devices shall employ the cognitive radio capability required by regulatory.

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11.2 Spectrum Manager operation

11.2.1 General

The SM, as shown in the IEEE 802.22 reference model (Figure 4), shall be part of the cognitive plane and shall always be present at the IEEE 802.22 BS. The SM is responsible for the most important tasks, such as maintaining spectrum availability information, channel selection, channel management, scheduling spectrum sensing operation, access to the database, enforcing IEEE 802.22 and regulatory domain policies, and enabling self-coexistence, etc. The detailed operation of the SM is described in 11.2.

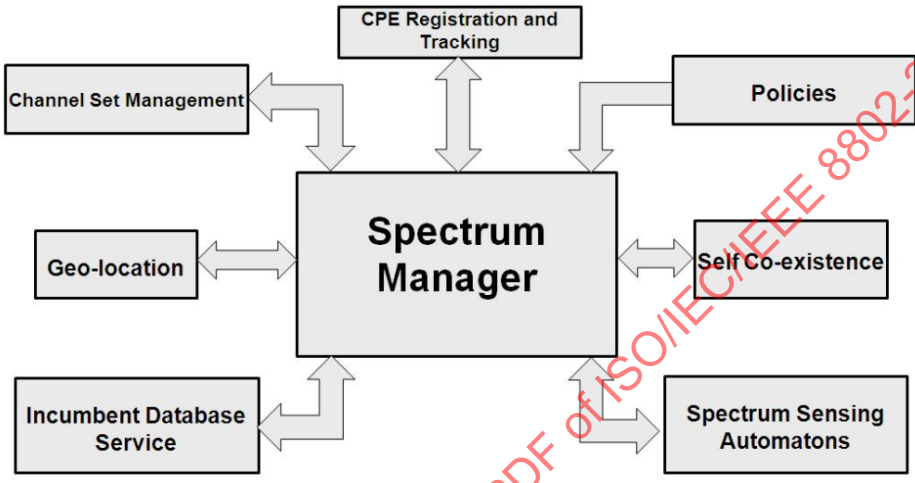

Figure 244—IEEE 802.22 spectrum manager and logical interfaces

All the IEEE 802.22 devices (BS and CPEs) shall also have an entity called the Spectrum Sensing Automaton (SSA). The SSA interfaces to the Spectrum Sensing Function (SSF) and executes the commands from the SM to enable spectrum sensing. The detailed operation of the SSA is described in 11.3. This subclause (11.2) describes the SM functionalities.

The SM is a central part of the WRAN BS, which shall be responsible for ensuring protection of incumbents and efficient spectrum utilization while complying with regulatory policies. For that, the SM centralizes all the decisions within the WRAN cell with respect to spectrum availability and utilization. In summary, the key functions of the SM are the following:

- Maintain spectrum availability Information
- Channel classification and selection
- Association control
- Channel set management
- Accessing the database service
- Scheduling quiet periods for spectrum sensing
- Enforcing IEEE 802.22 and regulatory domain policies
- Making channel move decisions for one or more CPEs or the entire cell
- Self-coexistence with other WRANs, etc.

These functions are described in the following clauses. It is important to note that this standard does not specify any particular SM implementation, but instead, it describes the mandatory behavior for any SM implementation in order to provide for proper protection of incumbents, compliance with regulatory domain policies, and interoperability among different WRAN implementations.

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The SM shall determine the requirements for the rate of SCWs to ensure sufficient self-coexistence information exchange capacity and shall work with the data scheduler to influence the amount of data going to a CPE so that it has sufficient time to clear enough backup channels during its idle time.

11.2.2 Maintain spectrum availability information

The SM shall maintain the status of the spectrum (i.e., channels) available for WRAN operation at its location within a regulatory domain according to the policies and rules established for that domain (e.g., regulatory rules established by the FCC in the USA for use of channels). The SM shall obtain information on the channel status with respect to the presence of incumbents and other WRANs in the area, and it shall use this information as input for its decisions with respect to channel selection, channel state management, and self-coexistence mechanisms.

To maintain the status of the channels available for operation, the SM shall be able to aggregate information from at least the following sources:

1) **Database service:** The SM shall access an incumbent database through the higher layers. The SM shall be responsible for accessing the database service in the regulatory domains that mandate the presence of such a database. The database service is a service officially operated under the rules of the local regulatory authority that provides a list of available channels and possibly the maximum EIRP allowable on these channels based on queries containing the geolocation of the WRAN devices. In the regulatory domains that do not mandate such database service, a database of available channels shall be provided by the operator.
2) **Geolocation:** The SM shall be able to access geolocation information available at the BS to identify its own location, and it shall also be able to obtain location information from all CPEs associated with the BS or that are requesting association with the BS.
3) **Spectrum sensing**: The SM shall interface with the Spectrum Sensing Automatons located within the BS and the CPEs. The SM shall use the MAC and PHY layer functionalities and management frames to control and coordinate spectrum sensing within the WRAN cell. The SM shall trigger the requests for the SSAs located within the BS and the CPEs to perform sensing and collect sensing reports. The SM shall combine the local sensing results with the results collected from CPEs.

The SM shall define the status of the channels with respect to the presence of incumbents by combining geolocation information, information from incumbent databases, and spectrum sensing results. In order for IEEE 802.22 systems to operate, the BS shall maintain communication with a database service containing location dependent available channels if it exists. When operating in a regulatory domain that does not require a database service, all channels are initially assumed to be available. In this case, the SM shall define the status of the available channels based on spectrum sensing.

The channel availability information shall be defined during the network initialization and it shall be periodically updated during the network operation.

For example, Annex A specifies the USA regulatory requirements for acquiring a channel (i.e., out-of-band sensing for IEEE 802.22 systems), and for in-service monitoring (i.e., in-band sensing for IEEE 802.22 systems). The actual values for these timings will depend on the regulatory domains and the specific values shall be obtained by the CPE through the MIBs at the time of initialization based on the regulatory classes defined in Table A.13.

11.2.3 Channel classification and selection

The SM shall assign the operating channel to the MAC/PHY modules in the WRAN. The SM shall also define the backup channel(s) and their corresponding priorities. The rest of the channels that are potentially available for operation, but that are not selected as the operating channel or as backup channel(s), may be

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classified as candidate, occupied or disallowed channel(s). The channels may be classified using the following categories:

Available: channels available for consideration for potential WRAN operation at a given location according to the database service. Channels not deemed available by the database service are precluded for use by WRANs.

Available channels are further classified into one of the following categories:

- **Disallowed:** Channels that are precluded from use by the operator due to operational or local regulatory constraints.
- **Operating:** The current channel used for communication between BS and CPEs within a WRAN cell. The operating channel shall be sensed at least every 2 s for the signal types as required by a particular regulatory domain. The operating channel shall also be sensed every 2 s for the IEEE 802.22.1 wireless beacon in the regulatory domains where the operation of such a beacon is allowed.
- **Backup:** Channels that have been cleared to immediately become the operating channel in case the WRAN needs to switch to another channel. The BS may maintain multiple backup channels at any given time and shall order them according to their relative priorities. Backup channels shall be sensed for incumbent detection at least once every 6 s. A channel can stay in the backup channel list as long as no incumbent is found on this channel towards which harmful interference could be produced by the WRAN transmission.
- **Candidate:** Channels that are candidates to become a backup channel. These are channels that the BS may request the CPEs to sense to evaluate the possibility of elevating them to a backup channel status. Although sensing of candidate channels could be infrequent, before a candidate channel is elevated to backup channel, it shall be sensed as incumbent-free at least every 6 s for no less than 30 s. If the first channel in the list can be confirmed to be clear of any incumbent operation towards which harmful interference could be produced by the WRAN transmission within the required time period, the BS can move it to the backup list if needed. The constitution of the candidate channel list relies on the extra time that the CPEs will have to do sensing beyond what is required to clear the backup channel list.
- **Protected:** Channels in which incumbent or the WRAN operation has been detected through sensing. Protected channels may be moved to the candidate channel set in the event that the incumbent or the WRAN systems have vacated the channel. Information from the database service or sensing may be used for this purpose. A protected channel may also become a backup channel, but before a protected channel is elevated to backup channel status, it shall be sensed as incumbent-free at least every 6 s for no less than 30 s. The SM should, when possible, determine the type of signals occupying every protected channel (see 11.2.5).
- **Unclassified:** channels that have not been sensed. These channels may be sensed according to the SM implementation. Once an unclassified channel has been sensed, it may be re-classified as protected or candidate channel depending on the sensing results.

For the preceding channel set as defined: “Disallowed,” “Operating,” “Backup,” “Candidate,” “Protected,” and “Unclassified,” all the states in the set are exclusive to each other, i.e., a channel cannot belong to more than one state at a time. However, because of the WRAN self-coexistence mechanism, an operating channel for one WRAN system can also be the operating channel of another WRAN system (“self-coexistence”) or belong to its backup or candidate list as explained in 11.2.3.1.

The specific algorithms for selecting the operating channel and defining how the backup and candidate channels are prioritized is outside the scope of this standard as long as these implementations meet the sensing requirements. However, any implementation of these algorithms shall use as input current channel availability information (as described in 11.2.2). Furthermore, other criteria may also be taken into account

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by the implementation, such as traffic requirements, location information, and self-coexistence with neighboring WRANs.

11.2.3.1 Transition diagrams for channel sets

Each channel on the available channel list that is returned from the database service (see 15.2.1.3) belongs to one of the possible channel states by the SM. At the end of the quiet period, depending on the activity of incumbent users and channel quality[29] each channel may transit to other states as shown by the state transition diagram in Figure 245. The transition diagram consists of 5 states and 9 events. The 5 states are described in 11.2.3. Note that these states are classified using spectrum sensing results obtained during WRAN initialization and operation. Therefore, disallowed and unavailable channels are omitted in this state transition diagram because those channels are classified by operator or database service. Possible Events for each state transition are described as follows:

Event 1: The channel in the operating, backup or candidate set becomes a member of the protected set as an incumbent is detected using spectrum sensing.

Event 2: No incumbent service has been detected on the channel.

Event 3: No incumbent has been detected on this channel and the timing requirements for sensing as per the definition of the backup channel are satisfied by all CPEs reporting to the BS. (Furthermore, a prioritization among the back up channels can be made based on the measured channel quality.)

Event 4: The channel is released due to the termination of WRAN usage.

Event 5: The channel becomes Operating by its new allocation to the WRAN service.

Event 6: The timing requirements for sensing are not satisfied as required by the definition of the backup channel by one or more CPEs. (Furthermore, a prioritization among the candidate channels can be made based on the measured channel quality.)

Event 7: Once an Unclassified channel has been sensed by all active CPEs, it can be reclassified as a Candidate channel by the SM if no incumbent service has been detected and reported within the predefined time duration.

Event 8: If the channel is not sensed within the timing requirements as specified in IEEE Std 802.22 or according to the regulatory domain requirements, the channel becomes Unclassified. However if the channel is in the Protected state and it has not been sensed as required, it shall remain in the Protected state. (Note that a channel has to be sensed by all active CPEs within the predefined time duration and the results reported to the BS to not be considered as Unclassified.)

The following legend applies to the transition diagram depicted in Figure 245.

a) Ovals indicate the state of the channel (the channel set to which it belongs)

b) Transition lines (i.e., channel state transition) are labeled as Event / Action. Actions triggered by the events for this figure are the state transitions themselves, and so they have been omitted in this diagram.

c) The detailed explanation for each transition Event was given previously.

[29] *Channel quality* refers to a compounded qualitative assessment of the likelihood of the channel to be occupied by an incumbent, the occupancy pattern, the number of CPEs that would be affected by the incumbent, and the level of interference-plus-noise in the channel. This assessment has to do with the implementation of the spectrum manager and does not need to be standardized.

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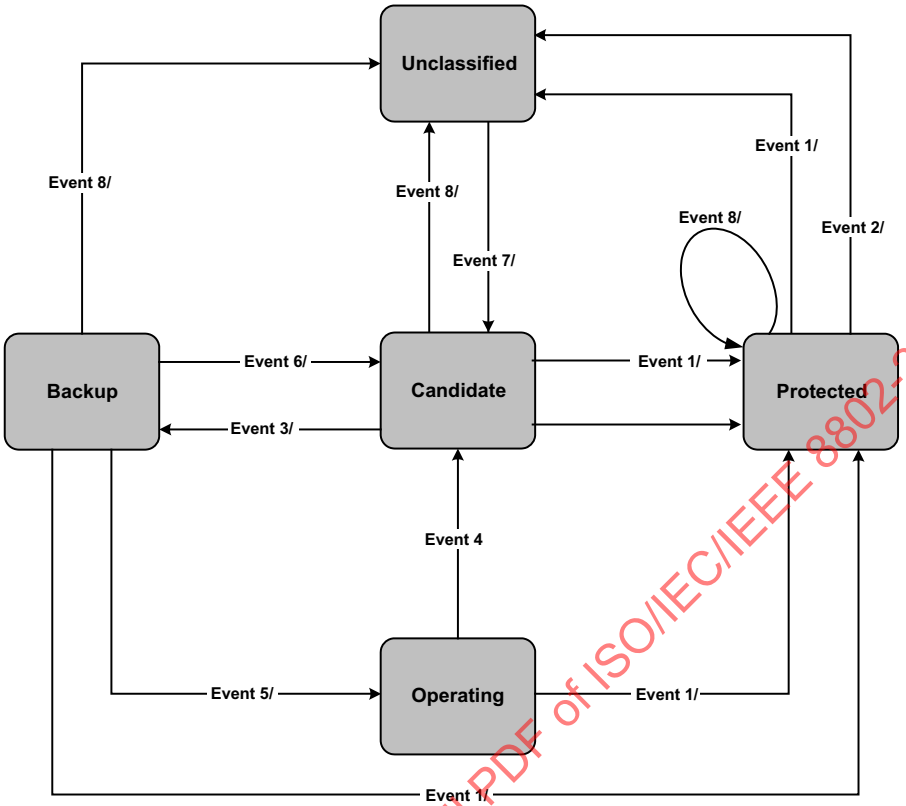

Figure 245—Channel set transition diagram

The channel set transition matrix is also presented in Table 313. Each row specifies the state transition due to each event. Each column specifies state transition due to the events in each row for a particular current state.

A shaded cell within the transition matrix implies that either the specific event cannot or should not occur within that state. And if the event does occur, the SM shall ignore it. For example, the Candidate channel cannot transition to Operating channel directly.

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Table 313—Channel set transition matrix

State / *Events*	***Unclassified***	***Candidate***	***Backup***	***Operating***	***Protected***
Event 1	Protected	Protected	Protected	Protected	
Event 2					Unclassified
Event 3		Backup			
Event 4				Candidate	
Event 5			Operating		
Event 6			Candidate		
Event 7	Candidate				
Event 8		Unclassified	Unclassified		Unclassified

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11.2.3.2 Backup and Candidate Channel Prioritization using spectrum etiquette

The channel selection at a cell obeys the spectrum etiquette rule so that the chosen channel does not interfere, or interferes with a minimum number of channels to be used by its neighbor cells. Without cooperation, the frequency selection in a cell may lead to one or more BS not having enough channels. For example, the available channel sets at BS1, BS2 and BS3 are {1, 3}, {1, 2, 3} and {1, 2, 3} respectively. If BS2 decides to use channel {1} and BS3 decides to use channel {3}, BS1 would have no channel to use. The cooperation also minimizes the channel collision probability when multiple cells switch their operational channels by avoiding using the same backup channel set.

The channel-selection decision of each cell follows the flowchart in Figure 102. The terms of central cell and neighbor cells are relative concepts. Beside the definition of channel sets as in 11.2.3, the following additional channel sets are defined in spectrum etiquette operation:

— WRAN occupied Channel Set: channels that are operating channels of the discovered neighboring WRAN cell.

— Neighbor WRAN Backup Channel Set: channels that are within the backup channel sets of the discovered neighboring WRAN cells. This channel set is built by listening to SCH/CBPs of the discovered neighboring cells carrying the backup channel information.

— Local Priority Set 1: = (Backup Channel Set ∪ Candidate Channel Set) \ (WRAN-Occupied Channel Set ∪ Neighbor WRAN Backup Channel Set)

— Local Priority Set 2: = (Backup Channel Set ∪ Candidate Channel Set) \ (WRAN-Occupied Channel Set)

— Local Priority Set 3: = (WRAN-Occupied Channel Set)

Note the following:

— Symbols ∪, ∩, and \ are set operation of union, intersection, and exclusion, respectively.

— Local Priority Sets 1~3 is local information, which is not shared with neighbor cells.

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The spectrum etiquette is triggered by the following events:

— Incumbent discovery

— Neighbor WRAN cells' discovery/update

— Operating channel switch demand (e.g., due to interference)

— Contention request received from neighbor WRAN cells

The procedure of WRAN spectrum etiquette is depicted in Figure 102 and explained in the following item. Note that the triggering event is defined in the previous paragraph.

1) The SM builds/updates channel sets as described in 7.24.1 and 11.2.3, either by receiving indication from the geolocation database, or spectrum awareness of incumbents and WRANs. The neighboring WRAN occupied channel set and neighboring WRAN backup channel set are built/updated accordingly.

2) Update backup channel set by choosing one or several channels from Local Priority Set 1; if Local Priority Set 1 is empty, update backup channel set by choosing one or several channels from Local Priority Set 2 that are backup channels by the least number of neighbor cells; (if several channels are backup channels of the same number of neighbor cells, the present cell shall choose from those channels randomly.) if Local Priority Set 2 is also empty, choose one or several channel from Local Priority Set 3, which are operating channels by the least number of neighbor cells; (if several channels are operating channels of the same number of neighbor cells, the present cell shall choose from those channels randomly.)

3) If switching operating channel is necessary or demanded by higher layer indication (due to incumbent discovery in the operating channel, significant detected interference in the operating channel, or preferable channel quality of a backup channel, etc.), promote the first backup channel to operating channel; go to step 2) to update backup channel set;

4) If the new operating channel is also an operating channel of a neighbor cell, initialize the self-coexistence contention procedure as described in 7.22.3.2.

5) Update the neighbor cells with new operating and backup channel sets via SCH/CBP.

The spectrum etiquette procedure is further illustrated using the example in Figure 246. The central cell has six neighbor cells. The central cell has one operating channel #1, one backup channel #2 (underlined), and one candidate channel #3 (double underlined). The channel sets information for the neighbor cells are accordingly noted as in Figure 246(a). In Figure 246 (b), two incumbents appear in the central cell on the operating and backup channel, and thus the central cell is forced to change both its operating and backup channel. The spectrum etiquette is triggered. The former candidate channel #7 is promoted to operating channel, and channel #5 is promoted to backup channel, which is only used by one neighbor cell as the operating channel. All the neighbor cells perform spectrum etiquette after receiving the channel set update information from the central cell accordingly, and the resultant channel sets for each cell are illustrated in Figure 246 (b) and Table 314. If another incumbent appears in the central cell on channel #7, the central cell will have to use channel #5 as the operating channel and start contention-based self-coexistence with its neighbor cell. The SM may use information on the performance on the CPE antenna to prioritize the list of candidate channels (see 7.9.7.3.4.9).

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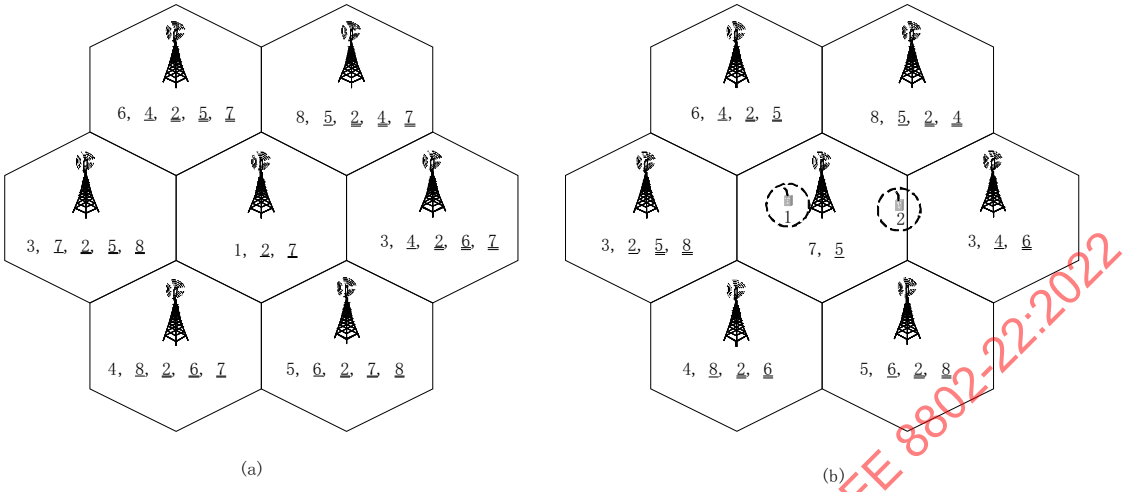

Figure 246—Illustration of the procedure of spectrum etiquette

Table 314—Illustration of the spectrum etiquette procedure

Central cell status	Before	Upon incumbent appearance	After spectrum etiquette
Operating Channel Set	1	~~1~~	7
Backup Channel Set	2	~~2~~	5
Candidate Channel Set	7	3,4,5,6,7,8	φ
WRAN-Occupied Channel Set	3,4,5,6,8	3,4,5,6,8	3,4,5,6,8
Neighbor Backup Channel Set	4,5,6,7,8	3,4,5,6,7,8	4,5,6,7,8
Local Priority Set 1:	2	~~2~~	φ
Local Priority Set 2:	2,7	~~2~~,7	φ
Local Priority Set 3:	3,4,5,6,8	~~2~~,3,4,5,6,7,8	3,4,5,6,8
NOTE—φ = empty set.			

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11.2.4 Association control

Association is defined as the process by which the CPE completes the registration with the BS. When CPEs request association with a WRAN BS (see CPE initialization procedure described in 7.16.2), the SM is responsible for granting or denying association rights to the requesting CPEs. For that, the SM shall consider location information, and basic and registered capabilities of each requesting CPE. The SM shall access the database service, to obtain the list of available channels and corresponding maximum EIRP limits at the CPE's location, and based on the received information, the SM shall decide whether to grant association rights to the CPE in its current operating channel and indicate the maximum transmit EIRP allowed for the

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CPE. It is the responsibility of the SM to granting association rights to the requesting CPE while avoiding harmful interference to incumbents. The SM shall make a decision on CPE association during the CPE registration process (REG-REQ) if it is satisfied that the specifications and capabilities of the CPE are within the tolerable limits for it to join the network.

11.2.5 Spectrum Manager policies

The SM shall be responsible for enforcing the IEEE 802.22 policies within the cell in order to guarantee the required protection of incumbents while supporting QoS for the WRAN users. The SM shall adhere to the policies as specified in Table 315.

Each of the policy in Table 315 is identified using a Policy ID, the event that triggers the policy, the event description and the corresponding action.

Policies with enumeration 1 are related to the events initiated from the database service but not from a locally generated operator database in case the local regulatory domain does not specify the use of such an incumbent database. For the purposes of the IEEE 802.22 operation, a database containing location dependent available channels shall always exist. The SM shall be responsible for accessing the database service in the regulatory domains that mandate the presence of such a database service. In the regulatory domains that do not mandate a database service, a database of available channels shall be provided by the operator. When operating in a regulatory domain that does not require a database service, all channels are initially assumed to be available.

Policies with enumeration 2 are related to an event that a TV signal is detected.

Policies with enumeration 3 are related to an event that a wireless microphone signal or the IEEE 802.22.1 beacon signal is detected.

Remaining policies are a combination of these earlier events or related to whether an IEEE 802.22 device is allowed to transmit under certain conditions.

The actions shall include the following:

— Switch the entire cell to a new operating channel
— Direct a single CPE or a group of CPEs to a different operating channel when possible
— Terminate operation in a given channel for a single CPE, a group of CPEs or the entire cell

The SM shall use one of the channel management mechanisms defined in 11.2.3.

Each channel management action may be triggered by one or more events. For instance, the action of switching channels for the entire cell may be triggered by the detection of an incumbent on the operating channel, by degradation of the QoS due to interference, or traffic load in the current channel.

Although different trigger events may be supported depending on the implementation, the trigger events and corresponding channel management actions shall be executed as described in to provide protection of incumbents or as required by regulatory policies applicable within the regulatory domain.

Note that the value for timer Tch_move (i.e., T44, see Table 338) used in is to be found in Table 315 for the various Regulatory domains where the WRAN operation takes place (see Table 315). The default value of Tch_move shall be 2 s.

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Table 315—Spectrum Manager policies

Policy ID	IEEE 802.22 component involved	Event trigger	Event description	Action
1a	BS	DB S	If the SM is directed by the database service that the current operating channel is no longer available for the BS (see 15.2.1.3.6)	Set the Flag Initiate_Channel_Move to '1'. Initiate a channel switch of the entire cell to a new operating channel within (Tch_move – 0.5) s from the time when the database service informed the SM. The new operating channel should be the highest priority backup channel. The timer Tch_move (i.e., T44) is to be found in Annex A for the various Regulatory domains where the WRAN operation takes place. The default value of the Tch_move shall be 2 s
1b	CPE	DBS	If the SM is directed by the database service that the current operating channel is no longer available for some of the CPEs (see 15.2.1.3.6)	**Option 1:** Set the Flag Initiate_Channel_Move to '1'. Initiate a channel switch of the entire cell to a new operating channel within (Tch_move – 0.5) s from the time when the database service informed the SM. The new operating channel should be the highest priority backup channel. The default value of the Tch_move shall be 2 s. **Option 2:** Disassociate the CPEs that are not allowed to operate on the current channel within (Tch_move – 0.5) s from the time when the database service informed the SM and continue normal operation with the other CPEs. A DREG-CMD with Action Code = 0x04 (7.9.12), aimed at dropping their association on the current operating channel, shall be sent to these CPEs so that they no longer wait for an allocation in the US-MAP and/or transmit an opportunistic BW request UCS or Ranging request. Optionally, the BS may signal the affected CPEs to move to a particular channel using the DREG-CMD with Action Code = 0x00, in order to re-associate with another BS and continue their operation. The default value of the Tch_move shall be 2 s.

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Table 315—Spectrum Manager policies *(continued)*

Policy ID	IEEE 802.22 component involved	Event trigger	Event description	Action
1c	BS	DBS	If the SM obtains information from the database service that indicates the current operating channel will become unavailable for the BS at a specific time in the future (see 15.2.1.3.6 and 15.2.1.4.4.4)	**Option 1:** Set the Flag Initiate_Channel_Move to '1'. Initiate a channel switch of the entire cell to a new operating channel no later than (Tch_move – 0.5) s after the time specified by the database service. The new operating channel should be the highest priority backup channel. The default value of the Tch_move shall be 2 s **Option 2:** Disassociate the CPEs that are not allowed to operate on the current channel within (Tch_move – 0.5) s after the time specified by the database service and continue normal operation with the other CPEs. A DREG-CMD with Action Code = 0x04 (7.9.2) aimed at dropping their association on the current operating channel shall be sent to these CPEs so that they no longer wait for an allocation in the US-MAP and/or transmit an opportunistic BW request UCS or Ranging request. Optionally, the BS may signal the affected CPEs to move to a particular channel using the DREG-CMD with Action Code = 0x00, in order to re-associate with another BS and continue their operation. The default value of the Tch_move shall be 2 s.
1d	CPE	DBS	If the SM obtains information from the database service that indicates the current operating channel will become unavailable for some of the CPEs at a specific time in the future (see 15.2.1.3.6 and 15.2.1.4.4.4)	**Option 1:** Schedule a channel switch for the entire cell to a new operating channel at least 0.5 s before the expected time (as obtained from the database service) at which its current channel will become unavailable, by setting the Flag Initiate_Channel_Move to '1'. The new operating channel should be the highest priority backup channel. **Option 2:** If the channel is going to be unavailable for a period of time less than the CPE_Registration_Timer (7.16.2.11) then temporarily dis-associate and disable the CPEs that are not allowed to operate on the current channel within (Tch_move – 0.5) s from the time when the database service informed the SM and continue normal operation with the other CPEs. A DREG-CMD with Action Code = 0x01 shall be sent to the CPEs (see 7.9.12), so that the CPEs affected will shutdown their transmission and only listen on the channel. Later, the BS may signal the affected CPEs to move to return to normal operation on that channel using the DREG-CMD with Action Code = 0x03 in order to re-associate with another BS and continue their operation. If the period of unavailability is greater than the CPE_Registration_Timer, than the timer will expire and the CPE shall attempt re-association on the next available channel. The default value of the Tch_move shall be 2 s.

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Table 315—Spectrum Manager policies *(continued)*

Policy ID	IEEE 802.22 component involved	Event trigger	Event description	Action
1e	BS	DBS	Where a database service exists for the regulatory domain of operation (see Annex A), if such a service becomes unavailable for greater than T45 specified in Annex A, for that domain (default value for T45 shall be 1 h) (see 15.2.1.3.6 and 15.2.1.4.4.4)	The BS shall de-register its associated CPEs and terminate its own operation until the database service becomes available.
1f	CPE	DBS	Where a database service exists for the regulatory domain of operation (see Annex A), and if a new CPE is trying to register (see 15.2.1.3.4 and 15.2.1.3.6)	Do not allow the CPE to register to the network until the channel availability information is available.
2	BS/CPE	Signal detect-ed	If the signal detected on the operating channel or either of its first adjacent channels is a TV signal through the BS spectrum sensing function or through a combination of sensing results from multiple CPEs. [a]	

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Table 315—Spectrum Manager policies *(continued)*

Policy ID	IEEE 802.22 component involved	Event trigger	Event description	Action
3a	BS/CPE	Signal detect-ed	If the signal detected on the operating channel is a wireless microphone signal through the BS spectrum sensing function or through the sensing results from a CPE or a combination of multiple CPEs.[b] See NOTE 1.	

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Table 315—Spectrum Manager policies *(continued)*

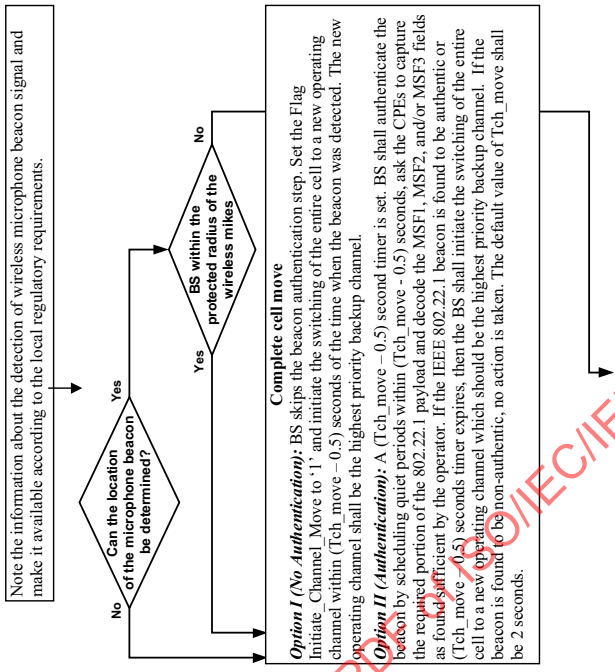
Policy ID	IEEE 802.22 component involved	Event trigger	Event description	Action
3b	BS/CPE	Signal detect-ed	If the signal detected on the operating channel is an IEEE 802.22.1 wireless microphone beacon signal.[c] See NOTE 2.	

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Table 315—Spectrum Manager policies *(continued)*

Policy ID	IEEE 802.22 component involved	Event trigger	Event description	Action
				Specific CPEs cease to operate or move ***Option I (No Authentication)*** **:** BS skips the beacon authentication step and dis-associates the CPEs that are within less than MPR from the wireless microphone operation within (Tch_move – 0.5) seconds from the time when the IEEE 802.22.1 signal was detected and continue normal operation with other CPEs. A DREG-CMD with Action Code = 0x04 shall be sent to these CPEs before dropping their association so that the CPEs no longer wait for an allocation in the US-MAP and/or transmit an opportunistic BW request, UCS notification or Ranging request. Optionally, the BS may signal the next channel to go to for the dis-associated CPEs in the DREG-CMD with Action Code = 0x00 before shutting down the communication. The default value of Tch_move shall be 2 seconds. ***Option II (Authentication):*** A (Tch_move – 0.5) second timer is set. BS shall authenticate the beacon by scheduling quiet periods within (Tch_move – 0.5) seconds, ask the CPEs to capture the required portion of the IEEE 802.22.1 payload and decode the MSF1, MSF2, and/or MSF3 fields as found sufficient by the operator. If the IEEE 802.22.1 beacon is found to be authentic or (Tch_move – 0.5) seconds timer expires then the BS shall dis-associate the CPEs that are within MPR from the wireless microphone operation within (Tch_move – 0.5) seconds from the time when the 802.22.1 signal was detected and continue normal operation with the other CPEs. A DREG-CMD with Action Code = 0x04 shall be sent to these CPEs before dropping their association so that the CPEs no longer wait for an allocation in the US-MAP and/or transmit an opportunistic BW request, UCS or Ranging request. Optionally, the BS may signal the next channel to go to for the dis-associated CPEs in the DREG-CMD with Action Code = 0x00 before shutting down the communication. If the beacon is found to be non-authentic, no action is taken. The default value of Tch_move shall be 2 seconds.
4	BS/CPE	DBS or Signal detect-ed	If there is no backup channel available AND (if the database service indicates that the current operating channel is not available or the signal detected on the operating channel is a wireless microphone or an IEEE 802.22.1 signal, or, in case of a TV signal, the signal is detected on the operating or any of its first adjacent channels) (see 15.2.1.3.6 and 15.2.2.1.3).	Terminate the operation of the entire cell in the current operating channel within Tch_move s. The default value of Tch_move shall be 2 s.

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Table 315—Spectrum Manager policies *(continued)*

Policy ID	IEEE 802.22 component involved	Event trigger	Event description	Action
5	CPE	Signal detected	If before the CPE has registered with a BS on the same channel, the signal detected on the operating channel is a wireless microphone or an IEEE 802.22.1 signal, or, in case of a TV signal, the signal is detected on the operating or any of its first adjacent channels.	The CPE shall not transmit on that channel.
6	CPE	Signal detected	If the signal detected on the operating channel is a wireless microphone or an IEEE 802.22.1 signal, or, in case of a TV signal, the signal is detected on the operating or any of its first adjacent channels and the CPE has already registered with the BS.	The CPE shall send a UCS to alert the BS of the presence of the detected signal in its coverage even if it did not plan to transmit because of the potential interference from the downstream transmission.
7a	BS/CPE	DBS or Signal detected	If the SM confirms the presence of any other device that is granted protection in the regulatory domain (see Annex A).	Comply to local regulations.
7b	BS/CPE	Signal detected	If the SM confirms the presence of any other device that is not granted protection in the regulatory domain (see Annex A).	No action is to be taken.

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Table 315—Spectrum Manager policies *(continued)*

Policy ID	IEEE 802.22 component involved	Event trigger	Event description	Action
8	CPE	Geo-location	BS has determined that the position of the CPE has changed by greater than that specified by the local regulations (see Annex A) (default 50 m radius).	BS shall request the CPE to geolocate and report its position to verify the change in location. If the location is confirmed to have changed, the BS shall immediately obtain a new list of available channels from the database service based on the new location of the CPE. The CPE shall abide by the EIRP limit specified by the database service or, if not available, abide by the regulatory requirements specified in Annex A. If the service for the affected CPE on the current operating channel at the new location is prohibited or if the device type is fixed as specified in Annex A, then the BS shall de-register the CPE using DREG-CMD with Action Code = 0x04.
NOTE 1— The variable microphone protection radius (MPR) is defined in Annex A for the various Regulatory domains where the WRAN operation takes place. The default value of the MPR should be 4 km. NOTE 2—The variable Microphone_Protection_Radius (MPR) is defined in Annex A for the various Regulatory domains where the WRAN operation takes place. The default value for MPR shall be 4 km.				

[a] Detection threshold is to be found in Annex A for the various Regulatory domains where the WRAN operation takes place.
[b] The following action should apply to any of the nodes (BS or CPE) that detected the wireless microphone signal.
[c] The following action should apply to any of the nodes (BS or CPE) that detected the IEEE 802.22.1 wireless microphone beacon signal.

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11.2.6 Spectrum Manager operation

The SM, as shown in the IEEE 802.22 reference model (Figure 4), shall be part of the cognitive plane and shall always be present at the IEEE 802.22 BS. The SM is responsible for important tasks, such as maintaining spectrum availability information, channel selection, channel management, scheduling spectrum sensing operation, access to the database, enforcing IEEE 802.22 and regulatory domain policies, enabling self-coexistence, etc. The detailed operation of the SM state machine and procedures is described in the following subclauses.

11.2.6.1 Spectrum Manager state machine

Figure 247 describes the SM state machine diagram. The SM has two states of operation, namely, the SM at Network Initialization, and the SM at Network Operation.

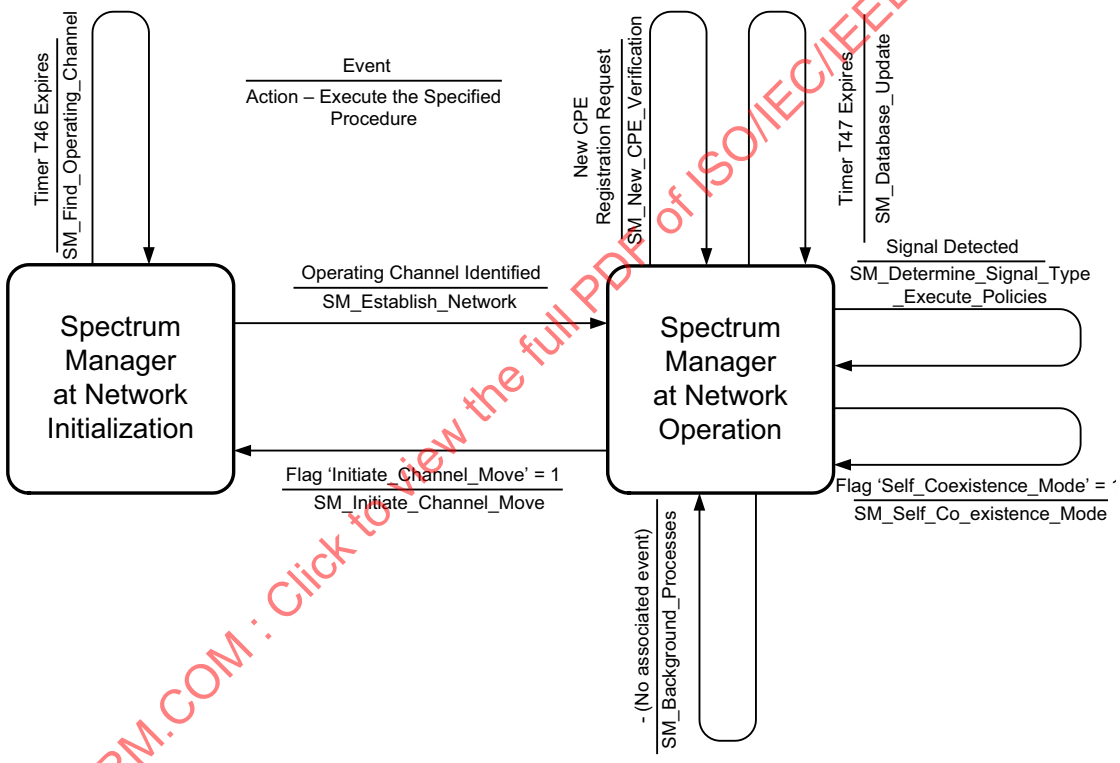

Figure 247—Spectrum Manager state machine

The Timer T46 in the State SM at Network Initialization shall be initially set to a default value of 20 ms. However; the value of this timer shall be configurable in accordance with the other regulatory domain requirements as specified in the Annex A.

During the Network Initialization state, the primary responsibility of the SM shall be to find the operating channel.

Once the Timer T46 expires, the SM shall execute the Procedure SM_Find_Operating_Channel. The various tasks involved in order to find an operating channel have been illustrated in Figure 248.

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In case, the SM at this stage already has an exclusive backup channel to operate on, the SM shall choose the operating channel based on spectrum etiquette as described in 11.2.3.2. The SM shall then execute the Procedure SM_Establish_Network in the Normal MAC Operational Mode and move to the State Spectrum Manager at Network Operation. This may happen when the SM was operating on some other channel before where it had already computed its backup channels, and now it is in a transition after it has initiated a channel move.

In case, no exclusive backup channels are available, the procedure to find an operating channel shall consist of accessing the database service to obtain a list of available channels, discovering neighboring IEEE 802.22 systems, synchronizing and scheduling quiet periods, initiating sensing for the primary user signals and exploring the possibility to convert some of the available channel to an operating channel once the conditions in 11.2.3 have been met. In selecting the new operating channel from the list of available channels, consideration should be given to the relative performance of the BS receive antenna at these various available channels for best operation.

11.2.6.2 Procedure SM_Find_Operating_Channel

The SM shall make sure that the database service is available within T45. If this is not the case, then it shall execute Policy 1e. Timer T45 as specified in Procedure SM_Find_Operating_Channel indicates the longest time that a WRAN service can operate in the unlicensed band without access to the database service. The timer values may be initially set to the United States regulatory domain, however they shall be configurable in accordance with the other regulatory domain requirements as specified in Annex A.

The SM shall take into consideration the database service information, to find a list of available channels. The SM shall then synchronize its quiet periods to other IEEE 802.22 systems, schedule its own quiet periods and convey the quiet period information to the Spectrum Sensing Automatons through a SCH or an appropriate MAC message. The SSA shall move into the ‘Initialization State’ as described in 11.3.2. Based on the sensing information, the Spectrum Sensing Automatons shall provide the SM with a list of candidate channels as a subset of the available channels. The SM shall schedule further quiet periods to convert the list of candidate channels to backup channels.

A candidate channel shall become a backup channel and a backup channel shall become an operating channel based on the state transition diagram as specified in 11.2.3.

In case one or more exclusive backup channels are available, the SM shall choose an operating channel using spectrum etiquette as described in 11.2.3.2. The SM may also use information on the performance on the CPE antenna to prioritize the list of candidate channels (see 7.9.7.3.4.9). The SM shall set the Flag Self_Coexistence_Mode to ‘0’, execute the Procedure SM_Establish_Network and move to the State Spectrum Manager at Network Operation.

As soon as the SM moves to the State Network Operation, it shall set the Timer $T_{Refresh_Database_Info}$. The default value for the Timer $T_{Refresh_Database_Info}$ shall be 1 h; however, the value for this timer shall be configurable in accordance with the other regulatory domain requirements as specified in Annex A.

In case no exclusive backup channels are found, the SM shall execute Procedure SM_Establish_Network in the Co-existence Mode. In this case, the SM shall set the Flag Self_Coexistence_Mode to ‘1’, execute the Procedure SM_Establish_Network and move to the State Spectrum Manager at Network Operation.

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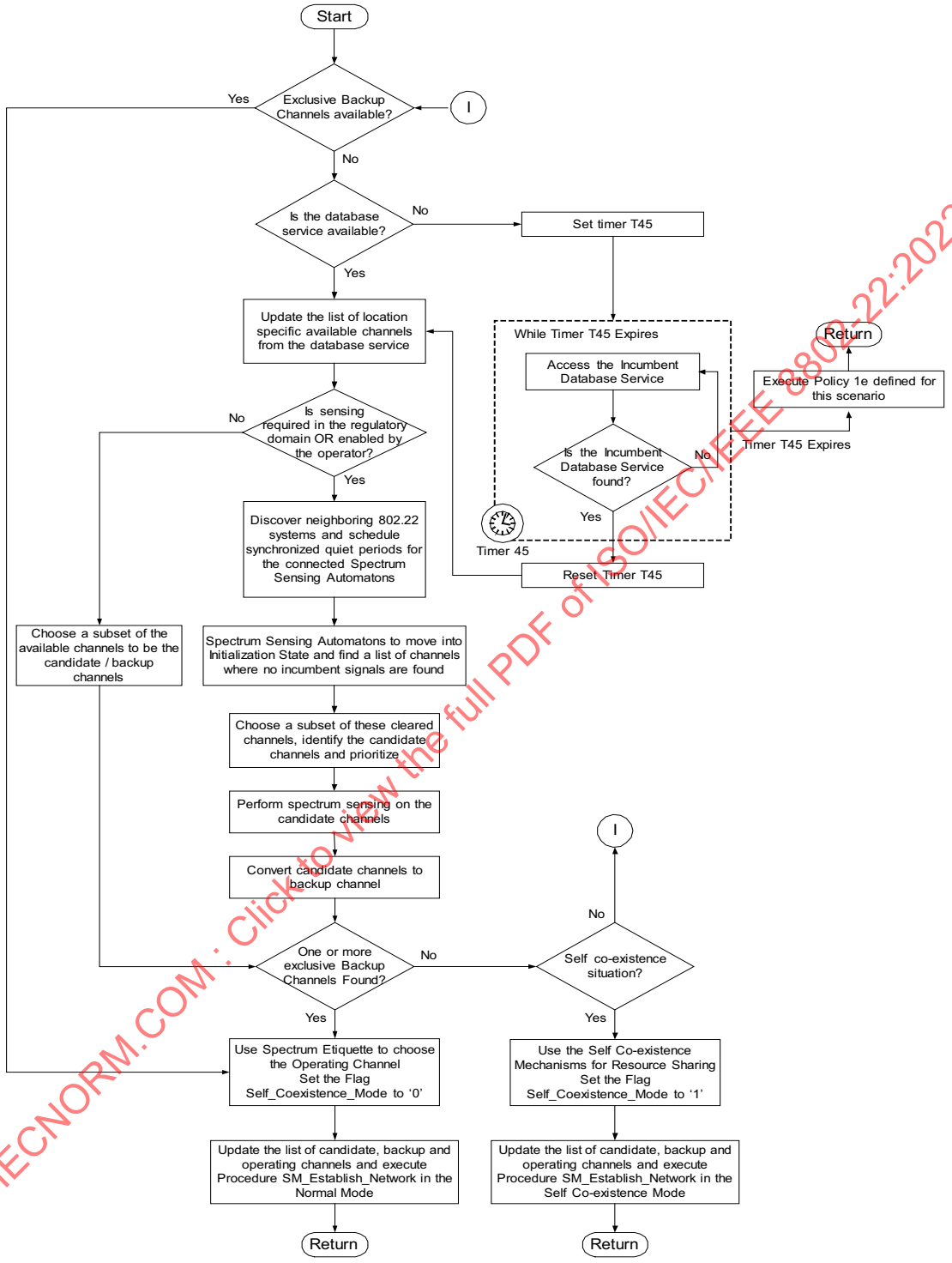

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Figure 248—Procedure find operating channel

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11.2.6.3 Procedure SM_Establish_Network

The Procedure SM_Establish_Network has been illustrated in Figure 249. Initially, the SM shall instruct the BS to synchronize to other IEEE 802.22 systems. If it is the Normal MAC Operational Mode of operation (Flag Self_Coexistence_Mode is '0'), the BS shall start transmission on the identified operating channel and wait for the CPEs to join the network. The CPE initialization operation and registration operation has been described in 7.16.2 and 7.16.2.11, respectively.

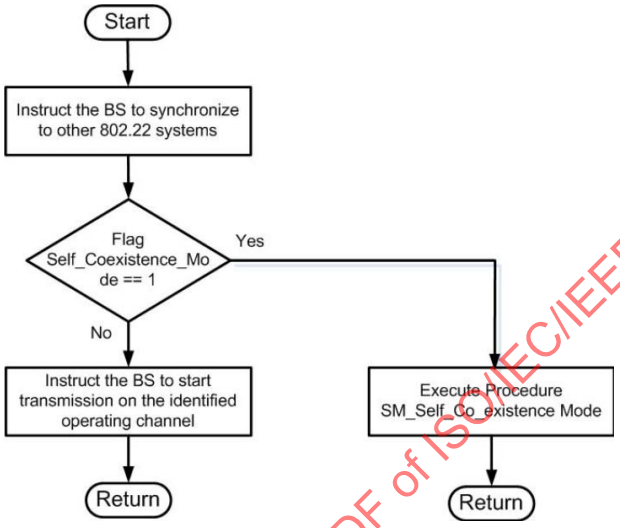

Figure 249—Procedure Establish_Network

In the Self-Coexistence Mode of operation, the BS shall execute Procedure SM_Self_Coexistence_Mode, which is described as follows.

11.2.6.4 Procedure SM_CPE_Registration_and_Tracking

For each new and unregistered CPE that makes a registration request to the BS, the SM shall access the database service to verify if the current operating channel is available at the CPE location. In addition, the SM shall verify the security suite that the CPE supports and its spectrum sensing capabilities are within tolerable limits. If the SM finds that the current occupied channel is not available at the CPE location, or the CPE capabilities are less than required, it shall choose to prevent the CPE from registering to the network. The SM shall also track the location of each CPE. Policy 8 in 11.2.5 specifies the action to be taken in case the location of any CPE has changed.

The SM may also make a decision that in order to accommodate one or more such CPEs; it may need to move to another operating channel. In this case, the SM shall set the Flag Initiate_Channel_Move to '1' and execute the Procedure SM_Initiate_Channel_Move. Figure 250 illustrates the SM operation during Procedure SM_ CPE_Registration_and_Tracking.

Note that the CPE registration messaging contains the location information as a NMEA string. The BS also tracks the CPE location by requesting CPE re-registration based on the expiration of timer T30 (see 7.16.2.11), for which the value can be configured for fixed or portable operation (see 7.9.7.3.5).

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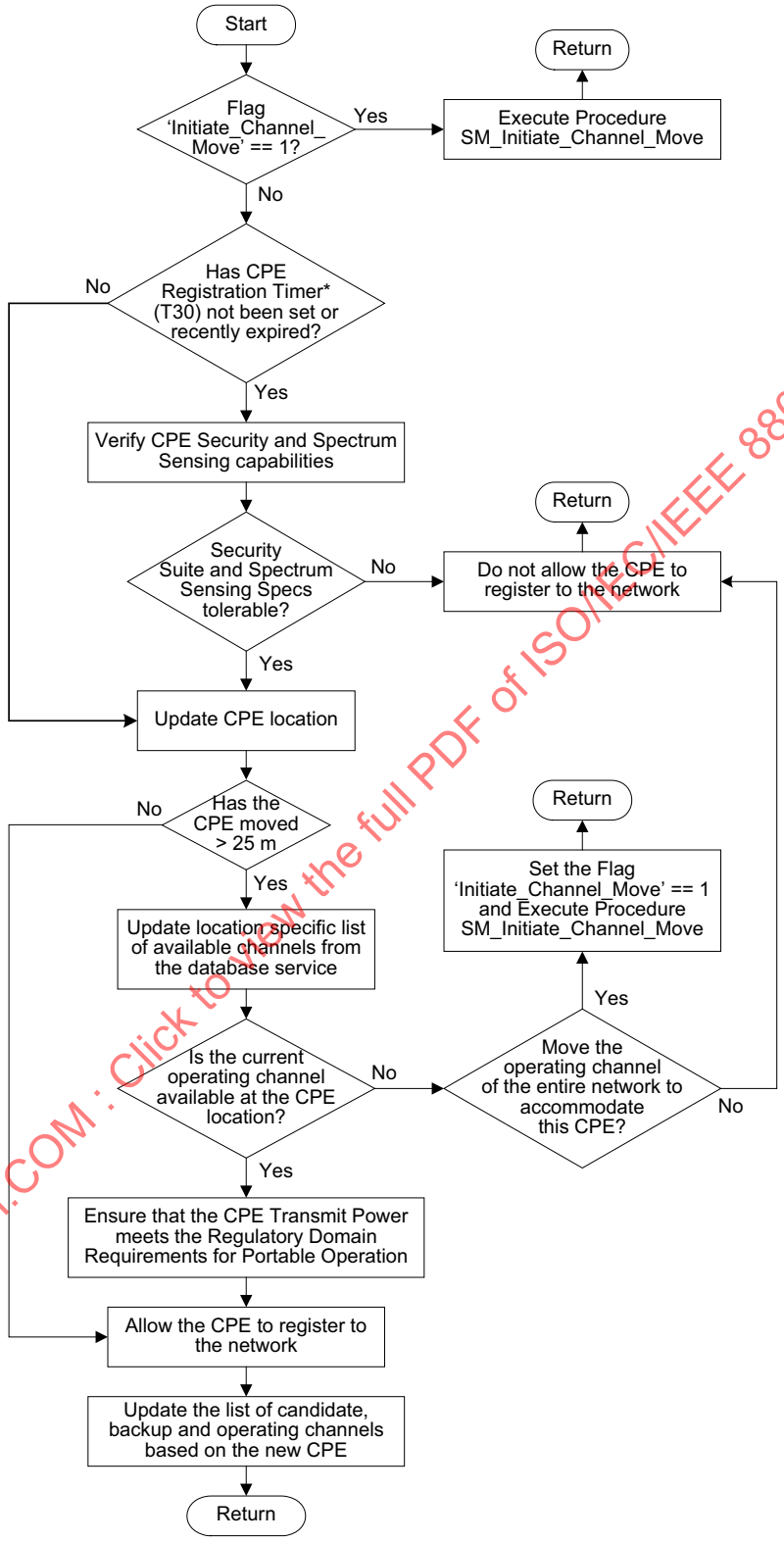

Figure 250—Procedure SM_CPE_Registration_and_Tracking

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11.2.6.5 Procedure SM_Database_Update

In the event that the Timer $T_{Refresh_Database_Info}$ expires, the SM shall execute Procedure SM_Database_Update as illustrated in Figure 251. During this procedure, the SM shall verify that the current operating channel is available for itself and all its CPEs. If the current operating channel is available for the BS and all its associated CPEs, the BS shall continue the operation on the existing operating channel.

If the current operating channel is not available for the BS or one or more of its CPEs, the SM shall execute the policies as specified in the Spectrum Manager policies in 11.2.5 and as shown in Figure 251. The SM shall also update the candidate and backup channel list based on the new information.

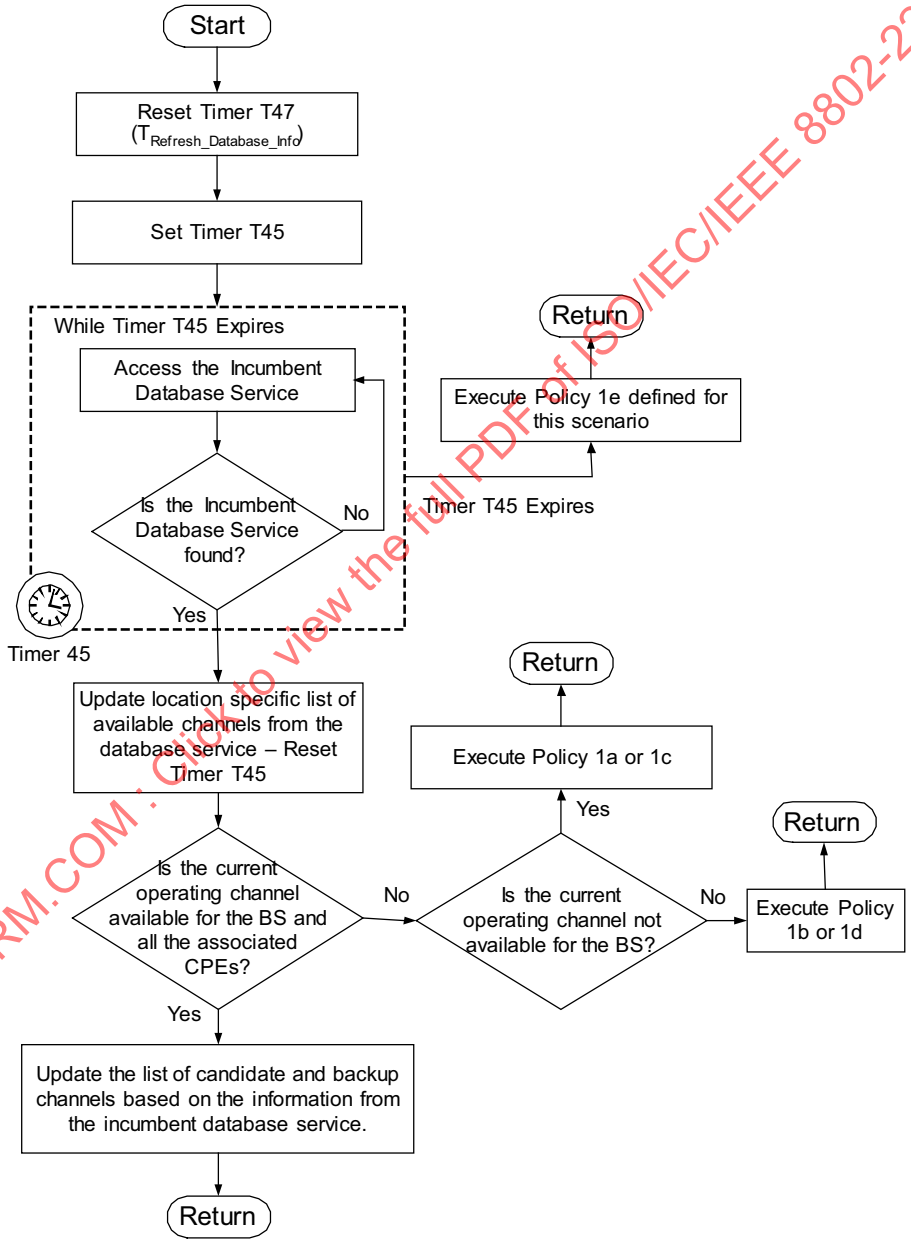

Figure 251—Procedure SM_Database_Update

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11.2.6.6 Procedure SM_Determine_Signal_Type_Execute_Policies

If the SM is notified that a signal is detected through the SSAs of the BS or one or more of its CPEs, the SM shall execute Procedure SM_Determine_Signal_Type_Execute_Policies. The Procedure SM_Determine_Signal_Type_Execute_Policies is illustrated in Figure 252. If a signal is detected, but its signal type cannot be determined, the SM shall schedule additional quiet periods for a larger spectrum sensing integration time. Based on the type of signal that is detected, the SM shall execute policies as specified in the Spectrum Manager policies in 11.2.5.

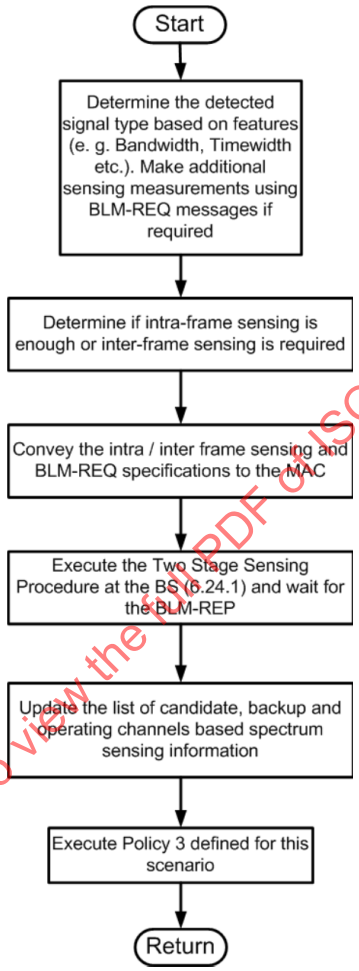

Figure 252—Procedure SM_Determine_Signal_Type_Execute_Policies

11.2.6.7 Procedure SM_Background_Processes

SM shall constantly run the Procedure SM_Background_Processes. In this procedure, the SM shall be responsible for prioritizing the list of backup/candidate channels, scheduling the quiet periods, assigning the sensing responsibilities to the corresponding SSAs, scheduling the CBP transmissions, scheduling the Self-Coexistence Windows (SCWs) collecting the spectrum sensing reports (through BLM-REP), maintaining the channel state information, monitoring the link quality of various CPEs, and deciding if channel move is needed. The prioritization of the backup/candidate channel list shall be based on information from the database service, spectrum sensing information, spectrum etiquette and the information on the CPE antenna gain as a function of frequency. The SM operation during Procedure SM_Background_Processes has been illustrated in Figure 253.

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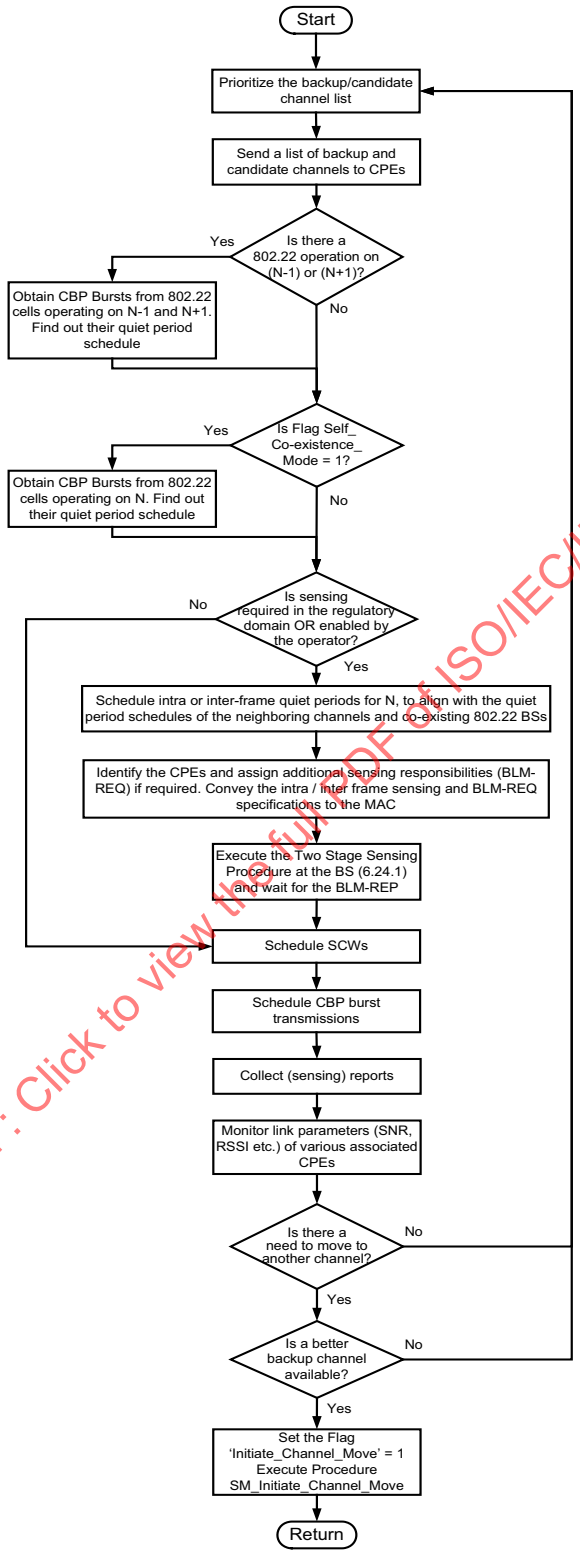

Figure 253—Procedure SM_Background_Processes

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11.2.6.8 Procedure SM_Initiate_Channel_Move

In case the SM finds that there is a need to move to another channel, the SM shall set the Flag Initiate_Channel_Move to '1'.

If the Flag Initiate_Channel_Move is set to '1', then the SM shall execute Procedure SM_Initiate_Channel_Move. Procedure SM_Initiate_Channel_Move has been illustrated in Figure 254. During the execution of this procedure the SM shall reset the Flag Initiate_Channel_Move to '0'. If exclusive backup channels are available, the SM shall update the list of operating, candidate and backup channels, and execute Procedure SM_Establish_Network.

In case no exclusive backup channels are available, the SM shall execute Procedure SM_Find_Operating_Channel.

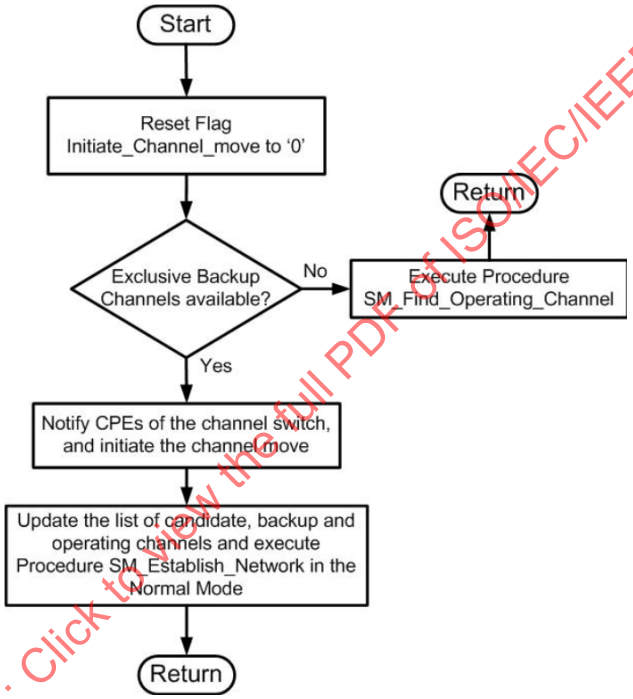

Figure 254—Procedure SM_Initiate_Channel_Move

11.2.6.9 Procedure SM_Self_Coexistence_Mode

If the Flag Self_Coexistence_Mode is set to '1', then the SM shall execute Procedure SM_Self_Coexistence_Mode as illustrated in Figure 255. During the Procedure SM_Self_Coexistence_Mode, the SM shall choose a BS to share the channel with, or allow another BS to share its own channel, alert the CPEs that the BS is in the self-coexistence MAC Operational mode via the SCH, and assist the BS in executing procedures that are defined in xx on self-coexistence mechanisms. In case an exclusive backup channel becomes available, the SM shall reset the Flag Self_Coexistence_Mode to '0'.

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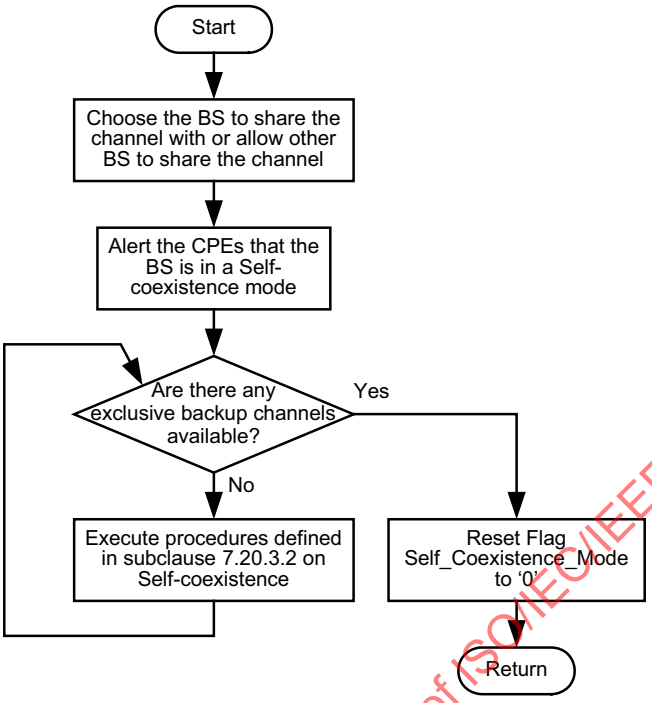

Figure 255—Procedure SM_Self_Coexistence_Mode

11.3 Spectrum Sensing Automaton

All the IEEE 802.22 devices (BS and CPEs) shall also have an entity called the Spectrum Sensing Automaton (SSA). The SSA interfaces to the Spectrum Sensing Function (SSF) and executes the commands from the SM to enable spectrum sensing. The BS normally controls the sensing behavior of the SSA. However, the SSA shall control its sensing behavior locally under the following six conditions:

1) At the initial turn-on of the BS before it starts to transmit any signal at initial turn-on of the CPE before association is established with the BS
2) During the quiet periods defined by the SM and signaled by the BS through the SCH for in-band sensing
3) During out-of-band sensing at the BS when the BS is not transmitting
4) During idle time at the CPE when the BS has not attributed any specific task to the CPE sensing signal path through the BLM-REQ message, see 7.9.18.1, when the CPE does not transmit or, if the WRAN operation and RF sensing use the same tuner, when the CPE does not transmit or receive
5) When the CPE loses contact with its BS.

The functionality of the SSA for these six specific cases, and embodied in the local sensing automaton, is covered by the normative behavioral models described in the following subclauses.

11.3.1 SSA state machine operation

The SSA state machine operation is shown in Figure 256. The SSA state machine consists of two states—SSA In-band Sensing and SSA Out-of-band Sensing. During the SSA Out-of-band Sensing state, the SSA may execute any of the three procedures as described in 11.3.2, 11.3.4, and 11.3.5, based on the event that may have occurred.

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During the SM scheduled in-band quiet periods, the SSA shall control in-band sensing on channels N and N±1.

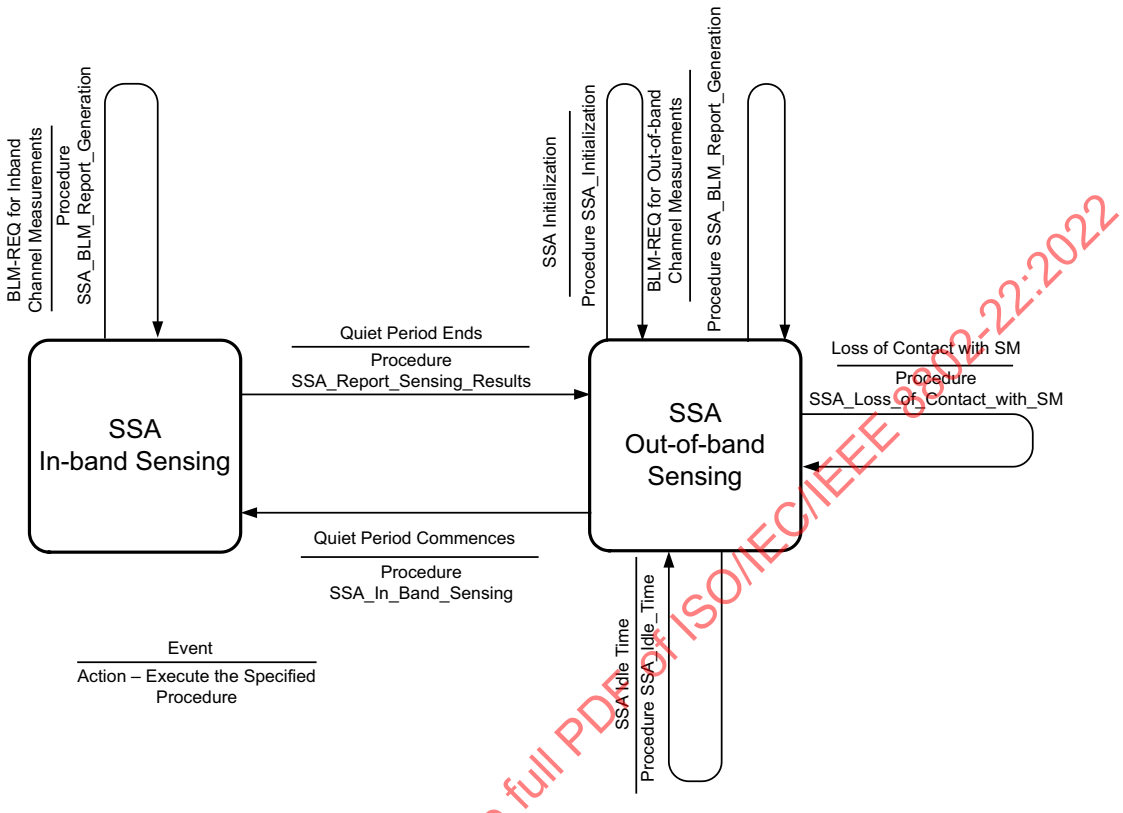

Figure 256—Spectrum Sensing Automaton state machine operation

11.3.2 Procedure SSA_Initialization

The functionality of the SSA local autonomous spectrum sensing process, when the BS is initially switched on or when the CPE is initialized before association with the BS, is described as follows and depicted in Figure 257 and Figure 258, respectively. This process is part of the more general BS and CPE initialization process described in 7.6.1 and 7.16.2, respectively. At initial turn-on and self-test, the SSA shall sweep a specific channel, a specified range of channels or all the channels that are likely to be impacted by the WRAN device operating on a given channel depending on pre-set information at the BS or CPE, or directions from the higher layers at the BS or CPE. If all channels of a range of operation need to be sensed, one additional channel at both ends of the range shall be sensed to cover the adjacent channel case unless this goes beyond the extent of the relevant TV band.

For each channel, an RSSI measurement[30] shall be performed on the WRAN signal path and attempt shall be made to capture a WRAN superframe header or a CBP burst. If an SCH is captured and the level of the RF signal on the WRAN signal path is sufficiently high (see Table 326), attempt shall be made to acquire the frame header, the broadcast PDUs sent by the BS to advertise the WRAN service for BS and CPE initialization and the list of channels prohibited from incumbent operation obtained from the BS by the

[30]See Footnote 20 of the FCC R&O 08-260. The RSSI measurements will generate more useful information than a simple signal detection and classification. When sufficiently high-level signals are present, the signal classification schemes developed for low signal levels may be replaced by simpler, faster, and more effective signal classification schemes. Such fast incumbent signal classification schemes will be implementation dependent.

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IPC-UPD management MAC message. If an SCH can be acquired but the signal level is insufficient or a CBP burst can be acquired but cannot be decoded, the presence of a WRAN signal shall be recorded along with the channel number and the measured RSSI. If an SCH or a CBP burst cannot be detected, RF signal sensing and signal classification shall be carried out to determine the presence of broadcast incumbents and their signal type. The result of the measurement and the signal classification shall be provided to the SM at the BS or stored at the CPE locally so that it can later be sent to the BS when association is established or later on upon request from the BS.

The channel shall then be incremented and the above initial sensing shall be repeated. The order in which the channels are to be sensed will be implementation dependent. Note that the list of channels prohibited from incumbent operation acquired from the SM through the IPC-UPD message can be used to skip sensing on these channels.

Note that when a BS initializes, it is primarily interested in identifying an empty channel where it can establish its service. When a CPE initializes, it is primarily interested in identifying operational WRAN channels with which it can associate. These two goals are not completely compatible and this is why two partly different SSA initialization processes shall exist at the BS and CPE (see Figure 257 and Figure 258).

In the case of the BS SSA initialization, if there is at least one available channel (N_0), a selection shall be made and a second round of spectrum sensing shall then take place on the adjacent channels ($N_0 \pm 1$) of the selected channel. Attempt to acquire an SCH or CBP burst shall be made on the WRAN signal path to determine the timing of the quiet periods of an eventual WRAN signal on these two adjacent channels. If a WRAN signal is detected, RF signal sensing and signal classification shall then be carried out on the channel (N_0+1 or N_0-1 or both) through the sensing path during the identified quiet periods to verify the presence and the identity of the incumbent service underneath the WRAN operation. In such case, a new available channel will need to be selected. If no incumbent signal is detected underneath the WRAN operation in the adjacent channels, then the BS can proceed with the next step in its initialization process (see 7.16.1).

If there is no channel available, the BS shall either abort its initialization process or initiate a self-coexistence process on a selected channel with the already existing WRAN operation (see 7.22.3.2).

In the case of the SSA initialization, if there is no WRAN channel that can be used at the location of the CPE, its initialization shall be aborted. Depending on the CPE implementation, the information obtained from the various WRAN BSs may be presented to the local interface of the CPE so that it could ultimately be displayed on a local screen to allow for an informed selection among available local WRAN networks available in the area at the CPE (similar to the Access Point selection in Wi-Fi). Local algorithms could also be implemented in the CPE to automate the process for choosing the WRAN network.

A second round of spectrum sensing shall then take place on the selected channel (N_0) and its adjacent channels ($N_0 \pm 1$). Since, by definition, a WRAN service is present on the selected channel, the WRAN signal path shall acquire the SCH or the CBP burst through the WRAN signal path to determine the timing of the quiet periods in this channel. RF signal sensing and signal classification shall then be carried out on channel N_0 by the sensing path during the quiet periods to verify the presence and, in this case, attempt to identify the incumbent service underneath the WRAN operation at the specific CPE location. The findings shall be recorded locally.

The sensing process shall then proceed to sense the two adjacent channels during the quiet periods by sensing the presence of an incumbent signal and classifying its type. The findings shall be recorded locally and if incumbents are found in these channels, the selected channel shall be removed from the list of available WRAN services and the updated list shall be presented to the higher layers at the CPE for the selection of another WRAN service. If no more WRAN service exists at the CPE, its initialization shall be aborted. However, if a WRAN service exists and no incumbent is present in the three channels (N_0 and $N_0 \pm 1$), the CPE initialization process shall continue as described in 7.16.2.

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In the case of the CPE initialization, if the authorization is refused by the currently selected BS, the currently selected channel shall be removed from the list of available WRAN services (entry "A" in Figure 257) and this list shall be presented to the higher layers at the CPE for a new channel selection to be made. Then, the next round of sensing process shall be repeated with the sensing of the newly selected channel (N_0) and its adjacent channels ($N_0 \pm 1$) as described above. If no incumbent is present in the three channels, the CPE initialization process shall continue as described in 7.16.2.

11.3.3 Procedure SSA_In-band_Sensing

The SM at the BS is responsible for scheduling the in-band (channels N and N±1) quiet periods. The SSA shall autonomously utilize those quiet periods to perform in-band spectrum sensing and report the results of incumbent discovery to the SM.

Once a Quiet period is scheduled by the SM and signaled by the SCH to the CPE, the CPE will first verify if the sensing timers have lapsed since the last sensing on channels N or N±1 (i.e., lapse timers > T53, see Figure 259). An urgent MAC message contained in the GMH (see QPA bit in Table 7) will be sent to the BS to ask the SM to increase its scheduling of the quiet periods. Then, the SSA will verify that this quiet period is sufficiently long to initiate in-band sensing. This length will depend on the local capability of the sensor at the CPE. Depending on the sensing technology used, sensing may need to be done in a 'contiguous' fashion to reach the required sensing threshold or with integration over a number of sensing instances of smaller length to be able to reach the required sensing threshold. If the quiet period that is scheduled is shorter than required, the SSA will have to skip sensing for that specific period. (Note that other CPEs that require less time to carry out sensing shall proceed with their sensing.)

If the sensing period is sufficiently long, the SSA shall undertake the sensing on N and N±1where needed. Once the quiet period is over, the in-band sensing shall be put on hold. At the start of the next scheduled quiet period, the SSA shall resume its in-band sensing activity by verifying the time lapsed since the last sensing on each of the N, N+1, and N–1 channels and initiate new sensing when the time lapsed since the last sensing gets close to the maximum period between sensing. As a result, if an incumbent is discovered, the SSA shall either use the UCS flag in the header of its next upstream PDU (see 7.8.1.1) to signal the presence of the incumbent in the channel or, if no bandwidth has been granted in the current upstream subframe but an opportunistic UCS notification window has been scheduled (either CDMA or contention-based, see 7.9.4.1.1), it shall send a UCS notification to the BS as illustrated in Figure 260. If neither of the conditions exists, the SSA shall then wait to report on the next frames when the opportunity is given.

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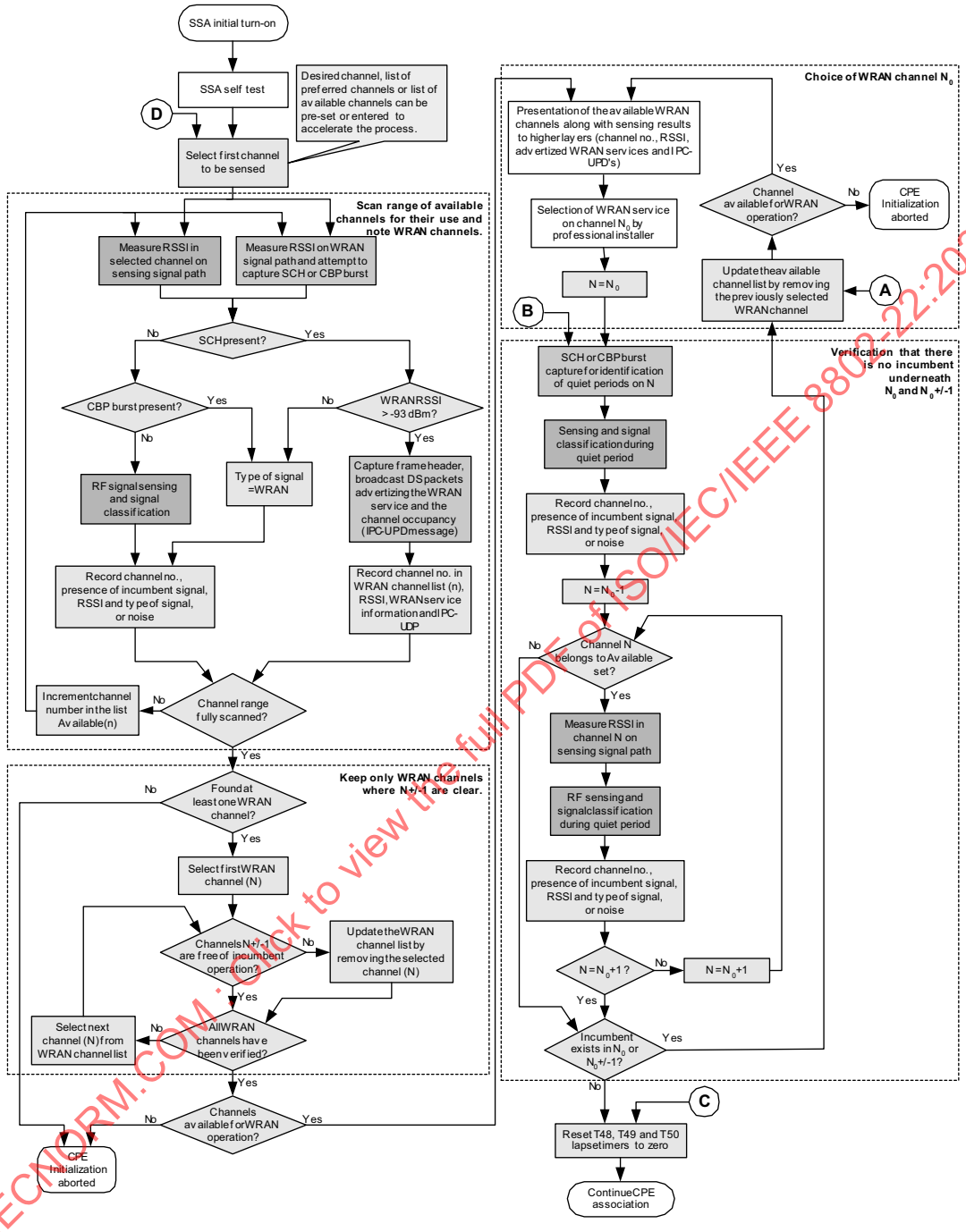

Figure 257—Flow diagram procedure SSA_initialization at the BS

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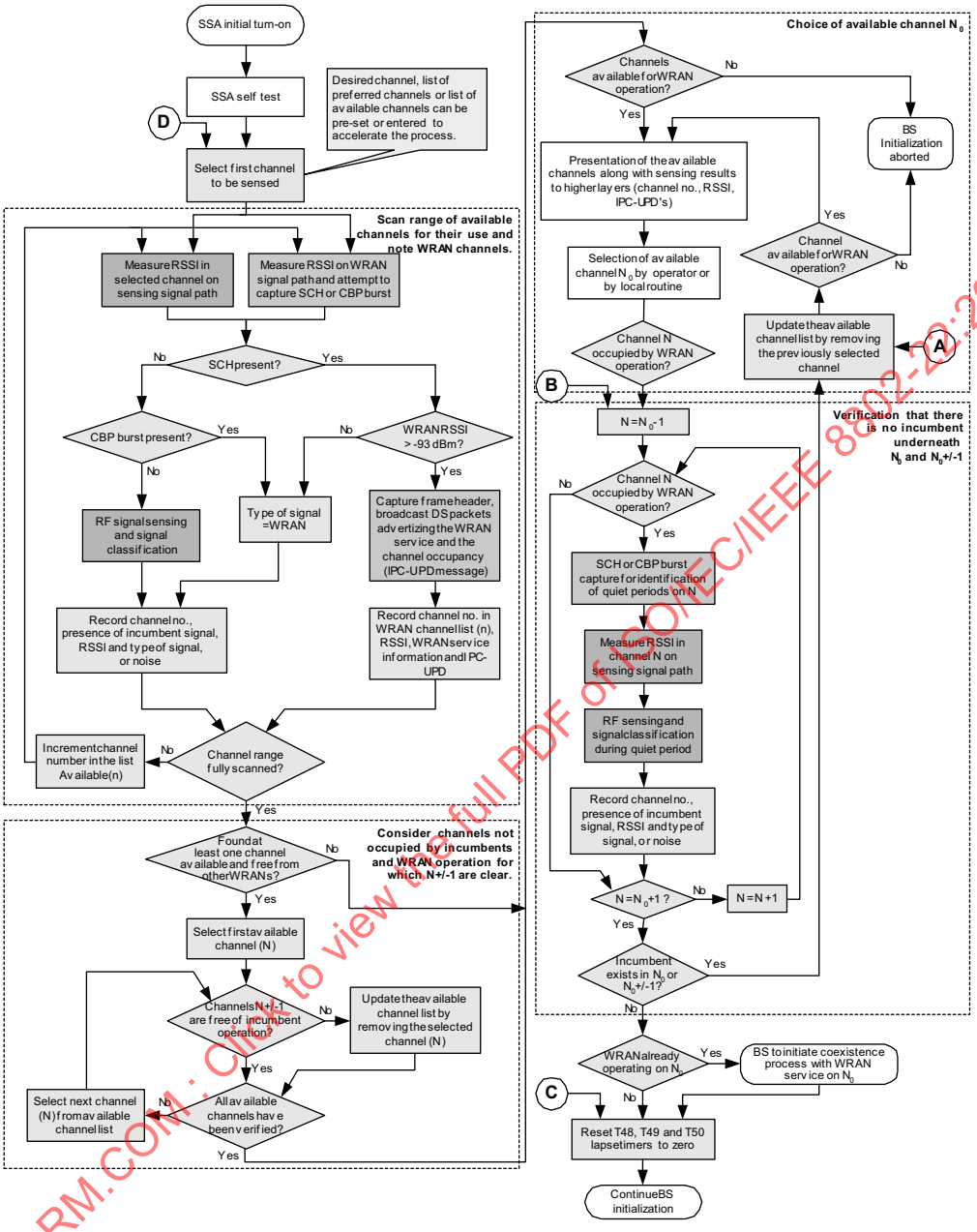

Figure 258—Flow diagram procedure SSA_initialization at the CPE

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At the start of every scheduled quiet period, the SSA shall verify whether channel N has been identified as prohibited from incumbent operation in the IPC-UPD message (i.e., it has been indicated to the CPE that there is no incumbent in this channel). If it is the case, sensing on N can be skipped. If not, it shall then verify that the sensing on the operating channel has been completed, and if not, it shall proceed to complete it. If it has been completed, it will verify the time lapsed since the last completion and compare it to the repetition period required by the local regulator (T_{INsens}, T53, see Table 333 and Annex A) less a safety margin corresponding to the time to carry out this sensing (T_{sensin}, T55, see Table 338). If this lapse time is larger than specified, the CPE shall re-initiate its sensing on the operational channel. Otherwise, the SSA shall skip to N+1 and repeat the verification process, and then skip to N–1 and repeat the same process.

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Once this is done and that N, N+1, and N–1 have been cleared, the remaining scheduled quiet periods can be used to perform the in-band sensing process as specified by the BLM-REQ message until the clearance period for any of N, N+1, or N–1 has lapsed, in such case, the above process is repeated.

11.3.4 Procedure SSA_Idle_Time SSA operation during CPE idle time

In addition to being able to carry out the in-band sensing process and any higher priority sensing requests coming from the BS through the specific MAC messages described in the BLM-REQ message (see 7.9.18.1), the SSA shall have the necessary local routines to autonomously sense the channels in its backup/candidate channel list in the proper order of priority during its idle time. This process is described below and depicted in Figure 261.

The SSA shall begin its autonomous sensing operation by sensing the first channel in the backup/candidate channel list. If the last sensing has been carried out less than T54 seconds earlier (see Table 338), the sensing on this channel can be skipped. The next channel is then selected in the order of the backup/candidate channel list. The SSA shall try to go as deep as possible in the backup/candidate channel list given the amount of idle time provided for local sensing.

A measure of the depth reached by the local out-of-band sensing process shall be kept at the BS and at each CPE to keep track of the number of channels that the SSA has been able to 'clear', i.e., verify that there is no incumbent on the channel and its two adjacent channels within the valid clearance period (T54 as specified in Table 338 and in Annex A for the various regulatory domains), between any interruption from the BS. After any interruption, the automaton shall restart its out-of-band sensing process with the first backup channel and the depth will track the number of channels that can be 'cleared' within the valid clearance period. Due to the nature of the algorithm, this process will be directed to any channel reaching the end of its period of validity (T54) in order of priority from the first backup channel through the backup list and the candidate list.

Sensing through the WRAN signal path will be interrupted and the WRAN signal path will be returned to the operating channel 'N_0' during the following intervals:

- Superframe headers
- Frame headers for the frames assigned to the BS to which the CPE is associated in a self-coexistence situation
- Downstream frame at the BS
- CPE receiving data during the DS subframe as signaled by the DS-MAP
- CPE transmitting data during the US subframe as signaled by the US-MAP
- CPE transmitting data during the opportunistic ranging/UCS notification/BW request window
- CPE monitoring activity as requested by the BS for CBP packet capture
- CPE transmitting activity as requested by the BS for CBP packet transmission

For each channel 'N' for which the $T_{OUTsens}$ (T54) validity period has lapsed,[31] the SSA shall measure the RSSI on this channel 'N' through its sensing path as well as through its WRAN signal path and attempt to capture the SCH or CBP burst of a WRAN transmission on that channel. If the SCH or CBP information can be decoded, the SSA will sense channels N, N–1, and N+1 during the appropriate quiet periods and record the channel number, the RSSI, the signal type (or noise if none is found) and the time at which the sensing took place.

[31] A time buffer T60 representing the time to carry out one typical round of out-of-band sensing, as depicted in Figure 261, should be removed from the T54 requirement to avoid that this time requirement lapses during the sensing process (see Table 338).

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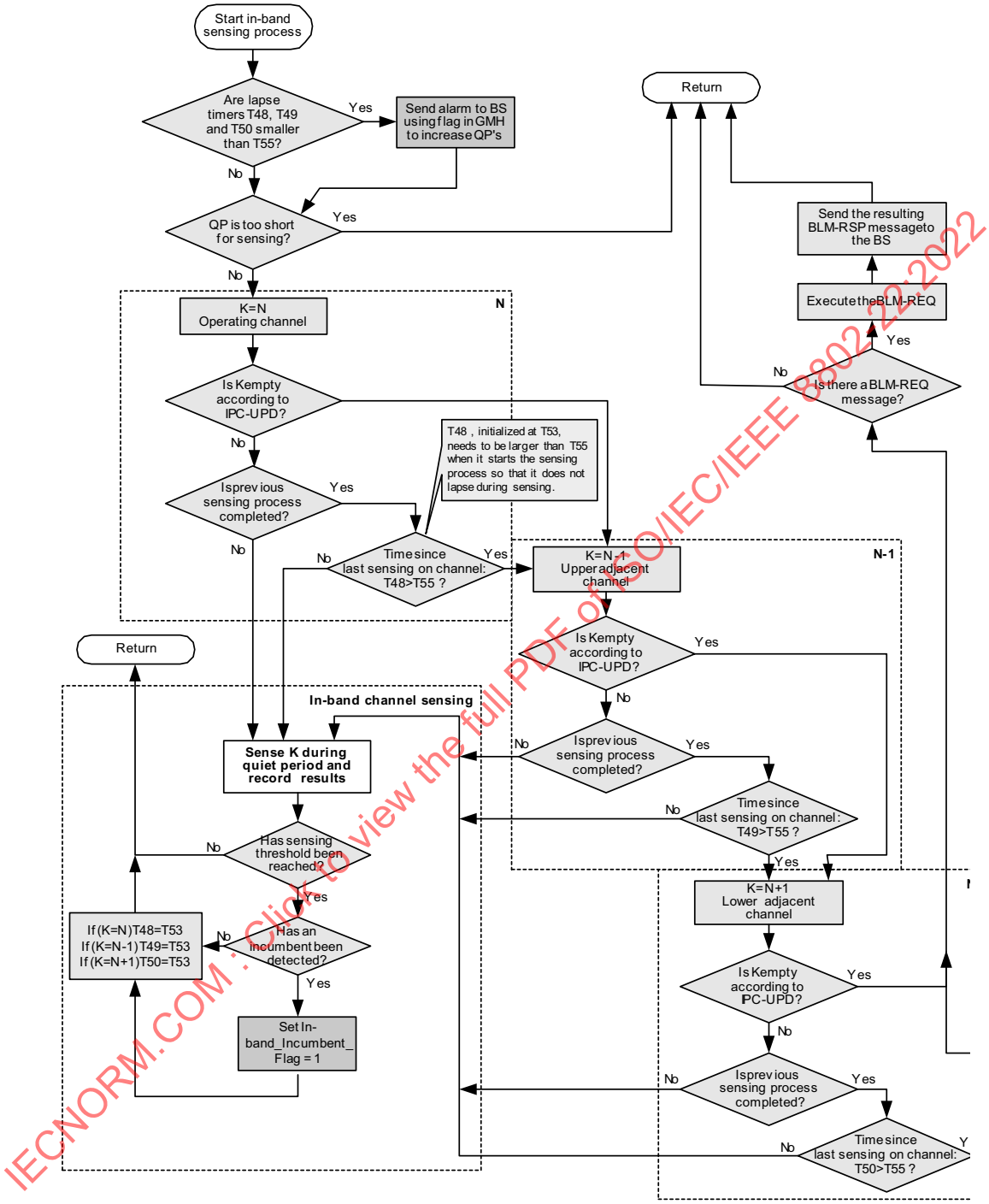

Figure 259—Procedure SSA_in-band_sensing

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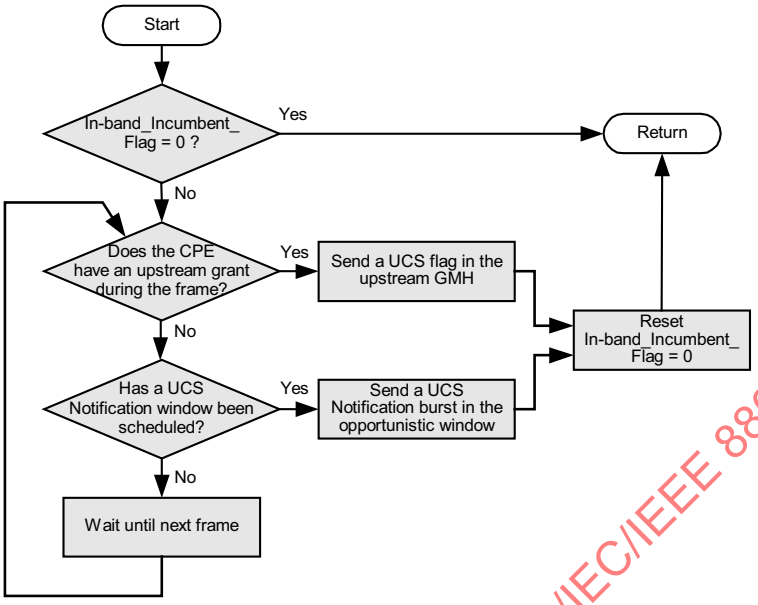

Figure 260—Flow diagram for procedure SSA_report_in-band_sensing_results

If there is no WRAN operation on the channel being sensed or the signal level is too low to decode the SCH or CBP burst, the sensing process shall verify whether there is WRAN operation on the two adjacent channels by trying to capture the SCH or the CBP burst to be able to schedule its sensing during the quiet intervals of these WRAN operations. If no WRAN operation is found on channels N and N±1, sensing on channel is N is then carried out with no consideration for quiet periods. Since signal sensing has to be done on the adjacent channels, if no WRAN operation can be detected on N and N±1, the sensing process shall verify whether there is WRAN operation on N±2 to be able to sense N±1 during the quiet intervals of N±2 because of possible adjacent channel leakage that could mask the presence of incumbents on N±1.[32] Sensing on N–1 and N+1 will then be carried out at any time or during quiet periods depending on whether WRAN operation is found in N–2 or N+2, respectively.

As a result, the SSA shall send a warning to the SM at the BS directly if at the BS or using the BLM-RSP message with the "Unavailable Backup Channel" IE, as illustrated in Figure 261, to be sent during the bandwidth allocation assigned to the CPE in the US-MAP or using the opportunistic BW Request mechanism to allow sending this MAC message in a later frame if an incumbent appears on one of the backup channels. Furthermore, if the depth reached by the SSA at the time of an interruption is less than the depth of the backup list, the SSA shall advise the SM directly if located at the BS or using the BLM-RSP message with the "Backup channel list clearance depth" IE, as illustrated in Figure 262, to be sent during the US bandwidth allocation assigned to the CPE in the US-MAP or using the opportunistic BW Request mechanism to allow sending this MAC message in a later frame to warn the BS. Otherwise, the SSA shall be prepared to provide the information on its current sensing depth in a solicited mode directly to the SM if located at the BS or with the BLM-RSP message with the IE "Backup/candidate channel list clearance depth" upon reception of the normal BLM-REQ MAC message whenever the BS requests it. This information collected by the BS from all SSAs will be used to adjust the size of the backup channel list. The BS will be responsible for reserving sufficient idle time in the scheduling of the data traffic towards each of its CPEs to allow them the time to verify the availability of the backup channels and some extra candidate channels if possible.

[32] It is assumed that the quiet periods will be aligned among WRAN cells operating on channels N, N±1, and N±2 in the same area.

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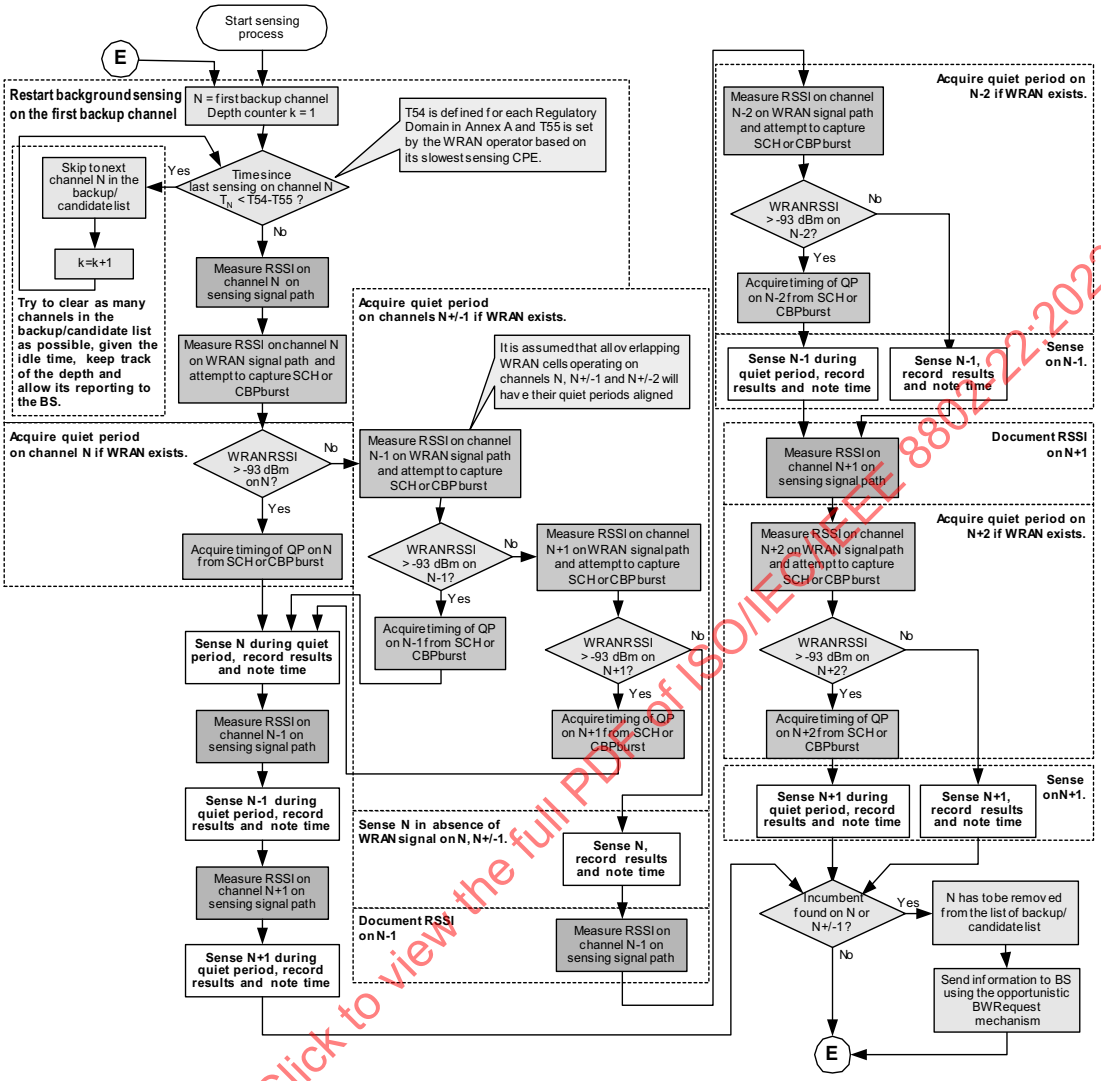

Figure 261—Flow diagram for CPE sensing during idle time

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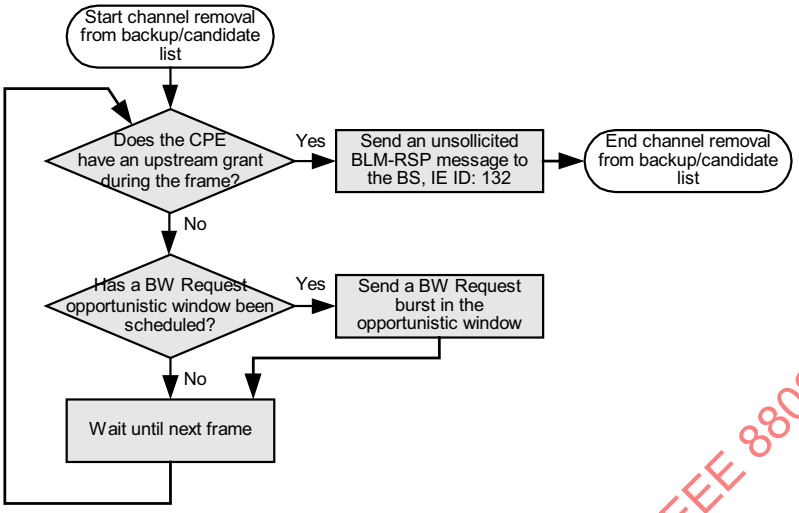

Figure 262—Flow diagram for procedure SSA_report_unavailable_backup_channel

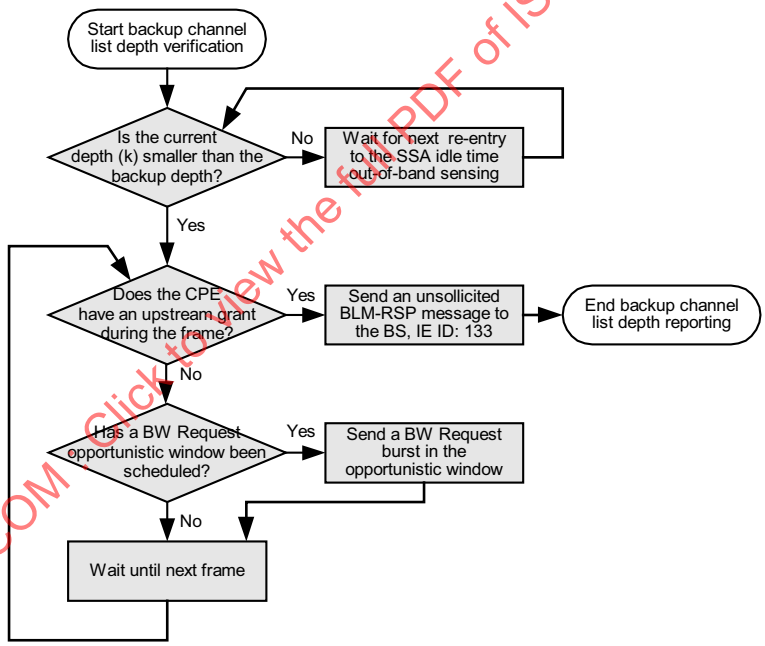

Figure 263—Flow diagram for procedure SSA_report_backup_channel_list dept

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11.3.5 Loss of contact with the BS

If the CPE looses contact with its BS, the SSA local intelligence shall make sure that a reasonable number of attempts are made to reconnect with the BS, while avoiding potential interference to licensed incumbents. The functionality of the SSA located at the CPE is summarized below for the loss of contact with the BS and is depicted in Figure 264.

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The SSA shall first identify whether or not a WRAN signal is still present on the selected channel by trying to capture the superframe header (SCH). If successful within the value set of the Lost_SCH Timer (T58) (e.g., 2 s maximum), attempts to re-associate shall be made through the BW Request opportunistic burst or upon specific invitation by the BS. If this does not work, the re-association shall start from an earlier stage with the CDMA ranging burst (entry 'C' in Figure 257). If re-association cannot be achieved within this time, then the CPE shall execute the second round of initial sensing for the co-channel and first adjacent channels cases to protect any broadcast incumbent that may have appeared in the affected channels since the loss of connection with the BS (entry 'B' in Figure 257).

If the WRAN signal is found to be no longer present in the channel for longer than the value set for the Timer TWait_channel_switch (T58 and/or T59), then the CPE shall select the next channel in its back-up list and try to capture the SCH to synchronize with the BS on this new channel. If a scheduled channel switch is performed with proper contact with the BS and done within the value set for the timer T59, re-association shall be made through the BW Request opportunistic burst or upon specific invitation by the BS, or through the earlier stage of the CDMA ranging burst (entry 'C' in Figure 257).

If the SCH capture on the new channel is not successful, then the CPE shall select the next channel on its backup list and repeat the process until a successful superframe capture is achieved. If re-association on all the valid channels in the backup list has failed, the CPE shall restart its entire initialization process (entry 'D' in Figure 257).

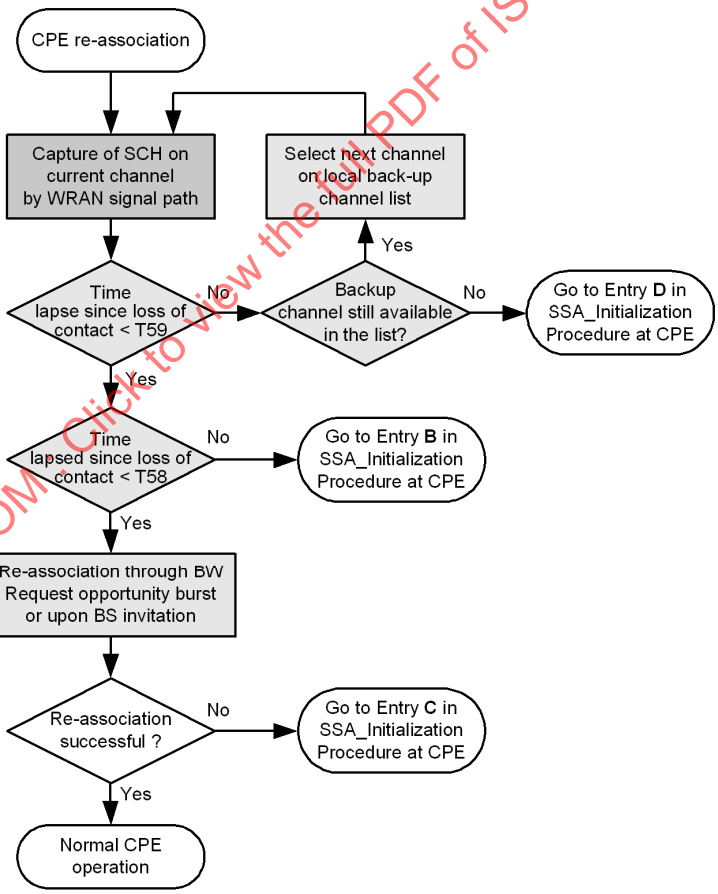

Figure 264—Flow diagram for procedure SSA_loss_of_contact_with_SM

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11.3.6 Procedure SSA_BLM_Report_Generation

Procedure SSA_BLM_Report_Generation is executed in response to an in-band or out-of-band Bulk Measurement request (BLM-REQ). The Procedure SSA_BLM_Report_Generation is as shown in Figure 265.

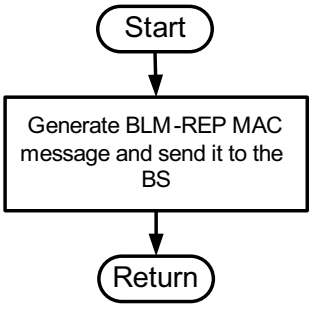

Figure 265—Flow diagram for procedure SSA_BLM_report_generation

11.3.7 Example of sensing information representation at the SSA

Once association has been achieved, the BS may request the SSA to send the complete results of the initial sensing or any update thereof at anytime directly to the SM if located at the BS or using the appropriate BLM-REQ PDU if located at the CPE. The SSAE will therefore need to keep the latest information stored by the sensing process in its local registers at all times. Table 316 gives an example of a possible representation of the information that needs to be stored locally. The SSA shall be capable of reporting the information from all rows of the table except for the two last rows that contain information obtained from the BS.

Table 316—Example of sensing registers at the CPE

Channel number	…	25	26	27	28	29	30	…
Time of last sensing								
Time of last positive								
Sensing path RSSI								
WRAN path RSSI								
Signal type								
WRAN service advertisement								
Sensing path RSSI under WRAN								
Signal type under WRAN								
List of incumbent prohibited channels from BS (IPC-UPD)								

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11.4 Spectrum sensing

Spectrum sensing is the process of observing the RF spectrum of a television channel to determine its occupancy (by either incumbents or other WRANs).

The BS and all CPEs shall implement the Spectrum Sensing Function (SSF).

The SSF shall be driven by the SSA. The SSF shall observe the RF spectrum of a television channel and shall report the results of that observation to the SM (at the BS) via its associated SSA. The Spectrum Sensing Function (SSF) is described in 11.4.1. The primitives for the SSF are described in 15.2.2.

11.4.1 Spectrum Sensing Function (SSF)

The Spectrum Sensing Function observes the RF spectrum of a television channel for a set of signal types and reports the results of this observation. The spectrum sensing function is implemented in both the BS and the CPEs. There are MAC management frames that allow the BS to control the operation of the spectrum sensing function within each of the CPEs. Figure 266 illustrates the inputs and outputs of the spectrum sensing function.

The inputs to the spectrum sensing function come from the SM via SSA. The inputs to the spectrum sensing function are described in 11.4.1.1. The outputs from the spectrum sensing function are returned to the SM via SSA. The outputs of the spectrum sensing function are described in 11.4.1.2. The behavior of the spectrum sensing function is described in 11.4.1.3.

Some of the possible sensing techniques that can be used to realize the spectrum sensing function are described in Annex C. The use of any specific sensing technique is optional, as long as the inputs, outputs and behavior meet the specification of this subclause.

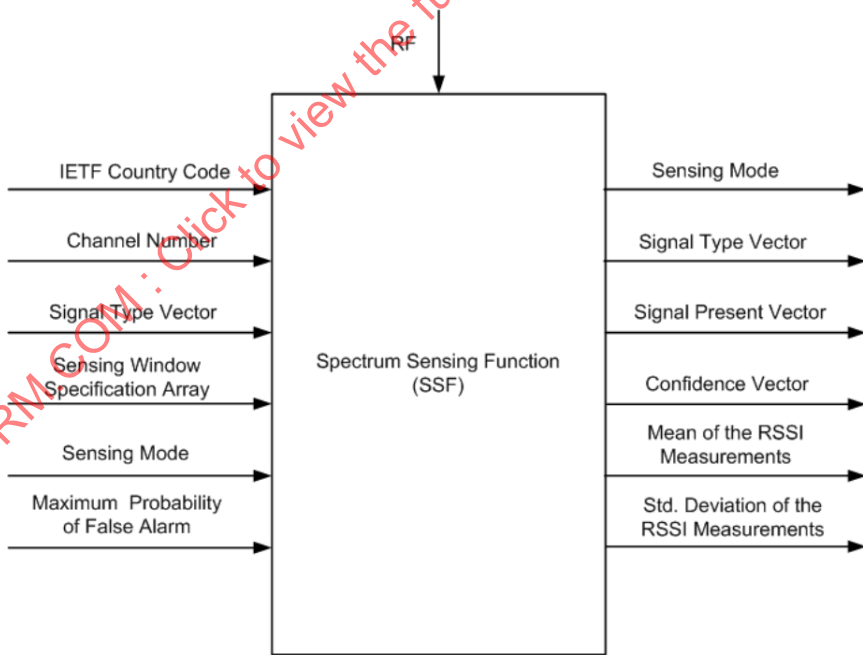

Figure 266—Spectrum sensing function

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11.4.1.1 SSF inputs

A summary of the spectrum sensing inputs is given in Table 317.

Table 317—Spectrum Sensing Function input signals

Input name	Input description	Length (bits)	Values
RF	Radio Frequency signal from the sensing antenna	N/A	N/A
ISO 3166 Country Code	Regulatory domain of operation	24	ASCII Characters—e.g., USA represents United States of America
Channel Number	The channel number that is to be sensed by the SSF	8	0–255
Channel Bandwidth	The bandwidth of the channel to be sensed by the SSF	4	0000 = 6 MHz 0001 = 7 MHz 0010 = 8 MHz 0011–111 = *Reserved*
Signal Type Array	An array indicating the signal types for which the SSF is to sense	32	Described in
Sensing Window Specification Array	An array of sensing window specifications. Each SFS specifies the details of the sensing window for a given signal type being sensed	N×32, where N is the number of signal types enumerated in Signal Type Array. The 24 bits cover the NumSensingPeriods, SensingPeriodDuration and SensingPeriodInterval.	Ranges for values given in: Bits 0–7: NumSensingPeriodsBits Bits 8–17: SensingPeriodDuration Bits 18–31: SensingPeriodInterval
Sensing Mode	The sensing mode specifies which SSF outputs are valid and in some cases it specifies the behavior of the SSF	2 bits	Sensing modes specified in
Maximum Probability of False Alarm)	In sensing modes 0 and 1 this value specifies the maximum probability of false alarm for each sensing mode decision in the signal present array	8 bits	Maximum Probability of False Alarm—0x00 indicates ‘0’ and 0x01 indicates ‘0.001’, and 0xFF = 0.255

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The RF input is connected via an RF stage to the WRAN sensing antenna.

The ISO 3166 country code defines the regulatory domain of operation. For example, the ISO 3166 country code ‘USA’ corresponds to the regulatory domain of the United States of America.

The channel number is the relative television channel number that the SSF is to sense. The center frequency for each channel number and the exact mapping between the relative channel number and the absolute channel number are given in Annex A.

The channel bandwidth is the bandwidth of the television channel that the SSF is to sense.

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The signal type array (STA) indicates which signal types that are to be sensed for by the SSF. The array is a one-dimensional array of length *STALength*, indexed from 0 to *STALength* –1. The STA is a binary array whose elements are either zero or 1. The i^{th} element in the array specifies whether the SSF is to sense for i^{th} signal type. The mapping of STA index to signal type is given in Table 318

The value of *STALength* is 32 and can be represented using 4 octets.

Table 318—Signal type array indices

STA Index	Signal type
0	Undetermined
1	IEEE 802.22 WRAN
2	ATSC
3	DVB-T
4	ISDB-T
5	NTSC
6	PAL
7	SECAM
8	Wireless Microphone
9	IEEE 802.22.1 Sync Burst
10	IEEE 802.22.1 PPDU MFS1
11	IEEE 802.22.1 PPDU MSF2
12	IEEE 802.22.1 PPDU MSF3
13–32	*Reserved*

A one in index zero of the STA indicates sensing for any signal type, with no distinction between signal types. A one in index one of the STA indicates the SSF should sense for an IEEE 802.22 WRAN.

As an example, if the STA is given as follows:

STA= (0010111000000000…00)

Then the SSF shall sense for an IEEE 802.22.1 Sync Burst, an ATSC signal, and NTSC signal and a wireless microphone. Table A.11 specifies that, depending upon the regulatory domain of operation, some STA indices in the STA shall be set at all times.

The sensing window specification array (SWSA) is a two-dimensional array of length STA Length N×32. Each row of the SWSA is a sensing window specification (SWS). If the i^{th} element of the STA is one (1), then the i^{th} row of the SWSA shall be set to a valid sensing window specification. If the i^{th} row of the STA is set to zero (0), then the i^{th} row of the SWSA does not need to be set to a valid SWS since it will be ignored by the SSF.

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A sensing window specification (SWS) consists of three parameters. These three parameters specify the window of time over which the SSF shall sense for specified signal type. Figure 267 illustrates a sensing window.

A sensing window consists of *NumSensingPeriods* number of sensing periods. The minimum number of sensing periods is one and the maximum number is 255. This maximum number is based on the need to avoid that a rogue BS could bring down other co-existing co-channel BSs in the area by excessive scheduling of quiet periods.

Each sensing period is of duration *SensingPeriodDuration* symbols and adjacent sensing periods are separated by *SensingPeriodInterval* symbols as shown in Figure 267.

The parameters in a sensing window specification are given in Table 319. Such sensing window can occupy a portion of a quiet period, an entire quiet period or multiple quiet periods.

The details on how quiet periods are scheduled are found in 7.7.1.

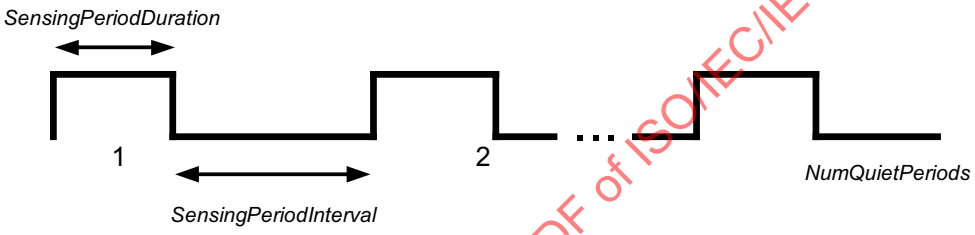

Figure 267—Sensing window

Table 319—Bounds of sensing window specifications

Parameter Name	Range	Units	Value
NumSensingPeriods	0 to 255	Integer	Comes from SM or SSA Default = 1, values from 128 to 255 are reserved
SensingPeriodDuration	0 to 1023	Symbols	Comes from SM or SSA Default = 16 symbols
SensingPeriodInterval	0 to 2047	Frames	Comes from SM or SSA Default = 200 frames

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Quiet periods are scheduled by the MAC layer. Quiet periods can be scheduled using the SCH as described in 7.7.1. Also, quiet periods can be scheduled using the channel quiet request message, as described in 7.9.17.3. A general discussion on quiet periods can found in 7.23.

The aggregate of all quiet period durations within which a spectrum sensing technique meets the required detection threshold for any signal type specified in Table 318 shall not exceed 200 ms. The processing latency to detect any signal shall not exceed 2 s.

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The sensing mode specifies which outputs of the SSF are valid and in some cases the behavior of the SSF. Table 320 summarizes the valid SSF outputs for each of the sensing modes. The table also includes a description of each sensing mode.

Table 320—Summary of the sensing modes

Sensing mode	Valid SSF outputs	Description
0	Signal Present Array	For each signal type the SSF generates a binary decision as to whether the signal is present in the television channel
1	Signal Present Array Confidence Array	Same as sensing mode 0 with the addition of a confidence metric for binary decision
2	Mean and standard deviation of the measured RSSI	For each signal type the SSF generates an estimate of the mean and standard deviation for up to 255 instantaneous RSSI measurements on a specified channel (see 7.9.18.3)

Sensing Mode 0 is mandatory at the BS and the CPE if sensing is required (see Annex A).

Sensing Mode 1 is optional at the BS and the CPE if sensing is required (see Annex A).

Sensing Mode 2 is optional at the BS and the CPE if sensing is required (see Annex A).

The maximum probability of false alarm input specifies the behavior of the elements of the signal present array when no signal is present on the RF input. The details of the behavior of the SSF, and its dependence on this input parameter, are given in 11.4.1.3.

11.4.1.2 SSF outputs

The sensing mode and the signal type array are passed through the SSF. These parameters indicate which of the other SSF outputs are valid and hence are useful for subsequent processing. The MAC messages for specifying the sensing measurement report structure are covered in 7.9.18. There is a general description of sensing measurement reporting in 7.24.1.

The signal present array is a one-dimensional array of length *STALength*. Each element in the array is a signal present decision. Each decision can take on three possible values, which are given in Table 321. The i^{th} signal present decision corresponds to the i^{th} signal type as listed in Table 318.

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Table 321—Values of the signal present decision

Value of signal present decision	Length (bits)	Value of signal present decision	Description
TRUE	8	0xFF	SSF decided that the signal is present in the channel
FALSE	8	0x00	SSF decided that the signal is not present in the channel
NODECISION	8	0x7F	The SSF makes no decision regarding the presence of the signal in the channel. This is the output when the SSF was not instructed to sense for the signal type.

The confidence array is a one-dimensional array of confidence metrics. The i^{th} confidence metric indicates the confidence in the i^{th} signal present decision. A confidence metric varies between a minimum of zero (0x00) indicating no confidence in the signal present decision and a maximum of 255 (0xFF) indicating total confidence in the signal present decision. The range of a confidence metric is given in Table 322 and shall be represented by an 8-bit variable. The Variable Confidence Metric at the present time shall always assume a value of 0x00 or 0xFF, and all other values are reserved.

Table 322—Range of a confidence metric

Limit	Value	Description
Minimum confidence metric	0x00	No confidence in signal present decision
Maximum confidence metric	10xFF	Total confidence in signal present decision

The RSSI measurement results are stored in a one-dimensional array of up to M instantaneous measurement results at the SSF for a channel. The integration time to acquire each RSSI measurement shall be set to a default 2 ms. The representation of the multiple RSSI estimates at the SSF is given in Table 323 for an 8-bit resolution.

Table 323—RSSI measurements

Limit	Length (bits)	Value	Units	Description
RSSI	M × 8	Signed Integer	dBm	Up to M RSSI measurements. M can be as large as 255. These RSSI shall be measured in dBm and shall be normalized for a 0 dBi antenna gain and 0 dB coupling and cable loss. Signed in units of dBm in 0.5 dB steps ranging from –104 dBm (encoded 0x00) to +23.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme.

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When the SM requests a number of repeated measurements through the BLM-REQ MAC message (see 7.9.18.1), the SSF shall calculate the mean for the M values acquired in the RSSI one-dimensional array. The standard deviation for these M values shall also be calculated and will represent the dynamic aspect of the RSSI during the M measurements. The range of the mean and the standard deviation of the RSSI measurements that will be reported by the SSF in the BLM-RSP MAC message (see 7.9.18.3.1.1) is given in Table 324.

Table 324—Range of the mean and standard deviation of a field strength estimate error

Parameter	Length (bits)	Value	Units	Description
RSSI	8	Signed Integer	dBm	Mean of the M RSSI measurements. Signed in units of dBm in 0.5 dB steps ranging from –104 dBm (encoded 0x00) to +23.5 dBm (encoded 0xFF). Values outside this range shall be assigned the closest extreme.
Standard Deviation	8	Integer	dB	Standard Deviation of the M RSSI measurements. Expressed in units of dB in 0.1 dB steps ranging from 0.0 dB (encoded 0x00) to +25.5 dB (encoded 0xFF). Values beyond +25.5 dB shall be encoded as 0xFF.

11.4.1.3 SSF behavior

In this clause, all references to signal power shall refer to the signal power in dBm measured at the input of the sensing receiver.

11.4.1.3.1 Sensing Mode 0

When the sensing mode is set to zero (0) the only valid SSF outputs are listed in Table 325.

Table 325—Valid outputs in Sensing Mode 0

Sensing Mode
Signal Type Array
Signal Present Array

The values of Sensing Mode and Signal Type Array shall be the same as their input values.

In sensing mode zero, if the i^{th} element of the signal type array is zero then the i^{th} element of the SPA shall be set to *NODECISION*.

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Table 326—Example of SPA for Sensing Mode Zero with STA(i) set to 0

Sensing mode	STA Index i	Signal type	STA(i)	SPA(i)
0	0	Undetermined	0	*NODECISION*
0	1	IEEE 802.22 WRAN	0	*NODECISION*
0	2	ATSC	0	*NODECISION*
0	3	DVB-T	0	*NODECISION*
0	4	ISDB-T	0	*NODECISION*
0	5	NTSC		
0	6	PAL		
0	7	SECAM		
0	8	Wireless microphone	0	*NODECISION*
0	9	IEEE 802.22.1 Sync Burst	0	*NODECISION*
0	10	IEEE 802.22.1 PPDU MSF1	0	*NODECISION*
0	11	IEEE 802.22.1 PPDU MSF2	0	*NODECISION*
0	12	IEEE 802.22.1 PPDU MFS3	0	*NODECISION*
0	13–32	*Reserved*		

In sensing mode zero if the i^{th} element of the signal type array is set to one and there is no signal present at the sensing antenna then the i^{th} element of the SPA shall be FALSE with probability greater than or equal to 1-MPFA, where MPFA is the maximum probability of false alarm for that signal as specified in the regulatory domain requirements, Annex A. The i^{th} element of the SPA shall be set to TRUE with probability less than or equal to MPFA. The regulatory domain requirements for various signal types, the minimum detection and maximum false alarm probabilities (MPFA) at specified signal power thresholds is provided in Annex A.

The behavior of the SSF in sensing mode 0 with the i^{th} element of STA set to one and with no signal present at the sensing antenna is summarized in Table 327.

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Table 327—Example of SPA for Sensing Mode Zero with STA (i) set to 1 with no signal present

Sensing mode	STA Index i	Signal type	STA(i)	SPA(i)
0	0	Undetermined	1	FALSE
0	1	IEEE 802.22 WRAN	1	FALSE
0	2	ATSC	1	FALSE
0	3	DVB-T	1	FALSE
0	4	ISDB-T	1	FALSE
0	5	NTSC	1	FALSE
0	6	PAL	1	FALSE
0	7	SECAM	1	FALSE
0	8	Wireless Microphone	1	FALSE
0	9	IEEE 802.22.1 Sync Burst	1	FALSE
0	10	IEEE 802.22.1 PPDU MSF1	1	FALSE
0	11	IEEE 802.22.1 PPDU MSF2	1	FALSE
0	12	IEEE 802.22.1 PPDU MSF3	1	FALSE
	13–32	*Reserved*		

In sensing mode zero with the i^{th} element of the STA set to one and if the signal is present in the channel at the specified signal power level given in Table 328, the i^{th} output of the SPA shall be TRUE with probability as specified for that signal type in that regulatory domain. The regulatory domain requirements for various signal types, the minimum detection and maximum false alarm probabilities at specified signal power thresholds is provided in Annex A.

The behavior of the SSF output SPA is specified in Table 328.

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Table 328—Summary of SSF Outputs for Sensing Mode Zero

Sensing Mode	STA Index i	Signal Type	STA(i)	Signal Power[a] (dBm)	SPA(i)
0	0	Undetermined	1	–90[b]	TRUE
0	1	IEEE 802.22 WRAN	1	–93	TRUE
0	2	ATSC	1	–114	TRUE
0	3	DVB-T	1	Not available	TRUE
0	4	ISDB-T	1	Not available	TRUE
0	5	NTSC	1	–114	TRUE
0	6	PAL	1	Not available	TRUE
0	7	SECAM	1	Not available	TRUE
0	68	Wireless Microphone	1	–114	TRUE
0	9	IEEE 802.22.1 Sync Burst	1	–116	TRUE
0	10	IEEE 802.22.1 PPDU MSF1	1	–116	TRUE
0	11	IEEE 802.22.1 PPDU MSF2	1	–116	TRUE
0	12	IEEE 802.22.1 PPDU MSF3	1	–123	TRUE

[a] This power level is based on the assumption of a 0 dBi sensing antenna gain, 0 dB connector and cable loss, VSWR = 1:1. Note that, in order to account for the possible desensitization of the sensing detector by distant WRAN operation where the signal level at the CPE location is too low to allow detection of the SCH to identify its quiet period scheduling, a 3 dB increase in detector sensitivity or RF front-end performance may be needed.

[b] Assumed sensing RF front-end Noise Figure = 10 dB.

11.4.1.3.2 Sensing Mode 1

When the sensing mode is set to one, the only valid SSF outputs are listed in Table 329.

Table 329—Valid outputs in Sensing Mode 1

Sensing Mode
Signal Type Array
Signal Present Array
Confidence Array

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The values of sensing mode, signal type array and signal present array shall be the same as in Sensing Mode 0.

If the i^{th} element of the signal type array is set to zero then the i^{th} element of the confidence array is set to 0.

If the i^{th} element of the signal type array is set to one then the i^{th} element of the confidence array is a confidence metric indicating the confidence the SSF has in the i^{th} element of the signal present array. A confidence metric is a measure of the confidence of a decision. The range of a confidence metric is given in Table 322.

11.4.1.3.3 Sensing Mode 2

When the sensing mode is set to two the only valid SSF outputs are listed in Table 330.

Table 330—Valid outputs in Sensing Mode 2

Sensing Mode
Signal Type Array
Mean of the RSSI Measurements
Standard Deviation of the RSSI Measurements

The values of sensing mode and signal type array are the same as their input values.

The output consists of the mean resulting from M instantaneous RSSI measurements for a particular channel, where M can be as large as 255. The integration time to acquire each RSSI measurement shall be set to a default 2 ms.

The output also consists of the standard deviation calculated from the M instantaneous RSSI measurements and it represents the dynamic nature of the channel over M RSSI measurements.

11.4.2 Special SSF considerations for the IEEE 802.22.1 beacon

The IEEE 802.22.1 beacon has been developed with the goal of allowing detection within a reasonable time window that allows IEEE 802.22 systems to attempt to provide tolerable QoS. The beacon has been designed such that the synch burst and index can be acquired within 5.1 ms, including the slippage due to the asynchronous capture of the burst. When types of signals such as DTV and analog TV need to be sensed, proper sensing schemes should be used to allow detection at the required sensing threshold within the same sensing window. The IEEE 802.22.1 beacon can also provide additional information such as the location of the beacon (MSF1), the beacon signature (MSF2) and its authentication (MSF3) with correspondingly larger sensing periods. See Table D.2.

The WRAN shall take the action of vacating a channel on which a valid IEEE 802.22.1 beacon signal has been received. Reception of the beacon is defined as either detection or demodulation of the beacon signal.

Acceptable methods to comply with detection of the beacon include energy detection, baud rate detection, correlation to the spreading sequence, or synchronization and determination of start-of-frame from the index. Other methods also exist. The WRAN shall cease operation on a channel on which a beacon is detected unless the WRAN operator chooses to demodulate the beacon and perform further verification and validation of the received beacon signal. Performing demodulation of the beacon signal increases confidence

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that a received beacon signal is legitimate. The degree to which demodulation is performed is also at the discretion of the WRAN operator but if validity is detected at the point at which the WRAN chooses to stop further investigation of the demodulated beacon, it shall protect the incumbent. It shall be at the discretion of the WRAN operator to determine the degree to which sequential steps are taken to validate the beacon. It can, therefore, make a decision after reception of MSF1 should it choose to do so. It may further choose to receive MSF1 combined with MSF2, and, if absolute confirmation is desired, MSF3. A determination of validity may be assessed at each step.

Demodulation of MSF1 allows the WRAN operator to acquire location and other pertinent information pertaining to the device protected by the beacon signal. The WRAN can, therefore, determine the best method to protect the incumbent device. This may include vacating the channel, reduction of power in the azimuth of the protected incumbent or moving a portion of its CPEs to a second channel. Other methods of protection also exist. Demodulation of the beacon information may, therefore, impact the WRAN operator and a BS's ability to schedule traffic in an optimal manner. In these cases, the QoS for a portion of the WRAN clients may not be satisfied while adequately protecting the incumbent.

Finally, if the WRAN operator is suspicious of the validity of a beacon signal, it may verify the signature and certificate of the beacon utilizing the data received in MSF2 and MSF3. MSF2 contains the signature and MSF3 contains the public key certificate. In general, MSF3 demodulation is not required as the certificate is generally available over the Internet. See Annex D for more details.

Beacon information to be reported depends on the sensing mode. There are 2 sensing modes: nominal (sync/index only) and beacon frame (MSF content).

a) Nominal sensing mode: this is the 5.1 ms quiet period used to sense for the beacon sync frame. The sync frame contains the 15-bit sync word, a (15,7) BCH-encoded index, and 2 reserved bits.
   - Sync word above threshold (needs only one bit)
   - BCH-encoded index passes error correction (needs only one bit)
   - Decoded index (needs only 5 bits for the 31 unique values including the index-0 inter-device communication period that is either all zeros if not aggregating or is opened up for RTS/ANP)
   - Total number of bits required is 7

Table 331—Rules for indicating successful detection of MSF1, MSF2, and MSF3

Syntax	Size	Notes
Sync	1 bit	1 = sync found 0 = sync absent *If sync absent, remaining values except reserved bits are 'don't care' and are set to 0.*
Index Status (only if "sync found")	1 bit	1 = passed decoding 0 = failed decoding
Index Value	5 bits	Binary value of the index
Other Detection Methods	1 bit	Correlation on spreading sequence or energy detection above threshold 1 = above threshold 0 = below threshold

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b) Beacon frame sensing mode: this mode is only activated for IEEE 802.22 devices that have reported a positive response from the nominal sensing mode. That is, the Sync was "sync found" and the Index Status was "passed decoding." At this point there are several options:

1) Capture MSF1 alone (no authentication) and find that it passes convolutional decoding and CRC. Report the MSF1 contents to the BS [requires 15 decoded bytes (the original 17 minus the 2 byte CRC) or 120 bits]. If it did not pass CRC, it would not pass the information along but would report a failed CRC. Depending on whether the BS received a successful MSF1 decoding from another CPE, it might change the channel or schedule another long quiet period to try again to get a successful MSF1 decoding.

2) Capture MSF1 and MSF2 where BS has access to certificates via backhaul. Report the relevant MSF1 content (15 bytes = 120 bits) and the signature portion of MSF2 (44 bytes = 352 bits) for a total of 59 bytes = 472 bits. If both CRC1 and CRC2 failed, it would not pass the information along but would report the failed CRCs. If MSF2 failed but MSF1 passed CRC, the CPE could at least report MSF1 (15 bytes) if requested by the BS. If MSF1 failed but MSF2 passed CRC, there is no useful information to report (0 bytes). Depending on whether the BS received a successful MSF1 + MSF2 decoding from another CPE, it might change the channel or schedule another long quiet period to try again to get a successful MSF1 + MSF2 decoding.

   — Optionally, a BS could collect a successful MSF1 from one CPE and a successful MSF2 from a different CPE. So, if one CPE reports only MSF1 passed and another CPE reports only MSF2 passed, the BS could request the appropriate information be passed from the respective CPEs, rather than schedule another long quiet period. This is sort of a spatial diversity.

3) Capture MSF1, MSF2, and MSF3 where the BS does not have backhaul access to the certificates. All CRCs need to be passed to be able to perform an authentication. If MSF1 passes but MSF2 and MSF3 fail, at least MSF1's contents could be sent if the BS requests.

   — Again, optionally a BS could collect a successful MSF1 from one CPE, a successful MSF2 from another CPE, and a successful MSF3 from yet another CPE, or it could accept multiple subframes from a single CPE, i.e., if CPE_1 has successful MSF1 and MSF3 decoding and CPE_2 has successful MSF2 decoding, the BS could use the two subframes from CPE_1 and the single subframe from CPE 2.

A multi-frame handshaking transfer can be used here. First, depending on the mode, the CPEs report which subframes were successfully decoded. Then, from its collection of CPEs, the BS can examine which ones can provide the successful subframes and assemble its collective superframe from the constituent parts. Then CPEs transmit the relevant portions of the subframes as requested. There need to be different downlink messages to do all of this as well.

Based on this initial response from a CPE, the BS might request it to send a second message with the relevant portions of the MAC subframes as shown in 7.9.18.3.1.8.

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Table 332—Rules for indicating successful decoding of MSF1, MSF2, and MSF3

Syntax	Size	Notes
CRC1 status	1 bit	1 = passed 0 = failed Used for all modes
CRC2 status	1 bit	1 = passed 0 = failed Used for modes b, c and d.
CRC3 status	1 bit	1 = passed 0 = failed Used for modes c and d.
Sync/index status	1 bit	1 = frame aligned 0 = frame misaligned Based on observed index words, the device did not capture the required portion of the superframe.
Reserved	2 bits	

11.5 Geolocation

Two modes of geolocation can be used with IEEE Std 802.22. satellite-based geolocation is mandatory. Terrestrially-based geolocation assisted by the CDMA ranging, superframe preamble, frame preamble, and the coexistence beacon protocol is also described in the subclauses that follow. The geolocation technology shall detect if any device in the network moves by a distance greater than the values specified in Table A.9. In such case, the BS and CPE shall follow the local regulations and shall obtain the new list of available channels from the database service based on the new location of the device.

11.5.1 Satellite-based Geolocation

The BS shall use its satellite-based geolocation capability to determine the latitude and longitude of its transmitting antenna within a radius of 50 m. The BS may also use the altitude information derived from the satellite-based geolocation capability.[33]

Each CPE shall use its satellite-based geolocation technology to determine the latitude and longitude of its antenna within a radius of 50 m. Each CPE may also use its altitude above mean sea level. Each CPE shall provide its geolocation coordinates using the NMEA strings to the BS during the registration process. The WRAN system shall use the NMEA strings provided by each CPE's satellite-based geolocation subsystem to determine the location of the CPEs.

The satellite-based geolocation antenna shall be co-located (i.e., ≤ 1 m separation) with the transmit and sensing antennas.

Lock to satellite-based geolocation system is not necessary to continue operation. However, the device shall cease operation if T30 expires after losing the lock. If movement is detected, the CPE shall be de-registered via the DREG-CMD with code 0x01. CPE transmission can be re-enabled with the code 0x03 if new

[33]The 50 m limit comes from the FCC R&O. No current requirement exists on the accuracy of the antenna height.

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coordinates can be obtained. If new coordinates cannot be obtained, the CPE can be shut down by a DREG-CMD with code 0x04 or be forced to reinitialize on the current operating channel via a DREG-CMD with code 0x05.

11.5.2 Terrestrially-based geolocation

IEEE Std 802.22 has been designed to support terrestrially-based geolocation capability by providing all the necessary PHY and MAC tools to make it possible. Terrestrially-based geolocation can be achieved in a two-step process. First, the range between the BS and a number of its CPEs involved in the process is determined with sufficient high accuracy. Second, in order to establish the geolocation of a CPE through triangulation, the precise distances between the CPE to be geolocated and a number of reference CPEs belonging to the same cell are determined. The goal of this process is to allow an entity called the geolocator to build a precise graphic representation of the geographic location of the CPEs that form a cell under the control of the BS. This is achieved using the capabilities of the coherent multicarrier modulation inherent to the OFDM/OFDMA technique used by IEEE Std 802.22 as explained in Annex B.

The IEEE 802.22 operational conditions under which the terrestrial geolocation can be achieved with sufficient accuracy conditions are described in 11.5.2.1, and the schemes, including the actual MAC messaging, to carry out the BS-to-CPE and CPE-to-CPE ‘fine’ ranging are detailed in 11.5.2.2 and 11.5.2.3. Once the necessary timing information has been acquired through these specific schemes, a geolocation process for which an example is given in 11.5.2.4 and 11.5.2.5 can be applied to obtain the new geolocation of a CPE. Annex B gives additional details on the scientific approach to support the terrestrial geolocation process based on the properties of the coherent multicarrier modulation technique used in IEEE Std 802.22, allowing the reader to better understand this terrestrial geolocation process.

11.5.2.1 Conditions to carry out precise ranging

It is first assumed that the WRAN cell is operating normally and that all the CPEs are synchronized in frequency and time to the BS on the downstream within the tolerance specified in 9.11 through the normal acquisition of the super-frame and frame preambles as described in 9.9.1. It is also assumed that the transmit frequency at the CPEs will be synchronized and locked to the frequency transmitted from the BS within the tolerance specified in and that proper upstream time synchronization is achieved through initial ranging and periodic ranging processes as described in 9.9.3. Note that these ranging processes, based on TU increments (i.e., nominal sampling period, seeTable 248) are called ‘coarse’ ranging processes for the purpose of this subclause as opposed to the more accurate ‘fine’ ranging processes needed to carry out terrestrial geolocation as described in the paragraphs that follow.

As part of the ‘coarse’ ranging process, the BS keeps an indication of the absolute timing advance required at the CPE in integer number of TUs to compensate for the signal propagation delay on both downstream and upstream RF paths as specified in . Such absolute timing advance is referenced to a zero value when the CPE is co-located with the BS and will increase as the distance between the BS and the CPE increases. This timing advance can therefore readily be used as a coarse indication of the range between the BS and the CPE. This parameter will be used in the ‘fine’ ranging processes described below.

The ‘fine’ ranging processes will need to work with accuracy in the range of nanoseconds and the various amounts of residual delay present in different CPEs will need to be taken into account. Such residual delay may vary from one CPE model to another as well as from one antenna setup to another in the case where the antenna is not integrated to the CPE. Such residual delay will need to be measured by the manufacturer with an accuracy of at least ±30 ns as specified in Table 61. This CPE residual delay will be declared during the CPE registration process through the REG-REQ MAC message (see 7.9.7.3.4.10).

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The normal time unit used by IEEE Std 802.22 in its time synchronization and 'coarse' ranging is the sampling period or Time Unit (TU, see Table 248). Better time accuracy will be needed to carry out the 'fine' ranging described in 11.5.2.2 and the use of a sort of "vernier" comes in handy.[34] This "vernier" will allow an improvement of some two orders of magnitude in timing accuracy through the use of the phase correlation between the orthogonal carriers of the OFDM modulation.

11.5.2.2 BS-to-CPE fine ranging

If the 'fine' BS-to-CPE ranging process is to take place, the following procedure shall be used to provide the necessary information to the terrestrial geolocation process described in 11.5.2.4 and 11.5.2.5 :

1) The BS transmits a RNG-CMD MAC message (see 7.9.6) to the specific CPE to re-range (ranging status = 011) and starts its counter T52 at the exact time when the downstream burst leaves the BS (i.e., at the start of the frame preamble). The T52 increments in TUs at the BS.

2) The BS keeps in memory (Range_map) the symbol number scheduled in the US-MAP (see 7.9.4) for the RNG-REQ message (UIUC = 6).

3) The BS notes the size of the TTG in TUs for the given channel bandwidth and the cyclic prefix used in the frame (see Table 249).

4) The CPE acquires the values of the amplitude and phase rotation (or I&Q values) of the received subcarriers sent during the frame preamble in the downstream, removes the STS encoding and keeps the resulting information locally as the vector 'Vernier$_1$'. Optionally, this amplitude and phase information can also include the results of the pilot carrier tracking taking place during the downstream subframe to increase accuracy.

5) The CPE stores this amplitude and phase rotation information, i.e., 'Vernier$_1$', in a local register (1680x2 bytes) and reports it to the BS when requested by the BLM-REQ message (see 7.9.18.3.1.10).

6) The BS can then arrange for this data to be processed to precisely determine the time of arrival of the key multipath (usually the first) relative to the synchronization time at the CPE (which is recovered by the preamble correlator). The precise time of arrival of the downstream burst (in ns) relative to the timing of the CPE clock (incremented in TUs) can then be deduced from the values contained in 'Vernier$_1$'. Unlike the process to gather the basic timing information described in this subclause, the calculations to accomplish this signal processing are beyond the scope of the standard and belong to the geolocation process for which a simple example is presented in 11.5.2.4 and 11.5.2.5. Note that the amplitude and phase rotation of the subcarriers recovered from the decoded frame preamble actually represent the frequency domain of the channel impulse response. Note also that typical OFDM demodulation processes readily use this information to correct the constellations in amplitude and phase at the output of the FFT for proper data decoding.

7) The CPE responds to the RNG-CMD MAC message by sending a RNG-REQ CDMA message in the time slot allocated in the US-MAP (UIUC = 6).

8) At the time of arrival of the CDMA ranging burst from the CPE, the BS stops the T52 timer precisely at the time of the first sampling period belonging to the CDMA burst.

9) The BS acquires the values of the amplitude and phase rotation (or I&Q values) of the 168 regularly spaced subcarriers (see 9.6.4) from the output of the FFT and removes the CDMA signature. These corrected values, which constitute 'Vernier$_2$' (168x2 bytes), are stored at the BS and sent to the geolocator for processing.

[34]Vernier: A vernier scale is an additional scale that allows a measurement to be read more precisely than directly reading a uniformly divided measurement scale (from: http://en.wikipedia.org/wiki/Vernier_scale).

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11.5.2.3 CPE-to-CPE fine ranging

Inter-CPE communication is possible by the means of the CBP bursts (7.22.1) transmitted during the SCW (Table 46, UIUC = 0 and 1). These bursts can be used for self-coexistence between adjacent and overlapping WRAN cells, for device identification as may be required by local regulation and for carrying out the CPE-to-CPE 'fine' ranging process described in this subclause.

If the 'fine' CPE-to-CPE ranging process is to take place, the following procedure shall be used to provide the necessary information to the terrestrial geolocation process described in 11.5.2.4 and 11.5.2.5:

1) The BS starts the process by signaling in the US-MAP the presence of an active mode SCW at the end of the frame for the CPE that needs to be ranged (see Table 46, UIUC = 0).
2) The BS indicates the Timing Advance that it wants this CPE to use for its CBP burst so that this burst is received within the cyclic prefix at the nearby reference CPEs unlike the RNG-CMD Timing Advance, which is adjusted so that the CPE burst is received within the cyclic prefix at the BS. The BS can also adjust the EIRP Density Level for sufficient local coverage noting that the CBP burst may be transmitted through the antenna backlobe and received by another CPE through its antenna backlobe depending on the geometry of the RF path.
3) The BS signals the presence of a passive mode SCW at the end of the frame for the reference CPEs that have been selected to carry out this 'fine' CPE-to-CPE ranging process. This is done at the BS by including IEs with UIUC = 1 addressing each reference CPE to be used for 'fine' CPE to CPE ranging in the US-MAP (see Table 46).
4) The BS indicates that the channel to be listen to during the SCW is the operating channel and the BS specifies that the reference CPEs are to use the synchronization mode = 0 so that the CBP burst capture is done synchronously with the internal frequency and time synchronization of each reference CPE that are locked to the BS (see Table 46, UIUC = 1).
5) The BS uses the same frame to carry out the 'fine' CPE-to-CPE ranging process between the CPE to be geolocated and the reference CPEs as that used for the BS-to-CPE 'fine' ranging process with its reference CPEs as well as with the CPE to be geolocated as described in 11.5.2.2. Note that the adjacent frames can also be used if frequency and time synchronization slippage between these consecutive frames is tightly controlled.
6) The CPE in active mode transmits its CBP burst with the specified Timing Advance relative to the start of the fourth symbol before the end of the frame and the specified EIRP Density Level for proper RF path propagation margin (see Table 46) and it should contains, at least, the CBP Identification IE (see 7.8.1.3.1.6) to confirm that the burst comes from the right CPE.
7) Each reference CPE signaled by the BS to be in SCW passive mode during this frame captures the CBP burst using its own internal synchronization locked to the BS (i.e., Synchronization Mode = 0, see Table 46) and acquires the amplitude and phase rotation (or I&Q values) of the subcarriers contained in the CBP preamble. Optionally, this amplitude and phase information can also include the results of the pilot carrier tracking taking place during the CBP burst decoding to increase accuracy. This information constitutes the vector 'Vernier$_3$', and is stored in a local register (840x2 or 1680x2 bytes).
8) The BS then queries the values contained in 'Vernier$_3$' from each reference CPE and arrange for this data to be processed by the terrestrial geolocation process.

11.5.2.4 Terrestrial geolocation process

The terrestrial geolocation process is responsible for managing the WRAN device 'fine' ranging process and collecting, through the MAC messages between the BS and its CPEs, all the information necessary to carry out the calculations required to geolocate a CPE.

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When the terrestrial geolocation process needs to locate a CPE, it determines which reference CPEs will be used for this purpose using existing geolocation information and its own criteria. The BS as well as a minimum of two reference CPEs, for which the location has already been determined through either surveying, satellite-based initial geolocation or by having pre-applied the current triangulation method based on other reference devices, are needed to carry out the new geolocation process. The terrestrial geolocation process signals to the BS the CPEs that it has selected to carry out the process and the BS initiates the necessary signaling process with these reference CPEs and the new CPE to be located and, once done, transfers the collected information to the terrestrial geolocation process. Triangulation calculations can then be carried out on the resulting device-to-device distances to find the location of the new CPE. All the signaling required takes place within the WRAN cell.

The BS establishes the precise distance to each of the reference CPEs as well as to the new CPE using the BS-to-CPE ranging process described in 11.5.2.2. This multiple 'fine' ranging process is conducted in parallel with the CPE-to-CPE ranging process to establish the distance between the new CPE and each reference CPE involved using the ranging process described in 11.5.2.3. It is assumed that the terrestrial geolocation process already knows the absolute location of the BS and of the reference CPEs and the BS only needs to gather the information that it has acquired from these various BS-to-CPE and CPE-to-CPE ranging processes.

Using all this information, the terrestrial geolocation process computes the location of the new CPE and returns a NMEA longitude-latitude string.

11.5.2.5 Geolocation calculations

Once the terrestrial geolocation process has acquired all the information generated by the 'fine' BS-to-CPE ranging process described in 11.5.2.2, the calculations to determine the precise BS-to-CPE propagation time and propagation distance can be carried out as follows:

BS-to-CPE Propagation time = T52 – (Range_map+TTG) – CPE residual delay + Vernier_1 + Vernier_2

BS-to-CPE Propagation distance = c × Propagation time / 2

Furthermore, the various propagation distances between the BS and the reference CPEs and the CPE to be geolocated will be augmented with the information on the propagation distances obtained from the 'fine' CPE-to-CPE ranging process between the CPE to be geolocated and each of these reference CPEs and calculated as follows based on the Vernier_3 acquired in 11.5.2.3:

CPE_1-to-CPE_2 Propagation time = Local transmit timing reference at CPE_1 + TA_{CBP} – Local receive timing reference at CPE_2 + Vernier_3

CPE_1-to-CPE_2 Propagation time = $-\text{PT}_1 + \text{TA}_{\text{CBP}} + (\text{PT}_2 - \text{CPE}_2$ residual delay) + Vernier_3

where

PT_1: Propagation time between the BS and CPE_1 as calculated by the previous equation for BS-to-CPE

PT_2: Propagation time between the BS and CPE_2 as calculated by the previous equation for BS-to-CPE

TA_{CBP}: Timing Advance of the CBP burst [see step 2) of 11.5.2.3]

(Note that the geolocation process will have to pre-adjust TA_{CBP} depending on the distance between the two CPE to be geolocated and the reference CPEs so that the delays measured by Vernier_3 fall within the symbol cyclic prefix (e.g., 74.68 µs corresponding to 22.4 km).

CPE_1-to-CPE_2 Propagation distance = c × Propagation time / 2

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Once these BS-to-CPE and CPE-to-CPE distances have been found, triangulation calculations can be carried out to come up with the precise position of the CPE to be geolocated.

The accuracy of the process will be limited first by the accuracy of the CPE residual delays reported at registration by each CPE involved through the RNG-REQ MAC message, which is specified to be ±30 ns in 7.9.7.3.4.10. It will also be limited by potential multipath contained in the channel impulse response received at each CPE. If complex multipath is experienced, it is possible that the right impulse that reflects the correct propagation distance may be hidden and/or diffused by other multipaths due to reflections on the RF channel. Low SNR resulting from blockage or distant reference CPEs may also impact the accuracy. However, accuracy can be improved in building redundancy in the process by using more reference CPEs. This would help in selecting the reference CPEs that provide the cleanest channels among those used for the ranging process. This choice will be made by the terrestrial geolocation process since it can have access to the channel impulse response at each reception point as the time domain representation of the different 'Vernier' vectors. More accuracy in the triangulation calculations can also be obtained by using more reference CPEs in these calculations.

11.6 Database service

11.6.1 System model for the database access

The system model that has been assumed all along in the development of IEEE Std 802.22 is a point-to-multipoint model for extending broadband access to less populated rural areas where more available channels can be found. In this model, the BS is assumed to control all RF parameters of its associated CPE (frequency, EIRP, modulation, etc.) in a "master-slave" relationship, so that the responsibility of protecting the TV broadcast incumbents is fully carried by the Wireless Regional Area Network (WRAN) operator. When this model was applied to an interface to the database service proposed in the FCC R&O 08-260, the initial finding made by the IEEE 802.22 Working Group was that this interface is to take place entirely between the database service and the BS rather than with its individual CPEs. The system architecture and interface to the database services that the IEEE 802.22 Working Group has developed is depicted in Figure 268.

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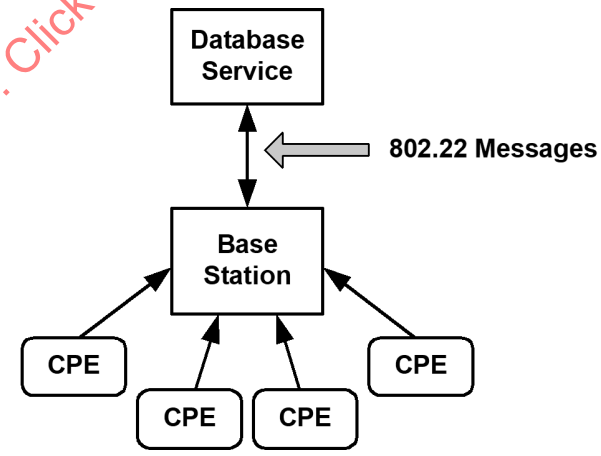

Figure 268—Structure of the IEEE 802.22 WRAN access to the database service

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11.6.2 Database service access

The BS will initially enlist with the database service as a fixed device.[35] It will also enlist all its associated CPEs with their geographic location, device identification, etc., as obtained at association on a real-time basis since its association may depend on the response from the database service. On an ongoing basis, the BS will then query the database (at least once every 24 h) using the M-DB-AVAILABLE-CHANNEL-REQUEST message so that it can retrieve the channel information. Furthermore, the database service could send any update relevant to the BS operation through *push* Internet technology, since the network address of the BS is provided as part of the messages. Such push technology would allow for a better reaction time than the 24 h minimum access time currently specified while keeping the database traffic to a minimum.

11.6.3 Security for these messages

Security on the messages exchanged between the BS and the database service will be critical for the proper operation of the systems to allow authentication of the database service provider as well as the WRAN system querying the service. Security will also be necessary to avoid the message exchange being altered on the backhaul connection. The network will only support SSL on the link between the database service and the BS to provide transport layer security. The IEEE 802.22 network shall use the same authentication protocols for device and database service authentication and for interacting with the database (i.e., EAP-TLS or EAP-TTLS, see 8.4.3) as those specified for device authentication in Clause 8. All database service primitives are exchanged between the CPE/BS and the database service via Attribute Value Pairs of EAP messaging. The formatting of said messages shall conform to the authentication service (e.g., RADIUS/RFC 2865 [B26] or DIAMETER/RFC 3588 [B29]) that the database service employs.

11.7 Operation in non-TV white-space bands

Since the inception of the regulations for the TV band white spaces, spectrum sharing in other frequency bands has become a new norm. In fact, there are more frequency bands that are being opened for commercial use on a shared spectrum basis today than clearing up the bands, or refarming them for future use cases. In the USA and many other countries, we anticipate frequency bands, such as 1.3 GHz to 1.75 GHz, 2.7 GHz to 3.7 GHz, and others, to be opened for commercial use on a shared spectrum basis. The *primary users* in these frequency bands may include satellite service, radars, terrestrial microwave links, etc. Since IEEE Std 802.22 is the first international standard that provides Cognitive Radio operation allowing sharing of the spectrum in the TV broadcast bands while avoiding harm to the primary users, we anticipate that the standard could advantageously be extended for use in those other frequency bands as well. The standards operating in these bands may need spectrum database access (e.g., Spectrum Access System), spectrum sensing, or beaconing approaches. IEEE Std 802.22 covers all these techniques in its specification.

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[35] For the purpose of this document, the BS is assumed to be the operator's contact point for the database service.

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12. Configuration

Tamper-proof mechanisms shall be implemented to prevent unauthorized modification to firmware and/or functionalities (e.g., MAC address, SM/SSA functionality, database service communication, RF sensing, DFS, TPC, tuning) that would allow device or network operation to violate either the specifications of IEEE Std 802.22 or the requirements of the local regulations. Any attempt to load unapproved firmware into an IEEE 802.22 device shall render it inoperable. Measures for both local and remote attestation of authorized and approved hardware and software running on an IEEE 802.22 device shall be implemented. Implementation of the Trusting Computing Group's Trusted Platform Module (TPM) Main Specification Level 2 Version 1.2 (Revision 103) (see TPM in Clause 2) shall be used to bind the hardware and software running on IEEE 802.22 devices to a cryptographic key.

When a CPE detects that the information on the antenna model and serial number has changed (see 9.12.2) after a request from the BS for this information (REG-REQ/RSP, see 7.9.7.3.4.9), the CPE shall re-initialize.

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13. Parameters and connection management

13.1 Parameters, timers, message IEs

This subclause defines bounds for various parameters, timers, and message/IE fields that are specified throughout the standard.

13.1.1 MAC (dynamic service flow, multicast, ARQ, capability, and bandwidth management)

Table 333—MAC parameters, timers, message IEs

Entity/ Scope	Name	Reference	Min value	Default value	Max value
CPE, BS/ A-BS/ Distributed Scheduling R-CPE	DSx Request Retries	Number of Timeout Retries on DSA/DSC/DSD Requests.	—	3	—
CPE, BS/ A-BS/ Distributed Scheduling R-CPE	DSx Response Retries	Number of Timeout Retries on DSA/DSC/DSD Responses.	—	3	—
CPE	T6	Wait for registration response.	—	—	3 s
CPE, BS/ A-BS/ Distributed Scheduling R-CPE	T7	Wait for DSA/DSC/DSD Response timeout.	—	—	1 s
CPE, BS/ A-BS/ Distributed Scheduling R-CPE	T8	Wait for DSA/DSC Acknowledge timeout.	—	—	300 ms
BS/A-BS/ Distributed Scheduling R-CPE	T9	Registration Timeout, the time allowed between the BS/A-BS/Distributed Scheduling R-CPE's sending a RNG-CMD (success) to a CPE and receiving a CBC-REQ from that same CPE.	300 ms	300 ms	—
CPE, BS/ A-BS/ Distributed Scheduling R-CPE	T10	Wait for Transaction End timeout.	—	—	3 s
BS/A-BS/ Distributed Scheduling R-CPE	T13	The time allowed for an CPE, following receipt of a REG-RSP message to send a TFTP-CPLT message to the BS.	15 min	15 min	—
CPE	T14	Wait for DSx-RSP/DSX-RVD Timeout.	—	—	200 ms
BS/A-BS/ Distributed Scheduling R-CPE	T15	Wait for MCA-RSP.	20 ms	20 ms	—

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Table 333—MAC parameters, timers, message IEs *(continued)*

Entity/ Scope	Name	Reference	Min value	Default value	Max value
CPE	T16	Wait for bandwidth request grant.	10 ms	—	Service QoS depen-dent
CPE	T18	Wait for CBC-RSP timeout.	—	5 ms	<< T9
CPE, BS/ A-BS/ Distributed Scheduling R-CPE	T22	Wait for ARQ-Reset.	—	—	0.5 s
CPE	T26	Wait for TFTP-RSP.	10 ms	10 ms	200 ms
BS/A-BS/ Distributed Scheduling R-CPE	T27 as idle timer	Maximum time between unicast grants to CPE when BS/A-BS/Distributed Scheduling R-CPE believes CPE upstream transmission quality is *good enough.*	CPE Ranging Response Processing Time	—	—
BS/A-BS/ Distributed Scheduling R-CPE	T27 as active timer	Maximum time between unicast grants to CPE when BS/A-BS/Distributed Scheduling R-CPE believes CPE upstream transmission quality is *not good enough.*	CPE Ranging Response Processing Time	—	—
BS/A-BS/ Distributed Scheduling R-CPE	T28	Time allowed for the BS/A-BS/Distributed Scheduling R-CPE to complete the transmission of the backup/candidate channel list to its CPEs after initial registration by a new CPE, including the database service query.	—	60 s	<< T45
CPE	CBC Request Retries	Number of retries on CBC Request.	—	3	—
	DSx Flow Control	Maximum # of ongoing dynamic service flow (DSx) transactions that are ongoing.	1	4	Infinite
	MCA Flow Control	Maximum # of ongoing multicast group assignment (MCA-REQ/RSP) transactions.	1	—	Infinite
	Max # of multicast groups	Maximum # of multicast groups the BS supports in a cell.	—	—	510
BS/A-BS/ Distributed Scheduling R-PE, CPE	T30	CPE registration Timer (see 7.9.7.3.5 and 7.16.2.11).	160 ms	40.8 s	10,485.6 s
BS/A-BS/ Distributed Scheduling R-CPE, CPE	ARQ_ BSN_ MODU-LUS	Number of unique BSN values.	—	2^10	—
BS/A-BS/ Distributed Scheduling R-CPE, CPE	ARQ_ WINDOW _SIZE	Max # of unacknowledged ARQ blocks at a given time.	—	—	≤ (ARQ_ BSN_ MODU-LUS)/2
BS/A-BS/ Distributed Scheduling R-CPE, CPE	ARQ_ BLOCK_ LIFE-TIME	Max time interval an ARQ block shall be managed by the Tx ARQ state machine.	10 µs	—	655.36 ms

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Table 333—MAC parameters, timers, message IEs *(continued)*

Entity/ Scope	Name	Reference	Min value	Default value	Max value
BS/A-BS/ Distributed Scheduling R-CPE, CPE	ARQ_ RETRY_ TIMEOUT (TRANS-MITTER_ DELAY/ RECEIVE R_ DELAY)	Minimum time interval a transmitter shall wait before retransmission of a unacknowledged block.	10 µs	—	655.36 ms
BS/A-BS/ Distributed Scheduling R-CPE, CPE	ARQ_ SYNC_ LOSS_ TIMEOUT	Max amount of time ARQ_TX_WINDOW_START or ARQ_RX_WINDOW_START shall be allowed to remain at the same value before declaring a loss of synchronization of the sender and receiver state machines for an ongoing transfer.	10 µs	—	655.36 ms
BS/A-BS/ Distributed Scheduling R-CPE, CPE	ARQ_RX_ PURGE_ TIMEOUT	Time interval the receiver shall wait after successful reception of a block that does not result in advancement of ARQ_RX_WINDOW_START, before advancing ARQ_RX_WINDOW_START.	10 µs	—	655.36 ms
BS/A-BS/ Distributed Scheduling R-CPE, CPE	ARQ_ BLOCK_ SIZE	Size of ARQ block that SDU is fragmented into.	1 octet	—	2040 octet
BS/A-BS/ Distributed Scheduling R-CPE	Max CPE Transmit EIRP	Maximum CPE Transmit EIRP as negotiated during registration.	–64 dBm	—	+63.5 dBm
CPE	Registra-tion Request Retries	Number of retries on registration requests.	3	—	—
CPE	Request Retries	Number of retries on bandwidth allocation requests.	16	—	—
	DSx Flow Control	Maximum # of ongoing dynamic service flow (DSx) transactions that are ongoing	1	4	Infinite
	MCA Flow Control	Maximum # of ongoing multicast group assignment (MCA-REQ/RSP) transactions	1	—	Infinite
	Max # of multicast groups	Maximum # of multicast groups the BS supports in a cell	1	—	511

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13.1.1.1 MAC (Relay, Multi-channel)

Table 334—MAC parameters, timers, message IEs

Entity	Name	Reference	Min value	Default value	Max value
CPE	T61	Wait for container ACK	10 ms	—	≤ T9
CPE	T62	Wait for local cell update acknowledgment	—	—	≤ T9
CPE	T63	Wait for DTT-RSP timeout	10 ms	—	≤ T9
A-BS	T64	Wait for DTT-RPT timeout	10 ms	—	≤ T9
CPE	T65	Wait for DTT-CFM timeout	20 ms	—	≤ T9
A-BS	T66	Wait for CAM-STP timeout	20 ms	—	160 ms
A-BS	T67	Wait for CAM-SWH timeout	10 ms	—	160 ms

13.1.2 PHY (initialization, operation, and DS/US synchronization)

Table 335—PHY parameters, timers, message IEs

Entity/ Scope	Name	Reference	Min value	Default value	Max value
BS/A-BS/ Distributed Scheduling R-CPE	DCD Interval	Time between transmission of DCD messages.			10 s
BS/A-BS/ Distributed Scheduling R-CPE	UCD Interval	Time between transmission of UCD messages.			10 s
BS/A-BS/ Distributed Scheduling R-CPE	UCD Transition	The time the BS/A-BS/Distributed Scheduling R-CPE shall wait after repeating a UCD message with an incremented Configuration Change Count before issuing a US-MAP message referring to Upstream_Burst_Profiles defined in that UCD message.	2 MAC frames		
BS/A-BS/ Distributed Scheduling R-CPE	DCD Transition	The time the BS/A-BS/Distributed Scheduling R-CPE shall wait after repeating a DCD message with an incremented Configuration Change Count before issuing a DS-MAP message referring to Downstream_Burst_Profiles defined in that DCD message.	2 MAC frames		
BS/A-BS/ Distributed Scheduling R-CPE	Initial Ranging Interval	Time between Initial Ranging opportunities assigned by the BS/A-BS/Distributed Scheduling R-CPE.			2 s

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Table 335—PHY parameters, timers, message IEs *(continued)*

Entity/ Scope	Name	Reference	Min value	Default value	Max value
BS/A-BS/ Distributed Scheduling R-CPE	CLK-CMP Interval	Time between the clock compare measurements used for the generation of CLK-CMP messages.	50 ms	50 ms	50 ms
CPE	Lost DSMAP Interval (T56)	Time since last received DS-MAP message before DS synchronization is considered lost.			600 ms
CPE	Lost USMAP Interval (T57)	Time since last received US-MAP message before upstream synchronization is considered lost.			600 ms
CPE	Lost SCH (T58)	Number of SCH on PHY-OM 1 that can be lost until synchronization is considered lost.			15
CPE	CDMA Ranging Retries	Number of retries on CDMA Ranging Requests.	1		4
CPE, BS/ A-BS/ Distributed Scheduling R-CPE	Invited Ranging Retries	Number of retries on inviting Ranging Requests.	16		
BS/A-BS/ Distributed Scheduling R-CPE	US-MAP Process Time	Time provided between arrival of the last bit of a US-MAP at a CPE and effectiveness of that map.	5 symbols		
BS/A-BS/ Distributed Scheduling R-CPE	CPE Ranging Response Processing Time	Time allowed for a CPE following receipt of a ranging response before it is expected to reply to an invited ranging request.	10 ms		
CPE	T1	Wait for DCD timeout.			5 × DCD interval maximum value
CPE	T2	Wait for broadcast ranging timeout.	—	—	5 × ranging interval
CPE	T3	Ranging Response reception timeout following the transmission of a Ranging Request.	—	200 ms	200 ms
CPE	T4	Wait for unicast ranging opportunity. If the pending-until-complete field was used earlier by this CPE, then the value of that field shall be added to this interval.	1 s	30 min (fixed) 10 min (portable	30 min
BS/A-BS/ Distributed Scheduling R-CPE	T5	Wait for Upstream Channel Change response.			2 s
CPE	T12	Wait for UCD descriptor.	—	—	5 × UCD Interval maximum value
CPE	T20	Time the CPE searches for preambles on a given channel.	2 MAC frames	—	—

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Table 335—PHY parameters, timers, message IEs *(continued)*

Entity/ Scope	Name	Reference	Min value	Default value	Max value
CPE	T21	Time the CPE searches for DS-MAP on a given channel.	—	—	10 s
BS/A-BS/ Distributed Scheduling R-CPE	$EIRP_{BS}$	EIRP of BS/A-BS/Distributed Scheduling R-CPE (DS).	–64 dBm		63.5 dBm
BS/A-BS/ Distributed Scheduling R-CPE	RTG	Receive-transmit Turnaround Gap.	81.8 µs	—	303.5 µs
BS/A-BS/ Distributed Scheduling R-CPE	DIUC Mandatory Exit Threshold	CINR at or below which this DIUC can no longer be used and where change to a more robust DIUC is required.	–64 dB	—	+63.5 dB
BS/A-BS/ Distributed Scheduling R-CPE	DIUC Mandatory Entry Threshold	The minimum CINR required to start using this DIUC when changing from a more robust DIUC is required.	–64 dB	—	+63.5 dB
BS/A-BS/ Distributed Scheduling R-CPE	SPC	Subcarrier Power Control applied to a DS allocation.	–99 dB	0 dB	0 dB
BS/A-BS/ Distributed Scheduling R-CPE, CPE	BW Request Backoff Start	Initial size of BW Request opportunity used by CPEs to contend to send BW requests to BS/A-BS/Distributed Scheduling R-CPE.	0		15
BS/A-BS/ Distributed Scheduling R-CPE, CPE	BW Request Backoff End	Final size of BW Request opportunity used by CPEs to contend to send BW requests to BS/A-BS/Distributed Scheduling R-CPE.	1		15
BS/A-BS/ Distributed Scheduling R-CPE, CPE	UCS notification Backoff Start	Initial backoff window size in units of UCS notification opportunity used by CPEs to contend to send UCS notifications to BS/A-BS/Distributed Scheduling R-CPE.	0		15
BS/A-BS/ Distributed Scheduling R-CPE, CPE	UCS notification Backoff End	Final size of UCS notification opportunity used by CPEs to contend to send UCS notification to BS/A-BS/Distributed Scheduling R-CPE.	1		15
BS/A-BS/ Distributed Scheduling R-CPE, CPE	Contention based reservation Timeout	Number of US-MAPs to receive before contention-based reservation is attempted again for the same connection.	1		255
BS/A-BS/ Distributed Scheduling R-CPE, CPE	BW Request opportunity size and CRZ BW Request opportunity size	Size (in OFDM slots) of PHY bursts, that a CPE may use to format and transmit a bandwidth request message in a contention request opportunity.	1		255

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Table 335—PHY parameters, timers, message IEs *(continued)*

Entity/ Scope	Name	Reference	Min value	Default value	Max value
BS/A-BS/ Distributed Scheduling R-CPE, CPE	UCS notification request opportunity size and CRZ UCS notification request opportunity size	Size (in OFDM slots) of PHY bursts that a CPE may use to transmit a UCS notification.	1		255
BS/A-BS/ Distributed Scheduling R-CPE, CPE	# of initial and CRZ initial ranging codes	Number of initial ranging CDMA codes (N).	1		255
BS/A-BS/ Distributed Scheduling R-CPE, CPE	# of periodic and CRZ periodic ranging codes	Number of periodic ranging CDMA codes (M).	1		255
BS/A-BS/ Distributed Scheduling R-CPE, CPE	# of bandwidth and CRZ bandwidth request codes	Number of bandwidth request CDMA codes (L).	1		255
BS/A-BS/ Distributed Scheduling R-CPE, CPE	# of UCS notification and CRZ UCS notification codes	Number of UCS notification CDMA codes (I).	1		255
BS/A-BS/ Distributed Scheduling R-CPE, CPE	Start of CDMA codes group	Indicates the starting number, S, of the group of codes used for the US.	0	See 6.10.3	255
BS/A-BS/ Distributed Scheduling R-CPE, CPE	EIRP Density Level	EIRP Transmitted per subcarrier.	–104 dBm		+23.5 dBm
BS/A-BS/ Distributed Scheduling R-CPE, CPE	EIRP Control	EIRP per subcarrier that the CPE should apply to correct its current transmission EIRP.	–104 dBm		+23.5 dBm
BS/A-BS/ Distributed Scheduling R-CPE	EIRP per subcarrier	EIRP transmitted per subcarrier.	–104 dBm		+23.5 dBm
CPE	Lost A-FCH (T68)	Number of A-FCH on PHY-OM2 that can be lost until synchronization is considered lost.			Lost SCH × 16
CPE	Lost DRZ-FCH (T69)	Number of DRZ-FCH that can be lost until synchronization in DRZ is considered lost.			Lost SCH × 16

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13.1.3 Coexistence

Table 336—Coexistence parameters, timers, message IEs

Entity/ Scope	Name	Reference	Min value	Default value	Max value
BS	T32	Wait for the Frame Contention Response message.	1 super-frame	—	32 super-frames
BS	FCW	Frame Contention Window: number of superframes during which a BS (FC_DST) accumulates the frame contention requests before reacting to it and responding to the FC_SRCs.	0 super-frame	—	16 super-frames
BS	SCWBack-off_Max	Integer denoting the maximum superframes for the SCW backoff window.	0	—	15
BS	Frame_ Contention_ Min	Number of frames not available for contention at a BS in a coexistence situation.	0	2	8
BS	FCN_range	Exponent in base 2 defining the extent of the range of the random number FCN.	4	—	16
BS	SF_release	Number of superframes after which the BS releases the frames won by another BS through frame contention.	—	5	—
CPE	T_{CBP} (T34)	The minimum time between transmissions of a CBP packet carrying its MAC address for identification by nearby CPEs and BSs for coexistence purpose, as well as by spectrum monitoring systems to identify potential interference situations. Timing value may depend on the regulatory domain where the WRAN system operates (see Annex A).	8 s	300 s	15 min
BS	SCWBack-off_Timer (T35)	Backoff timer that controls exiting or continuation of Frame contention procedure.	—	—	SCWBack-off_Max

13.1.4 Security

Table 337—Security parameters, timers, message IEs

Entity/ Scope	Name	Reference	Min value	Default value	Max value
CPE	EAP Authentica-tion Timer (T36)	Timeout period between sending SCM EAP-Start or EAP-Transfer (8.2.2.5).	2 s	10 s	30 s
CPE	Authentica-tion Grace Timer (T37)	Amount of time after authentication is complete that shall pass before reauthentication is complete (8.2.2.5).	5 min (300 s)	10 min (600 s)	6 h (21 600 s)

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Table 337—Security parameters, timers, message IEs *(continued)*

Entity/ Scope	Name	Reference	Min value	Default value	Max value
CPE	Max #of Authentica-tion Attempts	Maximum # of Times a CPE is allowed to attempt EAP Authentication (8.2.2.5).	1 s	5 s	10 s
CPE	Operational Wait Timeout (T38)	Timeout period between sending of Key Request messages from the Op Wait state (8.2.3.2.4).	1 s	1 s	10 s
CPE	Rekey Wait Timeout (T39)	Timeout period between sending of Key Request messages from the Rekey Wait state (8.2.3.2.4).	1 s	1 s	10 s
CPE	GTEK/TEK Grace Time (T40)	Time interval, in seconds before the estimated expiration of a GTEK/TEK (8.2.3.2.4).	5 min (300 s)	1 h (3600 s)	3.5 days (302 400 s)
BS	AK Lifetime	Lifetime BS assigns to new AK.	1 day (86 400 s)	7 days (604 800 s)	70 days (6 048 000 s)
BS	TEK Lifetime	Lifetime BS assigns to new TEK.	30 min (1800 s)	12 h (43 200 s)	7 days (604 800 s)
BS, CPE	SCM Flow Control	The maximum number of concurrent SCM transactions.	0 (Default: unlimited # of transactions	—	255
BS, CPE	Number of Supported Security Associations	The maximum # of supported security associations.	2	—	2+*m* where *m* is the number of multicast groups
BS, CPE	PN_ WINDOW_ SIZE	Window that defines the acceptable PNs for received PDUs that are to be processed by encryption/decryption process.	16	—	512
BS	T17	Time allowed for CPE to complete CPE Authorization and Key Exchange.	5 min	5 min	—

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13.1.5 Cognitive radio capabilities (SM, SSA, incumbent protection, QP management)

Table 338—Cognitive radio capability parameters, timers, message IEs

Entity/ Scope	Name	Reference	Min value	Default value	Max value
CPE	T29	Wait for BLM-ACK timeout.	10 ms	—	300 ms
BS	T31	Wait for BLM-REP timeout.	1 MAC frame	—	
CPE	BLM-REP Retries	Number of retries allowed for sending BLM-REP.	—	3	—
BS, CPE	Channel Availability Check Time	The time during which a channel SHALL be checked for the presence of licensed incumbent signals having a level above the Incumbent Detection Threshold prior to the commencement of WRAN operation in that channel and, in the case of TV, a related channel at an EIRP level that can affect the measured channel.	—	30 s	—
BS, CPE	Non-Occupancy Period	The required period during which WRAN device transmissions SHALL NOT occur in a given channel because of the detected presence of an incumbent signal in that channel above the Incumbent Detection Threshold, or in the case of TV, above a given EIRP level.	10 min	—	—
BS, CPE	Channel Detection Time	The maximum time taken by a WRAN device to detect a licensed incumbent signal above the Incumbent Detection Threshold within a given channel during normal WRAN operation.	—	≤ 2 s to ≥ 90% Probability of detection with a false alarm rate of ≤ 10%	—
BS, CPE	Channel Setup Time	The window of time that may be taken by a WRAN CPE to transmit control information to a WRAN BS in order to establish operation with that BS at the prescribed power or, in the case of TV, at or below the allowable EIRP within a given channel.	—	2 s	—
BS, CPE	Channel Opening Transmission Time (Aggregate transmission time)	The aggregate duration of control transmissions by WRAN devices during the Channel Setup Time, which starts at the end of the Channel Availability Check Time.	—	100 ms	—
BS, CPE	Channel Move Time (In-service monitoring)	The time taken by a WRAN system to cease all interfering transmissions on the current channel upon detection of a licensed incumbent signal above the relevant Incumbent Detection Threshold, or in the case TV, to alternatively reduce its EIRP to that which is allowable within a given channel upon detection of a TV signal in the same or a related channel.	—	2 s	—

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Table 338—Cognitive radio capability parameters, timers, message IEs *(continued)*

Entity/ Scope	Name	Reference	Min value	Default value	Max value
BS, CPE	Channel Closing Transmission Time (Aggregate transmission time)	The aggregate duration of control transmissions by the WRAN devices during the Channel Move/ EIRP Reduction Time, which starts upon detection of a licensed incumbent signal above the relevant Incumbent Detection Threshold.	—	100 ms	—
BS, CPE	Channel Number	The channel number to be sensed by the SSF (10.4).	0	—	255
BS, CPE	Channel Bandwidth	The bandwidth of the channel to be sensed by the SSF (10.4).	—	6/7/8 MHz (depending on regulatory domain)	—
BS, CPE	Maximum Probability of false alarm	In sensing modes 0 and 1 this value specifies the maximum probability of false alarm for each sensing mode decision in the signal present array.	0.0	—	0.255
BS, CPE	NumSensing Periods	Number of sensing periods field in a Sensing Window Specification Array entry.	0	1	127
BS, CPE	Sensing-Period-Duration	Duration of sensing period field (in units of OFDM symbols) in a Sensing Window Specification Array entry.	0	16	1023
BS, CPE	Sensing-Period-Interval	Periodicity of Sensing period field in a Sensing Window Specification Array entry.	0	200	2047
BS, CPE	Sensing Window Specification Array	Array containing Sensing Window specification for each signal type enumerated in Signal Type Array.	1×sizeof (NumSensingPeriods +Sensing-Period-Duration+ SensingPeriod-Interval)	—	32×sizeof (NumSensingPeriods+Sensing-Period-Duration+ Sensing-Period-Interval)
BS, CPE	Signal Type Array	Bitmap that indicates which signal types are to be sensed for in a given regulatory domain.	—	Set on a regulatory domain-by-domain basis; see Table A.11	—
BS, CPE	Sensing Mode	The sensing mode a CPE supports. Negotiated during CPE initialization. Various modes are described in Table 238.	—	No Sensing	—
BS, CPE	Signal Present Decision	Indication of whether a signal of a specific type has been detected. All unused values are reserved.	0x00 (Absent)	0x7F (No Decision could be made)	0xFF (Signal Present)
BS, CPE	Confidence Metric	Confidence with which sensing can determine the signal type.	0x00 (No Confidence)	—	0xFF (Full confidence)
BS, CPE	Mean RSSI	Mean of M RSSI measurements.	–104 dBm	—	+23.5 dBm

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Table 338—Cognitive radio capability parameters, timers, message IEs *(continued)*

Entity/ Scope	Name	Reference	Min value	Default value	Max value
BS, CPE	Standard Deviation of RSSI	Standard deviation of the M RSSI measurements.	+0.0 dB	—	+25.5 dB
BS, CPE	RSSI_ detection_ threshold	Energy detection threshold indicating the presence of an incumbent, other WRAN system, or interference.	–120 dBm	—	–10 dBm
BS, CPE	Microphone Protection Radius	Radius of the contour within which the WRAN system cannot operate due to potential interference with the microphone.	0.1 km	—	100 km
BS, CPE	$T_{Candidate_Channel_Refresh}$ (T41)	Maximum time interval allowed before sensing is performed on the candidate channel to determine that no incumbents are detected.	1 s	6 s	10 s
BS, CPE	$T_{Backup_Channel_Refresh}$ (T42)	Maximum time interval allowed before sensing is performed on the backup channel to determine that no incumbents are detected.	1 s	6 s	10 s
BS, CPE	$T_{Candidate_to_Backup_Transition}$ (T43)	Minimum time duration without detection of any incumbent for a candidate channel to transition to the backup channel.	1 s	30 s	100 s
BS, CPE	T_{Ch_Move} (T44)	Maximum time to determine that the channel move information is successfully conveyed to all the associated CPEs and BS (self-coexistence mode).	1 s	—	10 s
BS, CPE	T_{No_DB} (T45)	Maximum WRAN operation time without access to the incumbent database service.	0.1 h	—	72 h
BS	$T_{Wait_Before_Channel_Move}$ (T46)	Waiting time before which the BS moves to the first backup channel. This is used to make sure that all the CPEs are ready to move to the backup channel before BS switches operation to this backup channel.	1 frame	—	256×16 frames
CPE	$T_{Wait_Before_Channel_Move}$ (T59)	Waiting time before which the CPE moves to its backup channels if it no longer hears from its BS. This is used to make sure that the CPE waits long enough after its UCS Notification so that the BS has had time to move to a backup channel, if it decided to do so.	1 frame	—	256×16 frames
BS, CPE	$T_{Refresh_Database_Info}$ (T47)	The prescribed time by the WRAN operator to refresh the incumbent database service.	0.1 h	—	72 h
BS, CPE	T_{Clear_N} (T48)	Lapser Timer keeps track of whether the Operating Channel N has been cleared using spectrum sensing.	0.1 s	—	60 s
BS, CPE	T_{Clear_N-1} (T49)	Lapser Timer keeps track of whether the Adjacent Channel N–1 has been cleared using spectrum sensing.	0.1 s	—	60 s
BS, CPE	T_{Clear_N+1} (T50)	Lapser Timer keeps track of whether the Adjacent Channel N+1 has been cleared using spectrum sensing.	0.1 s	—	60 s
BS, CPE	$T_{Loss_of_BS_Contact}$ (T51)	Initiated when the CPE loses contact with the BS.	1 s	—	600 s

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Table 338—Cognitive radio capability parameters, timers, message IEs *(continued)*

Entity/ Scope	Name	Reference	Min value	Default value	Max value
BS, CPE	T_{Range1} (T52)	Used for terrestrial geolocation. Initiated when the downstream burst leaves the BS (i.e., at the start of the frame preamble).	1 TU	—	1000 TU
BS, CPE	T_{INsens} (T53)	The parameter T_{INsens} is used to verify that in-band sensing has been done within the required In-service monitoring period. The T_{INsens} parameter is driven by the regulatory domain requirements. See Annex A.	0.1 s	—	60 s
BS, CPE	$T_{OUTsens}$ (T54)	The parameter $T_{OUTsens}$ is used to verify that out-of-band sensing has been done within the required "Acquiring a channel monitoring period" specified in Table A.13 (30 s in the USA). This value would be used to either initialize a "lapse timer" for each channel in the backup/candidate list at each CPE so that it is compared to T_{sens}.	0.1 s	—	60 s
BS, CPE	T_{sensin} (T55)	T_{sensin} parameter corresponds to the maximum length of time required to carry out the sensing process on an in-band channel (N, N–1, or N+1). Manufacturers need to specify the sensing time required to detect the specified signals with required accuracy (see Figure 176).	1 ms	—	160 ms
CPE	$T_{sensout}$ (T60)	$T_{sensout}$ parameter corresponds to the maximum length of time required to carry out an out-of-band sensing process for a specified channel N (i.e., N, N–1, and N+1). Manufacturers need to specify the sensing time required to detect the specified signals out-of-band with required accuracy (see Figure 178).	20 ms	—	160 ms
BS, CPE	ISO 3166 IETF Country Code	Three-character, ASCII string denoting the regulatory domain of operation (e.g., "USA" is for United States of America").	—	3 characters	—
BS, CPE	TA_{CBP}	Timing Advance of the CBP burst (see step 2 of 10.5). Note that the geolocation process will have to pre-adjust TA_{CBP} depending on the distance between the two CPE to be geolocated and the reference CPEs so that the delays measured by $Vernier_3$ fall within the symbol cyclic prefix (e.g., 74.68 µs corresponding to 22.4 km).	–1024 TU	—	+1024 TU

13.2 Well-known CIDs

Connections assigned to CPEs and multicast groups in an IEEE 802.22 network are identified by two items, the station ID (SID) and flow Type (FT). A connection identifier (CID) can be constructed from the tuple of SID and FT (CID = SID | FT). The SID makes up the 9 MSB of the CID, while the FT makes up the 3 LSB of the CID. Figure 269 shows the relationship between SIDs and FTs, with respect to CIDs.

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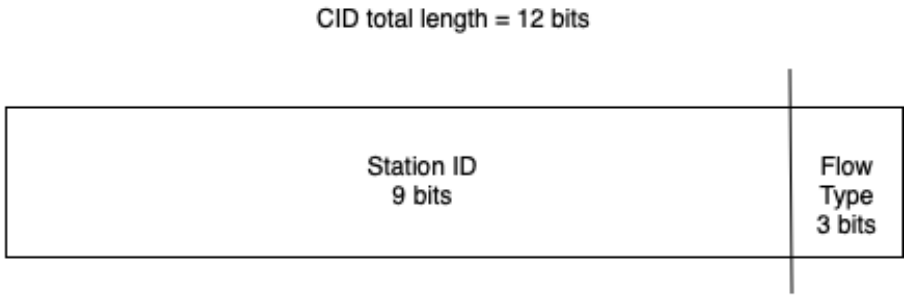

Figure 269—Relationship between CID, SID, and FT

CPEs operating under a particular BS are uniquely identified by a Station Identifier (SID). The SID is a 13-bit value, allowing for a maximum of up to 512 stations operating under the control of a BS. The number of unicast stations (e.g., individual CPEs) and multicast stations (e.g., multicast groups) is controlled by the operator. A SID is reserved for IEEE 802.22 broadcast and initial ranging communications. SIDs are shall be handled as described in Table 339.

Table 339—Station ID allocation

SID	Value	Description
Null	0x000	Cell-wide SID reserved for system testing to which no CPE should respond
Unicast	0x001 – m	SID for individual CPEs
Multicast	m+1 – 0x1FE	SID for multicast groups
Cell	0x1FF	Cell-wide SID reserved for broadcast and initial ranging to which all CPEs should respond

Traffic flows for a station are identified by the flow Type (FT). The FT is a 3-bit value, allowing for a maximum of up to 8 flows assigned to a particular SID. Table 340 to Table 342 show how FTs shall be used for the Cell, Unicast, and Multicast SIDs. In Table 340, ‘m’ refers to the “Maximum number of multicast Groups supported” (see REG-REQ/RSP IE in 7.9.7.3.4.6).

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Table 340—Flow Type allocation for Cell SID

FT	Value	Description
Broadcast	000	Traffic on broadcast connection mapped to the Broadcast Flow assigned to Cell SID
Initial Ranging	001	Traffic on initial ranging connection mapped to the Initial Ranging Flow assigned to Cell SID
BE	010	Data sent on Cell transport connection using the BE scheduling class napped to BE flow assigned to the Cell SID
nrtPS	011	Data sent on the Cell transport connection using the nrtPS scheduling class mapped to nrtPS Flow assigned to Cell SID
rtPS	100	Data sent on Cell transport connection using the rtPS scheduling class mapped to the rtPS Flow assigned to Cell SID
UGS	101	Data sent Cell transport connection using the UGS scheduling class mapped to the UGS Flow assigned to Cell SID
Reserved	110–111	Reserved for future use

Table 341—Flow Type allocation for Unicast SID

FT	Value	Description
Basic	000	Traffic on basic connection mapped to the Basic Flow assigned to a CPE SID
Primary Management	001	Traffic on primary management connection mapped to Primary Management Flow assigned to a CPE SID
BE	010	Data sent on unicast transport connection using the BE scheduling class mapped to BE Flow assigned to a CPE SID
nrtPS	011	Data sent on unicast transport connection using the nrtPS scheduling class mapped to nrtPS Flow assigned to a CPE SID
rtPS	100	Data sent on unicast transport connection using the rtPS scheduling class mapped to the rtPS Flow assigned to a CPE SID
UGS	101	Data sent on unicast transport connection using the UGS scheduling class mapped to the UGS Flow assigned to a CPE SID
Reserved	110	Reserved for future use
Secondary Management	111	Traffic on secondary management connection mapped to Secondary Management Flow assigned to a CPE SID

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Table 342—Flow Type allocation for Multicast SID

FT	Value	Description
Multicast Polling	000	Traffic on multicast bandwidth request polling sent on the Multicast Polling Flow assigned to multicast SID (group)
Multicast Management	001	Traffic on multicast management sent on the Multicast Management Flow assigned to multicast SID (group)
BE	010	Data sent on multicast transport connection using the BE scheduling class mapped to BE Flow assigned to multicast SID (group)
nrtPS	011	Data sent on multicast transport connection using the nrtPS scheduling class mapped to nrtPS Flow assigned to multicast SID (group)
rtPS	100	Data sent on multicast transport connection using the rtPS scheduling class mapped to the rtPS Flow assigned to multicast SID (group)
UGS	101	Data sent on multicast transport connection using the UGS scheduling class mapped to the UGS Flow assigned to multicast SID (group)
Reserved	110–111	Reserved for future use

From Figure 269 and Table 339 to Table 342, it is possible to construct CIDs for various system connections. The following is an example list of system connections and how they are constructed from SIDs and FTs.

— Basic CID = Unicast SID | Basic FT
— Broadcast CID = Cell SID | Broadcast FT
— Initial Ranging CID = Cell SID | Initial Ranging FT
— Unicast Transport CID using UGS = Unicast SID | UGS FT
— Multicast manage CID = Multicast SID | Multicast Management FT

This approach to CID management is taken to allow for a reduction of overhead by signaling just the SID in the DS/US-MAP allocation for a station, then identifying particular connections by the FT that is then carried in the GMH of individual MAC PDUs within a station's allocation.

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13.3 ARQ parameters

Table 343—ARQ parameters

Entity	Name	Description	Length (octets)	Value
BS, CPE	ARQ_BSN_MODULUS	7.11.3.1	2	2^{10}
BS, CPE	ARQ_WINDOW_SIZE	7.11.3.2	2	See Table 110.
BS, CPE	ARQ_BLOCK_LIFETIME	7.11.3.3	2	See Table 112.
BS, CPE	ARQ_RETRY_TIMEOUT	7.11.3.4	2	See Table 111.
BS, CPE	ARQ_SYNC_LOSS_TIMEOUT	7.11.3.5	2	See Table 113.
BS, CPE	ARQ_PURGE_TIMEOUT	7.11.3.6	2	See Table 115.
BS, CPE	ARQ_BLOCK_SIZE	7.11.3.7	2	See Table 116.

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14. MIB structure

The definition of managed objects in this standard is expressed in Structure of Management Information Version 2 (SMIv2). It supports a management protocol agnostic approach, including SNMP.

The basic MIB objects are the following:

— *wranDevMib*: Basic MIB for BS/CPE device management. Can be used to track software versioning of BS/CPE HW/SW and what SNMP traps can be configured on those devices.
— *wranIfBsMib*: Basic MIB for BS-related MIB objects related to providing fixed AND portable service.
— *wranIfBsSfMgmtMib:* Basic MIB for managing items related to Service Flow configuration, instantiation, and management.
— *wranIfCpeMib*: Basic MIB for CPE-related MIB objects related to operation of fixed AND portable CPEs.
— *wranIfSmMib*: Basic MIB for SM related MIB objects.
— *wranIfSsaMib*: Basic MIB for Spectrum Automaton related MIB objects.
— *wranIfDatabaseServiceMib*: Basic MIB for Database Service access related MIB objects.
— *wranIfABsMib*: MIB for advanced BS (A-BS) related objects.
— *wranIfACpeMib*: MIB for advanced CPE (A-CPE/R-CPE) related objects.

14.1 MIB description

14.1.1 wranDevMib

`wranDevMib` details objects that will be managed by the SNMP agent in the BS and CPE. This MIB element is broken down into the following MIB groups:

— `wranDevBsObjects`: MIB objects to be implemented by the SNMP agent in BS
— `wranDevCpeObjects`: MIB objects to be implemented by the SNMP agent in CPE
— `wranDevCommonObjects`: MIB objects to be implemented by the SNMP agent in BS/CPE

14.1.1.1 wranDevBsObjects

`wranDevBsObjects` is broken down into the following two items:

— `wranDevBsSoftwareUpgradeTable`: contains objects related to BS SW upgrade
— `wranDevBsNotification`: managed objects related to SNMP traps on BS

14.1.1.1.1 wranDevBsSoftwareUpgradeTable

This table defines objects associated with BS software configuration. It may have one or more entry, although only one software configuration shall be active at any given time. Each entry is defined by a compound attribute, `wranDevBsSoftwareUpgradeEntry`.

14.1.1.1.2 wranDevBsSoftwareUpgradeEntry

Each entry in the `wranDevBsSoftwareUpgradeTable` is made up of the following items:

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14.1.1.1.2.1 wranDevBsSoftwareUpgradeTimeStamp

This value is a timestamp to indicate when the last SW download or activation took place.

14.1.1.1.3 wranDevBsNotification

This group of objects relates to SNMP traps on the BS. There is a control element that enables/disables the traps (`wranDevBsTrapControl`) and what event information is logged when a trap is sent (`wranDevBsTrapDefinition`).

14.1.1.1.4 wranDevBsTrapControl

Defines control elements for traps. This is a 2-bit field that enables setting a trap to indicate when a BS event is logged (`wranDevBsEvent`) or when a event log buffer size overruns the configured threshold (`wranDevBsLogBuffExceedThreshold`).

14.1.1.1.4.1 wranDevBsTrapDefinition

This object groups all of the notification objects for the BS. It is defined to be compatible with SNMPv1, following 8.5 and 8.6 of IETF RFC 2758. It is a compound object made up of the contents of a logged BS event (`wranDevBsEventTrap`) and the indication of when the ratio of the portion used to total size of event log has been exceeded (`wranDevBsLogBuffExceedThresholdTrap`).

14.1.1.1.4.1.1 wranDevBsEventTrap

This object is a compound object that contains information that describes the event that is logged. This trap is caught when `wranDevBsEvent` in `wranDevBsTrapControl` is set.

14.1.1.1.4.1.2 wranDevBsLogBuffExceedThresholdTrap

This object is a compound object that indicates the index of an entry (defined by `wranDevCmnEventLogEntry`) in `wranDevCmnEventLogConfigTable` and the object in that entry that defines the ratio (defined by `wranDevCmnEventLogResidualBuffThreshold`) of used capacity in Event Log versus total capacity. This trap is caught when `wranDevBsLogBuffExceedThreshold` in `wranDevBsTrapControl` is set.

14.1.1.2 wranDevCpeObjects

wranDevCpeObjects are broken down into the following elements:

`wranDevCpeConfigFileEncodingTable`: Related to configuration information about the CPE

— `wranDevCpeNotification`: Related to SNMP traps that are particular to the CPE

14.1.1.2.1 wranDevCpeNotification

This group of objects relates to SNMP traps on the CPE. There is a control element that enables/disables the traps (`wranDevCpeTrapControl`) and what event information is logged when a trap is sent (`wranDevCpeTrapDefinition`).

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14.1.1.2.1.1 wranDevCpeTrapControl

Defines control elements for traps. This is a 2-bit field that enables setting a trap to indicate when a CPE event is logged (`wranDevCpeEvent`) or when a event log buffer size overruns the configured threshold (`wranDevCpeLogBuffExceedThreshold`).

14.1.1.2.1.1.1 wranDevCpeTrapDefinition

This object groups all of the notification objects for the CPE. It is defined to be compatible with SNMPv1, following 8.5 and 8.6 of IETF RFC 2758. It is a compound object made up of the contents of a logged BS event (`wranDevCpeEventTrap`) and the indication of when the ratio of the portion used to total size of event log has been exceeded (`wranDevCpeLogBuffExceedThresholdTrap`).

14.1.1.2.1.1.2 wranDevCpeEventTrap

This object is a compound object that contains information that describes the event that is logged. This trap is caught when `wranDevCpeEvent` in `wranDevCpeTrapControl` is set.

14.1.1.2.1.1.3 wranDevCpeLogBuffExceedThresholdTrap

This object is a compound object that indicates the index of an entry (defined by `wranDevCmnEventLogEntry`) in `wranDevCmnEventLogConfigTable` and the object in that entry that defines the ratio (defined by `wranDevCmnEventLogResidualBuffThreshold`) of used capacity in Event Log versus total capacity. This trap is caught when `wranDevCpeLogBuffExceedThreshold` in `wranDevCpeTrapControl` is set.

14.1.1.3 wranDevCommonObjects

This object contains the following managed elements that are common to CPE and BS:

- `wranDevCmnEventLog`: Contains managed objects related to the Event Log.
- `wranDevCmnSnmpAgent`: Contains managed objects related to SNMP agent configuration.
- `wranDevCmnDeviceConfig`: Contains common managed objects related to device configuration.

14.1.1.3.1 wranDevCmnEventLog

Event Log is a compound attribute made up of the following:

- `wranDevCmnEventLogConfigTable`: Configuration of parameters for Event Log operation.
- `wranDevCmnEventTable`: Defines events that are supported by the CPE and BS.
- `wranDevCmnEventLogTable`: Used to store local Events that shall reside in non-volatile memory.

14.1.1.3.2 wranDevCmnEventLogConfigTable

Each entry stores the Event Log configuration for a device. Each entry is defined as `wranDevCmnEventLogConfigEntry`.

14.1.1.3.2.1 wranDevCmnEventLogConfigEntry

This object is a compound object that Event Log configuration for a particular device, indicated by `wranDevCmnDeviceIndex`.

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14.1.1.3.2.1.1 wranDevCmnDeviceIndex

Index value that identifies a BS or CPE entry in the `wranDevCmnEventLogConfigTable`.

14.1.1.3.2.1.2 wranDevCmnEventLogEntryLimit

Maximum number of entries in `wranDevCmnEventLogConfigTable`. If this value is changed while entries exist in the `wranDevCmnEventLogTable`, old entries will be discarded until limit is reached.

14.1.1.3.2.1.3 wranDevCmnEventLogLifeTimeLimit

A value of 0 means that an entry is kept indefinitely. Any other value is the maximum time an entry can exist in `wranDevCmnEventLogTable`. If this value is changed while entries exist in `wranDevCmnEventLogTable`, entries older than this limit will be discarded.

14.1.1.3.2.1.4 wranDevCmnEventLogEntryLimitPerEventId

The number of log entries that can be logged per event.

14.1.1.3.2.1.5 wranDevCmnEventLogSeverityThreshold

Minimum severity level of an event that can be logged into the Event Log.

14.1.1.3.2.1.6 wranDevCmnEventLogWrapAroundBuffEnable

Indication of whether or not the Event Log can wrap around when full or is emptied when full.

14.1.1.3.2.1.7 wranDevCmnEventLogLatestEvent

Index of latest event in Event Log.

14.1.1.3.2.1.8 wranDevCmnEventLogPersistenceSupported

Indication of whether or not Event Log is to persist through power cycle or reset of device.

14.1.1.3.2.1.9 wranDevCmnEventLogResidualBuffThreshold

Threshold ratio of used capacity for Event Log to total capacity of Event Log, that when reached a TRAP is issued.

14.1.1.3.3 wranDevCmnEventTable

This compound object defines the types of events that are supported by a BS or CPE. Each event is defined by `wranDevCmnEventEntry`.

14.1.1.3.4 wranDevCmnEventEntry

This object defines the parameters of an event entry in the `wranDevCmnEventTable`. Each entry is indexed by `wranDevCmnEventIdentifier`.

14.1.1.3.4.1 wranDevCmnEventLogTable

This is the log table that stores local events as they happen. This table shall reside in non-volatile memory that may persist after power cycle or reset of the device. The maximum number of entries in this table is

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determined by the wranDevCmnEventLogEntryLimit. If it is setup as a wraparound log, then the oldest entry will be removed to make room for the newest entry. If it is not setup as a wraparound log, then the log will be flushed. Multiple entries are store in the table. Each entry is defined by wranDevCmnEventLogEntry.

14.1.1.3.4.1.1 wranDevCmnEventLogEntry

Each entry in the Event Log table is made up of several parameters.

14.1.1.3.4.1.2 wranDevCmnEventId

A counter used to index entries in the Event Log. When it reaches the maximum value, it will wrap around if configured to wrap around or the log will be flushed if it is not configured to wrap around.

14.1.1.3.5 wranDevCmnSnmpAgent

This compound object deals with the common objects (wranDevCmnSnmpAgent and wranDevCmnSnmpV1V2TrapDestTable) related to SNMP agent configuration.

14.1.1.3.6 wranDevCmnDeviceConfig

This compound attribute contains the following:

— wranDevCmnResetDevice: Object that is used to reset the device.
— wranDevMibGroups: MIB objects that are required for conformance.
— wranDevMibCompliance: MIB objects that are required for conformance.

14.1.1.3.7 wranDevCmnResetDevice

There are two actions defined for the object. When set to *actionResetDeviceNoAction*, no action is taken. When set to *actionResetDevice*, the device will reset itself.

14.1.1.3.7.1 wranDevMibGroups

This object helps define which MIB groups are necessary to meet conformance and what MIB objects are part of each group.

14.1.1.3.7.1.1 wranDevMibBsGroup

This MIB group is mandatory. It is made up of wranDevBsTrapControl.

14.1.1.3.7.1.2 wranDevMibBsSwUpgradeGroup

This MIB group is mandatory. It is a compound object made up of wranDevBsVendorId, wranDevBsHwId, wranDevBsCurrentSwVersion,

wranDevBsDownloadSwVersion,

wranDevBsUpgradeFileName,

wranDevBsSoftwareUpgradeAdminState,

wranDevBsDownloadSwProgress,

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wranDevBsSoftwareUpgradeTimeStamp.

It contains the values of the most recent/current entry in wranDevBsSoftwareUpgradeTable.

14.1.1.3.7.1.3 wranDevMibCpeGroup

This MIB group is mandatory. It is a compound object made up of the following:

wranDevCpeMicConfigSetting,

wranDevCpeVendorId,

wranDevCpeHwId,

wranDevCpeConfigFileVersion,

wranDevCpeUpgradeFileName,

wranDevCpeSwTftpServer,

wranDevCpeTftpServerTimeStamp,

wranDevCpeTrapControl.

It contains the values of the most recent/current entry in wranDevCpeConfigFileEncodingTable for a particular CPE.

14.1.1.3.7.1.4 wranDevMibCmnGroup

This MIB group is mandatory. It is a compound object made up of the following:

wranDevCmnSnmpV1V2TrapDestIpAddrType,

wranDevCmnSnmpV1V2TrapDestIpAddr,

wranDevCmnSnmpV1V2TrapDestPort,

wranDevCmnSnmpV1V2TrapDestRowStatus,

wranDevCmnResetDevice,

wranDevCmnDeviceIndex,

wranDevCmnEventLogEntryLimit,

wranDevCmnEventLogLifeTimeLimit,

wranDevCmnEventLogEntryLimitPerEventId,
wranDevCmnEventLogSeverityThreshold,
wranDevCmnEventLogWrapAroundBuffEnable,

wranDevCmnEventLogLatestEvent,

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wranDevCmnEventLogPersistenceSupported,
wranDevCmnEventLogResidualBuffThreshold,

wranDevCmnEventDescription,

wranDevCmnEventSeverity,

wranDevCmnEventNotification,

wranDevCmnEventNotificationOid,

wranDevCmnEventId, wranDevCmnEventLoggedTime,
wranDevCmnEventLogDescription,

wranDevCmnEventLogSeverity.

It contains the values of the most recent/current entry in wranDevCmnSnmpV1V2TrapDestTable and wranDevCmnEventLogTable.

14.1.1.3.7.1.5 wranDevMibBsNotificationGroup

This MIB group is optional. It is a compound object that contains wranDevBsEventTrap, wranDevBsLogBuffExceedThresholdTrap.

14.1.1.3.7.1.6 wranDevMibCpeNotificationGroup

This MIB group is optional. It is a compound object that contains wranDevCpeEventTrap, wranDevCpeLogBuffExceedThresholdTrap.

14.1.1.3.7.2 wranDevCpeTrapControlGroup

Contains objects related to enabling/disabling CPE device traps.

14.1.1.3.7.3 wranDevBsTrapControlGroup

Contains objects related to enabling/disabling BS device traps.

14.1.1.3.7.4 wranDevMibCompliance

This object indicates which MIB groups in wranDevMibGroups are optional and which ones are mandatory.

14.1.2 wranIfBsMib

This MIB represent core MIB functionality that all BSs shall support. It is based on the FCAPS reference model, which is comprised of MIBs relating to management of the following items: *Fault*, *Configuration*, *Accounting*, *Performance*, and *Security*. The following list defines MIBs that compose wranIfBsMib:

- wranIfBsFm: Fault management
- wranIfBsCm: Configuration management
- wranIfBsAm: Accounting management
- wranIfBsPm: Performance management/measurement
- wranIfBsScm: Security management

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14.1.2.1 wranIfBsFm

Exceptions and fault events can be reported by using the traps defined in this MIB. `wranIfBsFm` is made up of the following MIBs: `wranIfBsTrapControl`,

`wranIfBsTrapDefinition`,

`wranIfBsNotifactionObjectsTable`,

`wranIfBsFmMibGroups`,

`wranIfBsFmMibCompliance`.

14.1.2.1.1 wranIfBsTrapControl

This MIB is a bitmap that is used to disable/enable the following BS traps:

`wranIfBsCpeDynamicServiceNotification`
`wranIfBsSignalPowerMetricsStatusNotification`,
`wranIfBsCpeRegisterNotification`,

`wranIfBsCpeScmNotification`,

`wranIfBsCpeStartupStatusChangeNotification`,
`wranIfBsThroughputMetricsNotification`,
`wranIfBsNetworkEntryMetricsNotification`,
`wranIfBsPacketErrorRateChangeNotification`,
`wranIfBsUserMetricsChangeNotification`,
`wranIfBsCoexistenceStatusNotification`,
`wranIfBsBasicCapabilityNotification`,

`wranIfBsRangingNotification`,

`wranIfBsAuthMetricsNotification`.

Enable of a trap indicates that the trap will be recorded in `wranIfBsCpeNotificationObjectsTable`.

14.1.2.1.2 wranIfBsTrapDefinition

This object defines BS related traps for configuration, accounting, performance, and SCM management aspects in `wranIfBsMib`.

14.1.2.1.2.1 wranIfBsDynamicServiceTrap

This trap contains information related to updating the configuration of either provisioned service flows (`wranIfBsProvSfTable`) or active service flows (`wranIfBsActiveSfTable`).

14.1.2.1.2.2 wranIfBsSignalPowerMetricsTrap

This trap contains information related to updating of signal power metrics (`wranIfBsSignalPowerMetricsTable`).

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14.1.2.1.2.3 wranIfBsRegNotificationTrap

This trap contains the information related to indicating successful registration of a CPE (`wranIfBsCpeRegCapabilityRspTable`).

14.1.2.1.2.4 wranIfBsScmNotificationTrap

This trap contains the information related to updating the configuration of the SCM protocol capabilities on a CPE (`wranIfBsCpeScmCapabilityConfigTable`) or current authentication status (`wranIfBsCpeScmAuthConfigTable`).

14.1.2.1.2.5 wranIfBsStartupStatusTrap

This trap contains the information related to changes in a CPE's status with regard to network entry (`wranIfBsStartupMetricsTable`).

14.1.2.1.2.6 wranIfBsTxMetricsTrap

This trap contains the information related to changes in throughput metrics (`wranIfBsThroughputMetricsTable`) or ARQ metrics (`wranIfBsArqMetricsTable`).

14.1.2.1.2.7 wranIfBsNetEntryMetricsTrap

This trap contains the information related to updates in network entry and re-entry latency measurements (`wranIfBsNetworkEntryMetricsTable`).

14.1.2.1.2.8 wranIfBsPktErrorTrap

This trap contains the information related to updates in packet error rate measurements (`wranIfBsPacketErrorRateTable`).

14.1.2.1.2.9 wranIfBsUserMetricsTrap

This trap contains the information related to updates in tracking the number of active and non-active users (`wranIfBsUserMetricsTable`).

14.1.2.1.2.10 wranIfBsCoexistenceTrap

This trap contains the information related to updates in tracking ongoing coexistence transaction (e.g., On-Demand Frame Contention in `wranIfBsCoexistenceStatusTable`), discovery of new potential coexistence sources (`wranIfBsCoexistenceSourceTable`), discovery of resource usage in neighboring networks (`wranIfBsCoexistenceResourceListTable`), and updates to a BS's own coexistence configuration (`wranIfBsCoexistenceCurrentConfigTable`).

14.1.2.1.2.11 wranIfBsBasicCapabilityTrap

This trap contains the information related to updates in tracking updates to the basic capability configuration of CPEs (`wranIfBsCpeBasicCapabilityRspTable`).

14.1.2.1.2.12 wranIfBsRangingTrap

This trap contains the information related to updates in tracking status of ranging of (`wranIfBsCpeRngCapabilityCmdTable`).

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14.1.2.1.2.13 wranIfBsAuthMetricsTrap

This trap contains the information related to updates in tracking updates to authentication metrics (`wranIfBsAuthenticationMetricsTable`).

14.1.2.1.2.14 wranIfBsDynamicServiceMetricsTrap

This trap contains the information related to updates in tracking metrics for current provisioned and active service flows (`wranIfBsAuthenticationMetricsTable`).

14.1.2.1.3 wranIfBsNotificationObjectsTable

This table contains objects that represents notifications reported in BS fault traps. The table is made up of one or more entries.

14.1.2.1.3.1 wranIfBsNotificationObjectsEntry

This MIB is a compound object that represents an entry in the MIB object `wranIfBsNotificationsObjectsTable`.

14.1.2.1.3.1.1 wranIfBsNotificationObjectsIndex

Index of entry in the table.

14.1.2.1.3.1.2 wranIfBsNotificationMacAddr

The MAC address of the CPE reporting the notification.

14.1.2.1.3.1.3 wranIfBsDynamicServiceType

Indication if the configuration for a provisioned or active service flow has been configured.

14.1.2.1.3.1.4 wranIfBsDynamicServiceNotificationIndex

Index into `wranIfBsProvSfTable` or `wranIfBsActiveSfTable` that indicates which service flow configuration was added/updated.

14.1.2.1.3.1.5 wranIfBsSignaPowerNotificationIndex

Index into `wranIfBsSignalPowerMetricsTable` that indicates the entry that contains updated signal power metrics data.

14.1.2.1.3.1.6 wranIfBsBsRegCapabilityNotificationIndex

Index into `wranIfBsCpeRegCapabilityRspTable` that indicates the entry that contains updated registration for a CPE.

14.1.2.1.3.1.7 wranIfBsScmNotificationType

Indication if the configuration of the SCM protocol or the authentication status of a CPE has been updated.

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14.1.2.1.3.1.8 wranIfBsScmNotificationIndex

Index into `wranIfBsCpeScmCapabilityConfigTable` that indicates which CPE has updated their SCM configuration, or `wranIfBsCpeScmAuthConfigTable` that indicates which CPE has had their authentication status updated.

14.1.2.1.3.1.9 wranIfBsStartupNotificationIndex

This contains the index of entry in `wranIfBsStartupMetricsTable` that contains data on any changes in a CPE's status with regard to network entry.

14.1.2.1.3.1.10 wranIfBsTxMetricsType

Indication if throughput metrics contained or ARQ Metrics in have been updated.

14.1.2.1.3.1.11 wranIfBsTxMetricsNotificationIndex

Index into `wranIfBsThroughputMetricsTable` that indicates changes in measure throughput metrics, or `wranIfBsArqMetricsTable` that indicates changes in ARQ performance.

14.1.2.1.3.2 wranIfBsNetEntryMetricsNotificationIndex

This contains the index of entry in `wranIfBsNetworkEntryMetricsTable` that contains data on any changes in network entry and re-entry latency measurements.

14.1.2.1.3.2.1 wranIfBsPktErrorMetricsNotificationIndex

This contains the index of entry in `wranIfBsPacketErrorRateTable` that contains data on any changes in packet error rate measurements.

14.1.2.1.3.2.2 wranIfBsUserMetricsNotificationIndex

This contains the index of entry in `wranIfBsUserMetricsTable` that contains data on any changes in the number of active and non-active users in the cell.

14.1.2.1.3.2.3 wranIfBsCoexMetricsType

Indication if ongoing On-Demand Frame Coexistence Transactions, discovery of new potential coexistence resources, discovery of the resource usage in neighboring networks, and whether a BS's own coexistence configuration have been updated.

14.1.2.1.3.2.4 wranIfBsCoexNotificationIndex

Index into `wranIfBsCoexistenaceStatusTable` that indicates changes in ongoing On-Demand Frame Contention transactions, `wranIfBsCoexistenceSourceTable` that indicates changes in the discovery of new potential coexistence sources, `wranIfBsCoexistenceResourceListTable` that indicates discovery of resource usage in neighboring networks, or `wranIfBsCoexistenceCurrentConfigTable` that indicates whether a BS's own coexistence configuration have been updated.

14.1.2.1.3.2.5 wranIfBsBasicNotificationIndex

This contains the index of entry in `wranIfBsCpeBasicCapabilityRspTable` that contains data on any changes in tracking updates to the basic capability configuration of CPEs.

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14.1.2.1.3.2.6 wranIfBsRngNotificationIndex

This contains the index of entry in `wranIfBsCpeRngCapabilityCmdTable` that contains data on any changes in tracking updates to the status of ranging of CPEs.

14.1.2.1.3.2.7 wranIfBsAuthNotificationIndex

This contains the index of entry in `wranIfBsAuthenticationMetricsTable` that contains data on any changes in tracking updates to authentication metrics.

14.1.2.1.3.2.8 wranIfBsDynSrvMetricsNotificationIndex

This contains the index of entry in `wranIfBsServiceFlowMetricsTable` that contains information related to tracking metrics of ongoing.

14.1.2.1.4 wranIfBsFmMibGroups

This object helps define which MIB groups are available in this module (`wranIfBsFm`) and which MIB objects are part of each group.

14.1.2.1.4.1 wranIfBsFmTrapControlGroup

This group contains objects related to enabling/disabling traps use for management of the BS.

14.1.2.1.4.2 wranIfBsFmNotificationGroup

This group contains objects related to traps used for management of the BS.

14.1.2.1.5 wranIfBsFmMibCompliance

MIB objects that are optional or mandatory for `wranIfBsFm` compliance.

14.1.2.2 wranIfBsCm

This MIB contains various objects related to Configuration Management. Within this MIB, the following tables are handled:

`wranIfBsCpeRngCapabilityReqTable`, `wranIfBsCpeRngCapabilityCmdTable`, `wranIfBsCpeBasicCapabilityReqTable`, `wranIfBsCpeBasicCapabilityRspTable`, `wranIfBsCpeRegCapabilityReqTable`, `wranIfBsCpeMeasSupportReqTable`, `wranIfBsCpeRegCapabilityRspTable`, `wranIfBsCpeMeasSupportRspTable`, `wranIfBsCpeAntennaGainTable`, `wranIfBsScmCapabilityConfiguration`, `wranIfBsCpeScmCapabilityConfigTable`, `wranIfBsScmAuthConfigTable`, `wranIfBsActionsTable`, `wranIfBsCpeMulticastConfigTable`, `wranIfBsCoexistenceConfigTable`, `wranIfBsCpeBasicCapabilityCmn`, `wranIfBsCpeRegCapabilityCmn`, `wranIfBsCpeMeasSupportCmn`, `wranIfBsCpeSystemParametersTable`, `wranIfBsCpeRegCapabilityCmn`, `wranIfBsCmMibGroups`, and `wranIfBsCmMibCompliance`.

For CBC-REQ/RSP and REG-REQ/RSP there are two MIB object groups that represent entries that are common to Basic and Registered Capability negotiation.

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14.1.2.2.1 wranIfBsCpeRngCapabilityReqTable

This object provides a table containing the ranging configuration requested by the CPE in the RNG-REQ during network entry. Each table is made up of multiple entries, one for each CPE that has sent a RNG-REQ, which is defined by `wranIfBsCpeRngCapabilityReqEntry`.

14.1.2.2.1.1 wranIfBsCpeRngCapabilityReqEntry

This object is a compound object that contains the ranging parameters transmitted in RNG-REQ by the CPE during network entry.

14.1.2.2.1.1.1 wranIfBsCpeRngCapabilityReqIndex

Index of entry in the table.

14.1.2.2.1.1.2 wranIfBsCpeMacAddress

The MAC address of the CPE that has attempted ranging with the BS.

14.1.2.2.1.1.3 wranIfMmpPn

Current value of MMP_PN that CPE is using if authenticated ranging (see 8.2.4.6.1.2) is used.

14.1.2.2.1.1.4 wranIfCiphertextIcv

Calculated value of Ciphertext ICV, calculated over RNG-REQ is authenticated ranging (see 8.2.4.6.1.2).

14.1.2.2.1.1.5 wranIfRngAnomaly

Indication of any error condition detected by CPE during ranging process.

14.1.2.2.2 wranIfBsCpeRngCapabilityCmdTable

This object provides a table containing the ranging configuration the BS is specifying for CPE in the RNG-CMD during network entry. Each table is made up of multiple entries, one for each CPE that a RNG-CMD is sent to, that is defined by `wranIfBsCpeRngCapabilityCmdEntry`.

14.1.2.2.2.1 wranIfBsCpeRngCapabilityCmdEntry

This object is a compound object that contains the ranging parameters selected for the CPE by the BS and transmitted in RNG-CMD by the BS to CPE during network entry.

14.1.2.2.2.1.1 wranIfBsCpeRngCapabilityCmdIndex

Index of entry in the table.

14.1.2.2.2.1.2 wranIfBsCpeMacAddress

MAC Address of CPE that the RNG-CMD is sent to. This is used to fill in MAC Address field of RNG-CMD, when RNG-CMD is sent in response to initial ranging.

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14.1.2.2.2.1.3 wranIfBSCpeStationId

Station ID of CPE that RNG-CMD is sent to. This is used to fill in MAC Address field of RNG-CMD, when RNG-CMD is sent in response to initial ranging.

14.1.2.2.2.1.4 wranIfTimingAdvance

Timing advance parameter to Table 61.

14.1.2.2.2.1.5 wranIfEirpPerSubcarrier

EIRP per transmitted subcarrier parameter for the RNG-CMD in Table 61.

14.1.2.2.2.1.6 wranIfOffsetFreqAdjust

Offset frequency adjustment parameter of RNG-CMD in Table 61.

14.1.2.2.2.1.7 wranIfRangingStatus

Ranging status field of the RNG-CMD in Table 61.

14.1.2.2.2.1.8 wranIfActionSuperFrameNum

The Action Superframe Number field of the RNG-CMD in Table 61.

14.1.2.2.2.1.9 wranIfCdmaCode

The CDMA Code field of the RNG-CMD in Table 61.

14.1.2.2.2.1.10 wranIfTxOpportunityOffset

The Transmission Opportunity Offset field of the RNG-CMD in Table 61.

14.1.2.2.3 wranIfBsCpeBasicCapabilityReqTable

This object provides a table containing the basic capability information of CPEs that have requested configuration from the BS in the CBC-REQ. Each table is made up of multiple entries, one for each CPE that has transmitted the CBC-REQ, that are defined by `wranIfBsCpeBasicCapabilityReqEntry`.

14.1.2.2.3.1 wranIfBsCpeBasicCapabilityReqEntry

This object is a compound object that contains information on capabilities that a CPE has declared to a BS during network entry. The list of objects used to make up `wranIfBsCpeBasicCapabilityReqEntry` can be found in `wranIfBsCpeBasicCapabilityCmn` (14.1.2.2.16).

14.1.2.2.4 wranIfBsCpeBasicCapabilityRspTable

This object provides a table containing the basic capability information BS has configured for CPEs BS in the CBC-RSP. Each table is made up of multiple entries, one for each CPE that has transmitted the CBC-RSP, that are defined by `wranIfBsCpeBasicCapabilityRspEntry`.

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14.1.2.2.4.1 wranIfBsCpeBasicCapabilityRspEntry

This object is a compound object that contains the configuration of basic capabilities BS has selected for a CPE during network entry. This table reflects the current configuration of a CPE's basic capabilities. The list of objects used to make up `wranIfBsCpeBasicCapabilityRspEntry` can be found in `wranIfBsCpeBasicCapabilityCmn` (14.1.2.2.16).

14.1.2.2.5 wranIfBsCpeRegCapabilityReqTable

This object provides a table containing the capability information for which a CPE has requested confirmation from the BS during REG-REQ. Each table is made up of multiple entries, one for each CPE, that are defined by `wranIfBsCpeRegCapabilityRegEntry`.

14.1.2.2.5.1 wranIfBsCpeRegCapabilityReqEntry

This object is a compound object that contains the information on the capabilities that a CPE declared to the BS, e.g., through sending a REG-REQ to the BS. The objects that make up the entry are defined in `wranIfBsCpeRegCapabilityCmn` (14.1.2.2.17). A REG-REQ message comprises objects within this compound object, `wranIfBsCpeAntennaGainTable` (14.1.2.2.10), and `wranIfBsCpeMeasSupportReqTable` (14.1.2.2.6).

14.1.2.2.6 wranIfBsCpeMeasSupportReqTable

A compound object representing the Measurement Support IE of REG-REQ/RSP in 7.9.7.3.4.7. It is made up of multiple entries, one for each signal type supported by sensing. Each entry is defined by `wranIfBsCpeMeasSupportReqEntry`. Entries for a CPE are present only if the value for `wranIfSensModeSupportArray` is anything other than "No Sensing."

14.1.2.2.6.1 wranIfBsCpeMeasSupportReqEntry

A compound object representing entries of Measurement Support IE of REG-REQ in 7.9.7.3.4.7. It is made up of multiple objects. A CPE will have one entry for each Signal Type in the Signal Type Array of the Measurement Support IE. The rest of the objects that represent each entry are defined in `wranIfBsCpeMeasSupportCmn` (14.1.2.2.18).

14.1.2.2.7 wranIfBsCpeRegCapabilityRspTable

This object provides a table containing the capability information that a BS has configured for a CPE in REG-RSP. Each table is made up of multiple entries, one for each CPE, that are defined by `wranIfBsCpeRegCapabilityRspEntry`.

14.1.2.2.7.1 wranIfBsCpeRegCapabilityRspEntry

This object is a compound object that contains the capabilities information that a BS has configured for ~~a~~ the CPE, e.g., through sending a REG-RSP to the CPE. `wranIfRegCapabilityPermanentStationId` is unique to REG-RSP. The objects that make up the entry are defined in `wranIfBsCpeRegCapabilityCmn` (14.1.2.2.17). A REG-RSP message comprises objects within this compound object and `wranIfBsCpeMeasSupportRspTable` (14.1.2.2.8).

14.1.2.2.8 wranIfBsCpeMeasSupportRspTable

A compound object representing the Measurement Support IE of REG-REQ/RSP in 7.9.7.3.4.7. It is made up of multiple entries, one for each signal type that sensing supports. Each entry is defined by `wranIfBsCpeMeasSupportRspEntry`.

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14.1.2.2.8.1 wranIfBsCpeMeasSupportRspEntry

A compound object representing entries of Measurement Support IE of REG-RSP in 7.9.7.3.4.7. It is made up of multiple objects. A CPE will have one entry for each Signal Type in the Signal Type Array of the Measurement Support IE. Entries for a CPE are present only if the value for `wranIfSensModeSupportArray` is anything other than "No Sensing." The rest of the objects that represent each entry are defined in `wranIfBsCpeMeasSupportCmn` (14.1.2.2.18).

14.1.2.2.9 wranIfBsCpeAntennaGainTable

At the CPE, this object represents a compound object representing entries of the CPE Antenna Gain IE (7.9.7.3.4.9) that carries a CPE's antenna gain when a CPE transmits a REG-REQ to the BS. At the BS, this object is a compound object that represents the entries for its own transmit antenna gain as well as the antenna gain information for each CPE that sent a CPE Antenna Gain IE in a REG-REQ (and has successfully completed registration). This object is a table that is made up of multiple entries, each defined by wranIfBsCpeAntennaGainEntry.

14.1.2.2.9.1 wranIfBsCpeAntennaGainEntry

A compound object representing the on-axis gain (in dB) for each channel on which the CPE's or BS's antenna is capable of operating.

14.1.2.2.9.1.1 wranIfBsCpeMacAddress

MAC address of the device.

14.1.2.2.9.1.2 wranIfTvChannel

TV Channel number.

14.1.2.2.9.1.3 wranIfOnAxisGain

Maximum gain in the specified TV channel.

14.1.2.2.10 wranIfBsScmCapabilityConfiguration

This MIB provides a bitmap that describes the cryptographic suites that the BS supports. The list of suites is provided in Table 193.

14.1.2.2.11 wranIfBsCpeScmCapabilityConfigTable

This MIB provides a table that provides contains a listing for the security capabilities for each CPE. Each CPE stores this table, with one entry for itself. On the BS, this table is made up of multiple entries, one for each CPE. Entries on the BS table do not contain the `wranIfBsCpeEapTlsTtlsCredential` object. Each entry is defined by `wranIfBsCpeScmCapabilityConfigEntry`. The list of capabilities is listed in Table 193.

14.1.2.2.11.1 wranIfBsCpeScmCapabilityConfigEntry

This object is a compound object that provides the definition of the entries `wranIfBsCpeScmCapabilityConfigTable`.

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14.1.2.2.11.1.1 wranIfBsCpeScmCapabilityConfigIndex

Index of entry in the table.

14.1.2.2.11.1.2 wranIfBsCpeScmCapabilityConfigMacAddress

The MAC address of the CPE.

14.1.2.2.11.1.3 wranIfBsCpeScmCapabilityConfiguration

This MIB provides a bitmap that describes the cryptographic suites that the CPE supports. The list of suites is provided in Table 193.

14.1.2.2.11.1.4 wranIfBsCpeEapTlsTtlsCredentialSize

Size, in number of octets, of X.509 certificate that defines the credential the CPE exchanges with the AAA server to perform authentication.

14.1.2.2.11.2 wranIfBsCpeEapTlsTtlsCredential

X.509 certificate that defines the credential the CPE exchanges with the AAA server to perform authentication.

14.1.2.2.12 wranIfBsCpeScmAuthConfigTable

This MIB provides a table that provides the configuration of the SCM attributes (e.g., timers and other items relating to the authorization process). This table is made up of one entry, defined by `wranIfBsScmAuthConfigEntry`.

14.1.2.2.12.1 wranIfBsCpeScmAuthConfigEntry

This object is a compound object that defines an entry in `wranIfBsScmAuthConfigTable`.

14.1.2.2.12.1.1 wranIfBsScmAuthConfigIndex

Index of entry in the table.

14.1.2.2.12.1.2 wranIfBsT36

EAP Authentication Timer, T36.

14.1.2.2.12.1.3 wranIfBsT37

Authentication Grace Timer, T37.

14.1.2.2.12.1.4 wranIfBsMaxNumAuthAttempts

Maximum number of Authentication Attempts.

14.1.2.2.12.1.5 wranIfBsT38

Operational Wait Timeout, T38.

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14.1.2.2.12.1.6 wranIfBsT39

Rekey Wait Timeout, T39.

14.1.2.2.12.1.7 wranIfBsT40

GTEK/TEK Grace time, T40.

14.1.2.2.12.1.8 wranIfBsAkLifetime

Lifetime BS assigns to new AK.

14.1.2.2.12.1.9 wranIfBsTekLifetime

Lifetime BS assigns to new TEK.

14.1.2.2.12.1.10 wranIfBsMaxNumSa

Maximum number of SAs for which a CPE can be authorized.

14.1.2.2.12.1.11 wranIfBsT17

Time for CPE to complete authentication and key exchange.

14.1.2.2.13 wranIfBsActionsTable

This object provides a table that stores actions that can be configured to have BS direct a CPE to act upon receiving unsolicited MAC management messages such as RNG-CMD and DREG-CMD. Each table is made up of an entry for each action directed to a particular CPE. Each entry is defined by `wranIfBsActionsEntry`.

14.1.2.2.13.1 wranIfBsActionsEntry

This object is a compound object that contains actions that are requested for a particular CPE. A BS may skip directing the CPE to execute a particular action based on the current state of the CPE. Only one action is executable at a given time.

14.1.2.2.13.1.1 wranIfBsActionsIndex

Index of entry in this table.

14.1.2.2.13.1.2 wranIfBsCpeActionsMacAddress

This uniquely identifies the CPE that is the target of the action by the CPE's MAC address.

14.1.2.2.13.1.3 wranIfBsCpeActionsRngCpe

When set, the BS will send an unsolicited RNG-CMD to a CPE with the Ranging Status field set to 'abort' without any new parameter or the Ranging Status field set to 'abort' with a new set of parameters. No action is to be taken if this object is read.

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14.1.2.2.13.1.4 wranIfBsCpeActionsDeRegCpe

When set to an Action Code value as defined in Table 141, the BS will send a DREG-CMD to the CPE with that Action Code. No action is to be taken if this object is read or an invalid Action Code is specified.

14.1.2.2.13.1.5 wranIfBsCpeActionsSchedule

This object contains the status of the write operation for a component of the `wranIfBsCpeActionsEntry` to make sure the write operation has been executed properly.

14.1.2.2.14 wranIfBsCpeMcastConfigTable

This table contains the configuration of multicast groups and what CPEs are assigned to them. Each table is made up of multiple entries, defined by `wranIfBsCpeMulticastEntry`. A CPE may have multiple entries in this table, one for each multicast group that it belongs to. Entries will be deleted for a CPE whenever a CPE is asked to leave a multicast group.

14.1.2.2.14.1 wranIfBsCpeMcastConfigEntry

This object is a compound object that contains information about the configuration of a CPE's multicast group membership configuration.

14.1.2.2.14.1.1 wranIfBsCpeMcastConfigIndex

Index of entry in this table.

14.1.2.2.14.1.2 wranIfBsCpeMcastMacAddress

This object refers to a CPE's MAC address. It is used to uniquely index the multicast group configuration for a particular CPE in `wranIfBsCpeMulticastConfigTable`, along with `wranIfBsCpeMulticastCid`.

14.1.2.2.14.1.3 wranIfBsCpeMcastSid

This object refers to the multicast SID that is assigned to a multicast group.

14.1.2.2.14.1.4 wranIfBsCpeMcastPeriodicAllocParameterM

This object defines the 'm' value (see Table 124) that is used to calculate the periodic allocation for multicast transmission.

14.1.2.2.14.1.5 wranIfBsCpeMcastPeriodicAllocParameterK

This object defines the 'k' value (see Table 124) that is used to calculate the periodic allocation for multicast transmission.

14.1.2.2.14.1.6 wranIfBsMulticastPeriodicAllocationParameterN

This object defines the 'n' value (see Table 124) that is used to calculate the periodic allocation for multicast transmission.

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14.1.2.2.15 wranIfBsCoexistenceConfigTable

This table contains the configuration items related to self-coexistence operation and CBP transmission. It is made up of one entry represents the default values for self-coexistence operation and CBP transmission.

14.1.2.2.15.1 wranIfBsCoexistenceConfigEntry

This object represents a single entry that is in wranIfBsCoexistenceConfigTable.

14.1.2.2.15.1.1 wranIfBsCoexistenceConfigIndex

Index of entry in this table

14.1.2.2.15.1.2 wranIfBsT34

This governs how often (in seconds) the Device Identification IE is transmitted in a CBP burst. Default value is 300 s.

14.1.2.2.15.1.3 wranIfBsT33

Time between transmissions of CBP bursts with backup/candidate channel list information (see 7.8.1.3.1.1) to facilitate spectrum etiquette.

14.1.2.2.15.2 wranIfBsT32

Wait for Frame Contention Response (FC-RSP) message.

14.1.2.2.15.2.1 wranIfBsFcw

Frame contention window, the number of superframes that a contention destination accumulates frame contention requests before responding to them.

14.1.2.2.15.2.2 wranIfBsScwBackoffMax

Maximum number of superframes for the SCW backoff window.

14.1.2.2.15.2.3 wranIfBsFcMin

Number of frames not available for contention at the BS.

14.1.2.2.15.2.4 wranIfBsFcnRange

Exponent, base 2, defining the range of random numbers for the FCN.

14.1.2.2.15.2.5 wranIfBsSfRel

Number of superframes after which a BS releases the frames won by another BS through frame contention.

14.1.2.2.15.2.6 wranIfBsT35

SCW Backoff Timer, timer controlling continuation or exiting of Frame Contention Procedure.

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14.1.2.2.16 wranIfBsCpeBasicCapabilityCmn

This MIB object is a group containing objects that are common to `wranIfBsCpeBasicCapabilityReqEntry` and `wranIfBsCpeBasicCapabilityRspEntry`.

14.1.2.2.16.1 wranIfBasicCapabilityIndex

Index of entry in `wranIfBsCpeBasicCapabilityReqTable` or `wranIfBsCpeBasicCapabilityRspTable`.

14.1.2.2.16.2 wranIfBasicCapabilityNumAttempts

The current number of attempts that a CPE has attempted basic capability configuration during network entry. This item is set to 0 upon successful completion of registration process and a CPE is admitted into the network. This item is incremented every time a CPE attempts basic capability configuration, but is unsuccessful. If this value reaches the limit set by `wranIfBsMaxNumCbcReqAttempts`, then the BS shall reject the network entry request from the CPE. This object is only pertinent for entries in `wranIfBsCpeBasicCapabilityRspTable` (as the decision to reject basic capability negotiation is made by BS).

14.1.2.2.16.3 wranIfBasicCapabilityMacAddress

The MAC address of the CPE attempting basic capability configuration.

14.1.2.2.16.4 wranIfBasicCapabilityStationId

The Station ID of the CPE attempting basic capability configuration.

14.1.2.2.16.5 wranIfBasicCapabilityMacPduTxandConstruction

An integer value that indicates the methods for transmission and construction of MAC PDUs that the CPE supports. This reflects the setting of the IE defined in 7.9.11.3.1.

14.1.2.2.16.6 wranIfBasicCapabilityMaxCpeTxEirp

An integer value, encoded in hexadecimal, that indicates the maximum EIRP for which the CPE is configured. This reflects the setting of the IE defined in 7.9.11.3.2.1.

14.1.2.2.16.7 wranIfBasicCapabilityCpeDemodulator

A bit map that encodes the DIUCs that the CPE supports. This reflects the setting of the IE defined in 7.9.11.3.2.2.1.

14.1.2.2.16.8 wranIfBasicCapabilityCpeModulator

A bit map that encodes the UIUCs that the CPE supports. This reflects the setting of the IE defined in 7.9.11.3.2.2.2.

14.1.2.2.16.9 wranIfBasicCapabilityCpeScmVersionSupport

Indicator of what version of the SCM protocol that the CPE supports. This reflects the setting of the IE defined in 7.9.11.3.3.1.

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14.1.2.2.16.10 wranIfBasicCapabilityCpePnWindowSize

Size of PN_WINDOW (see 7.4) that is used to protect against replay attacks. This reflects the setting of the IE defined in 7.9.11.3.3.2.

14.1.2.2.16.11 wranIfBasicCapabilityCpeScmFlowControl

Maximum number of ongoing SCM transactions that the CPE can support. This reflects the setting of the IE defined in 7.9.11.3.3.3.

14.1.2.2.17 wranIfBsCpeRegCapabilityCmn

This MIB object is a group containing objects that are common to `wranIfBsCpeRegCapabilityReqEntry` and `wranIfBsCpeRegCapabilityRspEntry`.

14.1.2.2.17.1 wranIfRegCapabilityIndex

Index for unique entry in tables relating to registered capabilities.

14.1.2.2.17.2 wranIfRegCapabilityMacAddress

MAC address of CPE that is currently registered with BS.

14.1.2.2.17.3 wranIfRegCapabilityReqNumAttempts

The current number of attempts that a CPE has attempted network entry. This item is set to 0 upon successful completion of registration process and a CPE is admitted into the network. This item is incremented every time a CPE attempts registration, but is unsuccessful. If this value reaches the limit set by `wranIfBsMaxNumRegReqAttempts`, then the CPE shall restart network entry process.

14.1.2.2.17.4 wranIfRegCapabilityNMEALocStringSize

Size of NMEA location string of the CPE in REG-REQ (see 7.9.7.3.1), in octets.

14.1.2.2.17.5 wranIfRegCapabilityNMEALocString

NMEA location string of the CPE in REG-REQ (see 7.9.7.3.1).

14.1.2.2.17.6 wranIfRegCapabilityCsConfig

Indication in REG-REQ/RSP of how the provider will operate the CPE on an ongoing basis; either with the Ethernet CS only or the IP CS (see 7.9.7.3.2).

14.1.2.2.17.7 wranIfRegCapabilityIpVersion

What version of the IP protocol (either v4 or v6) indicate in REG-REQ/RSP the CPE supports (see 7.9.7.3.3).

14.1.2.2.17.8 wranIfRegCapabilityIpRohcSupport

Indicator in REG-REQ/RSP of whether CPE supports IP Robust Header Compression (ROHC) (see 7.9.7.3.4.1).

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14.1.2.2.17.9 wranIfRegCapabilityArqSupport

ARQ Support IE of REG-REQ/RSP in 7.9.7.3.4.2.

14.1.2.2.17.10 wranIfRegCapability2ndMgmtArqWindowSize

Secondary Management flow-ARQ Window Size IE of REG-REQ/RSP defined in 7.9.8.9.17.2.

14.1.2.2.17.11 wranIfRegCapability2ndMgmtArqRetryTxDelay

Secondary Management flow-Transmitter Delay component of ARQ Retry Timeout IE of REG-REQ/RSP defined in 7.9.8.9.17.3.

14.1.2.2.17.12 wranIfRegCapability2ndMgmtArqRetryRxDelay

Secondary Management flow-Receiver Delay component of ARQ Retry Timeout IE of REG-REQ/RSP defined in 7.9.8.9.17.3.

14.1.2.2.17.13 wranIfRegCapability2ndMgmtArqBlockLifetime

Secondary Management flow-ARQ Block Lifetime IE of REG-REQ/RSP defined in 7.9.8.9.17.4.

14.1.2.2.17.14 wranIfRegCapability2ndMgmtArqSyncLossTimeout

Secondary Management flow-ARQ Sync Loss Timeout IE of REG-REQ/RSP defined in 7.9.8.9.17.5.

14.1.2.2.17.15 wranIfRegCapability2ndMgmtArqDeliverInOrder

Secondary Management flow-ARQ Deliver In Order IE of REG-REQ/RSP defined in 7.9.8.9.17.6.

14.1.2.2.17.16 wranIfRegCapability2ndMgmtArqRxPurgeTimeout

Secondary Management flow-ARQ Rx Purge Timeout IE of REG-REQ/RSP defined in 7.9.8.9.17.7.

14.1.2.2.17.17 wranIfRegCapability2ndMgmtArqBlockSize

Secondary Management flow-ARQ Block Size IE of REG-REQ/RSP defined in 7.9.8.9.17.8.

14.1.2.2.17.18 wranIfRegCapabilityDsxFlowControl

DSx Flow Control IE of REG-REQ/RSP in 7.9.7.3.4.4.

14.1.2.2.17.19 wranIfRegCapabilityMcaFlowControl

MCA Flow Control IE of REG-REQ/RSP in 7.9.7.3.4.5.

14.1.2.2.17.20 wranIfRegCapabilityMaxNumMcastGroups

Maximum Number of Multicast Groups IE of REG-REQ/RSP in 7.9.7.3.4.6.

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14.1.2.2.17.21 wranIfRegCapabilitySensModeSupportArray

Value of the "Sensing Mode Support Array" of the Measurement Support IE in REG-REQ/RSP in 7.9.7.3.4.7. If the value of this is set to "No Sensing" then `wranIfBsCpeMeasSupportReqTable` and `wranIfBsCpeMeasSupportRspTable` will not be stored for the CPE.

14.1.2.2.17.22 wranIfRegCapabilityAntennaModelSize

Length of `wranIfRegCapabilityAntennaModel`, in octets (see Manufacturer Specific Antenna Model IE of REG-REQ in 7.9.7.3.4.8.

14.1.2.2.17.23 wranIfRegCapabilityAntennaModel

Manufacturer Specific Antenna Model IE of REG-REQ in 7.9.7.3.4.8.

14.1.2.2.17.24 wranIfRegCapabilityCpeResidualDelay

CPE Residual Delay IE of REG-REQ in 7.9.7.3.4.10.

14.1.2.2.17.25 wranIfRegCapability2ndMgmtIpAllocMethod

Method for allocating IP Addresses on Secondary Management Connection IE of REG-REQ/RSP in 7.9.7.3.4.11.

14.1.2.2.17.26 wranIfRegCapabilityCpeOperationalCapability

CPE Operation Capability IE of REG-REQ in 7.9.7.3.4.13.

14.1.2.2.17.27 wranIfRegCapabilityCpeRegistrationTimer

CPE Registration Timer IE of REG-REQ/RSP in 7.9.7.3.5 This value is used to set T30 for the CPE.

14.1.2.2.18 wranIfBsCpeMeasSupportCmn

This MIB object is a group containing objects that are common to `wranIfBsCpeMeasSupportReqEntry` and `wranIfBsCpeMeasSupportRspEntry`.

14.1.2.2.18.1 wranIfMeasSupportIndex

Index into entry of tables storing Measurement Support IE that is part of REG-REQ/RSP.

14.1.2.2.18.2 wranIfMeasSupportMacAddress

MAC address of CPE. This corresponds to an entry in wranIfBsCpeRegCapabilityReqTable for a registered CPE.

14.1.2.2.18.3 wranIfMeasSupportSignalType

Signal type to which measurement configuration this entry pertains (see Table 321).

14.1.2.2.18.4 wranIfMeasSupportThreshold

Signed number that signifies the sensitivity threshold for the signal type.

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14.1.2.2.18.5 wranIfMeasSupportPd

Probability of detection (PD) for the signal type.

14.1.2.2.18.6 wranIfMeasSupportMpfa

Maximum Probability of False Alarm for the signal type.

14.1.2.2.18.7 wranIfMeasSupportRecNumSensPeriods

Recommended number of sensing periods required to sense the signal type.

14.1.2.2.18.8 wranIfMeasSupportRecSensPeriodDuration

Recommended duration of sensing periods, units of symbols.

14.1.2.2.18.9 wranIfMeasSupportRecSensPeriodInterval

Recommended length of sensing period interval, units of integer number of frames.

14.1.2.2.19 wranIfBsCpeSystemParametersTable

This table contains objects that define system constants for REG-REQ/RSP, DSx-REQ/RSP, and MCA-RSP transactions. It only has one entry, as defined by `wranIfBsCpeSystemParametersEntry`.

14.1.2.2.19.1 wranIfBsCpeSystemParametersEntry

This is a compound object that defines the entry in `wranIfBsCpeSystemParametersTable`.

14.1.2.2.19.2 wranIfBsCpeSystemParametersIndex

Index of entry in the table (defaults to 1).

14.1.2.2.19.2.1 wranIfBsDsxReqRetries

Maximum number of timeout retries for DSx-REQ messages.

14.1.2.2.19.2.2 wranIfBsDsxRspRetires

Maximum number of timeout retries for DSx-RSP messages.

14.1.2.2.19.2.3 wranIfBsT6

Timeout for receiving REG-RSP.

14.1.2.2.19.2.4 wranIfBsT7

Wait for DSx-RSP timeout.

14.1.2.2.19.2.5 wranIfBsT8

Wait for DSA/DSC-RSP timeout.

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14.1.2.2.19.2.6 wranIfBsT9

Timeout between BS's transmitting RNG-CMD (success) to a CPE and receiving CBC-REQ from that same CPE.

14.1.2.2.19.2.7 wranIfBsT10

Wait for Transaction End timeout.

14.1.2.2.19.2.8 wranIfBsT13

Time allowed for a CPE, following receipt of a REG-RSP, to send a TFTP-CPLT message to the BS.

14.1.2.2.19.2.9 wranIfBsT14

Wait for DSx-RSP timeout.

14.1.2.2.19.2.10 wranIfBsT15

Wait for MCA-RSP.

14.1.2.2.19.2.11 wranIfBsT16

Wait for bandwidth request grant.

14.1.2.2.19.2.12 wranIfBsT18

Wait for CBC-RSP timeout.

14.1.2.2.19.2.13 wranIfBsT22

Wait for ARQ-Reset.

14.1.2.2.19.2.14 wranIfBsT26

Wait for TFT-RSP.

14.1.2.2.19.2.15 wranIfBsT27Idle

Maximum time between unicast grants to CPE when BS believe CPE transmission quality is good enough.

14.1.2.2.19.2.16 wranIfBsT27Active

Maximum time between unicast grants to CPE when BS believes CPE transmission quality is not good enough.

14.1.2.2.19.2.17 wranIfBsT28

Time allowed for BS to complete the transmission of the backup/candidate channel list to its CPEs after initial registration by a new CPE, including the database service query.

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14.1.2.2.20 wranIfBsCpeRegCapabilityDefTable

This object defines a table containing default values of REG-REQ/RSP IEs. This table can be used by the BS to judge/verify a CPE's REG-REQ and used to construct the REG-RSP message. There is one entry in this table defined by `wranIfBsCpeRegCapabilityDefEntry`.

14.1.2.2.20.1 wranIfBsCpeRegCapabilityDefEntry

This object defines an entry in `wranIfBsCpeRegCapabilityDefTable`. The objects that make up this entry are defined in `wranIfBsCpeRegCapabilityCmn` (14.1.2.2.18).

14.1.2.2.21 wranIfBsCpeBasicCapabilityDefTable

This object defines a table containing default values of CBC-REQ/RSP IEs. This table can be used by the BS to judge/verify a CPE's CBC-REQ and used to construct the CBC-RSP message. There is one entry in this table defined by `wranIfBsCpeBasicCapabilityDefEntry`. The objects that make up this table are defined in `wranIfBsCpeBasicCapabilityCmn` (14.1.2.2.17).

14.1.2.2.21.1 wranIfBsCpeBasicCapabilityDefEntry

This object defines an entry in `wranIfBsCpeBasicCapabilityDefTable`. The objects that make up this table are defined in `wranIfBsCpeBasicCapabilityCmn` (14.1.2.2.17).

14.1.2.2.22 wranIfBsCpeMeasurementSupportDefault

This Table is a compound object containing default values of used to configure the Measurement Support IE REG-REQ/RSP. This table can be used by the BS to judge/verify the Measurement Support IE in CPE's REG-REQ and used to construct the Measurement Support IE sent by the BS in the REG-RSP message. There is one entry for each signal type, defined by `wranIfBsCpeMeasurementSupportDefaultEntry`.

14.1.2.2.22.1 wranIfBsCpeMeasurementSupportDefaultEntry

A compound object representing the default entries of Measurement Support IE of REG-REQ in 7.9.7.3.4.7. There is one entry for each Signal Type that exists in the Signal Type Array IE in the REG-REQ/RSP. Each entry are defined in `wranIfBsCpeMeasSupportCmn` (14.1.2.2.19).

14.1.2.2.23 wranIfBsPhy

This MIB object contains managed objects related to the PHY configuration. All objects described are related to the OFDMA PHY that is supported.

14.1.2.2.23.1 wranIfBsOfdmaPhyUsChannelTable

This object provides a table to describe attributes of upstream channels. It is a compound object that is made up of multiple entries (one for each CPE), each described by `wranIfBsOfdmaPhyUsChannelTableEntry`.

14.1.2.2.23.1.1 wranIfBsOfdmaPhyUsChannelEntry

This object is a compound object that represents an entry for the upstream channel.

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14.1.2.2.23.1.1.1 wranIfBsOfdmaPhyUsChannelIndex

Index of entry in the table.

14.1.2.2.23.1.1.2 wranIfBsOfdmaPhyUsSid

SID of CPE this entry represents.

14.1.2.2.23.1.1.3 wranIfBsOfdmaPhyUsMacAddress

MAC Address of CPE this entry represents.

14.1.2.2.23.1.1.4 wranIfBsOfdmaCtBasedResvTimeout

The number of US-MAPs to receive before contention-based reservation is attempted again for the same connection.

14.1.2.2.23.1.1.5 wranIfBsOfdmaUsCenterFrequency

Upstream center frequency in kHz.

14.1.2.2.23.1.1.6 wranIfBsOfdmaUsRadioResource

Indicates the average percentage (ratio) of non-assigned US radio resource to total usable US radio resources.

14.1.2.2.23.1.1.7 wranIfBsOfdmaUsConfigChangeCount

Current UCD change count.

14.1.2.2.23.1.1.8 wranIfBsOfdmaUsUcsNotificationCodes

Number of CDMA codes for UCS Notification.

14.1.2.2.23.1.1.9 wranIfBsOfdmaUsInitRngCodes

Number of CDMA codes for initial ranging.

14.1.2.2.23.1.1.10 wranIfBsOfdmaUsPeriodicRngCodes

Number of CDMA codes for periodic ranging.

14.1.2.2.23.1.1.11 wranIfBsOfdmaUsBWReqCodes

Number of CDMA codes for bandwidth requests.

14.1.2.2.23.1.1.12 wranIfBsOfdmaUsPeriodicRngBackoffStart

Represented as a power of 2, initial size of backoff window used for periodic ranging contention.

14.1.2.2.23.1.1.13 wranIfBsOfdmaUsPeriodicRngBackoffEnd

Represented as a power of 2, final size of backoff window used for periodic ranging contention.

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14.1.2.2.23.1.1.14 wranIfBsOfdmaUsStartofCodes

Includes first code in block of codes to be used, known as S. The total set of codes ranges from S to (`wranIfBsOfdmaUsInitRngCodes`+`wranIfBsOfdmaUsPeriodicRngCodes` + `wranIfBsOfdmaUsBWReqCodes` + `wranIfBsOfdmaUsUcsNotificationCodes`) mod 256.

14.1.2.2.23.1.1.15 wranIfBsOfdmaUsNormalizedCnrOverride

This is a list of numbers and follows the specification of the Normalized CNR override as defined in Table 46 and in 9.9.4.2. The number encoded by each nibble represents the difference in normalized CNR relative to the previous one.

14.1.2.2.23.1.1.16 wranIfBsOfdmaUsInitialRangingInterval

Number of frames between initial ranging interval allocation.

14.1.2.2.23.1.1.17 wranIfBsOfdmaUsUcsNotificationBackoffStart

Expressed as a power of 2, initial backoff window size for UCS notification contention.

14.1.2.2.23.1.1.18 wranIfBsOfdmaUsUcsNotificationBackoffEnd

Expressed as a power of 2, final backoff window size for UCS notification contention.

14.1.2.2.23.1.1.19 wranIfBsOfdmaUsInitialRngBackoffStart

Expressed as a power of 2, initial backoff window size for initial ranging contention.

14.1.2.2.23.1.1.20 wranIfBsOfdmaUsInitialRngBackoffEnd

Expressed as a power of 2, final backoff window size for initial ranging contention.

14.1.2.2.23.1.1.21 wranIfBsOfdmaUsBwRequestBackoffStart

Expressed as a power of 2, initial backoff window for contention-based BW requests.

14.1.2.2.23.1.1.22 wranIfBsOfdmaUsBwRequestBackoffEnd

Expressed as a power of 2, the final backoff window size for contention-based BW requests.

14.1.2.2.23.1.1.23 wranIfBsOfdmaUsUcdInterval

Time between transmission of UCD messages.

14.1.2.2.23.1.1.24 wranIfBsOfdmaUsUcdTransition

Time BS shall wait after repeating a UCD message with an incremented Configuration Change Count before issuing a US-MAP message referring to Upstream_Burst_Profiles defined in that UCD message.

14.1.2.2.23.1.1.25 wranIfBsOfdmaUsClkCmpInterval

Time between the clock compare measurements used for the generation of CLK-CMP messages.

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14.1.2.2.23.1.1.26 wranIfBsOfdmaUsT57

Lost US-MAP interval, time since last received US-MAP message before upstream synchronization is considered lost (used on the CPE).

14.1.2.2.23.1.1.27 wranIfBsOfdmaT58

Number of SCH that can be lost until synchronization is considered lost.

14.1.2.2.23.1.1.28 wranIfBsOfdmaUsCdmaRngRetries

Number of retries on CDMA RNG-REQs.

14.1.2.2.23.1.1.29 wranIfBsOfdmaUsInvRngReq

Number of retries on inviting RNG-REQs.

14.1.2.2.23.1.1.30 wranIfBsOfdmaUsMapProcTime

Time provided between arrival of the last bit of a US-MAP at a CPE and the effectiveness of that map.

14.1.2.2.23.1.1.31 wranIfBsOfdmaUsT3

RNG-CMD reception timeout following the transmission of a RNG-REQ.

14.1.2.2.23.1.1.32 wranIfBsOfdmaUsT4

Time to wait for unicast ranging opportunity.

14.1.2.2.23.1.1.33 wranIfBsOfdmaUsT5

Time to wait for Upstream Channel Change response.

14.1.2.2.23.1.1.34 wranIfBsOfdmaUsT12

Wait for UCD descriptor.

14.1.2.2.23.2 wranIfBsOfdmaPhyDsChannelTable

This object provides a table to describe attributes of downstream channels. It is a compound object that is made up of multiple entries (one for each CPE), each described by `wranIfBsOfdmaPhyDsChannelTableEntry`.

14.1.2.2.23.2.1 wranIfBsOfdmaPhyDsChannelTableEntry

This object is a compound object that represents an entry for each downstream channel in each BS.

14.1.2.2.23.2.1.1 wranIfBsOfdmaPhyDsChannelIndex

Index of entry in the table.

14.1.2.2.23.2.2 wranIfBsOfdmaDsBsId

BS ID (MAC Address) of BS.

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14.1.2.2.23.2.3 wranIfBsOfdmaDsEirp

The equivalent isotropic radiated power of the BS, which is computed for a simple single-antenna transmitter.

14.1.2.2.23.2.4 wranIfBsOfdmaDsChannelNumber

Current operating channel.

14.1.2.2.23.2.5 wranIfBsOfdmaDsPhyMaxEirp

Initial ranging maximum EIRP, at BS in units of 1 dBm.

14.1.2.2.23.2.6 wranIfBsOfdmaDsCenterFreq

DS center frequency in kHz.

14.1.2.2.23.2.7 wranIfBsOfdmaDsMacVersion

The MAC version to which the BS is conformant.

14.1.2.2.23.2.8 wranIfBsOfdmaDsCyclicPrefix

Ratio of CP time to useful symbol time; possible values are 1/4, 1/8, 1/16, 1/32.

14.1.2.2.23.2.9 wranIfBsOfdmaDsRadioResource

Average ratio of non-assigned DS radio resources to total usable DS radio resources.

14.1.2.2.23.2.10 wranIfBsOfdmaDsCellType

This object identifies classes of BSs that can be used by CPE when selecting with which cell to attempt network entry.

14.1.2.2.23.2.11 wranIfBsOfdmaDsConfigChangeCount

Current BS DCD configuration change count.

14.1.2.2.23.2.12 wranIfBsOfdmaDsFrameDuration

Duration of the DS portion of a frame.

14.1.2.2.23.2.13 wranIfBsOfdmaDsRssiCinrAvgParameter

Bits 0–3 of default RSSI and CINR averaging parameter.

14.1.2.2.23.2.14 wranIfBsOfdmaDsThresholdAddBsServiceSet

Threshold used by CPE to add a neighbor BS to the list of available WRAN service.

14.1.2.2.23.2.15 wranIfBsOfdmaDsThresholdDelBsServiceSet

Threshold used by CPE to delete a neighbor BS to the diversity set.

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14.1.2.2.23.2.16 wranIfBsOfdmaDsDcdInterval

Time between transmission of DCD messages.

14.1.2.2.23.2.17 wranIfBsOfdmaDsDcdTransition

Time BS shall wait after repeating a DCD message with an incremented Configuration Change Count before issuing a DS-MAP message referring to Downstream_Burst_Profiles defined in that DCD message.

14.1.2.2.23.2.18 wranIfBsOfdmaDsT56

Time since last received DS-MAP message before downstream synchronization is considered lost.

14.1.2.2.23.2.19 wranIfBsOfdmaDsT1

Wait for DCD timeout.

14.1.2.2.23.2.20 wranIfBsOfdmaDsT2

Wait for broadcast ranging timeout.

14.1.2.2.23.2.21 wranIfBsOfdmaDsT20

Time CPE searches for preambles on a given channel.

14.1.2.2.23.2.22 wranIfBsOfdmaDsT21

Time the CPE searches for a DS-MAP on a given channel.

14.1.2.2.23.2.22.1 wranIfBsOfdmaDsTtg

Transmit/Receive Transition Gap.

14.1.2.2.23.3 wranIfBsOfdmaUcdBurstProfileTable

This table contains the UCD burst profile configurations for each upstream channel. Each entry in the table is represented by `wranIfBsOfdmaUcdBurstProfileEntry`.

14.1.2.2.23.3.1 wranIfBsOfdmaUcdBurstProfileEntry

This is a compound object that defines each entry in `wranIfBsOfdmaUcdBurstProfileTable`.

14.1.2.2.23.3.1.1 wranIfBsOfdmaUcdUiucIndex

The UIUC that indicates the upstream burst profile in the UCD message.

14.1.2.2.23.3.1.2 wranIfBsOfdmaUcdUiucExitThreshold

CINR at or below which this UIUC can no longer be used where change to a more robust UIUC is required.

14.1.2.2.23.3.1.3 wranIfBsOfdmaUcdUiucEntryThreshold

Minimum CINR required to starting using this UIUC when changing from a more robust UIUC is required.

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14.1.2.2.23.3.1.4 wranIfBsOfdmaUcdRangingDataRatio

Difference in power from burst UCD and power to be used for CDMA ranging in units of 1 dB.

14.1.2.2.23.4 wranIfBsOfdmaDcdBurstProfileTable

This table provides configuration for each DCD burst profile. It is made up of multiple entries defined by `wranIfBsOfdmaDcdBurstProfileEntry`.

14.1.2.2.23.4.1 wranIfBsOfdmaDcdBurstProfileEntry

This is a compound object that defines each entry in `wranIfBsOfdmaDcdBurstProfileTable`.

14.1.2.2.23.4.2 wranIfBsOfdmaDcdDiucIndex

The DIUC of the DS burst profile in the DCD message.

14.1.2.2.23.4.2.1 wranIfBsOfdmaDcdDiucExitThreshold

CINR at or below which this DIUC can no longer be used where change to a more robust DIUC is required.

14.1.2.2.23.4.2.2 wranIfBsOfdmaDcdDiucEntryThreshold

Minimum CINR required to starting using this DIUC when changing from a more robust DIUC is required.

14.1.2.2.23.5 wranIfBsOfdmaDsRegionTable

This table provides the configuration of the DS subframe. It is made up of entries defined by `wranIfBsOfdmaDsRegionEntry`.

14.1.2.2.23.5.1 wranIfBsOfdmaDsRegionEntry

This is a compound object that describes each entry in `wranIfBsOfdmaDsRegionTable`.

14.1.2.2.23.5.1.1 wranIfBsOfdmaDsRegionIndex

Index DS region in table.

14.1.2.2.23.5.1.2 wranIfBsOfdmaDsDuration

Number of OFDMA slots linearly allocated to a DS burst region.

14.1.2.2.23.6 wranIfBsOfdmaDsDuration

This table provides the configuration of the US subframe. It is made up of entries defined by `wranIfBsOfdmaUsRegionEntry`.

14.1.2.2.23.6.1 wranIfBsOfdmaUsRegionEntry

This is compound object that describes each entry in `wranIfBsOfdmaUsRegionTable`.

14.1.2.2.23.6.1.1 wranIfBsOfdmaUsRegionIndex

Index US region in table.

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14.1.2.2.23.6.1.2 wranIfBsOfdmaUsDuration

Number of OFDMA slots linearly allocated to a US burst region.

14.1.2.2.24 wranIfBsCmMibGroups

This object helps define which MIB groups are available in this module (`wranIfBsCm`) and which MIB objects are part of each group.

14.1.2.2.24.1 wranIfBsCmRangingGroup

This group contains objects related to management of the ranging process.

14.1.2.2.24.2 wranIfBsCmBasicCapabilityGroup

This group contains objects related to management of the CBC-REQ/RSP process.

14.1.2.2.24.3 wranIfBsCmRegCapabilityGroup

This group contains objects related to management of the REG-REQ/RSP process.

14.1.2.2.24.4 wranIfBsCmMeasSupportGroup

This group contains objects related to management of the measurement process.

14.1.2.2.24.5 wranIfBsCpeCmAntennaGroup

This group contains objects related to management of antenna configuration.

14.1.2.2.24.6 wranIfBsScmCmGroup

This group contains objects related to management of the SCM protocol and SCM status on a CPE/BS.

14.1.2.2.24.7 wranIfBsActionsCmGroup

This group contains objects related to management of actions the BS can take.

14.1.2.2.24.8 wranIfBsMulticastCmGroup

This group contains objects related to management of multicast configuration.

14.1.2.2.24.9 wranIfBsCoexistenceCmGroup

This group contains objects related to management of coexistence configuration.

14.1.2.2.24.10 wranIfBsSystemParametersCmGroup

This group contains objects related to management of system parameter configuration.

14.1.2.2.24.11 wranIfBsPhyCmGroup

This group contains objects related to management of PHY configuration.

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14.1.2.2.25 wranIfBsCmMibCompliance

MIB objects that are optional or mandatory for `wranIfBsCm` compliance.

14.1.2.3 wranIfBsAm

This MIB group contains various objects related to Accounting Management.

14.1.2.3.1 wranIfBsOtaUsageDataRecordTable

This object contains usage entries that track the number of octets/packets transmitted or received over the air interface. Records may be transferred to an external database, such as an AAA server, after which they can be deleted from this table. Each entry is defined by `wranIfBsOtaUsageDataRecordEntry`.

14.1.2.3.1.1 wranIfBsOtaUsageDataRecordEntry

This object is a compound object that identifies entries in the `wranIfBsOtausageDataRecordTable`.

14.1.2.3.1.1.1 wranIfBsOtaUsageDataRecordIndex

Index of entry in this table.

14.1.2.3.1.1.2 wranIfBsOtaUsageSid

A 9-bit Station ID that identifies the station that is carrying traffic.

14.1.2.3.1.1.3 wranIfBsOtaUsageFt

A 3-bit flow Type that identifies the specific flow assigned to a station that is carrying traffic. For data traffic this identifies the FT that is mapped to a SFID (i.e., `wranIfBsServiceFlowId`).

14.1.2.3.1.1.4 wranIfBsOtaUsageSessionId

An identifier for a session. A session is a segment in time when a service flow is active. Multiple sessions can be created during the service flow activation time to allow the BS to track usage during periods when the service flow configuration (e.g., QoS) is changing.

14.1.2.3.1.1.5 wranIfBsOtaUsageMacSduCount

Counter of the number of MAC SDUs transmitted on a FT. If the FT represents a basic, primary/secondary management, or multicast management CID, then this deals with traffic transmitted on both the DS and US.

14.1.2.3.1.1.6 wranIfBsOtaUsageOctetCount

Counter of the number of MAC SDUs/messages that have been transmitted and received over the air interface.

14.1.2.3.1.1.7 wranIfBsOtaUsageSessionStartTime

Date and time a session was established.

14.1.2.3.1.1.8 wranIfBsOtaUsageSessionEndTime

Date and time a session was ended.

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14.1.2.3.1.1.9 wranIfBsOtaUsageQoSServiceFlowListSize

Number of items in `wranIfBsOtaUsageQoSServiceFlowList`.

14.1.2.3.1.1.10 wranIfBsOtaUsageQoSServiceFlowList

A list of SFIDs for each service flow active during this session (i.e., a list of SFIDs that pertain to service flows as defined in `wranIfBsActiveSfTable`).

14.1.2.3.1.1.11 wranIfBsOtaUsageQoSProfileListSize

Number of items in `wranIfBsOtaUsageQoSProfileList`.

14.1.2.3.1.1.12 wranIfBsOtaUsageQoSProfileList

A list of indexes into `wranIfBsScTable`, that point to the definition of the QoS parameter set of each service flow listed in `wranIfBsOtaUsageQoSServiceFlowList` (and hence were active during this session).

14.1.2.3.2 wranIfBsAmMibGroups

This object helps define which MIB groups are available within this module and which MIB objects are part of each group.

14.1.2.3.2.1 wranIfBsOtaUsageDataGroup

This group contains objects related to tracking of OTA resources per CPE.

14.1.2.3.3 wranIfBsAmMibCompliance

MIB objects that are optional and mandatory for `wranIfBsAm` compliance.

14.1.2.4 wranIfBsPm

This MIB group contains objects related to Performance Management. The following tables are provided in this MIB:

- `wranIfBsPmConfigrationTable`: Provides configuration determining which tables are enabled.
- `wranIfBsSignalPowerMetricsTable`: Helps track metrics related to measurement of CPE upstream signal by BS and BS downstream signal by CPE.
- `wranIfBsStartupMetricsTable`: Help track non-timing metrics related to network entry and re-entry.
- `wranIfBsThroughputMetricsTable`: Help track metrics related to peak/average data rate.
- `wranIfBsNetworkEntryMetricsTable`: Help track timing metrics related to network entry and re-entry.
- `wranIfBsPacketErrorRateTable`: Help track metrics related to packet error rate measurements.
- `wranIfBsUserMetricsTable`: Help track metrics related to current status of CPEs in the cell.
- `wranIfBsServiceFlowMetricsTable`: Helps track metrics related to service flows.
- `wranIfBsArqMetricsTable`: Helps track the performance of ARQ.

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— `wranIfBsAuthenticationMericsTable`: Table helps track the number of authentication/ encryption errors that occur.

— `wranIfBsCoexistenceStatusTable`: Table helps track the status of ongoing coexistence (e.g., Frame Contention) transaction.

— `wranIfBsCoexistenceSourceTable`: Table helps track what neighbor BSs are attempting a coexistence (Frame Contention) transaction with a particular source BS.

— `wranIfBsCoexistenceResourceListTable`: Table helps track what resources neighboring WRANs are making use of. This includes the Backup/Candidate channel lists, DS/US splits, SCW schedule.

— `wranIfBsCoexistenceCurrentConfigTable`: Table helps keep track of current (frame) allocation allowed to winner of recent winner, and the release time.

— `wranIfBsPmMibGroups`: Helps define which MIB groups are available within this module and which MIB objects are part of each group.

— `wranIfBsPmMibCompliance`: Defines which groups are optional and mandatory for wranIfBsPm compliance.

14.1.2.4.1 wranIfBsPmConfigurationTable

The configuration of statistics capture and measurement is captured in this table. There is one entry in this table for each BS sector. The entries are defined by `wranIfBsPmConfigurationEntry`.

14.1.2.4.1.1 wranIfBsPmConfigurationEntry

This object is a compound object that represents an entry in `wranIfBsPmConfigurationTable`.

14.1.2.4.1.1.1 wranIfBsPmConfigurationEntryIndex

Index of entry in the table (defaults to 1).

14.1.2.4.1.1.2 wranIfBsGranularityInterval

Data rate statistics captured in `wranIfBsSignalPowerMetricsTable`, `wranIfBsStartupMetricsTable`, `wranIfBsThroughputMetricsTable`, `wranIfBsNetworkEntryMetricsTable`, `wranIfBsPacketErrorRateTable`, `wranIfBsUserMetricsTable`, `wranIfBsServiceFlowMetricsTable`, `wranIfBsArqMetricsTable`, and `wranIfBsAuthenticationMetricsTable` are measured over the time interval this object specifies.

14.1.2.4.1.1.3 wranIfBsCountersReportInterval

This MIB determines the interval in which traps in `wranIfBsTrapControlRegister` related to performance measurement are reported to the NCMS.

14.1.2.4.1.1.4 wranIfBsPmMeasurementBitmap

A 13-bit bitmap indicating which of the measurement tables are enabled or disabled. When a position in bitmap is set (=1), that measurement table is enabled; when it is unset (=0), the table is disabled.

14.1.2.4.2 wranIfBsSignalPowerMetricsTable

This MIB object contains a table that records BS upstream measurement of a CPE's transmissions as well as CPE measurement of BS downstream signal. The data is stored as a histogram. This table is made up of

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entries defined by `wranIfBsSignalPowerMetricsEntry`. Each entry is uniquely identified by the CPE's MAC address and the index of the entry in the histogram.

14.1.2.4.2.1 wranIfBsSignalPowerMetricsEntry

This is a compound object made up objects that represent an entry in `wranIfBsSignalPowerMetricsTable`.

14.1.2.4.2.1.1 wranIfBsSignalPowerMetricsIndex

Index in histogram to which entry pertains.

14.1.2.4.2.1.2 wranIfBsCpeMacAddress

MAC address of the CPE.

14.1.2.4.2.1.3 wranIfBsChannelDirection

Direction of channel, whether DS or US, on which the measurement was done.

14.1.2.4.2.1.4 wranIfBsStdDevRssiReport

Standard Deviation RSSI report.

14.1.2.4.2.1.5 wranIfBsMaxEIRPReport

Max EIRP Report.

14.1.2.4.2.1.6 wranIfBsPerScEIRPReport

Per Subchannel EIRP Report.

14.1.2.4.3 wranIfBsStartupMetricsTable

This MIB provides a table to track how CPEs perform during initial network entry and re-entry. This table is made of one entry, defined by `wranIfBsStartupMetricsEntry`. This entry reflects startup metrics recorded during the current reporting session.

14.1.2.4.3.1 wranIfBsStartupMetricsEntry

This object is a compound object that defines entries in `wranIfBsStartupMetricsTable`.

14.1.2.4.3.2 wranIfBsStartupMetricsIndex

Index for entry in this table.

14.1.2.4.3.2.1 wranIfBsNumAuthAttempt

A counter for the number of CPE authentication attempts.

14.1.2.4.3.2.2 wranIfBsNumAuthSuccess

A counter for the number of successful authentication handshake completions.

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14.1.2.4.3.2.3 wranIfBsAuthSuccessRate

Success rate of authentication attempts: `wranIfBsAuthSuccessRate` = 100 × (`wranIfBsNumAuthSuccess`/`wranIfBsNumAuthAttempt`).

14.1.2.4.3.2.4 wranIfBsNumRangingAttempt

Number of CPE ranging requests received.

14.1.2.4.3.2.5 wranIfBsNumRangingSuccess

Number of CPE ranging responses sent.

14.1.2.4.3.2.6 wranIfBsRangingSuccessRate

Success rate of ranging attempts: `wranIfBsRangingSuccessRate` = 100 × (`wranIfBsNumRangingSuccess`/`wranIfBsNumRangingAttempt`).

14.1.2.4.4 wranIfBsThroughputMetricsTable

This MIB object provides a table to record peak/average data rate. This table is made up of multiple entries, one for each sector of a BS. Each entry is defined by `wranIfBsThroughputMetricsEntry`.

14.1.2.4.4.1 wranIfBsThroughputMetricsEntry

This object is a compound object that contains an entry in `wranIfBsThroughputMetricsTable`.

14.1.2.4.4.1.1 wranIfBsThroughputMetricsIndex

Index of entry in the table.

14.1.2.4.4.1.2 wranIfBsAvgDsUserThroughput

This records the average user throughput in the US. This is a function of the number of octets of MAC SDUs transmitted by CPEs to the BS over time.

14.1.2.4.4.1.3 wranIfBsAvgUsUserThroughput

This records the average MAC throughput in the DS. This is a function of the number of octets of MAC PDUs transmitted by the BS to CPEs over time.

14.1.2.4.4.1.4 wranIfBsAvgDsMacThroughput

This records the average MAC throughput in the US. This is a function of the number of octets of MAC PDUs transmitted by the CPEs to the BS over time.

14.1.2.4.4.1.5 wranIfBsAvgUsMacThroughput

This records the average PHY throughput in the DS. This is a function of the number of burst octets (e.g., MAC PDU + PHYoverhead) transmitted by the BS to CPEs over time.

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14.1.2.4.4.1.6 wranIfBsAvgDsPhyThroughput

This records the average PHY throughput in the DS. This is a function of the number of burst octets (e.g., MAC PDU + PHYoverhead) transmitted by the BS to CPEs over time.

14.1.2.4.4.1.7 wranIfBsAvgUsPhyThroughput

This records the average PHY throughput in the US. This is a function of the number of octets of (e.g., MAC PDU + PHYoverhead) transmitted by the CPEs to the BS over time.

14.1.2.4.4.1.8 wranIfBsPeakDsUserThroughput

This records the Peak user throughput in the DS. This is the maximum of a function representing the number of octets of MAC SDUs transmitted by the BS to CPEs over time.

14.1.2.4.4.1.9 wranIfBsPeakUsUserThroughput

This records the peak user throughput in the US. This is a maximum of a function of the number of octets of MAC SDUs transmitted by CPEs to the BS over time.

14.1.2.4.4.1.10 wranIfBsPeakDsMacThroughput

This records the peak MAC throughput in the DS. This is a maximum of a function of the number of octets of MAC PDUs transmitted by the BS to CPEs over time.

14.1.2.4.4.1.11 wranIfBsPeakUsMacThroughput

This records the peak MAC throughput in the US. This is a maximum of a function of the number of octets of MAC PDUs transmitted by the CPEs to the BS over time.

14.1.2.4.4.1.12 wranIfBsPeakDsPhyThroughput

This records the peak PHY throughput in the DS. This is a maximum of the function of the number of burst octets (e.g., MAC PDU + PHYoverhead) transmitted by the BS to CPEs over time.

14.1.2.4.4.1.13 wranIfBsPeakUsPhyThroughput

This records the peak PHY throughput in the US. This is a maximum of the function of the number of octets of (e.g., MAC PDU + PHY overhead) transmitted by the CPEs to the BS over time.

14.1.2.4.4.1.14 wranIfBsAvgDsCellEdgeThroughput

This records the average MAC throughput in the DS transmitted with the most robust MCS. This is a function of the number of octets of MAC PDUs transmitted by the BS to CPEs over time using QPSK.

14.1.2.4.4.1.15 wranIfBsAvgUsCellEdgeThroughput

This records the average MAC throughput in the US transmitted with the most robust MCS. This is a function of the number of octets of MAC PDUs transmitted by CPEs to the BS over time using QPSK.

14.1.2.4.5 wranIfBsNetworkEntryMetricsTable

This MIB provides a table that contains latency (time) for network entry and network re-entry. Network entry time is measured as the time in between receiving the first RNG-REQ from a CPE until the CPE has

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received the REG-RSP. Network re-entry process is governed by policies in the Policy Table 315. This could require execution of the entire network re-entry process if the CPE is forced to re-initialize itself or it could only require execution of the CPE initialization procedure through the ranging process (see 7.16.2). There is one entry in the table for each BS sector. Each entry is defined by `wranIfBsNetworkEntryMetricsEntry`.

14.1.2.4.5.1 wranIfBsNetworkEntryMetricsEntry

This object is a compound object that represents an entry in `wranIfBsNetworkEntryMetricsTable`.

14.1.2.4.5.1.1 wranIfBsNetworkEntryMetricsIndex

Index into entry in the table.

14.1.2.4.5.1.2 wranIfBsAvgNetworkEntryLatency

Average network entry latency, measured in seconds.

14.1.2.4.5.1.3 wranIfBsMaxNetworkEntryLatency

Maximum network entry latency, measured in seconds.

14.1.2.4.5.1.4 wranIfBsAvgNetworkReEntryLatency

Average network re-entry latency, measured in seconds.

14.1.2.4.5.1.5 wranIfBsMaxNetworkReEntryLatency

Maximum network re-entry latency, measured in seconds.

14.1.2.4.5.1.6 wranIfBsNumNetworkEntryAttempts

Number of network entry attempts.

14.1.2.4.5.1.7 wranIfBsNumNetworkReEntryAttempts

Number of network re-entry attempts.

14.1.2.4.6 wranIfBsPacketErrorRateTable

This MIB object contains information about packet error rate measurements. The table is made up of multiple entries, one for each BS sector. Each entry is defined by `wranIfBsPacketErrorRateEntry`.

14.1.2.4.6.1 wranIfBsPacketErrorRateEntry

This object is a compound object that defines an entry in `wranIfBsPacketErrorRateTable`.

14.1.2.4.6.1.1 wranIfBsPacketErrorRateIndex

Index of entry in the table.

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14.1.2.4.6.1.2 wranIfBsDsPacketsSent

Total number of MAC SDUs that the BS has sent.

14.1.2.4.6.1.3 wranIfBsDsPacketsErrored

Total number of MAC SDUs, including ARQ blocks, that have not been acknowledged.

14.1.2.4.6.1.4 wranIfBsDsPacketErrorRate

`wranIfBsDsPacketErrorRate` = (`wranIfBsDsPacketsErrored` / `wranIfBsDsPacketsSent`) × 10000000, in units of 1e-7.

14.1.2.4.6.1.5 wranIfBsUsPacketsReceived

Total number of MAC SDUs that the BS has received.

14.1.2.4.6.1.6 wranIfBsUsPacketsErrored

Total number of MAC SDUs with CRC errors and/or ARQ blocks that required re-transmission that has been received by the BS.

14.1.2.4.6.1.7 wranIfBsUsPacketErrorRate

`wranIfBsUsPacketErrorRate` = (`wranIfBsUsPacketsErrored` / `wranIfBsUsPacketsReceived`) × 10000000, in units of 1e-7.

14.1.2.4.7 wranIfBsUserMetricsTable

This MIB object provides a table to track the current status of users in the cell. There is one row for each BS sector. Each entry is defined by `wranIfBsUserMetricsEntry`.

14.1.2.4.7.1 wranIfBsUserMetricsEntry

This object is a compound object that defines a row in `wranIfBsUserMetricsTable`.

14.1.2.4.7.1.1 wranIfBsUserMetricsIndex

Index of entry in the table.

14.1.2.4.7.1.2 wranIfBsNumActiveUsers

Total number of users that have CIDs with active SFs on them.

14.1.2.4.7.1.3 wranIfBsNumTotalUsers

Total number of users that have completed the registration (REG-REQ/RSP) process.

14.1.2.4.8 wranIfBsServiceFlowMetricsTable

This MIB object provides a table to track metrics related to service flows. This table is made up of one entry. Each entry is defined by `wranIfBsServiceFlowMetricsEntry`.

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14.1.2.4.8.1 wranIfBsServiceFlowMetricsEntry

This object is a compound object that represents an entry in `wranIfBsServiceFlowMetricsTable`.

14.1.2.4.8.1.1 wranIfBsServiceFlowMetricsIndex

Index of entry in the table.

14.1.2.4.8.1.2 wranIfBsNumDsaReq

Number of DSA-REQ counted during reporting period.

14.1.2.4.8.1.3 wranIfBsNumDsaReqSuccess

Number of successful SF activations counted during reporting period. A successful activation of a SF is noted when a BS receives a DSA-RSP with a successful confirmation in response to a particular DSA-REQ.

14.1.2.4.8.1.4 wranIfBsDsaSuccessRate

`wranIfBsNumDsaSuccessRate` = (`wranIfBsNumDsaReqSuccess` / `wranIfBsNumDsaReq`) × 100.

14.1.2.4.8.1.5 wranIfBsNumDscReq

Number of DSC-REQ BS sent during reporting period.

14.1.2.4.8.1.6 wranIfBsNumDscReqSuccess

Number of successful SF modifications counted during reporting period. A successful modification of a SF is noted when a BS receives a DSC-RSP with a successful confirmation in response to a particular DSC-REQ.

14.1.2.4.8.1.7 wranIfBsDsdSuccessRate

`wranIfBsNumDscSuccessRate` = (`wranIfBsNumDscReqSuccess` / `wranIfBsNumDscReq`) × 100.

14.1.2.4.8.1.8 wranIfBsNumDsdReq

Number of DSD-REQ BS sent during reporting period.

14.1.2.4.8.1.9 wranIfBsNumDsdReqSuccess

Number of successful SF deletions counted during reporting period. A successful deletion of a SF is noted when a BS receives a DSD-RSP with a successful confirmation in response to a particular DSD-REQ.

14.1.2.4.8.1.10 wranIfBsDsdSuccessRate

`wranIfBsNumDsdSuccessRate` = (`wranIfBsNumDsdReqSuccess` / `wranIfBsNumDsdReq`) × 100.

14.1.2.4.8.1.11 wranIfBsMaxActiveServiceFlow

Maximum number of service flows active during reporting period.

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14.1.2.4.8.1.12 wranIfBsAvgActiveServiceFlow

Average number of service flows active during reporting period.

14.1.2.4.8.1.13 wranIfBsMaxProvisionedServiceFlow

Maximum number of pre-provisioned service flows active during reporting period.

14.1.2.4.8.1.14 wranIfBsAvgProvisionedServiceFlow

Average number of pre-provisioned service flows active during reporting period.

14.1.2.4.8.1.15 wranIfBsMaxDsServiceFlow

Maximum number of DS service flows active during reporting period.

14.1.2.4.8.1.16 wranIfBsMaxUsServiceFlow

Maximum number of US service flows active during reporting period.

14.1.2.4.8.1.17 wranIfBsAvgDsServiceFlow

Average number of DS service flows active during reporting period.

14.1.2.4.8.1.18 wranIfBsAvgUsServiceFlow

Average number of US service flows active during reporting period.

14.1.2.4.8.1.19 wranIfBsNumSfidAllocated

Number of SFIDs allocated during reporting period.

14.1.2.4.9 wranIfBsArqMetricsTable

This MIB provides a table to track performance of ARQ. This table is made up of multiple entries, one for each BS sector. Each entry is defined by `wranIfBsArqMetricsEntry`.

14.1.2.4.9.1 wranIfBsArqMetricsEntry

This object is a compound object that provides a definition of entries in `wranIfBsArqMetricsTable`.

14.1.2.4.9.1.1 wranIfBsArqMetricsIndex

Index of entry in the table.

14.1.2.4.9.1.2 wranIfBsDsNumArqBlocks

Total number of ARQ blocks, including retransmissions, that the BS has sent during reporting period.

14.1.2.4.9.1.3 wranIfBsDsNumArqBlocksDropped

Total number of ARQ blocks that were dropped, due to unsuccessful attempts at retransmission.

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14.1.2.4.9.1.4 wranIfBsDsArqBlockErrorRate

`wranIfBsDsArqBlockErrorRate` = (`wranIfBsDsNumArqBlocksDropped` / `wranIfBsDsNumArqBlocks`) × 10000000, in units of 1e-7.

14.1.2.4.9.2 wranIfBsDsNumArqBlockReTx

Total number of ARQ blocks that were retransmitted.

14.1.2.4.9.2.1 wranIfBsDsArqBlockEfficiency

`wranIfBsDsArqBlockEfficiency` = (`wranIfBsDsNumArqBlockReTx`/ `wranIfBsDsNumArqBlocks`) × 10000000, in units of 1e-7.

14.1.2.4.9.2.2 wranIfBsUsNumArqBlocks

Total number of ARQ blocks, including retransmissions, that the BS has received during reporting period.

14.1.2.4.9.2.3 wranIfBsUsNumArqBlocksDropped

Total number of US ARQ blocks that were dropped, due to unsuccessful attempts at retransmission.

14.1.2.4.9.2.4 wranIfBsUsArqBlockErrorRate

`wranIfBsUsArqBlockErrorRate` = (`wranIfBsUsNumArqBlocksDropped` / `wranIfBsUsNumArqBlocks`) × 10000000, in units of 1e-7.

14.1.2.4.9.2.5 wranIfBsUsNumArqBlockReTx

Total number of ARQ blocks that were retransmitted by CPE during reporting period.

14.1.2.4.9.2.6 wranIfBsDsArqBlockEfficiency

`wranIfBsUsArqBlockEfficiency` = (`wranIfBsUsNumArqBlockReTx` / `wranIfBsUsNumArqBlocks`) × 10000000, in units of 1e-7.

14.1.2.4.10 wranIfBsAuthenticationMetricsTable

This MIB provides a table to track the number of authentication/encryption errors that occur. This information can be used to detect if an active attack on the system is occurring. This table is made up of multiple entries, one for each BS sector. Each entry is defined by `wranIfBsAuthenticationMetricsEntry`.

14.1.2.4.10.1 wranIfBsAuthenticationMetricsEntry

This object is a compound object that defines an entry in `wranIfBsAuthenticationMetricsTable`.

14.1.2.4.10.1.1 wranIfBsAuthenticationMetricsIndex

Index of entry in the table.

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14.1.2.4.10.1.2 2 wranIfBsMgmtAuthErrors

A counter that gets incremented every time a management message from the CPE cannot be properly authenticated.

14.1.2.4.10.1.3 wranIfBsDataAuthErrors

A counter that gets incremented every time a data message from the CPE can not be properly authenticated.

14.1.2.4.10.1.4 wranIfBsWiMicAuthErrors

A counter that gets incremented every time a wireless microphone beacon (MSF1+MSF2+MSF3) cannot be properly authenticated.

14.1.2.4.10.1.5 wranIfBsCbpAuthErrors

A counter that gets incremented every time a CBP from a neighboring WRAN cannot be properly authenticated.

14.1.2.4.11 wranIfBsCoexistenceStatusTable

This MIB provides a table to track the ongoing coexistence (Frame Contention) transactions. This table is made up of multiple entries, one for each ongoing transaction. Each entry is defined by `wranIfBsCoexistenceStatusEntry`. If a Frame Contention Destination receives a FC-REQ from a source on a channel for which it already has a message from, then the existing entry is updated.

14.1.2.4.11.1 wranIfBsCoexistenceStatusEntry

This object is a compound object that defines an entry in `wranIfBsCoexistenceStatusTable`.

14.1.2.4.11.1.1 wranIfBsCoexistenceStatusIndex

Index of entry in the table.

14.1.2.4.11.1.2 wranIfBsContentionChannel

Channel number on which FC-REQ was received (i.e., channel that is being contented for).

14.1.2.4.11.1.3 wranIfBsFCREQSourceID

BS ID (MAC Address) of the transmitter of a FC-REQ message in a CBP burst. This is pulled from the SCH data in the CBP MAC PDU header pulled from the CBP burst containing the FC-REQ.

14.1.2.4.11.1.4 wranIfBsFrameContentionSeqNum

Sequence number field of the received FC-REQ message.

14.1.2.4.11.1.5 wranIfBsFrameContentionNumber

Value of the Frame Contention Number (FCN) in the FC-REQ.

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14.1.2.4.11.1.6 wranIfBsContentionReqFrameIndexVector

Bitmap index of data frames within a superframe that a Frame Contention Source is requesting, to be scheduled in the next superframe after the current one.

14.1.2.4.12 wranIfBsCoexistenceSourceTable

This MIB provides a table to track what neighbor BSs are attempting a coexistence (Frame Contention) transaction with a particular BS or have communicated other information (e.g., Backup/Candidate channel list) via CBP. Each entry is defined by `wranIfBsCoexistenceSourceEntry`.

14.1.2.4.12.1 wranIfBsCoexistenceSourceEntry

This object is a compound object that defines an entry in wranIfBsCoexistenceSourceTable. When a CBP is received from a neighboring WRAN that already has an entry in the table, the existing entry is updated.

14.1.2.4.12.1.1 wranIfBsCoexistenceSourceIndex

Index of entry in the table.

14.1.2.4.12.1.2 wranIfBsCBPSourceID

BS ID of the BS that sent the CBP burst; obtained from SCH data in CBP MAC PDU header (see Table 1 and Table 15) for PHY-OM1 or from A-FCH/ExFCH data in CBP MAC PDU header (see Table 4 and Table 15) for PHY-OM2.

14.1.2.4.12.1.3 wranIfBsCtrlHdrDataIndex

SCH Data Index field of CBP MAC PDU header for PHY-OM1, or Advanced FCH/Extened FCH Index field of CBP MAC PDU header for PHY-OM2. It indicates the length of and an indication of what fields comprise the `wranIfBsCtrlHdrData` in this table.

14.1.2.4.12.1.4 wranIfBsCtrlHdrData

SCH Data from CBP MAC PDU header for PHY-OM1, or Advanced FCH/Extened FCH Index field of CBP MAC PDU header for PHY-OM2. The length of this field is governed by `wranIfBsCtrlHdrDataIndex`.

14.1.2.4.13 wranIfBsCoexistenceResourceListTable

This MIB provides a table to track the resources being used by neighboring WRANs. This includes the Backup/Candidate Lists being transmitted by neighboring WRANs, as well as the DS/US split. This table is made up of multiple entries, defined by `wranIfBsChannelListEntry`. A BS may keep an entry in this table for its own settings.

14.1.2.4.13.1 wranIfBsCoexistenceResourceListEntry

This object is a compound object that defines an entry in wranIfBsChannelListTable. When a CBP is received from a neighboring WRAN that already has an entry in the table, the existing entry is updated.

14.1.2.4.13.1.1 wranIfBsCoexistenceResourceListIndex

Index of entry in the table. When set to 1, refers to a BS own Coexistence Resource.

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14.1.2.4.13.1.2 wranIfBsCoexistenceResourceID

BS ID of the BS that sent the CBP burst, obtained from SCH data in CBP MAC PDU header (see Table 1 and Table 15) for PHY-OM1, or from Advanced FCH/Extened FCH data in CBP MAC PDU header (see Table 4 and Table 15) for PHY-OM2.

14.1.2.4.13.1.3 wranIfBsSelfCoexistenceCapabilityIndicator

Field within SCH Data field within CBP MAC PDU header for PHY-OM1, or from within A-FCH field within CBP MAC PDU header for PHY-OM2, that indicates what coexistence capabilities a BS supports. If this field is 0000, the remaining fields of this entry are null

14.1.2.4.13.1.4 wranIfBsNumBackupChannels

Number of backup channels in `wranIfBsBackupChannelList`.

14.1.2.4.13.1.5 wranIfBsBackupChannelList

This object is a vector, of the length = 8 bits × `wranIfBsNumBackupChannels`, that contains the backup/candidate channel list received in a CBP burst from a neighbor WRAN.

14.1.2.4.13.1.6 wranIfBsCurrentDSUSSplit

Current US/DS split indicated in SCH data of CBP MAC PDU header for PHY-OM1, or in A-FCH/ExFCH data of CBP MAC PDU header for PHY-OM2, received from neighbor WRAN.

14.1.2.4.13.1.7 wranIfBsClaimedDSUSSplit

Claimed US/DS split indicated in SCH data of CBP MAC PDU header for PHY-OM1, or in A-FCH/ExFCH data of CBP MAC PDU header for PHY-OM2, received from neighbor WRAN.

14.1.2.4.13.1.8 wranIfBsDSUSChangeOffset

US/DS change offset inidicated in SCH data of CBP MAC PDU header for PHY-OM1, or in A-FCH/ExFCH data of CBP MAC PDU header for PHY-OM2, received from neighbor WRAN.

14.1.2.4.13.1.9 wranIfBsFrameAllocationMap

Indicates which frames in a superframe are allocated to the neighbor WRAN BS. A frame is allocated if the bit is set to 1 and unallocated if the bit is set to 0.

14.1.2.4.13.1.10 wranIfBsScwCycleLength

SCW Cycle Length being applied by neighbor WRAN.

14.1.2.4.13.1.11 wranIfBsScwCycleOffset

SCW Cycle Offset being applied by neighbor WRAN.

14.1.2.4.13.1.12 wranIfBsScwCycleFrameBitmap

Valid within the context of a superframe, indicateds for each frame if now SCW is setup (00), the BS has setup a reservation-based SCW for intself (11), a reservation-based SCW for a neighboring WRAN (10), or

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a contention-based SCW to be shared by neighrobring WRANs (01). This is set in groups of bits, e.g.Bit#0 and Bit#1 correspond to frame 1 w/in superframe.

14.1.2.4.14 wranIfBsCoexistenceCurrentConfigTable

This MIB provides a table to track what frame allocation has been awarded to a frame contention winner, and when the awarded resource will be released. It is made up of multiple entries, one for each channel that frame contention procedure was executed on, as defined in `wranIfBsCoexistenceCurrentConfigEntry`. When a frame contention winner is selected, the corresponding entries in `wranIfCoexistenceStatusTable` are removed.

14.1.2.4.14.1 wranIfBsCoexistenceCurrentConfigEntry

This object is a compound object that defines an entry in `wranIfBsCoexistenceCurrentConfigTable` when a frame contention winner is selected and entry into this table is filled. When frames are reclaimed, the corresponding entry in this table is removed.

14.1.2.4.14.1.1 wranIfBsCoexistenceCurrentConfigIndex

Index of entry in the table.

14.1.2.4.14.1.2 wranIfBsContentionChannel

Channel number on which the frame contention was executed.

14.1.2.4.14.1.3 wranIfBsFrameContentionSourceID

BS ID of frame contention source that has won contention

14.1.2.4.14.1.4 wranIfBsAwardedSeqNum

Sequence number of the frame contention winner from the FC-REQ message.

14.1.2.4.14.1.5 wranIfBsContentionRspFrameIndexVector

Sequence number of the frame contention winner from the FC-REQ message.

14.1.2.4.14.1.6 wranIfBsContentionRspFrameReleaseTime

Starting from the next superframe, the number of superframes after which the TV channel shall be released by the frame contention destination.

14.1.2.4.15 wranIfBsPmMibGroups

This object helps define which MIB groups are available within this module and which MIB objects are part of each group.

14.1.2.4.15.1 wranIfBsPmConfigGroup

This group contains objects relate to configuration of measurement records used in `wranIfBsPm`.

14.1.2.4.15.2 wranIfBsPmSignalPowerGroup

This group contains objects related to tracking CPE signal power measurements.

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14.1.2.4.15.3 wranIfBsPmStartupGroup

This group contains objects related to tracking CPE performance during network entry and re-entry.

14.1.2.4.15.4 wranIfBsPmThroughputGroup

This group contains objects related to tracking CPE peak/average data rate.

14.1.2.4.15.5 wranIfBsPmNetEntryGroup

This group contains objects related to tracking latency of network entry and re-entry for CPEs.

14.1.2.4.15.6 wranIfBsPmPktErrorGroup

This group contains objects related to tracking packet error rate measurements.

14.1.2.4.15.7 wranIfBsPmUserGroup

This group contains objects related to tracking status of users in the cell.

14.1.2.4.15.8 wranIfBsPmServiceFlowGroup

This group contains objects related to tracking services flow metrics.

14.1.2.4.15.9 wranIfBsPmArqGroup

This group contains objects related to tracking ARQ performance.

14.1.2.4.15.10 wranIfBsPmAuthGroup

This group contains objects related to tracking the number of authentication/encryption errors that occur.

14.1.2.4.15.11 wranIfBsPmCoexStatusGroup

This group contains objects related to tracking the status of on going coexistence (Frame Contention) transactions.

14.1.2.4.15.12 wranIfBsPmCoexSourceGroup

This group contains objects related to tracking which neighbor BSs are attempting a coexistence (Frame Contention) transaction.

14.1.2.4.15.13 wranIfBsPmCoexResourceGroup

This group contains objects related to tracking what resources are used by neighboring WRANs.

14.1.2.4.15.14 wranIfBsPmCoexConfigGroup

This group contains objects related to tracking what resources have been allocated to neighboring WRANs during coexistence (Frame Contention) transactions.

14.1.2.4.16 wranIfBsPmMibCompliance

MIB objects that are optional and mandatory for `wranIfBsPm` compliance.

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14.1.2.5 wranIfBsScm

This MIB group has objects related to Security Management. The following tables are included in this MIB object:

- `wranIfBsCpeScmAuthStatusTable`: Contains information related to the current status of CPE authentication.
- `wranIfBsCpeScmSaConfigTable`: Contains information related to attributes of SAs that are configured on CPEs.
- `wranIfBsCpeTekRefreshTable`: Contains information related to ongoing SCM Key-Request/Reply transactions.
- `wranIfBsCBPAuthCACertTable`: Contains CA root certificates used in CBP Authentication.
- `wranIfBsCBPAuthBsImplicitCertTable`: Contains BS implicit certificates used in CBP Authentication.
- `wranIfBsWiMicAuthCertTable`: Contains implicit certificates contained in MSF3 of captured wireless microphone beacons.
- `wranIfBsScmMibGroups`: Defines which MIB groups are available within this module and which MIB objects are part of each group.
- `wranIfBsScmMibCompliance`: MIB objects that are optional and mandatory for `wranIfBsPm` compliance.

14.1.2.5.1 wranIfBsCpeScmAuthStatusTable

This object provides a table that stores information regarding the current state of the CPE's authentication state machine. This table is stored on each CPE and made up of one entry, defined by `wranIfBsCpeScmAuthStatusEntry`.

14.1.2.5.1.1 wranIfBsCpeScmAuthStatusEntry

This object is a compound object that defines an entry in `wranIfBsCpeScmAuthStatusTable`.

####### 14.1.2.5.1.1.1 wranIfBsCpeAuthStatusIndex

Index of entry in the table.

####### 14.1.2.5.1.1.2 wranIfBsCpeScmAuthStatus

Current state of CPE's authentication state machine (see Figure 161).

####### 14.1.2.5.1.1.3 wranIfBsCpeScmAuthRecentEvent

Indication of the most recent event (see 8.2.2.4) that has occurred in the ASM.

####### 14.1.2.5.1.1.4 wranIfBsCpeScmNumAuthAttempts

Current number of EAP authentication attempts.

####### 14.1.2.5.1.1.5 wranIfBsCpeScmAuthRecentMsgSize

Size of `wranIfBsCpeScmAuthRecentMsg` in octets.

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14.1.2.5.1.1.6 wranIfBsCpeScmAuthRecentMsg

Contents of most recent authentication message, either EAP-Start or EAP-Transfer.

14.1.2.5.1.1.7 wranIfBsCpeScmAuthEapAuthTimerExpiration

Indication of when EAP Authentication timer for pending EAP-Start or EAP-Transfer message is to expire.

14.1.2.5.1.1.8 wranIfBsCpeScmAuthGraceTimer1

Indication of when Authentication Grace timer for the current (active) AK will expire.

14.1.2.5.1.1.9 wranIfBsCpeScmAuthGraceTimer2

Indication of when Authentication Grace timer for second generation (non-active) AK will expire.

14.1.2.5.1.1.10 wranIfBsCpeScmAk1Lifetime

Remaining lifetime for current (active) AK.

14.1.2.5.1.1.11 wranIfBsCpeScmAk2Lifetime

Remaining lifetime for second generation (non-active) AK.

14.1.2.5.1.1.12 wranIfBsCpeScmConfigRequestSize

Size of `wranIfBsCpeScmConfigRequest` in octets.

14.1.2.5.1.1.13 wranIfBsCpeScmConfigRequest

Contents of SCM configuration request (see Table 234) sent by CPE, upon initial authentication or re-authentication, to AAA server.

14.1.2.5.1.1.14 wranIfBsCpeScmConfigReplySize

Size of `wranIfBsCpeScmConfigReply` in octets.

14.1.2.5.1.1.15 wranIfBsCpeScmConfigReply

Contents of SCM configuration reply (see Table 235) sent by AAA server, upon confirmation of initial authentication or reauthentication, to CPE.

14.1.2.5.2 wranIfBsCpeScmSaConfigTable

This object provides a table that provides the configuration of the SA attributes that are related to SAs configured on each CPE. This table is maintained on each CPE as well as on the BS. On the BS, this table represents the configuration of SAs for all CPEs under its control. On the CPE, this table is made up of one entry for each SA that a CPE supports. Each entry is defined by `wranIfBsCpeScmSaConfigEntry`.

14.1.2.5.2.1 wranIfBsCpeScmSaConfigEntry

This object is a compound object that defines an entry in `wranIfBsCpeScmSaConfigTable`.

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14.1.2.5.2.1.1 wranIfBsCpeScmSaConfigIndex

Index of entry in the table.

14.1.2.5.2.1.2 wranIfBsCpeMacAddress

MAC address of the CPE.

14.1.2.5.2.1.3 wranIfBsCpeSaid

SAID of SA to which this entry refers.

14.1.2.5.2.1.4 wranIfBsCpeSaType

Type of SA, either Null, Unnicast Management, Unicast Transport, or Group.

14.1.2.5.2.1.5 wranIfBsCpeCryptoSuiteListSize

Number of items in `wranIfBsCpeCryptoSuiteList`.

14.1.2.5.2.1.6 wranIfBsCpeCryptoSuiteList

This object provides a list that describes the cryptographic suites that the CPE supports for this particular SA. The complete list of suites is provided in Table 246.

14.1.2.5.2.1.7 wranIfBsCpeActiveTekSequenceNumber

The EKS value for the current (active) generation of the two TEKs that are configured for this SA.

14.1.2.5.2.1.8 wranIfBsCpeActiveTekLifetime

The lifetime, in units of time (e.g., seconds), for the current (active) generation of the two TEKs that are configured for this SA.

14.1.2.5.2.1.9 wranIfBsCpeActiveTekPn

Current value of the PN counter for the first (active) generation of the two TEKs that are configured for this SA.

14.1.2.5.2.1.10 wranIfBsCpeActiveTekExpireTime

Time at which current (active) generation of the two TEKS configured for an SA will expire. This time is calculated as a function of the (Reception Time of Key Reply with Active TEK) + (`wranIfBsCpeActiveTekLifetime`).

14.1.2.5.2.1.11 wranIfBsCpeNonActiveTekSequenceNumber

The EKS value for the second (non-active) generation of the two TEKs that are configured for this SA.

14.1.2.5.2.1.12 wranIfBsCpeNonActiveTekLifetime

The lifetime, in units of time (e.g., seconds), for the second (non-active) generation of the two TEKs that are configured for this SA.

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14.1.2.5.2.1.13 wranIfBsCpeNonActiveTekPn

Current value of the PN counter for the second (non-active) generation of the two TEKs that are configured for this SA.

14.1.2.5.2.1.14 wranIfBsCpeNonActiveTekExpireTime

Time at which second (non-active) generation of the two TEKS configured for an SA will expire. This time is calculated as a function of the Reception Time of Key Reply with TEK N + TEK N Lifetime.

14.1.2.5.3 wranIfBsCpeTekRefreshTable

This MIB object provides a table to track information related to ongoing Key-Request transactions. This table has one entry for each current SCM Key-Request transaction. Each entry is defined by `wranIfBsCpeTekRefreshEntry`.

14.1.2.5.3.1 wranIfBsCpeTekRefreshEntry

This object is a compound object that provides a definition for entries in `wranIfBsCpeTekRefreshTable`.

14.1.2.5.3.1.1 wranIfBsCpeTekRefreshIndex

Index of entry in the table.

14.1.2.5.3.1.2 wranIfBsCpeScmReqTransactionId

Value of Transaction ID field of SCM REQ that carried the corresponding Key-Request message (see Table 160).

14.1.2.5.3.1.3 wranIfBsCpeScmKeyReqKeySeqNum

Key Sequence Number of Key-Request message (see Table 192).

14.1.2.5.3.1.4 wranIfBsCpeScmKeyReqSaid

SAID for which keys are being requested.

14.1.2.5.3.1.5 wranIfBsCpeScmKeyReqGroupKeyIndicator

Indicator of whether Key-Request was for a Unicast Transport or GSA.

14.1.2.5.3.1.6 wranIfBsCpe ScmKeyReqCpeRandom

Random number generated by CPE and sent in the Key-Request.

14.1.2.5.4 wranIfBsCBPAuthCACertTable

This object provides a table to CA root certificates (see 8.6.2.3) used to validate CBP BS implicit certificates. There will be one entry for each CA for which a root certificate is installed. Each entry is defined by `wranIfBsCBPAuthCACertEntry`.

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14.1.2.5.4.1 wranIfBsCBPAuthCACertEntry

This object is a compound object that provides a definition for entries in wranIfBsCBPAuthCACertTable.

14.1.2.5.4.2 wranIfBsCBPAuthCACertIndex

Index of entry in the table.

14.1.2.5.4.2.1 wranIfBsCBPAuthCACertCAID

CA ID, identifier of CA in CA root certificate.

14.1.2.5.4.2.2 wranIfBsCBPAuthCACertKeyID

Key ID, identifier of assigned to public key reconstruction data in CA root certificate.

14.1.2.5.4.2.3 wranIfBsCBPAuthCACertKeyValidityDate

Key Validity Date (Not Before), date/time at which CA root certificate becomes valid.

14.1.2.5.4.2.4 wranIfBsCBPAuthCACertKeyValidityTimePeriod

Key Validity Time Period, length of time from Key Validity Date (Not Before) in 6-month increments, during which CA root certificate is valid.

14.1.2.5.4.2.5 wranIfBsCBPAuthCACertVersion

Version of CBP Authentication being applied that the CA root certificate supports.

14.1.2.5.4.2.6 wranIfBsCBPAuthCACertECDomainParameters

Elliptic Curve domain parameters that the CA uses.

14.1.2.5.4.2.7 wranIfBsCBPAuthCACertCAPubKrdSize

Size of `wranIfBsCBPAuthCACertCAPubKrd` in octets.

14.1.2.5.4.2.8 wranIfBsCBPAuthCACertCAPubKrd

Public Key Reconstruction Data that can be used to generate the public key associated with CA root certificate.

14.1.2.5.5 wranIfBsCBPAuthBsImplicitCertTable

This object provides a table to store BS implicit certificates for neighbor WRANs that use CBP authentication. There will be one entry for each BS whose implicit certificate is installed (via this object) on the BS or received by CERT-REQ/RSP. A BS may keep an entry for its own implicit certificate in this object. Each entry is defined by `wranIfBsCBPAuthBsImplicitCertEntry`.

14.1.2.5.5.1 wranIfBsCBPAuthBsImplicitCertEntry

This object is a compound object that provides a definition for entries in `wranIfBsCBPAuthBsImplicitCertTable`

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14.1.2.5.5.1.1 wranIfBsCBPAuthBsImplicitCertIndex

Index of entry in the table.

14.1.2.5.5.1.2 wranIfBsCBPAuthBsImplicitCertBsID

BS ID (MAC Address) of BS that implicit certificate belongs to.

14.1.2.5.5.1.3 wranIfBsCBPAuthBsImplicitCertCAID

CA ID, identifier of CA in BS implicit certificate.

14.1.2.5.5.1.4 wranIfBsCBPAuthBsImplicitCertKeyID

Key ID, identifier of assigned to public key reconstruction data in BS implicit certificate.

14.1.2.5.5.1.5 wranIfBsCBPAuthBsImplicitCertKeyValidityDate

Key Validity Date (Not Before), date/time at which BS implicit certificate becomes valid.

14.1.2.5.5.1.6 wranIfBsCBPAuthBsImplictCertKeyValidityTimePeriod

Key Validity Time Period, length of time from Key Validity Date (Not Before) in which BS implicit certificate is valid.

14.1.2.5.5.1.7 wranIfBsCBPAuthBsImplictCertVersion

Version of CBP Authentication being applied that the BS implicit certificate supports.

14.1.2.5.5.1.8 wranIfBsCBPAuthBsImplictCertPubKrdSize

Size of `wranIfBsCBPAuthBsImplicitCertPubKrd` in octets.

14.1.2.5.5.1.9 wranIfBsCBPAuthBsImplictCertPubKrd

Public Key reconstructed from `wranIfBsCBPAuthBsImplicitCertPubKrd` that can be used to generate the public key associated with BS implicit certificate.

14.1.2.5.6 wranIfBsWiMicAuthCertTable

This object provides a table to store wireless microphone implicit certificates contained in MSF3 of decoded wireless microphone beacons. This table is made up of multiple entries, one defined for each unique wireless microphone beacon implicit certificate. Each entry is defined by `wranIfBsWiMicAuthCertEntry`. Entries are added to this table when a wireless microphone beacon (MSF1+MSF2+MSF3) has been successfully received and decoded.

14.1.2.5.6.1 wranIfBsWiMicAuthCertEntry

This object is a compound object that provides a definition for entries in `wranIfBsWiMicAuthCertTable`.

14.1.2.5.6.1.1 wranIfBsWiMicAuthCertIndex

Index of entry in the table.

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14.1.2.5.6.1.2 wranIfBsWiMicAuthSrcAddress

Source Address from MSF1 of received wireless microphone beacon. It is stored as a 48-bit IEEE conformant MAC address that identifies the beaconing device associated with the implicit certificate

14.1.2.5.6.1.3 wranIfBsWiMicAuthImplicitCertSize

Size of `wranIfBsWiMicAuthImplictCert` in octets.

14.1.2.5.6.1.4 wranIfBsWiMicAuthImplicitCert

Wireless microphone beacon implicit certificate obtained from MSF3 of received wireless microphone beacon. Format of implicit certificate is defined in 7.5.5 of IEEE Std 802.22.1-2010.

14.1.2.5.7 wranIfBsScmMibGroups

This object helps define which MIB groups are available within this module and which MIB objects are part of each group.

14.1.2.5.7.1 wranIfBsScmAuthStatusGroup

This group contains objects related to tracking the current state of a CPEs authentication state machine.

14.1.2.5.7.2 wranIfBsScmSaConfigGroup

This group contains objects related to tracking the configurations of SAs configured on CPEs.

14.1.2.5.7.3 wranIfBsScmTekGroup

This group contains objects related to tracking on going Key-Request transactions.

14.1.2.5.7.4 wranIfBsScmCBPAuthCACertGroup

This group contains objects related to storing CA Root certificates that used to validate BS Implicit Certificates used in CBP authentication.

14.1.2.5.7.5 wranIfBsScmCBPBsCertGroup

This group contains objects related to storing BS implicit certificates used in CBP authentication.

14.1.2.5.7.6 wranIfBsScmWiMicAuthGroup

This group contains objects related to storing wireless microphone beacon (IEEE Std 802.22.1-2010) certificates transmitted in MSF3 of wireless microphone beacons.

14.1.2.5.8 wranIfBsScmMibCompliance

MIB objects that are optional and mandatory for `wranIfBsScm`.

14.1.3 wranIfBsSfMgmtMib

This MIB group provides objects for managing service flows in the network.

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Classification rules to be defined by the operator shall be downloadable to the BS and CPEs in a uniform and standardized format. The resulting behavior of a given classification rule shall be standardized and implementation independent. This shall be done by the MIB.

In this MIB group the following tables are defined as follows:

- `wranIfBsProvSfTable`: Contains information about service flows provisioned by the NCMS.
- `wranIfBsScTable`: Contains the QoS parameter set for service flows defined for the supported service classes.
- `wranIfBsActiveSfTable`: Contains information about dynamic service flows that are created/torn-down on-the-fly.
- `wranIfBsProvClassifierRuleTable`: Contains information about classifier rules as applied to service flows provisioned by the NCMS.
- `wranIfBsClassifierRuleTable`: Contains information about classifier rules as applied to service flows applied to dynamic service flows.
- `wranIfBsSfTrapControl`: Defines trap control related to enabling/disabling service flow management event recording.
- `wranIfBsSfTrapDefinition`: Defines configuration of data recorded with traps.
- `wranIfBsSfNotificationObjectsTable`: Table that tracks information reported by traps.
- `wranIfBsSfMibGroups`: Definition of MIB groups available within `wranIfBsSfMgmtMib`.
- `wranIfBsSfMibCompliance`: Definition of compliance object for `wranIfBsSfMgmtMib`.

14.1.3.1 wranIfBsProvSfTable

This MIB object defines the profiles for services that are provisioned by the NCMS. Services flow that are provisioned for a particular CPE are tied to that CPE via that CPE's MAC Address. This table is made up of multiple entries, each specific to a particular provisioned service flow. Each entry is defined by `wranfBsProvSfEntry`.

The QoS parameters for provisioned service flows are mapped to information in `wranIfBsScTable`. Classification rules for provisioned service flows are defined in `wranIfBsProvClassifierRuleTable`.

14.1.3.1.1 wranIfBsProvSfEntry

This object is a compound object that defines an entry in `wranIfBsProvSfTable`.

14.1.3.1.1.1 wranIfBsProvEntryIndex

Index of entry in the table.

14.1.3.1.1.2 wranIfBsCpeProvMacAddress

MAC address of the CPE for which the service flow is provisioned.

14.1.3.1.1.3 wranIfBsProvSfId

Unique identifier for the SF that is provisioned between a BS and a particular CPE.

14.1.3.1.1.4 wranIfBsProvSfDirection

Indication of whether or not the SF is a US SF or a DS SF.

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14.1.3.1.1.5 wranIfBsProvScIndex

Index into a `wranIfBsScTable` entry that indicates the QoS parameter set for this service flow.

14.1.3.1.1.6 wranIfBsProvCsSpecification

Indication of which convergence sublayer has been used to encapsulate the higher-layer SDU (see 7.9.8.9.18.1).

14.1.3.1.1.7 wranIfBsProvSfStatus

Indication of whether the provisioned service flow is currently provisioned, admitted, or active (see 7.9.8.9.4 and 7.20.2).

14.1.3.1.1.8 wranIfBsProvSfProvisioningTime

If currently active (see 14.1.3.1.1.7), the time at which the service flow was provisioned.

14.1.3.1.1.9 wranIfBsProvTargetSaid

SAID of SA to which the service flow is being mapped. Provisioned service flows can be mapped to the Primary or Secondary SA of the CPE.

14.1.3.1.1.10 wranIfBsProvClsRuleListSize

Number of `wranIfBsProvClsfrRuleIndex` values in `wranIfBsProvClsRuleList`.

14.1.3.1.1.11 wranIfBsProvClsRuleList

List of `wranIfBsProvClsfrRuleIndex` values pointing to entries in the `wranIfBsProvClassifierRuleTable` that contain packet classification rules assigned to this service flow.

14.1.3.2 wranIfBsScTable

This MIB object provides a table that describes attributes of provisioned and dynamic service flows, such as the QoS parameter set. This table is made up of multiple entries, one for each service class. Each entry is defined by `wranIfBsScEntry`.

14.1.3.2.1 wranIfBsScEntry

This object is a compound object that defines an entry in `wranIfBsScTable`.

14.1.3.2.1.1 wranIfBsScIndex

Index value to uniquely identify an entry into `wranIfBsScTable`.

14.1.3.2.1.2 wranIfBsQosSfSfid

SFID of service flow.

14.1.3.2.1.3 wranIfBsQosSfFt

FT to which service flow is mapped.

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0.0.0.0.0.1 wranIfBsQosServiceClassNameSize

Size, e.g., number of octets, of `wranIfBsQosServiceClassName`.

14.1.3.2.1.4 wranIfBsQosServiceClassName

Defines the name of the service class associated with this entry. If a service class is not assigned, this will be blank.

14.1.3.2.1.5 wranIfBsQosParameterSetType

Indication of whether the QoS Parameter set defined by this entry is applied to the Provisioned, Admitted, or Active parameter set of the service flow.

14.1.3.2.1.6 wranIfBsQosMaxSustainedRate

Peak information/data rate of SDUs carried by the service flow, defined in units of bits per second.

14.1.3.2.1.7 wranIfBsQosTrafficSize

If fixed-length SDUs (see 14.1.3.2.1.12) are enabled, this represents the size of SDU assigned to the service flow. If variable-length SDUs (see 14.1.3.2.1.12) are enabled, this represents the average size of SDU assigned the service flow.

14.1.3.2.1.8 wranIfBsQosMinReservedRate

Minimum required information/date rate of SDUs carried by the service flow, defined in units of bits per second.

14.1.3.2.1.9 wranIfBsQosToleratedJitter

The maximum jitter (variation in delay) that can be suffered by the traffic assigned to the service flow.

14.1.3.2.1.10 wranIfBsQosMaxLatency

The maximum delay that can be suffered by traffic assigned to the service flow.

14.1.3.2.1.11 wranIfBsQosEnableVariableLengthSdus

Setting this object allows the turning on/off of variable-length SDUs support. Default is to allow use of variable-length SDUs.

14.1.3.2.1.12 wranIfBsQosSchedulingType

The scheduling type, e.g., BE, nrtPS, rtPS, or UGS. Default is BE.

14.1.3.2.1.13 wranIfBsQosArqEnable

Setting this object enables/disables ARQ for a service flow. Default is that ARQ is enabled.

14.1.3.2.1.14 wranIfBsQosArqWindowSize

Indication of the maximum number of unacknowledged fragments at any given time. Only valid if `wranIfBsQosArqEnable` is set.

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14.1.3.2.1.15 wranIfBsQosArqTxRetryTimeout

Total time before timing out retransmissions of ARQ blocks (in 10 µs blocks). For BS, this should include time to compensate for scheduling and the propagation time for transmission.

14.1.3.2.1.16 wranIfBsQosArqRxRetryTimeout

Total time before timing out reception of ARQ block retransmission (in 10 µs blocks). For BS, this should include time to compensate for scheduling and the propagation time for transmission.

14.1.3.2.1.17 wranIfBsQosArqBlockLifetime

The maximum amount of time that an ARQ block can be held in the ARQ state machine before it is dropped.

14.1.3.2.1.18 wranIfBsQosArqSyncLossTimeout

Timeout for determining that the transmitter and receiver state machines have become unsynchronized.

14.1.3.2.1.19 wranIfBsQosArqDeliverInOrderEnable

Disable/enables ability to deliver ARQ blocks to higher layer at receiver in the same order they were transmitted by the transmitter.

14.1.3.2.1.20 wranIfBsQosArqRxPurgeTimeout

How much the ARQ window is advanced after an ARQ fragment is received.

14.1.3.2.1.21 wranIfBsQosArqBlockSizeReq

This object defines the value of the ARQ block size included in DSA-REQ and REG-REQ messages.

14.1.3.2.1.22 wranIfBsQosArqBlockSizeRsp

This object defines the value of the ARQ block size included in DSA-RSP and REG-RSP messages.

14.1.3.2.1.23 wranIfBsQosReqTxPolicy

This value is a bitmap that enables/disables the following capabilities for a service flow: Use of broadcast BW request for US, use of multicast BW request for US only, piggyback BW requests on data for US transmissions, enable/disable fragmentation, enable/disable packing, and use of CRC for MAC PDU.

14.1.3.3 wranIfBsActiveSfTable

This MIB object provides a table that is used to manage service flows that are currently active between the BS and CPEs. This table is made up of multiple entries, one for each service flow mapped to a particular CPE. Each entry is defined by `wranIfBsActiveSfEntry`.

14.1.3.3.1 wranIfBsActiveSfEntry

This object is a compound object that provides the definition of an entry in `wranIfBsActiveSfTable`.

14.1.3.3.1.1 wranIfBsActiveSfIndex

Index of entry in `wranIfBsActiveSfTable`

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14.1.3.3.1.2 wranIfBsActiveSfSfid

SFID of the active service flow that is assigned to a particular CPE.

14.1.3.3.1.3 wranIfBsActiveSfMacAddress

The 48-bit MAC Address assigned to CPE to which this service flow is mapped.

14.1.3.3.1.4 wranIfBsActiveSfSid

SID of CPE assigned to service flow. If `wranIfBsActiveSfSid` is a multicast SID, there will be multiple entries in this table, one for each `wranIfBsActiveSfMacAddress` assigned to this service flow with the same `wranIfBsActiveSfSid`.

14.1.3.3.1.5 wranIfBsActiveSfDirection

Direction of service flow: BS to CPE (DS), CPE to BS (US).

14.1.3.3.1.6 wranIfBsActiveSfStatus

Current state of service flow. Service flow can be in one of four states: inactive, provisioned, admitted (service flow initiated but not received BW yet), or active (service flow initiated and there has been bandwidth assigned to use on service flow).

14.1.3.3.1.7 wranIfBsActiveScIndex

Index into a `wranIfBsScTable` entry that indicates the QoS parameter set for this service flow.

14.1.3.3.1.8 wranIfBsActiveCsSpecification

The CS used for encapsulating SDUs for this service flow.

14.1.3.3.1.9 wranIfBsActiveTargetSaid

SAID of SA to which the service flow is being mapped.

14.1.3.3.1.10 wranIfBsActiveSfClsRuleListSize

Number of items in `wranIfBsActiveClsRuleList`.

14.1.3.3.1.11 wranIfBsActiveSfClsRuleList

List of `wranIfBsClsfrRuleIndex` values pointing to entries in the `wranIfBsClassifierRuleTable` that contain packet classification rules assigned to this service flow.

14.1.3.4 wranIfBsProvClassifierRuleTable

This table contains classifier rules that are to be applied to service flows for CPEs that are provisioned by the NCMS. There are multiple entries in this table, one for each classifier rule. Each entry is defined by `wranIfBsProvClassifierRuleEntry`.

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14.1.3.4.1 wranIfBsProvClassifierRuleEntry

This object is a compound object that provides the definition of entries in `wranIfBsProvClassifierRuleTable`.

14.1.3.4.1.1 wranIfBsProvClsfrRuleIndex

Index to uniquely identify an entry in `wranIfBsProvClassiferRuleTable`.

14.1.3.4.1.2 wranIfBsProvClsfrRuleMap

A bitmap that indicates which classification parameters are included in the classification rule. A parameter exists in this rule if the corresponding bit is set to 1.

14.1.3.4.1.3 wranIfBsProvClsfrRulePriority

Priority of the classification rule. This determines the order in which classification rules are applied.

14.1.3.4.1.4 wranIfBsProvClsfrRuleIpProtocol

Value of IP Protocol field. For IPv6 headers, this refers to the next header entry in the last header of the IP header list. The value of this field follows the “Protocol Numbers” specification defined by IANA.

14.1.3.4.1.5 wranIfBsProvClsfrRuleIpSrcAddrType

Type of IP address that Source IP address from IP header is.

14.1.3.4.1.6 wranIfBsProvClsfrRuleIpSrcAddr

Source IP address from IP header.

14.1.3.4.1.7 wranIfBsProvClsfrRuleIpSrcMask

IP address mask. IP source address (`wranIfBsProvClsfrRuleIpSrcAddr`) is matched when output of applying (bitwise AND) this value to IP source address from IP packet.

14.1.3.4.1.8 wranIfBsProvClsfrRuleIpDestAddrType

Type of IP address that Destination IP address from IP header is.

14.1.3.4.1.9 wranIfBsProvClsfrRuleIpDestAddr

Destination IP address from IP header.

14.1.3.4.1.10 wranIfBsProvClsfrRuleIpDestMask

IP address mask. IP destination address (`wranIfBsProvClsfrRuleIpDestAddr`) is matched when output of applying (bitwise AND) this value to IP destination address from IP packet.

14.1.3.4.1.11 wranIfBsProvClsfrRuleSrcPortStart

Start (inclusive) of range of source ports against which that packet will be compared.

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14.1.3.4.1.12 wranIfBsProvClsfrRuleSrcPortEnd

End (inclusive) of range of source ports against which that packet will be compared.

14.1.3.4.1.13 wranIfBsProvClsfrRuleDestPortStart

Start (inclusive) of range of destination ports against which that packet will be compared.

14.1.3.4.1.14 wranfBsProvClsfrRuleDestPortEnd

End (inclusive) of range of destination ports against which that packet will be compared.

14.1.3.4.1.15 wranIfBsProvClsfrRuleDestMacAddr

Destination MAC address to be matched against the destination MAC address in Ethernet header.

14.1.3.4.1.16 wranIfBsProvClsfrRuleDestMacAddrMask

MAC address mask. A destination MAC address (`wranIfBsProvClsfrRuleDestMacAddr`) is matched when the destination MAC address from Ethernet header is applied (bitwise AND) with this mask.

14.1.3.4.1.17 wranIfBsProvClsfrRuleSrcMacAddr

Source MAC address to be matched against the source MAC address in Ethernet header.

14.1.3.4.1.18 wranIfBsProvClsfrRuleSrcMacAddrMask

MAC address mask. A source MAC address (`wranIfBsProvClsfrRuleSrcMacAddr`) is matched when the source MAC address from Ethernet header is applied (bitwise AND) with this mask.

14.1.3.4.1.19 wranIfBsProvClsfrRuleEnetProtType

Identifier of layer 3 protocol type in an Ethernet frame. There are three types defined in Ethernet frame classification: no layer 3 protocol type in Ethernet frame, EtherType in DIX/SNAP based frames, and DSAP in IEEE 802.3 frames. If IEEE Std 802.1Q™ [B9] is supported, the EtherType value in the IEEE 802.1Q header is used.

14.1.3.4.1.20 wranIfBsProvClsfrRuleEnetProtocol

Ethernet protocol type value that is used for classification. When `wranIfBsProvClsfrRuleEnetProtType` is set to EtherType, the value of this object is matched against the 16-bit EtherType value in an Ethernet header or IEEE 802.1Q header (if IEEE Std 802.1Q [B9] is supported). When `wranIfBsProvClsfrRuleEnetProtType` is set to DSAP, then the DSAP byte in IEEE 802.3 frames is matched against the 8 LSBs of this object's value.

14.1.3.4.1.21 wranIfBsProvClsfrRuleUserPriLow

Low value (inclusive) in range of 3-bit user priority value. This field is part of 16 bit tag of an IEEE 802.1Q header. Only valid if IEEE Std 802.1Q [B9] is being used

14.1.3.4.1.22 wranIfBsProvClsfrRuleUserPriHigh

High value (inclusive) in range of 3-bit user priority value. This field is part of a 16 bit tag of an IEEE 802.1Q header. Only valid if IEEE Std 802.1Q [B9] is being used.

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14.1.3.4.1.23 wranIfBsProvClsfrRuleVlanId

VLAN Id from Ethernet frame. Only valid if IEEE Std 802.1Q [B9] is being used.

14.1.3.4.1.24 wranIfBsProvClsfrRuleIpv6FlowLabel

Flow label field from IPv6 header. The IPv6 Flow Label field is mapped to the 20 LSBs of this object, and the first 4 MSBs are set to 0.

14.1.3.4.1.25 wranIfBsProvClsfrRuleIpTypeOfService

The value to match the IP TOS octet from IP header. The 6 MSBs of the value contained in this object are read in as the DSCP (IETF RFC 2474 [B24]), and the 2 LSBs are ignored.

14.1.3.5 wranIfBsClassifierRuleTable

This MIB object provides a table to contain classification rules for service flows that are dynamically created/destroyed. There are multiple entries in this table, one for each classifier rule. Each entry is defined by `wranIfBsClassifierRuleEntry`.

14.1.3.5.1 wranIfBsClassifierRuleEntry

This object is a compound object that provides the definition of entries in `wranIfBsClassifierRuleTable`.

14.1.3.5.1.1 wranIfBsClsfrRuleIndex

Index to uniquely identify an entry in `wranIfBsClassiferRuleTable`.

14.1.3.5.1.2 wranIfBsClsfrRuleMap

A bitmap that indicates which classification parameters are included in the classification rule. A parameter exists in this rule if the corresponding bit is set to 1.

14.1.3.5.1.3 wranIfBsClsfrRulePriori

Priority of the classification rule. This determines the order in which classification rules are applied.

14.1.3.5.1.4 wranIfBsClsfrRuleIpProtocol

Value of IP Protocol field. For IPv6 headers, this refers to the next header entry in the last header of the IP header list. The value of this field follows the “Protocol Numbers” specification defined by IANA

14.1.3.5.1.5 wranIfBsClsfrRuleIpSrcAddrType

Type of IP address that Source IP address from IP header is.

14.1.3.5.1.6 wranIfBsClsfrRuleIpSrcAddr

Source IP address from IP header.

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14.1.3.5.1.7 wranIfBsClsfrRuleIpSrcMask

IP address mask. IP source address (`wranIfBsClsfrRuleIpSrcAddr`) is matched when output of applying (bitwise AND) this value to IP source address from IP packet.

14.1.3.5.1.8 wranIfBsClsfrRuleIpDestAddrType

Type of IP address that Destination IP address from IP header is.

14.1.3.5.1.9 wranIfBsClsfrRuleIpDestAddr

Destination IP address from IP header.

14.1.3.5.1.10 wranIfBsClsfrRuleIpDestMask

IP address mask. IP destination address (`wranIfBsClsfrRuleIpDestAddr`) is matched when output of applying (bitwise AND) this value to IP destination address from IP packet.

14.1.3.5.1.11 wranIfBsClsfrRuleSrcPortStart

Start (inclusive) of range of source ports against which that packet will be compared.

14.1.3.5.1.12 wranIfBsClsfrRuleSrcPortEnd

End (inclusive) of range of source ports against which that packet will be compared.

14.1.3.5.1.13 wranIfBsClsfrRuleDestPortStart

Start (inclusive) of range of destination ports against which that ~~that~~ packet will be compared.

14.1.3.5.1.14 wranIfBsClsfrRuleDestPortEnd

End (inclusive) of range of destination ports against which that packet will be compared

14.1.3.5.1.15 wranIfBsClsfrRuleDestMacAddr

Destination MAC address to be matched against the destination MAC address in Ethernet header.

14.1.3.5.1.16 wranIfBsClsfrRuleDestMacAddrMask

MAC address mask. A destination MAC address (`wranIfBsProvClsfrRuleDestMacAddr`) is matched when the destination MAC address from Ethernet header is applied (bitwise AND) with this mask.

14.1.3.5.1.17 wranIfBsClsfrRuleSrcMacAddr

Source MAC address to be matched against the source MAC address in Ethernet header.

14.1.3.5.1.18 wranIfBsClsfrRuleSrcMacAddrMask

MAC address mask. A source MAC address (`wranIfBsProvClsfrRuleSrcMacAddr`) is matched when the source MAC address from Ethernet header is applied (bitwise AND) with this mask.

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14.1.3.5.1.19 wranIfBsClsfrRuleEnetProtType

Identifier of layer 3 protocol type in an Ethernet frame. There are three types defined in Ethernet frame classification: no layer-3 protocol type in Ethernet frame, EtherType in DIX/SNAP based frames, DSAP in IEEE 802.3 frames. All are used in Ethernet frame classification. If IEEE Std 802.1Q [B9] is supported, the EtherType value in the IEEE 802.1Q header is used.

14.1.3.5.1.20 wranIfBsClsfrRuleEnetProtocol

Ethernet protocol type value that is used for classification. This value will be processed based on what is set in `wranIfBsClsfrRuleEnetProtType`.

14.1.3.5.1.21 wranIfBsClsfrRuleUserPriLow

Low value (inclusive) in range of 3-bit user priority value. This field is part of 16-bit tag of an IEEE 802.1Q header. Only valid if IEEE Std 802.1Q [B9] is being used.

14.1.3.5.1.22 wranIfBsClsfrRuleUserPriHigh

High value (inclusive) in range of 3-bit user priority value. This field is part of a 16 bit tag of an IEEE 802.1Q header. Only valid if IEEE Std 802.1Q [B9] is being used.

14.1.3.5.1.23 wranIfBsClsfrRuleVlanId

VLAN Id from Ethernet frame. Only valid if IEEE Std 802.1Q [B9] is being used.

14.1.3.5.1.24 wranIfBsClsfrRuleIpv6FlowLabel

Flow label field from IPv6 header.

14.1.3.5.1.25 wranIfBsClsfrRuleIpTypeOfService

The value to match the IP TOS octet from the IP header. The 6 MSBs are read in as the DSCP (IETF RFC 2474 [B24]).

14.1.3.6 wranIfBsSfTrapControl

Defines control elements for traps related to management of service flows. This is a 5-bit field that enables setting a trap for particular Service Flow events: `wranIfBsProvSfChange`, `wranIfBsScChange`, `wranIfBsActiveSfChange`, `wranIfBsProvClassifierRuleChange`, and `wranIfBsClassifierRuleChange`.

14.1.3.7 wranIfBsSfTrapDefinition

This object defines service flow management traps that can be enabled/disabled in `wranIfBsSfTrapControl`.

14.1.3.7.1 wranIfBsProvSfChangeTrap

This trap contains the information related to the status of provisioned service flows.

14.1.3.7.2 wranIfBsScChangeTrap

This trap contains the information related to the status of the configuration of service flow parameters.

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14.1.3.7.3 wranIfBsActiveSfChangeTrap

This trap contains the information related to the status of dynamic service flows.

14.1.3.7.4 wranIfBsProvClassifierRuleChangeTrap

This trap contains the information related to the status of classifier rules for provisioned service flows.

14.1.3.7.5 wranIfBsClassifierRuleChangeTrap

This trap contains the information related to the status of classifier rules for dynamic service flows.

14.1.3.7.6 wranIfBsSfNotificationObjectsTable

This MIB provides a table to track notification objects that have been reported by the traps related to the management of service flows. It is made up of one entry containing objects related to the most recent trap/even. The entry is defined by `wranIfBsNotificationObjectsEntry`.

14.1.3.7.7 wranIfBsSfNotificationObjectsEntry

This object defines an entry in `wranIfBsNotificationObjectsTable`.

14.1.3.7.7.1 wranIfBsSfNotificationIndex

Index of entry in the table (defaults to 1).

14.1.3.7.7.2 wranIfBsSfNotificationProvSfStatus

Status of provisioned service flow for which trap is enabled; see `wranIfBsProvSfStatus` (14.1.3.1.1.7).

14.1.3.7.7.3 wranIfBsSfNotificationProvEntryIndex

Index into `wranIfBsProvSfTable` that contains information on provisioned service that was recently modified.

14.1.3.7.7.4 wranIfBsSfNotificationScEntryIndex

Index into `wranIfBsScTable` that contains information on modified service flow parameters.

14.1.3.7.7.5 wranIfBsSfNotificationActiveSfIndex

Index into `wranIfBsActiveSfTable` that contains information on active service flows whose configuration has been updated.

14.1.3.7.7.6 wranIfBsSfNotificationActiveSfStatus

Current status of dynamic service flow; see `wranIfBsActiveSfStatus` (14.1.3.1.1.6).

14.1.3.7.7.7 wranIfBsSfNotificationProvClsfrRuleIndex

Index of entry in `wranIfBsProvClassifierRuleTable` that contains entry pertaining to a classifier rule for a provisioned service flow that was recently modified.

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14.1.3.7.7.8 wranIfBsSfNotificationProvClsfrRuleMap

Value of `wranIfBsProvClsfrRuleMap` that contains the configuration of which classifier rules are part of the classifier rule set of a provisioned service flow that was recently modified.

14.1.3.7.7.9 wranIfBsSfNotificationClsfrRuleIndex

Index of entry in `wranIfBsClassifierRuleTable` that contains entry pertaining to a classifier rule for a dynamic service flow that was recently modified.

14.1.3.7.7.10 wranIfBsSfNotificationProvClsfrRuleMap

Value of `wranIfBsClsfrRuleMap` that contains the configuration of which classifier rules are part of the classifier rule set of a dynamic service flow that was recently modified.

14.1.3.8 wranIfBsSfMibGroups

This object helps define which MIB groups are available within this module and which MIB objects are part of each group.

14.1.3.8.1 wranIfBsProvSfMibGroup

This group contains objects related to the configuration of provisioned service flows.

14.1.3.8.2 wranIfBsScMibGroup

This group contains objects related to the configuration of QoS parameters for provisioned and dynamic service flows.

14.1.3.8.3 wranIfBsActiveSfMibGroup

This group contains objects related to the configuration of dynamic service flows.

14.1.3.8.4 wranIfBsProvClassifierRuleMibGroup

This group contains objects related to the configuration of classifier rules for provisioned service flows.

14.1.3.8.5 wranIfBsClassifierRuleMibGroup

This group contains objects related to the configuration of classifier rules for dynamic service flows.

14.1.3.8.6 wranIfBsSfTrapControlGroup

This group contains objects related to enabling/disabling traps used for service flow management.

14.1.3.8.7 wranIfBsSfNotificationMibGroup

This group contains objects related to traps used for service flow management.

14.1.3.9 wranIfBsSfMibCompliance

MIB objects that are optional and mandatory for service flow management compliance.

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14.1.4 wranIfCpeMib

This MIB defines objects used for managing CPEs. It is broken up into the following subclauses:

- `wranIfCpeConfigurationTable`: Definition of system parameters, timers, and constants related to CPE operation.
- `wranIfCpeTrapControl`: Enabling/disabling of traps concerning events related to CPE operation.
- `wranIfCpeThresholdConfigTable`: Table containing configuration bounds for recording CPE events.
- `wranIfCpeTrapDefinition`s: Definition of traps and objects that can be reported by traps.
- `wranIfCpeNotificationObjectsTable`: Table containing information related to configured traps.

14.1.4.1 wranIfCpeConfigurationTable

This MIB provides a table that provides the values for system parameters. The parameters in this table are applied to all CPEs in the network; hence there is one entry in the table, defined by `wranIfCpeConfigurationEntry`.

14.1.4.1.1 wranIfCpeConfigurationEntry

This object is a compound object that provides the definition of the (single) entry into `wranIfCpeConfigurationTable`.

14.1.4.1.1.1 wranIfCpeConfigurationIndex

Index of entry in this table (defaults to 1).

14.1.4.1.1.2 wranIfCpeLostDsMapInterval

Amount of time since reception of last DS-MAP before DS synchronization is considered lost.

14.1.4.1.1.3 wranIfCpeLostUsMapInterval

Amount of time since reception of last US-MAP before US synchronization is considered lost.

14.1.4.1.1.4 wranIfCpeContentionRangingRetries

Maximum number of retries allowed for contention-based ranging.

14.1.4.1.1.5 wranIfCpeContentionBwRetries

Maximum number of retries allowed for contention-based bandwidth requests.

14.1.4.1.1.6 wranIfCpeRegReqRetries

Maximum number of retries allowed for registration requests.

14.1.4.1.1.7 wranIfCpeTftpBackoffStart

Initial backoff for TFTP Start.

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14.1.4.1.1.8 wranIfCpeTftpBackoffEnd

Last value for TFTP backoff.

14.1.4.1.1.9 wranIfCpeTftpReqRetries

Maximum number of retries allowed for attempting TFTP to get CPE configuration.

14.1.4.1.1.10 wranIfCpeTftpDownloadRetries

Maximum number of retries allowed for re-attempting TFTP (after a failed/corrupted download) to get CPE configuration.

14.1.4.1.1.11 wranIfCpeTftpWait

Time to wait before consecutive attempts to obtain configuration via TFTP.

14.1.4.1.1.12 wranIfCpeToDRetries

Maximum number of retries allowed for attempting to establish time of day.

14.1.4.1.1.13 wranIfCpeToDRetryPeriod

Amount of time to wait before retrying establishment of time of day after failed attempt.

14.1.4.1.1.14 wranIfCpeCBCReqRetries

Maximum number of retries allowed for sending CBC request.

14.1.4.1.1.15 wranIfCpeTftpCpltRetries

Maximum number of retries allowed for sending TFTP-CPLT message to BS.

14.1.4.1.1.16 wranIfCpeInvitedRangRetries

Maximum number of retries on invited ranging requests.

14.1.4.1.1.17 wranIfCpeDSxReqRetries

Maximum number of timeout retries on DSx-REQ.

14.1.4.1.1.18 wranIfCpeDSxRspRetries

Maximum number of timeout retries on DSx-RSP.

14.1.4.2 wranIfCpeTrapControl

Defines a control element for traps related to CPE operation. This MIB object is a bitmap that allows the following SNMP traps to be set for CPEs: `wranIfCpeDhcpSuccess`, `wranIfCpeRssiStatusChange`, `wranIfCpeEirpPerScStatusChange`, `wranIfCpeMaxEirpStatusChange`, and `wranIfCpeScmStateChange`.

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14.1.4.3 wranIfCpeThresholdConfigTable

This MIB provides a table that allows the setting of thresholds that can be used to detect the crossing of RSSI and EIRP thresholds. Each table is made up of one entry defined by `wranIfCpeThresholdConfigEntry`.

14.1.4.3.1 wranIfCpeThresholdConfigEntry

This object is a compound object that provides definition of entries into `wranIfCpeThresholdConfigTable`.

14.1.4.3.2 wranIfCpeThresholdConfigIndex

Index of entry in this table (defaults to 1).

14.1.4.3.2.1 wranIfCpeRssiLowThreshold

Low threshold for generating an RSSI alarm.

14.1.4.3.2.2 wranIfCpeRssiHighThreshold

High threshold for generating an RSSI alarm.

14.1.4.3.2.3 wranIfCpeEirpPerScLowThreshold

Low threshold for generating an EIRP per subcarrier alarm.

14.1.4.3.2.4 wranIfCpeEirpPerScHighThreshold

High threshold for generating an EIRP per subcarrier alarm.

14.1.4.3.2.5 wranIfCpeMaxEirpLowThreshold

Low threshold for generating a maximum EIRP (over all 60 subchannels) alarm.

14.1.4.3.2.6 wranIfCpeMaxEirpHighThreshold

High threshold for generating a maximum EIRP (over all 60 subchannels) alarm.

14.1.4.4 wranIfCpeTrapDefinition

This MIB group specifies the definition of CPE traps that can be enabled/disabled in `wranIfCpeTrapControl`.

14.1.4.4.1 wranIfCpeRssiStatusChangeTrap

This trap indicates that the RSSI is outside the range defined by `wranIfCpeRssiLowThreshold` and `wranIfCpeRssiHighThreshold`.

14.1.4.4.2 wranIfCpeEirpPerScStatusChangeTrap

This trap indicates that the EIRP per subcarrier is outside the range defined by `wranIfCpeEirpPerScLowThreshold` and `wranIfCpeEirpPerScHighThreshold`.

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14.1.4.4.3 wranIfCpeDhcpSuccessTrap

This trap indicates whether a specific CPE has been successful in acquiring an IP address via DHCP.

14.1.4.4.4 wranIfCpeScmStateChangeTrap

This trap indicates that the CPE has entered the Idle state of the SCM Authentication state machine.

14.1.4.4.5 wranIfCpeMaxEirpStatusChangeTrap

This trap indicates that the maximum EIRP per subcarrier is outside the range defined by `wranIfCpeMaxEirpLowThreshold` and `wranIfCpeMaxEirpHighThreshold`.

14.1.4.5 wranIfCpeNotificationObjectsTable

This MIB provides a table to track notification objects that have been reported by traps on a particular CPE. There is one entry in this table, defining the notification objects for that particular CPE. Each entry is defined by `wranIfCpeNotificationObjectsEntry`.

14.1.4.5.1 wranIfCpeNotificationObjectsEntry

This object is a compound object that contains the definition of an entry in `wranIfCpeNotificationObjectsTable`.

14.1.4.5.1.1 wranIfCpeNotificationObjectsEntryIndex

Index of entry in the table.

14.1.4.5.1.2 wranIfCpeNotificationMacAddress

MAC address of the CPE generating the trap.

14.1.4.5.1.3 wranIfCpeRssiStatus

An RSSI alarm is generated when RSSI is lower than `wranIfCpeRssiLowThreshold` or higher than `wranIfCpeRssiHighThreshold`. This alarm is generated when `wranIfCpeRssiStatusChange` in `wranIfCpeTrapControl` is set.

14.1.4.5.1.4 wranIfCpeEirpPerScStatus

An EIRP alarm is generated when EIRP is lower than `wranIfCpeEirpPerScLowThreshold` or higher than `wranIfCpeEirpPerScHighThreshold`. This alarm is generated when `wranIfCpeEirpPerScStatusChange` in `wranIfCpeTrapControl` is set.

14.1.4.5.1.5 wranIfCpeMaxEirpStatus

An EIRP alarm is generated when EIRP is lower than `wranIfCpeMaxEirpLowThreshold` or higher than `wranIfCpeMaxEirpHighThreshold`. This alarm is generated when `wranIfCpeMaxEirpStatusChange` in `wranIfCpeTrapControl` is set.

14.1.4.5.1.6 wranIfCpeDhcpStatus

An DHCP alarm is generated when CPE is able to obtain an IP address via DHCP. This alarm is generated when `wranIfCpeDhcpSuccess` in `wranIfCpeTrapControl` is set.

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14.1.4.5.1.7 wranIfCpeScmStatus

An SCM state alarm is generated when the CPE's authentication state machine changes state. This alarm is generated when `wranIfCpeScmStateChange` in `wranIfCpeTrapControl` is set.

14.1.4.6 wranIfCpeMibGroups

This object helps define which MIB groups are available in this module and which MIB objects are part of each group. Two groups are defined: `wranIfCpeMibConfigGroup` and `wranIfCpeMibNotificationsGroup`.

14.1.4.6.1 wranIfCpeMibConfigGroup

This group contains configuration objects for the CPE.

14.1.4.6.2 wranIfCpeTrapControlGroup

This group contains configuration objects related to enabling/disabling traps for the CPE.

14.1.4.6.3 wranIfCpeMibNotificationsGroup

This group contains CPE event notifications.

14.1.4.7 wranIfCpeMibCompliance

MIB objects that are optional and mandatory for CPE conformance.

14.1.5 wranIfSmMib

This MIB group deals with objects related to the configuration, operation, and monitoring of the SM. This MIB group is made up of the following objects:

- `wranIfSmConfigTable`: Definition of system parameters, timers, and constants related to SM operation.
- `wranIfSmPendingBlmReqTable`: Tracks the status of the execution of ongoing sensing requests (BLM-REQ).
- `wranIfSmBlmRepTable`: Tracks the status of ongoing reporting (BLM-REP) in response to sensing requests.
- `wranIfSmChClassificationStatusTable`: Tracks classification status of channels the SM is managing.
- `wranIfSmChannelSetTable`: Stores information related to the Occupied, Backup, and Local Priority Channel sets used by the SM.
- `wranIfSmCurrentStatusTable`: Tracks current state of the SM state machine.
- `wranIfSmRegTrackingTable`: Tracks the location of CPEs currently associated with the BS.
- `wranIfSmTrapControl`: Control element related to enabling/disabling of traps for the SM.
- `wranIfSmTrapDefinition`: Definition of traps that can be enabled/disabled in `wranIfSnTrapControl`.
- `wranIfSmNotificationObjectsTable`: Contains information related to most recent event raise by a trap.
- `wranIfSmMibGroups`: Definition of which MIB groups are available within this module and which MIB objects are a part of each group.

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— `wranIfSmMibCompliance`: Defines MIB objects that are optional and mandatory for SM compliance.

14.1.5.1 wranIfSmConfigTable

This MIB object represents a table that tracks what the default configuration of SM timers and constants. There is only one entry in this table, to define the default configuration of the SM. This entry is defined by wran`IfSmConfigEntry`.

14.1.5.1.1 wranIfSmConfigEntry

This object represents the entry in `wranIfSmConfigTable`.

14.1.5.1.1.1 wranIfSmConfigIndex

Index of entry in the table (defaults to 1).

14.1.5.1.1.2 wranIfSmT31

Wait for BLM-REP timeout.

14.1.5.1.1.3 wranIfSmChAvailabilityCheckTime

Time during which a TV channel shall be checked for the presence of licensed incumbent signals having a level above the incumbent detection threshold prior to commencement of WRAN operation in the channel, and in the case of TV, a related channel at an EIRP level that can affect the measured TV channel.

14.1.5.1.1.4 wranIfSmNonOccupancyPeriod

The required period during which WRAN device transmissions SHALL NOT occur in a given TV channel because of the detected presence of an incumbent signal in that channel above the Incumbent detection threshold, or in the case of TV, above a given EIRP level.

14.1.5.1.1.5 wranIfSmChannelDetectionTime

Maximum time taken by a WRAN device to detect a licensed incumbent signal above the Incumbent Detection Threshold within a given TV channel during normal WRAN operation.

14.1.5.1.1.6 wranIfSmChannelSetupTime

The window of time that may be taken by a WRAN CPE to transmit control information to a WRAN BS in order to establish operation with that BS at the prescribed power or, in the case of TV, at or below the allowable EIRP within a given TV channel.

14.1.5.1.1.7 wranIfSmChannelOpeningTxTime

The aggregate duration of control transmissions by WRAN devices during the Channel Setup Time that starts at the end of the Channel Availability Check Time.

14.1.5.1.1.8 wranIfSmChannelMoveTime

The time taken by WRAN system to cease all interfering transmissions on the current TV channel upon detection of a license incumbent signal above the relevant Incumbent Detection Threshold, or in the case of

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TV, to alternatively reduce its EIRP to that which is allowable within a given TV channel upon detection of a TV signal in the same or a related channel.

14.1.5.1.1.9 wranIfSmChannelClosingTxTime

The aggregate duration of control transmissions by the WRAN devices during the Channel Move/EIRP Reduction Time that starts upon detection of a licensed incumbent signal above the relevant Incumbent Detection Threshold.

14.1.5.1.1.10 wranIfSmMicProtectionRadius

Radius of contour within which the WRAN system cannot operate due to potential interference with the microphone.

14.1.5.1.1.11 wranIfSmT41

Maximum time interval allowed before sensing is performed on the candidate channel to determine that no incumbents are detected.

14.1.5.1.1.12 wranIfSmT42

Maximum time interval allowed before sensing is performed on the backup channel to determine that no incumbents are detected.

14.1.5.1.1.13 wranIfSmT43

Minimum time duration without detection of any incumbent for a candidate channel to transition to the backup channel.

14.1.5.1.1.14 wranIfSmT44

Maximum time to determine that the channel move information is successfully conveyed to all the associated CPEs and BS (self-coexistence mode).

14.1.5.1.1.15 wranIfSmT45

Maximum WRAN operation time without access to the incumbent database service.

14.1.5.1.1.16 wranIfSmT46

Waiting time before which the BS moves to the first backup channel. This is used to make sure that all the CPEs are ready to move to the backup channel before BS switches operation to this backup channel.

14.1.5.1.1.17 wranIfSmT59

Waiting time before which the CPE moves to its backup channels if it no longer hears from its BS. This is used to make sure that the CPE waits long enough after UCS Notification so that BS has had time to move to the backup channel, if it decided to do so.

14.1.5.1.1.18 wranIfSmT47

The prescribed time by the WRAN operator to refresh the incumbent database service.

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14.1.5.1.1.19 wranIfSmT48

Lapse timer keeps track of whether the Operating Channel N has been cleared using spectrum sensing

14.1.5.1.1.20 wranIfSmT49

Lapse timer keeps track of whether the Adjacent Channel N+1 has been cleared using spectrum sensing.

14.1.5.1.1.21 wranIfSmT50

Lapse timer keeps track of whether the Adjacent Channel N+1 has been cleared using spectrum sensing.

14.1.5.1.1.22 wranIfSmT51

Initiated when SSA loses contact with the SM.

14.1.5.1.1.23 wranIfSmT53

The parameter T_{INsens} is used to verify that in-band sensing has been done within the required In-service monitoring period. The T_{INsens} parameter is driven by regulatory domain requirements (Annex A).

14.1.5.1.1.24 wranIfSmT54

The parameter $T_{OUTsens}$ is used to verify that out-of-band sensing has been done within the required "Acquiring a channel monitoring period" specified in Annex A. This value would be used to initialize a lapse timer for each channel in the backup candidate channel list at each CPE so that it is compared to $T_{sensout}$.

14.1.5.1.1.25 wranIfSmT55

The T55 or T_{sensin} parameter corresponds to the maximum length of time required to carry out the sensing process on an in-band channel (see Figure 259). Manufacturers need to specify the sensing time required to detect the specified signals with required accuracy.

0.0.0.0.0.2 wranIfSmT60

The T60 or $T_{sensout}$ parameter corresponds to the maximum length of time required to carry out the out-of-band sensing process (see Figure 178). Manufacturers need to specify the sensing time required to detect the specified signals with required accuracy for out-of-band sensing.

14.1.5.2 wranIfSmPendingBlmReqTable

This MIB object represents a table that tracks the status of the execution of ongoing sensing requests (BLM-REQ). For each BLM-REQ there is a corresponding BLM-RSP to indicate that REQ message was received by the SSA. When an SSA is done with the sensing it will send a BLM-REP to the SM. This table keeps track of any BLM-REP messages that are pending transmission from the SSA. When a report is received a response is acknowledgement is sent to the SSA, and then the entry corresponding to the report and request will be cleared. This entry is defined by `wranIfSmPendingBlmReqEntry`.

14.1.5.2.1 wranIfSmPendingBlmReqEntry

This object represents the entry in `wranIfSmPendingBlmReqTable`.

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14.1.5.2.1.1 wranIfSmPendinBlmReqIndex

Index of entry in this table.

14.1.5.2.1.2 wranIfSsaPendingBlmReqTransactionId

Transaction ID of BLM-REQ.

14.1.5.2.1.3 wranIfSmPendingBlmReqMsgSize

Size of BLM-REQ message pending a report.

14.1.5.2.1.4 wranIfSmPendingBlmReqMsg

Contents of BLM-REQ message pending a report.

14.1.5.2.1.5 wranIfSmPendingBlmRspReceived

Indication of whether or not BLM-RSP pertaining to BLM-REQ has been received from SSA.

14.1.5.2.1.6 wranIfSmPendingBlmRspMulticastReceived

If BLM-REQ was multicast, indication of whether or not BLM-RSP pertaining to BLM-REQ has been received from each SSA (CPE) in the multicast group.

14.1.5.2.1.7 wranIfSmPendingBlmRepTimeout

Indication of current value of T31 set for this BLM-REP.

14.1.5.2.1.8 wranIfSmPendingBlmRepReceived

Indication of whether or not BLM-REP pertaining to BLM-REQ has been received from SSA.

14.1.5.2.1.9 wranIfSmPendingBlmRepMulticastReceived

If BLM-REQ was multicast, indication of whether or not BLM-REP pertaining to BLM-REQ has been received from each SSA (CPE) in the multicast group.

14.1.5.2.1.10 wranIfSsaPendingBlmRepAck

Indication of whether or not BLM-ACK, used to indicate sent to SSA(s) whether or not BLM-REP was received, is sent to SSA(s).

14.1.5.3 wranIfSmBlmRepTable

This object contains BLM-REP messages received in response to BLM-REQ; it is made up of multiple entries, one for each BLM-REP that pertains to a BLM-REQ. Each entry is defined by `wranIfSmBlmRepEntry`.

14.1.5.3.1 wranIfSmBlmRepEntry

This object represents the entry in `wranIfSmBlmRepTable`.

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14.1.5.3.1.1 wranIfSmBlmRepIndex

Index of entry in the table.

14.1.5.3.1.2 wranIfSmBlmRepSid

SID of CPE that sent the BLM-REP.

14.1.5.3.1.3 wranIfSmBlmRepTransactionId

Transaction ID of BLM-REP, it should match a transaction ID of an entry in `wranIfSmPendingBlmReqTable`.

14.1.5.3.1.4 wranIfSmBlmRepMsgSize

Size of BLM-REP msg.

14.1.5.3.1.5 wranIfSmBlmRepMsg

Contents of BLM-REP msg.

14.1.5.4 wranIfSmChClassificationStatusTable

This MIB object represents a table that the status for channels that the SM is managing. It is made up multiple entries, one for each channel, as defined in `wranIfSmChClassificationStatusEntry`.

14.1.5.4.1 wranIfSmChClassificationStatusEntry

This object represents the entry in `wranIfSmChClassificationStatusTable`.

14.1.5.4.1.1 wranIfSmChClassificationIndex

Index of entry in this table.

14.1.5.4.1.2 wranIfSmManagedChannel

Channel number of channel being managed.

14.1.5.4.1.3 wranIfSmManagedChannelStatus

The state of the channel as set by the states in the Channel Set Transition Diagram (Figure 245) or disallowed state (if channel is in IPC-UPD).

14.1.5.4.1.4 wranIfSmManagedChannelRecentEvent

Most recent event (see 11.2.3.1) that dictated a transition to the current state.

14.1.5.5 wranIfSmChannelSetTable

This MIB object represents a table that stores information related to the contents of the Occupied, Backup, and Local Priority Channel sets used by the SM (see 11.2.3.2). There is one entry in this table defined by `wranIfSmChannelSetEntry`.

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14.1.5.5.1 wranIfSmChannelSetEntry

This object defines an entry in `wranIfSmChannelSetTable`. There is only one entry in this table.

14.1.5.5.1.1 wranIfSmChannelSetIndex

Index of entry in the table (defaults to 1).

14.1.5.5.1.2 wranIfSmSizeWranOccupiedChannelSet

Number of channels in Neighbor WRAN Backup Channel Set.

14.1.5.5.1.3 wranIfSmWranOccupiedChannelSet

Vector of channels of length 8 bits × `wranIfSmSizeNghbrWranBackupChannelSet` that indicates the channels that occupy the Neighbor WRAN Backup Channel Set used by the Spectrum Etiquette procedure (see 9.2).

14.1.5.5.1.4 wranIfSmSizeNghbVrWranBackupChannelSet

Number of channels in Neighbor WRAN Backup Channel Set.

14.1.5.5.1.5 wranIfSmNghbrWranBackupChannelSet

Vector of channels of length 8 bits × `wranIfSmSizeNghbrWranBackupChannelSet` that indicates the channels that occupy the Neighbor WRAN Backup Channel Set used by the Spectrum Etiquette procedure (see 9.2).

14.1.5.5.1.6 wranIfSmSizeLocalPrioritySet1

Number of channels in Local Priority Set 1.

14.1.5.5.1.7 wranIfSmLocalPrioritySet1

Vector of channels of length 8 bits × `wranIfSmSizeLocalPrioritySet1` that indicate the channels that occupy the Local Priority Set 1 used by Spectrum Etiquette procedure (see 11.2.3.2).

14.1.5.5.1.8 wranIfSmSizeLocalPrioritySet2

Number of channels in Local Priority Set 2.

14.1.5.5.1.9 wranIfSmLocalPrioritySet2

Vector of channels of length 8 bits × `wranIfSmSizeLocalPrioritySet2` that indicate the channels that occupy the Local Priority Set 2 used by Spectrum Etiquette procedure (see 11.2.3.2).

14.1.5.5.1.10 wranIfSmSizeLocalPrioritySet3

Number of channels in Local Priority Set 3, should be the same size as `wranIfSmSizeWranOccupiedChannelSet`.

14.1.5.5.1.11 wranIfSmLocalPrioritySet3

Vector of channels of length 8 bits × `wranIfSmSizeLocalPrioritySet3` that indicate the channels

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that occupy the Local Priority Set 3 used by Spectrum Etiquette procedure (see 11.2.3.2). Should contain the same channel set as `wranIfSmWranOccupiedChannelSet`.

14.1.5.6 wranIfSmCurrentStatusTable

This MIB object represents a table that the records the current status of the SM. This includes the state the SM is in, the event that triggered a move into that state, as well as the current state of any relevant timers. There is one entry in this table defined in `wranIfSmCurrentStatusEntry`.

14.1.5.6.1 wranIfSmCurrentStatusEntry

This object represents the entry in `wranIfSmCurrentStatusTable`.

14.1.5.6.1.1 wranIfSmCurrentStatusIndex

Index of entry in the table.

14.1.5.6.1.2 wranIfSmCurrentState

The state (see Figure 247) that the SM is in.

14.1.5.6.1.3 wranIfSmRecentEvent

Recent event that triggered a transition into the current state as given in11.2.6.1.

14.1.5.6.1.4 wranIfSmRecentAction

Recent action that was taken when transitioning into the current state as given in 11.2.6.1.

14.1.5.6.1.5 wranIfSmInitiateChannelMove

Current value of ‘Initiate_Channel_Move’ flag.

14.1.5.6.1.6 wranIfSmSelfCoexistenceMode

Current value of ‘Self_Coexistence_Mode’ flag.

14.1.5.6.1.7 wranIfSmCurrentOperatingChannel

Current operating channel.

14.1.5.6.1.8 wranIfSmRecentSignalType

Type of signal recently detected (see Table 321).

14.1.5.6.1.9 wranIfSmCurrentT47

Current value of T47.

14.1.5.6.1.10 wranIfSmCurrentT46

Current value of T46.

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14.1.5.7 wranIfSmRegTrackingTable

This MIB object represents a table that records the SM's monitoring of CPE's associated with the BS. It contains the location data string and current value of T30 for each CPE. There are multiple entries in this table (one for each CPE) defined in `wranIfSmRegTrackingEntry`.

14.1.5.7.1 wranIfSmRegTrackingEntry

This object represents the entry in `wranIfSmRegTrackingTable`.

14.1.5.7.1.1 wranIfSmRegTrackingIndex

Index of entry in the table.

14.1.5.7.1.2 wranIfSmRegTrackingCpeSid

SID of CPE currently associated with BS.

14.1.5.7.1.3 wranIfSmRegTrackingCurrentT30

Current value of CPE's T30, as known by SM.

14.1.5.7.1.4 wranIfSmRegTrackingLocStringSize

Size of the location string in octets.

14.1.5.7.1.5 wranIfSmRegTrackingLocString

CPE's location string.

14.1.5.8 wranIfSmTrapControl

Defines control elements for traps related to the operation of the SM. This is a 9-bit field that enables setting a trap for particular SM events: `wranIfSmBlmReqChange`, `wranIfSmBlmRepChange`, `wranIfSmOccupiedChannelSetChange`, `wranIfSmNghbrBackupChannelSetChange`, `wranIfSmLocalPrioritySet1Change`, `wranIfSmLocalPriority2Change`, `wranIfSmLocalPriority3Change`, `wranIfSmCurrentStatusChange`, and `wranIfSmRegTrackingChange`.

14.1.5.9 wranIfSmTrapDefinition

This MIB group specifies the definition of traps that can be enabled/disabled in `wranIfSnTrapControl`.

14.1.5.9.1 wranIfSmBlmReqChangeTrap

This trap contains the information related to a BLM-REQ that is pending in the SM.

14.1.5.9.2 wranIfSmBlmRepChangeTrap

This trap contains the information related to a BLM-REP that is received by the SM.

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14.1.5.9.3 wranIfSmOccupiedChannelSetChangeTrap

This trap contains the information related to the current state of the Occupied Channel Set in the SM.

14.1.5.9.4 wranIfSmNghbrBackupChannelSetChangeTrap

This trap contains the information related to the current state of the Neighbor WRAN Backup Channel Set in the SM.

14.1.5.9.5 wranIfSmLocalPrioritySet1ChangeTrap

This trap contains the information related to the current state of the Local Priority Set 1 in the SM.

14.1.5.9.6 wranIfSmLocalPrioritySet2ChangeTrap

This trap contains the information related to the current state of the Local Priority Set 2 in the SM.

14.1.5.9.7 wranIfSmLocalPrioritySet3ChangeTrap

This trap contains the information related to the current state of the Local Priority Set 3 in the SM.

14.1.5.9.8 wranIfSmCurrentStatusChangeTrap

This trap contains the information related to the current state the SM is in.

14.1.5.9.9 wranIfSmRegTrackingChangeTrap

This trap contains the information related to tracking the location of CPEs within the purview of the BS.

14.1.5.10 wranIfSmNotificationObjectsTable

This MIB provides a table to track notification objects that have been reported by traps related to the operation of the SM. It is made up of one entry containing the objects related to the most recent trap/event. The entry is defined by `wranIfSmNotificationObjectsEntry`.

14.1.5.10.1 wranIfSmNotificationObjectsEntry

This object defines an entry in `wranIfSmNotificationObjectsTable`.

14.1.5.10.1.1 wranIfSmNotificationObjectsEntryIndex

Index of entry in the table.

14.1.5.10.1.2 wranIfSmNotificationSid

SID of station generating trap. `wranIfNotificationSid` set == 0 is reserved for traps dealing with channel set management (see `wranIfSmOccupiedChannelSetChangeTrap`, `wranIfSmNghbrBackupChannelSetChangeTrap`, `wranIfSmLocalPrioritySet1ChangeTrap`, `wranIfSmLocalPrioritySet2ChangeTrap`, `wranIfSmLocalPrioritySet3ChangeTrap`) and the current state of the SM (see `wranIfSmCurrentStatusChangeTrap`). `wranIfNotificationSid` set == 1..511 when dealing with traps for bulk measurement (see `wranIfSmBlmReqChangeTrap`, `wranIfSmBlmRepChangeTrap`) or CPE registration tracking (see `wranIfSmRegTackingChangeTrap`).

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14.1.5.10.1.3 wranIfSmNotificationBlmTransactionId

The transaction ID of the bulk measurement transaction. Only pertinent when `wranIfSmBlmReqChangeTrap` or `wranIfSmBlmRepChangeTrap` is enabled.

14.1.5.10.1.4 wranIfSmNotificationSizeOccupiedChannelSet

Size of the current/new WRAN Occupied Channel Set. Only pertinent when `wranIfSmOccupiedChannelSetChangeTrap` is enabled.

14.1.5.10.1.5 wranIfSmNotificationOccupiedChannelSet

The current/new contents of the WRAN Occupied Channel Set. Only pertinent when `wranIfSmOccupiedChannelSetChangeTrap` is enabled.

14.1.5.10.1.6 wranIfSmNotificationSizeBackupChannelSet

Size of the current/new Neighbor WRAN Backup Channel Set. Only pertinent when `wranIfSmNghbrBackupChannelSetChangeTrap` is enabled.

14.1.5.10.1.7 wranIfSmNotificationBackupChannelSet

The current/new contents of the Neighbor WRAN Backup Channel Set. Only pertinent when `wranIfSmNghbrBackupChannelSetChangeTrap` is enabled.

14.1.5.10.1.8 wranIfSmNotificationSizeLocalPrioritySet1

Size of the current/new Local Priority Set 1. Only pertinent when `wranIfSmLocalPrioritySet1ChangeTrap` is enabled.

14.1.5.10.1.9 wranIfSmNotificationLocalPrioritySet1

The current/new contents of the Local Priority Set 1. Only pertinent when `wranIfSmLocalPrioritySet1ChangeTrap` is enabled.

14.1.5.10.1.10 wranIfSmNotificationSizeLocalPrioritySet2

Size of the current/new Local Priority Set 2. Only pertinent when `wranIfSmLocalPrioritySet2ChangeTrap` is enabled.

14.1.5.10.1.11 wranIfSmNotificationLocalPrioritySet2

The current/new contents of the Local Priority Set 2. Only pertinent when `wranIfSmLocalPrioritySet2ChangeTrap` is enabled.

14.1.5.10.1.12 wranIfSmNotificationSizeLocalPrioritySet3

Size of the current/new Local Priority Set 3. Only pertinent when `wranIfSmLocalPrioritySet3ChangeTrap` is enabled.

14.1.5.10.1.13 wranIfSmNotificationLocalPrioritySet3

The current/new contents of the Local Priority Set 3. Only pertinent when `wranIfSmLocalPrioritySet3ChangeTrap` is enabled.

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14.1.5.10.1.14 wranIfSmNotificationRecentAction

Value of `wranIfSmRecentAction` that triggered transition to current state of SM. Only pertinent when `wranIfSmCurrentStatusChangeTrap` is enabled.

14.1.5.10.1.15 wranIfSmPendingBlmReqStatus

Indicates BLM-RSP pertaining to bulk measurement transaction (defined by `wranIfSmNotificationBlmTransactionId`) was received from `wranIfSmNotificationSid`, if `wranIfSmNotificationSid` is a unicast SID, or if all BLM-RSP received from members of the multicast group identified by `wranIfSmNotificationSid`.

14.1.5.10.1.16 wranIfSmBlmRepStatus

Indicates whether BLM-ACK has been sent, pertaining to BLM-REP received in bulk measurement transaction defined by `wranIfSmNotificationBlmTransactionId`.

14.1.5.10.1.17 wranIfSmOccupiedChannelSetStatus

Indication of whether channels have been added or removed when the WRAN Occupied Channel Set is modified.

14.1.5.10.1.18 wranIfSmNghbrBackupChannelSetStatus

Indication of whether channels have been added or removed when the Neighbor WRAN Backup Channel Set is modified.

14.1.5.10.1.19 wranIfSmLocalPrioritySet1Status

Indication of whether channels have been added or removed when the Local Priority Set 1 is modified.

14.1.5.10.1.20 wranIfSmLocalPrioritySet2Status

Indication of whether channels have been added or removed when the Local Priority Set 2 is modified.

14.1.5.10.1.21 wranIfSmLocalPrioritySet3Status

Indication of whether channels have been added or removed when the Local Priority Set 3 is modified.

14.1.5.10.1.22 wranIfSmCurrentStateStatus

Bitmap indicating current value of Initiate_Channel_Move flag, value of Self_Coexistence_Mode flag, whether operating channel assignment has been changed, whether recently detected signal was properly classified (i.e., not found to be == undetermined), whether T47 expired, and whether T46 has expired.

14.1.5.11 wranIfSmMibGroups

This object helps define which MIB groups are available within this module and which MIB objects are a part of each group.

14.1.5.11.1 wranIfSmConfigGroup

This group contains objects related to configuration of the SM.

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14.1.5.11.2 wranIfSmPendingBlmReqGroup

This group contains objects related to tracking pending BLM-REQs.

14.1.5.11.3 wranIfSmBlmReqGroup

This group contains objects related to tracking received BLM-REPs.

14.1.5.11.4 wranIfSmChClassificationGroup

This group contains objects used to track how channels the SM is managing have been classified.

14.1.5.11.5 wranIfSmChannelSetGroup

This group contains objects used to track the various channel sets with which the SM operates.

14.1.5.11.6 wranIfSmCurrentStatusGroup

This group contains objects used to track the current state of the SM.

14.1.5.11.7 wranIfSmRegTrackingGroup

This group contains objects the SM uses to keep track of the location of registered CPEs.

14.1.5.11.8 wranIfSmTrapControlGroup

This group contains objects related to enabling/disabling traps related to SM operation.

14.1.5.11.9 wranIfSmNotificationsGroup

This group contains notification objects related to traps configured for the SM.

14.1.5.12 wranIfSmMibCompliance

Defines MIB objects that are optional and mandatory for SM compliance.

14.1.6 wranIfSsaMib

This MIB group deals with objects related to the configuration, operation, and monitoring of the Spectrum Automaton.

The automaton needs to be told what needs to be sensed in the given regulatory domain. This can be done through the MIB referring to the regulatory domain information from Annex A. The CPE also need to be told which type of incumbent requires urgent, less urgent, and non-urgent reporting to the BS (see Table A.7). The background sensing done by the automaton shall be done under the MIB guidance.

This MIB group is made up of the following objects:

- `wranIfSsaSensingCapTable`: Definition of SSA sensing capabilities.
- `wranIfSsaStatusTable`: Tracks the status of the SSA state machine.
- `wranIfSsaConfigTable`: Defines the default configuration of SSA timers and constants.
- `wranIfSsaPendingBlmRepTable`: Tracks the status of ongoing sensing reporting (BLM-REP) the SSA has been assigned.

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— `wranIfSsaSensingRecordTable`: Tracks status of sensing on each channel.
— `wranIfSsaSsfMode0OutputTable`: Tracks output of Mode 0 sensing by SSF.
— `wranIfSsaSsfMode1OutputTable`: Tracks output of Mode 1 sensing by SSF.
— `wranIfSsaSsfMode2OutputTable`: Tracks output of Mode 2 sensing by SSF.
— `wranIfSsaSsfWiMicMSFTable`: Tracks output of wireless microphone beacon sensing by SSF.
— `wranIfSsaGeolocationTable`: Tracks calculation of parameters used in geolocation functions.
— `wranIfSsaTrapControl`: Defines control element to enable/disable traps related to SSA.
— `wranIfSsaTrapDefinition`: Definition of traps that can be enabled for SSA monitoring.
— `wranIfSsaNotificationObjectsTable`: Tracks notification objects reported by SSA traps.
— `wranIfSsaMibGroups`: Defines MIB groups associated with this module.
— `wranIfSsaMibCompliance`: Defines MIB objects that are optional and mandatory for SSA compliance.

14.1.6.1 wranIfSsaSensingCapTable

This MIB object represents a table that stores the current sensing capabilities for an SSA under control of the SM. There is one entry in this table for an SSA, defined by `wranIfSsaSensingCapEntry`. This MIB is stored at the BS and CPE. These values are also stored in `wranIfBsCpeRegCapabilityRspTable` (14.1.2.2.) at the BS, in an entry specific to this CPE.

14.1.6.1.1 wranIfSsaSensingCapEntry

This object represents the entry that stores a CPE's sensing capabilities.

14.1.6.1.1.1 wranIfSsaSensingCapIndex

Index of entry in this table (defaults to 1).

14.1.6.1.1.2 wranIfSsaSensingThreshold

This object is the recommended sensing threshold that the CPE is capable of supporting. It is in units of dBm, encoded in a single, integer byte value that is assumed to be negative (e.g., 0x01 = –1 dBm, 0 x 72 = –114 dBm).

14.1.6.1.1.3 wranIfSsaSensRecContigPeriodDuration

This object is the recommended contiguous sensing period duration that the CPE is capable of supporting. It is in integer, in units of symbols. This value ranges from 0 to 1023, and is encoded in a 2-octet length value.

14.1.6.1.1.4 wranIfSsaSensRecNumPeriods

This object is the recommended number of sensing periods that a CPE can support. It is an integer value, encoded in 1-octet length value.

14.1.6.1.1.5 wranIfSsaSensRecPeriodInterval

This object is the recommended interval between sensing periods that a CPE can support. It is an integer value, in units of frames. It is encoded in a 2-octet length value.

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14.1.6.2 wranIfSsaStatusTable

This MIB object represents a table that tracks what the current state the SSA is in. There is only one entry in this table, to define the current state of the SSA, as well as any parameters of interest for current SSA procedures. This entry is defined by `wranIfSsaStatusEntry`.

14.1.6.2.1 wranIfSsaStatusEntry

This object represents the entry in `wranIfSsaStatusTable`.

14.1.6.2.1.1 wranIfSsaStatusIndex

Index of entry in the table (defaults to 1).

14.1.6.2.1.2 wranIfSsaCurrentState

The current state of the SSA is in either “SSA In-band Sensing” or “SSA Out-of-band Sensing” (see 11.3.1, Figure 257).

14.1.6.2.1.3 wranIfSsaRecentEvent

The recent event that caused entry into the current state (see 11.3.1, Figure 257).

14.1.6.2.1.4 wranIfSsaRecentAction

The recent action, triggered by recent event, that was undertaken while entering into the current state (see 11.3.1, Figure 257).

14.1.6.2.1.5 wranIfSsaIpcUpdChannelsSize

Number of channels in `wranIfSsaIpcUpdChannels`.

14.1.6.2.1.6 wranIfSsaIpcUpdChannels

Contents of most recent IPC-UPD message received from SM.

14.1.6.2.1.7 wranIfSsaCurrentT48

Current value of T48 at the SSA in 0.1 s increments from 0 to 60 s.

14.1.6.2.1.8 wranIfSsaCurrentT49

Current value of T49 at the SSA in 0.1 s increments from 0 to 60 s.

14.1.6.2.1.9 wranIfSsaCurrentT50

Current value of T50 at the SSA in 0.1 s increments from 0 to 60 s.

14.1.6.2.1.10 wranIfSsaIntraFrameQpCycleLength

Obtained from CHQ-REQ or SCH. Specified in number of superframes, it indicates the spacing between the superframes for which the intra-frame quiet period specification is valid. For example, if this field is set to 1, the Quiet Period Cycle repeats every superframe; if it is set to 2, the Quiet Period Cycle repeats every

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2 superframes, etc. When = 0, no intra-frame quiet period is scheduled or the current intra-frame quiet period is canceled

14.1.6.2.1.11 wranIfSsaIntraFrameQpCycleOffset

Obtained from CHQ-REQ or SCH. Valid only if intra-frame Sensing Cycle Length > 0. Used for in-band intra-frame sensing. Specified in number of superframes, it indicates the offset from this SCH transmission to the beginning of the first superframe in the current intra-frame sensing cycle.

14.1.6.2.1.12 wranIfSsaIntraFrameQpCycleFrameBitmap

Obtained from CHQ-REQ or SCH. Valid only if Intra-frame Quiet Period Cycle Length > 0. Valid for each superframe identified by the Intra-frame Quiet Period Cycle Length, each bit in the bitmap corresponds to one frame within the superframe. If the bit is set to 0, no intra-frame quiet period shall be scheduled in the corresponding frame. If the bit is set to 1, an intra-frame quiet period shall be scheduled within the corresponding frame for the duration specified by Intra-frame Quiet period Duration.

14.1.6.2.1.13 wranIfSsaIntraFrameQpDuration

Obtained from CHQ-REQ or SCH. Valid only if Intra-frame Quiet Period Cycle Length > 0. If this field is set to a value different from 0 (zero): it indicates the number of symbols starting from the end of the frame during which no transmission shall take place.

14.1.6.2.1.14 wranIfSsaInterFrameQpDuration

Obtained from CHQ-REQ or SCH. Used for in-band inter-frame sensing, it indicates the duration of the next scheduled quiet period. When > 0, it indicates the number of frames starting from Inter-frame Quiet Period Offset that shall be used to perform inter-frame sensing. When == 0, it cancels the next scheduled quiet period for inter-frame sensing or indicates that no inter-frame sensing are currently scheduled.

14.1.6.2.1.15 wranIfSsaInterFrameQpOffset

Obtained from CHQ-REQ or SCH. Used for in-band inter-frame sensing, it indicates the time span between the transmission of this information and the next scheduled quiet period for inter-frame sensing. Bit 11–4: index the superframe number. Bit 3–0: index the frame number when the next scheduled quiet period for inter-frame sensing will start.

14.1.6.3 wranIfSsaConfigTable

This MIB object represents a table that tracks what the default configuration of SSA timers and constants. There is only one entry in this table, to define the default configuration of the SSA. This entry is defined by `wranIfSsaConfigEntry`.

14.1.6.3.1 wranIfSsaConfigEntry

This object represents the entry in `wranIfSsaConfigTable`.

14.1.6.3.1.1 wranIfSsaConfigIndex

Index of entry in this table.

14.1.6.3.1.2 wranIfSsaT19

Time DS-channel remains unusable.

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14.1.6.3.1.3 wranIfSsaT29

Wait for BLM-ACK timeout.

14.1.6.3.1.4 wranIfSsaMaxBlmRepRetries

Maximum number of retry attempts allowed for sending BLM-REP.

14.1.6.3.1.5 wranIfSsaChAvailabilityCheckTime

Time during which a TV channel shall be checked for the presence of licensed incumbent signals having a level above the incumbent detection threshold prior to commencement of WRAN operation in the channel and, in the case of TV, a related channel at an EIRP level that can affect the measured TV channel.

14.1.6.3.1.6 wranIfSsaNonOccupancyPeriod

The required period during which WRAN device transmissions SHALL NOT occur in a given TV channel because of the detected presence of an incumbent signal in that channel above the incumbent detection threshold or, in the case of TV, above a given EIRP level.

14.1.6.3.1.7 wranIfSsaChannelDetectionTime

Maximum time taken by a WRAN device to detect a licensed incumbent signal above the incumbent detection threshold within a given TV channel during normal WRAN operation.

14.1.6.3.1.8 wranIfSsaChannelSetupTime

The window of time that may be taken by a WRAN CPE to transmit control information to a WRAN BS in order to establish operation with that BS at the prescribed power or, in the case of TV, at or below the allowable EIRP within a given TV channel.

14.1.6.3.1.9 wranIfSsaChannelOpeningTxTime

The aggregate duration of control transmissions by WRAN devices during the Channel Setup Time, which starts at the end of the Channel Availability Check Time.

14.1.6.3.1.10 wranIfSsaChannelMoveTime

The time taken by WRAN system to cease all interfering transmissions on the current TV channel upon detection of a license incumbent signal above the relevant incumbent detection threshold or, in the case of TV, to alternatively reduces its EIRP to which is allowable within a given TV channel upon detection of a TV signal in the same or a related channel.

14.1.6.3.1.11 wranIfSsaChannelClosingTxTime

The aggregate duration of control transmissions by the WRAN devices during the Channel Move/EIRP Reduction Time, which starts upon detection of a licensed incumbent signal above the relevant incumbent detection threshold.

14.1.6.3.1.12 wranIfSsaMicProtectionRadius

Radius of contour within which the WRAN system cannot operate due to potential interference with the microphone.

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14.1.6.3.1.13 wranIfSsaT41

Maximum time interval allowed before sensing is performed on the candidate channel to determine that no incumbents are detected.

14.1.6.3.1.14 wranIfSsaT42

Maximum time interval allowed before sensing is performed on the candidate channel to determine that no incumbents are detected.

14.1.6.3.1.15 wranIfSsaT43

Minimum time duration without detection of any incumbent for a candidate channel to transition to the backup channel.

14.1.6.3.1.16 wranIfSsaT44

Maximum time to determine that the channel move information is successfully conveyed to all the associated CPEs and BS (self-coexistence mode).

14.1.6.3.1.17 wranIfSsaT45

Maximum WRAN operation time without access to the incumbent database service.

14.1.6.3.1.18 wranIfSsaT59

Waiting time before which the CPE moves to its backup channels if it no longer hears from its BS. This is used to make sure that the CPE waits long enough after UCS notification so that BS has had time to move to the backup channel, if it decided to do so.

14.1.6.3.1.19 wranIfSsaT47

The prescribed time by the WRAN operator to refresh the incumbent database service.

14.1.6.3.1.20 wranIfSsaT48

Lapse timer keeps track of whether the Operating Channel N has been cleared using spectrum sensing.

14.1.6.3.1.21 wranIfSsaT49

Lapse timer keeps track of whether the Adjacent Channel N–1 has been cleared using spectrum sensing.

14.1.6.3.1.22 wranIfSsaT50

Lapse timer keeps track of whether the Adjacent Channel N+1 has been cleared using spectrum sensing.

14.1.6.3.1.23 wranIfSsaT51

Initiated when SSA loses contact with the SM.

14.1.6.3.1.24 wranIfSsaT53

The parameter T_{INsens} is used to verify that in-band sensing has been done within the required in-service

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monitoring period. The T_{INsens} parameter is driven by regulatory domain requirements (Annex A).

14.1.6.3.1.25 wranIfSsaT54

The parameter $T_{OUTsens}$ is used to verify that out-of-band sensing has been done within the required "Acquiring a channel monitoring period" specified in Annex A. This value would be used to initialize a lapse timer for each channel in the backup candidate channel list at each CPE so that it compared to $T_{sensout}$.

14.1.6.3.1.26 wranIfSsaT55

The T55 or T_{sensin} parameter corresponds to the maximum length of time required to carry out the in-band sensing process (see Figure 259). Manufacturers need to specify the sensing time required to detect the specified signals with required accuracy for in-band sensing.

14.1.6.3.1.27 wranIfSsaT60

The T60 or $T_{sensout}$ parameter corresponds to the maximum length of time required to carry out the out-of-band sensing process (see Figure 259). Manufacturers need to specify the sensing time required to detect the specified signals with required accuracy for out-of-band sensing.

14.1.6.4 wranIfSsaPendingBlmRepTable

This MIB object represents a table that tracks the status of the execution of ongoing reporting (BLM-REP) in response to BLM-REQs. For each BLM-REQ there is a corresponding BLM-RSP to indicate that REQ message was received by the SSA. When an SSA is done with the sensing, it will send a BLM-REP to the SM. This table keeps track of any BLM-REP messages that are pending acknowledgement from the SM. When a report sent in a response is acknowledged, then the entry corresponding to the report and request will be cleared. This entry is defined by `wranIfSsaPendingBlmRepEntry`.

14.1.6.4.1 wranIfSsaPendingBlmRepEntry

This object represents the entry in `wranIfSsaPendingBlmRepTable`.

14.1.6.4.1.1 wranIfSsaPendingBlmReqIndex

Index of entry in this table.

14.1.6.4.1.2 wranIfSsaPendingBlmReqTransactionId

Transaction ID for pending BLM-REQ.

14.1.6.4.1.3 wranIfSsaPendingBlmReqMsgSize

Size of BLM-REQ message stored in `wranIfSsaPendingBlmReqMsg`.

14.1.6.4.1.4 wranIfSsaPendingBlmReqMsg

Contents of pending BLM-REQ message.

14.1.6.4.1.5 wranIfSsaPendingBlmRspSent

Indication of whether or not BLM-RSP pertaining to BLM-REQ has been sent.

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14.1.6.4.1.6 wranIfSsaPendingBlmRepGenerated

Indication of whether or not BLM-REP corresponding to BLM-REQ has been generated, i.e., sensing has been executed.

14.1.6.4.1.7 wranIfSsaPendingBlmRepMsgSize

Size of BLM-REP message stored in `wranIfSsaPendingBlmRepMsg`.

14.1.6.4.1.8 wranIfSsaPendingBlmRepMsg

Contents of BLM-REP message that corresponds to the BLM-REQ.

14.1.6.4.1.9 wranIfSsaPendingBlmRepSent

Indication of whether or not BLM-REP pertaining to BLM-REQ has been sent.

14.1.6.4.1.10 wranIfSsaPendingBlmRepAck

Indication of whether BLM-ACK has been sent to acknowledge all transmitters of BLM-REP messages pertaining to BLM-REQ that was issued.

14.1.6.4.1.11 wranIfSsaPendingBlmRepNumTx

Current number of times that BLM-REP has been resent.

14.1.6.5 wranIfSsaSensingRecordTable

This object contains information the sensing status of each channel. It is made of multiple entries, one for each channel, as defined by `wranIfSsaSensingRecordEntry`.

14.1.6.5.1 wranIfSsaSensingRecordEntry

This object represents the entry in `wranIfSsaSensingRecordTable`.

14.1.6.5.1.1 wranIfSsaSensingRecordIndex

Index of entry in the table.

14.1.6.5.1.2 wranIfSsaSensingChannel

Channel that sensing has been conducted on, or not conducted on if in IPC-UPD.

14.1.6.5.1.3 wranIfSsaTimeLastSensing

Last time that this channel was sensed.

14.1.6.5.1.4 wranIfSsaTimeLastPositive

Last time that signal was positively confirmed on this channel.

14.1.6.5.1.5 wranIfSsaSensingPathRssi

RSSI on sensing path.

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14.1.6.5.1.6 wranIfSsaWranPathRssi

RSSI on WRAN sensing path.

14.1.6.5.1.7 wranIfSsaSignalType

Type of signal that was sensed on the channel.

14.1.6.5.1.8 wranIfSsaWranServiceAdvertisement

If signal type was for WRAN, this indicates the BS ID of the captured SCH from neighbor WRAN.

14.1.6.5.1.9 wranIfSsaIdcUpdIndication

Indication if channel is on IPC-UPD.

14.1.6.6 wranIfSsaSsfMode0OutputTable

This object contains the current output of SSF Mode 0 sensing. It is made up of multiple entries, one for each signal type that was sensed. Each entry is defined by `wranIfSsaSsfMode0OutputEntry`.

14.1.6.6.1 wranIfSsaSsfMode0OutputEntry

This object represents the entry in `wranIfSsaSsfMode0OutputTable`.

14.1.6.6.1.1 wranIfSsaSsfMode0OutputIndex

Index of entry in the table.

14.1.6.6.1.2 wranIfSsaSsfMode0SignalType

Type of signal that was to be sensed.

14.1.6.6.1.3 wranIfSsaSsfMode0SignalPresent

Indication of whether or not a signal of signal type was detected.

14.1.6.7 wranIfSsaSsfMode1OutputTable

This object contains the current output of SSF Mode 1 sensing. It is made up of multiple entries, one for each signal type that was sensed. Each entry is defined by `wranIfSsaSsfMode1OutputEntry`.

14.1.6.7.1 wranIfSsaSsfMode1OutputEntry

This object represents the entry in `wranIfSsaSsfMode1OutputTable`.

14.1.6.7.1.1 wranIfSsaSsfMode1OutputIndex

Index of entry in table.

14.1.6.7.1.2 wranIfSsaSsfMode1SignalType

Type of signal that was to be sensed.

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14.1.6.7.1.3 wranIfSsaSsfMode1SignalPresent

Indication of whether or not a signal of signal type was detected.

14.1.6.7.1.4 wranIfSsaSsfMode1SignalConfidence

Confidence level in signal present decision, where 0x00 represents no confidence and 0xFF represents total confidence (see).

14.1.6.8 wranIfSsaSsfMode2OutputTable

This object contains the current output of SSF Mode 2 sensing. It is made up of multiple entries, one for each signal type that was sensed. Each entry is defined by `wranIfSsaSsfMode2OutputEntry`.

14.1.6.8.1 wranIfSsaSsfMode2OutputEntry

This object represents the entry in `wranIfSsaSsfMode2OutputTable`.

14.1.6.8.1.1 wranIfSsaSsfMode2OutputIndex

Index of entry in the table.

14.1.6.8.1.2 wranIfSsaSsfMode2SignalType

Type of signal that was to be sensed.

14.1.6.8.1.3 wranIfSsaSsfMode2SignalRssiMean

Mean of RSSI signal measurements.

14.1.6.8.1.4 wranIfSsaSsfMode2SignalStdDevRssi

Standard Deviation of RSSI signal measurements.

14.1.6.9 wranIfSsaSsfWiMicMSFTable

This object contains the current output payload of MSF1, MSF1+MSF2, or MSF1+MSF2+MSF3 of an IEEE 802.22.1 beacon on recently sensed channels. It is made up of multiple entries for each channel on which one or more MSFs have been. Each entry is defined by `wranIfSsaSsfWiMicMSFEntry`.

14.1.6.9.1 wranIfSsaSsfWiMicMSFEntry

This object represents the entry in `wranIfSsaSsfWiMicMSFTable`.

14.1.6.9.1.1 wranIfSsaSsfWiMicMSFIndex

An index to an entry in this table.

14.1.6.9.1.2 wranIfSsaSsfWiMicMSFChannel

Channel number on which the wireless microphone beacon was captured.

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14.1.6.9.1.3 wranIfSsaSsfWiMicMSFPayloadSize

Size of MSF payload stored in `wranIfSsaSsfWiMicMSFPayload`. Indicates whether MSF1 by itself (17 octets), MSF1+MSF2 (68 octets), or MSF1+MSF2+MSF3 (101 octets) have been captured (see Figure 16, 7.2.1, 7.2.2, and 7.2.3 of IEEE Std 802.22.1-2010). This size does not reflect CRC1/CRC2/CRC3 from the MSFs.

14.1.6.9.2 wranIfSsaSsfWiMicMSFPayload

Payload of MSF1, MSF1+MSF2, or MSF1+MSF2+MSF3, not including the CRC1/CRC2/CRC3 field (see 7.2.1, 7.2.2, and 7.2.3 of IEEE Std 802.22.1-2010).

14.1.6.9.2.1 wranIfSsaSsfWiMicMSFCrc1Status

Indication of whether or not MSF1 passed verification of CRC1.

14.1.6.9.2.2 wranIfSsaSsfWiMicMSFCrc2Status

Indication of whether MSF2 passed verification of CRC2.

14.1.6.9.2.3 wranIfSsaSsfWiMicMSFCrc3Status

Indication of whether MSF3 passed verification of CRC3.

14.1.6.10 wranIfSsaGeolocationTable

This object contains the current parameters and calculations being used by the geolocation component of the SSA. It is made up of one entry to contain current values being used/calculated in the BS-to-CPE fine ranging, CPE-to-CPE fine ranging, and geolocation calculation functions. It is made up of one entry, defined by `wranIfSsaGeolocationEntry`.

14.1.6.10.1 wranIfSsaGeolocationEntry

This object represents the entry in `wranIfSsaGeolocationTable`.

14.1.6.10.1.1 wranIfSsaGeolocationIndex

Index of entry in the table.

14.1.6.10.1.2 wranIfSsaGeolocationVernier1Size

Size of Vernier_1 data recorded only at the CPE.

14.1.6.10.1.3 wranIfSsaGeolocationVernier1

Vernier_1, recorded only at the CPE.

14.1.6.10.1.4 wranIfSsaGeolocationVernier2Size

Size of Vernier_2 data recorded only at the BS.

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14.1.6.10.1.5 wranIfSsaGeolocationVernier2

$Vernier_2$, recorded only at the BS.

14.1.6.10.1.6 wranIfSsaGeolocationVernier3Size

Size of $Vernier_3$ data recorded only at the CPE.

14.1.6.10.1.7 wranIfSsaGeolocationVernier3

$Vernier_3$, recorded only at the CPE.

14.1.6.10.1.8 wranIfSsaGeolocationTRange1

T_{Range1}, also known as T52. Set by BS when downstream bust leaves the BS, i.e., at start of frame preamble.

14.1.6.10.1.9 wranIfSsaGeolocationTACbp

TA_{CBP}, Timing advance for CBP burst used in ranging calculations.

14.1.6.11 wranIfSsaTrapControl

Defines control elements for traps related to interaction with the SSA. This is 9-bit field that enables setting a trap for particular CPE events: `wranIfSsaSensingCpaChange`, `wranIfSsaStatusChange`, `wranIfSsaBlmRepChange`, `wranIfSsaSensingRecordChange`, `wranIfSsaSsfMode0Change`, `wranIfSsaSsfMode1Change`, `wranIfSsaSsfMode2Change`, `wranIfSsaSsfWiMicChange`, and `wranIfSsaGeolocationChange`.

14.1.6.12 wranIfSsaTrapDefinition

This MIB group specifies the definition of traps that can be enabled/disabled in `wranIfSsaTrapControl`.

14.1.6.12.1 wranIfSsaSensingCapChangeTrap

This trap contains information related to the configuration of SSA sensing capabilities.

14.1.6.12.2 wranIfSsaStatusChangeTrap

This traps contains information related to current state of the SSA.

14.1.6.12.3 wranIfSsaBlmRepChangeTrap

This trap contains information related to pending BLM transactions at the SSA.

14.1.6.12.4 wranIfSsaSensingRecordChangeTrap

This trap contains information related to sensing records maintained by the SSA.

14.1.6.12.5 wranIfSsaSsfMode0ChangeTrap

This trap contains information related to sensing output using Mode 0.

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14.1.6.12.6 wranIfSsaSsfMode1ChangeTrap

This trap contains information related to sensing output using Mode 1.

14.1.6.12.7 wranIfSsaSsfMode2ChangeTrap

This trap contains information related to sensing output using Mode 2.

14.1.6.12.8 wranIfSsaSsfWiMicMSFChangeTrap

This trap contains information related to sensing and capturing wireless microphone beacons (see IEEE Std 802.22.1-2010).

14.1.6.12.9 wranIfSsaGeolocationChangeTrap

This trap contains information related to terrestrial geolocation.

14.1.6.13 wranIfSsaNotificationObjectsTable

This MIB provides a table to track notification objects that have been reported by the traps related to operation of the SSA. It is made up of one entry, containing the objects related to the most recent trap/event. The entry is defined by `wranIfSsaNotificationObjectsEntry`.

14.1.6.13.1 wranIfSsaNotificationObjectsEntry

Definition of an entry in `wranIfSsaNotificationObjectsTable`. Each entry is defined by `wranIfSsaNotificationIndex`.

14.1.6.13.1.1 wranIfSsaNotificationIndex

Index of entry in the table.

14.1.6.13.1.2 wranIfSsaNotificationCurrentState

Current state that SSA is in as defined by current value of `wranIfSsaCurrentState`.

14.1.6.13.1.3 wranIfSsaNotificationRecentEvent

Recent event that occurred for SSA as defined by current value of `wranIfSsaRecentEvent`.

14.1.6.13.1.4 wranIfSsaNotificationRecentAction

Recent action SSA has taken as defined by current value of `wranIfSsaRecentAction`.

14.1.6.13.1.5 wranIfSsaNotificationPendingBlmRepIndex

Index of entry in `wranIfSsaPendingBlmRepTable` that indicates the handling of which pending BLM-REP has triggered a trap.

14.1.6.13.1.6 wranIfSsaNotificationSensingRecordIndex

Index of entry in `wranIfSsaSensingRecordTable` that indicates the handling of which sensing record has triggered a trap.

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14.1.6.13.1.7 wranIfSsaSsfNotificationMode0OutputIndex

Index of entry in `wranIfSsaSsfMode0OutputTable` that indicates the handling of which signal type detected by Mode 0 triggered a trap.

14.1.6.13.1.8 wranIfSsaSsfNotificationMode1OutputIndex

Index of entry in `wranIfSsaSsfMode1OutputTable` that indicates the handling of which signal type detected by Mode 1 triggered a trap.

14.1.6.13.1.9 wranIfSsaSsfNotificationMode1Confidence

Confidence value of entry indexed by `wranIfSsaSsfNotificationMode1OutputIndex` in `wranIfSsaSsafMode1OutputTable` that indicates handling of which signal type detected by Mode 1 triggered a trap.

14.1.6.13.1.10 wranIfSsaSsfNotificationMode2OutputIndex

Index of entry in `wranIfSsaSsfMode2OutputTable` that indicates the handling of which signal type detected by Mode 2 triggered a trap.

14.1.6.13.1.11 wranIfSsaSsfNotificationMode2SignalRssiMean

Current Mean of RSSI signal measurements, between –104 dBm to +23.5 dBm in 0.5 dB steps, for which a trap was caught.

14.1.6.13.1.12 wranIfSsaSsfNotificationMode2SignalStdDevRssi

Current Standard Deviation of RSSI signal measurements, between –104 dBm to +23.5 dBm in 0.5 dB steps, for which a trap was caught.

14.1.6.13.1.13 wranIfSsaNotificationWiMicMSFIndex

Index of entry in `wranIfSsaSsfWiMicMSFTable` that indicates the handling of which channel the capture of a wireless microphone beacon MSF has triggered a trap.

14.1.6.13.1.14 wranIfSsaSensingCapabilityStatus

The 8-bit bitmap that indicates changes to the sensing capabilities defined in `wranIfSsaSensingCapTable`.

14.1.6.13.1.15 wranIfSsaStatus

Concerning the current state of the SSA, this 10-bit bitmap indicates whether what type of change to SSA state occurred to trigger the trap.

14.1.6.13.1.16 wranIfSsaBlmRepStatus

Concerning the current state of pending BLM-REQ messages, this object indicates how far along in the sensing and report generation process is the SSA.

14.1.6.13.1.17 wranIfSsaSensingRecordStatus

A 5-bit bitmap concerning the update of an entry in `wranIfSsaSensingRecordTable`.

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14.1.6.13.1.18 wranIfSsaSsfMode0Status

Whether a specific signal type is present or not present using Mode 0 sensing.

14.1.6.13.1.19 wranIfSsaSsfMode1Status

Whether a specific signal type is present or not present using Mode 1 sensing.

14.1.6.13.1.20 wranIfSsaSsfMode2Status

Whether the mean or standard deviation RSSI for a detected signal has changed.

14.1.6.13.1.21 wranIfSsaSsfWiMicMSFStatus

Indication of how much wireless microphone beacon payload has been received and decoded on a given channel.

14.1.6.13.1.22 wranIfSsaGeolocationStatus

Indication of which geolocation parameters have been updated.

14.1.6.14 wranIfSsaMibGroups

This object helps define which MIB groups are available within this module and which MIB objects are part of each group.

14.1.6.14.1 wranIfSsaSensingCapGroup

This group represents objects related to the sensing capabilities supported by the SSA.

14.1.6.14.2 wranIfSsaStatusGroup

This group represents objects related to the current state of the SSA.

14.1.6.14.3 wranIfSsaConfigGroup

This group represents objects related to the configuration of the SSA.

14.1.6.14.4 wranIfSsaPendingBlmRepGroup

This group represents objects related to the pending BLM transactions and sensing reports (BLM-REP) that are to be generated.

14.1.6.14.5 wranIfSsaSensingRecordGroup

This group represents objects related to the sensing status of each channel.

14.1.6.14.6 wranIfSsaSsfMode0OutputGroup

This group represents objects related to output of Mode 0 sensing.

14.1.6.14.7 wranIfSsaSsfMode1OutputGroup

This group represents objects related to output of Mode 1 sensing.

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14.1.6.14.8 wranIfSsaSsfMode2OutputGroup

This group represents objects related to output of Mode 2 sensing.

14.1.6.14.9 wranIfSsaSsfWiMicMSFGroup

This group contains objects related to the detection of wireless microphone beacons as defined by IEEE Std 802.22.1-2010.

14.1.6.14.10 wranIfSsaGeolocationGroup

This group contains objects related to geolocation function of the SSA.

14.1.6.14.11 wranIfSsaTrapControlGroup

This group contains objects related to enabling/disabling traps on the SSA.

14.1.6.14.12 wranIfSsaNotificationsGroup

This group contains objects related to traps that are configured for the SSA.

14.1.6.15 wranIfSsaMibCompliance

MIB objects that are optional and mandatory for SSA compliance.

14.1.7 wranIfDatabaseServiceMib

This MIB group deals with objects related to the configuration of access to, as well as the interaction with, the database service. This group is made up of the following objects:

- `wranIfBsMgmtInfoTable`: Stores information on BS's management interface the database service can access.
- `wranIfBsDeviceEnlistmentTable`: Stores information regarding devices for which BS has attempted registration with database service.
- `wranIfDbsChannelIndicationTable`: Stores information on channels indicated as available by database service.
- `wranIfDbsAccessTable`: Stores access information for database service(s) that are available.
- `wranIfDbsTrapControl`: Enables/Disables recording of traps regarding database service access and interaction.
- `wranIfDbsTrapDefinition`: Defines traps related to database service access and interaction.
- `wranIfDbsNotificationObjectsTable`: Stores notification objects related to most recent trap.
- `wranIfDbsMibGroups`: Definition of MIB groups associated with this module.
- `wranIfDbsMibCompliance`: Definition of which MIB groups are mandatory or optional for compliance.

14.1.7.1 wranIfBsMgmtInfoTable

This object stores information regarding information on the BS management interface the DBS can access. It is made up of one entry, defined by `wranIfBsMgmtInfoEntry`.

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14.1.7.1.1 wranIfBsMgmtInfoEntry

This object defines an entry in `wranIfBsMgmtInfoTable`.

14.1.7.1.1.1 wranIfBsMgmtInfoIndex

Index of entry in the table (defaults to 0).

14.1.7.1.1.2 wranIfBsSizeMgmtUrl

Size of BS Management URL (see 15.2.1.3).

14.1.7.1.1.3 wranIfBsMgmtUrl

BS Management URL (see 15.2.1.3).

14.1.7.1.1.4 wranIfBsSizeMgmtDeviceId

Size of BS FCC Device ID (see 15.2.1.3).

14.1.7.1.1.5 wranIfBsMgmtDeviceId

BS FCC Device ID (see 15.2.1.3).

14.1.7.1.1.6 wranIfBsSizeMgmtSn

Size of BS serial number (see 15.2.1.3).

14.1.7.1.1.7 wranIfBsMgmtSn

BS serial number (see 15.2.1.3).

14.1.7.1.1.8 wranIfBsSizeMgmtLocation

Size of Location data string of BS (see 15.2.1.3).

14.1.7.1.1.9 wranIfBsMgmtLocation

Location data string of BS.

14.1.7.1.1.10 wranIfBsMgmtAntennaHeight

Antenna height at the BS (see 15.2.1.3).

14.1.7.1.1.11 wranIfBsSizeMgmtContactName

Size of Contact Name for person(s) who has ownership of the BS (see 15.2.1.3).

14.1.7.1.1.12 wranIfBsMgmtContactName

Contact Name for person(s) who has ownership of the BS (see 15.2.1.3).

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14.1.7.1.1.13 wranIfBsSizeMgmtContactPhysAddress

Size of Physical address for the owner of the BS (see 15.2.1.3).

14.1.7.1.1.14 wranIfBsMgmtContactPhysAddress

Physical address for contacting the owner of the BS (see 15.2.1.3).

14.1.7.1.1.15 wranIfBsSizeMgmtEmailAddress

Size of E-mail address for the owner of the BS (see 15.2.1.3).

14.1.7.1.1.16 wranIfBsMgmtEmailAddress

E-mail address for contacting the owner of the BS (seesee 15.2.1.3).

14.1.7.1.1.17 wranIfBsSizeMgmtPhoneNumber

Size of Telephone number for the owner of the BS (see 15.2.1.3).

14.1.7.1.1.18 wranIfBsMgmtPhoneNumber

Telephone number for contacting the owner of the BS (see 15.2.1.3).

14.1.7.1.1.19 wranIfBsSizeAccessUrl

Size of BS Access Service URL (see 15.2.1.3).

14.1.7.1.1.20 wranIfBsAccessUrl

BS Access Service URL (see 15.2.1.3).

14.1.7.2 wranIfDbsDeviceEnlistmentTable

This object stores information regarding information on devices entering the network that the BS has attempted to enlist/register with the database service. It is made up of multiple entries, each defined by `wranIfDbsDeviceEnlistmentEntry`.

14.1.7.2.1 wranIfDbsDeviceEnlistmentEntry

This object defines an entry in `wranIfDbsDeviceEnlistmentTable`.

14.1.7.2.1.1 wranIfDbsDeviceEnlistmentIndex

Index of entry in the table.

14.1.7.2.1.2 wranIfDbsDeviceEnlistmentConfirmed

Has this enlistment been confirmed via receipt of M-DB-ENLISTMENT-CONFIRMATION (see 15.2.1.3.4) from the database service?

14.1.7.2.1.3 wranIfDbsConfirmedDeviceType

Type of device being registered, fixed BS, fixed CPE, personal/portable.

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14.1.7.2.1.4 wranIfDbsSizeConfirmedDeviceId

Size of Device ID of device that is being enlisted/registered with the database service.

14.1.7.2.1.5 wranIfDbsConfirmedDeviceId

Device ID for the device that is being enlisted/registered with the database service.

14.1.7.2.1.6 wranIfDbsSizeConfirmedDeviceSn

Size of Serial number of device that is being enlisted/registered with the database service.

14.1.7.2.1.7 wranIfDbsConfirmedDeviceSn

Serial number of the device that is being enlisted/registered with the database service.

14.1.7.2.1.8 wranIfDbsSizeConfirmedDeviceLocation

Size of location string of device requesting enlistment.

14.1.7.2.1.9 wranIfDbsConfirmedDeviceLocation

Location string of the device requesting enlistment.

14.1.7.2.1.10 wranIfDbsSizeProxyDeviceId

Device ID of proxy device BS may use to send queries to the database.

14.1.7.2.1.11 wranIfDbsProxyDeviceId

Device ID of proxy device BS may use to send queries to the database.

14.1.7.2.1.12 wranIfDbsSizeProxySn

Size of Serial number of proxy device BS may use to send queries to the database.

14.1.7.2.1.13 wranIfDbsProxySn

Serial number of proxy device BS may use to send queries to the database.

14.1.7.2.1.14 wranIfDbsSizeRespPartyName

Name of party responsible for device enlistment/registration.

14.1.7.2.1.15 wranIfDbsRespPartyName

Name of the party responsible for the device enlistment/registration.

14.1.7.2.1.16 wranIfDbsConfirmedDeviceAntennaHeight

Antenna height of the device being enlisted.

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14.1.7.2.1.17 wranIfDbsSizeConfirmedDeviceContactName

Size of Contact Name for person(s) who has ownership of the device; only pertinent if device type is fixed BS or CPE.

14.1.7.2.1.18 wranIfDbsConfirmedDeviceContactName

Contact Name for person(s) who has ownership of the device; only pertinent ~~o~~if device type is fixed BS or CPE.

14.1.7.2.1.19 wranIfDbsSizeConfirmedDeviceContactPhysAddress

Size of Physical address for the owner of the device; only pertinent if device type is fixed BS or CPE.

14.1.7.2.1.20 wranIfDbsConfirmedDeviceContactPhysAddress

Antenna height of the device being enlisted.

14.1.7.2.1.21 wranIfDbsSizeConfirmedDeviceEmailAddress

Size of E-mail address for the owner of the device; only pertinent if device type is fixed BS or CPE.

14.1.7.2.1.22 wranIfDbsConfirmedDeviceEmailAddress

E-mail address for contacting the owner of the BS; the only pertinent device types are fixed BS and fixed CPE.

14.1.7.2.1.23 wranIfDbsSizeConfirmedDevicePhoneNumber

Size of Telephone number for the owner of the device; only pertinent if device type is fixed BS or CPE.

14.1.7.2.1.24 wranIfDbsConfirmedDevicePhoneNumber

Telephone number for contacting the owner of the BS, the only pertinent device types are fixed BS and fixed CPE.

14.1.7.2.1.25 wranIfDbsConfirmedDeviceAntennaInformation

Antenna information of device; only applicable if transmission of antenna information is supported by the database service.

14.1.7.2.1.26 wranIfDbsConfirmedDeviceAntennaAzimuth

Antenna azimuth of device; only applicable if transmission of antenna information is supported by the database service.

14.1.7.2.1.27 wranIfDbsConfirmedDeviceConfirmationMsgTime

Timestamp of transmission for M-DB-ENLISTMENT-REQUEST.

14.1.7.3 wranIfDbsChannelIndicationTable

This object stores information on what channels have been indicated (upon receipt of M-DB-AVAILABLE-CHANNEL-INDICATION) as available and their EIRP limit at a given location for a particular device. It is

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made up of multiple entries, one each for the tuple of location||channel||EIRP||DeviceID. Each entry is defined by `wranIfDbsChannelIndicationEntry`.

14.1.7.3.1 wranIfDbsChannelIndicationEntry

Compound object that defines an entry in `wranIfDbsChannelIndicationTable`.

14.1.7.3.1.1 wranIfDbsChannelIndicationIndex

Index of entry in this table.

14.1.7.3.1.2 wranIfDbsSizeDeviceId

Size of Device ID of device for which channel is indicated as available.

14.1.7.3.1.3 wranIfDbsDeviceId

Device ID of device for which the channel is indicated as available.

14.1.7.3.1.4 wranIfDbsSizeDeviceSn

Size of Serial number of device for which channel is indicated as available.

14.1.7.3.1.5 wranIfDbsDeviceSn

Serial number of device for which the channel is indicated as available.

14.1.7.3.1.6 wranIfDbsDeviceChannelNumber

Channel number for which availability is indicated.

14.1.7.3.1.7 wranIfDbsDeviceMaxAllowedEirp

Maximum allowed EIRP on the channel.

14.1.7.3.1.8 wranIfDbsSizeDeviceLocation

Size of Location string of device requesting for which channel availability is indicated.

14.1.7.3.1.9 wranIfDbsDeviceLocation

Location string of device requesting that the channel availability is indicated.

14.1.7.3.1.10 wranIfDbsDeviceDbsIndex

Index of entry in `wranIfDbsAccessTable` that corresponds to the database service that provided this channel indication.

14.1.7.4 wranIfDbsAccessTable

This object stores information regarding access information for accessing a database service. There is more than one entry in this table, one for each database service that is available. Each entry is defined by `wranIfDbsAccessEntry`.

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14.1.7.4.1 wranIfDbsAccessEntry

A compound object that stores entries in `wranIfDbsAccessTable`.

14.1.7.4.1.1 wranIfDbsAccessEntryIndex

Index of entry in this table.

14.1.7.4.1.2 wranIfDbsSizeAccessUrl

Size of URL used to access database service.

14.1.7.4.1.3 wranIfDbsAccessUrl

URL used to access database service.

14.1.7.4.1.4 wranIfDbsAccessCredentialType

Indication of the type of credential to be used when authenticating access and transfer of information to the database service.

14.1.7.4.1.5 wranIfDbsSizeAccessCertCredential

Size of Certificate Credential BS or proxy device uses to authenticate access to the database; only pertinent when `wranIfDbsAccessCredentialType` is set to certificate.

14.1.7.4.1.6 wranIfDbsAccessCertCredential

Certificate Credential BS or proxy device used to authenticate access to the database; only pertinent when `wranIfDbsAccessCredentialType` is set to certificate.

14.1.7.4.1.7 wranIfDbsSizeAccessUserID

Size of login User ID used for accessing the database service; only pertinent when `wranIfDbsAccessCredentialType` is set to userID and password.

14.1.7.4.1.8 wranIfDbsAccessUserID

Login User ID used for accessing the database service; only pertinent when `wranIfDbsAccessCredentialType` is set to userID and password.

14.1.7.4.1.9 wranIfDbsSizeAccessPassword

Size of login password (or hash of password) used for accessing the database service; only pertinent when `wranIfDbsAccessCredentialType` is set to userID and password.

14.1.7.4.1.10 wranIfDbsAccessPassword

Login password (or hash of password) used for accessing the database service; only pertinent when `wranIfDbsAccessCredentialType` is set to userID and password.

14.1.7.4.1.11 wranIfDbsAccessLastTxTime

Time indication of the last transmission of a message to the database service.

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14.1.7.4.1.12 wranIfDbsAccessLastRxTime

Time indication of the last reception of a message from the database service.

14.1.7.4.1.13 wranIfDbsAccessAntennaInfoRequired

Indication of whether or not antenna info is required to be transmitted to database service.

14.1.7.4.1.14 wranIfDbsAccessPriority

Priority of database service. Higher priority means that a particular database service will be preferred when device enlistment and channel indication requests need to be made.

14.1.7.5 wranIfDbsTrapControl

Defines control elements for traps related to interaction with the database service. This is 3-bit field that enables setting a trap for particular CPE events: `wranIfDbsAvailabilityChange`, `wranIfDbsEnlistmentChange`, and `wranIfDbsChannelIndicationChange`.

14.1.7.6 wranIfDbsTrapDefinition

This MIB group specifies the definition of traps that can be enabled/disable in `wranIfDbsTrapControl`.

14.1.7.6.1 wranIfDbsAvailabilityChangeTrap

This trap contains information related to the last time a particular database service was accessed.

14.1.7.6.2 wranIfDbsEnlistmentChangeTrap

This traps contains information regarding the status of enlistment confirmation for a particular device in the network.

14.1.7.6.3 wranIfDbsChannelIndicationChangeTrap

This trap contains information regarding the status of channel indication responses from the database service.

14.1.7.7 wranIfDbsNotificationObjectsTable

This MIB provides a table to track notification objects that have been reported by the traps related to access to the database. It is made up of one entry containing the objects related to the most recent trap/event. The entry is defined by `wranIfDbsNotificationObjectsEntry`.

14.1.7.7.1 wranIfDbsNotificationObjectsEntry

Definition of an entry in `wranIfDbsNotificationObjectsTable`. Each entry is identified by `wranIfNotificationDeviceId`.

14.1.7.7.1.1 wranIfDbsNotificationObjectsEntryIndex

Index of entry in the table.

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14.1.7.7.1.2 wranIfDbsNotificationSizeDeviceId

Size of Device ID of the device for which trap status information is stored.

14.1.7.7.1.3 wranIfDbsNotificationDeviceId

Device ID of the device for which trap status information is stored.

14.1.7.7.1.4 wranIfDbsNotificationSizeDeviceSn

Size of Serial Number of the device for which trap status information is stored.

14.1.7.7.1.5 wranIfDbsNotificationDeviceSn

Serial Number of the device for which trap status information is stored.

14.1.7.7.1.6 wranIfDbsNotificationDbsSizeAccessUrl

Size of Access URL of database service with which device enlistment of channel indication query was exchanged.

14.1.7.7.1.7 wranIfDbsNotificationDbsAccessUrl

Access URL of database service with which device enlistment of channel indication query was exchanged.

14.1.7.7.1.8 wranIfDbsAccessStatus

Indication of whether a message is transmitted or received from database service.

14.1.7.7.1.9 wranIfDbsConfirmedDeviceStatus

Indication of whether the enlistment of the device has been successfully completed.

14.1.7.7.1.10 wranIfDbsChannelIndicationStatus

Indication of whether channels have been indicated as available for the device in question.

14.1.7.8 wranIfDbsMibGroups

This object helps define which MIB groups are available within this module and which MIB objects are part of each group.

14.1.7.8.1 wranIfDbsMgmtGroup

This group contains configuration objects related to the management interface on the BS that the database service can access.

14.1.7.8.2 wranIfDbsEnlistmentGroup

This group contains configuration objects related to enlistment of devices.

14.1.7.8.3 wranIfDbsChannelIndicationGroup

This group contains configuration objects related to indication of available channels.

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14.1.7.8.4 wranIfDbsAccessGroup

This group contains configuration objects related to current accessibility of the database service.

14.1.7.8.5 wranIfDbsTrapControlGroup

This group contains configuration objects related to enabling/disabling traps related to the accessibility of the database service.

14.1.7.8.6 wranIfDbsNotificationsGroup

This group contains notification objects related to traps configured for access to the database service.

14.1.7.9 wranIfDbsMibCompliance

Defines MIB objects that are optional and mandatory for database service.

14.1.8 wranIfABsMib

This MIB represents MIB functionality related to A-BS operation only. It is based on the FCAPS reference model, but is limited to the following items: *Fault*, *Configuration*, and *Performance*. The following list defines MIBs that compose `wranIfABsMib`:

- `wranIfABsFm`: Fault management
- `wranIfABsCm`: Configuration management
- `wranIfABsPm`: Performance management/measurement

14.1.8.1 wranIfABsFm

Exceptions and fault events can be reported by using the traps defined in this MIB. wranIfBsFm is made up of the following MIBs: `wranIfABsTrapControl`, `wranIfABsTrapDefinition`, `wranIfABsNotificationObjectsTable`, `wranIfABsFmMibGroups`, and `wranIfABsFmMibCompliance`.

14.1.8.1.1 wranIfABsTrapControl

This MIB is a bitmap that is used to enable/disable the following A-BS traps: `wranIfABsGroupResourceAllocationNotification`, `wranIfABsMultiChannelConfigNotification`, `wranIfABsRelayCpeConfigNotification`, and `wranIfABsTwoLinkArqNotification`. Enabling of a trap, indicates that the trap will be recorded in `wranIfABsNotificationObjectsTable`.

14.1.8.1.2 wranIfABsTrapDefinition

This object defines A-BS related traps for related to configuration and performance management.

14.1.8.1.2.1 wranIfABsGroupResourceAllocationTrap

This trap contains information related to the updating of group configurations used for group resource allocation.

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14.1.8.1.2.2 wranIfABsMultiChannelConfigTrap

This trap contains information related to the updating of CHU/CAM configurations used for multi-channel operation.

14.1.8.1.2.3 wranIfABsRelayCpeConfigTrap

This trap contains information related to the changing/updating configuration of relay CPEs operating in the network.

14.1.8.1.2.4 wranIfABsTwoLinkArqTrap

This trap contains information related to the upating of Two-Link ARQ metrics.

14.1.8.1.3 wranIfABsNotificationObjectsTable

This table contains objects that represent notifications reported in A-BS fault traps. The table is made up of one or more entries.

14.1.8.1.3.1 wranIfABsNotificationObjectsEntry

This MIB is a compound object that represents an entry in the MIB object `wranIfABsNotificationObjectsTable`.

14.1.8.1.3.1.1 wranIfABsNotificationObjectsIndex

Index of entry in the table.

14.1.8.1.3.1.2 wranIfABsNotificationMacAddr

The MAC Address of the CPE reporting the notification.

14.1.8.1.3.1.3 wranIfABsGroupResourceAllocationConfigType

Indication as to whether or not CPE has had a GRA configuration added, modified, or deleted.

14.1.8.1.3.1.4 wranIfABsGroupResourceAllocationConfigIndex

Index into `wranIfABsGroupResourceAllocConfigTable` that indicates contains the current GRA configuration/status for the CPE.

14.1.8.1.3.1.5 wranIfABsMultiChannelConfigType

Indication as to whether or not CPE has had a CAM/CHU configuration added, modified, or deleted.

14.1.8.1.3.1.6 wranIfABsMultiChannelConfigIndex

Index into `wranIfABsMultiChnConfigTable` that indicates contains the current CAM/CHU configuration/status for the CPE.

14.1.8.1.3.1.7 wranIfABsRelayCpeConfigIndex

Index into `wranIfABsRelayConfigTable` that indicates contains the current relay configuration/ status for the CPE.

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14.1.8.1.3.1.8 wranIfABsArqMetricsIndex

Index into `wranIfABsArqMetricsTable` that indicates contains the current Two-Link ARQ statistics for the CPE.

14.1.8.1.4 wranIfABsFmMibGroups

This object helps define which MIB groups are available in this module (`wranIfABsFm`) and which MIB objects are part of each group.

14.1.8.1.5 wranIfABsFmMibCompliance

Defines which objects are optional and which ones are mandatory for `wranIfABsFm` compliance.

14.1.8.2 wranIfABsCm

This MIB contains various objects related to Configruation Management at the A-BS. Within this MIB, the following tables are handled:

- `wranIfABsCpeBasicCapabilityReqTable`
- wranIfABsCpeBasicCapabilityRspTable
- wranIfABsCpeBasicCapabilityDefTable
- wranIfABsCpeBasicCapabilityCmn
- wranIfABsGraConfigTable
- wranIfABsMultiChnConfigTable
- wranIfABsRelayConfigTable
- wranIfABsRelayConfigTable
- wranIfABsPhy
- wranIfABsCmMibGroups
- wranIfABsCmMibComplieance

14.1.8.2.1 wranIfABsCpeBasicCapabilityReqTable

This table contains objects that define capabilities negotiated by A-CPEs during network entry. The table is made up of one or more entries, defined by `wranIfABsCpeBasicCapabilityReqEntry`.

14.1.8.2.1.1 wranIfABsCpeBasicCapabilityReqEntry

This is object is a compound object that contains information on capabilities A-CPEs have declared to A-BS during network entry. This list of objects that make up `wranIfABsCpeBasicCapabilityReqEntry` can be found in `wranIfABsCpeBasicCapabilityCmn` (see 14.1.8.2.4).

14.1.8.2.2 wranIfABsCpeBasicCapabilityRspTable

This table contains objects that define capabilities the A-BS has configured for A-CPEs during network entry. The table is made up of one or more entries, defined by `wranIfABsCpeBasicCapabilityRspEntry`.

14.1.8.2.2.1 wranIfABsCpeBasicCapabilityReqEntry

This is object is a compound object that contains information on capabilities the A-BS have configured for

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A-CPEs during network entry. This list of objects that make up `wranIfABsCpeBasicCapabilityReqEntry` can be found in `wranIfABsCpeBasicCapabilityCmn` (see 14.1.8.2.4).

14.1.8.2.3 wranIfABsCpeBasicCapabilityDefTable

This table contains objects that define default values of CBC-REQ/RSP IEs for A-CPEs. This table can be used to judge /verify a CPE's CBC-REQ and used to construct the CBC-RSP message. This table has one entry defined by `wranIfABsCpeBasicCapabilityDefEntry`.

14.1.8.2.3.1 wranIfABsCpeBasicCapabilityDefEntry

This is object is a compound object that defines a entry in `wranIfABsCpeBasicCapabilityDefTable`. The objects that make up this compound object are defined in `wranIfABsCpeBasicCapabilityCmn` (see 14.1.8.2.4).

14.1.8.2.4 wranIfABsCpeBasicCapabilityCmn

This MIB object is a group containing objects that are common to `wranIfABsCpeBasicCapabilityReqEntry`, `wranIfABsCpeBasicCapabilityRspEntry`, and `wranIfABsBasicCapabilitiesDefEntry` objects.

14.1.8.2.4.1 wranIfABsBasicCapabilityIndex

Index of entry into `wranIfABsCpeBasicCapabilityReqTable`, `wranIfABsCpeBasicCapabilityRspTable`, and `wranIfABsCpeBasicCapabilityDefTable`.

14.1.8.2.4.2 wranIfABsBasicCapabilityCrzModulator

Defines modulator setting for Centralized Scheduling R-CPE

14.1.8.2.4.3 wranIfABsBasicCapabilityCrzDemodulator

Defines demodulator setting for Centralized Scheduling R-CPE

14.1.8.2.4.4 wranIfABsBasicCapabilityRelayCpeMode

Defines whether R-CPE is operating in Centralized or Distriubted Scheduling Mode.

14.1.8.2.4.5 wranIfABsBasicCapabilityMultichannelSupport

Defines what multi-channel capability the A-CPE supports

14.1.8.2.5 wranIfABsGraConfigTable

This MIB object defines a table containing information on all groups created for supporting group resource allocation (GRA) operation.

14.1.8.2.5.1 wranIfABsGraConfigEntry

Compound object that defines an entry into `wranIfABsGraConfigTable`.

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14.1.8.2.5.1.1 wranIfABsGraConfigIndex

Index of entry into `wranIfABsGraConfigTable`.

14.1.8.2.5.1.2 wranIfABsGraCpeMacAddress

MAC Address of CPE

14.1.8.2.5.1.3 wranIfABsGraCpeSid

Current Station ID of CPE

14.1.8.2.5.1.4 wranIfABsGraGroupId

ID of GRA group that CPE belongs to.

14.1.8.2.5.1.5 wranIfABsGraGroupType

GRA group type, fixed or portable.

14.1.8.2.5.1.6 wranIfABsGraGroupLat

Latitude portion of group location

14.1.8.2.5.1.7 wranIfABsGraGroupLon

Longitude portion of group location

14.1.8.2.5.1.8 wranIfABsGraMaxGroupSize

Current maximum size of GRA group.

14.1.8.2.6 wranIfABsMultiChnConfigTable

This MIB object defines a table containing information for all CAM/CHUs configured for CPEs.

14.1.8.2.6.1 wranIfABsMultiChnConfigEntry

Compound object that defines an entry into `wranIfABsMultiChnConfigTable`.

14.1.8.2.6.1.1 wranIfABsMultiChnConfigIndex

Index of entry into `wranIfABsMultiChnConfigTable`.

14.1.8.2.6.1.2 wranIfABsMultiChnMacAddress

MAC Address of CPE.

14.1.8.2.6.1.3 wranIfABsMultiChnMaxAggChns

Maximum number of aggregation channels allowed at CPE

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14.1.8.2.6.1.4 wranIfABsMultiChnCurNumAggChns

Current number of aggregation channels used by CPE

14.1.8.2.6.1.5 wranIfABsMultiChnAggChnList

Octet string containing list of channels assigned to CPE for use as aggregation channels

14.1.8.2.7 wranIfABsRelayConfigTable

This MIB object defines a table containing DS/US zone configuration for Relay CPEs.

14.1.8.2.7.1 wranIfABsRelayConfigEntry

Compound object that defines an entry into `wranIfABsRealyConfigTable`. Each CPE has multiple instances of this object in the table, one for each zone the Relay CPE is configured for.

14.1.8.2.7.1.1 wranIfABsRelayConfigIndex

Index of entry into `wranIfABsRelayConfigTable`.

14.1.8.2.7.1.2 wranIfABsRelayConfigMacAddress

MAC Address of relay CPE.

14.1.8.2.7.1.3 wranIfABsRelayZoneIndex

Index of relay zone.

14.1.8.2.7.1.4 wranIfABsRelayZoneMode

Mode of zone, i.e. access, centralized relay, distributed relay.

14.1.8.2.7.1.5 wranIfABsRelayZoneSegStartPos

Start position of segment, if zone mode is distributed relay.

14.1.8.2.7.1.6 wranIfABsRelayZoneSegBandwidth

Bandwidth of segment, if zone mode is distributed relay.

14.1.8.2.7.1.7 wranIfABsRelayZoneOfdmaSymOffset

Zone starts at this OFDMA symbol offset, counted after the preamble of the frame.

14.1.8.2.7.1.8 wranIfABsRelayCpeSid

SID of distributed scheduling relay CPE.

14.1.8.2.7.1.9 wranIfABsRelayZoneDir

Indication if this is a US or DS relay zone.

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14.1.8.2.8 wranIfABsPhy

MIB object contains managed objects related to PHY configuration.

14.1.8.2.8.1 wranIfABsOfdmaPhyUsChannelTable

Table that defines attributes of US channels. Made of multiple entries, defined by `wranIfABsOfdmaPhyUsChannelEntry`.

14.1.8.2.8.1.1 wranIfABsOfdmaPhyUsChannelEntry

Compound object that defines entry in `wranIfABsOfdmaPhyUsChannelTable`.

14.1.8.2.8.1.1.1 wranIfABsOfdmaPhyUsChannelIndex

Index of entry in table.

14.1.8.2.8.1.1.2 wranIfABsOfdmaPhyUsSid

SID of CPE whose US is defined in this entry.

14.1.8.2.8.1.1.3 wranIfABsOfdmaPhyUsMacAddress

MAC Address of CPE whose US is defined in this entry.

14.1.8.2.8.1.1.4 wranIfABsOfdmaPhyUsOM

PHY operational mode of CPE US.

14.1.8.2.8.1.1.5 wranIfABsOfdmaPhyUsSegmentConfig

Distributed relay zone US segment that CPE is operating in. Defaults to '0' indicating CPE operating through CRZ or directly attached to A-BS.

14.1.8.2.8.1.1.6 wranIfABsOfdmaPhyUsCenterFrequency

Center Frequency of US channel in kHz.

14.1.8.2.8.2 wranIfABsOfdmaPhyDsChannelTable

Table that defines attributes of DS channels. Made of multiple entries, defined by `wranIfABsOfdmaPhyDsChannelEntry`.

14.1.8.2.8.2.1 wranIfABsOfdmaPhyDsChannelEntry

Compound object that defines entry in `wranIfABsOfdmaPhyDsChannelTable`.

14.1.8.2.8.2.1.1 wranIfABsOfdmaPhyDsChannelIndex

Index of entry in table.

14.1.8.2.8.2.1.2 wranIfABsOfdmaPhyDsSid

SID of CPE whose DS is defined in this entry.

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14.1.8.2.8.2.1.3 wranIfABsOfdmaPhyDsMacAddress

MAC Address of CPE whose DS is defined in this entry.

14.1.8.2.8.2.1.4 wranIfABsOfdmaPhyDsOM

PHY operational mode of CPE US.

14.1.8.2.8.2.1.5 wranIfABsOfdmaPhyDsSegmentConfig

Distributed relay zone US segment that CPE is operating in. Defaults to '0' indicating CPE operating through CRZ or directly attached to A-BS.

14.1.8.2.8.2.1.6 wranIfABsOfdmaPhyDsCenterFrequency

Center Frequency of DS channel in kHz.

14.1.8.2.8.2.1.7 wranIfABsOfdmaPhyDsCellType

Classes of BS that CPE can be used to attempt network entry.

14.1.8.2.8.2.1.8 wranIfABsOfdmaPhyDsMacVersion

Version of MAC run in the DS/US.

14.1.8.2.8.3 wranIfABsOfdmaPhyUsRegionTable

Table that defines configuration of US subframe. Made of multiple entries, defined by `wranIfABsOfdmaPhyUsRegionEntry`.

14.1.8.2.8.3.1 wranIfABsOfdmaPhyUsRegionEntry

Compound object that defines entry in `wranIfABsOfdmaPhyUsRegionTable`.

14.1.8.2.8.3.1.1 wranIfABsOfdmaPhyUsRegionIndex

Index of entry in table.

14.1.8.2.8.3.1.2 wranIfABsOfdmaPhyUsRegionSegmentNum

Segment of US region, defaults to '0' if this segment is the US of a CRZ relay.

14.1.8.2.8.3.1.3 wranIfABsOfdmaPhyUsRegionDuration

Number of OFDMA slots allocated to region.

14.1.8.2.8.4 wranIfABsOfdmaPhyDsRegionTable

Table that defines configuration of DS subframe. Made of multiple entries, defined by `wranIfABsOfdmaPhyDsRegionEntry`.

14.1.8.2.8.4.1 wranIfABsOfdmaPhyDsRegionEntry

Compound object that defines entry in `wranIfABsOfdmaPhyDsRegionTable`.

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14.1.8.2.8.4.1.1 wranIfABsOfdmaPhyDsRegionIndex

Index of entry in table.

14.1.8.2.8.4.1.2 wranIfABsOfdmaPhyDsRegionSegmentNum

Segment of US region, defaults to '0' if this segment is the DS of a CRZ relay.

14.1.8.2.8.4.1.3 wranIfABsOfdmaPhyDsRegionSegmentNum

Numberf of OFDMA slots allocated to region.

14.1.8.2.8.5 wranIfABsOfdmaDcdBurstProfileTable

This table provides the configuration of DCD burst profiles for new modes supported in PHY-OM2 only (see Table 36). Made of multiple entries, defined by `wranIfABsOfdmaDcdBurstProfileEntry`.

14.1.8.2.8.5.1 wranIfABsOfdmaDcdBurstProfileEntry

Compound object that defines entry in `wranIfABsOfdmaDcdBurstProfileTable`.

14.1.8.2.8.5.1.1 wranIfABsOfdmaDcdDiucIndex

DIUC of burst profile as defined in Table 36 for PHY-OM2.

14.1.8.2.8.5.1.2 wranIfABsOfdmaDcdDiucExitThreshold

Minimum CINR required to start using this DIUC when changing from a more robust DIUC is required.

14.1.8.2.8.5.1.3 wranIfABsOfdmaDcdDiucEntryThreshold

CINR at which this DIUC can no longer be used where change to a more robust DIUC is required.

14.1.8.2.8.6 wranIfABsOfdmaUcdBurstProfileTable

This table provides the configuration of UCD burst profiles for new modes supported in PHY-OM2 only (see Table 51). Made of multiple entries, defined by `wranIfABsOfdmaUcdBurstProfileEntry`.

14.1.8.2.8.6.1 wranIfABsUcdBurstProfileEntry

Compound object that defines entry in `wranIfABsOfdmaUcdBurstProfileTable`.

14.1.8.2.8.6.1.1 wranIfABsOfdmaUcdUiucIndex

UIUC of burst profile as defined in Table 51 for PHY-OM2.

14.1.8.2.8.6.1.2 wranIfABsOfdmaUcdUiucExitThreshold

Minimum CINR required to start using this UIUC when changing from a more robust UIUC is required.

14.1.8.2.8.6.1.3 wranIfABsOfdmaUcdUiucEntryThreshold

CINR at which this UIUC can no longer be used where change to a more robust UIUC is required.

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14.1.8.2.9 wranIfABsCmMibGroups

This object helps define which MIB groups are available in this module (`wranIfABsCm`) and which MIB objects are part of each group.

14.1.8.2.10 wranIfABsCmMibCompliance

Defines which objects are optional and which ones are mandatory for `wranIfABsCm` compliance.

14.1.8.3 wranIfABsPm

This MIB contains various objects related to Perfmance Management at the A-BS. Within this MIB, the following tables are handled:

- `wranIfABsPmConfigurationTable`
- wranIfABsArqMetricsTable
- wranIfABsPmMibGroups
- wranIfABsPmMibComplieance

14.1.8.3.1 wranIfABsPmConfigurationTable

The configuration of statistics capture and measurement at the A-BS is captured in this table. There is one entry in this table for each BS sector. The entries are defined by `wranIfBsPmConfigurationEntry`.

14.1.8.3.1.1 wranIfABsPmConfigurationEntry

This object defines a compound object that represents an entry in `wranIfABsPmConfigurationTable`.

14.1.8.3.1.1.1 wranIfABsPmConfigurationIndex

Index of entry into table, defaults to 1.

14.1.8.3.1.1.2 wranIfABsGranularityInterval

The interval in which statistics captured in `wranIfABsTrapControl` related to performance measurement reported to the NCMS.

14.1.8.3.1.1.3 wranIfABsTwoLinkArqConfig

This object indicates whether or not Two Link ARQ measurements (`wranIfABsArqMetricsTable`).

14.1.8.3.2 wranIfABsArqMetricsTable

This MIB provides a table to track performance of Two Link ARQ being used with A-CPEs attached to A-S through distributed scheduling R-CPE. The entries are defined by `wranIfABsArqMetricsEntry`.

14.1.8.3.2.1 wranIfABsArqMetricsEntry

This object defines a compound object that represents an entry in `wranIfABsArqMetricsTable`.

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14.1.8.3.2.1.1 wranIfABsRelayLinkDsNumArqBlocks

The total # of ARQ blocks, include retransmissions, that the A-BS has sent on the relay link (to distributed scheduling R-CPE) during the reporting period.

14.1.8.3.2.1.2 wranIfABsAccessLinkDsNumArqBlocks

The total # of ARQ blocks, include retransmissions, that A-CPEs has sent on the access link during the reporting period.

14.1.8.3.2.1.3 wranIfABsRelayLinkDsNumArqBlocksDropped

Total # of ARQ blocks that were dropped, that the A-BS has sent during the reporting period.

14.1.8.3.2.1.4 wranIfABsAccessLinkDsNumArqBlocksDropped

The total # of ARQ blocks that were dropped, that A-CPEs has sent on the access link during the reporting period.

14.1.8.3.2.1.5 wranIfABsRelayLinkDsArqBlockErrorRate

Error Rate on DS Relay Link.

14.1.8.3.2.1.6 wranIfABsAccessLinkDsArqBlockErrorRate

Error Rate on DS Access Link.

14.1.8.3.2.1.7 wranIfABsRelayLinkDsArqBlockReTx

The # of ARQ blocks that were retransmitted by the A-BS during the reporting period.

14.1.8.3.2.1.8 wranIfABsAccessLinkDsArqBlockReTx

The # of ARQ blocks that were retransmitted by the A-CPE during the reporting period.

14.1.8.3.2.1.9 wranIfABsRelayLinkUsNumArqBlocks

The total # of ARQ blocks, include retransmissions, that the A-BS has received on the relay link (from distributed scheduling R-CPE) during the reporting period.

14.1.8.3.2.1.10 wranIfABsAccessLinkUsNumArqBlocks

The total # of ARQ blocks, include retransmissions, that A-CPEs has received on the access link during the reporting period.

14.1.8.3.2.1.11 wranIfABsRelayLinkUsNumArqBlocksDropped

Total # of ARQ blocks that were dropped, that the A-BS has received during the reporting period.

14.1.8.3.2.1.12 wranIfABsAccessLinkUsNumArqBlocksDropped

The total # of ARQ blocks that were dropped, that A-CPEs has received on the access link during the reporting period.

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14.1.8.3.2.1.13 wranIfABsRelayLinkUsArqBlockErrorRate

Error Rate on US Access Link.

14.1.8.3.2.1.14 wranIfABsAccessLinkUsArqBlockErrorRate

Error Rate on US Relay Link.

14.1.8.3.2.1.15 wranIfABsRelayLinkUsArqBlockReTx

The # of ARQ blocks that were retransmitted by the R-CPE during the reporting period on the relay link.

14.1.8.3.2.1.16 wranIfABsAccessLinkUsArqBlockReTx

The # of ARQ blocks that were retransmitted by the A-CPE during the reporting period on the access link.

14.1.8.3.2.1.17 wranIfABsRelayLinkDsEfficiency

Efficiency of transmission on DS relay link.

14.1.8.3.2.1.18 wranIfABsAccessLinkDsEfficiency

Efficiency of transmission on DS access link.

14.1.8.3.2.1.19 wranIfABsRelayLinkUsEfficiency

Efficiency of transmission on US relay link.

14.1.8.3.2.1.20 wranIfABsAccessLinkUsEfficiency

Efficiency of transmission on US access link.

14.1.8.3.3 wranIfABsPmMibGroups

This object helps define which MIB groups are available in this module (`wranIfABsPm`) and which MIB objects are part of each group.

14.1.8.3.4 wranIfABsPmMibCompliance

Defines which objects are optional and which ones are mandatory for `wranIfBsPm` compliance.

14.1.9 wranIfACpeMib

This MIB represents MIB functionality related to managing A-CPEs. It is broken up into the following sublclauses:

- `wranIfACpeSystemParametersTable`: Definition of system parameters, timers, and constants related to CPE operation.
- `wranIfACpeMibGroups`: Defines which MIB groups are available in this module and which MIB objects are a part of each group.
- `wranIfACpeMibCompliance`: Defines which MIB objects are optional, and which ones are mandatory for CPE conformance.

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14.1.9.1 wranIfACpeSystemParametersTable

This table contains objects that define system constants related to A-BS/A-CPE operation.

14.1.9.1.1 wranIfACpeSystemParametersEntry

This is a compound object that defines an entry in `wranIfACpeSystemParametersTable`.

14.1.9.1.1.1 wranIfACpeSystemParametersIndex

Index of entry into table.

14.1.9.1.1.2 wranIfABsT61

Timeout for waiting for container ACK message.

14.1.9.1.1.3 wranIfABsT62

Timeout for waiting for local cell update acknowledgment.

14.1.9.1.1.4 wranIfABsT63

Timeout for DTT-RSP message.

14.1.9.1.1.5 wranIfABsT64

Timeout for DTT-RPT message.

14.1.9.1.1.6 wranIfABsT65

Timeout for DTT-CFM message.

14.1.9.1.1.7 wranIfABsT66

Timeout for CAM-STP message.

14.1.9.1.1.8 wranIfABsT67

Timeout for CAM-SWH message.

14.1.9.2 wranIfACpeMibGroups

This object helps define which MIB groups are available in this module (`wranIfACpe`) and which MIB objects are part of each group.

14.1.9.3 wranIfACpeMibCompliance

This defines which MIB objects are optional and mandatory for CPE conformance

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14.2 MIB module definitions (ASN.1)

14.2.1 wranDevMib

```
IEEE802dot22-WRAN-DEV-MIB  ::= BEGIN

  IMPORTS
    MODULE-IDENTITY,
    OBJECT-TYPE,
    NOTIFICATION-TYPE,
    Unsigned32, Integer32
       FROM SNMPv2-SMI
             SnmpAdminString
                   FROM SNMP-FRAMEWORK-MIB
             TEXTUAL-CONVENTION,
             RowStatus, TruthValue,
             TimeStamp, DateAndTime
                   FROM SNMPv2-TC
             InetAddressType, InetAddress
                   FROM INET-ADDRESS-MIB
             OBJECT-GROUP,
             MODULE-COMPLIANCE,
             NOTIFICATION-GROUP
                   FROM SNMPv2-CONF;

       wranDevMib  MODULE-IDENTITY
             LAST-UPDATED "201405300000Z" - May 30, 2014
             ORGANIZATION "IEEE 802.22"
             CONTACT-INFO
                   "WG E-mail:  STDS-802-22@LISTSERV.IEEE.ORG
                    WG Chair:   Apurva N. Mody
                    E-mail:     apurva.mody@ieee.org

                    TGa Chair/Editor:  Ranga Reddy
                    E-mail:      ranga.reddy@ieee.org"
             DESCRIPTION
                   "This material is from IEEE Std 802.22a-2014
                    Copyright (c) 2014. This MIB Module
                    Defines device related manage objects
                    for IEEE Std 802.22-2011 base Customer
                    Premise Equipment and Base Station and
                    is under
                    iso(1).std(0).iso8802(8802).wran(22).wranDevMib(1)"
             REVISION    "201405300000Z"
             DESCRIPTION
                   "The first version of IEEE802dot22-WRAN-DEV-MIB."
             ::= {iso std(0) iso8802(8802) wran(22) 1}
```

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```
      wranDevBsObjects  OBJECT IDENTIFIER ::= { wranDevMib 1 }
      wranDevCpeObjects OBJECT IDENTIFIER ::= { wranDevMib 2 }
      wranDevCommonObjects    OBJECT IDENTIFIER ::= { wranDevMib 3 }

      wranDevBsObjects  OBJECT IDENTIFIER
                                          ::= { wranDevMib 1 }
      wranDevBsSoftwareUpgradeTable OBJECT IDENTIFIER
                                          ::= { wranDevBsObjects 1 }
      wranDevBsNotification   OBJECT IDENTIFIER
                                          ::= { wranDevBsObjects 2 }

      wranDevBsSoftwareUpgradeTable OBJECT-TYPE
            SYNTAXSEQUENCE OF wranDevBsSoftwareUpgradeEntry
            MAX-ACCESSnot-accessible
            STATUScurrent
            DESCRIPTION
                  "This table defines objects associated with BS
                   software configuration"
    ::= { wranDevBsObjects 1 }

  wranDevBsSoftwareUpgradeEntryOBJECT-TYPE
    SYNTAXwranDevBsSoftwareUpgradeEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
       "Definition of an entry in
                   wranDevBsSoftwareUpgradeTable. Each entry is
                   identified by wranDevBsDeviceIndex."
    INDEX{ wranDevBsDeviceIndex }
    ::= { wranDevBsSoftwareUpgradeTable 1 }

  wranDevBsSoftwareUpgradeEntry ::= SEQUENCE {
    wranDevBsDeviceIndexINTEGER,
    wranDevBsVendorIdOCTET STRING,
    wranDevBsHwId    OCTET STRING,
    wranDevBsCurrentSwVersionOCTET STRING,
    wranDevBsDownloadSwVersionOCTET STRING,
    wranDevBsUpgradeFileNameOCTET STRING,
    wranDevBsSoftwareUpdgradeAdminStateINTEGER,
    wranDevBsDownloadSwProgressINTEGER,
    wranDevBsSoftwareUpgradeTimeStampDateAndTime }

  wranDevBsDeviceIndexOBJECT-TYPE
    SYNTAXINTEGER (1..10)
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
       "Index of entry in table."
```

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```
  ::= { wranDevBsSoftwareUpgradeEntry 1 }

wranDevBsVendorIdOBJECT-TYPE
  SYNTAX       OCTET STRING (SIZE(2..256))
  MAX-ACCESS   read-only
  STATUS       current
  DESCRIPTION
     "This value identifies the managed BS vendor to
                  which SW upgrade was applied."
  ::= { wranDevBsSoftwareUpgradeEntry 2 }

wranDevBsHwIdOBJECT-TYPE
  SYNTAX       OCTET STRING (SIZE(2..256))
  MAX-ACCESS   read-only
  STATUS       current
  DESCRIPTION
     "Version of HW that SW upgrade is applied to."
  ::= { wranDevBsSoftwareUpgradeEntry 3 }

wranDevBsCurrentSwVersionOBJECT-TYPE
  SYNTAX       OCTET STRING (SIZE(2..256))
  MAX-ACCESS   read-only
  STATUS       current
  DESCRIPTION
     "Version of SW that is currently running on the BS.
                  This value is set by the vendor specified by the
                  Vendor ID. The  SW version and HW ID (wranDevBsHwId)
                  should be a unique Tuple. After the downloaded
                  software is activated, the  value in this object
                  shall value of this object shall be replaced with
                  the version in wranDevBsDownloadSwVersion."
  ::= { wranDevBsSoftwareUpgradeEntry 4 }

wranDevBsDownloadSwVersionOBJECT-TYPE
  SYNTAX       OCTET STRING (SIZE(2..256))
  MAX-ACCESS   read-write
  STATUS       current
  DESCRIPTION
     "Version of the SW to be downloaded. This value is
                  set by the vendor specified by the Vendor ID. The SW
                  version and  HW ID  (wranDevBsHwId) should be a
                  unique type. This should be initialized before
                  software is downloaded or activated."
  ::= { wranDevBsSoftwareUpgradeEntry 5 }

wranDevBsUpgradeFileNameOBJECT-TYPE
  SYNTAX       OCTET STRING (SIZE(2..256))
  MAX-ACCESS   read-write
```

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```
    STATUS       current
    DESCRIPTION
       "Fully qualified path name that points to the
                   location of the SW version that is to be
                   downloaded/activated."
    ::= { wranDevBsSoftwareUpgradeEntry 6 }

  wranDevBsSoftwareUpgradeAdminStateOBJECT-TYPE
    SYNTAX       INTEGER { null(0), download(1)
                         activate(2)}
    MAX-ACCESS   read-write
    STATUS       current
    DESCRIPTION
       "This value can take on two states. When set to
                   Download, the software listed by
                   wranDevBsDownloadSwVersion will be downloaded. When
                   set to Activate, the software recently downloaded
                   will be activated. The Download and Activate
                   procedures are vendor specific operations that are
                   not defined in this standard."
    DEFVAL{ null }
    ::= { wranDevBsSoftwareUpgradeEntry 7 }

  wranDevBsDownloadSwProgressOBJECT-TYPE
    SYNTAX       INTEGER (0..100)
    UNITS          "%"
    MAC-ACCESS   read-only
    STATUS       current
    DESCRIPTION
       "This value shows the progress of the SW download
                   highlighted by wranDevBsDownloadSwVersion, encoded
                   as the percentage of the download successfully
                   completed."
    ::= { wranDevBsSoftwareUpgradeEntry 8 }

  wranDevBsSoftwareUpgradeTimeStampOBJECT-TYPE
    SYNTAX       DateAndTime
    MAX-ACCESS   read-only
    STATUS       current
    DESCRIPTION
       "This value is a timestamp to indicate when the last
                   SW download or activation took place."
    ::= { wranDevBsSoftwareUpgradeEntry 9 }

-- wranDevBsNotification: Managed Objects related to SNMP traps on BS

  wranDevBsNotificationOBJECT IDENTIFIER
                    ::= { wranDevBsObjects 2 }
```

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```
  wranDevBsTrapControlOBJECT IDENTIFIER
                    ::= { wranDevBsNotification 1 }
  wranDevBsTrapDefinitionOBJECT IDENTIFIER
                    ::= { wranDevBsNotification 2 }

  wranDevBsTrapControlOBJECT-TYPE
    SYNTAXBITS   { wranDevBsEvent(0),
                   wranDevBsLogBuffExceedThreshold(1) }
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
       "Defines control elements for traps. This is a 2-bit
                   field that enables setting a trap to indicate when a
                   BS event is logged (wranDevBsEvent) or when a event
                   log buffer size overruns configured threshold
                   (wranDevBsLogBuffExceedThreshold)."
    ::= { wranDevBsNotification 1 }

-- wranDevBsTrapDefinition: This object groups all of the notification
-- objects for the BS. It is defined to be compatible with SNMPv1,
-- following Sections 8.5 and 8.6 of RFC 2758.

  wranDevBsTrapDefinitionOBJECT IDENTIFIER
                    ::= { wranDevBsNotification 2 }
  wranDevBsEventTrapOBJECT IDENTIFIER
                    ::= { wranDevBsTrapDefinition 1 }
  wranDevBsLogBuffExceedThresholdTrapOBJECT IDENTIFER
                    ::= { wranDevBsTrapDefinition 2 }

  wranDevBsEventTrapNOTIFICATION-TYPE
    OBJECTS{ wranDevCmnEventId,
                  wranDevCmnEventLogIndex,
                  wranDevCmnEventLoggedTime,
                  wranDevCmnEventDescription,
                  wranDevCmnEventSeverity }
    STATUScurrent
    DESCRIPTION
       "This object is a compound object that contains
                   information the objects in wranDevCmnEventEntry in
                   wranDevCmnEventLogTable that describes the event
                   that is logged. This trap is caught when
                   wranDevBsEvent in wranDevBsTrapControl is set."
    ::= { wranDevBsTrapDefinition 1 }

  wranDevBsLogBuffExceedThresholdTrapNOTIFICATION-TYPE
    OBJECTS{ wranDevCmnEventId,
                  wranDevCmnEventLogResidualBuffThreshold }
    STATUScurrent
```

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```
  DESCRIPTION
     "This object is a compound object that indicates the
                  index of an entry (defined by
                  wranDevCmnEventLogEntry) in
                  wranDevCmnEventLogConfigTable and the object in
                  that entry that defines the ratio (defined by
                  wranDevCmnEventLogResidualBuffThreshold) of used
                  capacity in the Event Log vs. total capacity. This
                  trap is caught when wranDevBsLogBuffExceedThreshold
                  in wranDevBsTrapControl is set."
  ::= { wranDevBsTrapDefinition 2 }

wranDevCpeObjectsOBJECT IDENTIFIER
                          ::= { wranDevMib 2 }
wranDevCpeConfigFileEncodingTableOBJECT IDENTIFIER
                          ::= { wranDevCpeObjects 1 }
wranDevCpeNotificationOBJECT IDENTIFIER
                          ::= { wranDevCpeObjects 2 }

wranDevCpeConfigFileEncodingTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranDevCpeFileEncodingEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
     "This table defines objects associated with CPE
                  software configuration. This table may only have one
                  entry, defined by a compound attribute,
                  wranDevCpeConfigFileEncodingEntry."
  ::= { wranDevCpeObjects 1 }

wranDevCpeConfigFileEncodingEntryOBJECT-TYPE
  SYNTAXwranDevCpeConfigFileEncodingEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
     "Definition of an entry in
                  wranDevBsSoftwareUpgradeTable. Each entry is
                  identified by wranDevBsDeviceIndex."
  INDEX{ wranDevCpeDeviceIndex }
  ::= { wranDevCpeConfigFileEncodingTable 1 }

wranDevCpeConfigFileEncodingEntry ::= SEQUENCE {
  wranDevCpeDeviceIndexINTEGER,
  wranDevCpeMicConfigSettingOCTET STRING,
  wranDevBsVendorIdOCTET STRING,
  wranDevBsHwId    OCTET STRING,
  wranDevCpeConfigFileVersionOCTET STRING,
  wranDevCpeUpgradeFileNameOCTET STRING,
```

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```
  wranDevCpeSwTftpServerInetAddress,
  wranDevCpeTftpServerTimeStampDateAndTime }

wranDevCpeDeviceIndexOBJECT-TYPE
  SYNTAXINTEGER (1..1)
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
     "Index of entry in table, defaults to 1."
  ::= { wranDevCpeConfigFileEncodingEntry 1 }

wranDevCpeMicConfigSettingOBJECT-TYPE
  SYNTAXOCTET STRING (SIZE(20))
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
     "This value contains the MIC (Message Integrity Code)
                  calculated for the CPE configuration file."
  ::= { wranDevCpeConfigFileEncodingEntry 2 }

wranDevCpeVendorIdOBJECT-TYPE
  SYNTAX       OCTET STRING (SIZE(2..256))
  MAX-ACCESS   read-only
  STATUS       current
  DESCRIPTION
     "This value identifies the vendor of the managed CPE
                  to which a configuration file upgrade is to be
                  applied."
  ::= { wranDevCpeConfigFileEncodingEntry 3 }

wranDevCpeHwIdOBJECT-TYPE
  SYNTAX       OCTET STRING (SIZE(2..256))
  MAX-ACCESS   read-only
  STATUS       current
  DESCRIPTION
     "This value identifies the hardware version of the
                  CPE to which the configuration file upgrade is to be
                  applied."
  ::= { wranDevCpeConfigFileEncodingEntry 4 }

wranDevCpeConfigFileVersionOBJECT-TYPE
  SYNTAX       OCTET STRING (SIZE(2..256))
  MAX-ACCESS   read-only
  STATUS       current
  DESCRIPTION
     "Version of the configuration file to be downloaded.
                  This value is set by the vendor specified by the
                  Vendor ID. The SW version and HW ID (wranDevCpeHwId)
```

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```
                    should be a unique tuple. This should be initialized
                    before software is downloaded or activated."
    ::= { wranDevCpeConfigFileEncodingEntry 5 }

  wranDevCpeUpgradeFileNameOBJECT-TYPE
    SYNTAX       OCTET STRING (SIZE(2..256))
    MAX-ACCESS   read-only
    STATUS       current
    DESCRIPTION
       "Fully qualified path name that points to the
                    location of the SW version that is to be
                    downloaded/activated."
    ::= { wranDevCpeConfigFileEncodingEntry 6 }

  wranDevCpeSwTftpServerOBJECT-TYPE
    SYNTAX       InetAddress
    MAX-ACCESS   read-only
    STATUS       current
    DESCRIPTION
       "IP address of the TFTP server on which the new
                    configuration file resides."
    ::= { wranDevCpeConfigFileEncodingEntry 7 }

  wranDevCpeTftpServerTimeStampOBJECT-TYPE
    SYNTAX       DateAndTime
    MAX-ACCESS   read-only
    STATUS       current
    DESCRIPTION
       "The time the configuration file was in seconds, as
                    defined by IETF RFC 868."
    ::= { wranDevCpeConfigFileEncodingEntry 8 }

-- wranDevCpeNotification: This group of objects relate to SNMP traps
-- on the CPE. There is a control element that enables/disables the
-- traps
-- (wranDevCpeTrapControl) and what event information is logged when a
-- trap is sent (wranDevCpeTrapDefinition).

  wranDevCpeNotificationOBJECT IDENTIFIER
                    ::= { wranDevCpeObjects 2 }
  wranDevCpeTrapControlOBJECT IDENTIFIER
                    ::= { wranDevCpeNotification 1 }
  wranDecCpeTrapDefinitionOBJECT IDENTIFIER
                    ::= { wranDevCpeNotification 2 }

  wranDevCpeTrapControlOBJECT-TYPE
    SYNTAXBITS   { wranDevCpeEvent(0),
                    wranDevCpeLogBuffExceedThreshold(1) }
```

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```
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
       "Defines control elements for traps. This is a 2-bit
                  field that enables setting a trap to indicate when a
                  CPE event is logged (wranDevCpeEvent) or when a
                  event log buffer size overruns configured threshold
                 (wranDevCpeLogBuffExceedThreshold)."
    ::= { wranDevCpeNotification 1 }

-- wranDevCpeTrapDefinition: This object groups all of the notification
-- objects for the CPE. It is defined to be compatible with SNMPv1,
-- following Sections 8.5 and 8.6 of RFC 2758. It is a compound object
-- made of the elements of a logged BS event
-- (wranDevCpeEventTrap) and the indication of when the ratio used
-- portion to total size of event log has been exceeded
-- (wranDevCpeLogBuffExceedThresholdTrap).

  wranDevCpeTrapDefinition OBJECT IDENTIFIER
                    ::= { wranDevCpeNotification 2 }
  wranDevCpeEventTrapOBJECT IDENTIFIER
                    ::= { wranDevCpeTrapDefinition 1 }
  wranDevCpeLogBuffExceedThresholdTrapOBJECT IDENTIFER
                    ::= { wranDevCpeTrapDefinition 2 }

  wranDevCpeEventTrapNOTIFICATION-TYPE
    OBJECTS{ wranDevCmnEventId,
                  wranDevCmnEventLogIndex,
                  wranDevCmnEventLoggedTime,
                  wranDevCmnEventDescription,
                  wranDevCmnEventSeverity }
    STATUScurrent
    DESCRIPTION
       "This object is a compound object that contains
                  information the objects in wranDevCmnEventEntry in
                  wranDevCmnEventLogTable that describes the event
                  that is logged. This trap is caught when
                  wranDevCpeEvent in wranDevCpeTrapControl is set."
    ::= { wranDevCpeTrapDefinition 1 }

  wranDevCpeLogBuffExceedThresholdTrapNOTIFICATION-TYPE
    OBJECTS{ wranDevCmnEventId,
                  wranDevCmnEventLogResidualBuffThreshold }
    STATUScurrent
    DESCRIPTION
       "This object is a compound object that indicates the
                  index of an entry (defined by
                  wranDevCmnEventLogEntry) in
```

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```
                    wranDevCmnEventLogConfigTable and the object in
                    that entry that  defines the ratio (defined by
                    wranDevCmnEventLogResidualBuffThreshold) of used
                    capacity in the Event Log vs. total capacity. This
                    trap is caught when wranDevCpeLogBuffExceedThreshold
                    in wranDevCpeTrapControl is set."
    ::= { wranDevCpeTrapDefinition 2 }

-- wranDevCommonObjects: This object contains managed elements that are
-- common to the CPE and BS.

  wranDevCommonObjectsOBJECT IDENTIFIER
                    ::= { wranDevMib 3 }
  wranDevCmnEventLogOBJECT IDENTIFIER
                    ::= { wranDevCommonObjects 1 }
  wranDevCmnSnmpAgentOBJECT IDENTIFIER
                    ::= { wranDevCommonObjects 2 }
  wranDevCmnDeviceConfigOBJECT IDENTIFER
                    ::= { wranDevCommonObjects 3 }

--wranDevCmnEventLog comprises three tables that control the
-- configuration of event recording and store recorded events.

  wranDevCmnEventLogOBJECT IDENTIFIER
                    ::= { wranDevCommonObjects 1 }
  wranDevCmnEventLogConfigTableOBJECT IDENTIFIER
                            ::= { wranDevCmnEventLog 1 }
  wranDevCmnEventTableOBJECT IDENTIFIER
                            ::= { wranDevCmnEventLog 2 }
  wranDevCmnEventLogTableOBJECT IDENTIFIER
                            ::= { wranDevCmnEventLog 3 }

  wranDevCmnEventLogConfigTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranDevCmnEventLogConfigEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
       "Each entry stores the Event Log configuration for a
                    device."
    ::= { wranDevCmnEventLog 1 }

  wranDevCmnEventLogConfigEntryOBJECT-TYPE
    SYNTAXwranDevCmnEventLogConfigEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
       "Definition of an entry in
                    wranDevCmnEventLogConfigTable. Each  entry is
```

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```
                    identified by wranDevCmnDeviceIndex."
  INDEX{ wranDevCmnDeviceIndex }
  ::= { wranDevCmnEventLogConfigTable 1 }

wranDevCmnEventLogConfigEntry::= SEQUENCE {
  wranDevCmnDeviceIndexINTEGER,
  wranDevCmnEventLogEntryLimitINTEGER,
  wranDevCmnEventLogLifeTimeLimitINTEGER,
  wranDevCmnEventLogEntryLimitPerEventIdINTEGER,
  wranDevCmnEventLogSeverityThresholdINTEGER,
  wranDevCmnEVentLogWrapAroundBuffEnableTruthEnable,
  wranDevCmnEventLogLatestEventUnsigned32,
  wranDevCmnEventLogPersistenceSupportedTruthEnable,
  wranDevCmnEventLogResidualBuffThresholdINTEGER }

wranDevCmnDeviceIndexOBJECT-TYPE
  SYNTAXINTEGER (1..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
     "Index value that identifies a BS or CPE entry in the
                    wranDevCmnEventLogConfigTable."
  ::= { wranDevCmnEventLogConfigEntry 1 }

wranDevCmnEventLogEntryLimitOBJECT-TYPE
  SYNTAXINTEGER (1..10000)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
     "Maximum number of entries in
                    wranDevCmnEventLogConfigTable. If this value is
                    changed while entries exist in
                    wranDevCmnEventLogTable, old entries will be
                    discarded until limit is reached."
  DEFVAL{ 100 }
  ::= { wranDevCmnEventLogConfigEntry 2 }

wranDevCmnEventLogLifeTimeLimitOBJECT-TYPE
  SYNTAXINTEGER (1..10000)
  UNITS        "minutes"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
     "A value of 0 means that an entry is kept
                    indefinitely. Any other value is the maximum time
                    an entry can exist in wranDevCmnEventLogTable. If
                    this value is changed while entries exist in
                    wranDevCmnEventLogTable, entries older that this
```

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```
                limit will be discarded."
  DEFVAL{ 1440 }
  ::= { wranDevCmnEventLogConfigEntry 3 }

wranDevCmnEventLogEntryLimitPerEventIdOBJECT-TYPE
  SYNTAXINTEGER (1..100)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
     "The number of log entries that can be logged per
                event."
  DEFVAL{ 10 }
  ::= { wranDevCmnEventLogConfigEntry 4 }

wranDevCmnEventLogSeverityThresholdOBJECT-TYPE
  SYNTAX       INTEGER (emergency(1),
                        alert(2),
                        critical(3),
                        error(4),
                        warning(5),
                        notice(6),
                        informational(7),
                        debug(8)}
  MAX-ACCESS   read-write
  STATUS       current
  DESCRIPTION
     "Minimum severity level of an event that can be
                logged into the Event Log."
  DEFVAL{ warning }
  ::= { wranDevCpeConfigFileEncodingEntry 5 }

wranDevCmnEventLogWrapAroundBuffEnableOBJECT-TYPE
  SYNTAXTruthEnable
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
                "True (1), indicates that the log buffer will be
                 wrapped around with the buffer is full."
  DEFVAL{ true }
  ::= { wranDevCpeConfigFileEncodingEntry 6 }

wranDevCmnEventLogLatestEventOBJECT-TYPE
  SYNTAXUnsigned32 (1..4294967295)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
                "Index of latest event in Event Log."
  DEFVAL{ 1 }
```

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```
  ::= { wranDevCpeConfigFileEncodingEntry 7 }

wranDevCmnEventLogPersistenceSupportedOBJECT-TYPE
  SYNTAXTruthValue
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
                "True (1), indicates that the Event Log persisted
                 through power cycle and reset."
  ::= { wranDevCpeConfigFileEncodingEntry 8 }

wranDevCmnEventLogResidualBuffThresholdOBJECT-TYPE
  SYNTAXINTEGER (1..100)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
                "Threshold ratio of used capacity for Event Log to
                 total capacity of Event Log, that when reached a
                 TRAP is issued."
  ::= { wranDevCpeConfigFileEncodingEntry 9 }

wranDevCmnEventTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranDevCmnEventEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
     "This compound object defines the types of events
                 that are supported by a BS or CPE. Each event is
                 defined."
  ::= { wranDevCmnEventLog 2 }

wranDevCmnEventEntryOBJECT-TYPE
  SYNTAXwranDevCmnEventEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
     "This object defines the parameters of an event entry
                 into the wranDevCmnEventTable. Each entry is indexed
                 by wranDevCmnEventIdentifier."
  INDEX{ wranDevCmnEventIdentifier }
  ::= { wranDevCmnEventTable 1 }

wranDevCmnEventEntry::= SEQUENCE {
  wranDevCmnEventIdentifierINTEGER,
  wranDevCmnEventDescriptionSnmpAdminString,
  wranDevCmnEventSeverityINTEGER,
  wranDevCmnEventNotificationTruthValue,
  wranDevCmnEventNotificationOidOBJECT IDENTIFIER }
```

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```
wranDevCmnEventIdentifierOBJECT-TYPE
  SYNTAXINTEGER (0..100000)
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
     "Event Identifier encoded as a numeric value."
  ::= { wranDevCmnEventEntry 1 }

wranDevCmnEventDescriptionOBJECT-TYPE
  SYNTAXSnmpAdminString
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
     "Description of the event in the form of an
                 SnmpAdminString"
  ::= { wranDevCmnEventEntry 2 }

wranDevCmnEventSeverityOBJECT-TYPE
  SYNTAX       INTEGER {emergency(1),
                        alert(2),
                        critical(3),
                        error(4),
                        warning(5),
                        notice(6),
                        informational(7),
                        debug(8)}
  MAX-ACCESS   read-write
  STATUS       current
  DESCRIPTION
     "The severity of the event as assigned by the device.
                 The severity assigned to an event is configurable by
                 the system."
  DEFVAL{ warning }
  ::= { wranDevCmnEventEntry 3 }

wranDevCmnEventNotificationOBJECT-TYPE
  SYNTAXTruthValue
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
     "When True (1), an event notification will be
                 reported."
  DEFVAL{ false }
  ::= { wranDevCmnEventEntry 4 }

wranDevCmnEventNotificationOidOBJECT-TYPE
  SYNTAXOBJECT IDENTIFIER
```

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```
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
       "This is the object identifier of a notification
                   object. If wranDevCmnEventNotification True (1), a
                   trap identified by the OID
                   will be reported."
    ::= { wranDevCmnEventEntry 5 }

  wranDevCmnEventLogTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranDevCmnEventLogEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
       "This is the log table that stores local events as
                   they happen. This table shall reside in non-volatile
                   memory that may persist after power cycle or resent
                   of the device. The maximum number of entries in this
                   table is determined by the
                   wranDevCmnEventLogEntryLimit. If it is setup as a
                   wrap-around log, then the oldest entry will be
                   remove to make room for the newest entry. If it is
                   not set up as a wrap-around log, then the log will
                   be flushed. Multiple entries are stored in the
                   table. Each entry is defined by
                   wranDevCmnEventLogEntry."
    ::= { wranDevCmnEventLog 3 }

  wranDevCmnEventLogEntryOBJECT-TYPE
    SYNTAXwranDevCmnEventLogEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
       "This object represents an entry in
                   wranDevCmnEventLogTable. It is indexed by
                   wranDevCmnEventId."
    INDEX{ wranDevCmnEventLogId }
    ::= { wranDevCmnEventLogTable 1 }

  wranDevCmnEventLogEntry::= SEQUENCE {
    wranDevCmnEventLogIdUnsigned32,
    wranDevCmnEventLoggedTimeDateAndTime,
    wranDevCmnEventLogDescriptionSnmpAdminString,
    wranDevCmnEventLogSeverityINTEGER }

  wranDevCmnEventIdOBJECT-TYPE
    SYNTAXUnsigned32(1..4294967295)
    MAX-ACCESSread-only
```

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```
    STATUScurrent
    DESCRIPTION
       "A counter used to index entries in the Event Log.
                   When it reaches a maximum value, it will wrap-
                   around if configured to wrap-around or the log will
                   be flushed if it is not configured to wrap-around."
    ::= { wranDevCmnEventLogEntry 1 }

  wranDevCmnEventLoggedTimeOBJECT-TYPE
    SYNTAXTimeStamp
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
       "The time that the entry was placed into the Event
                   Log. If this event happened just before the last
                   initialization of the management system, then this
                   value is set to 0."
    ::= { wranDevCmnEventLogEntry 2 }

  wranDevCmnEventLogDescriptionOBJECT-TYPE
    SYNTAXSnmpAdminString
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
       "Description of the event, in the form of an
                   SnmpAdminString"
    ::= { wranDevCmnEventLogEntry 3 }

  wranDevCmnEventLogSeverityOBJECT-TYPE
    SYNTAX       INTEGER {emergency(1),
                          alert(2),
                          critical(3),
                          error(4),
                          warning(5),
                          notice(6),
                          informational(7),
                          debug(8)}
    MAX-ACCESS   read-only
    STATUS       current
    DESCRIPTION
       "Severity of the recorded event."
    DEFVAL{ warning }
    ::= { wranDevCmnEventLogEntry 4 }

-- wranDevCmnSnmpAgent: This object comprises one table that
-- deals with SNMP agent configuration.

  wranDevCmnSnmpAgentOBJECT IDENTIFIER
```

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```
                    ::= { wranDevCommonObjects 2 }
wranDevCmnSnmpV1V2TrapDestTable OBJECT IDENTIFIER
                    ::= { wranDevCmnSnmpAgent 1 }

wranDevCmnSnmpV1V2TrapDestTable OBJECT-TYPE
  SYNTAXSEQUENCE OF wranDevCmnSnmpV1V2TrapDestEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
     "This compound object deals with the configuration of
                  items of the SNMP agent. Each configuration item is
                  represented by wranDevCmnSnmpV1V2TrapDestEntry."
  ::= { wranDevCmnSnmpAgent 1 }

wranDevCmnSnmpV1V2TrapDestEntryOBJECT-TYPE
  SYNTAXwranDevCmnSnmpV1V2TrapDestEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
     "The compound object contains the parameters that
                  identify the destination of an SNMP trap."
  INDEX{ wranDevCmnSnmpV1V1TrapDestIndex }
  ::= { wranDevCmnSnmpV1V2TrapDestTable 1 }

wranDevCmnSnmpV1V2TrapDestEntry::= SEQUENCE {
  wranDevCmnSnmpV1V1TrapDestIndexUnsigned32,
  wranDevCmnSnmpV1V2TrapDestIpAddrTypeInetAddressType,
  wranDevCmnSnmpV1V2TrapDestIpAddrInetAddress,
  wranDevCmnSnmpV1V2TrapDestPortInteger32,
  wranDevCmnSnmpV1V2TrapDestRowStatusRowStatus }

wranDevCmnSnmpV1V1TrapDestIndexOBJECT-TYPE
  SYNTAXINTEGER (1..8)
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
     "Identifies the trap in the table. This parameter
                  shall have a maximum value of 8."
  ::= { wranDevCmnSnmpV1V2TrapDestEntry 1 }

wranDevCmnSnmpV1V2TrapDestIpAddrTypeOBJECT-TYPE
  SYNTAXInetAddressType
  MAX-ACCESSread-create
  STATUScurrent
  DESCRIPTION
     "Type of IP address stored in
                  wranDevCmnSnmpV1V2TrapDestIpAddr."
  ::= { wranDevCmnSnmpV1V2TrapDestEntry 2 }
```

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```
wranDevCmnSnmpV1V2TrapDestIpAddrOBJECT-TYPE
  SYNTAX       InetAddress
  MAX-ACCESS   read-create
  STATUS       current
  DESCRIPTION
     "SNMP manager's IP address that is configured as a
                  destination for traps."
  ::= { wranDevCmnSnmpV1V2TrapDestEntry 3 }

wranDevCmnSnmpV1V2TrapDestPortOBJECT-TYPE
  SYNTAXInteger32 (0..65535)
  MAX-ACCESSread-create
  STATUScurrent
  DESCRIPTION
     "Port number of SNMP manager application configured
                  as trap destination."
  ::= { wranDevCmnSnmpV1V2TrapDestEntry 4 }

wranDevCmnSnmpV1V2TrapDestRowStatusOBJECT-TYPE
  SYNTAXRowStatus
  MAX-ACCESSread-create
  STATUScurrent
  DESCRIPTION
     "This object is used to make sure that any write
                  operation to multiple columns is treated as an
                  atomic operation."
  ::= { wranDevCmnSnmpV1V2TrapDestEntry 5 }

wranDevCmnDeviceConfigOBJECT IDENTIFER
                  ::= { wranDevCommonObjects 3 }
wranDevCmnResetDeviceOBJECT IDENTIFIER
                  ::= { wranDevCmnDeviceConfig 1 }
wranDevMibGroupsOBJECT IDENTIFIER
                  ::= { wranDevCmnDeviceConfig 2 }
wranDevMibComplianceOBJECT IDENTIFIER
                  ::= { wranDevCmnDeviceConfig 3 }

wranDevCmnResetDeviceOBJECT-TYPE
  SYNTAXINTEGER { actionResetDeviceNoAction(0),
                    actionResetDevice(1) }
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
     "There are two actions defined. When set to
      actionResetDeviceNoAction, no action is taken. When
                  set to actionResetDevice, device will reset itself."
  ::= { wranDevCmnDeviceConfig 1 }
```

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```
-- wranDevMibGroups: This object helps define which MIB groups are
-- necessary to meet conformance and what MIB objects are part of each
-- group.

  wranDevMibGroupsOBJECT IDENTIFIER
                    ::= { wranDevCmnDeviceConfig 2 }
  wranDevMibBsGroupOBJECT IDENTIFIER
                    ::= { wranDevMibGroups 1 }
  wranDevMibBsSwUpgradeGroupOBJECT IDENTIFIER
                    ::= { wranDevMibGroups 2 }
  wranDevMibCpeGroupOBJECT IDENTIFIER
                    ::= { wranDevMibGroups 3 }
  wranDevMibCmnGroupOBJECT IDENTIFIER
                           ::= { wranDevMibGroups 4 }
  wranDevMibBsNotificationGroupOBJECT IDENTIFIER
                           ::= { wranDevMibGroups 5 }
  wranDevMibCpeNotificationGroup OBJECT IDENTIFIER
                           ::= { wranDevMibGroups 6 }
  wranDevCpeTrapControlGroupOBJECT IDENTIFIER
                           ::= { wranDevMibGroups 7 }
  wranDevBsTrapControlGroupOBJECT IDENTIFIER
                           ::= { wranDevMibGroups 8 }

  wranDevMibBsGroupOBJECT-GROUP
    OBJECTS{ wranDevBsTrapControl }
    STATUScurrent
    DESCRIPTION
       "Group of objects for the BS."
    ::= { wranDevMibGroups 1 }

  wranDevMibBsSwUpgradeGroupOBJECT-GROUP
    OBJECTS{ wranDevBsVendorId, wranDevBsHwId,
                  wranDevBsCurrentSwVersion,
                  wranDevBsUpgradeFileName,
                  wranDevBsSoftwareUpgradeAdminState,
                  wranDevBsDownloadSwProgress,
                  wranDevBsSoftwareUpgradeAdminState,
                  wranDevBsDownloadSwProgress,
                  wranDevBsSoftwareUpgradeTimeStamp }
    STATUScurrent
    DESCRIPTION
       "This group contains the values of the most
                   recent/current entry in
                   wranDevBsSoftwareUpgradeTable."
    ::= { wranDevMibGroups 2 }

  wranDevMibCpeGroupOBJECT-GROUP
```

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```
  OBJECTS{ wranDevCpeMicConfigSetting,
                wranDevCpeVendorId,  wranDevCpeHwId,
                wranDevCpeConfigFileVersion,
                wranDevCpeUpgradeFileName,
                wranDevCpeSwTftpServer,
                wranDevCpeTftpServerTimeStamp,
                wranDevCpeTrapControl }
  STATUScurrent
  DESCRIPTION
     "This group contains values of the most
                 recent/current entry in
                 wranDevCpeConfigFileEncodingTable for a particular
                 CPE."
  ::= { wranDevMibGroups 3 }

wranDevMibCmnGroupOBJECT-GROUP
  OBJECTS{ wranDevCmnSnmpV1V2TrapDestIpAddrType,
                wranDevCmnSnmpV1V2TrapDestIpAddr,
                wranDevCmnSnmpV1V2TrapDestPort,
                wranDevCmnSnmpV1V2TrapDestRowStatus,
                wranDevCmnResetDevice, wranDevCmnDeviceIndex,
                wranDevCmnEventLogEntryLimit,
                wranDevCmnEventLogLifeTimeLimit,
                wranDevCmnEventLogEntryLimitPerEventId,
                wranDevCmnEventLogSeverityThreshold,
                wranDevCmnEventLogWrapAroundBuffEnable,
                wranDevCmnEventLogLatestEvent,
                wranDevCmnEventLogPersistenceSupported,
                wranDevCmnEventLogResidualBuffThreshold,
                wranDevCmnEventDescription,
                wranDevCmnEventSeverity,
                wranDevCmnEventNotification,
                wranDevCmnEventNotificationOid,
                wranDevCmnEventId, wranDevCmnEventLoggedTime,
                wranDevCmnEventLogDescription,
                wranDevCmnEventLogSeverity }
  STATUScurrent
  DESCRIPTION
     "It contains the values of most recent/current entry
                 in wranDevVMnSnmpV1V2TrapDestTable and
                 wranDevCmnEventLogTable."
  ::= { wranDevMibGroups 4 }

wranDevMibBsNotificationGroupOBJECT-GROUP
  OBJECTS{ wranDevBsEventTrap,
                wranDevBsLogBuffExceedThresholdTrap }
  STATUScurrent
  DESCRIPTION
```

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```
      "Contains the contents of wranDevBsEventTrap and
       wranDevBsLogBuffExceedThresholdTrap."
    ::= { wranDevMibGroups 5 }

  wranDevMibCpeNotificationGroupOBJECT-GROUP
    OBJECTS{ wranDevCpeEventTrap,
                  wranDevCpeLogBuffExceedThresholdTrap }
    STATUScurrent
    DESCRIPTION
       "Contains the contents of wranDevCpeEventTrap and
        wranDevCpeLogBuffExceedThresholdTrap."
    ::= { wranDevMibGroups 6 }

  wranDevCpeTrapControlGroupOBJECT-GROUP
    OBJECTS{ wranDevCpeTrapControl }
    STATUScurrent
    DESCRIPTION
       "Contains objects related to enabling/disabling CPE
                  device traps."
    ::= { wranDevMibGroups 7 }

  wranDevBsTrapControlGroupOBJECT-GROUP
    OBJECTS{ wranDevBsTrapControl }
    STATUScurrent
    DESCRIPTION
       "Contains objects related to enabling/disabling BS
                  device traps."
    ::= { wranDevMibGroups 8 }

  wranDevMibComplianceMODULE-COMPLIANCE
    STATUScurrent
    DESCRIPTION
       "MIB object groups that are optional and mandatory
                  for conformance."
    MODULEwranDevMib
    MANDATORY-GROUPS{ wranDevMibBsGroup,
                  wranDevMibBsSwUpgradeGroup,
                  wranDevMibCpeGroup, wranDevMibCmnGroup,
                  wranDevCpeTrapControlGroup,
                  wranDevBsTrapControlGroup }
    -- OPTIONAL-GROUPS{ wranDevMibBsNotificationGroup,
                     wranDevMibCpeNotificationGroup }
    ::= { wranDevCmnDeviceConfig 3 }

END
```

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14.2.2 wranIfBsMib

```
IEEE802dot22-WRAN-IF-BS-MIB::=BEGIN

  IMPORTS
    MODULE-IDENTITY,
    OBJECT-TYPE,
    NOTIFICATION-TYPE,
            Unsinged32, Integer32, Counter32
            Counter64
                  From SNMPv2-SMI
            SnmpAdminString
                  FROM SNMP-FRAMEWORK-MIB
            TEXTUAL-CONVENTION,
            MacAddress, RowStatus, TruthValue,
            TimeStamp, DateAndTime
                  FROM SNMPv2-TC
            InetAddressType, InetAddress
                  FROM INET-ADDRESS-MIB
            OBJECT-GROUP,
            MODULE-COMPLIANCE,
            NOTIFICATION-GROUP
                  FROM SNMPv2-CONF

      wranIfBsMib MODULE-IDENTITY
            LAST-UPDATED"201405300000Z"-- May 30, 2014
            ORGANIZATION"IEEE 802.22"
            CONTACT-INFO
                  "WG E-mail:STDS-802-22@LISTSERV.IEEE.ORG
                   WG Chair:Apurva N. Mody
                   E-mail:apurva.mody@ieee.org

                   TGa Chair/Editor:  Ranga Reddy
                   E-mail:      ranga.reddy@ieee.org"
            DESCRIPTION
                  "This material is from IEEE Std 802.22a-2014
                   Copyright (c) 2014. This MIB Module Defines managed
                   objects for Base Station based on IEEE Std 802.22-
                   2011 and is under
                   iso(1).std(0).iso8802(8802).wran(22).wranIfBsMib(2)"
    REVISION      "201405300000Z"
    DESCRIPTION
      "The first version of IEEE802dot22-WRAN-IF-BS-
                   MIB that provides for management of the base
                   station."
    ::= {iso std(0) iso8802(8802) wran(22) 2}

  wranIfBsFm      OBJECT IDENTIFIER ::= { wranIfBsMib 1 }
```

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```
  wranIfBsCm      OBJECT IDENTIFIER ::= { wranIfBsMib 2 }
  wranIfBsAm      OBJECT IDENTIFIER ::= { wranIfBsMib 3 }
  wranIfBsPm      OBJECT IDENTIFIER ::= { wranIfBsMib 4 }
  wranIfBsScm     OBJECT IDENTIFIER ::= { wranIfBsMib 5 }


-- wranIfBsFm: Exceptions and fault events can be reported using the
-- traps defined in this MIB.

  wranIfBsTrapControlOBJECT IDENTIFIER
                            ::= { wranIfBsFm 1 }
  wranIfBsTrapDefinitionOBJECT IDENTIFIER
                            ::= { wranIfBsFm 2 }
  wranIfBsNotificationObjectsTableOBJECT IDENTIFIER
                            ::= { wranIfBsFm 3 }


  wranIfBsTrapControlOBJECT-TYPE
    SYNTAXBITS { dynamicService(0),
                 signalPowerMetrics(1),
                 regNotification(2), scmNotification(3),
                 cpeStartupStatusChange(4),
                 txMetrics(5), netEntryMetrics(6),
                 pktErrRateNotification(7),
                 userMetricsNotification(8),
                 coexistenceNotification(9),
                 basicCapabilityNotification(10),
                 rangingNotification(11),
                 authMetricsNotification(12)
                 dynamicServeMetrics(13) }
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "This object is a bitmap that allows
                 enabling/disabling of traps related
                 setup/configuration of dynamic service flows (Bit0),
                 recording power measurements (Bit1), registration of
                 CPEs (Bit2), authentication+keying of CPEs (Bit3),
                 startup status of CPEs (Bit4), change in throughput
                 & retransmission metrics (Bit5), update of network
                 entry metrics (Bit6), update of packet error metrics
                 (Bit7), update of user metrics (Bit8), change in
                 coexistence status (Bit9), change in basic
                 capability configuration of CPEs (Bit10), change in
                 ranging status of CPEs (Bit11), update of
                 authentication metrics (Bit12), update of dynamic
                 service metrics (Bit13). A trap is enabled if the
                 bit is set to 1 and disable if set to 0."
```

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```
    ::= { wranIfBsFm 1 }


  wranIfBsTrapDefinition OBJECT IDENTIFIER
                          ::= { wranIfBsFm 2 }
  wranIfBsDynamicServiceTrap OBJECT IDENTIFIER
                          ::= { wranIfBsTrapDefinition 1 }
  wranIfBsSignalPowerMetricsTrap OBJECT IDENTIFIER
                          ::= { wranIfBsTrapDefinition 2 }
  wranIfBsRegNotificationTrap OBJECT IDENTIFIER
                          ::= { wranIfBsTrapDefinition 3 }
  wranIfBsScmNotificationTrap OBJECT IDENTIFIER
                          ::= { wranIfBsTrapDefinition 4 }
  wranIfBsStartupStatusTrap OBJECT IDENTIFIER
                          ::= { wranIfBsTrapDefinition 5 }
  wranIfBsTxMetricsTrap OBJECT IDENTIFIER
                          ::= { wranIfBsTrapDefinition 6 }
  wranIfBsNetEntryMetricsTrap OBJECT IDENTIFIER
                          ::= { wranIfBsTrapDefinition 7 }
  wranIfBsPktErrorTrap OBJECT IDENTIFIER
                          ::= { wranIfBsTrapDefinition 8 }
  wranIfBsUserMetricsTrap OBJECT IDENTIFIER
                          ::= { wranIfBsTrapDefinition 9 }
  wranIfBsCoexistenceTrap OBJECT IDENTIFIER
                          ::= { wranIfBsTrapDefinition 10 }
  wranIfBsBasicCapabilityTrap OBJECT IDENTIFIER
                          ::= { wranIfBsTrapDefinition 11 }
  wranIfBsRangingTrap OBJECT IDENTIFIER
                          ::= { wranIfBsTrapDefinition 12 }
  wranIfBsAuthMetricsTrap OBJECT IDENTIFIER
                          ::= { wranIfBsTrapDefinition 13 }
  wranIfBsDynamicServiceMetricsTrap OBJECT IDENTIFIER
                          ::= { wranIfBsTrapDefinition 14 }

  wranIfBsDynamicServiceTrapNOTIFICATION-TYPE
    OBJECTS{ wranIfBsDynamicServiceType,
                  wranIfBsDynamicServiceNotificationIndex }
    STATUScurrent
    DESCRIPTION
      "This trap contains the information related to
                  updating the configuration of either provisioned
                  service flows (wranIfBsProvSfTable) or active
                  service flows (wranIfBsActiveSfTable)."
    ::= { wranIfBsTrapDefinition 1 }

  wranIfBsSignalPowerMetricsTrapNOTIFICATION-TYPE
    OBJECTS{ wranIfBsSignalPowerNotificationIndex }
```

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```
    STATUScurrent
    DESCRIPTION
      "This trap contains the information related to
                  updating of signal power metrics
                  (wranIfBsSignalPowerMetricsTable)."
    ::= { wranIfBsTrapDefinition 2 }

  wranIfBsRegNotificationTrapNOTIFICATION-TYPE
    OBJECTS{ wranIfBsRegCapabilityNotificationIndex }
    STATUScurrent
    DESCRIPTION
      "This trap contains the information related to
                  indicating successful execution of the registration
                  of a CPE (wranIfBsCpeRegCapabilityRspTable)."
    ::= { wranIfBsTrapDefinition 3 }

  wranIfBsScmNotificationTrapNOTIFICATION-TYPE
    OBJECTS{ wranIfBsScmNotificationType,
                  wranIfBsScmNotificationIndex }
    STATUScurrent
    DESCRIPTION
      "This trap contains the information related to
                  updating the configuration of either SCM protocol
                  capabilities on a CPE
                  (wranIfBsCpeScmCapabilityConfigTable) or current
                  authentication status
                  (wranIfBsCpeScmAuthConfigTable)."
    ::= { wranIfBsTrapDefinition 4 }

  wranIfBsStartupStatusTrapNOTIFICATION-TYPE
    OBJECTS{ wranIfBsStartupNotificationIndex }
    STATUScurrent
    DESCRIPTION
      "This trap contains the information related to
                  changes in a CPE's status with regard to network
                  entry (wranIfBsStartupMetricsTable)."
    ::= { wranIfBsTrapDefinition 5 }

  wranIfBsTxMetricsTrapNOTIFICATION-TYPE
    OBJECTS{ wranIfBsTxMetricsType,
                  wranIfBsTxMetricsNotificationIndex }
    STATUScurrent
    DESCRIPTION
      "This trap contains the information related to
                  changes in throughput metrics
                  (wranIfBsThroughputMetricsTable) or ARQ metrics
                  (wranIfBsArqMetricsTable)."
    ::= { wranIfBsTrapDefinition 6 }
```

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```
wranIfBsNetEntryMetricsTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfBsNetEntryMetricsNotificationIndex }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to
                updates in network entry and re-entry latency
                measurements (wranIfBsNetworkEntryMetricsTable)."
  ::= { wranIfBsTrapDefinition 7 }

wranIfBsPktErrorTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfBsPktErrorMetricsNotificationIndex }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to
                updates in packet error rate measurements
                (wranIfBsPacketErrorRateTable)."
  ::= { wranIfBsTrapDefinition 8 }

wranIfBsUserMetricsTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfBsUserMetricsNotificationIndex }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to
                updates in tracking the number of active and non-
                active users in the cell
                (wranIfBsUserMetricsTable)."
  ::= { wranIfBsTrapDefinition 9 }

wranIfBsCoexistenceTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfBsCoexMetricsType,
                wranIfBsCoexNotificationIndex }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to
                updates in tracking ongoing coexistence (e.g., On-
                Demand Frame Contention transactions
                wranIfBsCoexistenceStatusTable), discovery of new
                potential coexistence sources
                (wranIfBsCoexistenceSourceTable), discovery the
                the resource usage in neighboring networks
                (wranIfBsCoexistenceResourceListTable), and updates
                to a BS's own coexistence configuration
                (wranIfBsCoexistenceCurrentConfigTable)."
  ::= { wranIfBsTrapDefinition 10 }

wranIfBsBasicCapabilityTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfBsBasicNotificationIndex }
```

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```
    STATUScurrent
    DESCRIPTION
      "This trap contains the information related to
                  updates in tracking updates to basic capability
                  configuration of CPEs
                  (wranIfBsCpeBasicCapabilityRspTable)."
    ::= { wranIfBsTrapDefinition 11 }

  wranIfBsRangingTrapNOTIFICATION-TYPE
    OBJECTS{ wranIfBsRngNotificationIndex }
    STATUScurrent
    DESCRIPTION
      "This trap contains the information related to
                  updates in tracking updates to status of ranging of
                  CPEs (wranIfBsCpeRngCapabilityCmdTable)."
    ::= { wranIfBsTrapDefinition 12 }

  wranIfBsAuthMetricsTrapNOTIFICATION-TYPE
    OBJECTS{ wranIfBsAuthNotificationIndex }
    STATUScurrent
    DESCRIPTION
      "This trap contains the information related to
                  updates in tracking updates to authentication
                  metrics (wranIfBsAuthenticationMetricsTable)."
    ::= { wranIfBsTrapDefinition 13 }

  wranIfBsDynamicServiceMetricsTrapNOTIFICATION-TYPE
    OBJECTS{ wranIfBsDynSrvMetricsNotificationIndex }
    STATUScurrent
    DESCRIPTION
      "This trap contains the information related to
                  updates in tracking metrics current provisioned and
                  active service flows
                  (wranIfBsServiceFlowMetricsTable)."
    ::= { wranIfBsTrapDefinition 14 }

  wranIfBsNotificationObjectsTable OBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsNotificationObjectsEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This table contains objects that represents
                  notifications reported in BS fault traps. The table
                  is made up of one or more entries."
    ::= { wranIfBsFm 3 }

  wranIfBsNotificationObjectsEntryOBJECT-TYPE
    SYNTAXwranIfBsNotificationObjectsEntry
```

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```
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      " This MIB is a compound object that represents an
                  entry in the MIB object
                  wranIfBsNotificationsObjectsTable."
    INDEX{ wranIfBsNotificationObjectsIndex }
    ::= { wranIfBsNotificationObjectsTable 1 }

  wranIfBsNotificationObjectsEntry::= SEQUENCE {
    wranIfBsNotificationObjectsIndexINTEGER,
    wranIfBsNotificationMacAddrMacAddress,
    wranIfBsDynamicServiceTypeINTEGER,
    wranIfBsDynamicServiceNotificationIndexInteger32,
    wranIfBsSignalPowerNotificationIndexInteger32,
    wranIfBsRegCapabilityNotificationIndexInteger32,
    wranIfBsScmNotificationTypeINTEGER,
    wranIfBsScmNotificationIndexInteger32,
    wranIfBsStartupNotificationIndexINTEGER,
    wranIfBsTxMetricsTypeINTEGER,
    wranIfBsTxMetricsNotificationIndexINTEGER,
    wranIfBsNetEntryMetricsNotificationIndexINTEGER,
    wranIfBsPktErrorMetricsNotificationIndexINTEGER,
    wranIfBsUserErrorMetricsNotificationIndexINTEGER,
    wranIfBsCoexMetricsTypeINTEGER,
    wranIfBsCoexNotificationIndexInteger32,
    wranIfBsBasicNotificationIndexInteger32,
    wranIfBsRngNotificationIndexInteger32,
    wranIfBsAuthNotificationIndexINTEGER,
    wranIfBsDynSrvMetricsNotificationIndexINTEGER }

  wranIfBsNotificationObjectsIndexOBJECT-TYPE
    SYNTAXINTEGER (1..1)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index of entry in table."
    ::= { wranIfBsNotificationObjectsEntry 1 }

  wranIfBsNotificationMacAddrOBJECT-TYPE
    SYNTAXMacAddress
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "MAC Address reporting the notification."
    ::= { wranIfBsNotificationObjectsEntry 2 }

  wranIfBsDynamicServiceTypeOBJECT-TYPE
```

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```
    SYNTAXINTEGER { provisioned(0), active(1) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Indication if the configuration for a provisioned
                  or active service flow has been configured."
    ::= { wranIfBsNotificationObjectsEntry 3 }

  wranIfBsDynamicServiceNotificationIndexOBJECT-TYPE
    SYNTAXInteger32 (1..2048)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index into wranIfBsProvSfTable or
                  wranIfBsActiveSfTable that indicates which service
                  flow configuration was added/updated."
    ::= { wranIfBsNotificationObjectsEntry 4 }

  wranIfBsSignalPowerNotificationIndexOBJECT-TYPE
    SYNTAXInteger32 (1..261120)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index into wranIfBsSignalPowerMetricsTable that
                  indicates the entry that contains updated signal
                  power metrics data."
    ::= { wranIfBsNotificationObjectsEntry 5 }

  wranIfBsRegCapabilityNotificationIndexOBJECT-TYPE
    SYNTAXwranIfRegCapabilityIndex
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index into wranIfBsCpeRegCapabilityRspTable that
                  indicates the entry that contains updated
                  registration for a CPE."
    ::= { wranIfBsNotificationObjectsEntry 6 }

  wranIfBsScmNotificationTypeOBJECT-TYPE
    SYNTAXINTEGER { scmCapability(0), scmAuthConfig(1) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Indication if the configuration of the SCM protocol
                  or the authentication status of a CPE has been
                  updated."
    ::= { wranIfBsNotificationObjectsEntry 7 }
```

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```
wranIfBsScmNotificationIndexOBJECT-TYPE
  SYNTAXInteger32 (1..512)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index into wranIfBsCpeScmCapabilityConfigTable that
                indicates which CPE has updated their SCM
                configuration or wranIfBsCpeScmAuthConfigTable that
                indicates which CPE has had their authentication
                status updated."
  ::= { wranIfBsNotificationObjectsEntry 8 }

wranIfBsStartupNotificationIndexOBJECT-TYPE
  SYNTAXINTEGER (1..1)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "This contains the index of entry in
                wranIfBsStartupMetricsTable that contains data on
                any changes in a CPE's status with regard to network
                entry."
  ::= { wranIfBsNotificationObjectsEntry 9 }

wranIfBsTxMetricsTypeOBJECT-TYPE
  SYNTAXINTEGER { throughput(0), arq(1) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Indication if throughput metrics or ARQ metrics have
                been updated."
  ::= { wranIfBsNotificationObjectsEntry 10 }

wranIfBsTxMetricsIndexOBJECT-TYPE
  SYNTAXINTEGER (1..1)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index into wranIfBsThroughputMetricsTable that
                indicates changes in measure throughput metrics, or
                wranIfBsArqMetricsTable that indicates changes in
                ARQ performance."
  ::= { wranIfBsNotificationObjectsEntry 11 }

wranIfBsNetEntryMetricsNotificationIndexOBJECT-TYPE
  SYNTAXINTEGER (1..1)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
```

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```
      "This contains the index of entry in
                  wranIfBsNetworkEntryMetricsTable that contains data
                  on any changes in network entry and re-entry latency
                  measurements."
    ::= { wranIfBsNotificationObjectsEntry 12 }

  wranIfBsPktErrorMetricsNotificationIndexOBJECT-TYPE
    SYNTAXINTEGER (1..1)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This contains the index of entry in
                  wranIfBsPacketErrorRateTable that contains data on
                  any changes in packet error rate measurements."
    ::= { wranIfBsNotificationObjectsEntry 13 }

  wranIfBsUserMetricsNotificationIndexOBJECT-TYPE
    SYNTAXINTEGER (1..1)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This contains the index of entry in
                  wranIfBsUserMetricsTable that contains data on any
                  changes in the number of active and non-active users
                  in the cell."
    ::= { wranIfBsNotificationObjectsEntry 14 }

  wranIfBsCoexMetricsTypeOBJECT-TYPE
    SYNTAXINTEGER { odfcTransaction(0),
                    potentialCoexSource(1),
                    resourceUsage(2),
                    coexistenceConfig(3) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Indication if ongoing On-Demand Frame Coexistence
                  Transactions, discovery of new potential coexistence
                  resources, discovery of the resource usage in
                  neighboring networks, and whether a BS's own
                  coexistence configuration have been updated."
    ::= { wranIfBsNotificationObjectsEntry 15 }

  wranIfBsCoexNotificationIndexOBJECT-TYPE
    SYNTAXInteger32 (1..4096)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index into wranIfBsCoexistenaceStatusTable that
```

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```
                    indicates changes in ongoing On-Demand Frame
                    Contention transactions,
                    wranIfBsCoexistenceSourceTable that indicates
                    changes in the discovery of new potential
                    coexistence sources,
                    wranIfBsCoexistenceResourceListTable that indicates
                    discovery of resource usage in neighboring networks,
                    or wranIfBsCoexistenceCurrentConfigTable that
                    indicates whether a BS's own coexistence
                    configuration have been updated."
    ::= { wranIfBsNotificationObjectsEntry 16 }

  wranIfBsBasicNotificationIndexOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityIndex
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This contains the index of entry in
                    wranIfBsCpeBasicCapabilityRspTable that contains
                    data on any changes in tracking updates to the basic
                    capability configuration of CPEs."
    ::= { wranIfBsNotificationObjectsEntry 17 }

  wranIfBsRngNotificationIndexOBJECT-TYPE
    SYNTAXInteger32 (1..512)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This contains the index of entry in
                    wranIfBsCpeRngCapabilityCmdTable that contains data
                    on any changes in tracking updates to the status of
                    ranging of CPEs."
    ::= { wranIfBsNotificationObjectsEntry 18 }

  wranIfBsAuthNotificationIndexOBJECT-TYPE
    SYNTAXINTEGER (1..1)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This contains the index of entry in
                    wranIfBsAuthenticationMetricsTable that contains
                    data on any changes in tracking updates to
                    authentication metrics."
    ::= { wranIfBsNotificationObjectsEntry 19 }

  wranIfBsDynSrvMetricsNotificationIndexOBJECT-TYPE
    SYNTAXINTEGER (1..1)
    MAX-ACCESSread-only
```

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```
    STATUScurrent
    DESCRIPTION
      "This contains the index of entry in
                  wranIfBsServiceFlowMetricsTable that contains
                  information related to tracking metrics of ongoing."
    ::= { wranIfBsNotificationObjectsEntry 20 }

-- wranIfBsFmMibGroups: This object helps define which MIB groups are
-- available in this module (wranIfBsFm) and which MIB objects are
-- part of each group.

  wranIfBsFmMibGroupsOBJECT IDENTIFIER
                            ::= { wranIfBsFm 4 }
  wranIfBsFmTrapControlGroupOBJECT IDENTIFIER
                            ::= { wranIfBsFmMibGroups 1 }
  wranIfBsFmNotificationGroupOBJECT IDENTIFIER
                            ::= { wranIfBsFmMibGroups 2 }

  wranIfBsFmTrapControlGroupOBJECT-GROUP
    OBJECTS{ wranIfBsTrapControl }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                  enabling/disabling traps used for  service
                  flow management."
    ::= { wranIfBsFmMibGroups 1 }

  wranIfBsFmNotificationGroupOBJECT-GROUP
    OBJECTS{ wranIfBsDynamicServiceTrap,
                  wranIfBsSignalPowerMetricsTrap,
                  wranIfBsRegNotificationTrap,
                  wranIfBsScmNotificationTrap,
                  wranIfBsStartupStatusTrap,
                  wranIfBsTxMetricsTrap,
                  wranIfBsNetEntryMetricsTrap,
                  wranIfBsPktErrorTrap, wranIfBsUserMetricsTrap,
                  wranIfBsCoexistenceTrap,
                  wranIfBsBasicCapabilityTrap,
                  wranIfBsRangingTrap, wranIfBsAuthMetricsTrap,
                  wranIfBsDynamicServiceMetricsTrap,
                  wranIfBsNotificationObjectsIndex,
                  wranIfBsNotificationMacAddr,
                  wranIfBsDynamicServiceType,
                  wranIfBsDynamicServiceNotificationIndex,
                  wranIfBsSignalPowerNotificationIndex,
                  wranIfBsRegCapabilityNotificationIndex,
                  wranIfBsScmNotificationType,
                  wranIfBsScmNotificationIndex,
```

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```
                    wranIfBsStartupNotificationIndex,
                    wranIfBsTxMetricsType,
                    wranIfBsTxMetricsNotificationIndex,
                    wranIfBsNetEntryMetricsNotificationIndex,
                    wranIfBsPktErrorMetricsNotificationIndex,
                    wranIfBsUserErrorMetricsNotificationIndex,
                    wranIfBsCoexMetricsType,
                    wranIfBsCoexNotificationIndex,
                    wranIfBsBasicNotificationIndex,
                    wranIfBsRngNotificationIndex,
                    wranIfBsAuthNotificationIndex,
                    wranIfBsDynSrvMetricsNotificationIndex }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                    traps used for management of the BS."
    ::= { wranIfBsFmMibGroups 2 }


  wranIfBsFmMibComplianceMODULE-COMPLIANCE
    STATUScurrent
    DESCRIPTION
      "MIB objects that are optional and mandatory for
                    wranIfBsFm compliance."
    MODULEwranIfBsFm
    MANDATORY-GROUPS{ wranIfBsFmTrapControlGroup }
    -- OPTIONAL-GROUPS{ wranIfBsFmNotificationGroup }
    ::= { wranIfBsFm 5 }

-- wranIfBsCm: This MIB group contains various objects related to
-- Configuration Management.

  wranIfBsCpeRngCapabilityReqTableOBJECT IDENTIFIER
                                ::= { wranIfBsCm 1 }
  wranIfBsCpeRngCapabilityCmdTableOBJECT IDENTIFIER
                                ::= { wranIfBsCm 2 }
  wranIfBsCpeBasicCapabilityReqTableOBJECT IDENTIFIER
                                ::= { wranIfBsCm 3 }
  wranIfBsCpeBasicCapabilityRspTableOBJECT IDENTIFIER
                                ::= { wranIfBsCm 4 }
  wranIfBsCpeRegCapabilityReqTableOBJECT IDENTIFIER
                                ::= { wranIfBsCm 5 }
  wranIfBsCpeMeasSupportReqTableOBJECT IDENTIFIER
                                ::= { wranIfBsCm 6 }
  wranIfBsCpeRegCapabilityRspTableOBJECT IDENTIFIER
                                ::= { wranIfBsCm 7 }
  wranIfBsCpeMeasSupportRspTableOBJECT IDENTIFIER
                                ::= { wranIfBsCm 8 }
```

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```
wranIfBsCpeAntennaGainTableOBJECT IDENTIFIER
                                ::= { wranIfBsCm 9 }
wranIfBsScmCapabilityConfigurationOBJECT IDENTIFIER
                                ::= { wranIfBsCm 10 }
wranIfBsCpeScmCapabilityConfigTableOBJECT IDENTIFIER
                                ::= { wranIfBsCm 11 }
wranIfBsScmAuthConfigTableOBJECT IDENTIFIER
                                ::= { wranIfBsCm 12 }
wranIfBsActionsTableOBJECT IDENTIFIER
                                ::= { wranIfBsCm 13 }
wranIfBsCpeMulticastConfigTableOBJECT IDENTIFIER
                                ::= { wranIfBsCm 14 }
wranIfBsCoexistenceConfigTableOBJECT IDENTIFIER
                                ::= { wranIfBsCm 15 }
wranIfBsCpeBasicCapabilityCmnOBJECT IDENTIFIER
                                ::= { wranIfBsCm 16 }
wranIfBsCpeRegCapabilityCmnOBJECT IDENTIFIER
                                ::= { wranIfBsCm 17 }
wranIfBsCpeMeasSupportCmnOBJECT IDENTIFIER
                                ::= { wranIfBsCm 18 }
wranIfBsCpeSystemParametersTableOBJECT IDENTIFIER
                                ::= { wranIfBsCm 19 }
wranIfBsPhy                OBJECT IDENTIFIER
                                ::= { wranIfBsCm 20 }

wranIfBsCpeRngCapabilityReqTable OBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfBsCpeRngCapabilityReqEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object provides a table containing the ranging
                configuration requested by the CPE in RNG-REQ during
                network entry. The table is made up of multiple
                entries, one for each CPE that has sent a RNG-REQ,
                that is defined by
                wranIfBsCpeRngCapabilityReqEntry."
  ::= { wranIfBsCm 1 }

wranIfBsCpeRngCapabilityReqEntryOBJECT-TYPE
  SYNTAXwranIfBsCpeRngCapabilityReqEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object is a compound object that defines an
                entry in wranIfBsCpeRngCapabilityReqTable."
  INDEX{ wranIfBsCpeRngCapabilityReqIndex }
  ::= { wranIfBsCpeRngCapabilityReqTable 1 }
```

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```
wranIfBsCpeRngCapabilityReqEntry::= SEQUENCE {
  wranIfBsCpeRngCapabilityReqIndexInteger32,
  wranIfBsCpeMacAddressMacAddress,
  wranIfMmpPn             Integer32,
  wranIfCiphertextIcvCounter64,
  wranIfRngAnomaly    BITS }

wranIfBsCpeRngCapabilityReqIndexOBJECT-TYPE
  SYNTAXInteger32 (1.. 512)
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "Index of entry in this table."
  ::= { wranIfBsCpeRngCapabilityReqEntry 1 }

wranIfBsCpeMacAddressOBJECT-TYPE
  SYNTAXMacAddress
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in this table."
  ::= { wranIfBsCpeRngCapabilityReqEntry 2 }

wranIfMmpPnOBJECT-TYPE
  SYNTAXInteger32 (0..16777215)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Current value of MMP_PN that CPE is using if
                authenticated ranging (see 8.2.4.6.1.2) is used."
  ::= { wranIfBsCpeRngCapabilityReqEntry 3 }

wranIfCiphertextIcvOBJECT-TYPE
  SYNTAXCounter64
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Calculated value of Ciphertext ICV, calculated over
                RNG-REQ is authenticated ranging (see 8.2.4.6.1.2)."
  ::= { wranIfBsCpeRngCapabilityReqEntry 4 }

wranIfRngAnomalyOBJECT-TYPE
  SYNTAXBITS { atMaxEIRP(0), atMinEIRP(1),
                timingAdvTooLarge(2) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
```

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```
      "3-bit bitmap that gives indication of any error
                  condition detected by CPE during ranging process."
    ::= { wranIfBsCpeRngCapabilityReqEntry 5 }

  wranIfBsCpeRngCapabilityCmdTable OBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsCpeRngCapabilityCmdEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object provides a table containing the ranging
                  configuration the BS is specifying for CPE in the
                  RNG-CMD during network entry. Each table is made up
                  of multiple entries, one for each CPE that a RNG-CMD
                  is sent, that is defined by
                  wranIfBsCpeRngCapabilityCmdEntry."
    ::= { wranIfBsCm 2 }

  wranIfBsCpeRngCapabilityCmdEntryOBJECT-TYPE
    SYNTAXwranIfBsCpeRngCapabilityReqEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object is a compound object that defines an
                  entry in wranIfBsCpeRngCapabilityCmdTable."
    INDEX{ wranIfBsCpeRngCapabilityCmdIndex }
    ::= { wranIfBsCpeRngCapabilityCmdTable 1 }

  wranIfBsCpeRngCapabilityCmdEntry::= SEQUENCE {
    wranIfBsCpeRngCapabilityCmdIndexInteger32,
    wranIfBsCpeMacAddressMacAddress,
    wranIfBsCpeStationIdInteger32,
    wranIfTimingAdvanceInteger32,
    wranIfEirpPerSubcarrierINTEGER,
    wranIfOffsetFreqAdjustInteger32,
    wranIfRangingStatusINTEGER,
    wranIfActionSuperFrameNumINTEGER,
    wranIfCdmaCode       INTEGER,
    wranIfTxOpportunityOffsetINTEGER }

  wranIfBsCpeRngCapabilityCmdIndexOBJECT-TYPE
    SYNTAXInteger32 (1.. 512)
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "Index of entry in this table."
    ::= { wranIfBsCpeRngCapabilityCmdEntry 1 }

  wranIfBsCpeMacAddressOBJECT-TYPE
```

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```
    SYNTAXMacAddress
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "MAC Address of CPE that RNG-CMD is sent to. This is
                  used to fill in the MAC Address field of RNG-CMD,
                  when RNG-CMD is sent in response to initial
                  ranging."
    ::= { wranIfBsCpeRngCapabilityCmdEntry 2 }

  wranIfBsCpeStationIdOBJECT-TYPE
    SYNTAXInteger32 (1..512)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Station ID of CPE that RNG-CMD is sent to. This is
                  used to fill in the Station ID field of RNG-CMD,
                  when RNG-CMD is sent in response to initial
                  ranging."
    ::= { wranIfBsCpeRngCapabilityCmdEntry 3 }

  wranIfTimingAdvanceOBJECT-TYPE
    SYNTAXInteger32 (0..65535)
    UNITS"TU"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Unsigned timing advance to be applied to compensate
                  for signal propagation delay on both the US and DS,
                  in number of TU."
    ::= { wranIfBsCpeRngCapabilityCmdEntry 4 }

  wranIfEirpPerSubcarrierOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "EIRP to be applied to subcarrier, from -104 dBm to
                  +23.5 dBm in 0.5 dB steps."
    ::= { wranIfBsCpeRngCapabilityCmdEntry 5 }

  wranIfOffsetFreqAdjustOBJECT-TYPE
    SYNTAXInteger32 (0..65535)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Offset frequency adjustment parameter of RNG-CMD."
    ::= { wranIfBsCpeRngCapabilityCmdEntry 6 }
```

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```
wranIfRangingStatusOBJECT-TYPE
  SYNTAXINTEGER { continue(0), abort(1),
                  success(2), reRange(3),
                  reAuth(4), reRngAndreReg(5) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Ranging status sent to CPE in RNG-CMD to indicate
                what step the CPE should take next."
  ::= { wranIfBsCpeRngCapabilityCmdEntry 7 }

wranIfActionSuperFrameNumOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "The superframe number (modulo 256) at which Channel
                Action shall be performed."
  ::= { wranIfBsCpeRngCapabilityCmdEntry 8 }

wranIfCdmaCodeOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "CDMA code value to be sent in RNG-CMD to enable
                dedicated ranging (selected from initial ranging
                codeset)."
  ::= { wranIfBsCpeRngCapabilityCmdEntry 9 }

wranIfTxOpportunityOffsetOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  UNITS "symbols"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Transmission opportunity offset sent to CPE in RNG-
                CMD, to used for dedicated ranging."
  ::= { wranIfBsCpeRngCapabilityCmdEntry 10 }


wranIfBsCpeBasicCapabilityReqTable OBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfBsCpeBasicCapabilityReqEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object provides a table containing the basic
```

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```
                capability information CPEs that have declared to
                the BS in the CBC-REQ. Each table is made up of
                multiple entries, one for each CPE that has
                transmitted the CBC-REQ, that is defined by
                wranIfBsCpeBasicCapabilityReqEntry."
  ::= { wranIfBsCm 3 }

wranIfBsCpeBasicCapabilityReqEntryOBJECT-TYPE
  SYNTAXwranIfBsCpeBasicCapabilityReqEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object is a compound object that contains
                information on capabilities that a CPE has declared
                to a BS during network entry. The list of objects
                used to make wranIfBsCpeBasicCapabilityReqEntry can
                be found in 14.1.2.2.6
                (wranIfBsCpeBasicCapabilityCmn)."
  INDEX{ wranIfBsCpeBasicCapabilityReqIndex }
  ::= { wranIfBsCpeBasicCapabilityReqTable 1 }

wranIfBsCpeBasicCapabilityReqEntry::= SEQUENCE {
  wranIfBsCpeBasicCapabilityReqIndex
    wranIfBasicCapbilityIndex,
  wranIfBsCpeBasicCapabilityReqMacAddress
    wranIfBasicCapabilityMacAddress,
  wranIfBsCpeBasicCapabilityReqStationId
    wranIfBasicCapbilityStationId,
  wranIfBsCpeBasicCapabilityReqMacPduTxAndConstruction
    wranIfBasicCapabilityMacPduTxAndConstruction,
  wranIfBsCpeBasicCapabilityReqMaxCpeTxEirp
    wranIfBasicCapabilityMaxCpeTxEirp,
  wranIfBsCpeBasicCapabilityReqCpeDemodulator
    wranIfBasicCapabilityCpeDemodulator,
  wranIfBsCpeBasicCapabilityReqCpeModulator
    wranIfBasicCapabilityCpeModulator,
  wranIfBsCpeBasicCapabilityReqScmVersionSupport
    wranIfBasicCapabilityCpeScmVersionSupport,
  wranIfBsCpeBasicCapabilityReqPnWindowSize
    wranIfBasicCapabilityCpePnWindowSize,
  wranIfBsCpeBasicCapabilityReqScmFlowControl
    wranIfBasicCapabilityScmFlowControl }

wranIfBsCpeBasicCapabilityReqIndexOBJECT-TYPE
  SYNTAXwranIfBasicCapbilityIndex
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
```

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```
      "Defined by wranIfBasicCapabilityIndex."
    ::= { wranIfBsCpeBasicCapabilityReqEntry 1 }

  wranIfBsCpeBasicCapabilityReqMacAddressOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityMacAdddress
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfBasicCapabilityMacAdddress."
    ::= { wranIfBsCpeBasicCapabilityReqEntry 2 }

  wranIfBsCpeBasicCapabilityReqStationIdOBJECT-TYPE
    SYNTAXwranIfBasicCapbilityStationId
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfBasicCapbilityStationId."
    ::= { wranIfBsCpeBasicCapabilityReqEntry 3 }

  wranIfBsCpeBasicCapabilityReqMacPduTxAndConstructionOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityMacPduTxAndConstruction
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfBasicCapabilityMacPduTxAndConstruction."
    ::= { wranIfBsCpeBasicCapabilityReqEntry 4 }

  wranIfBsCpeBasicCapabilityReqMaxCpeTxEirpOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityMaxCpeTxEirp
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfBasicCapabilityMaxCpeTxEirp."
    ::= { wranIfBsCpeBasicCapabilityReqEntry 5 }

  wranIfBsCpeBasicCapabilityReqCpeDemodulatorOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityCpeDemodulator
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfBasicCapabilityCpeDemodulator."
    ::= { wranIfBsCpeBasicCapabilityReqEntry 6 }

  wranIfBsCpeBasicCapabilityReqCpeModulatorOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityCpeModulator
    MAX-ACCESSread-only
    STATUScurrent
```

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```
    DESCRIPTION
      "Defined by wranIfBasicCapabilityCpeModulator."
    ::= { wranIfBsCpeBasicCapabilityReqEntry 7 }

  wranIfBsCpeBasicCapabilityReqScmVersionSupportOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityCpeScmVersionSupport
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfBasicCapabilityCpeScmVersionSupport."
    ::= { wranIfBsCpeBasicCapabilityReqEntry 8 }

  wranIfBsCpeBasicCapabilityReqPnWindowSizeOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityCpePnWindowSize
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfBasicCapabilityCpePnWindowSize."
    ::= { wranIfBsCpeBasicCapabilityReqEntry 9 }

  wranIfBsCpeBasicCapabilityReqScmFlowControlOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityScmFlowControl
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfBasicCapabilityScmFlowControl."
    ::= { wranIfBsCpeBasicCapabilityReqEntry 10 }

  wranIfBsCpeBasicCapabilityRspTable OBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsCpeBasicCapabilityRspEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object provides a table containing the basic
                  capability information BS has configured for CPEs in
                  the CBC-RSP. Each table is made up of multiple
                  entries, one for each CPE that has transmitted the
                  CBC-RSP, that is defined by
                  wranIfBsCpeBasicCapabilityRspEntry."
    ::= { wranIfBsCm 4 }

  wranIfBsCpeBasicCapabilityRspEntryOBJECT-TYPE
    SYNTAXwranIfBsCpeBasicCapabilityRspEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object is a compound object that contains
```

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```
                    information on capabilities that a BS has selected
                    for a CPE during network entry. This table reflects
                    the current configuration of a CPE's basic
                    capabilities. The list of objects used to make up
                    wranIfBsCpeBasicCapabilityRspEntry can be found in
                    14.1.2.2.6 (wranIfBsCpeBasicCapabilityCmn)."
    INDEX{ wranIfBsCpeBasicCapabilityRspIndex }
    ::= { wranIfBsCpeBasicCapabilityRspTable 1 }

  wranIfBsCpeBasicCapabilityRspEntry::= SEQUENCE {
    wranIfBsCpeBasicCapabilityRspIndex
      wranIfBasicCapbilityIndex,
    wranIfBsCpeBasicCapabilityRspNumAttempts
      wranIfBasicCapabilityNumAttempts,
    wranIfBsCpeBasicCapabilityRspMacAddress
      wranIfBasicCapabilityMacAdddress,
    wranIfBsCpeBasicCapabilityRspStationId
      wranIfBasicCapbilityStationId,
    wranIfBsCpeBasicCapabilityRspMacPduTxAndConstruction
      wranIfBasicCapabilityMacPduTxAndConstruction,
    wranIfBsCpeBasicCapabilityRspCpeDemodulator
      wranIfBasicCapabilityCpeDemodulator,
    wranIfBsCpeBasicCapabilityRspCpeModulator
      wranIfBasicCapabilityCpeModulator,
    wranIfBsCpeBasicCapabilityRspScmVersionSupport
      wranIfBasicCapabilityCpeScmVersionSupport,
    wranIfBsCpeBasicCapabilityRspPnWindowSize
      wranIfBasicCapabilityCpePnWindowSize,
    wranIfBsCpeBasicCapabilityRspScmFlowControl
      wranIfBasicCapabilityScmFlowControl }

  wranIfBsCpeBasicCapabilityRspIndexOBJECT-TYPE
    SYNTAXwranIfBasicCapbilityIndex
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfBasicCapabilityIndex."
    ::= { wranIfBsCpeBasicCapabilityRspEntry 1 }

  wranIfBsCpeBasicCapabilityRspNumAttemptsOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityNumAttempts
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfBasicCapabilityNumAttempts."
    ::= { wranIfBsCpeBasicCapabilityRspEntry 2 }

  wranIfBsCpeBasicCapabilityRspMacAddressOBJECT-TYPE
```

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```
    SYNTAXwranIfBasicCapabilityMacAdddress
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfBasicCapabilityMacAdddress."
    ::= { wranIfBsCpeBasicCapabilityRspEntry 3 }

  wranIfBsCpeBasicCapabilityRspStationIdOBJECT-TYPE
    SYNTAXwranIfBasicCapbilityStationId
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfBasicCapbilityStationId."
    ::= { wranIfBsCpeBasicCapabilityRspEntry 4 }

  wranIfBsCpeBasicCapabilityRspMacPduTxAndConstructionOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityMacPduTxAndConstruction
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfBasicCapabilityMacPduTxAndConstruction."
    ::= { wranIfBsCpeBasicCapabilityRspEntry 5 }

  wranIfBsCpeBasicCapabilityRspCpeDemodulatorOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityCpeDemodulator
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfBasicCapabilityCpeDemodulator."
    ::= { wranIfBsCpeBasicCapabilityRspEntry 6 }

  wranIfBsCpeBasicCapabilityRspCpeModulatorOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityCpeModulator
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfBasicCapabilityCpeModulator."
    ::= { wranIfBsCpeBasicCapabilityRspEntry 7 }

  wranIfBsCpeBasicCapabilityRspScmVersionSupportOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityCpeScmVersionSupport
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfBasicCapabilityCpeScmVersionSupport."
    ::= { wranIfBsCpeBasicCapabilityRspEntry 8 }
```

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```
wranIfBsCpeBasicCapabilityRspPnWindowSizeOBJECT-TYPE
  SYNTAXwranIfBasicCapabilityCpePnWindowSize
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Defined by wranIfBasicCapabilityCpePnWindowSize."
  ::= { wranIfBsCpeBasicCapabilityRspEntry 9 }

wranIfBsCpeBasicCapabilityRspScmFlowControlOBJECT-TYPE
  SYNTAXwranIfBasicCapabilityScmFlowControl
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Defined by wranIfBasicCapabilityScmFlowControl."
  ::= { wranIfBsCpeBasicCapabilityRspEntry 10 }

wranIfBsCpeRegCapabilityReqTable OBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfBsCpeRegCapabilityReqEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object provides a table containing the
                capability information that a CPE has declared to
                the BS in the REG-REQ. Each table is made up of
                multiple entries, one for each CPE, that is defined
                by wranIfBsCpeRegCapabilityReqEntry."
  ::= { wranIfBsCm 5 }

wranIfBsCpeRegCapabilityReqEntryOBJECT-TYPE
  SYNTAXwranIfBsCpeRegCapabilityReqEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object is a compound object that contains
                information on capabilities that a CPE has declared
                to a BS, e.g., through sending a REG-REQ to the BS.
                The objects that make up the entry are defined in
                wranIfBsCpeRegCapabilityCmn (14.1.2.2.17). A REG-REQ
                message comprises objects within this compound
                object, wranIfBsCpeAntennaGainTable(14.1.2.2.9), and
                wranIfBsCpeMeasSupportReqTable
                (14.1.2.2.6)."
  INDEX{ wranIfBsCpeRegCapabilityReqIndex }
  ::= { wranIfBsCpeRegCapabilityReqTable 1 }

wranIfBsCpeRegCapabilityReqEntry::= SEQUENCE {
  wranIfBsCpeRegCapabilityReqIndex
```

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```
    wranIfRegCapabilityIndex,
  wranIfBsCpeRegCapabilityReqMacAddress
    wranIfRegCapabilityMacAdddress,
  wranIfBsCpeRegCapabilityReqNMEALocStringSize
    wranIfRegCapabilityNMEALocStringSize,
  wranIfBsCpeRegCapabilityReqNMEALocString
    wranIfRegCapabilityNMEALocString,
  wranIfBsCpeRegCapabilityReqCsConfig
    wranIfRegCapabilityCsConfig,
  wranIfBsCpeRegCapabilityReqIpVersion
    wranIfRegCapabilityIpVersion,
  wranIfBsCpeRegCapabilityReqIpRochSupport
    wranIfRegCapabilityIpRochSupport,
  wranIfBsCpeRegCapabilityReqArqSupport
    wranIfRegCapabilityArqSupport,
  wranIfBsCpeRegCapabilityReq2ndMgmtArqWindowSize
    wranIfRegCapability2ndMgmtArqWindowSize,
  wranIfBsCpeRegCapabilityReq2ndMgmtArqRetryTxDelay
    wranIfRegCapability2ndMgmtArqRetryTxDelay,
  wranIfBsCpeRegCapabilityReq2ndMgmtArqRetryRxDelay
    wranIfRegCapability2ndMgmtArqRetryRxDelay,
  wranIfBsCpeRegCapabilityReq2ndMgmtArqBlockLifetime
    wranIfRegCapability2ndMgmtArqBlockLifetime,
  wranIfBsCpeRegCapabilityReq2ndMgmtArqSyncLossTimeout
    wranIfRegCapability2ndMgmtArqSyncLossTimeout,
  wranIfBsCpeRegCapabilityReq2ndMgmtArqDeliverInOrder
    wranIfRegCapability2ndMgmtArqDeliverInOrder,
  wranIfBsCpeRegCapabilityReq2ndMgmtArqRxPurgeTimeout
    wranIfRegCapability2ndMgmtArqRxPurgeTimeout,
  wranIfBsCpeRegCapabilityReq2ndMgmtArqBlockSize
    wranIfRegCapability2ndMgmtArqBlockSize,
  wranIfBsCpeRegCapabilityReqDsxFlowControl
    wranIfRegCapabilityDsxFlowControl,
  wranIfBsCpeRegCapabilityReqMcaFlowControl
    wranIfRegCapabilityMcaFlowControl,
  wranIfBsCpeRegCapabilityReqMaxNumMcastGroups
    wranIfRegCapabilityMaxNumMcastGroups,
  wranIfBsCpeRegCapabilityReqSensModeSupportArray
    wranIfRegCapabilitySensModeSupportArray,
  wranIfBsCpeRegCapabilityReqAntennaModelSize
    wranIfRegCapabilityAntennaModelSize,
  wranIfBsCpeRegCapabilityReqAntennaModel
    wranIfRegCapabilityAntennaModel,
  wranIfBsCpeRegCapabilityReqCpeResidualDelay
    wranIfRegCapabilityCpeResidualDelay,
  wranIfBsCpeRegCapabilityReq2ndMgmtIpAllocMethod
    wranIfRegCapability2ndMgmtIpAllocMethod,
  wranIfBsCpeRegCapabilityReqCpeOperationalCapability
```

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```
      wranIfRegCapabilityCpeOperationalCapability,
    wranIfBsCpeRegCapabilityReqCpeRegistrationTimer
      wranIfRegCapabilityCpeRegistrationTimer }

wranIfBsCpeRegCapabilityReqIndexOBJECT-TYPE
    SYNTAXwranIfRegCapabilityIndex
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityIndex."
    ::= { wranIfBsCpeRegCapabilityReqEntry 1 }

wranIfBsCpeRegCapabilityReqMacAddressOBJECT-TYPE
    SYNTAXwranIfRegCapabilityMacAdddress
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityMacAdddress."
    ::= { wranIfBsCpeRegCapabilityReqEntry 2 }

wranIfBsCpeRegCapabilityReqNMEALocStringSizeOBJECT-TYPE
    SYNTAXwranIfRegCapabilityNMEALocStringSize
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityNMEALocStringSize."
    ::= { wranIfBsCpeRegCapabilityReqEntry 3 }

wranIfBsCpeRegCapabilityReqNMEALocStringOBJECT-TYPE
    SYNTAXwranIfRegCapabilityNMEALocString
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityNMEALocString."
    ::= { wranIfBsCpeRegCapabilityReqEntry 4 }

wranIfBsCpeRegCapabilityReqCsConfigOBJECT-TYPE
    SYNTAXwranIfRegCapabilityCsConfig
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityCsConfig."
    ::= { wranIfBsCpeRegCapabilityReqEntry 5 }

wranIfBsCpeRegCapabilityReqIpVersionOBJECT-TYPE
    SYNTAXwranIfRegCapabilityIpVersion
    MAX-ACCESSread-only
    STATUScurrent
```

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```
    DESCRIPTION
      "Defined by wranIfRegCapabilityIpVersion."
    ::= { wranIfBsCpeRegCapabilityReqEntry 6 }

  wranIfBsCpeRegCapabilityReqIpRochSupportOBJECT-TYPE
    SYNTAXwranIfRegCapabilityIpRochSupport
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityIpRochSupport."
    ::= { wranIfBsCpeRegCapabilityReqEntry 7 }

  wranIfBsCpeRegCapabilityReqArqSupportOBJECT-TYPE
    SYNTAXwranIfRegCapabilityArqSupport
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityArqSupport."
    ::= { wranIfBsCpeRegCapabilityReqEntry 8 }

  wranIfBsCpeRegCapabilityReq2ndMgmtArqWindowSizeOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqWindowSize
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapability2ndMgmtArqWindowSize."
    ::= { wranIfBsCpeRegCapabilityReqEntry 9 }

  wranIfBsCpeRegCapabilityReq2ndMgmtArqRetryTxDelayOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqRetryTxDelay
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapability2ndMgmtArqRetryTxDelay."
    ::= { wranIfBsCpeRegCapabilityReqEntry 10 }

  wranIfBsCpeRegCapabilityReq2ndMgmtArqRetryRxDelayOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqRetryRxDelay
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapability2ndMgmtArqRetryRxDelay."
    ::= { wranIfBsCpeRegCapabilityReqEntry 11 }

  wranIfBsCpeRegCapabilityReq2ndMgmtArqBlockLifetimeOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqBlockLifetime
```

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```
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapability2ndMgmtArqBlockLifetime."
    ::= { wranIfBsCpeRegCapabilityReqEntry 12 }

  wranIfBsCpeRegCapabilityReq2ndMgmtArqSyncLossTimeoutOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqSyncLossTimeout
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapability2ndMgmtArqSyncLossTimeout."
    ::= { wranIfBsCpeRegCapabilityReqEntry 13 }

  wranIfBsCpeRegCapabilityReq2ndMgmtArqDeliverInOrderOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqDeliverInOrder
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapability2ndMgmtArqDeliverInOrder."
    ::= { wranIfBsCpeRegCapabilityReqEntry 14 }

  wranIfBsCpeRegCapabilityReq2ndMgmtArqRxPurgeTimeoutOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqRxPurgeTimeout
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapability2ndMgmtArqRxPurgeTimeout."
    ::= { wranIfBsCpeRegCapabilityReqEntry 15 }

  wranIfBsCpeRegCapabilityReq2ndMgmtArqBlockSizeOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqBlockSize
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapability2ndMgmtArqBlockSize."
    ::= { wranIfBsCpeRegCapabilityReqEntry 16 }

  wranIfBsCpeRegCapabilityReqDsxFlowControlOBJECT-TYPE
    SYNTAXwranIfRegCapabilityDsxFlowControl
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityDsxFlowControl."
```

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```
    ::= { wranIfBsCpeRegCapabilityReqEntry 17 }

  wranIfBsCpeRegCapabilityReqMcaFlowControlOBJECT-TYPE
    SYNTAXwranIfRegCapabilityMcaFlowControl
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityMcaFlowControl."
    ::= { wranIfBsCpeRegCapabilityReqEntry 18 }

  wranIfBsCpeRegCapabilityReqMaxNumMcastGroupsOBJECT-TYPE
    SYNTAXwranIfRegCapabilityMaxNumMcastGroups
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityMaxNumMcastGroups."
    ::= { wranIfBsCpeRegCapabilityReqEntry 19 }

  wranIfBsCpeRegCapabilityReqSensModeSupportArrayOBJECT-TYPE
    SYNTAXwranIfRegCapabilitySensModeSupportArray
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilitySensModeSupportArray."
    ::= { wranIfBsCpeRegCapabilityReqEntry 20 }

  wranIfBsCpeRegCapabilityReqAntennaModelSizeOBJECT-TYPE
    SYNTAXwranIfRegCapabilityAntennaModelSize
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityAntennaModelSize."
    ::= { wranIfBsCpeRegCapabilityReqEntry 21 }

  wranIfBsCpeRegCapabilityReqAntennaModelOBJECT-TYPE
    SYNTAXwranIfRegCapabilityAntennaModel
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityAntennaModel."
    ::= { wranIfBsCpeRegCapabilityReqEntry 22 }

  wranIfBsCpeRegCapabilityReqCpeResidualDelayOBJECT-TYPE
    SYNTAXwranIfRegCapabilityCpeResidualDelay
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityCpeResidualDelay."
```

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```
    ::= { wranIfBsCpeRegCapabilityReqEntry 23 }

wranIfBsCpeRegCapabilityReq2ndMgmtIpAllocMethodOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtIpAllocMethod
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapability2ndMgmtIpAllocMethod."
    ::= { wranIfBsCpeRegCapabilityReqEntry 24 }

wranIfBsCpeRegCapabilityReqCpeOperationalCapabilityOBJECT-TYPE
    SYNTAXwranIfRegCapabilityCpeOperationalCapability
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapabilityCpeOperationalCapability."
    ::= { wranIfBsCpeRegCapabilityReqEntry 25 }

wranIfBsCpeRegCapabilityReqCpeRegistrationTimerOBJECT-TYPE
    SYNTAXwranIfRegCapabilityCpeRegistrationTimer
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapabilityCpeRegistrationTimer."
    ::= { wranIfBsCpeRegCapabilityReqEntry 26 }

wranIfBsCpeMeasSupportReqTable OBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsCpeMeasSupportReqEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "A compound object representing the Measurement
                  Support IE of REG-REQ in 7.9.7.3.4.7. It is made
                  up of multiple entries, one for each signal type
                  supported by sensing. Each entry is defined by
                  wranIfBsCpeMeasSupportReqEntry. Entries for a CPE
                  are only present if the value for
                  wranIfSensModeSupportArray is anything other than
                  'No Sensing'."
    ::= { wranIfBsCm 6 }

wranIfBsCpeMeasSupportReqEntryOBJECT-TYPE
    SYNTAXwranIfBsCpeMeasSupportReqEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
```

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```
      "A compound object representing the entries of
                  Measurement Support IE of REG-REQ in 7.9.7.3.4.7. It
                  is made up of multiple objects. A CPE will have one
                  entry for each Signal Type in the Signal Type Array
                  of the Measurement Support IE. The rest of the
                  objects that represent each entry are defined in
                  wranIfBsCpeMeasSupportCmn (14.1.2.2.18)."
    INDEX{ wranIfBsCpeMeasSupportReqIndex }
    ::= { wranIfBsCpeMeasSupportReqTable 1 }

  wranIfBsCpeMeasSupportReqEntry::= SEQUENCE {
    wranIfBsCpeMeasSupportReqIndex
      wranIfMeasSupportIndex,
    wranIfBsCpeMeasSupportReqMacAddress
      wranIfMeasSupportMacAdddress,
    wranIfBsCpeMeasSupportReqSignalType
      wranIfMeasSupportSignalType,
    wranIfBsCpeMeasSupportReqThreshold
      wranIfMeasSupportThreshold,
    wranIfBsCpeMeasSupportReqPd
      wranIfMeasSupportPd,
    wranIfBsCpeMeasSupportReqMpfa
      wranIfMeasSupportMpfa,
    wranIfBsCpeMeasSupportReqRecNumSensPeriods
      wranIfMeasSupportRecNumSensPeriods,
    wranIfBsCpeMeasSupportReqRecSensPeriodDuration
      wranIfMeasSupportRecSensPeriodDuration,
    wranIfBsCpeMeasSupportReqRecSensPeriodInterval
      wranIfMeasSupportRecSensPeriodInterval }

  wranIfBsCpeMeasSupportReqIndexOBJECT-TYPE
    SYNTAXwranIfMeasSupportIndex
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportIndex."
    ::= { wranIfBsCpeMeasSupportReqEntry 1 }

  wranIfBsCpeMeasSupportReqMacAddressOBJECT-TYPE
    SYNTAXwranIfMeasSupportMacAdddress
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportMacAdddress."
    ::= { wranIfBsCpeMeasSupportReqEntry 2 }

  wranIfBsCpeMeasSupportReqSignalTypeOBJECT-TYPE
    SYNTAXwranIfMeasSupportSignalType
```

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```
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportSignalType."
    ::= { wranIfBsCpeMeasSupportReqEntry 3 }

  wranIfBsCpeMeasSupportReqThresholdOBJECT-TYPE
    SYNTAXwranIfMeasSupportThreshold
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportThreshold."
    ::= { wranIfBsCpeMeasSupportReqEntry 4 }

  wranIfBsCpeMeasSupportReqPdOBJECT-TYPE
    SYNTAXwranIfMeasSupportPd
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportPd."
    ::= { wranIfBsCpeMeasSupportReqEntry 5 }

  wranIfBsCpeMeasSupportReqMpfaOBJECT-TYPE
    SYNTAXwranIfMeasSupportMpfa
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportMpfa."
    ::= { wranIfBsCpeMeasSupportReqEntry 6 }

  wranIfBsCpeMeasSupportReqRecNumSensPeriodsOBJECT-TYPE
    SYNTAXwranIfMeasSupportRecNumSensPeriods
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportRecNumSensPeriods."
    ::= { wranIfBsCpeMeasSupportReqEntry 7 }

  wranIfBsCpeMeasSupportReqRecSensPeriodDurationOBJECT-TYPE
    SYNTAXwranIfMeasSupportRecSensPeriodDuration
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportRecSensPeriodDuration."
    ::= { wranIfBsCpeMeasSupportReqEntry 8 }

  wranIfBsCpeMeasSupportReqRecSensPeriodIntervalOBJECT-TYPE
    SYNTAXwranIfMeasSupportRecSensPeriodInterval
```

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```
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportRecSensPeriodInterval."
    ::= { wranIfBsCpeMeasSupportReqEntry 9 }

  wranIfBsCpeRegCapabilityRspTable OBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsCpeRegCapabilityRspEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object provides a table containing the
                capability information that a BS has configured for
                a CPE in REG-RSP. Each table is made up of multiple
                entries, one for each CPE, that is defined by
                wranIfBsCpeRegCapabilityRspEntry."
    ::= { wranIfBsCm 7 }

  wranIfBsCpeRegCapabilityRspEntryOBJECT-TYPE
    SYNTAXwranIfBsCpeRegCapabilityRspEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object is a compound object that contains the
                capabilities information that a BS has configured
                for the CPE, e.g., through sending a REG-RSP to the
                CPE. wranIfRegCapabilityPermanentStationId is unique
                to REG-RSP. The objects that make up the entry are
                defined in wranIfBsCpeRegCapabilityCmn
                (14.1.2.2.18). A REG-RSP message comprises
                objects within this compound and
                wranIfBsCpeMeasSupportRspTable (14.1.2.2.8)."
    INDEX{ wranIfBsCpeRegCapabilityRspIndex }
    ::= { wranIfBsCpeRegCapabilityRspTable 1 }

  wranIfBsCpeRegCapabilityRspEntry::= SEQUENCE {
    wranIfBsCpeRegCapabilityRspIndex
      wranIfRegCapabilityIndex,
    wranIfBsCpeRegCapabilityRspMacAddress
      wranIfRegCapabilityMacAdddress,
    wranIfBsCpeRegCapabilityRspNumAttempts
      wranIfRegCapabilityNumAttempts,
    wranIfBsCpeRegCapabilityRspCsConfig
      wranIfRegCapabilityCsConfig,
    wranIfBsCpeRegCapabilityRspIpVersion
      wranIfRegCapabilityIpVersion,
    wranIfBsCpeRegCapabilityRspIpRochSupport
      wranIfRegCapabilityIpRochSupport,
```

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```
    wranIfBsCpeRegCapabilityRspArqSupport
      wranIfRegCapabilityIpArqSupport,
    wranIfBsCpeRegCapabilityRsp2ndMgmtArqWindowSize
      wranIfRegCapability2ndMgmtArqWindowSize,
    wranIfBsCpeRegCapabilityRsp2ndMgmtArqRetryTxDelay
      wranIfRegCapability2ndMgmtArqRetryTxDelay,
    wranIfBsCpeRegCapabilityRsp2ndMgmtArqRetryRxDelay
      wranIfRegCapability2ndMgmtArqRetryRxDelay,
    wranIfBsCpeRegCapabilityRsp2ndMgmtArqBlockLifetime
      wranIfRegCapability2ndMgmtArqBlockLifetime,
    wranIfBsCpeRegCapabilityRsp2ndMgmtArqSyncLossTimeout
      wranIfRegCapability2ndMgmtArqSyncLossTimeout,
    wranIfBsCpeRegCapabilityRsp2ndMgmtArqDeliverInOrder
      wranIfRegCapability2ndMgmtArqDeliverInOrder,
    wranIfBsCpeRegCapabilityRsp2ndMgmtArqRxPurgeTimeout
      wranIfRegCapability2ndMgmtArqRxPurgeTimeout,
    wranIfBsCpeRegCapabilityRsp2ndMgmtArqBlockSize
      wranIfRegCapability2ndMgmtArqBlockSize,
    wranIfBsCpeRegCapabilityRspDsxFlowControl
      wranIfRegCapabilityDsxFlowControl,
    wranIfBsCpeRegCapabilityRspMcaFlowControl
      wranIfRegCapabilityMcaFlowControl,
    wranIfBsCpeRegCapabilityRspMaxNumMcastGroups
      wranIfRegCapabilityMaxNumMcastGroups,
    wranIfBsCpeRegCapabilityRspSensModeSupportArray
      wranIfRegCapabilitySensModeSupportArray,
    wranIfBsCpeRegCapabilityRspAntennaModelSize
      wranIfRegCapabilityAntennaModelSize,
    wranIfBsCpeRegCapabilityRspAntennaModel
      wranIfRegCapabilityAntennaModel,
    wranIfBsCpeRegCapabilityRsp2ndMgmtIpAllocMethod
      wranIfRegCapability2ndMgmtIpAllocMethod,
    wranIfBsCpeRegCapabilityRspCpeOperationalCapability
      wranIfRegCapabilityCpeOperationalCapability,
    wranIfBsCpeRegCapabilityRspCpeRegistrationTimer
      wranIfRegCapabilityCpeRegistrationTimer,
    wranIfBsCpeRegCapabilityRspPermanentSid
      wranIfRegCapabilityPermanentSid }

  wranIfBsCpeRegCapabilityRspIndexOBJECT-TYPE
    SYNTAXwranIfRegCapabilityIndex
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityIndex."
    ::= { wranIfBsCpeRegCapabilityRspEntry 1 }

  wranIfBsCpeRegCapabilityRspMacAddressOBJECT-TYPE
```

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```
    SYNTAXwranIfRegCapabilityMacAdddress
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityMacAdddress."
    ::= { wranIfBsCpeRegCapabilityRspEntry 2 }

  wranIfBsCpeRegCapabilityRspNumAttemptsOBJECT-TYPE
    SYNTAXwranIfRegCapabilityNumAttempts
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityNumAttempts."
    ::= { wranIfBsCpeRegCapabilityRspEntry 3 }

  wranIfBsCpeRegCapabilityRspCsConfigOBJECT-TYPE
    SYNTAXwranIfRegCapabilityCsConfig
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityCsConfig."
    ::= { wranIfBsCpeRegCapabilityRspEntry 4 }

  wranIfBsCpeRegCapabilityRspIpVersionOBJECT-TYPE
    SYNTAXwranIfRegCapabilityIpVersion
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityIpVersion."
    ::= { wranIfBsCpeRegCapabilityRspEntry 5 }

  wranIfBsCpeRegCapabilityRspIpRochSupportOBJECT-TYPE
    SYNTAXwranIfRegCapabilityIpRochSupport
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityIpRochSupport."
    ::= { wranIfBsCpeRegCapabilityRspEntry 6 }

  wranIfBsCpeRegCapabilityRspArqSupportOBJECT-TYPE
    SYNTAXwranIfRegCapabilityArqSupport
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityArqSupport."
    ::= { wranIfBsCpeRegCapabilityRspEntry 7 }

  wranIfBsCpeRegCapabilityRsp2ndMgmtArqWindowSizeOBJECT-TYPE
```

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```
    SYNTAXwranIfRegCapability2ndMgmtArqWindowSize
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapability2ndMgmtArqWindowSize."
    ::= { wranIfBsCpeRegCapabilityRspEntry 8 }

  wranIfBsCpeRegCapabilityRsp2ndMgmtArqRetryTxDelayOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqRetryTxDelay
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapability2ndMgmtArqRetryTxDelay."
    ::= { wranIfBsCpeRegCapabilityRspEntry 9 }

  wranIfBsCpeRegCapabilityRsp2ndMgmtArqRetryRxDelayOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqRetryRxDelay
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapability2ndMgmtArqRetryRxDelay."
    ::= { wranIfBsCpeRegCapabilityRspEntry 10 }

  wranIfBsCpeRegCapabilityRsp2ndMgmtArqBlockLifetimeOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqBlockLifetime
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapability2ndMgmtArqBlockLifetime."
    ::= { wranIfBsCpeRegCapabilityRspEntry 11 }

  wranIfBsCpeRegCapabilityRsp2ndMgmtArqSyncLossTimeoutOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqSyncLossTimeout
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapability2ndMgmtArqSyncLossTimeout."
    ::= { wranIfBsCpeRegCapabilityRspEntry 12 }

  wranIfBsCpeRegCapabilityRsp2ndMgmtArqDeliverInOrderOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqDeliverInOrder
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
```

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```
      "Defined by
                  wranIfRegCapability2ndMgmtArqDeliverInOrder."
    ::= { wranIfBsCpeRegCapabilityRspEntry 13 }

  wranIfBsCpeRegCapabilityRsp2ndMgmtArqRxPurgeTimeoutOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqRxPurgeTimeout
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapability2ndMgmtArqRxPurgeTimeout."
    ::= { wranIfBsCpeRegCapabilityRspEntry 14 }

  wranIfBsCpeRegCapabilityRsp2ndMgmtArqBlockSizeOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqBlockSize
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapability2ndMgmtArqBlockSize."
    ::= { wranIfBsCpeRegCapabilityRspEntry 15 }

  wranIfBsCpeRegCapabilityRspDsxFlowControlOBJECT-TYPE
    SYNTAXwranIfRegCapabilityDsxFlowControl
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityDsxFlowControl."
    ::= { wranIfBsCpeRegCapabilityRspEntry 16 }

  wranIfBsCpeRegCapabilityRspMcaFlowControlOBJECT-TYPE
    SYNTAXwranIfRegCapabilityMcaFlowControl
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityMcaFlowControl."
    ::= { wranIfBsCpeRegCapabilityRspEntry 17 }

  wranIfBsCpeRegCapabilityRspMaxNumMcastGroupsOBJECT-TYPE
    SYNTAXwranIfRegCapabilityMaxNumMcastGroups
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityMaxNumMcastGroups."
    ::= { wranIfBsCpeRegCapabilityRspEntry 18 }

  wranIfBsCpeRegCapabilityRspSensModeSupportArrayOBJECT-TYPE
    SYNTAXwranIfRegCapabilitySensModeSupportArray
    MAX-ACCESSread-only
```

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```
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilitySensModeSupportArray."
    ::= { wranIfBsCpeRegCapabilityRspEntry 19 }

  wranIfBsCpeRegCapabilityRspAntennaModelSizeOBJECT-TYPE
    SYNTAXwranIfRegCapabilityAntennaModelSize
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityAntennaModelSize."
    ::= { wranIfBsCpeRegCapabilityRspEntry 20 }

  wranIfBsCpeRegCapabilityRspAntennaModelOBJECT-TYPE
    SYNTAXwranIfRegCapabilityAntennaModel
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityAntennaModel."
    ::= { wranIfBsCpeRegCapabilityRspEntry 21 }

  wranIfBsCpeRegCapabilityRsp2ndMgmtIpAllocMethodOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtIpAllocMethod
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapability2ndMgmtIpAllocMethod."
    ::= { wranIfBsCpeRegCapabilityRspEntry 22 }

  wranIfBsCpeRegCapabilityRspCpeOperationalCapabilityOBJECT-TYPE
    SYNTAXwranIfRegCapabilityCpeOperationalCapability
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapabilityCpeOperationalCapability."
    ::= { wranIfBsCpeRegCapabilityRspEntry 23 }

  wranIfBsCpeRegCapabilityRspCpeRegistrationTimerOBJECT-TYPE
    SYNTAXwranIfRegCapabilityCpeRegistrationTimer
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapabilityCpeRegistrationTimer."
    ::= { wranIfBsCpeRegCapabilityRspEntry 24 }

  wranIfBsCpeRegCapabilityRspPermanentSidOBJECT-TYPE
```

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```
    SYNTAXwranIfRegCapabilityPermanentSid
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapabilityPermanentSid."
    ::= { wranIfBsCpeRegCapabilityRspEntry 25 }

  wranIfBsCpeMeasSupportRspTable OBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsCpeMeasSupportRspEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "A compound object representing the Measurement
                  Support IE of REG-RSP in 7.9.7.3.4.7. It is made
                  up of multiple entries, one for each signal type
                  supported by sensing. Each entry is defined by
                  wranIfBsCpeMeasSupportRspEntry. Entries for a CPE
                  are only present if the value for
                  wranIfSensModeSupportArray is anything other than
                  'No Sensing'."
    ::= { wranIfBsCm 8 }

  wranIfBsCpeMeasSupportRspEntryOBJECT-TYPE
    SYNTAXwranIfBsCpeMeasSupportRspEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "A compound object representing the entries of
                  Measurement Support IE of REG-RSP in 7.9.7.3.4.7. It
                  is made up of multiple objects. A CPE will have one
                  entry for each Signal Type in the Signal Type Array
                  of the Measurement Support IE. The rest of the
                  objects that represent each entry are defined in
                  wranIfBsCpeMeasSupportCmn (14.1.2.2.18)."
    INDEX{ wranIfBsCpeMeasSupportRspIndex }
    ::= { wranIfBsCpeMeasSupportRspTable 1 }

  wranIfBsCpeMeasSupportRspEntry::= SEQUENCE {
    wranIfBsCpeMeasSupportRspIndex
      wranIfMeasSupportIndex,
    wranIfBsCpeMeasSupportRspMacAddress
      wranIfMeasSupportMacAdddress,
    wranIfBsCpeMeasSupportRspSignalType
      wranIfMeasSupportSignalType,
    wranIfBsCpeMeasSupportRspThreshold
      wranIfMeasSupportThreshold,
    wranIfBsCpeMeasSupportRspPd
```

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```
      wranIfMeasSupportPd,
    wranIfBsCpeMeasSupportRspMpfa
      wranIfMeasSupportMpfa,
    wranIfBsCpeMeasSupportRspRecNumSensPeriods
      wranIfMeasSupportRecNumSensPeriods,
    wranIfBsCpeMeasSupportRspRecSensPeriodDuration
      wranIfMeasSupportRecSensPeriodDuration,
    wranIfBsCpeMeasSupportRspRecSensPeriodInterval
      wranIfMeasSupportRecSensPeriodInterval }

wranIfBsCpeMeasSupportRspIndexOBJECT-TYPE
    SYNTAXwranIfMeasSupportIndex
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportIndex."
    ::= { wranIfBsCpeMeasSupportRspEntry 1 }

wranIfBsCpeMeasSupportRspMacAddressOBJECT-TYPE
    SYNTAXwranIfMeasSupportMacAdddress
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportMacAdddress."
    ::= { wranIfBsCpeMeasSupportRspEntry 2 }

wranIfBsCpeMeasSupportRspSignalTypeOBJECT-TYPE
    SYNTAXwranIfMeasSupportSignalType
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportSignalType."
    ::= { wranIfBsCpeMeasSupportRspEntry 3 }

wranIfBsCpeMeasSupportRspThresholdOBJECT-TYPE
    SYNTAXwranIfMeasSupportThreshold
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportThreshold."
    ::= { wranIfBsCpeMeasSupportRspEntry 4 }

wranIfBsCpeMeasSupportRspPdOBJECT-TYPE
    SYNTAXwranIfMeasSupportPd
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportPd."
```

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```
    ::= { wranIfBsCpeMeasSupportRspEntry 5 }

  wranIfBsCpeMeasSupportRspMpfaOBJECT-TYPE
    SYNTAXwranIfMeasSupportMpfa
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportMpfa."
    ::= { wranIfBsCpeMeasSupportRspEntry 6 }

  wranIfBsCpeMeasSupportRspRecNumSensPeriodsOBJECT-TYPE
    SYNTAXwranIfMeasSupportRecNumSensPeriods
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportRecNumSensPeriods."
    ::= { wranIfBsCpeMeasSupportRspEntry 7 }

  wranIfBsCpeMeasSupportRspRecSensPeriodDurationOBJECT-TYPE
    SYNTAXwranIfMeasSupportRecSensPeriodDuration
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportRecSensPeriodDuration."
    ::= { wranIfBsCpeMeasSupportRspEntry 8 }

  wranIfBsCpeMeasSupportRspRecSensPeriodIntervalOBJECT-TYPE
    SYNTAXwranIfMeasSupportRecSensPeriodInterval
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportRecSensPeriodInterval."
    ::= { wranIfBsCpeMeasSupportRspEntry 9 }

  wranIfBsCpeAntennaGainTable OBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsCpeAntennaGainEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "At the CPE this object represents a compound object
                representing the entries of the CPE Antenna Gain IE
                (7.9.7.3.4.7), that carries a CPE's receive antenna
                gain when a CPE transmits a REG-REQ to the BS. At
                the BS, this object is a compound object that
                represents the entries for its own transmit antenna
                gain as well as the receive antenna gain information
                for each CPE that sent a CPE Antenna Gain IE in a
                REG-REQ (and successfully completed registration).
```

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```
                    This object is a table that is made up of multiple
                    entries, each defined by
                    wranIfBsCpeAntennaGainEntry."
    ::= { wranIfBsCm 9 }

  wranIfBsCpeAntennaGainEntryOBJECT-TYPE
    SYNTAXwranIfBsCpeAntennaGainEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "A compound object representing the on-axis gain (in
                    dB) for each channel the CPE's or BS's antenna is
                    capable of operating on."
    INDEX{ wranIfBsCpeAntennaGainIndex }
    ::= { wranIfBsCpeAntennaGainTable 1 }

  wranIfBsCpeAntennaGainEntry::= SEQUENCE {
    wranIfBsCpeAntennaGainIndexInteger32,
    wranIfBsCpeAntennaGainMacAddressMacAddress,
    wranIfBsCpeTvChannelINTEGER,
    wranIfBsCpeOnAxisGainINTEGER }

  wranIfBsCpeAntennaGainIndexOBJECT-TYPE
    SYNTAXInteger32 (1.. 131072)
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "Index of entry in this table."
    ::= { wranIfBsCpeAntennaGainEntry 1 }

  wranIfBsCpeAntennaGainMacAddressOBJECT-TYPE
    SYNTAXMacAddress
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "MAC Address of the device."
    ::= { wranIfBsCpeAntennaGainEntry 2 }

  wranIfBsCpeTvChannelOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "TV Channel number."
    ::= { wranIfBsCpeAntennaGainEntry 3 }

  wranIfBsCpeOnAxisGainOBJECT-TYPE
    SYNTAXINTEGER (0..255)
```

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```
    UNITS          "dB"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Maximum gain in the specified TV channel, from -91.5
                  dB."
    ::= { wranIfBsCpeAntennaGainEntry 4 }

  wranIfBsScmCapabilityConfiguration OBJECT-TYPE
    SYNTAXBITS    { suite0(0), suite1(1), suite1(2),
                    suite3(3), suite4(4), suite5(5),
                    suite6(6), suite7(7), suite8(8),
                    suite9(9), suiteA(10), suiteB(11),
                    suiteC(12), suiteD(13), suiteE(14),
                    suiteF(15) }
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This MIB object provides a bitmap that describes the
                  cryptographic suites that the BS supports. The list
                  of suites is provided in Table 193 in 8.4.1.
                  The bit for suite0 corresponds to 'No Protection',
                  and so on. A cryptographic suite is supported when
                  the corresponding bit is set to 1 and disabled/not
                  supported when the suite is not supported. Currently
                  Bit8-Bit15 will all be set to 0."
    ::= { wranIfBsCm 10 }

  wranIfBsCpeScmCapabilityConfigTable OBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsCpeScmCapabilityConfigEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This MIB provides a table that contains a listing
                  for the security capabilities of each CPE. CPE
                  stores this table. On the BS, this table is made
                  up of multiple entries, one for each CPE. Each entry
                  is defined by wranIfBsCpeScmCapabilityConfigEntry.
                  Entries on the BS table do not contain the
                  wranIfBsCpeEapTlsTtlsCredential object. The list of
                  capabilities is listed in Table 193."
    ::= { wranIfBsCm 11 }

  wranIfBsCpeScmCapabilityConfigEntryOBJECT-TYPE
    SYNTAXwranIfBsCpeScmCapabilityConfigEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
```

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```
      "This object is a compound object that provides the
                  definition of entries in
                  wranIfBsCpeScmCapabilityConfigTable."
    INDEX{ wranIfBsCpeScmCapabilityConfigIndex }
    ::= { wranIfBsCpeScmCapabilityConfigTable 1 }

  wranIfBsCpeScmCapabilityConfigEntry::= SEQUENCE {
    wranIfBsCpeScmCapabilityConfigIndexInteger32,
    wranIfBsCpeScmCapabilityConfigMacAddressMacAddress,
    wranIfBsCpeScmCapabilityConfigurationBITS,
    wranIfBsCpeEapTlsTtlsCredentialSizeInteger32,
    wranIfBsCpeEapTlsTtlsCredentialOCTET STRING }

  wranIfBsCpeScmCapabilityConfigIndexOBJECT-TYPE
    SYNTAXInteger32 (1.. 512)
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "Index of entry in this table."
    ::= { wranIfBsCpeScmCapabilityConfigEntry 1 }

  wranIfBsCpeScmCapabilityConfigMacAddressOBJECT-TYPE
    SYNTAXMacAddress
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "MAC Address of the CPE."
    ::= { wranIfBsCpeScmCapabilityConfigEntry 2 }

  wranIfBsCpeScmCapabilityConfigurationOBJECT-TYPE
    SYNTAXBITS    { suite0(0), suite1(1), suite1(2),
                    suite3(3), suite4(4), suite5(5),
                    suite6(6), suite7(7), suite8(8),
                     suite9(9), suiteA(10), suiteB(11),
                     suiteC(12), suiteD(13), suiteE(14),
                     suiteF(15) }
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This MIB object provides a bitmap that describes the
                  cryptographic suites that the CPE supports. The list
                  of suites is provided in Table 193 in 8.4.1.
                  The bit for suite0 corresponds to 'No Protection',
                  and so on. A cryptographic suite is supported when
                  the corresponding bit is set to 1 and disabled/not
                  supported when the suite is not supported. Currently
                  Bit8-Bit15 will all be set to 0."
    ::= { wranIfBsCpeScmCapabilityConfigEntry 3 }
```

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```
wranIfBsCpeEapTlsTtlsCredentialSizeOBJECT-TYPE
  SYNTAXInteger32 (1..10000)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Size, in # of octets, of X.509 certificate that
                defines the credential the CPE exchanges with the
                AAA server to perform authentication."
  ::= { wranIfBsCpeScmCapabilityConfigEntry 4 }

wranIfBsCpeEapTlsTtlsCredentialOBJECT-TYPE
  SYNTAXOCTET STRING
                  (SIZEOF(wranIfBsCpeEapTlsTtlsCredentialSize))
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "X.509 certificate that defines the credential the
                CPE exchanges with the AAA server to perform
                authentication."
  ::= { wranIfBsCpeScmCapabilityConfigEntry 5 }


wranIfBsCpeScmAuthConfigTable OBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfBsCpeScmAuthConfigEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB provides a table that provides the
                configuration of the SCM attributes (e.g., timers
                and other items related to the authentication
                process). This table is made up of one entry,
                defined by wranIfBsCpeScmAuthConfigEntry."
  ::= { wranIfBsCm 12 }

wranIfBsCpeScmAuthConfigEntryOBJECT-TYPE
  SYNTAXwranIfBsCpeScmAuthConfigEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object is a compound object that provides the
                definition of entries in
                wranIfBsCpeScmCapabilityConfigTable."
  INDEX{ wranIfBsCpeScmAuthConfigIndex }
  ::= { wranIfBsCpeScmAuthConfigTable 1 }

wranIfBsCpeScmAuthConfigEntry::= SEQUENCE {
  wranIfBsScmAuthConfigIndexInteger32,
```

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```
    wranIfBsT36          INTEGER,
    wranIfBsT37          Integer32,
    wranIfBsMaxNumAuthAttemptsINTEGER,
    wranIfBsT38          INTEGER,
    wranIfBsT39          INTEGER,
    wranIfBsT40          Integer32,
    wranIfBsAkLifetimeInteger32,
    wranIfBsTekLifetimeInteger32,
    wranIfBsMaxNumSaInteger32,
    wranIfBsT17          INTEGER }

  wranIfBsCpeScmAuthConfigIndexOBJECT-TYPE
    SYNTAXInteger32 (1.. 512)
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "Index of entry in this table."
    ::= { wranIfBsCpeScmAuthConfigEntry 1 }

  wranIfBsT36OBJECT-TYPE
    SYNTAXINTEGER (2..30)
    UNITS         "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "EAP Authentication Timer, T36."
    ::= { wranIfBsCpeScmAuthConfigEntry 2 }

  wranIfBsT37OBJECT-TYPE
    SYNTAXInteger32 (300..3024000)
    UNITS         "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Authentication Grace Timer, T37."
    ::= { wranIfBsCpeScmAuthConfigEntry 3 }

  wranIfBsMaxNumAuthAttemptsOBJECT-TYPE
    SYNTAXINTEGER (1..10)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Maximum # of Authentication Attempts."
    ::= { wranIfBsCpeScmAuthConfigEntry 4 }

  wranIfBsT38OBJECT-TYPE
    SYNTAXINTEGER (1..10)
    UNITS         "seconds"
```

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```
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Operational Wait Timeout, T38."
    ::= { wranIfBsCpeScmAuthConfigEntry 5 }

  wranIfBsT39OBJECT-TYPE
    SYNTAXINTEGER (1..10)
    UNITS         "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Rekey Wait Timeout, T39."
    ::= { wranIfBsCpeScmAuthConfigEntry 6 }

  wranIfBsT40OBJECT-TYPE
    SYNTAXInteger32 (300..302400)
    UNITS         "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "GTEK/TEK Grace Time, T40."
    ::= { wranIfBsCpeScmAuthConfigEntry 7 }

  wranIfBsAkLifetimeOBJECT-TYPE
    SYNTAXInteger32 (86400..6048000)
    UNITS         "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Lifetime BS assigns to new AK."
    ::= { wranIfBsCpeScmAuthConfigEntry 8 }

  wranIfBsTekLifetimeOBJECT-TYPE
    SYNTAXInteger32 (1800..604800)
    UNITS         "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Lifetime BS assigns to new TEK."
    ::= { wranIfBsCpeScmAuthConfigEntry 9 }

  wranIfBsMaxNumSaOBJECT-TYPE
    SYNTAXInteger32 (1..510)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Maximum # of multicast groups."
```

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```
    ::= { wranIfBsCpeScmAuthConfigEntry 10 }

  wranIfBsT17OBJECT-TYPE
    SYNTAXInteger32 (5..5)
    UNITS         "minutes"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Time for CPE to complete authentication and key
                  exchange."
    ::= { wranIfBsCpeScmAuthConfigEntry 11 }

  wranIfBsActionsTable OBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsActionsEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object provides a table that stores actions
                  that can be configured to have BS direct a CPE how
                  to act up receiving unsolicited MAC management
                  messages such as RNG-CMD and DREG-CMD. This table is
                  made up of multiple entries, one for each CPE for
                  which an  action is set up. Each entry is defined by
                  wranIfBsActionsEntry."
    ::= { wranIfBsCm 13 }

  wranIfBsActionsEntryOBJECT-TYPE
    SYNTAXwranIfBsActionsEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object defines an entry in
                  wranIfBsActionsTable."
    INDEX{ wranIfBsCpeActionsIndex }
    ::= { wranIfBsActionsTable 1 }

  wranIfBsActionsEntry::= SEQUENCE {
    wranIfBsCpeActionsIndexInteger32,
    wranIfBsCpeActionsMacAddressMacAddress,
    wranIfBsCpeActionsRngCpeINTEGER,
    wranIfBsCpeActionsDeRegCpeINTEGER,
    wranIfBsCpeActionsScheduleDateAndTime }

  wranIfBsCpeActionsIndexOBJECT-TYPE
    SYNTAXInteger32 (1.. 512)
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
```

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```
      "Index of entry in this table."
    ::= { wranIfBsActionsEntry 1 }

  wranIfBsCpeActionsMacAddressOBJECT-TYPE
    SYNTAXMacAddress
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "MAC Address of CPE that action is directed towards."
    ::= { wranIfBsActionsEntry 2 }

  wranIfBsCpeActionsRngCpeOBJECT-TYPE
    SYNTAXINTEGER { continue(0), abort(1), success(2),
                    reRange(3), reAuth(4),
                    reRangeAndreRegister(5),
                                doNothing(15) }
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "When set, the BS will send an unsolicited RNG-CMD to
                a CPE with the Ranging Status field set to the value
                written to this object. No action is to be taken if
                this object is read or if set to an invalid Ranging
                Status value. Valid values for the Ranging Status
                field of RNG-CMD are listed in Table 44."
    ::= { wranIfBsActionsEntry 3 }

  wranIfBsCpeActionsDeRegCpeOBJECT-TYPE
    SYNTAXINTEGER { ac0(0), ac1(1), ac2(2),
                    ac3(3), ac4(4), ac5(5),
                    doNothing(15) }
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "When set to an Action code value as defined in Table
                115, the BS will send a DREG-CMD to the CPE with
                that Action Code. No action is to be taken if this
                object is read or an invalid Action Code is
                specified."
    ::= { wranIfBsActionsEntry 4 }

  wranIfBsCpeActionsScheduleOBJECT-TYPE
    SYNTAXDateAndTime
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "This object contains the date and time, whereby
                scheduled action, either DREG-CMD or RNG-CMD, is
```

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```
                    sent to the CPE."
    ::= { wranIfBsActionsEntry 5 }

  wranIfBsCpeMcastConfigTable OBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsCpeMcastConfigEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This table contains the configuration of multicast
                    groups and what CPEs are assigned to them. Each
                    table is made up of multiple entries, defined by
                    wranIfBsCpeMcastConfigEntry. A CPE may have multiple
                    entries in this table, one for each multicast group
                    that it belongs to. Entries will be deleted whenever
                    a CPE is asked to leave a multicast group."
    ::= { wranIfBsCm 14 }

  wranIfBsCpeMcastConfigEntryOBJECT-TYPE
    SYNTAXwranIfBsCpeMcastConfigEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object defines an entry in
                    wranIfBsCpeMcastConfigTable."
    INDEX{ wranIfBsCpeMcastConfigIndex }
    ::= { wranIfBsCpeMcastConfigTable 1 }

  wranIfBsCpeMcastConfigEntry::= SEQUENCE {
    wranIfBsCpeMcastConfigIndexInteger32,
    wranIfBsCpeMcastMacAddressMacAddress,
    wranIfBsCpeMcastSid Integer32,
    wranIfBsCpeMcastPeriodicAllocParameterMINTEGER,
    wranIfBsCpeMcastPeriodicAllocParameterKINTEGER,
    wranIfBsCpeMcastPeriodicAllocParameterNINTEGER }

  wranIfBsCpeMcastIndexOBJECT-TYPE
    SYNTAXInteger32 (1..262144)
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "Index of entry in this table."
    ::= { wranIfBsCpeMcastConfigEntry 1 }

  wranIfBsCpeMcastMacAddressOBJECT-TYPE
    SYNTAXMacAddress
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
```

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```
      "This object refers to a CPE's MAC address. It is
                  used to uniquely identify the multicast group
                  configuration for a particular CPE in
                  wranIfBsCpeMcastConfigTable, along with
                  wranIfBsCpeMcastSid."
    ::= { wranIfBsCpeMcastConfigEntry 2 }

  wranIfBsCpeMcastSidOBJECT-TYPE
    SYNTAXInteger32 (1..512)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This object refers to the multicast SID that is
                  assigned to a multicast SID that is assigned to a
                  multicast group."
    ::= { wranIfBsCpeMcastConfigEntry 3 }

  wranIfBsCpeMcastPeriodicAllocParameterMOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This object defines the 'M' value (see Table 103)
                  that is used to calculate the periodic allocation
                  for multicast transmission."
    ::= { wranIfBsCpeMcastConfigEntry 4 }

  wranIfBsCpeMcastPeriodicAllocParameterKOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This object defines the 'K' value (see Table 103)
                  that is used to calculate the periodic allocation
                  for multicast transmission."
    ::= { wranIfBsCpeMcastConfigEntry 5 }

  wranIfBsCpeMcastPeriodicAllocParameterNOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This object defines the 'N' value (see Table 103)
                  that is used to calculate the periodic allocation
                  for multicast transmission."
    ::= { wranIfBsCpeMcastConfigEntry 6 }

  wranIfBsCoexistenceConfigTable OBJECT-TYPE
```

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```
    SYNTAXSEQUENCE OF wranIfBsCoexistenceConfigEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This table contains configuration items related to
                  Coexistence operation and CBP transmission. It is
                  made up of one entry that represents the default
                  values for Coexistence operation and CBP
                  transmission."
    ::= { wranIfBsCm 15 }

  wranIfBsCoexistenceConfigEntryOBJECT-TYPE
    SYNTAXwranIfBsCoexistenceConfigEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object defines an entry in
                  wranIfBsCoexistenceConfigTable."
    INDEX{ wranIfBsCoexistenceConfigIndex }
    ::= { wranIfBsCoexistenceConfigTable 1 }

  wranIfBsCoexistenceConfigEntry::= SEQUENCE {
    wranIfBsCoexistenceConfigIndexINTEGER,
    wranIfBsT34             Integer32,
    wranIfBsT33             INTEGER,
    wranIfBsT32             INTEGER,
    wranIfBsFcw             INTEGER,
    wranIfBsScwBackoffMaxINTEGER,
    wranIfBsFcMin       INTEGER,
    wranIfBsFcnRange    INTEGER,
    wranIfBsSfRel       INTEGER,
    wranIfBsT35             INTEGER }

  wranIfBsCoexistenceConfigIndexOBJECT-TYPE
    SYNTAXINTEGER (1..1)
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "Index of entry in this table."
    ::= { wranIfBsCoexistenceConfigEntry 1 }

  wranIfBsT34OBJECT-TYPE
    SYNTAXInteger32 (8..900)
    UNITS        “seconds”
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This governs how often in (seconds) the Device
```

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```
                Identification IE is transmitted in a CBP burst.
                Recommended value is 300s."
  ::= { wranIfBsCoexistenceConfigEntry 2 }

wranIfBsT33OBJECT-TYPE
  SYNTAXINTEGER (1..60)
  UNITS        "seconds"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Time between transmission of CBP bursts with
                backup/candidate channel list information (see
                7.6.1.3.1.1) to facilitate spectrum etiquette."
  ::= { wranIfBsCoexistenceConfigEntry 3 }

wranIfBsT32OBJECT-TYPE
  SYNTAXINTEGER (1..32)
  UNITS        "superframes"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Time between transmission of CBP bursts with
                backup/candidate channel list information (see
                7.6.1.3.1.1) to facilitate spectrum etiquette."
  ::= { wranIfBsCoexistenceConfigEntry 4 }

wranIfBsFcwOBJECT-TYPE
  SYNTAXINTEGER (1..16)
  UNITS        "superframes"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Frame contention window, the number of superframes
                that a contention destination accumulates frame
                contention requests before responding to them."
  ::= { wranIfBsCoexistenceConfigEntry 5 }

wranIfBsScwBackoffMaxOBJECT-TYPE
  SYNTAXINTEGER (1..16)
  UNITS        "superframes"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Maximum number of superframes for the SCW backoff
                window."
  ::= { wranIfBsCoexistenceConfigEntry 6 }

wranIfBsFcMinOBJECT-TYPE
```

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```
    SYNTAXINTEGER (0..8)
    UNITS         "superframes"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Maximum number of superframes for the SCW backoff
                  window."
    ::= { wranIfBsCoexistenceConfigEntry 7 }

  wranIfBsFcnRangeOBJECT-TYPE
    SYNTAXINTEGER (4..16)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Exponent, base 2, defining range of random numbers
                  for the FCN."
    ::= { wranIfBsCoexistenceConfigEntry 8 }

  wranIfBsSfRelOBJECT-TYPE
    SYNTAXINTEGER (5..16)
    UNITS         "superframes"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of superframes, after which a BS releases the
                  frames won by another BS through frame contention."
    ::= { wranIfBsCoexistenceConfigEntry 9 }

  wranIfBsT35OBJECT-TYPE
    SYNTAXINTEGER (1..255)
    UNTIS         "self-coexistence windows"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "SCW backoff timer, timer controlling continuation or
                  exiting of Frame Contention procedure."
    ::= { wranIfBsCoexistenceConfigEntry 10 }

--  wranIfBsCpeBasicCapabilityCmn: This MIB object is defines group
--  containing objects that are common to
--  wranIfBsCpeBasicCapabilityReqEntry,
--  wranIfBsCpeBasicCapabilityRspEntry, and
--  wranIfBsCpeBasicCapabilityDefEntry.

  wranIfBsCpeBasicCapabilityCmnOBJECT IDENTIFIER
                  ::= { wranIfBsCm 16 }
  wranIfBasicCapabilityIndex  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeBasicCapabilityCmn 1 }
```

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```
wranIfBasicCapabilityNumAttempts  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeBasicCapabilityCmn 2 }
wranIfBasicCapabilityMacAddress  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeBasicCapabilityCmn 3 }
wranIfBasicCapabilityStationId  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeBasicCapabilityCmn 4 }
wranIfBasicCapabilityMacPduTxandConstruction  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeBasicCapabilityCmn 5 }
wranIfBasicCapabilityMaxCpeTxEirp  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeBasicCapabilityCmn 6 }
wranIfBasicCapabilityCpeDemodulator  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeBasicCapabilityCmn 7 }
wranIfBasicCapabilityCpeModulator OBJECT IDENTIFIER
                  ::= { wranIfBsCpeBasicCapabilityCmn 8 }
wranIfBasicCapabilityCpeScmVersionSupport  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeBasicCapabilityCmn 9 }
wranIfBasicCapabilityCpePnWindowSize  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeBasicCapabilityCmn 10 }
wranIfBasicCapabilityCpeScmFlowControl  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeBasicCapabilityCmn 11 }

wranIfBasicCapabilityIndex::= TEXTUAL-CONVENTION
  STATUScurrent
  DESCRIPTION
    "Index of entry in this table."
  SYNTAXInteger32 (1..511)
  ::= { wranIfBsCpeBasicCapabilityCmn 1 }

wranIfBasicCapabilityNumAttempts::= TEXTUAL-CONVENTION
  STATUScurrent
  DESCRIPTION
    "The current number of attempts that a CPE has
                  attempted basic capability configuration during
                  network entry. This item is set to 0 upon
                  successful completion of registration process and a
                  CPE is admitted into the network. This item is
                  incremented every time a CPE attempts basic
                  capability configuration, but is unsuccessful. If
                  this value reaches the limit set by
                  wranIfBsMaxNumCbcReqAttempts, then the BS shall
                  reject network entry."
  SYNTAXINTEGER (5..10)
  ::= { wranIfBsCpeBasicCapabilityCmn 2 }

wranIfBasicCapabilityMacAddress::= TEXTUAL-CONVENTION
  STATUScurrent
  DESCRIPTION
    "The MAC address of the CPE attempting basic
```

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```
                    capability configuration."
    SYNTAXMacAddress
    ::= { wranIfBsCpeBasicCapabilityCmn 3 }

  wranIfBasicCapabilityStationId::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "The Station ID of the CPE attempting basic
                    capability configuration."
    SYNTAXInteger32 (1..512)
    ::= { wranIfBsCpeBasicCapabilityCmn 4 }

  wranIfBasicCapabilityMacPduTxandConstruction
                              ::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "An integer value that indicates the methods for
                    transmission and construction of MAC PDUs that the
                    CPE supports. This reflects the setting of the IE
                    defined in 7.9.11.3.1."
    SYNTAXINTEGER { reqPiggybackedWithData(0) }
    ::= { wranIfBsCpeBasicCapabilityCmn 5 }

  wranIfBasicCapabilityMaxCpeTxEirp::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "An integer value, encoded in hexadecimal, that
                    indicates the maximum EIRP for which the CPE is
                    configured. This reflects the setting of the IE
                    defined in 7.9.11.3.2.1. On the range from -64 dBm
                    (0x00) to +63.5 dBm (0xFF) in 0.5 dB steps."
    SYNTAXINTEGER (0..255)
    ::= { wranIfBsCpeBasicCapabilityCmn 6 }

  wranIfBasicCapabilityCpeDemodulator::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "A bit map that encodes the DIUCs that the CPE
                    supports. This reflects the setting of the IE
                    defined in 7.9.11.3.2.2.1. DIUCs are listed in Table
                    27."
    BITS{ diuc0(0), diuc1(1), diuc2(2), diuc3(3), diuc4(4),
        diuc5(5), diuc6(6), diuc7(7), diuc8(8), diuc9(9),
        diuc10(10), diuc11(11), diuc12(12), diuc13(13),
        diuc14(14), diuc15(15), diuc16(16), diuc17(17),
        diuc18(18), diuc19(19), diuc20(20), diuc21(21),
        diuc22(22), diuc23(23), diuc24(24), diuc25(25),
        diuc26(26), diuc27(27), diuc28(28), diuc29(29),
```

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```
        diuc30(30), diuc31(31), diuc32(32), diuc33(33),
        diuc34(34), diuc35(35), diuc36(36), diuc37(37),
        diuc38(38), diuc39(39), diuc40(40), diuc41(41),
        diuc42(42), diuc43(43), diuc44(44), diuc45(45),
        diuc46(46), diuc47(47), diuc48(48), diuc49(49),
        diuc50(50), diuc51(51), diuc52(52), diuc53(53),
        diuc54(54), diuc55(55), diuc56(56), diuc57(57),
        diuc58(58), diuc59(59), diuc60(60), diuc61(61),
        diuc62(62), diuc63(63) }
    ::= { wranIfBsCpeBasicCapabilityCmn 7 }

  wranIfBasicCapabilityCpeModulator::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "A bit map that encodes the UIUCs that the CPE
                  supports. This reflects the setting of the IE
                  defined in 7.9.11.3.2.2.2. UIUCs are listed in Table
                  36."
    BITS{ uiuc0(0), uiuc1(1), uiuc2(2), uiuc3(3), uiuc4(4),
        uiuc5(5), uiuc6(6), uiuc7(7), uiuc8(8), uiuc9(9),
        uiuc10(10), uiuc11(11), uiuc12(12), uiuc13(13),
        uiuc14(14), uiuc15(15), uiuc16(16), uiuc17(17),
        uiuc18(18), uiuc19(19), uiuc20(20), uiuc21(21),
        uiuc22(22), uiuc23(23), uiuc24(24), uiuc25(25),
        uiuc26(26), uiuc27(27), uiuc28(28), uiuc29(29),
        uiuc30(30), uiuc31(31), uiuc32(32), uiuc33(33),
        uiuc34(34), uiuc35(35), uiuc36(36), uiuc37(37),
        uiuc38(38), uiuc39(39), uiuc40(40), uiuc41(41),
        uiuc42(42), uiuc43(43), uiuc44(44), uiuc45(45),
        uiuc46(46), uiuc47(47), uiuc48(48), uiuc49(49),
        uiuc50(50), uiuc51(51), uiuc52(52), uiuc53(53),
        uiuc54(54), uiuc55(55), uiuc56(56), uiuc57(57),
        uiuc58(58), uiuc59(59), uiuc60(60), uiuc61(61),
        uiuc62(62), uiuc63(63) }
    ::= { wranIfBsCpeBasicCapabilityCmn 8 }

  wranIfBasicCapabilityCpeScmVersionSupport::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
                  "Indicator of what version of SCM protocol the CPE
                   supports."
    SYNTAXINTEGER { v1(0) }
  ::= { wranIfBsCpeBasicCapabilityCmn 9 }

  wranIfBasicCapabilityCpePnWindowSize::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
```

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```
                    "Size of PN_WINDOW (see 7.4) that is used to protect
                    against replay attacks. This reflects the setting of
                    the IE defined in 7.9.11.3.3.2."
    SYNTAXInteger32 (1..65535)
    ::= { wranIfBsCpeBasicCapabilityCmn 10 }

  wranIfBasicCapabilityCpeScmFlowControl::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
                    "Maximum # of ongoing SCM transactions the CPE can
                     support. This reflects the setting of the IE defined
                     in 7.9.11.3.3.3. Here a value of (0x00) indicates no
                     limit, while 0x01-0xFF indicates 1..255
                     transactions."
    SYNTAXINTEGER (0..255)
    ::= { wranIfBsCpeBasicCapabilityCmn 11 }


-- wranIfBsCpeRegCapabilityCmn: This MIB object is defines group
-- containing objects that are common to
-- wranIfBsCpeRegCapabilityReqEntry,
-- wranIfBsCpeRegCapabilityRspEntry, and
-- wranIfBsCpeRegCapabilityDefEntry.

  wranIfBsCpeRegCapabilityCmnOBJECT IDENTIFIER
                    ::= { wranIfBsCm 17 }
  wranIfRegCapabilityIndex  OBJECT IDENTIFIER
                    ::= { wranIfBsCpeRegCapabilityCmn 1 }
  wranIfRegCapabilityMacAddress  OBJECT IDENTIFIER
                    ::= { wranIfBsCpeRegCapabilityCmn 2 }
  wranIfRegCapabilityReqNumAttempts  OBJECT IDENTIFIER
                    ::= { wranIfBsCpeRegCapabilityCmn 3 }
  wranIfRegCapabilityNMEALocStringSize  OBJECT IDENTIFIER
                    ::= { wranIfBsCpeRegCapabilityCmn 4 }
  wranIfRegCapabilityNMEALocString  OBJECT IDENTIFIER
                    ::= { wranIfBsCpeRegCapabilityCmn 5 }
  wranIfRegCapabilityCsConfig  OBJECT IDENTIFIER
                    ::= { wranIfBsCpeRegCapabilityCmn 6 }
  wranIfRegCapabilityIpVersion  OBJECT IDENTIFIER
                    ::= { wranIfBsCpeRegCapabilityCmn 7 }
  wranIfRegCapabilityIpRohcSupport  OBJECT IDENTIFIER
                    ::= { wranIfBsCpeRegCapabilityCmn 8 }
  wranIfRegCapabilityArqSupport  OBJECT IDENTIFIER
                    ::= { wranIfBsCpeRegCapabilityCmn 9 }
  wranIfRegCapability2ndMgmtArqWindowSize  OBJECT IDENTIFIER
                    ::= { wranIfBsCpeRegCapabilityCmn 10 }
  wranIfRegCapability2ndMgmtArqRetryTxDelay  OBJECT IDENTIFIER
                    ::= { wranIfBsCpeRegCapabilityCmn 11 }
```

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```
wranIfRegCapability2ndMgmtArqRetryRxDelay  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeRegCapabilityCmn 12 }
wranIfRegCapability2ndMgmtArqBlockLifetime  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeRegCapabilityCmn 13 }
wranIfRegCapability2ndMgmtArqSyncLossTimeout  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeRegCapabilityCmn 14 }
wranIfRegCapability2ndMgmtArqDeliverInOrder  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeRegCapabilityCmn 15 }
wranIfRegCapability2ndMgmtArqRxPurgeTimeout  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeRegCapabilityCmn 16 }
wranIfRegCapability2ndMgmtArqBlockSize  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeRegCapabilityCmn 17 }
wranIfRegCapabilityDsxFlowControl  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeRegCapabilityCmn 18 }
wranIfRegCapabilityMcaFlowControl  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeRegCapabilityCmn 19 }
wranIfRegCapabilityMaxNumMcastGroups  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeRegCapabilityCmn 20 }
wranIfRegCapabilitySensModeSupportArray  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeRegCapabilityCmn 21 }
wranIfRegCapabilityAntennaModelSize  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeRegCapabilityCmn 22 }
wranIfRegCapabilityAntennaModel  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeRegCapabilityCmn 23 }
wranIfRegCapabilityCpeResidualDelay  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeRegCapabilityCmn 24 }
wranIfRegCapability2ndMgmtIpAllocMethod  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeRegCapabilityCmn 25 }
wranIfRegCapabilityCpeOperationalCapability  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeRegCapabilityCmn 26 }
wranIfRegCapabilityCpeRegistrationTimer  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeRegCapabilityCmn 27 }
wranIfRegCapabilityPermanentStationId OBJECT IDENTIFIER
                  ::= { wranIfBsCpeRegCapabilityCmn 28 }

wranIfRegCapabilityIndex::= TEXTUAL-CONVENTION
  STATUScurrent
  DESCRIPTION
    "Index of entry in this table."
  SYNTAXInteger32 (1..511)
  ::= { wranIfBsCpeRegCapabilityCmn 1 }

wranIfRegCapabilityMacAddress::= TEXTUAL-CONVENTION
  STATUScurrent
  DESCRIPTION
    "The MAC address of the CPE that is currently
                registered with BS."
  SYNTAXMacAddress
```

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```
    ::= { wranIfBsCpeRegCapabilityCmn 2 }

  wranIfRegCapabilityReqNumAttempts::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "The current number of attempts that a CPE has
                  attempted network entry. This item is set to 0
                  upon successful completion of registration process
                  and a CPE is admitted into the network. This item
                  is incremented every time a CPE attempts
                  registration, but is unsuccessful. If this value
                  reaches the limit set by
                  wranIfBsmaxNumRegReqAttempts, then the CPE shall
                  restart the network entry process."
    SYNTAXINTEGER (5..10)
    ::= { wranIfBsCpeRegCapabilityCmn 3 }

  wranIfRegCapabilityNMEALocStringSize::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "Size of NMEA Location String of the CPE (see
                  7.9.7.3.1), in octets."
    SYNTAXInteger32 (1..10000)
    ::= { wranIfBsCpeRegCapabilityCmn 4 }

  wranIfRegCapabilityNMEALocString::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "NMEA Location String of the CPE (see
                7.9.7.3.1), in octets."
    SYNTAX
      OCTET STRING (SIZE(wranIfRegCapabilityNMEALocStringSize))
    ::= { wranIfBsCpeRegCapabilityCmn 5 }

  wranIfRegCapabilityCsConfig::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "Indication in REG-REQ/RSP of how the provider will
                  operate the CPE on an ongoing basis; either with
                  Ethernet CS only or the IP CS (see 7.9.7.3.2)."
    SYNTAXINTEGER { ethCS(0), ipCS(1) }
    ::= { wranIfBsCpeRegCapabilityCmn 6 }

  wranIfRegCapabilityIpVersion::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "What version of the IP protocol (either v4 or v6)
                  indicate in REG-REQ/RSP the CPE supports (see
```

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```
                    7.9.7.3.3)."
    SYNTAXINTEGER { ipv4(0), ipv6(1) }
    ::= { wranIfBsCpeRegCapabilityCmn 7 }

  wranIfRegCapabilityIpRohcSupport::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "Indicator in REG-RES/RSP of whether CPE
                    supports IP Robust Header Compression (ROHC), see
                    7.9.7.3.4.1."
    SYNTAX      INTEGER { ipROHCdisabled(0), ipROHCenabled (1) }
    ::= { wranIfBsCpeRegCapabilityCmn 8 }

  wranIfRegCapabilityArqSupport::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "ARQ Support IE of REG-REQ/RSP in 7.9.7.3.4.2."
    SYNTAXINTEGER { noARQ(0), arqOn2ndMgmtOnly(1),
                        arqOnTransportOnly(2), arqOnAll(3) }
    ::= { wranIfBsCpeRegCapabilityCmn 9 }

  wranIfRegCapability2ndMgmtArqWindowSize::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "Secondary Management flow - ARQ Window Size IE of
                    REG-REQ/RSP defined in 7.9.8.9.17.2. Where
                    ARQ_BSN_MODULUS is the # of unique BSN values =
                    2^10."
    SYNTAXInteger32 (1..ARQ_BSN_MODULUS/2)
    ::= { wranIfBsCpeRegCapabilityCmn 10 }

  wranIfRegCapability2ndMgmtArqRetryTxDelay::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "Secondary Management flow - Transmitter delay
                    component of ARQ Retry Timeout IE of REG-REQ/RSP
                    defined in 7.9.8.9.17.3. Encoded from 0 to 655350
                    microseconds in 10-microsecond blocks."
    SYNTAXInteger32 (0..65535)
    ::= { wranIfBsCpeRegCapabilityCmn 11 }

  wranIfRegCapability2ndMgmtArqRetryRxDelay::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "Secondary Management flow - Receiver delay
                    component of ARQ Retry Timeout IE of REG-REQ/RSP
                    defined in 7.9.8.9.17.3. Encoded from 0 to 655350
                    microseconds in 10-microsecond blocks."
```

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```
    SYNTAXInteger32 (0..65535)
    ::= { wranIfBsCpeRegCapabilityCmn 12 }

  wranIfRegCapability2ndMgmtArqBlockLifetime
                              ::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "Secondary Management flow - ARQ Block Lifetime IE of
                  REG-REQ/RSP defined in 7.9.8.9.17.4. =0 indicates
                  Infinite lifetime. =1..65535 # of 10-microsecond
                  blocks."
    SYNTAXInteger32 (0..65535)
    ::= { wranIfBsCpeRegCapabilityCmn 13 }

  wranIfRegCapability2ndMgmtArqSyncLossTimeout
                              ::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "Secondary Management flow - ARQ Sync Loss Timeout IE
                  of REG-REQ/RSP defined in 7.9.8.9.17.5. =0 indicates
                  Infinite timeout. =1..65535 # of 10-microsecond
                  blocks."
    SYNTAXInteger32 (0..65535)
    ::= { wranIfBsCpeRegCapabilityCmn 14 }

  wranIfRegCapability2ndMgmtArqDeliverInOrder
                              ::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "Secondary Management flow - ARQ Deliver in Order IE
                  of REG-REQ/RSP defined in 7.9.8.9.17.6."
    SYNTAXINTEGER { notInOrder(0), orderPreserved(1) }
    ::= { wranIfBsCpeRegCapabilityCmn 15 }

  wranIfRegCapability2ndMgmtArqRxPurgeTimeout
                              ::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "Secondary Management flow - ARQ Rx Purge Timeout IE
                  of REG-REQ/RSP defined in 7.9.8.9.17.7. =0 indicates
                  Infinite timeout. =1..65535 # of 10-microsecond
                  blocks."
    SYNTAXInteger32 (0..65535)
    ::= { wranIfBsCpeRegCapabilityCmn 16 }

  wranIfRegCapability2ndMgmtArqBlockSize ::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
```

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```
      "Secondary Management flow - ARQ Block Size IE
                  of REG-REQ/RSP defined in 7.9.8.9.17.8"
    SYNTAXInteger32 (1..2040)
    ::= { wranIfBsCpeRegCapabilityCmn 17 }

  wranIfRegCapabilityDsxFlowControl ::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "DSx Flow Control IE of REG-REQ/RSP defined in
                  7.9.7.3.4.4. =0, no limit. 1..255 indicates #
                  maximum concurrent transactions."
    SYNTAXINTEGER (0..255)
    ::= { wranIfBsCpeRegCapabilityCmn 18 }

  wranIfRegCapabilityMcaFlowControl ::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "MCA Flow Control IE of REG-REQ/RSP defined in
                  7.9.7.3.4.5. =0, no limit. 1..255 indicates #
                  maximum concurrent transactions."
    SYNTAXINTEGER (0..255)
    ::= { wranIfBsCpeRegCapabilityCmn 19 }

  wranIfRegCapabilityMaxNumMcastGroups ::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "Maximum # of Multicast Groups IE of REG-REQ/RSP
                  defined in 7.9.7.3.4.5. =0, no limit. 1..255
                  indicates # maximum concurrent transactions."
    SYNTAXINTEGER (0..255)
    ::= { wranIfBsCpeRegCapabilityCmn 20 }

  wranIfRegCapabilitySensModeSupportArray ::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "Value of the 'Sensing Mode Support Array' of the
                  Measurement Support IE in REG-REQ/RSP in
                  7.9.7.3.4.7. If the value of this is set to 'No
                  Sensing', then wranIfBsCpeMeasSupportReqTable and
                  wranIfBsCpeMeasSupportRspTable will not be stored
                  for the CPE. Bit4 through Bit7 are reserved and set
                  to 0. A mode is supported when the corresponding bit
                  is set to 1 and disabled when set to 0."
    SYNTAXBITS { noSensing(0), mode0(1), mode1(2),
                  mode2(3), res1(4), res2(5), res3(6),
                  res4(7) }
    ::= { wranIfBsCpeRegCapabilityCmn 21 }
```

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```
wranIfRegCapabilityAntennaModelSize::= TEXTUAL-CONVENTION
  STATUScurrent
  DESCRIPTION
    "Length of wranIfRegCapabilityAntennaModel, in octets
                (see Manufacturer Specific Antenna Model IE of REG-
                REQ in 7.9.7.3.4.8)."
  SYNTAXInteger32 (1..65535)
  ::= { wranIfBsCpeRegCapabilityCmn 22 }

wranIfRegCapabilityAntennaModel::= TEXTUAL-CONVENTION
  STATUScurrent
  DESCRIPTION
    "Manufacturer Specific Antenna Model IE of REG-
                REQ in 7.9.7.3.4.8."
  SYNTAX
     OCTET STRING (SIZE(wranIfRegCapabilityAntennaModelSize))
  ::= { wranIfBsCpeRegCapabilityCmn 23 }

wranIfRegCapabilityCpeResidualDelay::= TEXTUAL-CONVENTION
  STATUScurrent
  UNITS         "nanoseconds"
  DESCRIPTION
    "CPE Residual Delay IE of REG-REQ in 7.9.7.3.4.10."
  SYNTAXInteger32 (-16777215..16777216)
  ::= { wranIfBsCpeRegCapabilityCmn 24 }

wranIfRegCapability2ndMgmtIpAllocMethod::= TEXTUAL-CONVENTION
  STATUScurrent
  DESCRIPTION
    "Method for allocating IP Address on Secondary
                Management Connection IE of REG-REQ in
                7.9.7.3.4.11. A method is selected when the bit in
                corresponding position is set to 1 and is disabled
                when the bit is set to 0. Bit4-Bit7 Reserved and set
                to 0."
  SYNTAXBITS { DHCPv4(0), MIPv4(1), DHCPv6(2),
                v6Stateless(3), res1(4), res2(5),
                res3(6), res4(7) }
  ::= { wranIfBsCpeRegCapabilityCmn 25 }

wranIfRegCapabilityCpeOperationalCapability
                        ::= TEXTUAL-CONVENTION
  STATUScurrent
  DESCRIPTION
    "CPE Operation Capability IE of REG-REQ in
                7.9.7.3.4.13."
  SYNTAXINTEGER { fixed(0), portable(1) }
  ::= { wranIfBsCpeRegCapabilityCmn 26 }
```

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```
  wranIfRegCapabilityCpeRegistrationTimer::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "CPE Registration Timer IE of REG-REQ/RSP in
                  7.9.7.3.5. This value is used to set T30 for the
                  CPE. =0x0000 is reserved. =0x0001..0xFFFF represents
                  time in units of 160 ms blocks. "
    SYNTAXInteger32 (1..65535)
    ::= { wranIfBsCpeRegCapabilityCmn 27 }

-- wranIfBsCpeMeasSupportCmn: This MIB object is a group containing
-- objects that textual conventions used in to
-- wranIfBsCpeMeasSupportReqEntry, wranIfBsCpeMeasSupportRspEntry, and
-- wranIfBsCpeMeasSupportDefEntry.

  wranIfBsCpeMeasSupportCmnOBJECT IDENTIFIER
                  ::= { wranIfBsCm 18 }
  wranIfMeasSupportIndexOBJECT IDENTIFIER
                  ::= { wranIfBsCpeMeasSupportCmn 1 }
  wranIfMeasSupportMacAddressOBJECT IDENTIFIER
                  ::= { wranIfBsCpeMeasSupportCmn 2 }
  wranIfMeasSupportSignalTypeOBJECT IDENTIFIER
                  ::= { wranIfBsCpeMeasSupportCmn 3 }
  wranIfMeasSupportThreshold  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeMeasSupportCmn 4 }
  wranIfMeasSupportPd    OBJECT IDENTIFIER
                  ::= { wranIfBsCpeMeasSupportCmn 5 }
  wranIfMeasSupportMpfa    OBJECT IDENTIFIER
                  ::= { wranIfBsCpeMeasSupportCmn 6 }
  wranIfMeasSupportRecNumSensPeriods  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeMeasSupportCmn 7 }
  wranIfMeasSupportRecSensPeriodDuration  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeMeasSupportCmn 8 }
  wranIfMeasSupportRecSensPeriodInterval  OBJECT IDENTIFIER
                  ::= { wranIfBsCpeMeasSupportCmn 9 }

  wranIfMeasSupportIndex::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "Index of entry defined by
                  wranIfBsCpeMeasSupportReqEntry or
                  wranifBsCpeMeasSupportRspEntry."
    SYNTAXInteger32 (1.. 16384)
    ::= { wranIfBsCpeMeasSupportCmn 1 }

  wranIfMeasSupportMacAddress::= TEXTUAL-CONVENTION
    STATUScurrent
```

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```
    DESCRIPTION
      "MAC address of CPE. This corresponds to an entry in
                  wranIfBsCpeRegCapabilityReqTable for a registered
                  CPE."
    SYNTAXMacAddress
    ::= { wranIfBsCpeMeasSupportCmn 2 }

  wranIfMeasSupportSignalType::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "Signal type to which measurement configuration this
                  entry pertains (see Table 237)."
    SYNTAXINTEGER { undetermined(0), dot22Wran(1),
                     atsc(2), dvbt(3), isdbt(4), ntsc(5),
                     pal(6), secam(7), wimic(8),
                     dot22dot1SyncBurst(9),
                     dot22dot1Msf1(10), dot22dot1Msf2(11),
                     dot22dot1Msf3(12) }
    ::= { wranIfBsCpeMeasSupportCmn 3 }

  wranIfMeasSupportThreshold::= TEXTUAL-CONVENTION
    STATUScurrent
    UNITS         "dBm"
    DESCRIPTION
      "Signed # that signifies the sensitivity threshold
                  for the signal type. Values indicates a sensitivity
                  threshold in dBm on the range from -127.5 to +128
                  dBm in 0.5 dB steps."
    SYNTAXInteger32 (0..511)
    ::= { wranIfBsCpeMeasSupportCmn 4 }

  wranIfMeasSupportPd::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "Probability of detection (PD) for the signal type.
                  Ranges from 0 (0x00) to 1 (0xFA) in increments of
                  0.004."
    SYNTAXINTEGER (0..250)
    ::= { wranIfBsCpeMeasSupportCmn 5 }

  wranIfMeasSupportMpfa::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "Maximum Probability of False Alarm for the signal
                  type. Probability is specified from 0 (0x00) to
                  0.255 (0xFF) in 0.001 increments."
    SYNTAXINTEGER (0..255)
    ::= { wranIfBsCpeMeasSupportCmn 6 }
```

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```
  wranIfMeasSupportRecNumSensPeriods::= TEXTUAL-CONVENTION
    STATUScurrent
    DESCRIPTION
      "Recommended # of sensing periods required to sense
                  signal type (see Table 238)."
    SYNTAXINTEGER (0..127)
    ::= { wranIfBsCpeMeasSupportCmn 7 }

  wranIfMeasSupportRecSensPeriodDuration::= TEXTUAL-CONVENTION
    STATUScurrent
    UNITS         "symbols"
    DESCRIPTION
      "Recommended duration of sensing periods in units of
                  symbols (see Table 238)."
    SYNTAXInteger32 (0..1023)
    ::= { wranIfBsCpeMeasSupportCmn 8 }

  wranIfMeasSupportRecSensPeriodInterval::= TEXTUAL-CONVENTION
    STATUScurrent
    UNITS         "frames"
    DESCRIPTION
      "Recommended length of sensing period interval, units
                  of integer number of frames (see Table 238)."
    SYNTAXInteger32 (0..2047)
::= { wranIfBsCpeMeasSupportCmn 9 }

  wranIfBsCpeSystemParametersTable OBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsCpeSystemParametersEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This table contains objects that define system
                  constants for REG-REQ/RSP, DSx-REQ/RSP, and MCA-RSP
                  transactions. It only has one entry, as defined by
                  wranIfBsCpeSystemParametersEntry."
    ::= { wranIfBsCm 19 }

  wranIfBsCpeSystemParametersEntryOBJECT-TYPE
    SYNTAXwranIfBsCpeSystemParametersEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object defines an entry in
                  wranIfBsCpeSystemParametersTable."
    INDEX{ wranIfBsCpeSystemParametersIndex }
    ::= { wranIfBsCpeSystemParametersTable 1 }
```

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```
wranIfBsCpeSystemParametersEntry::= SEQUENCE {
   wranIfBsCpeSystemParametersIndexINTEGER,
   wranIfBsDsxReqRetriesINTEGER,
   wranIfBsDsxRspRetriesINTEGER,
   wranIfBsT6              INTEGER,
   wranIfBsT7              INTEGER,
   wranIfBsT8              Integer32,
   wranIfBsT9              Integer32,
   wranIfBsT10             INTEGER,
   wranIfBsT13             INTEGER,
   wranIfBsT14             INTEGER,
   wranIfBsT15             INTEGER,
   wranIfBsT16             Integer32,
   wranIfBsT18             Integer32,
   wranIfBsT22             INTEGER,
   wranIfBsT26             INTEGER,
   wranIfBsT27Idle     Integer32,
   wranIfBsT27Active   Integer32,
   wranIfBsT28             Integer32 }

wranIfBsCpeSystemParametersIndexOBJECT-TYPE
   SYNTAXINTEGER (1..1)
   MAX-ACCESSnot-accessible
   STATUScurrent
   DESCRIPTION
     "Index of entry in this table."
   ::= { wranIfBsCpeSystemParametersEntry 1 }

wranIfBsDsxReqRetriesOBJECT-TYPE
   SYNTAXINTEGER (3..5)
   MAX-ACCESSread-only
   STATUScurrent
   DESCRIPTION
     "Maximum number of timeout retries for DSx-REQ
                 messages."
   ::= { wranIfBsCpeSystemParametersEntry 2 }

wranIfBsDsxRspRetriesOBJECT-TYPE
   SYNTAXINTEGER (3..5)
   MAX-ACCESSread-only
   STATUScurrent
   DESCRIPTION
     "Maximum number of timeout retries for DSx-RSP
                 messages."
   ::= { wranIfBsCpeSystemParametersEntry 3 }

wranIfBsT6OBJECT-TYPE
   SYNTAXINTEGER (1..3)
```

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```
    UNITS         "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Timeout for receiving REG-RSP."
    ::= { wranIfBsCpeSystemParametersEntry 4 }

  wranIfBsT7OBJECT-TYPE
    SYNTAXINTEGER (1..250)
    UNITS         "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Timeout for receiving DSx-RSP, representing a range
                  from 4 ms to 1 s in 4 ms increments."
    ::= { wranIfBsCpeSystemParametersEntry 5 }

  wranIfBsT8OBJECT-TYPE
    SYNTAXInteger32 (1..300)
    UNITS         "milliseconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Timeout for receiving DSA-ACK/DSC-ACK, representing
                  a range from 1 ms to 300 ms in 1 ms increments."
    ::= { wranIfBsCpeSystemParametersEntry 6 }

  wranIfBsT9OBJECT-TYPE
    SYNTAXInteger32 (300..1000)
    UNITS         "milliseconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Timeout between BS's transmitting RNG-CMD (success)
                  to a CPE and receiving CBC-REQ from that same CPE."
    ::= { wranIfBsCpeSystemParametersEntry 7 }

  wranIfBsT10OBJECT-TYPE
    SYNTAXINTEGER (1..3)
    UNITS         "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Wait for Transaction End timeout."
    ::= { wranIfBsCpeSystemParametersEntry 8 }

  wranIfBsT13OBJECT-TYPE
    SYNTAXINTEGER (1..3)
```

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```
    UNITS         "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Time allowed for CPE, following receipt of a REG-RSP
                  to send a TFTP-CPLT message to the BS."
    ::= { wranIfBsCpeSystemParametersEntry 9 }

  wranIfBsT14OBJECT-TYPE
    SYNTAXINTEGER (10..200)
    UNITS         "milliseconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Wait for DSx-RSP timeout."
    ::= { wranIfBsCpeSystemParametersEntry 10 }

  wranIfBsT15OBJECT-TYPE
    SYNTAXINTEGER (20..200)
    UNITS         "milliseconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Wait for MCA-RSP."
    ::= { wranIfBsCpeSystemParametersEntry 11 }

  wranIfBsT16OBJECT-TYPE
    SYNTAXInteger32 (10..2000)
    UNITS         "milliseconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Wait for bandwidth request grant."
    ::= { wranIfBsCpeSystemParametersEntry 12 }

  wranIfBsT18OBJECT-TYPE
    SYNTAXInteger32 (10..2000)
    UNITS         "milliseconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Wait for CBC-REQ timeout."
    ::= { wranIfBsCpeSystemParametersEntry 13 }

  wranIfBsT22OBJECT-TYPE
    SYNTAXINTEGER (1..250)
    UNITS         "milliseconds"
    MAX-ACCESSread-only
```

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```
    STATUScurrent
    DESCRIPTION
      "Wait for ARQ-Reset."
    ::= { wranIfBsCpeSystemParametersEntry 14 }

  wranIfBsT26OBJECT-TYPE
    SYNTAXINTEGER (1..250)
    UNITS         "milliseconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Wait for TFT-RSP."
    ::= { wranIfBsCpeSystemParametersEntry 15 }

  wranIfBsT27IdleOBJECT-TYPE
    SYNTAXInteger32 (200..500)
    UNITS         "milliseconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Maximum time between unicast grants to CPE when BS
                  believe CPE transmission quality is good enough."
    ::= { wranIfBsCpeSystemParametersEntry 16 }

  wranIfBsT27ActiveOBJECT-TYPE
    SYNTAXInteger32 (200..500)
    UNITS         "milliseconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Maximum time between unicast grants to CPE when BS
                  believe CPE transmission quality is not good
                  enough."
    ::= { wranIfBsCpeSystemParametersEntry 17 }

  wranIfBsT28OBJECT-TYPE
    SYNTAXInteger32 (60..300)
    UNITS         "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Time allowed for BS to complete the transmission of
                  the backup/candidate channel list to its CPEs after
                  initial registration by a new CPE, including the
                  database service query."
    ::= { wranIfBsCpeSystemParametersEntry 18 }

  wranIfBsCpeRegCapabilityDefTable OBJECT-TYPE
```

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```
    SYNTAXSEQUENCE OF wranIfBsCpeRegCapabilityDefEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object defines a table containing default
                values of REG-REQ/RSP IEs. This table can be used by
                the BS to judge/verify a CPE's REG-REQ and used to
                construct the REG-RSP message. There is one entry in
                this table, defined by
                wranIfBsCpeRegCapabilityDefEntry."
    ::= { wranIfBsCm 20 }

  wranIfBsCpeRegCapabilityDefEntryOBJECT-TYPE
    SYNTAXwranIfBsCpeRegCapabilityDefEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object defines an entry in
                wranIfBsCpeRegCapabilityDefTable. The objects that
                make up this entry are defined in
                wranIfBsCpeRegCapabilityCmn (14.1.2.2.17)."
    INDEX{ wranIfBsCpeRegCapabilityDefIndex }
    ::= { wranIfBsCpeRegCapabilityDefTable 1 }

  wranIfBsCpeRegCapabilityDefEntry::= SEQUENCE {
    wranIfBsCpeRegCapabilityDefIndex
      wranIfRegCapbilityIndex,
    wranIfBsCpeRegCapabilityDefCsConfig
      wranIfRegCapabilityCsConfig,
    wranIfBsCpeRegCapabilityDefIpVersion
      wranIfRegCapabilityIpVersion,
    wranIfBsCpeRegCapabilityDefIpRochSupport
      wranIfRegCapabilityIpRochSupport,
    wranIfBsCpeRegCapabilityDefArqSupport
      wranIfRegCapabilityArqSupport,
    wranIfBsCpeRegCapabilityDef2ndMgmtArqWindowSize
      wranIfRegCapability2ndMgmtArqWindowSize,
    wranIfBsCpeRegCapabilityDef2ndMgmtArqRetryTxDelay
      wranIfRegCapability2ndMgmtArqRetryTxDelay,
    wranIfBsCpeRegCapabilityDef2ndMgmtArqRetryRxDelay
      wranIfRegCapability2ndMgmtArqRetryRxDelay,
    wranIfBsCpeRegCapabilityDef2ndMgmtArqBlockLifetime
      wranIfRegCapability2ndMgmtArqBlockLifetime,
    wranIfBsCpeRegCapabilityDef2ndMgmtArqSyncLossTimeout
      wranIfRegCapability2ndMgmtArqSyncLossTimeout,
    wranIfBsCpeRegCapabilityDef2ndMgmtArqDeliverInOrder
      wranIfRegCapability2ndMgmtArqDeliverInOrder,
    wranIfBsCpeRegCapabilityDef2ndMgmtArqRxPurgeTimeout
```

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```
    wranIfRegCapability2ndMgmtArqRxPurgeTimeout,
  wranIfBsCpeRegCapabilityDef2ndMgmtArqBlockSize
    wranIfRegCapability2ndMgmtArqBlockSize,
  wranIfBsCpeRegCapabilityDefDsxFlowControl
    wranIfRegCapabilityDsxFlowControl,
  wranIfBsCpeRegCapabilityDefMcaFlowControl
    wranIfRegCapabilityMcaFlowControl,
  wranIfBsCpeRegCapabilityDefMaxNumMcastGroups
    wranIfRegCapabilityMaxNumMcastGroups,
  wranIfBsCpeRegCapabilityDefSensModeSupportArray
    wranIfRegCapabilitySensModeSupportArray,
  wranIfBsCpeRegCapabilityDef2ndMgmtIpAllocMethod
    wranIfRegCapability2ndMgmtIpAllocMethod,
  wranIfBsCpeRegCapabilityDefCpeOperationalCapability
    wranIfRegCapabilityCpeOperationalCapability,
  wranIfBsCpeRegCapabilityDefCpeRegistrationTimer
    wranIfRegCapabilityCpeRegistrationTimer }

wranIfBsCpeRegCapabilityDefIndexOBJECT-TYPE
  SYNTAXwranIfRegCapbilityIndex
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "Defined by wranIfRegCapbilityIndex."
  ::= { wranIfBsCpeRegCapabilityDefEntry 1 }

wranIfBsCpeRegCapabilityDefCsConfigOBJECT-TYPE
  SYNTAXwranIfRegCapabilityCsConfig
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Defined by wranIfRegCapabilityCsConfig."
  ::= { wranIfBsCpeRegCapabilityDefEntry 2 }

wranIfBsCpeRegCapabilityDefIpVersionOBJECT-TYPE
  SYNTAXwranIfRegCapabilityIpVersion
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Defined by wranIfRegCapabilityIpVersion."
  ::= { wranIfBsCpeRegCapabilityDefEntry 3 }

wranIfBsCpeRegCapabilityDefIpRochSupportOBJECT-TYPE
  SYNTAXwranIfRegCapabilityIpRochSupport
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Defined by wranIfRegCapabilityIpRochSupport."
```

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```
    ::= { wranIfBsCpeRegCapabilityDefEntry 4 }

  wranIfBsCpeRegCapabilityDefArqSupportOBJECT-TYPE
    SYNTAXwranIfRegCapabilityArqSupport
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityArqSupport."
    ::= { wranIfBsCpeRegCapabilityDefEntry 5 }

  wranIfBsCpeRegCapabilityDef2ndMgmtArqWindowSizeOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqWindowSize
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapability2ndMgmtArqWindowSize."
    ::= { wranIfBsCpeRegCapabilityDefEntry 6 }

  wranIfBsCpeRegCapabilityDef2ndMgmtArqRetryTxDelayOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqRetryTxDelay
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapability2ndMgmtArqRetryTxDelay."
    ::= { wranIfBsCpeRegCapabilityDefEntry 7 }

  wranIfBsCpeRegCapabilityDef2ndMgmtArqRetryRxDelayOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqRetryRxDelay
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapability2ndMgmtArqRetryRxDelay."
    ::= { wranIfBsCpeRegCapabilityDefEntry 8 }

  wranIfBsCpeRegCapabilityDef2ndMgmtArqBlockLifetimeOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqBlockLifetime
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapability2ndMgmtArqBlockLifetime."
    ::= { wranIfBsCpeRegCapabilityDefEntry 9 }

  wranIfBsCpeRegCapabilityDef2ndMgmtArqSyncLossTimeoutOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqSyncLossTimeout
    MAX-ACCESSread-only
```

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```
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapability2ndMgmtArqSyncLossTimeout."
    ::= { wranIfBsCpeRegCapabilityDefEntry 10 }

  wranIfBsCpeRegCapabilityDef2ndMgmtArqDeliverInOrderOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqDeliverInOrder
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapability2ndMgmtArqDeliverInOrder."
    ::= { wranIfBsCpeRegCapabilityDefEntry 11 }

  wranIfBsCpeRegCapabilityDef2ndMgmtArqRxPurgeTimeoutOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqRxPurgeTimeout
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfRegCapability2ndMgmtArqRxPurgeTimeout."
    ::= { wranIfBsCpeRegCapabilityDefEntry 12 }

  wranIfBsCpeRegCapabilityDef2ndMgmtArqBlockSizeOBJECT-TYPE
    SYNTAXwranIfRegCapability2ndMgmtArqBlockSize
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapability2ndMgmtArqBlockSize."
    ::= { wranIfBsCpeRegCapabilityDefEntry 13 }

  wranIfBsCpeRegCapabilityDefDsxFlowControlOBJECT-TYPE
    SYNTAXwranIfRegCapabilityDsxFlowControl
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityDsxFlowControl."
    ::= { wranIfBsCpeRegCapabilityDefEntry 14 }

  wranIfBsCpeRegCapabilityDefMcaFlowControlOBJECT-TYPE
    SYNTAXwranIfRegCapabilityMcaFlowControl
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfRegCapabilityMcaFlowControl."
    ::= { wranIfBsCpeRegCapabilityDefEntry 15 }
```

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```
wranIfBsCpeRegCapabilityDefMaxNumMcastGroupsOBJECT-TYPE
  SYNTAXwranIfRegCapabilityMaxNumMcastGroups
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Defined by wranIfRegCapabilityMaxNumMcastGroups."
  ::= { wranIfBsCpeRegCapabilityDefEntry 16 }

wranIfBsCpeRegCapabilityDefSensModeSupportArrayOBJECT-TYPE
  SYNTAXwranIfRegCapabilitySensModeSupportArray
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Defined by wranIfRegCapabilitySensModeSupportArray."
  ::= { wranIfBsCpeRegCapabilityDefEntry 17 }

wranIfBsCpeRegCapabilityDef2ndMgmtIpAllocMethodOBJECT-TYPE
  SYNTAXwranIfRegCapability2ndMgmtIpAllocMethod
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Defined by wranIfRegCapability2ndMgmtIpAllocMethod."
  ::= { wranIfBsCpeRegCapabilityDefEntry 18 }

wranIfBsCpeRegCapabilityDefCpeOperationalCapabilityOBJECT-TYPE
  SYNTAXwranIfRegCapabilityCpeOperationalCapability
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Defined by
                wranIfRegCapabilityCpeOperationalCapability."
  ::= { wranIfBsCpeRegCapabilityDefEntry 19 }

wranIfBsCpeRegCapabilityDefCpeRegistrationTimerOBJECT-TYPE
  SYNTAXwranIfRegCapabilityCpeRegistrationTimer
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Defined by
                wranIfRegCapabilityCpeRegistrationTimer."
  ::= { wranIfBsCpeRegCapabilityDefEntry 20 }

wranIfBsCpeBasicCapabilityDefTable OBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfBsCpeBasicCapabilityDefEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines a table containing default
```

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```
                values of CBC-REQ/RSP IEs. This table can be used by
                the BS to judge/verify a CPE's CBC-REQ and used to
                construct the CBC-RSP message. There is one entry in
                this table defined by
                wranIfBSCpeBasicCapabilityDefEntry."
  ::= { wranIfBsCm 21 }

wranIfBsCpeBasicCapabilityDefEntryOBJECT-TYPE
  SYNTAXwranIfBsCpeBasicCapabilityDefEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                wranIfBsCpeBasicCapabilityDefTable The objects that
                make up this table are defined in
                wranIfBsCpeBasicCapabilityCmn (14.1.2.2.16)."
  INDEX{ wranIfBsCpeBasicCapabilityDefIndex }
  ::= { wranIfBsCpeBasicCapabilityDefTable 1 }

wranIfBsCpeBasicCapabilityDefEntry::= SEQUENCE {
  wranIfBsCpeBasicCapabilityDefIndex
    wranIfBasicCapbilityIndex,
  wranIfBsCpeBasicCapabilityDefMacPduTxAndConstruction
    wranIfBasicCapbilityMacPduTxAndConstruction,
  wranIfBsCpeBasicCapabilityDefCpeDemodulator
    wranIfBasicCapabilityCpeDemodulator,
  wranIfBsCpeBasicCapabilityDefCpeModulator
    wranIfBasicCapabilityCpeModulator,
  wranIfBsCpeBasicCapabilityDefScmVersionSupport
    wranIfBasicCapabilityCpeScmVersionSupport,
  wranIfBsCpeBasicCapabilityDefPnWindowSize
    wranIfBasicCapabilityCpePnWindowSize,
  wranIfBsCpeBasicCapabilityDefScmFlowControl
    wranIfBasicCapabilityScmFlowControl }

wranIfBsCpeBasicCapabilityDefIndexOBJECT-TYPE
  SYNTAXwranIfBasicCapbilityIndex
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "Defined by wranIfBasicCapabilityIndex."
  ::= { wranIfBsCpeBasicCapabilityDefEntry 1 }

wranIfBsCpeBasicCapabilityDefMacPduTxAndConstructionOBJECT-TYPE
  SYNTAXwranIfBasicCapbilityMacPduTxAndConstruction
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
```

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```
      "Defined by
                  wranIfBasicCapbilityMacPduTxAndConstruction."
    ::= { wranIfBsCpeBasicCapabilityDefEntry 2 }

  wranIfBsCpeBasicCapabilityDefCpeDemodulatorOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityCpeDemodulator
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfBasicCapabilityCpeDemodulator."
    ::= { wranIfBsCpeBasicCapabilityDefEntry 3 }

  wranIfBsCpeBasicCapabilityDefCpeModulatorOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityCpeModulator
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfBasicCapabilityCpeModulator."
    ::= { wranIfBsCpeBasicCapabilityDefEntry 4 }

  wranIfBsCpeBasicCapabilityDefScmVersionSupportOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityCpeScmVersionSupport
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by
                  wranIfBasicCapabilityCpeScmVersionSupport."
    ::= { wranIfBsCpeBasicCapabilityDefEntry 5 }

  wranIfBsCpeBasicCapabilityDefPnWindowSizeOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityCpePnWindowSize
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfBasicCapabilityCpePnWindowSize."
    ::= { wranIfBsCpeBasicCapabilityDefEntry 6 }

  wranIfBsCpeBasicCapabilityDefScmFlowControlOBJECT-TYPE
    SYNTAXwranIfBasicCapabilityScmFlowControl
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfBasicCapabilityScmFlowControl."
    ::= { wranIfBsCpeBasicCapabilityDefEntry 7 }

  wranIfBsCpeMeasSupportDefTable OBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsCpeMeasSupportDefEntry
    MAX-ACCESSnot-accessible
```

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```
    STATUScurrent
    DESCRIPTION
      "A compound object representing the default
                  configuration of the Measurement Support IE of REG-
                  REQ/RSP. This table can be used by the BS to
                  judge/verify the Measurement Support IE in CPE's
                  REG-REQ and used to construct the Measurement
                  Support IE sent by the BS in the REG-RSP message.
                  There is one entry for each signal type, defined by
                  wranIfBsCpeMeasSupportDefEntry. This table is only
                  valid if the value for wranIfSensModeSupportArray is
                  anything other than 'No Sensing'."
    ::= { wranIfBsCm 22 }

  wranIfBsCpeMeasSupportDefEntryOBJECT-TYPE
    SYNTAXwranIfBsCpeMeasSupportDefEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "A compound object representing the entries
                  of wranIfBsCpeMeasSupportDefTable. Each part
                  entry is defined in wranIfBsCpeMeasSupportCmn
                  (14.1.2.2.18)."
    INDEX{ wranIfBsCpeMeasSupportDefIndex }
    ::= { wranIfBsCpeMeasSupportDefTable 1 }

  wranIfBsCpeMeasSupportReqEntry::= SEQUENCE {
    wranIfBsCpeMeasSupportDefIndex
      wranIfMeasSupportIndex,
    wranIfBsCpeMeasSupportDefSignalType
      wranIfMeasSupportSignalType,
    wranIfBsCpeMeasSupportDefThreshold
      wranIfMeasSupportThreshold,
    wranIfBsCpeMeasSupportDefPd
      wranIfMeasSupportPd,
    wranIfBsCpeMeasSupportDefMpfa
      wranIfMeasSupportMpfa,
    wranIfBsCpeMeasSupportDefRecNumSensPeriods
      wranIfMeasSupportRecNumSensPeriods,
    wranIfBsCpeMeasSupportDefRecSensPeriodDuration
      wranIfMeasSupportRecSensPeriodDuration,
    wranIfBsCpeMeasSupportDefRecSensPeriodInterval
      wranIfMeasSupportRecSensPeriodInterval }

  wranIfBsCpeMeasSupportDefIndexOBJECT-TYPE
    SYNTAXwranIfMeasSupportIndex
    MAX-ACCESSnot-accessible
    STATUScurrent
```

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```
    DESCRIPTION
      "Defined by wranIfMeasSupportIndex."
    ::= { wranIfBsCpeMeasSupportDefEntry 1 }

  wranIfBsCpeMeasSupportDefSignalTypeOBJECT-TYPE
    SYNTAXwranIfMeasSupportSignalType
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportSignalType."
    ::= { wranIfBsCpeMeasSupportDefEntry 2 }

  wranIfBsCpeMeasSupportDefThresholdOBJECT-TYPE
    SYNTAXwranIfMeasSupportThreshold
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportThreshold."
    ::= { wranIfBsCpeMeasSupportDefEntry 3 }

  wranIfBsCpeMeasSupportDefPdOBJECT-TYPE
    SYNTAXwranIfMeasSupportPd
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportPd."
    ::= { wranIfBsCpeMeasSupportDefEntry 4 }

  wranIfBsCpeMeasSupportDefMpfaOBJECT-TYPE
    SYNTAXwranIfMeasSupportMpfa
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportMpfa."
    ::= { wranIfBsCpeMeasSupportDefEntry 5 }

  wranIfBsCpeMeasSupportDefRecNumSensPeriodsOBJECT-TYPE
    SYNTAXwranIfMeasSupportRecNumSensPeriods
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportRecNumSensPeriods."
    ::= { wranIfBsCpeMeasSupportDefEntry 6 }

  wranIfBsCpeMeasSupportDefRecSensPeriodDurationOBJECT-TYPE
    SYNTAXwranIfMeasSupportRecSensPeriodDuration
    MAX-ACCESSread-only
    STATUScurrent
```

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```
    DESCRIPTION
      "Defined by wranIfMeasSupportRecSensPeriodDuration."
    ::= { wranIfBsCpeMeasSupportDefEntry 7 }

  wranIfBsCpeMeasSupportDefRecSensPeriodIntervalOBJECT-TYPE
    SYNTAXwranIfMeasSupportRecSensPeriodInterval
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Defined by wranIfMeasSupportRecSensPeriodInterval."
    ::= { wranIfBsCpeMeasSupportDefEntry 8 }

-- wranIfBsPhy: This MIB object contains managed objects related to PHY
-- configuration. All object described are related to the OFDMA PHY
-- that is supported.

  wranIfBsPhy            OBJECT IDENTIFIER
                             ::= { wranIfBsCm 23 }
  wranIfBsOfdmaPhyUsChannelTableOBJECT IDENTIFIER
                             ::= { wranIfBsPhy 1 }
  wranIfBsOfdmaPhyDsChannelTableOBJECT IDENTIFIER
                             ::= { wranIfBsPhy 2 }
  wranIfBsOfdmaUcdBurstProfileTableOBJECT IDENTIFIER
                             ::= { wranIfBsPhy 3 }
  wranIfBsOfdmaDcdBurstProfileTableOBJECT IDENTIFIER
                             ::= { wranIfBsPhy 4 }
  wranIfBsOfdmaDsRegionTableOBJECT IDENTIFIER
                             ::= { wranIfBsPhy 5 }
  wranIfBsOfdamUsRegionTableOBJECT IDENTIFER
                             ::= { wranIfBsPhy 6 }

  wranIfBsOfdmaPhyUsChannelTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsOfdmaPhyUsChannelEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object provides a table to describe attributes
                of upstream channels. It is a compound object that
                is made up of multiple entries (one for each CPE),
                described by wranIfBsOfdmaPhyUsChannelTableEntry."
    ::= { wranIfBsPhy 1 }

  wranIfBsOfdmaPhyUsChannelEntryOBJECT-TYPE
    SYNTAXwranIfBsOfdmaPhyUsChannelEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object is a compound object that represents an
```

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```
                    entry a CPE's upstream channel configuration."
    INDEX{ wranIfBsOfdmaPhyUsChannelIndex }
    ::= { wranIfBsOfdmaPhyUsChannelTable 1 }

  wranIfBsOfdmaPhyUsChannelEntry::= SEQUENCE {
    wranIfBsOfdmaPhyUsChannelIndexInteger32,
    wranIfBsOfdmaPhyUsSid   Integer32,
    wranIfBsOfdmaPhyUsMacAddressMacAddress,
    wranIfBsOfdmaCtBasedResvTimeoutINTEGER,
    wranIfBsOfdmaUsCenterFrequencyInteger32,
    wranIfBsOfdmasUsRadioResourceINTEGER,
    wranIfBsOfdmaUsUcsConfigChangeCountINTEGER,
    wranIfBsOfdmaUsUcsNotificationCodesINTEGER,
    wranIfBsOfdmaUsInitRngCodesINTEGER,
    wranIfBsOfdmaUsPeriodicRngCodesINTEGER,
    wranIfBsOfdmaUsBWReqCodesINTEGER,
    wranIfBsOfdmaUsPeriodicRngBackoffStartINTEGER,
    wranIfBsOfdmaUsPeriodicRngBackoffEndINTEGER,
    wranIfBsOfdmaUsStartofCodesINTEGER,
    wranIfBsOfdmaUsNormalizedCnrOverrideOCTET STRING,
    wranIfBsOfdamUsInitialRangingIntervalINTEGER,
    wranIfBsOfdmaUsUcsNotificationBackoffStartINTEGER,
    wranIfBsOfdmaUsUcsNotificationBackoffEndINTEGER,
    wranIfBsOfdmaUsInitialRngBackoffStartINTEGER,
    wranIfBsOfdmaUsInitialRngBackoffEndINTEGER,
    wranIfBsOfdmaUsBwRequestBackoffStartINTEGER,
    wranIfBsOfdmaUsBwRequestBackoffEndINTEGER,
    wranIfBsOfdmaUsUcdIntervalINTEGER,
    wranIfBsOfdmaUsUcdTransitionINTEGER,
    wranIfBsOfdmaUsClkCmpIntervalINTEGER,
    wranIfBsOfdmaUsT57      INTEGER,
    wranIfBsOfdmaUsT58      INTEGER,
    wranIfBsOfdmaUsCdmaRngRetriesINTEGER,
    wranIfBsOfdmaUsInvRngReqINTEGER,
    wranIfBsOfdmaUsMapProcTimeINTEGER,
    wranIfBsOfdmaUsT3       INTEGER,
    wranIfBsOfdmaUsT4       Integer32,
    wranIfBsOfdmaUsT5       INTEGER,
    wranIfBsOfdmaUsT12      INTEGER }

  wranIfBsOfdmaPhyUsChannelIndexOBJECT-TYPE
    SYNTAXInteger32 (1.. 131071)
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "Index of entry in this table, defaults to 1."
    ::= { wranIfBsOfdmaPhyUsChannelEntry 1 }
```

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```
wranIfBsOfdmaPhyUsSidOBJECT-TYPE
  SYNTAXInteger32 (0.. 512)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "A 9-bit Station ID that identifies the station whose
                US is defined in this entry."
  ::= { wranIfBsOfdmaPhyUsChannelEntry 2 }

wranIfBsOfdmaPhyUsMacAddressOBJECT-TYPE
  SYNTAXMacAddress
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "MAC Address of CPE whose upstream is defined in this
                table."
  ::= { wranIfBsOfdmaPhyUsChannelEntry 3 }

wranIfBsOfdmaCtBasedResvTimeoutOBJECT-TYPE
  SYNTAXINTEGER (1..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "The number of US-MAPs to receive before contention-
                based reservation is attempted again for the same
                connection."
  ::= { wranIfBsOfdmaPhyUsChannelEntry 4 }

wranIfBsOfdmaUsCenterFrequencyOBJECT-TYPE
  SYNTAXInteger32 (0..6000000)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Upstream center frequency in kHz."
  ::= { wranIfBsOfdmaPhyUsChannelEntry 5 }

wranIfBsOfdmaUsRadioResourceOBJECT-TYPE
  SYNTAXINTEGER (0..100)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Indicates the average percentage (ratio) of non-
                assigned US radio resources to total usable US radio
                resources (should be the same across all CPEs on the
                same channel."
  ::= { wranIfBsOfdmaPhyUsChannelEntry 6 }

wranIfBsOfdmaUsConfigChangeCountOBJECT-TYPE
```

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```
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Current UCD change count."
    ::= { wranIfBsOfdmaPhyUsChannelEntry 7 }

  wranIfBsOfdmaUsUcsNotificationCodesOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of CDMA codes for UCS Notification."
    ::= { wranIfBsOfdmaPhyUsChannelEntry 8 }

  wranIfBsOfdmaUsInitRngCodesOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of CDMA codes for Initial Ranging."
    ::= { wranIfBsOfdmaPhyUsChannelEntry 9 }

  wranIfBsOfdmaUsPeriodicRngCodesOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of CDMA codes for periodic ranging."
    ::= { wranIfBsOfdmaPhyUsChannelEntry 10 }

  wranIfBsOfdmaUsBWReqCodesOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of CDMA codes for bandwidth requests."
    ::= { wranIfBsOfdmaPhyUsChannelEntry 11 }

  wranIfBsOfdmaUsPeriodicRngBackoffStartOBJECT-TYPE
    SYNTAXINTEGER (0..15)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Expressed as a power of 2, initial backoff window
                  size for Periodic ranging."
    ::= { wranIfBsOfdmaPhyUsChannelEntry 12 }
```

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```
wranIfBsOfdmaUsPeriodicRngBackoffEndOBJECT-TYPE
  SYNTAXINTEGER (1..15)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Represented in powers of 2, initial size of backoff
                window used for periodic ranging contention."
  ::= { wranIfBsOfdmaPhyUsChannelEntry 13 }

wranIfBsOfdmaUsStartofCodesOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Includes first code in block of codes to be used in
                a particular BS, known as S. The total set of codes
                ranges from S to
               (wranIfBsOfdmaUsInitRngCodes+wranIfBsOfdmaUsPeriodicR
               ngCodes+wranIfBsOfdmaUsBWReqCodes+wranIfBsOfdmaUsUcsN
               otificationCodes) mod 256."
  ::= { wranIfBsOfdmaPhyUsChannelEntry 14 }

wranIfBsOfdmaUsNormalizedCnrOverrideOBJECT-TYPE
  SYNTAXOCTET STRING (SIZE(7))
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "This is a list of numbers and follows the
                specification of the Normalized CNR override as
                defined in Table 33 and in 8.10.3.2. The
                number encoded by each nibble represents the
                difference in normalized CNR relative to the
                previous one."
  ::= { wranIfBsOfdmaPhyUsChannelEntry 15 }

wranIfBsOfdamUsInitialRangingIntervalOBJECT-TYPE
  SYNTAXINTEGER (2..15)
  UNITS        "seconds"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Number of frames between initial ranging interval
                allocation."
  ::= { wranIfBsOfdmaPhyUsChannelEntry 16 }

wranIfBsOfdmaUsUcsNotificationBackoffStartOBJECT-TYPE
  SYNTAXINTEGER (0..15)
  MAX-ACCESSread-only
```

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```
    STATUScurrent
    DESCRIPTION
      "Represented in powers of 2, initial backoff
                  window size used for UCS notification contention."
    ::= { wranIfBsOfdmaPhyUsChannelEntry 17 }

  wranIfBsOfdmaUsUcsNotificationBackoffEndOBJECT-TYPE
    SYNTAXINTEGER (1..15)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Represented in powers of 2, final backoff
                  window size used for UCS notification contention."
    ::= { wranIfBsOfdmaPhyUsChannelEntry 18 }

  wranIfBsOfdmaUsInitialRngBackoffStartOBJECT-TYPE
    SYNTAXINTEGER (0..15)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Represented in powers of 2, initial backoff
                  window size used for initial ranging contention."
    ::= { wranIfBsOfdmaPhyUsChannelEntry 19 }

  wranIfBsOfdmaUsInitialRngBackoffEndOBJECT-TYPE
    SYNTAXINTEGER (1..15)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Represented in powers of 2, final backoff
                  window size used for initial ranging contention."
    ::= { wranIfBsOfdmaPhyUsChannelEntry 20 }

  wranIfBsOfdmaUsBwRequestBackoffStartOBJECT-TYPE
    SYNTAXINTEGER (0..15)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Represented in powers of 2, initial backoff
                  window size used for contention-based BW requests
                  contention."
    ::= { wranIfBsOfdmaPhyUsChannelEntry 21 }

  wranIfBsOfdmaUsBwRequestBackoffEndOBJECT-TYPE
    SYNTAXINTEGER (1..15)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
```

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```
      "Represented in powers of 2, final backoff
                  window size used for contention-based BW requests
                  contention."
   ::= { wranIfBsOfdmaPhyUsChannelEntry 22 }

wranIfBsOfdmaUsUcdIntervalOBJECT-TYPE
   SYNTAXINTEGER (1..10)
   UNITS         "seconds"
   MAX-ACCESSread-only
   STATUScurrent
   DESCRIPTION
      "Time between transmission of UCD messages."
   ::= { wranIfBsOfdmaPhyUsChannelEntry 23 }

wranIfBsOfdmaUsUcdTransitionOBJECT-TYPE
   SYNTAXINTEGER (2..5)
   UNITS         "frames"
   MAX-ACCESSread-only
   STATUScurrent
   DESCRIPTION
      "Time BS shall wait after repeating a UCD message
                  with an incremented Configuration Change Count
                  before issuing a US-MAP message referring to
                  Upstream_Burst_Profiles defined in that UCD
                  message."
   ::= { wranIfBsOfdmaPhyUsChannelEntry 24 }

wranIfBsOfdmaUsClkCmpIntervalOBJECT-TYPE
   SYNTAXINTEGER (50)
   UNITS         "milliseconds"
   MAX-ACCESSread-only
   STATUScurrent
   DESCRIPTION
      "Time between the clock compare measurements used for
                  the generation of CLK-CMP messages."
   ::= { wranIfBsOfdmaPhyUsChannelEntry 25 }

wranIfBsOfdmaUsT57OBJECT-TYPE
   SYNTAXInteger32 (10..600)
   UNITS         "milliseconds"
   MAX-ACCESSread-only
   STATUScurrent
   DESCRIPTION
      "Lost US-MAP interval, time since last received US-
                  MAP message before upstream synchronization is
                  considered lost (used on the CPE)."
   ::= { wranIfBsOfdmaPhyUsChannelEntry 26 }
```

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```
wranIfBsOfdmaUsT58OBJECT-TYPE
   SYNTAXInteger32 (10..600)
   UNITS         "milliseconds"
   MAX-ACCESSread-only
   STATUScurrent
   DESCRIPTION
     "Number of SCH that can be lost until synchronization
                 is considered lost."
   ::= { wranIfBsOfdmaPhyUsChannelEntry 27 }

wranOfBsOfdmaUsCdmaRngRetriesOBJECT-TYPE
   SYNTAXINTEGER (1..4)
   MAX-ACCESSread-only
   STATUScurrent
   DESCRIPTION
     "# of retries on CDMA RNG-REQs."
   ::= { wranIfBsOfdmaPhyUsChannelEntry 28 }

wranIfBsOfdmaUsInvRngReqOBJECT-TYPE
   SYNTAXINTEGER (16..32)
   MAX-ACCESSread-only
   STATUScurrent
   DESCRIPTION
     "# of retries on inviting RNG-REQs."
   ::= { wranIfBsOfdmaPhyUsChannelEntry 29 }

wranIfBsOfdmaUsMapProcTimeOBJECT-TYPE
   SYNTAXINTEGER (5)
   UNITS         "symbols"
   MAX-ACCESSread-only
   STATUScurrent
   DESCRIPTION
     "Time provided between arrival of the last bit of a
                 US-MAP at a CPE and the effectiveness of that map."
   ::= { wranIfBsOfdmaPhyUsChannelEntry 30 }

wranIfBsOfdmaUsT3OBJECT-TYPE
   SYNTAXINTEGER (200)
   UNITS         "milliseconds"
   MAX-ACCESSread-only
   STATUScurrent
   DESCRIPTION
     "RNG-CMD reception timeout following the transmission
                 of RNG-REQ."
   ::= { wranIfBsOfdmaPhyUsChannelEntry 31 }

wranIfBsOfdmaUsT4OBJECT-TYPE
   SYNTAXInteger32 (1..1800)
```

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```
    UNITS          "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Time to wait for unicast ranging opportunity."
    ::= { wranIfBsOfdmaPhyUsChannelEntry 32 }

  wranIfBsOfdmaUsT5OBJECT-TYPE
    SYNTAXINTEGER (2)
    UNITS          "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Time to wait for Upstream Channel Change response."
    ::= { wranIfBsOfdmaPhyUsChannelEntry 33 }

  wranIfBsOfdmaUsT12OBJECT-TYPE
    SYNTAXINTEGER (1..50)
    UNITS          "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Wait for UCD descriptor."
    ::= { wranIfBsOfdmaPhyUsChannelEntry 34 }

  wranIfBsOfdmaPhyDsChannelTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsOfdmaPhyDsChannelEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object provides a table to describe attributes
                of downstream channels. It is a compound object that
                is made up of multiple entries (one for each CPE),
                described by wranIfBsOfdmaPhyDsChannelTableEntry."
    ::= { wranIfBsPhy 2 }

  wranIfBsOfdmaPhyDsChannelEntryOBJECT-TYPE
    SYNTAXwranIfBsOfdmaPhyDsChannelEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object is a compound object that represents an
                entry a each downstream channel in each BS."
    INDEX{ wranIfBsOfdmaPhyDsChannelIndex }
    ::= { wranIfBsOfdmaPhyDsChannelTable 1 }

  wranIfBsOfdmaPhyDsChannelEntry::= SEQUENCE {
    wranIfBsOfdmaPhyDsChannelIndexINTEGER,
```

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```
    wranIfBsOfdmaDsBsId MacAddress,
    wranIfBsOfdmaDsEirp INTEGER,
    wranIfBsOfdmaDsChannelNumberINTEGER,
    wranIfBsOfdmaDsPhyMaxEirpINTEGER,
    wranIfBsOfdmaDsCenterFreqInteger32,
    wranIfBsOfdmaDsMacVersionINTEGER,
    wranIfBsOfdmaDsCyclicPrefixINTEGER,
    wranIfBsOfdmaDsRadioResourceINTEGER,
    wranIfBsOfdmaDsCellTypeINTEGER,
    wranIfBsOfdmaDsConfigChangeCountINTEGER,
    wranIfBsOfdmaDsFrameDurationOCTET STRING,
    wranIfBsOfdmaDsRssiCinrAvgParameterBITS,
    wranIfBsOfdmaDsThresholdAddBsServiceSetINTEGER,
    wranIfBsOfdmaDsThresholdDelBsServiceSetINTEGER,
    wranIfBsOfdmaDsDcdIntervalINTEGER,
    wranIfBsOfdmaDsDcdTransitionINTEGER,
    wranIfBsOfdmaDsT56  Integer32,
    wranIfBsOfdmaDsT1       INTEGER,
    wranIfBsOfdmaDsT2       INTEGER,
    wranIfBsOfdmaDsT20  INTEGER,
    wranIfBsOfdmaDsT21  INTEGER,
    wranIfBsOfdmaDsTtg  INTEGER }

  wranIfBsOfdmaPhyDsChannelIndexOBJECT-TYPE
    SYNTAXINTEGER (1.. 255)
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "Index of entry in this table, defaults to 1."
    ::= { wranIfBsOfdmaPhyDsChannelEntry 1 }

  wranIfBsOfdmaDsBsIdOBJECT-TYPE
    SYNTAXMacAddress
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "BS ID (MAC Address) of the base station."
    ::= { wranIfBsOfdmaPhyDsChannelEntry 2 }

  wranIfBsOfdmaDsEirpOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    UNITS        "dBm"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "The equivalent isotropic radiated power of the base
                station, which is computed for a simple single-
                antenna transmitter (ranging from -64 dBm to +63.5
```

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```
                    dBm in 0.5 dB steps)."
    ::= { wranIfBsOfdmaPhyDsChannelEntry 3 }

  wranIfBsOfdmaDsChannelNumberOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Current operating channel."
    ::= { wranIfBsOfdmaPhyDsChannelEntry 4 }

  wranIfBsOfdmaDsPhyMaxEirpOBJECT-TYPE
    SYNTAXINTEGER (0..127)
    UNITS         "dBm"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Initial ranging maximum EIRP, at BS in units of 1
                    dBm (ranging from -104 dBm to +23 dBm)."
    ::= { wranIfBsOfdmaPhyDsChannelEntry 5 }

  wranIfBsOfdmaDsCenterFreqOBJECT-TYPE
    SYNTAXInteger32 (0..10000000)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "DS center frequency in kHz."
    ::= { wranIfBsOfdmaPhyDsChannelEntry 6 }

  wranIfBsOfdmaDsMacVersionOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "The MAC version to which the BS is conformant."
    ::= { wranIfBsOfdmaPhyDsChannelEntry 7 }

  wranIfBsOfdmaDsCyclicPrefixOBJECT-TYPE
    SYNTAXINTEGER { oneQuarter(0), oneEighth(1),
                    oneSixteenth(2),
                    oneThirtySecond(3) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Ratio of CP time to useful symbol time; possible
                    values are 1/4, 1/8, 1/16, and 1/32."
    ::= { wranIfBsOfdmaPhyDsChannelEntry 8 }
```

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```
wranIfBsOfdmaDsRadioResourceOBJECT-TYPE
  SYNTAXINTEGER (0..100)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Average ratio of non-assigned DS radio resources to
                total usable DS radio resources."
  ::= { wranIfBsOfdmaPhyDsChannelEntry 9 }

wranIfBsOfdmaDsCellTypeOBJECT-TYPE
  SYNTAXINTEGER { fixed(0), personalPortable(1) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "This object identifies classes of BSs that can be
                used by CPE when selecting the cell with which to
                attempt network entry."
  ::= { wranIfBsOfdmaPhyDsChannelEntry 10 }

wranIfBsOfdmaDsConfigChangeCountOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Current BS DCD configuration change count."
  ::= { wranIfBsOfdmaPhyDsChannelEntry 11 }

wranIfBsOfdmaDsFrameDurationOBJECT-TYPE
  SYNTAXINTEGER (0..63)
  UNITS         "symbols"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Duration of DS portion of a frame (from the start of
                frame including preambles)."
  ::= { wranIfBsOfdmaPhyDsChannelEntry 12 }

wranIfBsOfdmaDsRssiCinrAvgParameterOBJECT-TYPE
  SYNTAXBITS { avg0(0), avg1(1), avg2(2), avg3(3) }
  UNITS         "seconds"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Bits 0-3 of default RSSI and CINR averaging
                parameter."
  ::= { wranIfBsOfdmaPhyDsChannelEntry 13 }

wranIfBsOfdmaDsThresholdAddBsServiceSetOBJECT-TYPE
```

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```
    SYNTAXINTEGER (0..255)
    UNITS         "dBm"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Threshold used by CPE to add a neighbor BS to the
                list of available WRAN services (ranging from -104
                dBm to +23.5 dBm in 0.5 dB steps)."
    ::= { wranIfBsOfdmaPhyDsChannelEntry 14 }

  wranIfBsOfdmaDsThresholdDelBsServiceSetOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Threshold used by CPE to delete a neighbor BS from
                the list of available WRAN services (ranging from
                -104 dBm to +23.5 dBm in 0.5 dB steps)."
    ::= { wranIfBsOfdmaPhyDsChannelEntry 15 }

  wranIfBsOfdmaDsDcdIntervalOBJECT-TYPE
    SYNTAXINTEGER (1..10)
    UNITS         "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Time between transmission of DCD messages."
    ::= { wranIfBsOfdmaPhyDsChannelEntry 16 }

  wranIfBsOfdmaDsDcdTransitionOBJECT-TYPE
    SYNTAXINTEGER (2..5)
    UNITS         "frames"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Time BS shall wait after repeating a DCD message
                with an incremented Configuration Change Count
                before issuing a DS-MAP message referring to
                Downstream_Burst_Profiles defined in that DCD
                message."
    ::= { wranIfBsOfdmaPhyDsChannelEntry 17 }

  wranIfBsOfdmaDsT56OBJECT-TYPE
    SYNTAXInteger32 (10..600)
    UNITS         "milliseconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
```

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```
      "Time since last received DS-MAP message before
                  downstream synchronization is considered lost."
   ::= { wranIfBsOfdmaPhyDsChannelEntry 18 }

wranIfBsOfdmaDsT1OBJECT-TYPE
   SYNTAXINTEGER (1..50)
   UNITS         "seconds"
   MAX-ACCESSread-only
   STATUScurrent
   DESCRIPTION
      "Wait for DCD timeout."
   ::= { wranIfBsOfdmaPhyDsChannelEntry 19 }

wranIfBsOfdmaDsT2OBJECT-TYPE
   SYNTAXINTEGER (1..10)
   UNITS         "seconds"
   MAX-ACCESSread-only
   STATUScurrent
   DESCRIPTION
      "Wait for broadcast ranging timeout."
   ::= { wranIfBsOfdmaPhyDsChannelEntry 20 }

wranIfBsOfdmaDsT20OBJECT-TYPE
   SYNTAXINTEGER (1..5)
   UNTIS         "frames"
   MAX-ACCESSread-only
   STATUScurrent
   DESCRIPTION
      "Time CPE searches for preambles on a given channel."
   ::= { wranIfBsOfdmaPhyDsChannelEntry 21 }

wranIfBsOfdmaDsT21OBJECT-TYPE
   SYNTAXINTEGER (1..10)
   UNITS         "seconds"
   MAX-ACCESSread-only
   STATUScurrent
   DESCRIPTION
      "Time the CPE searches for a DS-MAP on a given
                  channel."
   ::= { wranIfBsOfdmaPhyDsChannelEntry 22 }

wranIfBsOfdmaDsTtgOBJECT-TYPE
   SYNTAXINTEGER { 105us(0), 210us(1), 333us(3) }
   MAX-ACCESSread-only
   STATUScurrent
   DESCRIPTION
      "Transmit/Receive Transition Gap."
   ::= { wranIfBsOfdmaPhyDsChannelEntry 23 }
```

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```
wranIfBsOfdmaUcdBurstProfileTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfBsOfdmaUcdBurstProfileEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This table contains the UCD burst profile
                configurations for each upstream channel. Each entry
                in the table is represented by
                wranIfBsOfdmaUcdBurstProfileEntry."
  ::= { wranIfBsPhy 3 }

wranIfBsOfdmaUcdBurstProfileEntryOBJECT-TYPE
  SYNTAXwranIfBsOfdmaUcdBurstProfileEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This is a compound object that defines an entry in
                wranIfBsOfdmaUcdBurstProfileTable."
  INDEX{ wranIfBsOfdmaUcdUiucIndex }
  ::= { wranIfBsOfdmaUcdBurstProfileTable 1 }

wranIfBsOfdmaUcdBurstProfileEntry::= SEQUENCE {
  wranIfBsOfdmaUcdUiucIndexINTEGER,
  wranIfBsOfdmaUcdUicuExitThresholdINTEGER,
  wranIfBsOfdmaUcdUicuEntryThresholdINTEGER,
  wranIfBsOfdmaUcdRangingDataRatioINTEGER }

wranIfBsOfdmaUcdUiucIndexOBJECT-TYPE
  SYNTAXINTEGER (0.. 63)
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "Index of entry in this table, this index value
                maps to the UIUCs listed in Table 36."
  ::= { wranIfBsOfdmaUcdBurstProfileEntry 1 }

wranIfBsOfdmaUcdUicuExitThresholdOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  UNITS        "dBm"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "CINR at or below which this UIUC can no longer be
                used where change to a more robust UIUC is required
                (ranging from -104 dBm to +23.5 dBm in 0.5 dB
                steps)."
  ::= { wranIfBsOfdmaUcdBurstProfileEntry 2 }
```

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```
wranIfBsOfdmaUcdUicuEntryThresholdOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  UNITS         "dBm"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Minimum CINR required to start using this UIUC when
                changing from a more robust UIUC is required
                (ranging from -104 dBm to +23.5 dBm in 0.5 dB
                steps)."
  ::= { wranIfBsOfdmaUcdBurstProfileEntry 3 }

wranIfBsOfdmaUcdRangingDataRatioOBJECT-TYPE
  SYNTAXINTEGER (0..127)
  UNITS         "dB"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Difference in power from burst UCD and power to be
                used for CDMA ranging in units of 1 dB (ranging from
                -104 dBm to +23 dBm)."
  ::= { wranIfBsOfdmaUcdBurstProfileEntry 4 }

wranIfBsOfdmaDcdBurstProfileTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfBsOfdmaDcdBurstProfileEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This table provides configuration for each DCD burst
                profile. It is made up of multiple entries defined
                by wranIfBsOfdmaDcdBurstProfileEntry."
  ::= { wranIfBsPhy 4 }

wranIfBsOfdmaDcdBurstProfileEntryOBJECT-TYPE
  SYNTAXwranIfBsOfdmaDcdBurstProfileEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This is a compound object that defines an entry in
                wranIfBsOfdmaDcdBurstProfileTable."
  INDEX{ wranIfBsOfdmaDcdDiucIndex }
  ::= { wranIfBsOfdmaDcdBurstProfileTable 1 }

wranIfBsOfdmaDcdBurstProfileEntry::= SEQUENCE {
  wranIfBsOfdmaDcdDiucIndexINTEGER,
  wranIfBsOfdmaDcdDicuExitThresholdINTEGER,
  wranIfBsOfdmaDcdDicuEntryThresholdINTEGER }
```

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```
wranIfBsOfdmaDcdDiucIndexOBJECT-TYPE
  SYNTAXINTEGER (0.. 63)
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "Index of entry in this table, this index value
                maps to the DIUCs listed in Table 27."
  ::= { wranIfBsOfdmaDcdBurstProfileEntry 1 }

wranIfBsOfdmaDcdDicuExitThresholdOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  UNITS         "dBm"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "CINR at or below which this DIUC can no longer be
                used where change to a more robust DIUC is required
                (ranging from -104 dBm to +23.5 dBm in 0.5 dB
                steps)."
  ::= { wranIfBsOfdmaDcdBurstProfileEntry 2 }

wranIfBsOfdmaDcdDicuEntryThresholdOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  UNITS         "dBm"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Minimum CINR required to start using this DIUC when
                changing from a more robust DIUC is required
                (ranging from -104 dBm to +23.5 dBm in 0.5 dB
                steps)."
  ::= { wranIfBsOfdmaDcdBurstProfileEntry 3 }

wranIfBsOfdmaDsRegionTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfBsOfdmaDsRegionEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This table provides the configuration of the DS
                subframe. It is made up of entries defined by
                wranIfBsOfdmaDsRegionEntry."
  ::= { wranIfBsPhy 5 }

wranIfBsOfdmaDsRegionEntryOBJECT-TYPE
  SYNTAXwranIfBsOfdmaDsRegionEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
```

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```
    DESCRIPTION
      "This is a compound object that describes each entry
                  in wranIfBsOfdmaDsRegionTable."
    INDEX{ wranIfBsOfdmaDsRegionIndex }
    ::= { wranIfBsOfdmaDsRegionTable 1 }

  wranIfBsOfdmaDsRegionEntry::= SEQUENCE {
    wranIfBsOfdmaDsRegionIndexINTEGER,
    wranIfBsOfdmaDsDurationINTEGER }

  wranIfBsOfdmaDsRegionIndexOBJECT-TYPE
    SYNTAXInteger32 (1.. 512)
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "Index DS region in table."
    ::= { wranIfBsOfdmaDsRegionEntry 1 }

  wranIfBsOfdmaDsDurationOBJECT-TYPE
    SYNTAXInteger32 (0..65535)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of OFDMA slots allocated to a DS burst
                  region."
    ::= { wranIfBsOfdmaDsRegionEntry 2 }

  wranIfBsOfdmaUsRegionTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsOfdmaUsRegionEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This table provides the configuration of the DS
                  subframe. It is made up of entries defined by
                  wranIfBsOfdmaUsRegionEntry."
    ::= { wranIfBsPhy 6 }

  wranIfBsOfdmaUsRegionEntryOBJECT-TYPE
    SYNTAXwranIfBsOfdmaUsRegionEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This is a compound object that describes each entry
                  in wranIfBsOfdmaUsRegionTable."
    INDEX{ wranIfBsOfdmaUsRegionIndex }
    ::= { wranIfBsOfdmaUsRegionTable 1 }

  wranIfBsOfdmaUsRegionEntry::= SEQUENCE {
```

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```
    wranIfBsOfdmaUsRegionIndexINTEGER,
    wranIfBsOfdmaUsDurationINTEGER }

  wranIfBsOfdmaUsRegionIndexOBJECT-TYPE
    SYNTAXInteger32 (1.. 512)
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "Index US region in table."
    ::= { wranIfBsOfdmaUsRegionEntry 1 }

  wranIfBsOfdmaUsDurationOBJECT-TYPE
    SYNTAXInteger32 (0..65535)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of OFDMA slots allocated to a US burst
                  region."
    ::= { wranIfBsOfdmaUsRegionEntry 2 }

-- wranIfBsCmMibGroups: This object helps define which MIB groups are
-- available within this module and which MIB objects are part of each
-- group.

  wranIfBsCmMibGroupsOBJECT IDENTIFIER
                              ::= { wranIfBsCm 24 }
  wranIfBsCmRangingGroupOBJECT IDENTIFIER
                              ::= { wranIfBsCmMibGroups 1 }
  wranIfBsCmBasicCapabilityGroup OBJECT IDENTIFIER
                              ::= { wranIfBsCmMibGroups 2 }
  wranIfBsCmRegCapabilityGroupOBJECT IDENTIFIER
                              ::= { wranIfBsCmMibGroups 3 }
  wranIfBsCmMeasSupportGroupOBJECT IDENTIFIER
                              ::= { wranIfBsCmMibGroups 4 }
  wranIfBsCpeCmAntennaGroupOBJECT IDENTIFIER
                              ::= { wranIfBsCmMibGroups 5 }
  wranIfBsScmCmGroupOBJECT IDENTIFIER
                              ::= { wranIfBsCmMibGroups 6 }
  wranIfBsActionsCmGroupOBJECT IDENTIFIER
                              ::= { wranIfBsCmMibGroups 7 }
  wranIfBsMulticastCmGroupOBJECT IDENTIFIER
                              ::= { wranIfBsCmMibGroups 8 }
  wranIfBsCoexistenceCmGroupOBJECT IDENTIFIER
                              ::= { wranIfBsCmMibGroups 9 }
  wranIfBsSystemParametersCmGroup OBJECT IDENTIFIER
                               ::= { wranIfBsCmMibGroups 10 }
  wranIfBsPhyCmGroupOBJECT IDENTIFIER
                                := { wranIfBsCmMibGroups 11 }
```

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```
wranIfBsCmRangingGroupOBJECT-GROUP
  OBJECTS{ wranIfBsCpeRngCapabilityReqIndex,
                  wranIfBsCpeMacAddress, wranIfMmpPn,
                  wranIfCiphertextIcv,
                  wranIfRngAnomaly,
                  wranIfBsCpeRngCapabilityCmdIndex,
                  wranIfBsCpeMacAddress,
                  wranIfBsCpeStationId,
                  wranIfTimingAdvance,
                  wranIfEirpPerSubcarrier,
                  wranIfOffsetFreqAdjust,
                  wranIfRangingStatus,
                  wranIfActionSuperFrameNum,
                  wranIfCdmaCode,
                  wranIfTxOpportunityOffset }
  STATUScurrent
  DESCRIPTION
    "This group contains objects related to
                management of the ranging process."
  ::= { wranIfBsCmMibGroups 1 }

wranIfBsCmBasicCapabilityGroupOBJECT-GROUP
  OBJECTS{ wranIfBsCpeBasicCapabilityReqIndex,
    wranIfBsCpeBasicCapabilityReqMacAddress,
    wranIfBsCpeBasicCapabilityReqStationId,
    wranIfBsCpeBasicCapabilityReqMacPduTxAndConstruction,
    wranIfBsCpeBasicCapabilityReqMaxCpeTxEirp,
    wranIfBsCpeBasicCapabilityReqCpeDemodulator,
    wranIfBsCpeBasicCapabilityReqCpeModulator,
    wranIfBsCpeBasicCapabilityReqScmVersionSupport,
    wranIfBsCpeBasicCapabilityReqPnWindowSize,
    wranIfBsCpeBasicCapabilityReqScmFlowControl,
    wranIfBsCpeBasicCapabilityRspIndex,
    wranIfBsCpeBasicCapabilityRspNumAttempts,
    wranIfBsCpeBasicCapabilityRspMacAddress,
    wranIfBsCpeBasicCapabilityRspStationId,
    wranIfBsCpeBasicCapabilityRspMacPduTxAndConstruction,
    wranIfBsCpeBasicCapabilityRspCpeDemodulator,
    wranIfBsCpeBasicCapabilityRspCpeModulator,
    wranIfBsCpeBasicCapabilityRspScmVersionSupport,
    wranIfBsCpeBasicCapabilityRspPnWindowSize,
    wranIfBsCpeBasicCapabilityRspScmFlowControl,
    wranIfBsCpeBasicCapabilityDefIndex,
    wranIfBsCpeBasicCapabilityDefMacPduTxAndConstruction,
    wranIfBsCpeBasicCapabilityDefCpeDemodulator,
    wranIfBsCpeBasicCapabilityDefCpeModulator,
    wranIfBsCpeBasicCapabilityDefScmVersionSupport,
```

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```
    wranIfBsCpeBasicCapabilityDefPnWindowSize,
    wranIfBsCpeBasicCapabilityDefScmFlowControl }
  STATUScurrent
  DESCRIPTION
    "This group contains objects related to
                management of the CBC-REQ/RSP process."
  ::= { wranIfBsCmMibGroups 2 }

wranIfBsCmRegCapabilityGroupOBJECT-GROUP
  OBJECTS{ wranIfBsCpeRegCapabilityReqIndex,
    wranIfBsCpeRegCapabilityReqMacAddress,
    wranIfBsCpeRegCapabilityReqNMEALocStringSize,
    wranIfBsCpeRegCapabilityReqNMEALocString,
    wranIfBsCpeRegCapabilityReqCsConfig,
    wranIfBsCpeRegCapabilityReqIpVersion,
    wranIfBsCpeRegCapabilityReqIpRochSupport,
    wranIfBsCpeRegCapabilityReqArqSupport,
    wranIfBsCpeRegCapabilityReq2ndMgmtArqWindowSize,
    wranIfBsCpeRegCapabilityReq2ndMgmtArqRetryTxDelay,
    wranIfBsCpeRegCapabilityReq2ndMgmtArqRetryRxDelay,
    wranIfBsCpeRegCapabilityReq2ndMgmtArqBlockLifetime,
    wranIfBsCpeRegCapabilityReq2ndMgmtArqSyncLossTimeout,
    wranIfBsCpeRegCapabilityReq2ndMgmtArqDeliverInOrder,
    wranIfBsCpeRegCapabilityReq2ndMgmtArqRxPurgeTimeout,
    wranIfBsCpeRegCapabilityReq2ndMgmtArqBlockSize,
    wranIfBsCpeRegCapabilityReqPsxFlowControl,
    wranIfBsCpeRegCapabilityReqMcaFlowControl,
    wranIfBsCpeRegCapabilityReqMaxNumMcastGroups,
    wranIfBsCpeRegCapabilityReqSensModeSupportArray,
    wranIfBsCpeRegCapabilityReqAntennaModelSize,
    wranIfBsCpeRegCapabilityReqAntennaModel,
    wranIfBsCpeRegCapabilityReqCpeResidualDelay,
    wranIfBsCpeRegCapabilityReq2ndMgmtIpAllocMethod,
    wranIfBsCpeRegCapabilityReqCpeOperationalCapability,
    wranIfBsCpeRegCapabilityReqCpeRegistrationTimer,
    wranIfBsCpeRegCapabilityRspIndex,
    wranIfBsCpeRegCapabilityRspMacAddress,
    wranIfBsCpeRegCapabilityRspNumAttempts,
    wranIfBsCpeRegCapabilityRspCsConfig,
    wranIfBsCpeRegCapabilityRspIpVersion,
    wranIfBsCpeRegCapabilityRspIpRochSupport,
    wranIfBsCpeRegCapabilityRspArqSupport,
    wranIfBsCpeRegCapabilityRsp2ndMgmtArqWindowSize,
    wranIfBsCpeRegCapabilityRsp2ndMgmtArqRetryTxDelay,
    wranIfBsCpeRegCapabilityRsp2ndMgmtArqRetryRxDelay,
    wranIfBsCpeRegCapabilityRsp2ndMgmtArqBlockLifetime,
    wranIfBsCpeRegCapabilityRsp2ndMgmtArqSyncLossTimeout,
    wranIfBsCpeRegCapabilityRsp2ndMgmtArqDeliverInOrder,
```

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```
    wranIfBsCpeRegCapabilityRsp2ndMgmtArqRxPurgeTimeout,
    wranIfBsCpeRegCapabilityRsp2ndMgmtArqBlockSize,
    wranIfBsCpeRegCapabilityRspDsxFlowControl,
    wranIfBsCpeRegCapabilityRspMcaFlowControl,
    wranIfBsCpeRegCapabilityRspMaxNumMcastGroups,
    wranIfBsCpeRegCapabilityRspSensModeSupportArray,
    wranIfBsCpeRegCapabilityRspAntennaModelSize,
    wranIfBsCpeRegCapabilityRspAntennaModel,
    wranIfBsCpeRegCapabilityRsp2ndMgmtIpAllocMethod,
    wranIfBsCpeRegCapabilityRspCpeOperationalCapability,
    wranIfBsCpeRegCapabilityRspCpeRegistrationTimer,
    wranIfBsCpeRegCapabilityRspPermanentSid,
    wranIfBsCpeRegCapabilityDefIndex,
    wranIfBsCpeRegCapabilityDefCsConfig,
    wranIfBsCpeRegCapabilityDefIpVersion,
    wranIfBsCpeRegCapabilityDefIpRochSupport,
    wranIfBsCpeRegCapabilityDefArqSupport,
    wranIfBsCpeRegCapabilityDef2ndMgmtArqWindowSize,
    wranIfBsCpeRegCapabilityDef2ndMgmtArqRetryTxDelay,
    wranIfBsCpeRegCapabilityDef2ndMgmtArqRetryRxDelay,
    wranIfBsCpeRegCapabilityDef2ndMgmtArqBlockLifetime,
    wranIfBsCpeRegCapabilityDef2ndMgmtArqSyncLossTimeout,
    wranIfBsCpeRegCapabilityDef2ndMgmtArqDeliverInOrder,
    wranIfBsCpeRegCapabilityDef2ndMgmtArqRxPurgeTimeout,
    wranIfBsCpeRegCapabilityDef2ndMgmtArqBlockSize,
    wranIfBsCpeRegCapabilityDefDsxFlowControl,
    wranIfBsCpeRegCapabilityDefMcaFlowControl,
    wranIfBsCpeRegCapabilityDefMaxNumMcastGroups,
    wranIfBsCpeRegCapabilityDefSensModeSupportArray,
    wranIfBsCpeRegCapabilityDef2ndMgmtIpAllocMethod,
    wranIfBsCpeRegCapabilityDefCpeOperationalCapability,
    wranIfBsCpeRegCapabilityDefCpeRegistrationTimer }
  STATUScurrent
  DESCRIPTION
    "This group contains objects related to
              management of the REG-REQ/RSP process."
  ::= { wranIfBsCmMibGroups 3 }

wranIfBsCmMeasSupportGroupOBJECT-GROUP
  OBJECTS{ wranIfBsCpeMeasSupportReqIndex,
    wranIfBsCpeMeasSupportReqMacAddress,
    wranIfBsCpeMeasSupportReqSignalType,
    wranIfBsCpeMeasSupportReqThreshold,
    wranIfBsCpeMeasSupportReqPd,
    wranIfBsCpeMeasSupportReqMpfa,
    wranIfBsCpeMeasSupportReqRecNumSensPeriods,
    wranIfBsCpeMeasSupportReqRecSensPeriodDuration,
    wranIfBsCpeMeasSupportReqRecSensPeriodInterval,
```

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```
      wranIfBsCpeMeasSupportRspIndex,
      wranIfBsCpeMeasSupportRspMacAddress,
      wranIfBsCpeMeasSupportRspSignalType,
      wranIfBsCpeMeasSupportRspThreshold,
      wranIfBsCpeMeasSupportRspPd,
      wranIfBsCpeMeasSupportRspMpfa,
      wranIfBsCpeMeasSupportRspRecNumSensPeriods,
      wranIfBsCpeMeasSupportRspRecSensPeriodDuration,
      wranIfBsCpeMeasSupportRspRecSensPeriodInterval,
      wranIfBsCpeMeasSupportDefIndex,
      wranIfBsCpeMeasSupportDefSignalType,
      wranIfBsCpeMeasSupportDefThreshold,
      wranIfBsCpeMeasSupportDefPd,
      wranIfBsCpeMeasSupportDefMpfa,
      wranIfBsCpeMeasSupportDefRecNumSensPeriods,
      wranIfBsCpeMeasSupportDefRecSensPeriodDuration,
      wranIfBsCpeMeasSupportDefRecSensPeriodInterval }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                  management of the measurement process."
    ::= { wranIfBsCmMibGroups 4 }

  wranIfBsCpeCmAntennaGroupOBJECT-GROUP
    OBJECTS{ wranIfBsCpeAntennaGainIndex,
                  wranIfBsCpeAntennaGainMacAddress,
                  wranIfBsCpeTvChannel,
                  wranIfBsCpeOnAxisGain }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                  management of the antenna configuration."
    ::= { wranIfBsCmMibGroups 5 }

  wranIfBsScmCmGroupOBJECT-GROUP
    OBJECTS{ wranIfBsScmCapabilityConfiguration,
                  wranIfBsCpeScmCapabilityConfigIndex,
                  wranIfBsCpeScmCapabilityConfigMacAddress,
                  wranIfBsCpeScmCapabilityConfiguration,
                  wranIfBsCpeEapTlsTtlsCredentialSize,
                  wranIfBsCpeEapTlsTtlsCredential,
                  wranIfBsScmAuthConfigIndex,
                  wranIfBsT36, wranIfBsT37,
                  wranIfBsMaxNumAuthAttempts,
                  wranIfBsT38, wranIfBsT39,
                  wranIfBsT40, wranIfBsAkLifetime,
                  wranIfBsTekLifetime, wranIfBsMaxNumSa,
                  wranIfBsT17 }
```

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```
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                  management of the SCM protocol and SCM status
                  on a CPE/BS."
    ::= { wranIfBsCmMibGroups 6 }

  wranIfBsActionsCmGroupOBJECT-GROUP
    OBJECTS{ wranIfBsCpeActionsIndex,
                  wranIfBsCpeActionsMacAddress,
                  wranIfBsCpeActionsRngCpe,
                  wranIfBsCpeActionsDeRegCpe,
                  wranIfBsCpeActionsSchedule }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                  management of actions the BS can take."
    ::= { wranIfBsCmMibGroups 7 }

  wranIfBsMulticastCmGroupOBJECT-GROUP
    OBJECTS{ wranIfBsCpeMcastConfigIndex,
                  wranIfBsCpeMcastMacAddress,
                  wranIfBsCpeMcastSid,
                  wranIfBsCpeMcastPeriodicAllocParameterM,
                  wranIfBsCpeMcastPeriodicAllocParameterK,
                  wranIfBsCpeMcastPeriodicAllocParameterN }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                  management of multicast configuration."
    ::= { wranIfBsCmMibGroups 8 }

  wranIfBsCoexistenceCmGroupOBJECT-GROUP
    OBJECTS{ wranIfBsCoexistenceConfigIndex,
                  wranIfBsT34, wranIfBsT33,
                  wranIfBsT32, wranIfBsFcw,
                  wranIfBsScwBackoffMax,
                  wranIfBsFcMin, wranIfBsFcnRange,
                  wranIfBsSfRel, wranIfBsT35 }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                  management of coexistence configuration."
    ::= { wranIfBsCmMibGroups 9 }

  wranIfBsSystemParametersCmGroupOBJECT-GROUP
    OBJECTS{ wranIfBsCpeSystemParametersIndex,
                  wranIfBsDsxReqRetries,
```

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```
                    wranIfBsDsxRspRetries,
                    wranIfBsT6, wranIfBsT7, wranIfBsT8,
                    wranIfBsT9, wranIfBsT10, wranIfBsT13,
                    wranIfBsT14, wranIfBsT15, wranIfBsT16,
                    wranIfBsT18, wranIfBsT22, wranIfBsT26,
                    wranIfBsT27Idle, wranIfBsT27Active,
                    wranIfBsT28 }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                    management of system parameter configuration."
    ::= { wranIfBsCmMibGroups 10 }

  wranIfBsPhyCmGroupOBJECT-GROUP
    OBJECTS{ wranIfBsOfdmaPhyUsChannelIndex,
                    wranIfBsOfdmaPhyUsSid,
                    wranIfBsOfdmaPhyUsMacAddress,
                    wranIfBsOfdmaCtBasedResvTimeout,
                    wranIfBsOfdmaUsCenterFrequency,
                    wranIfBsOfdmasUsRadioResource,
                    wranIfBsOfdmaUsUcsConfigChangeCount,
                    wranIfBsOfdmaUsUcsNotificationCodes,
                    wranIfBsOfdmaUsInitRngCodes,
                    wranIfBsOfdmaUsPeriodicRngCodes,
                    wranIfBsOfdmaUsBWReqCodes,
                    wranIfBsOfdmaUsPeriodicRngBackoffStart,
                    wranIfBsOfdmaUsPeriodicRngBackoffEnd,
                    wranIfBsOfdmaUsStartofCodes,
                    wranIfBsOfdmaUsNormalizedCnrOverride,
                    wranIfBsOfdamUsInitialRangingInterval,
                    wranIfBsOfdmaUsUcsNotificationBackoffStart,
                    wranIfBsOfdmaUsUcsNotificationBackoffEnd,
                    wranIfBsOfdmaUsInitialRngBackoffStart,
                    wranIfBsOfdmaUsInitialRngBackoffEnd,
                    wranIfBsOfdmaUsBwRequestBackoffStart,
                    wranIfBsOfdmaUsBwRequestBackoffEnd,
                    wranIfBsOfdmaUsUcdInterval,
                    wranIfBsOfdmaUsUcdTransition,
                    wranIfBsOfdmaUsClkCmpInterval,
                    wranIfBsOfdmaUsT57,
                    wranIfBsOfdmaUsT58,
                    wranIfBsOfdmaUsCdmaRngRetries,
                    wranIfBsOfdmaUsInvRngReq,
                    wranIfBsOfdmaUsMapProcTime,
                    wranIfBsOfdmaUsT3,
                    wranIfBsOfdmaUsT4,
                    wranIfBsOfdmaUsT5,
                    wranIfBsOfdmaUsT12,
```

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```
                    wranIfBsOfdmaPhyDsChannelIndex,
                    wranIfBsOfdmaDsBsId,
                    wranIfBsOfdmaDsEirp,
                    wranIfBsOfdmaDsChannelNumber,
                    wranIfBsOfdmaDsPhyMaxEirp,
                    wranIfBsOfdmaDsCenterFreq,
                    wranIfBsOfdmaDsMacVersion,
                    wranIfBsOfdmaDsCyclicPrefix,
                    wranIfBsOfdmaDsRadioResource,
                    wranIfBsOfdmaDsCellType,
                    wranIfBsOfdmaDsConfigChangeCount,
                    wranIfBsOfdmaDsFrameDuration,
                    wranIfBsOfdmaDsRssiCinrAvgParameter,
                    wranIfBsOfdmaDsThresholdAddBsServiceSet,
                    wranIfBsOfdmaDsThresholdDelBsServiceSet,
                    wranIfBsOfdmaDsDcdInterval,
                    wranIfBsOfdmaDsDcdTransition,
                    wranIfBsOfdmaDsT56,
                    wranIfBsOfdmaDsT1,
                    wranIfBsOfdmaDsT2,
                    wranIfBsOfdmaDsT20,
                    wranIfBsOfdmaDsT21,
                    wranIfBsOfdmaDsTtg,
                    wranIfBsOfdmaUcdUiucIndex,
                    wranIfBsOfdmaUcdUicuExitThreshold,
                    wranIfBsOfdmaUcdUicuEntryThreshold,
                    wranIfBsOfdmaUcdRangingDataRatio,
                    wranIfBsOfdmaDcdDiucIndex,
                    wranIfBsOfdmaDcdDicuExitThreshold,
                    wranIfBsOfdmaDcdDicuEntryThreshold,
                    wranIfBsOfdmaDsRegionIndex,
                    wranIfBsOfdmaDsDuration,
                    wranIfBsOfdmaUsRegionIndex,
                    wranIfBsOfdmaUsDuration }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                    management of PHY configuration."
    ::= { wranIfBsCmMibGroups 11 }

wranIfBsCmMibComplianceMODULE-COMPLIANCE
    STATUScurrent
    DESCRIPTION
      "MIB objects that are optional and mandatory for
                    wranIfBsCm compliance."
    MODULEwranIfBsCm
    MANDATORY-GROUPS{ wranIfBsCmRangingGroup,
                      wranIfBsCmBasicCapabilityGroup,
```

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```
                    wranIfBsCmRegCapabilityGroup,
                    wranIfBsCmMeasSupportGroup,
                    wranIfBsCpeAntennaGroup,
                    wranIfBsActionsGroup,
                    wranIfBsScmGroup,
                    wranIfBsActionsGroup,
                    wranIfBsCoexistenceGroup,
                    wranIfBsSystemParametersGroup,
                    wranIfBsPhyGroup }
    -- OPTIONAL-GROUPS{ wranIfBsMulticastGroup }
    ::= { wranIfBsCm 25 }

-- wranIfBsAm: This MIB group contains various objects related to
-- Accounting Management.

  wranIfBsOtaUsageDataRecordTable OBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsOtaUsageDataRecordEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object contains usage entries that track the
                    number of octets/packets transmitted or received
                    over the air interface. Records may be transferred
                    to an external database, such as an AAA server,
                    after which they can be deleted from this table.
                    Each entry is defined by
                    wranIfBsOtaUsageDataRecordEntry."
    ::= { wranIfBsAm 1 }

  wranIfBsOtaUsageDataRecordEntryOBJECT-TYPE
    SYNTAXwranIfBsOtaUsageDataRecordEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object is a compound object that defines an
                    entry in wranIfBsOtaUsageDataRecordTable."
    INDEX{ wranIfBsOtaUsageDataRecordIndex }
    ::={ wranIfBsOtaUsageDataRecordTable 1 }

  wranIfBsOtaUsageDataRecordEntry::= SEQUENCE {
    wranIfBsOtaUsageDataRecordIndexInteger32,
    wranIfBsOtaUsageSid  Integer32,
    wranIfBsOtaUsageFt   INTEGER,
    wranIfBsOtaUsageSessionIdInteger32,
    wranIfBsOtaUsageMacSduCountInteger32,
    wranIfBsOtaUsageOctetCountINTEGER,
    wranIfBsOtaUsageSessionStartTimeDateAndTime,
    wranIfBsOtaUsageSessionEndTimeDateAndTime,
```

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```
    wranIfBsOtaUsageQoSServiceFlowListSizeINTEGER,
    wranIfBsOtaUsageQoSServiceFlowListOCTET STRING,
    wranIfBsOtaUsageQoSProfileListSizeINTEGER,
    wranIfBsOtaUsageQoSProfileListOCTET STRING }

  wranIfBsOtaUsageDataRecordIndexOBJECT-TYPE
    SYNTAXInteger32 (1.. 2048)
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "Index of entry in this table, defaults to 1."
    ::= { wranIfBsOtaUsageDataRecordEntry 1 }

  wranIfBsOtaUsageSidOBJECT-TYPE
    SYNTAXInteger32 (0.. 512)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "A 9-bit Station ID that identifies the station that
                  is carrying traffic."
    ::= { wranIfBsOtaUsageDataRecordEntry 2 }

  wranIfBsOtaUsageFtOBJECT-TYPE
    SYNTAXINTEGER (0..7)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "A 3-bit Flow Type that identifies the specific flow
                  assigned to a station that is carrying traffic. For
                  data traffic this identifies the FT that is mapped
                  to a service flow id (i.e., wranIfBsServiceFlowId)."
    ::= { wranIfBsOtaUsageDataRecordEntry 3 }

  wranIfBsOtaUsageSessionIdOBJECT-TYPE
    SYNTAXInteger32 (0..4294967295)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "An identifier for a session. A session is a segment
                  in time when a service flow is active. Multiple
                  sessions can be created during service flow
                  activation time to the allow the BS to track usage
                  during period when service flow configuration is
                  changing."
    ::= { wranIfBsOtaUsageDataRecordEntry 4 }

  wranIfBsOtaUsageMacSduCountOBJECT-TYPE
    SYNTAXInteger32 (0.. 4294967295)
```

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```
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Counter of the number of MAC SDUs transmitted on a
                  FT. If the FT represents a basic,
                  primary/secondary management, or multicast
                  management FT, then this deals with traffic
                  transmitted on both the DS and US."
    ::= { wranIfBsOtaUsageDataRecordEntry 5 }

  wranIfBsOtaUsageOctetCountOBJECT-TYPE
    SYNTAXInteger32 (0.. 4294967295)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Counter of the number of MAC PDUs that have been
                  transmitted and received over the air interface."
    ::= { wranIfBsOtaUsageDataRecordEntry 6 }

  wranIfBsOtaUsageSessionStartTimeOBJECT-TYPE
    SYNTAXDateAndTime
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Date and time session was established."
    ::= { wranIfBsOtaUsageDataRecordEntry 7 }

  wranIfBsOtaUsageSessionEndTimeOBJECT-TYPE
    SYNTAXDateAndTime
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Date and time session was ended."
    ::= { wranIfBsOtaUsageDataRecordEntry 8 }

  wranIfBsOtaUsageServiceFlowListSizeOBJECT-TYPE
    SYNTAXINTEGER (1..255)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Number of items in
                  wranIfBsOtaUsageQoSServiceFlowList."
    ::= { wranIfBsOtaUsageDataRecordEntry 9 }

  wranIfBsOtaUsageServiceFlowListOBJECT-TYPE
    SYNTAXOCTET STRING
                   (SIZE(wranIfBsOtaUsageServiceFlowListSize*4))
    MAX-ACCESSread-write
```

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```
    STATUScurrent
    DESCRIPTION
      "A list of service flow Ids (SFIDs), identifying
                  each service flow active during this session (i.e.,
                  a list of SFIDs that pertain to service flows as
                  defined in wranIfBsActiveSfTable)."
    ::= { wranIfBsOtaUsageDataRecordEntry 10 }

  wranIfBsOtaUsageQoSProfileListSizeOBJECT-TYPE
    SYNTAXINTEGER (1..255)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Number of items in
                  wranIfBsOtaUsageQoSProfileList."
    ::= { wranIfBsOtaUsageDataRecordEntry 11 }

  wranIfBsOtaUsageQoSProfileListOBJECT-TYPE
    SYNTAXOCTET STRING
   (SIZE(wranIfBsOtaUsageQoSProfileListSize*2))
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "A list of indexes into wranIfBsScTable, that point
                  to the definition of the QoS parameter set of each
                  service flow listed in
                  wranIfBsOtaUsageQoSServiceFlowList (and hence were
                  active during this session)."
    ::= { wranIfBsOtaUsageDataRecordEntry 12 }

-- wranIfBsAmMibGroups: This object helps define which MIB groups are
-- available within this module and which MIB objects are part of each
-- group.

  wranIfBsAmMibGroupsOBJECT IDENTIFIER
                            ::= { wranIfBsAm 2 }
  wranIfBsAmOtaUsageDataGroupOBJECT IDENTIFIER
                            ::= { wranIfBsAmMibGroups 1 }

  wranIfBsAmOtaUsageDataGroupOBJECT-GROUP
    OBJECTS{ wranIfBsOtaUsageDataRecordIndex,
                  wranIfBsOtaUsageSid,
                  wranIfBsOtaUsageFt,
                  wranIfBsOtaUsageSessionId,
                  wranIfBsOtaUsageMacSduCount,
                  wranIfBsOtaUsageOctetCount,
                  wranIfBsOtaUsageSessionStartTime,
                  wranIfBsOtaUsageSessionEndTime,
```

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```
                    wranIfBsOtaUsageQoSServiceFlowListSize,
                    wranIfBsOtaUsageQoSServiceFlowList,
                    wranIfBsOtaUsageQoSProfileListSize,
                    wranIfBsOtaUsageQoSProfileList }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                    tracking usage of OTA resources per CPE."
    ::= { wranIfBsAmMibGroups 1 }

  wranIfBsAmMibComplianceMODULE-COMPLIANCE
    STATUScurrent
    DESCRIPTION
      "MIB objects that are optional and mandatory for
                    wranIfBsAm compliance."
    MODULEwranIfBsCm
    MANDATORY-GROUPS{ wranIfBsAmOtaUsageDataGroup }
    ::= { wranIfBsAm 3 }

-- wranIfBsPm: This MIB group contains various objects related to
-- Performance Management.

  wranIfBsPmConfigurationTable
                    OBJECT IDENTIFIER ::= { wranIfBsPm 1 }
  wranIfBsSignalPowerMetricsTable
                    OBJECT IDENTIFIER ::= { wranIfBsPm 2 }
  wranIfBsStartupMetricsTable
                    OBJECT IDENTIFIER ::= { wranIfBsPm 3 }
  wranIfBsThroughputMetricsTable
                    OBJECT IDENTIFIER ::= { wranIfBsPm 4 }
  wranIfBsNetworkEntryMetricsTable
                    OBJECT IDENTIFIER ::= { wranIfBsPm 5 }
  wranIfBsPacketErrorRateTable
                    OBJECT IDENTIFIER ::= { wranIfBsPm 6 }
  wranIfBsUserMetricsTable
                    OBJECT IDENTIFIER ::= { wranIfBsPm 7 }
  wranIfBsServiceFlowMetricsTable
                    OBJECT IDENTIFIER ::= { wranIfBsPm 8 }
  wranIfBsArqMetricsTable
                    OBJECT IDENTIFIER ::= { wranIfBsPm 9 }
  wranIfBsAuthenticationMetricsTable
                    OBJECT IDENTIFIER ::= { wranIfBsPm 10 }
  wranIfBsCoexistenceStatusTable
                    OBJECT IDENTIFIER ::= { wranIfBsPm 11 }
  wranIfBsCoexistenceSourceTable
                    OBJECT IDENTIFIER ::= { wranIfBsPm 12 }
  wranIfBsCoexistenceResourceListTable
```

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```
                OBJECT IDENTIFIER ::= { wranIfBsPm 13 }
wranIfBsCoexistenceCurrentConfigTable
                OBJECT IDENTIFIER ::= { wranIfBsPm 14 }
wranIfBsPmMibGroups
                OBJECT IDENTIFIER ::= { wranIfBsPm 15 }
wranIfBsPmMibCompliance
                OBJECT IDENTIFIER ::= { wranIfBsPm 16 }

wranIfBsPmConfigurationTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfBsPmConfigurationEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "The configuration of statistics recording and
                measurement is captured in this table. There is one
                entry in this table, defined by
                wranIfBsPmConfigurationEntry."
  ::= { wranIfBsPm 1 }

wranIfBsPmConfigurationEntryOBJECT-TYPE
  SYNTAXwranIfBsPmConfigurationEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object is a compound object that defines an
                entry in wranIfBsPmConfigurationTable."
  INDEX{ wranIfBsPmConfigurationEntryIndex }
  ::= { wranIfBsPmConfigurationTable 1 }

wranIfBsPmConfigurationEntry::= SEQUENCE {
  wranIfBsPmConfigurationEntryIndexINTEGER,
  wranIfBsGranularityIntervalInteger32,
  wranIfBsCountersReportIntervalInteger32,
  wranIfBsPmMeasurementBitmapBITS }

wranIfBsPmConfigurationEntryIndexOBJECT-TYPE
  SYNTAXINTEGER (1.. 1)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in this table, defaults to 1."
  ::= { wranIfBsPmConfigurationEntry 1 }

wranIfBsGranularityIntervalOBJECT-TYPE
  SYNTAXINTEGER (1.. 255)
  UNITS         "seconds"
  MAX-ACCESSread-write
  STATUScurrent
```

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```
    DESCRIPTION
      "Data rate statistics captured in
                  wranIfBsRssiCinrMetricsTable,
                  wranIfBsStartupMetricsTable,
                  wranIfBsThroughputMetricsTable,
                  wranIfBsPacketErrorRateTable,
                  wranIfBsUserMetricsTable,
                  wranIfBsServiceFlowMetricsTable,
                  wranIfBsArqMetricsTable, and
                  wranIfBsAuthenticationMetricsTable are measured over
                  the time interval this object specifics."
    ::= { wranIfBsPmConfigurationEntry 2 }

  wranIfBsCountersReportIntervalOBJECT-TYPE
    SYNTAXINTEGER (1.. 255)
    UNITS         "minutes"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Determines the interval in which traps is enabled in
                  wranIfBsTrapControl, related to performance
                  measurement, are sent to the NCMS."
    ::= { wranIfBsPmConfigurationEntry 2 }

  wranIfBsPmMeasurementBitmapOBJECT-TYPE
    SYNTAXBITS { RssiCinr(0),
                  Startup(1),
                  Throughput(2),
                  NetworkEntry(3),
                  PacketError(4),
                  User(5),
                  ServiceFlow(6),
                  Arq(7),
                  Authentication(8),
                  CoexistenceStatus(9),
                  CoexistenceSource(10),
                  CoexistenceResourceList(11),
                  CoexistenceCurrentConfig(12) }
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "A 13-bit bitmap indicating which of the measurement
                  tables are enabled or disabled. When a position in
                  the bitmap is set(=1) that measurement table is
                  enabled, when it is unset (=0) the table is
                  disabled. The bitmap position to table assignment is
                  as follows:
                 Bit0->wranIfBsSignalPowerMetricsTable
```

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```
                    Bit1->wranIfBsStartupMetricsTable
                    Bit2->wranIfBsThroughputMetricsTable
                    Bit3->wranIfBsNetworkEntryMetricsTable
                    Bit4->wranIfBsPacketErrorRateTable
                    Bit5->wranIfBsUserMetricsTable
                    Bit6->wranIfBsServiceFlowMetricsTable
                    Bit7->wranIfBsArqMetricsTable
                    Bit8->wranIfBsAuthenticationMetricsTable
                    Bit9->wranIfBsCoexistenceStatusTable
                    Bit10->wranIfBsCoexistenceSourceTable
                    Bit11->wranIfBsCoexistenceResourceListTable
                    Bit12->wranIfBsCoexistenceCurrentConfigTable."
  ::= { wranIfBsPmConfigurationEntry 3 }

wranIfBsSignalPowerMetricsTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfBsSignalPowerMetricsEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB object contains a table that records BS US
                measurement of a CPE's transmissions, as well as CPE
                measurement of BS DS signal. The data in each entry
                is stored as a histogram. This table is made up of
                entries defined by wranIfBsRssiCinrMetricsEntry.
                Each entry is uniquely identified by the CPE's MAC
                Address and the index of the entry in the table."
  ::= { wranIfBsPm 2 }

wranIfBsSignalPowerMetricsEntryOBJECT-TYPE
  SYNTAXwranIfBsSignalPowerMetricsEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object is a compound object that defines an
                entry in wranIfBsRssiCinrMetricsTable."
  INDEX{ wranIfBsSignalPowerMetricsIndex }
  ::= { wranIfBsSignalPowerMetricsTable 1 }

wranIfBsSignalPowerMetricsEntry::= SEQUENCE {
  wranIfBsRssiCinrMetricsIndexInteger32,
  wranIfBsCpeMacAddressMacAddress,
  wranIfBsChannelDirectionINTEGER,
  wranIfBsChannelNumberINTEGER,
  wranIfBsStartFrameINTEGER
  wranIfBsMeasurementDurationInteger32,
  wranIfBsSignalReportTypeINTEGER,
  wranIfBsMeanCinrReportINTEGER,
  wranIfBsMeanRssiReportINTEGER,
```

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```
    wranIfBsStdDevCinrReportINTEGER,
    wranIfBsStdDevRssiReportINTEGER,
    wranIfBsMaxEIRPReportINTEGER,
    wranIfBsPerScEIRPReportINTEGER }

  wranIfBsSignalPowerMetricsIndexOBJECT-TYPE
    SYNTAXInteger32 (1.. 261120)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index of entry in this table, defaults to 1."
    ::= { wranIfBsSignalPowerMetricsEntry 1 }

  wranIfBsCpeMacAddressOBJECT-TYPE
    SYNTAXMacAddress
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "MAC Address of the CPE."
    ::= { wranIfBsSignalPowerMetricsEntry 2 }

  wranIfBsChannelDirectionOBJECT-TYPE
    SYNTAXINTEGER { ds(0), us(1) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Direction of channel, whether DS or US, that
                  measurement was done on."
    ::= { wranIfBsSignalPowerMetricsEntry 3 }

  wranIfBsChannelNumberOBJECT-TYPE
    SYNTAXINTEGER
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Channel number that measurement was done on."
    ::= { wranIfBsSignalPowerMetricsEntry 4 }

  wranIfBsStartFrameOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Frame number in which measurement was conducted in."
    ::= { wranIfBsSignalPowerMetricsEntry 5 }

  wranIfBsMeasurementDurationOBJECT-TYPE
    SYNTAXInteger32 (1.. 16777215)
```

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```
    UNITS         "symbols"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Duration of measurement period in units of symbol
                  period."
    ::= { wranIfBsRssiCinrMetricsEntry 6 }

  wranIfBsSignalReportTypeOBJECT-TYPE
    SYNTAXINTEGER { undetermined(0),
                    ieee802dot22wran(1),
                    atsc(2),
                    dvbt(3),
                    isdbt(4),
                    ntsc(5),
                    pal(6),
                    secam(7),
                    wirelessMicrophone(8),
                    ieee802dot22dot1Sync(9),
                    ieee802dot22dot1Msf1(10),
                    ieee802dot22dot1Msf2(11),
                    ieee802dot22dot1Msf3(12) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Type of signal detected during the measurement
                  recorded in this entry."
    ::= { wranIfBsSignalPowerMetricsEntry 7 }

  wranIfBsMeanCinrReportOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    UNITS         "dBm"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Mean CINR report, on an interval -64 to +63.5 dBm in
                  0.5 dB steps."
    ::= { wranIfBsSignalPowerMetricsEntry 8 }

  wranIfBsMeanRssiReportOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    UNITS         "dBm"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Mean RSSI report, on an interval -104 to +23.5 dBm
                  in 0.5 dB steps."
    ::= { wranIfBsSignalPowerMetricsEntry 9 }
```

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```
wranIfBsStdDevCinrReportOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  UNITS         "dBm"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Standard Deviation CINR report, on an interval -64
                to +63.5 dBm in 0.5 dB steps."
  ::= { wranIfBsSignalPowerMetricsEntry 10 }

wranIfBsStdDevRssiReportOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  UNITS         "dBm"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Standard Deviation RSSI report, on an interval -104
                to +23.5 dBm in 0.5 dB steps."
  ::= { wranIfBsSignalPowerMetricsEntry 11 }

wranIfBsMaxEIRPReportOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  UNITS         "dBm"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Max EIRP report, on an interval -104 to +23.5 dBm in
                0.5 dB steps."
  ::= { wranIfBsSignalPowerMetricsEntry 12 }

wranIfBsPerScEIRPReportOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  UNITS         "dBm"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Per subchannel EIRP report, on an interval -104 to
                +23.5 dBm in 0.5 dB steps."
  ::= { wranIfBsSignalPowerMetricsEntry 13 }

wranIfBsStartupMetricsTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfBsStartupMetricsEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB provides a table to track how CPEs perform
                during initial network entry and re-entry. This
```

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```
                table is made of one entry, defined by
                wranIfBsStartupMetricsEntry. This entry reflects the
                startup metrics recorded ruing the current reporting
                session."
  ::= { wranIfBsPm 3 }

wranIfBsStartupMetricsEntryOBJECT-TYPE
  SYNTAXwranIfBsStartupMetricsEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object is a compound object that defines an
                entry in wranIfBsStartupMetricsTable."
  INDEX{ wranIfBsStartupMetricsIndex }
  ::= { wranIfBsStartupMetricsTable 1 }

wranIfBsStartupMetricsEntry::= SEQUENCE {
  wranIfBsStartupMetricsIndexINTEGER,
  wranIfBsNumAuthAttemptInteger32,
  wranIfBsNumAuthSuccessInteger32,
  wranIfBsAuthSuccessRateINTEGER,
  wranIfBsNumRangingAttemptInteger32
  wranIfBsNumRangingSuccessInteger32,
  wranIfBsRangingSuccessRateINTEGER,
  wranIfBsMeanCinrReportINTEGER }

wranIfBsStartupMetricsIndexOBJECT-TYPE
  SYNTAXINTEGER (1.. 1)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in this table, defaults to 1."
  ::= { wranIfBsStartupMetricsEntry 1 }

wranIfBsNumAuthAttemptOBJECT-TYPE
  SYNTAXInteger32 (1.. 16777216)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "A counter for the number of CPE authentication
                attempts."
  ::= { wranIfBsStartupMetricsEntry 2 }

wranIfBsNumAuthSuccessOBJECT-TYPE
  SYNTAXInteger32 (1.. 16777216)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
```

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```
      "A counter for the number of successful
                  authentication handshake completions. "
    ::= { wranIfBsStartupMetricsEntry 3 }

  wranIfBsAuthSuccessRateOBJECT-TYPE
    SYNTAXINTEGER (0..100)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Success rate of authentication attempts:
                  wranIfBsAuthSuccessRate = floor( 100 *
                  wranIfBsNumAuthSuccess / wranIfBsNumAuthAttempts )."
    ::= { wranIfBsStartupMetricsEntry 4 }

  wranIfBsNumRangingAttemptOBJECT-TYPE
    SYNTAXInteger32 (1.. 16777216)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of CPE ranging requests received."
    ::= { wranIfBsStartupMetricsEntry 5 }

  wranIfBsNumRangingSuccessOBJECT-TYPE
    SYNTAXInteger32 (1.. 16777216)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of CPE ranging responses sent."
    ::= { wranIfBsStartupMetricsEntry 6 }

  wranIfBsRangingSuccessRateOBJECT-TYPE
    SYNTAXINTEGER (0..100)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Success rate of ranging attempts:
                  wranIfBsRangingSuccessRate = floor( 100 *
                  wranIfBsNumRangingSuccess /
                  wranIfBsNumRangingAttempts )."
    ::= { wranIfBsStartupMetricsEntry 7 }

  wranIfBsThroughputMetricsTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsThroughputMetricsEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This MIB object provides a table to record
                  peak/average data rate. This table is made of one
```

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```
                    entry, defined by wranIfBsThroughputMetricsEntry."
    ::= { wranIfBsPm 4 }

  wranIfBsThroughputMetricsEntryOBJECT-TYPE
    SYNTAXwranIfBsThroughputMetricsEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object is a compound object that defines an
                    entry in wranIfBsThroughputMetricsTable."
    INDEX{ wranIfBsThroughputMetricsIndex }
    ::= { wranIfBsThroughputMetricsTable 1 }

  wranIfBsThroughputMetricsEntry::= SEQUENCE {
    wranIfBsThroughputMetricsIndexINTEGER,
    wranIfBsAvgDsUserThroughputInteger32,
    wranIfBsAvgUsUserThroughputInteger32,
    wranIfBsAvgDsMacThroughputInteger32,
    wranIfBsAvgUsMacThroughputInteger32
    wranIfBsAvgDsPhyThroughputInteger32,
    wranIfBsAvgUsPhyThroughputInteger32,
    wranIfBsPeakDsUserThroughputInteger32,
    wranIfBsPeakUsUserThroughputInteger32,
    wranIfBsPeakDsMacThroughputInteger32,
    wranIfBsPeakUsMacThroughputInteger32,
    wranIfBsPeakDsPhyThroughputInteger32,
    wranIfBsPeakUsPhyThroughputInteger32,
    wranIfBsAvgDsCellEdgeThroughputInteger32,
    wranIfBsAvgUsCellEdgeThroughputInteger32 }

  wranIfBsThroughputMetricsIndexOBJECT-TYPE
    SYNTAXINTEGER (1.. 1)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index of entry in this table, defaults to 1."
    ::= { wranIfBsThroughputMetricsEntry 1 }

  wranIfBsAvgDsUserThroughputOBJECT-TYPE
    SYNTAXInteger32 (0..4294967295)
    UNITS         "bps"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This records the average user throughput in the DS.
                    This is a function of the number of octets of MAC
                    SDUs transmitted by the BS to CPEs over time."
    ::= { wranIfBsThroughputMetricsEntry 2 }
```

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```
wranIfBsAvgUsUserThroughputOBJECT-TYPE
  SYNTAXInteger32 (0..4294967295)
  UNITS         "bps"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "This records the average user throughput in the US.
                This is a function of the number of octets of MAC
                SDUs transmitted by the CPEs to BS over time."
  ::= { wranIfBsThroughputMetricsEntry 3 }

wranIfBsAvgDsMacThroughputOBJECT-TYPE
  SYNTAXInteger32 (0..4294967295)
  UNITS         "bps"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "This records the average MAC throughput in the DS.
                This is a function of the number of octets of MAC
                PDUs transmitted by the BS to CPEs over time."
  ::= { wranIfBsThroughputMetricsEntry 4 }

wranIfBsAvgUsMacThroughputOBJECT-TYPE
  SYNTAXInteger32 (0..4294967295)
  UNITS         "bps"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "This records the average MAC throughput in the US.
                This is a function of the number of octets of MAC
                PDUs transmitted by the CPEs to BS over time."
  ::= { wranIfBsThroughputMetricsEntry 5 }

wranIfBsAvgDsPhyThroughputOBJECT-TYPE
  SYNTAXInteger32 (0..4294967295)
  UNITS         "bps"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "This records the average PHY throughput in the DS.
                This is a function of the number of burst octets
                (e.g., MAC PDU + PHY overhead) transmitted by the BS
                to CPEs over time."
  ::= { wranIfBsThroughputMetricsEntry 6 }

wranIfBsAvgUsPhyThroughputOBJECT-TYPE
  SYNTAXInteger32 (0..4294967295)
```

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```
    UNITS         "bps"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This records the average PHY throughput in the US.
                  This is a function of the number of burst octets
                  (e.g., MAC PDU + PHY overhead) transmitted by the
                  CPEs to BS over time."
    ::= { wranIfBsThroughputMetricsEntry 7 }

  wranIfBsPeakDsUserThroughputOBJECT-TYPE
    SYNTAXInteger32 (0..4294967295)
    UNITS         "bps"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This records the peak user throughput in the DS.
                  This is a function of the number of octets of MAC
                  SDUs transmitted by the BS to CPEs over time."
    ::= { wranIfBsThroughputMetricsEntry 8 }

  wranIfBsPeakUsUserThroughputOBJECT-TYPE
    SYNTAXInteger32 (0..4294967295)
    UNITS         "bps"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This records the peak user throughput in the US.
                  This is a function of the number of octets of MAC
                  SDUs transmitted by the CPEs to BS over time."
    ::= { wranIfBsThroughputMetricsEntry 9 }

  wranIfBsPeakDsMacThroughputOBJECT-TYPE
    SYNTAXInteger32 (0..4294967295)
    UNITS         "bps"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This records the peak MAC throughput in the DS.
                  This is a function of the number of octets of MAC
                  PDUs transmitted by the BS to CPEs over time."
    ::= { wranIfBsThroughputMetricsEntry 10 }

  wranIfBsPeakUsMacThroughputOBJECT-TYPE
    SYNTAXInteger32 (0..4294967295)
    UNITS         "bps"
    MAX-ACCESSread-only
    STATUScurrent
```

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```
    DESCRIPTION
      "This records the peak MAC throughput in the US.
                  This is a function of the number of octets of MAC
                  PDUs transmitted by the CPEs to BS over time."
    ::= { wranIfBsThroughputMetricsEntry 11 }

  wranIfBsPeakDsPhyThroughputOBJECT-TYPE
    SYNTAXInteger32 (0..4294967295)
    UNITS         "bps"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This records the peak PHY throughput in the DS.
                  This is a function of the number of burst octets
                  (e.g., MAC PDU + PHY overhead) transmitted by the BS
                  to CPEs over time."
    ::= { wranIfBsThroughputMetricsEntry 12 }

  wranIfBsPeakUsPhyThroughputOBJECT-TYPE
    SYNTAXInteger32 (0..4294967295)
    UNITS         "bps"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This records the peak PHY throughput in the US.
                  This is a function of the number of burst octets
                  (e.g., MAC PDU + PHY overhead) transmitted by the
                  CPEs to BS over time."
    ::= { wranIfBsThroughputMetricsEntry 13 }

  wranIfBsAvgDsCellEdgeThroughputOBJECT-TYPE
    SYNTAXInteger32 (0..4294967295)
    UNITS         "bps"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This records the average MAC throughput in the DS
                  transmitted with the most robust MCS. This is a
                  function of the number of octets of MAC PDUs
                  transmitted by the BS to the CPEs over time using
                  QPSK."
    ::= { wranIfBsThroughputMetricsEntry 14 }

  wranIfBsAvgUsCellEdgeThroughputOBJECT-TYPE
    SYNTAXInteger32 (0..4294967295)
    UNITS         "bps"
    MAX-ACCESSread-only
    STATUScurrent
```

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```
    DESCRIPTION
      "This records the average MAC throughput in the US
                  transmitted with the most robust MCS. This is a
                  function of the number of octets of MAC PDUs
                  transmitted by the CPEs to the BS over time using
                  QPSK."
    ::= { wranIfBsThroughputMetricsEntry 15 }

  wranIfBsNetworkEntryMetricsTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsNetworkEntryMetricsEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This MIB provides a table that contains latency
                  (time) for network entry and re-entry. Network entry
                  time is measured as the time in between receiving
                  the first RNG-REQ from a CPE until the CPE has
                  received the REG-RSP. Network re-entry process is
                  governed by the policies in (Policy) Table 234.
                  This could required execution of the entire network
                  entry process if the CPE is forced to re-initialize
                  itself or it could only required execution of the
                  CPE initialization procedure through the ranging
                  process (see 7.14.2). There is one entry in the
                  table, defined by wranIfBsNetworkEntryMetricsEntry."
    ::= { wranIfBsPm 5 }

  wranIfBsNetworkEntryMetricsEntryOBJECT-TYPE
    SYNTAXwranIfBsNetworkEntryMetricsEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object is a compound object that defines an
                  entry in wranIfBsNetworkEntryMetricsTable."
    INDEX{ wranIfBsNetworkEntryMetricsIndex }
    ::= { wranIfBsNetworkEntryMetricsTable 1 }

  wranIfBsNetworkEntryMetricsEntry::= SEQUENCE {
    wranIfBsNetworkEntryMetricsIndexINTEGER,
    wranIfBsAvgNetworkEntryLatencyInteger32,
    wranIfBsMaxNetworkEntryLatencyInteger32,
    wranIfBsAvgNetworkReEntryLatencyInteger32,
    wranIfBsMaxNetworkReEntryLatencyInteger32,
    wranIfBsNumNetworkEntryAttemptsInteger32,
    wranIfBsNumNetworkReEntryAttemptsInteger32 }

  wranIfBsNetworkEntryMetricsIndexOBJECT-TYPE
    SYNTAXINTEGER (1.. 1)
```

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```
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index of entry in this table, defaults to 1."
    ::= { wranIfBsNetworkEntryMetricsEntry 1 }

  wranIfBsAvgNetworkEntryLatencyOBJECT-TYPE
    SYNTAXInteger32 (1.. 3600000)
    UNITS "milliseconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Average network entry latency, measured in milli-
                  seconds."
    ::= { wranIfBsNetworkEntryMetricsEntry 2 }

  wranIfBsMaxNetworkEntryLatencyOBJECT-TYPE
    SYNTAXInteger32 (1.. 3600000)
    UNITS "milliseconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Maximum network entry latency, measured in milli-
                  seconds."
    ::= { wranIfBsNetworkEntryMetricsEntry 3 }

  wranIfBsAvgNetworkReEntryLatencyOBJECT-TYPE
    SYNTAXInteger32 (1.. 3600000)
    UNITS "milliseconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Average network re-entry latency, measure in milli-
                  seconds."
    ::= { wranIfBsNetworkEntryMetricsEntry 4 }

  wranIfBsMaxNetworkReEntryLatencyOBJECT-TYPE
    SYNTAXInteger32 (1.. 3600000)
    UNITS "milliseconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Average network re-entry latency, measure in milli-
                  seconds."
    ::= { wranIfBsNetworkEntryMetricsEntry 5 }

  wranIfBsNumNetworkEntryAttemptsOBJECT-TYPE
    SYNTAXInteger32 (1.. 3600000)
```

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```
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of network entry attempts."
    ::= { wranIfBsNetworkEntryMetricsEntry 6 }

  wranIfBsNumNetworkReEntryAttemptsOBJECT-TYPE
    SYNTAXInteger32 (1.. 3600000)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of network re-entry attempts."
    ::= { wranIfBsNetworkEntryMetricsEntry 7 }

  wranIfBsPacketErrorRateTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsPacketErrorRateEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This MIB object contains information about packet
                  error rate measurements. There is one entry in the
                  table, defined by wranIfBsPacketErrorRateEntry."
    ::= { wranIfBsPm 6 }

  wranIfBsPacketErrorRateEntryOBJECT-TYPE
    SYNTAXwranIfBsPacketErrorRateEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object is a compound object that defines an
                  entry in wranIfBsPacketErrorRateTable."
    INDEX{ wranIfBsPacketErrorRateIndex }
    ::= { wranIfBsPacketErrorRateTable 1 }

  wranIfBsNetworkEntryMetricsEntry::= SEQUENCE {
    wranIfBsPacketErrorRateIndexINTEGER,
    wranIfBsDsPacketsSentInteger32,
    wranIfBsDsPacketsErroredInteger32,
    wranIfBsDsPacketsErrorRateINTEGER,
    wranIfBsUsPacketsSentInteger32,
    wranIfBsUsPacketsErroredInteger32,
    wranIfBsUsPacketsErrorRateINTEGER }

  wranIfBsPacketErrorRateIndexOBJECT-TYPE
    SYNTAXINTEGER (1.. 1)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
```

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```
      "Index of entry in this table, defaults to 1."
    ::= { wranIfBsPacketErrorRateEntry 1 }

  wranIfBsDsPacketsSentOBJECT-TYPE
    SYNTAXInteger32 (1.. 4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Total number of MAC SDUs that the BS has sent."
    ::= { wranIfBsPacketErrorRateEntry 2 }

  wranIfBsDsPacketsErroredOBJECT-TYPE
    SYNTAXInteger32 (1.. 4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Total number of MAC SDUs, including ARQ blocks that
                  have not been acknowledged."
    ::= { wranIfBsPacketErrorRateEntry 3 }

  wranIfBsDsPacketsErrorRateOBJECT-TYPE
    SYNTAXInteger32 (1..4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "DS Packet error rate, as measured:
                  wranIfBsPacketErrorRate = (wranIfBsDsPacketsErrored
                  / wranIfBsDsPacketsSent) * 10000000, in units of
                  1e-7."
    ::= { wranIfBsPacketErrorRateEntry 4 }

  wranIfBsUsPacketsReceivedOBJECT-TYPE
    SYNTAXInteger32 (1..4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Total number of MAC SDUs that the BS has received."
    ::= { wranIfBsPacketErrorRateEntry 5 }

  wranIfBsUsPacketsErroredOBJECT-TYPE
    SYNTAXInteger32 (1.. 4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Total number of MAC SDUs with CRC errors and/or ARQ
                  blocks that required retransmission that have been
                  received by BS."
    ::= { wranIfBsPacketErrorRateEntry 6 }
```

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```
wranIfBsUsPacketsErrorRateOBJECT-TYPE
  SYNTAXInteger32 (1.. 4294967295)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "US Packet error rate, as measured:
                wranIfBsUsPacketsErrorRate =
                (wranIfBsUsPacketsErrored /
                wranIfBsUsPacketsReceived) * 10000000, in unites of
                1e-7."
  ::= { wranIfBsPacketErrorRateEntry 7 }

wranIfBsUserMetricsTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfUserMetricsEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB object provides a table to track the
                current status of users in the cell. There is one
                entry in the table, defined by
                wranIfUserMetricsEntry."
  ::= { wranIfBsPm 7 }

wranIfUserMetricsEntryOBJECT-TYPE
  SYNTAXwranIfUserMetricsEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object is a compound object that defines an
                entry in wranIfBsUserMetricsTable."
  INDEX{ wranIfBsUserMetricsIndex }
  ::= { wranIfBsUserMetricsTable 1 }

wranIfUserMetricsEntry::= SEQUENCE {
  wranIfBsUserMetricsIndexINTEGER,
  wranIfBsNumActiveUsersInteger32,
  wranIfBsNumTotalUsersInteger32 }

wranIfBsUserMetricsIndexOBJECT-TYPE
  SYNTAXINTEGER (1.. 1)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in this table, defaults to 1."
  ::= { wranIfUserMetricsEntry 1 }

wranIfBsNumActiveUsersOBJECT-TYPE
```

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```
    SYNTAXINTEGER (0..512)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Total number of users that have FTs with active SFs
                  on them."
    ::= { wranIfUserMetricsEntry 2 }

  wranIfBsNumTotalUsersOBJECT-TYPE
    SYNTAXINTEGER (0..512)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Total number of users that have completed
                  registration (REG-REQ/RSP) process."
    ::= { wranIfUserMetricsEntry 3 }

  wranIfBsServiceFlowMetricsTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsServiceFlowMetricsEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This MIB object provides a table to track metrics
                  related to service flows. There is one entry in the
                  table, defined by wranIfBsServiceFlowMetricsEntry."
    ::= { wranIfBsPm 8 }

  wranIfBsServiceFlowMetricsEntryOBJECT-TYPE
    SYNTAXwranIfBsServiceFlowMetricsEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object is a compound object that defines an
                  entry in wranIfBsServiceFlowMetricsTable."
    INDEX{ wranIfBsServiceFlowMetricsIndex }
    ::= { wranIfBsServiceFlowMetricsTable 1 }

  wranIfBsServiceFlowMetricsEntry::= SEQUENCE {
    wranIfBsServiceFlowMetricsIndexINTEGER,
    wranIfBsNumDsaReq    Integer32,
    wranIfBsNumDsaReqSuccessInteger32,
    wranIfBsDsaSuccessRateINTEGER,
    wranIfBsNumDscReq    Integer32,
    wranIfBsNumDscReqSuccessInteger32,
    wranIfBsDscSuccessRateINTEGER,
    wranIfBsNumDsdReq    Integer32,
    wranIfBsNumDsdReqSuccessInteger32,
    wranIfDsdSuccessRateINTEGER,
```

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```
    wranIfBsMaxActiveServiceFlowInteger32,
    wranIfBsAvgActiveServiceFlowInteger32,
    wranIfBsMaxProvisionedServiceFlowInteger32,
    wranIfBsAvgProvisionedServiceFlowInteger32,
    wranIfBsMaxDsServiceFlowInteger32,
    wranIfBsMaxUsServiceFlowInteger32,
    wranIfBsAvgDsServiceFlowInteger32,
    wranIfBsAvgUsServiceFlowInteger32,
    wranIfBsNumSfidAllocatedInteger32 }

wranIfBsServiceFlowMetricsIndexOBJECT-TYPE
    SYNTAXINTEGER (1.. 1)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index of entry in this table, defaults to 1."
    ::= { wranIfBsServiceFlowMetricsEntry 1 }

wranIfBsNumDsaReqOBJECT-TYPE
    SYNTAXInteger32 (1..4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of DSA-REQ counted during reporting period."
    ::= { wranIfBsServiceFlowMetricsEntry 2 }

wranIfBsNumDsaReqSuccessOBJECT-TYPE
    SYNTAXInteger32 (1..4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of successful SF activations counted during
                reporting period. A successful activation of SF is
                noted when a BS receives a DSA-RSP with a successful
                confirmation in response to a particular DSA-REQ."
    ::= { wranIfBsServiceFlowMetricsEntry 3 }

wranIfBsDsaSuccessRateOBJECT-TYPE
    SYNTAXINTEGER (0..100)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "wranIfBsDsaSuccessRate = ( wranIfBsNumDsaReqSuccess
                / wranIfBsNumDsaReq ) * 100."
    ::= { wranIfBsServiceFlowMetricsEntry 4 }

wranIfBsNumDscReqOBJECT-TYPE
    SYNTAXInteger32 (1..4294967295)
```

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```
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of DSC-REQ counted during reporting period."
    ::= { wranIfBsServiceFlowMetricsEntry 5 }

  wranIfBsNumDscReqSuccessOBJECT-TYPE
    SYNTAXInteger32 (1..4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of successful SF modifications counted during
                  reporting period. A successful modification of SF is
                  noted when a BS receives a DSC-RSP with a successful
                  confirmation in response to a particular DSC-REQ."
    ::= { wranIfBsServiceFlowMetricsEntry 6 }

  wranIfBsDscSuccessRateOBJECT-TYPE
    SYNTAXINTEGER (0..100)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "wranIfBsDscSuccessRate = ( wranIfBsNumDscReqSuccess
                  / wranIfBsNumDscReq ) * 100."
    ::= { wranIfBsServiceFlowMetricsEntry 7 }

  wranIfBsNumDsdReqOBJECT-TYPE
    SYNTAXInteger32 (1..4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of DSD-REQ counted during reporting period."
    ::= { wranIfBsServiceFlowMetricsEntry 8 }

  wranIfBsNumDsdReqSuccessOBJECT-TYPE
    SYNTAXInteger32 (1..4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of successful SF deletions counted during
                  reporting period. A successful deletion of SF is
                  noted when a BS receives a DSD-RSP with a successful
                  confirmation in response to a particular DSD-REQ."
    ::= { wranIfBsServiceFlowMetricsEntry 9 }

  wranIfBsDsdSuccessRateOBJECT-TYPE
    SYNTAXINTEGER (0..100)
    MAX-ACCESSread-only
```

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```
    STATUScurrent
    DESCRIPTION
      "wranIfBsDsdSuccessRate = ( wranIfBsNumDsdReqSuccess
                  / wranIfBsNumDsdReq ) * 100."
    ::= { wranIfBsServiceFlowMetricsEntry 10 }

  wranIfBsMaxActiveServiceFlowOBJECT-TYPE
    SYNTAXInteger32 (1..4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Maximum number of service flows active during
                  reporting period."
    ::= { wranIfBsServiceFlowMetricsEntry 11 }

  wranIfBsAvgActiveServiceFlowOBJECT-TYPE
    SYNTAXInteger32 (1..4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Average number of service flows active during
                  reporting period."
    ::= { wranIfBsServiceFlowMetricsEntry 12 }

  wranIfBsMaxProvisionedServiceFlowOBJECT-TYPE
    SYNTAXInteger32 (1.. 4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Maximum number of pre-provisioned service flows
                  active during reporting period."
    ::= { wranIfBsServiceFlowMetricsEntry 13 }

  wranIfBsAvgProvisionedServiceFlowOBJECT-TYPE
    SYNTAXInteger32 (1.. 4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Average number of pre-provisioned service flows
                  active during reporting period."
    ::= { wranIfBsServiceFlowMetricsEntry 14 }

  wranIfBsMaxDsServiceFlowOBJECT-TYPE
    SYNTAXInteger32 (1.. 4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Maximum number of DS service flows active during
```

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```
                reporting period."
  ::= { wranIfBsServiceFlowMetricsEntry 15 }

wranIfBsMaxUsServiceFlowOBJECT-TYPE
  SYNTAXInteger32 (1.. 4294967295)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Maximum number of US service flows active during
                reporting period."
  ::= { wranIfBsServiceFlowMetricsEntry 16 }

wranIfBsAvgDsServiceFlowOBJECT-TYPE
  SYNTAXInteger32 (1.. 4294967295)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Average number of DS service flows active during
                reporting period."
  ::= { wranIfBsServiceFlowMetricsEntry 17 }

wranIfBsAvgUsServiceFlowOBJECT-TYPE
  SYNTAXInteger32 (1.. 4294967295)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Average number of US service flows active during
                reporting period."
  ::= { wranIfBsServiceFlowMetricsEntry 18 }

wranIfBsNumSfidAllocatedOBJECT-TYPE
  SYNTAXInteger32 (1.. 4294967295)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Number of SFIDs allocated during reporting period."
  ::= { wranIfBsServiceFlowMetricsEntry 19 }

wranIfBsArqMetricsTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfArqMetricsEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB object provides a table to track metrics
                related to service flows. There is one entry in the
                table, defined by wranIfArqMetricsEntry."
  ::= { wranIfBsPm 9 }
```

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```
wranIfBsArqMetricsEntryOBJECT-TYPE
  SYNTAXwranIfArqMetricsEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object is a compound object that defines an
                entry in wranIfBsArqMetricsTable."
  INDEX{ wranIfBsArqMetricsIndex }
  ::= { wranIfBsArqMetricsTable 1 }

wranIfBsArqMetricsEntry::= SEQUENCE {
  wranIfBsArqMetricsIndexINTEGER,
  wranIfBsDsNumArqBlocksInteger32,
  wranIfBsDsNumArqBlocksDroppedInteger32,
  wranIfBsDsNumArqBlockErrorRateINTEGER,
  wranIfBsDsNumArqBlockReTxInteger32,
  wranIfBsDsNumArqBlockEfficiencyINTEGER,
  wranIfBsUsNumArqBlocksInteger32,
  wranIfBsUsNumArqBlocksDroppedInteger32,
  wranIfBsUsNumArqBlockErrorRateINTEGER,
  wranIfBsUsNumArqBlockReTxInteger32,
  wranIfBsUsNumArqBlockEfficiencyINTEGER }

wranIfBsArqMetricsIndexOBJECT-TYPE
  SYNTAXINTEGER (1.. 1)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in this table, defaults to 1."
  ::= { wranIfBsArqMetricsEntry 1 }

wranIfBsDsNumArqBlocksOBJECT-TYPE
  SYNTAXInteger32 (1.. 4294967295)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Total number of ARQ blocks, including
                retransmissions, that BS has sent during reporting
                period."
  ::= { wranIfBsArqMetricsEntry 2 }

wranIfBsDsNumArqBlocksDroppedOBJECT-TYPE
  SYNTAXInteger32 (1.. 4294967295)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Total number of ARQ blocks that were dropped, due
                to unsuccessful attempts at retransmission."
```

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```
    ::= { wranIfBsArqMetricsEntry 3 }

  wranIfBsDsArqBlockErrorRateOBJECT-TYPE
    SYNTAXINTEGER (0..100)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "wranIfBsDsArqBlockErrorRate = (
                  wranIfBsDsNumArqBlocksDropped / wranIfBsNumArqBlocks
                  ) * 10000000, in units of 1e-7."
    ::= { wranIfBsArqMetricsEntry 4 }

  wranIfBsDsNumArqBlockReTxOBJECT-TYPE
    SYNTAXInteger32 (1.. 4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Total number of ARQ blocks that were retransmitted."
    ::= { wranIfBsArqMetricsEntry 5 }

  wranIfBsDsArqBlockEfficiencyOBJECT-TYPE
    SYNTAXINTEGER (0..100)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "wranIfBsDsArqBlockEfficiency = (
                  wranIfBsDsNumArqBlockReTx / wranIfBsDsNumArqBlocks )
                  * 10000000, in units of 1e-7."
    ::= { wranIfBsArqMetricsEntry 6 }

  wranIfBsUsNumArqBlocksOBJECT-TYPE
    SYNTAXInteger32 (1.. 4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Total number of ARQ blocks, including
                  retransmissions, that BS has received during
                  reporting period."
    ::= { wranIfBsArqMetricsEntry 7 }

  wranIfBsUsNumArqBlocksDroppedOBJECT-TYPE
    SYNTAXInteger32 (1..4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Total number of US ARQ blocks that were dropped, due
                  to unsuccessful attempts at retransmission."
    ::= { wranIfBsArqMetricsEntry 8 }
```

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```
wranIfBsUsArqBlockErrorRateOBJECT-TYPE
  SYNTAXINTEGER (0..100)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "wranIfBsUsArqBlockErrorRate = (
                wranIfBsUsNumArqBlocksDropped /
                wranIfBsUsNumArqBlocks ) * 10000000, in units of 1e-
               7."
  ::= { wranIfBsArqMetricsEntry 9 }

wranIfBsUsNumArqBlockReTxOBJECT-TYPE
  SYNTAXInteger32 (1.. 4294967295)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Total number of US ARQ blocks that were
                retransmitted."
  ::= { wranIfBsArqMetricsEntry 10 }

wranIfBsUsArqBlockEfficiencyOBJECT-TYPE
  SYNTAXINTEGER (0..100)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "wranIfBsUsArqBlockEfficiency = (
                wranIfBsUsNumArqBlockReTx / wranIfBsUsNumArqBlocks )
                * 10000000, in units of 1e-7."
  ::= { wranIfBsArqMetricsEntry 11 }

wranIfBsAuthenticationMetricsTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfBsAuthenticationMetricsEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB provides a table to track the number of
                authentication/encryption errors that occur. This
                table is made up of one entry, defined by
                wranIfBsAuthenticationMetricsEntry."
  ::= { wranIfBsPm 10 }

wranIfBsAuthenticationMetricsEntryOBJECT-TYPE
  SYNTAXwranIfBsAuthenticationMetricsEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object is a compound object that defines an
```

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```
                    entry in wranIfBsAuthenticationMetricsTable."
    INDEX{ wranIfBsAuthenticationMetricsIndex }
    ::= { wranIfBsAuthenticationMetricsTable 1 }

  wranIfBsAuthenticationMetricsEntry::= SEQUENCE {
    wranIfBsAuthenticationMetricsIndexINTEGER,
    wranIfBsMgmtAuthErrorsInteger32,
    wranIfBsDataAuthErrorsInteger32,
    wranIfBsWiMicAuthErrorsInteger32,
    wranIfBsDsNumArqBlockReTxInteger32,
    wranIfBsDsNumArqBlockEfficiencyINTEGER,
    wranIfBsUsNumArqBlocksInteger32,
    wranIfBsUsNumArqBlocksDroppedInteger32,
    wranIfBsUsNumArqBlockErrorRateINTEGER,
    wranIfBsUsNumArqBlockReTxInteger32,
    wranIfBsUsNumArqBlockEfficiencyINTEGER }

  wranIfBsAuthenticationMetricsIndexOBJECT-TYPE
    SYNTAXINTEGER (1.. 1)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index of entry in this table, defaults to 1."
    ::= { wranIfBsAuthenticationMetricsEntry 1 }

  wranIfBsMgmtAuthErrorsOBJECT-TYPE
    SYNTAXINTEGER (1..4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Current count of the number of management messages
                    from CPEs that cannot be properly authenticated."
    ::= { wranIfBsAuthenticationMetricsEntry 2 }

  wranIfBsDataAuthErrorsOBJECT-TYPE
    SYNTAXINTEGER (1..4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Current count of the number of data messages
                    from CPEs that cannot be properly authenticated."
    ::= { wranIfBsAuthenticationMetricsEntry 3 }

  wranIfBsWiMicAuthErrorsOBJECT-TYPE
    SYNTAXINTEGER (1..4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
```

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```
      "Current count of the number of wireless microphones
                  beacons (MSF1+MSF2+MSF3) that were not properly
                  authenticated."
   ::= { wranIfBsAuthenticationMetricsEntry 4 }

wranIfBsCbpAuthErrorsOBJECT-TYPE
   SYNTAXINTEGER (1..4294967295)
   MAX-ACCESSread-only
   STATUScurrent
   DESCRIPTION
      "Current count of the number of CBP bursts from
                  neighboring WRANs that were not properly
                  authenticated."
   ::= { wranIfBsAuthenticationMetricsEntry 5 }

wranIfBsCoexistenceStatusTableOBJECT-TYPE
   SYNTAXSEQUENCE OF wranIfBsCoexistenceStatusEntry
   MAX-ACCESSnot-accessible
   STATUScurrent
   DESCRIPTION
      "This MIB provides a table to track the on going
                  coexistence (Frame Contention) transactions. This
                  table is made up of multiple entries, one for each
                  ongoing transaction. Each entry is defined by
                  wranIfBsCoexistenceStatusEntry. If a Frame
                  Contention Destination receives a FC-REQ from a
                  source on a channel from which it already has a
                  message, then the existing entry is updated."
   ::= { wranIfBsPm 11 }

wranIfBsCoexistenceStatusEntryOBJECT-TYPE
   SYNTAXwranIfBsCoexistenceStatusEntry
   MAX-ACCESSnot-accessible
   STATUScurrent
   DESCRIPTION
      "This object is a compound object that defines an
                  entry in wranIfBsCoexistenceStatusTable."
   INDEX{ wranIfBsCoexistenceStatusIndex }
   ::= { wranIfBsCoexistenceStatusTable 1 }

wranIfBsCoexistenceStatusEntry::= SEQUENCE {
   wranIfBsCoexistenceStatusIndexIntege32,
   wranIfBsContentionChannelINTEGER,
   wranIfBsFCREQSourceIDMacAddress,
   wranIfBsFrameContentionSeqNumINTEGER,
   wranIfBsFrameContentionNumberInteger32,
   wranIfBsContentionReqFrameIndexVectorBITS }
```

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```
wranIfBsCoexistenceStatusIndexOBJECT-TYPE
  SYNTAXInteger32 (1..4096)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in this table. At BS can conduct
                Frame Contention with at most 16 other BSs
                simultaneously on a given channel."
  ::= { wranIfBsCoexistenceStatusEntry 1 }

wranIfBsContentionChannelOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Channel # of channel that FC-REQ was received on
                (i.e., channel that is being contended for)."
  ::= { wranIfBsCoexistenceStatusEntry 2 }

wranIfBsFCREQSourceIDOBJECT-TYPE
  SYNTAXMacAddress
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "BS ID (MAC Address) of the transmitter of a FC-REQ
                message in a CBP burst. This is pulled from the SCH
                data in the CBP MAC PDU header pulled from the CBP
                burst containing the FC-REQ."
  ::= { wranIfBsCoexistenceStatusEntry 3 }

wranIfBsFrameContentionSeqNumOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Sequence # field of received FC-REQ message."
  ::= { wranIfBsCoexistenceStatusEntry 4 }

wranIfBsFrameContentionNumberOBJECT-TYPE
  SYNTAXInteger32 (0..65535)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Value of the frame contention number (FCN) in FC-
                REQ."
  ::= { wranIfBsCoexistenceStatusEntry 5 }

wranIfBsFrameContentionReqFrameIndexVectorOBJECT-TYPE
```

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```
    SYNTAXBITS { frame1(0), frame2(1),
                 frame3(2), frame4(3),
                 frame5(4), frame6(5),
                 frame7(6), frame8(7),
                 frame9(8), frame10(9),
                 frame11(10), frame12(11),
                 frame13(12), frame14(13),
                 frame15(14), frame16(15) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Bitmap index of data frames w/in a superframe that a
                 Frame Contention Source is requesting, to be
                 scheduled in the next superframe after the current
                 one. A frame is selected if the Bit is set to 1 and
                 is not selected when set to 0."
    ::= { wranIfBsCoexistenceStatusEntry 6 }

  wranIfBsCoexistenceSourceTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsCoexistenceSourceEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This MIB provides a table to track what neighbor BSs
                 are attempting a coexistence (Frame Contention)
                 transaction with a particular BS or have
                 communicated other information (e.g.,
                 Backup/Candidate channel list) via CBP. Each entry
                 is defined by wranIfBsCoexistenceSourceEntry."
    ::= { wranIfBsPm 12 }

  wranIfBsCoexistenceSourceEntryOBJECT-TYPE
    SYNTAXwranIfBsCoexistenceSourceEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object is a compound object that defines an
                 entry in wranIfBsCoexistenceSourceTable."
    INDEX{ wranIfBsCoexistenceSourceIndex }
    ::= { wranIfBsCoexistenceSourceTable 1 }

  wranIfBsCoexistenceSourceEntry::= SEQUENCE {
    wranIfBsCoexistenceSourceIndexInteger32,
    wranIfBsCBPSourceIDMacAddress,
    wranIfBsSchDataIndexINTEGER,
    wranIfBsSchData      OCTET STRING }

  wranIfBsCoexistenceSourceIndexOBJECT-TYPE
```

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```
    SYNTAXInteger32 (1..4096)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index of entry in this table. At BS can conduct
                  Frame Contention with at most 16 other BSs
                  simultaneously on a given channel."
    ::= { wranIfBsCoexistenceSourceEntry 1 }

  wranIfBsCBPSourceIDOBJECT-TYPE
    SYNTAXMacAddress
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "BS ID of BS that sent CBP burst, obtained from SCH
                  data in CBP MAC PDU header (see Table 2 and Table
                  14) for PHY-OM1, or from A-FCH/ExFCH data in CBP
                  MAC PDU header (see Table 4 and Table 15) for
                  PHY-OM2."
    ::= { wranIfBsCoexistenceSourceEntry 2 }

  wranIfBsCtrlHdrDataIndexOBJECT-TYPE
    SYNTAXINTEGER { FirstSeven(0),
                    DsUsSplit(1),
                    ScwScheduling(2),
                    InterFrameQP(4),
                    IntraFrameQP(8) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "SCH Data Index field of CBP MAC PDU header for PHY-OM1, or the
       Advanced FCH/Extened FCH Data index field of CBP MAC PDU header
       for PHY-OM2. It
                  indicates the length of and indication of what
                  fields comprise the wranIfBsCtrlHdrData contents. For
                  example, when set to 0 wranIfBsCtrlHdrData
                  contains 11 octets and comprises the first
                  seven parameters of the SCH in PHY-OM1."
    ::= { wranIfBsCoexistenceSourceEntry 3 }

  wranIfBsSchDataOBJECT-TYPE
    SYNTAXOCTET STRING (SIZE(wranIfBsSchDataIndex))
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "SCH Data from CBP MAC PDU header. The length of this
                  field is governed by wranIfBsSchDataIndex."
    ::= { wranIfBsCoexistenceSourceEntry 4 }
```

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```
wranIfBsCoexistenceResourceListTableOBJECT-TYPE
  SYNTAX
    SEQUENCE OF wranIfBsCoexistenceResourceListEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB provides a table to track the resources
                being used by neighboring WRANs. This includes the
                Backup/Candidate Lists being transmitted by
                neighboring WRANs, as well as the DS/US split. This
                table is made up of multiple entries defined by
                wranIfBsCoexistenceResourceListEntry."
  ::= { wranIfBsPm 13 }

wranIfBsCoexistenceResourceListEntryOBJECT-TYPE
  SYNTAXwranIfBsCoexistenceResourceListEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object is a compound object that defines an
                entry in wranIfBsCoexistenceResourceListTable."
  INDEX{ wranIfBsCoexistenceResourceListIndex }
  ::= { wranIfBsCoexistenceResourceListTable 1 }

wranIfBsCoexistenceResourceListEntry::= SEQUENCE {
  wranIfBsCoexistenceResourceListIndexInteger32,
  wranIfBsCoexistenceResourceIDMacAddress,
  wranIfBsSelfCoexistenceCapabilityIndicator
                        INTEGER,
  wranIfBsNumBackupChannelsINTEGER,
  wranIfBsBackupChannelListOCTET STRING,
  wranIfBsCurrentDSUSSplitINTEGER,
  wranIfBsClaimedDSUSSplitINTEGER,
  wranIfBsDSUSChangeOffsetINTEGER,
  wranfBsFrameAllocationMapBITS,
  wranIfBsScwCycleLengthINTEGER,
  wranIfBsScwCycleOffsetINTEGER,
  wranIfBsScwCycleFrameBitmapBITS }

wranIfBsCoexistenceResourceListIndexOBJECT-TYPE
  SYNTAXInteger32 (1..4096)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in this table. When set to 1,
                refers to a BS's own coexistence resource
                configuration."
```

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```
    ::= { wranIfBsCoexistenceResourceListEntry 1 }

  wranIfBsCoexistenceResourceIDOBJECT-TYPE
    SYNTAXMacAddress
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "BS ID of BS that sent CBP burst, obtained from SCH
                  data in CBP MAC PDU header (see Table 2 and Table
                  14) for PHY-OM1, or from Advanced FCH/Extened FCH
                  data in CBP MAC PDU header  (see Table 4 and Table
                  15) for PHY-OM2."
    ::= { wranIfBsCoexistenceResourceListEntry 2 }

  wranIfBsSelfCoexistenceCapabilityIndicatorOBJECT-TYPE
    SYNTAXINTEGER { noCapability(0),
                    onlySE(1),
                    SEAndFC(2) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Field within SCH Data field of CBP MAC PDU header for PHY-OM1,
       or from within A-FCH data field of CBP MAC PDU head for PHY-OM2
that indicates what coexistence capabilities a BS
                  supports. If this field is 0000, the remaining
                  fields of this entry are null."
    ::= { wranIfBsCoexistenceResourceListEntry 3 }

  wranIfBsNumBackupChannelsOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of backup and candidate channels in the
                  wranIfBsBackupChannelList."
    ::= { wranIfBsCoexistenceResourceListEntry 4 }

  wranIfBsBackupChannelListOBJECT-TYPE
    SYNTAXOCTET STRING (SIZE(wranIfBsNumBackupChannels))
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This object is a vector, of length = 8 bits *
                  wranIfBsBackupChannelList, that contains
                  backup/candidate channel list received in a CBP
                  burst from a neighbor WRAN."
    ::= { wranIfBsCoexistenceResourceListEntry 5 }
```

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```
wranIfBsCurrentDSUSSplitOBJECT-TYPE
  SYNTAXINTEGER (0..63)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Current US/DS split indicated in SCH data of CBP MAC
                PDU header for PHY-OM1, or in A-FCH/ExFCH
                data of CBP MAC PDU header for PHY-OM2, received
                from neighbor WRAN."
  ::= { wranIfBsCoexistenceResourceListEntry 6 }

wranIfBsClaimedDSUSSplitOBJECT-TYPE
  SYNTAXINTEGER (0..63)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Claimed US/DS split indicated in SCH data of CBP MAC
                PDU header for PHY-OM1, or in A-FCH/ExFCH
                Data of CBP MAC PDU header for PHY-OM2, received
                from neighbor WRAN."
  ::= { wranIfBsCoexistenceResourceListEntry 7 }

wranIfBsDSUSChangeOffsetOBJECT-TYPE
  SYNTAXInteger32 (0..4095)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "DS/US Change Offset indicated in SCH data of CBP MAC
                PDU header for PHY-OM1, or in A-FCH/ExFCH data of
                CBP MAC PDU header for PHY-OM2 received from
                neighbor WRAN."
  ::= { wranIfBsCoexistenceResourceListEntry 8 }

wranIfBsFrameAllocationMapOBJECT-TYPE
  SYNTAXBITS { frame1(0), frame2(1),
                frame3(2), frame4(3),
                frame5(4), frame5(5),
                frame7(6), frame8(7),
                frame9(8), frame10(9),
                frame11(10), frame12(11),
                frame13(12), frame14(13),
                frame15(14), frame16(15) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Indicates which frames in a superframe are allocated
                to the neighbor WRAN BS. A frame is allocated if the
                bit is set to 1 and unallocated if the bit is set to
```

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```
                    0."
    ::= { wranIfBsCoexistenceResourceListEntry 9 }

  wranIfBsScwCycleLengthOBJECT-TYPE
    SYNTAXINTEGER { never(0), every1SF(1),
                    every2SF(2), every4SF(4),
                    every8SF(8), every16SF(16) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "SCW Cycle Length being applied by neighbor WRAN."
    ::= { wranIfBsCoexistenceResourceListEntry 10 }

  wranIfBsScwCycleOffsetOBJECT-TYPE
    SYNTAXINTEGER { never(0), every1SF(1),
                    every2SF(2), every4SF(4),
                    every8SF(8), every16SF(16) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "SCW Cycle Offset being applied by neighbor WRAN."
    ::= { wranIfBsCoexistenceResourceListEntry 11 }

  wranIfBsScwCycleFrameBitmapOBJECT-TYPE
    SYNTAXBITS { frame1bit1(0), frame1bit2(1),
                 frame2bit1(2), frame2bit2(3),
                 frame3bit1(4), frame3bit2(5),
                 frame4bit1(6), frame4bit2(7),
                 frame5bit1(8), frame5bit2(9),
                 frame6bit1(10), frame6bit2(11),
                 frame7bit1(12), frame7bit2(13),
                 frame8bit1(14), frame8bit2(15),
                 frame9bit1(16), frame9bit2(17),
                 frame10bit1(18), frame10bit2(19),
                 frame11bit1(20), frame11bit2(21),
                 frame12bit1(22), frame12bit2(23),
                 frame13bit1(24), frame13bit2(25),
                 frame14bit1(26), frame14bit2(27),
                 frame15bit1(28), frame15bit2(29),
                 frame16bit1(30), frame16bit2(31) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Valid within the context of a superframe, indicates
                 for each frame if no SCW is setup (00), the BS has
                 setup a reservation-based SCW for itself (11), a
                 reservation-based SCW for a neighboring WRAN (10),
                 or a contention-based SCW to be shared by
```

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```
                    neighboring WRANs (01). This is set in groups of two
                    bits, e.g., BIT#0 & BIT#1 correspond to frame 1
                    within the superframe."
    ::= { wranIfBsCoexistenceResourceListEntry 12 }

  wranIfBsCoexistenceCurrentConfigTableOBJECT-TYPE
    SYNTAX
      SEQUENCE OF wranIfBsCoexistenceCurrentConfigEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This MIB provides a table to track what frame
                    allocation has been awarded to a frame contention
                    winner and when the awarded resource will be
                    released. It is made up of multiple entries, one for
                    each channel that frame contention procedure was
                    executed on, as defined in
                    wranIfBsCoexistenceCurrentConfigEntry. When a frame
                    contention winner is selected, the corresponding
                    entries in wranIfBsCoexistenceCurrentConfigTable are
                    removed."
    ::= { wranIfBsPm 14 }

  wranIfBsCoexistenceCurrentConfigEntryOBJECT-TYPE
    SYNTAXwranIfBsCoexistenceCurrentConfigEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object is a compound object that defines an
                    entry in wranIfBsCoexistenceCurrentConfigTable."
    INDEX{ wranIfBsCoexistenceCurrentConfigIndex }
    ::= { wranIfBsCoexistenceCurrentConfigTable 1 }

  wranIfBsCoexistenceCurrentConfigEntry::= SEQUENCE {
    wranIfBsCoexistenceCurrentConfigIndexINTEGER,
    wranIfBsContentionChannelINTEGER,
    wranIfBsFrameContentionSourceIDMacAddress,
    wranIfBsAwardedSeqNumINTEGER,
    wranIfBsContentionRspFrameIndexVectorBITS,
    wranIfBsContentionRspFrameReleaseTimeINTEGER }

  wranIfBsCoexistenceCurrentConfigIndexOBJECT-TYPE
    SYNTAXINTEGER (1..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index of entry in the table."
    ::= { wranIfBsCoexistenceCurrentConfigEntry 1 }
```

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```
wranIfBsContentionChannelOBJECT-TYPE
  SYNTAXINTEGER (1..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Channel # of channel that frame contention was
                executed on."
  ::= { wranIfBsCoexistenceCurrentConfigEntry 2 }

wranIfBsFrameContentionSourceIDOBJECT-TYPE
  SYNTAXMacAddress
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "BS ID of frame contention source that has won
                contention."
  ::= { wranIfBsCoexistenceCurrentConfigEntry 3 }

wranIfBsAwardedSeqNumOBJECT-TYPE
  SYNTAXINTEGER (1..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Sequence number from FC-REQ message of frame
                contention winner."
  ::= { wranIfBsCoexistenceCurrentConfigEntry 4 }

wranIfBsContentionRspFrameIndexVectorOBJECT-TYPE
  SYNTAXBITS { frame1(0), frame2(1),
                frame3(2), frame4(3),
                frame5(4), frame5(5),
                frame7(6), frame8(7),
                frame9(8), frame10(9),
                frame11(10), frame12(11),
                frame13(12), frame14(13),
                frame15(14), frame16(15) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "A bitmap containing the indexes of frames within the
                superframe that the Contention Source has won. When
                a frame is allocated to the contention source, it is
                set to 1. When a frame is not allocated, the
                corresponding bit is set to 0."
  ::= { wranIfBsCoexistenceCurrentConfigEntry 5 }

wranIfBsContentionRspFrameReleaseTimeOBJECT-TYPE
```

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```
    SYNTAXINTEGER (1..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Starting from the next superframe, the number of
                  superframes after which the channel shall be
                  released by the frame contention destination BS."
    ::= { wranIfBsCoexistenceCurrentConfigEntry 6 }

-- wranIfBsPmMibGroups: This object helps define which MIB groups are
-- available within this module and which MIB objects are part of each
-- group.

  wranIfBsPmMibGroupsOBJECT IDENTIFIER
                              ::= { wranIfBsPm 15 }
  wranIfBsPmConfigGroupOBJECT IDENTIFIER
                              ::= { wranIfBsPmMibGroups 1 }
  wranIfBsPmSignalPowerGroupOBJECT IDENTIFIER
                              ::= { wranIfBsPmMibGroups 2 }
  wranIfBsPmStartupGroupOBJECT IDENTIFIER
                              ::= { wranIfBsPmMibGroups 3 }
  wranIfBsPmThroughputGroupOBJECT IDENTIFIER
                              ::= { wranIfBsPmMibGroups 4 }
  wranIfBsPmNetEntryGroupOBJECT IDENTIFIER
                              ::= { wranIfBsPmMibGroups 5 }
  wranIfBsPmPktErrorGroupOBJECT IDENTIFIER
                              ::= { wranIfBsPmMibGroups 6 }
  wranIfBsPmUserGroupOBJECT IDENTIFIER
                              ::= { wranIfBsPmMibGroups 7 }
  wranIfBsPmServiceFlowGroupOBJECT IDENTIFIER
                              ::= { wranIfBsPmMibGroups 8 }
  wranIfBsPmArqGroupOBJECT IDENTIFIER
                              ::= { wranIfBsPmMibGroups 9 }
  wranIfBsPmAuthGroupOBJECT IDENTIFIER
                               ::= { wranIfBsPmMibGroups 10 }
  wranIfBsPmCoexStatusGroupOBJECT IDENTIFIER
                               ::= { wranIfBsPmMibGroups 11 }
  wranIfBsPmCoexSourceGroupOBJECT IDENTIFIER
                               ::= { wranIfBsPmMibGroups 12 }
  wranIfBsPmCoexResourceGroupOBJECT IDENTIFIER
                               ::= { wranIfBsPmMibGroups 13 }
  wranIfBsPmCoexConfigGroupOBJECT IDENTIFIER
                               ::= { wranIfBsPmMibGroups 14 }

  wranIfBsPmConfigGroupOBJECT-GROUP
    OBJECTS{ wranIfBsPmConfigurationEntryIndex,
                  wranIfBsGranularityInterval,
                  wranIfBsCountersReportInterval,
```

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```
                    wranIfBsPmMeasurementBitmap }
    STATUScurrent
    DESCRIPTION
      "This group contains objects configuration of
                    measurement records used in wranIfBsPm."
    ::= { wranIfBsPmMibGroups 1 }

  wranIfBsPmSignalPowerGroupOBJECT-GROUP
    OBJECTS{ wranIfBsRssiCinrMetricsIndex,
                    wranIfBsCpeMacAddress,
                    wranIfBsChannelDirection,
                    wranIfBsChannelNumber,
                    wranIfBsStartFrame,
                    wranIfBsMeasurementDuration,
                    wranIfBsSignalReportType,
                    wranIfBsMeanCinrReport,
                    wranIfBsMeanRssiReport,
                    wranIfBsStdDevCinrReport,
                    wranIfBsStdDevRssiReport,
                    wranIfBsMaxEIRPReport,
                    wranIfBsPerScEIRPReport }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                    tracking CPE signal power measurements."
    ::= { wranIfBsPmMibGroups 2 }

  wranIfBsPmStartupGroupOBJECT-GROUP
    OBJECTS{ wranIfBsStartupMetricsIndex,
                    wranIfBsNumAuthAttempt,
                    wranIfBsNumAuthSuccess,
                    wranIfBsAuthSuccessRate,
                    wranIfBsNumRangingAttempt,
                    wranIfBsNumRangingSuccess,
                    wranIfBsRangingSuccessRate,
                    wranIfBsMeanCinrReport }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                    tracking CPE performance during network entry
                    and re-entry."
    ::= { wranIfBsPmMibGroups 3 }

  wranIfBsPmThroughputGroupOBJECT-GROUP
    OBJECTS{ wranIfBsThroughputMetricsIndex,
                    wranIfBsAvgDsUserThroughput,
                    wranIfBsAvgUsUserThroughput,
                    wranIfBsAvgDsMacThroughput,
```

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```
                    wranIfBsAvgUsMacThroughput,
                    wranIfBsAvgDsPhyThroughput,
                    wranIfBsAvgUsPhyThroughput,
                    wranIfBsPeakDsUserThroughput,
                    wranIfBsPeakUsUserThroughput,
                    wranIfBsPeakDsMacThroughput,
                    wranIfBsPeakUsMacThroughput,
                    wranIfBsPeakDsPhyThroughput,
                    wranIfBsPeakUsPhyThroughput,
                    wranIfBsAvgDsCellEdgeThroughput,
                    wranIfBsAvgUsCellEdgeThroughput }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                    tracking CPE peak/average data rate."
    ::= { wranIfBsPmMibGroups 4 }

  wranIfBsPmNetEntryGroupOBJECT-GROUP
    OBJECTS{ wranIfBsNetworkEntryMetricsIndex,
                    wranIfBsAvgNetworkEntryLatency,
                    wranIfBsMaxNetworkEntryLatency,
                    wranIfBsAvgNetworkReEntryLatency,
                    wranIfBsMaxNetworkReEntryLatency,
                    wranIfBsNumNetworkEntryAttempts,
                    wranIfBsNumNetworkReEntryAttempts }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                    tracking latency of network entry and re-entry
                    for CPEs."
    ::= { wranIfBsPmMibGroups 5 }

  wranIfBsPmPktErrorGroupOBJECT-GROUP
    OBJECTS{ wranIfBsPacketErrorRateIndex,
                    wranIfBsDsPacketsSent,
                    wranIfBsDsPacketsErrored,
                    wranIfBsDsPacketsErrorRate,
                    wranIfBsUsPacketsSent,
                    wranIfBsUsPacketsErrored,
                    wranIfBsUsPacketsErrorRate }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                    tracking packet error rate measurements."
    ::= { wranIfBsPmMibGroups 6 }

  wranIfBsPmUserGroupOBJECT-GROUP
    OBJECTS{ wranIfBsUserMetricsIndex,
```

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```
                wranIfBsNumActiveUsers,
                wranIfBsNumTotalUsers }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                tracking status of users in the cell."
    ::= { wranIfBsPmMibGroups 7 }

  wranIfBsPmServiceFlowGroupOBJECT-GROUP
    OBJECTS{ wranIfBsServiceFlowMetricsIndex,
                wranIfBsNumDsaReq,
                wranIfBsNumDsaReqSuccess,
                wranIfBsDsaSuccessRate,
                wranIfBsNumDscReq,
                wranIfBsNumDscReqSuccess,
                wranIfBsDscSucessRate,
                wranIfBsNumDsdReq,
                wranIfBsNumDsdReqSuccess,
                wranIfDsdSuccessRate,
                wranIfBsMaxActiveServiceFlow,
                wranIfBsAvgActiveServiceFlow,
                wranIfBsMaxProvisionedServiceFlow,
                wranIfBsAvgProvisionedServiceFlow,
                wranIfBsMaxDsServiceFlow,
                wranIfBsMaxUsServiceFlow,
                wranIfBsAvgDsServiceFlow,
                wranIfBsAvgUsServiceFlow,
                wranIfBsNumSfidAllocated }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                tracking service flow metrics."
    ::= { wranIfBsPmMibGroups 8 }

  wranIfBsPmArqGroupOBJECT-GROUP
    OBJECTS{ wranIfBsArqMetricsIndex,
                wranIfBsDsNumArqBlocks,
                wranIfBsDsNumArqBlocksDropped,
                wranIfBsDsNumArqBlockErrorRate,
                wranIfBsDsNumArqBlockReTx,
                wranIfBsDsNumArqBlockEfficiency,
                wranIfBsUsNumArqBlocks,
                wranIfBsUsNumArqBlocksDropped,
                wranIfBsUsNumArqBlockErrorRate,
                wranIfBsUsNumArqBlockReTx,
                wranIfBsUsNumArqBlockEfficiency }
    STATUScurrent
    DESCRIPTION
```

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```
      "This group contains objects related to
                  tracking ARQ performance."
    ::= { wranIfBsPmMibGroups 9 }

  wranIfBsPmAuthGroupOBJECT-GROUP
    OBJECTS{ wranIfBsAuthenticationMetricsIndex,
                  wranIfBsMgmtAuthErrors,
                  wranIfBsDataAuthErrors,
                  wranIfBsWiMicAuthErrors,
                  wranIfBsDsNumArqBlockReTx,
                  wranIfBsDsNumArqBlockEfficiency,
                  wranIfBsUsNumArqBlocks,
                  wranIfBsUsNumArqBlocksDropped,
                  wranIfBsUsNumArqBlockErrorRate,
                  wranIfBsUsNumArqBlockReTx,
                  wranIfBsUsNumArqBlockEfficiency }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                tracking the number of
                authentication/encryption errors that occur."
    ::= { wranIfBsPmMibGroups 10 }

  wranIfBsPmCoexStatusGroupOBJECT-GROUP
    OBJECTS{ wranIfBsCoexistenceStatusIndex,
                  wranIfBsContentionChannel,
                  wranIfBsFCREQSourceID,
                  wranIfBsFrameContentionSeqNum,
                  wranIfBsFrameContentionNumber,
                  wranIfBsContentionReqFrameIndexVector }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                tracking the status of on going coexistence (Frame
                Contention) transactions."
    ::= { wranIfBsPmMibGroups 11 }

  wranIfBsPmCoexSourceGroupOBJECT-GROUP
    OBJECTS{ wranIfBsCoexistenceSourceIndex,
                  wranIfBsCBPSourceID,
                  wranIfBsCtrlHdrDataIndex,
                  wranIfBsCtrlHdrData }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                tracking which neighbor BSs are attempting
                a coexistence (Frame Contention) transaction."
    ::= { wranIfBsPmMibGroups 12 }
```

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```
wranIfBsPmCoexResourceGroupOBJECT-GROUP
  OBJECTS{ wranIfBsCoexistenceResourceListIndex,
                wranIfBsCoexistenceResourceID,
                wranIfBsSelfCoexistenceCapabilityIndicator,
                wranIfBsNumBackupChannels,
                wranIfBsBackupChannelList,
                wranIfBsCurrentDSUSSplit,
                wranIfBsClaimedDSUSSplit,
                wranIfBsDSUSChangeOffset,
                wranfBsFrameAllocationMap,
                wranIfBsScwCycleLength,
                wranIfBsScwCycleOffset,
                wranIfBsScwCycleFrameBitmap }
  STATUScurrent
  DESCRIPTION
    "This group contains objects related to
             tracking what resources are used by
             neighboring WRANs."
  ::= { wranIfBsPmMibGroups 13 }

wranIfBsPmCoexConfigGroupOBJECT-GROUP
  OBJECTS{ wranIfBsCoexistenceCurrentConfigIndex,
                wranIfBsContentionChannel,
                wranIfBsFrameContentionSourceID,
                wranIfBsAwardedSeqNum,
                wranIfBsContentionRspFrameIndexVector,
                wranIfBsContentionRspFrameReleaseTime }
  STATUScurrent
  DESCRIPTION
    "This group contains objects related to
             tracking what resources have been
             allocated to neighboring WRANs during
             coexistence (Frame Contention) transactions."
  ::= { wranIfBsPmMibGroups 14 }


wranIfBsPmMibComplianceMODULE-COMPLIANCE
  STATUScurrent
  DESCRIPTION
    "MIB objects that are optional and mandatory for
             wranIfBsPm compliance."
  MODULEwranIfBsCm
  MANDATORY-GROUPS{ wranIfBsPmConfigGroup }
  -- OPTIONAL-GROUPS{ wranIfBsPmSignalPowerGroup,
                      wranIfBsPmStartupGroup,
                      wranIfBsPmThroughputGroup,
                      wranIfBsPmNetEntryGroup,
```

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```
                        wranIfBsPmPktErrorGroup,
                        wranIfBsPmUserGroup,
                        wranIfBsPmServiceFlowGroup,
                        wranIfBsPmArqGroup,
                        wranIfBsPmAuthGroup,
                        wranIfBsPmCoexStatusGroup,
                        wranIfBsPmCoexSourceGroup,
                        wranIfBsPmCoexResourceGroup,
                        wranIfBsPmCoexConfigGroup }
    ::= { wranIfBsPm 16 }

-- wranIfBsScm: This MIB group has objects related to security
-- management.

  wranIfBsCpeScmAuthStatusTable
                  OBJECT IDENTIFIER ::= { wranIfBsScm 1 }
  wranIfBsCpeScmSaConfigTable
                  OBJECT IDENTIFIER ::= { wranIfBsScm 2 }
  wranIfBsCpeTekRefreshTable
                  OBJECT IDENTIFIER ::= { wranIfBsScm 3 }
  wranIfBsCBPAuthCACertTable
                  OBJECT IDENTIFIER ::= { wranIfBsScm 4 }
  wranIfBsCBPAuthBsImplicitCertTable
                  OBJECT IDENTIFIER ::= { wranIfBsScm 5 }
  wranIfBsWiMicAuthCertTable
                  OBJECT IDENTIFIER ::= { wranIfBsScm 6 }
  wranIfBsPmMibGroups
                  OBJECT IDENTIFIER ::= { wranIfBsScm 7 }
  wranIfBsScmMibCompliance
                  OBJECT IDENTIFIER ::= { wranIfBsScm 8 }

  wranIfBsCpeScmAuthStatusTableOBJECT-TYPE
    SYNTAX
      SEQUENCE OF wranIfBsCpeScmAuthStatusEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object provides a table that stores information
                  regarding the current state of the CPE's
                  authentication state machine. This table is stored
                  on each CPE and made of one entry, defined by
                  wranIfBsCpeScmAuthStatusEntry."
    ::= { wranIfBsScm 1 }

  wranIfBsCpeScmAuthStatusEntryOBJECT-TYPE
    SYNTAXwranIfBsCpeScmAuthStatusEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
```

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```
    DESCRIPTION
      "This object is a compound object that defines an
                  entry in wranIfBsCpeScmAuthStatusTable."
    INDEX{ wranIfBsCpeAuthStatusIndex }
    ::= { wranIfBsCpeScmAuthStatusTable 1 }

  wranIfBsCpeScmAuthStatusEntry::= SEQUENCE {
    wranIfBsCpeAuthStatusIndexINTEGER,
    wranIfBsCpeScmAuthStatusINTEGER,
    wranIfBsCpeScmAuthRecentEventMacAddress,
    wranIfBsCpeScmNumAuthAttemptsINTEGER,
    wranIfBsCpeAuthRecentMsgSizeInteger32,
    wranIfBsCpeScmAuthRecentMsgOCTET STRING,
    wranIfBsCpeScmAuthEapAuthTimerExpirationInteger32,
    wranIfBsCpeAuthGraceTimer1Integer32,
    wranIfBsCepAuthGraceTimer2Integer32,
    wranIfBsCpeScmAk1LifetimeInteger32,
    wranIfBsCpeScmAk2LifetimeInteger32,
    wranIfBsCpeScmConfigRequestSizeInteger32,
    wranIfBsCpeScmConfigRequestOCTET STRING,
    wranIfBsCpeScmConfigReplySizeInteger32,
    wranIfBsCpeScmConfigReplyOCTET STRING }

  wranIfBsCpeAuthStatusIndexOBJECT-TYPE
    SYNTAXINTEGER (1..1)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index of entry in the table."
    ::= { wranIfBsCpeScmAuthStatusEntry 1 }

  wranIfBsCpeScmAuthStatusOBJECT-TYPE
    SYNTAXINTEGER { idle(0), notAuthenticated(1),
                    reAuthWait(2), authenticated(3) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Current state of CPE's authentication state machine
                  (see 8.2.2.1)."
    ::= { wranIfBsCpeScmAuthStatusEntry 2 }

  wranIfBsCpeScmAuthRecentEventOBJECT-TYPE
    SYNTAXINTEGER { startAuth(0), eapTimeout(1),
                    eapFailure(2), eapRetryExhaustion(3),
                    eapSuccess(4), reAuthNeeded(5),
                    authGraceTimeout(6) }
    MAX-ACCESSread-only
    STATUScurrent
```

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```
    DESCRIPTION
      "Indication of most recent event (see 8.2.2.4) that
                  has occurred in the ASM."
    ::= { wranIfBsCpeScmAuthStatusEntry 3 }

  wranIfBsCpeScmNumAuthAttemptsOBJECT-TYPE
    SYNTAXINTEGER (1..11)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Current # of EAP authentication attempts."
    ::= { wranIfBsCpeScmAuthStatusEntry 4 }

  wranIfBsCpeAuthRecentMsgSizeOBJECT-TYPE
    SYNTAXInteger32 (1..65535)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Size of wranIfBsCpeScmAuthRecentMsg in octets."
    ::= { wranIfBsCpeScmAuthStatusEntry 5 }

  wranIfBsCpeAuthRecentMsgOBJECT-TYPE
    SYNTAX
      OCTETS STRING (SIZE(wranIfCpeAuthRecentMsgSize))
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Contents of most recent authentication message,
                  either EAP-Start or EAP-Transfer."
    ::= { wranIfBsCpeScmAuthStatusEntry 6 }

  wranIfBsCpeScmAuthEapAuthTimerExpirationOBJECT-TYPE
    SYNTAXInteger32 (300..3024000)
    UNITS          "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Contents of most recent authentication message,
                  either EAP-Start or EAP-Transfer."
    ::= { wranIfBsCpeScmAuthStatusEntry 7 }

  wranIfBsCpeScmAuthGraceTimer1OBJECT-TYPE
    SYNTAXInteger32 (1..3024000)
    UNITS          "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Indication of when Authentication Grace timer for
```

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```
                    current (active) AK will expire."
    ::= { wranIfBsCpeScmAuthStatusEntry 8 }

  wranIfBsCpeScmAuthGraceTimer2OBJECT-TYPE
    SYNTAXInteger32 (1..3024000)
    UNITS         "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Indication of when Authentication Grace timer for
                    second generation (non-active) AK will expire."
    ::= { wranIfBsCpeScmAuthStatusEntry 9 }

  wranIfBsCpeScmAk1LifetimeOBJECT-TYPE
    SYNTAXInteger32 (1..6048000)
    UNITS         "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Remaining lifetime for current (active) AK."
    ::= { wranIfBsCpeScmAuthStatusEntry 10 }

  wranIfBsCpeScmAk2LifetimeOBJECT-TYPE
    SYNTAXInteger32 (1..6048000)
    UNITS         "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Remaining lifetime for second generation (non-
                    active) AK."
    ::= { wranIfBsCpeScmAuthStatusEntry 11 }

  wranIfBsCpeScmConfigRequestSizeOBJECT-TYPE
    SYNTAXInteger32 (1..65535)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Size of wranIfBsCpeScmConfigRequest in octets."
    ::= { wranIfBsCpeScmAuthStatusEntry 12 }

  wranIfBsCpeScmConfigRequestOBJECT-TYPE
    SYNTAX
      OCTETS STRING (SIZE(wranIfBsCpeScmConfigRequestSize))
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Contents of SCM configuration request (see Table
                    187) sent by CPE, upon initial authentication or re-
```

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```
                    authentication, to AAA server."
    ::= { wranIfBsCpeScmAuthStatusEntry 13 }

  wranIfBsCpeScmConfigReplySizeOBJECT-TYPE
    SYNTAXInteger32 (1..65535)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Size of wranIfBsCpeScmConfigReply in octets."
    ::= { wranIfBsCpeScmAuthStatusEntry 14 }

  wranIfBsCpeScmConfigReplyOBJECT-TYPE
    SYNTAX
      OCTETS STRING (SIZE(wranIfBsCpeScmConfigReplySize))
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Contents of SCM configuration reply (see Table
                    188) sent by AAA server, upon confirmation of
                    initial authentication or re-authentication, to
                    CPE."
    ::= { wranIfBsCpeScmAuthStatusEntry 15 }

  wranIfBsCpeScmSaConfigTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsCpeScmConfigEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object provides a table that provides the
                    configuration of the SA attributes that are related
                    to SAs configured on each CPE. This table is
                    maintained on each CPE as well as on the BS. On the
                    BS, this table represents the configuration of SAs
                    for all CPEs under its control. On the CPE, this
                    table is made up of entry for each SA that a CPE
                    supports. Each entry is defined by
                    wranIfBsCpeScmSaConfigEntry."
    ::= { wranIfBsScm 2 }

  wranIfBsCpeScmSaConfigEntryOBJECT-TYPE
    SYNTAXwranIfBsCpeScmSaConfigEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object is a compound object that defines an
                    entry in wranIfBsCpeScmSaConfigTable."
    INDEX{ wranIfBsCpeScmSaConfigIndex }
    ::= { wranIfBsCpeScmSaConfigTable 1 }
```

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```
wranIfBsCpeScmSaConfigEntry::= SEQUENCE {
  wranIfBsCpeScmSaConfigIndexInteger32,
  wranIfBsCpeMacAddressMacAddress,
  wranIfBsCpeSaid         Integer32,
  wranIfBsCpeSaType       INTEGER,
  wranIfBsCpeCryptoSuiteListSizeINTEGER,
  wranIfBsCpeCryptoSuiteListOCTET STRING,
  wranIfBsCpeActiveTekSequenceNumberINTEGER,
  wranIfBsCpeActiveTekLifetimeInteger32,
  wranIfBsCpeActiveTekPnInteger32,
  wranIfBsCpeActiveTekExpireTimeDateAndTime,
  wranIfBsCpeNonActiveTekSequenceNumberINTEGER,
  wranIfBsCpeNonActiveTekLifetimeInteger32,
  wranIfBsCpeNonActiveTekPnInteger32,
  wranIfBsCpeNonActiveTekExpireTimeDateAndTime }

wranIfBsCpeScmSaConfigIndexOBJECT-TYPE
  SYNTAXInteger32 (1..65535)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in the table."
  ::= { wranIfBsCpeScmSaConfigEntry 1 }

wranIfBsCpeMacAddressOBJECT-TYPE
  SYNTAXMacAddress
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "MAC address of CPE."
  ::= { wranIfBsCpeScmSaConfigEntry 2 }

wranIfBsCpeSaidOBJECT-TYPE
  SYNTAXInteger32 (1..65535)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "SAID of SA that this entry refers to."
  ::= { wranIfBsCpeScmSaConfigEntry 3 }

wranIfBsCpeSaTypeOBJECT-TYPE
  SYNTAXINTEGER { null(0), unicastManagement(1),
                  unicastTransport(2), group(3) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
```

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```
      "Type of SA, either Null, Unicast Management, Unicast Transport,
or
                  Group."
    ::= { wranIfBsCpeScmSaConfigEntry 4 }

  wranIfBsCpeCryptoSuiteListSizeOBJECT-TYPE
    SYNTAXINTEGER (1..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Number of items in wranIfBsCpeCryptoSuiteList."
    ::= { wranIfBsCpeScmSaConfigEntry 5 }

  wranIfBsCpeCryptoSuiteListOBJECT-TYPE
    SYNTAX
      OCTET STRING (SIZE(wranIfBsCpeCryptoSuiteListSize))
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "This object provides a list that describes the
                  cryptographic suites that the CPE supports for this
                  particular SA. The complete list of suites is
                  provided in Table 193."
    ::= { wranIfBsCpeScmSaConfigEntry 6 }

  wranIfBsCpeActiveTekSequenceNumberOBJECT-TYPE
    SYNTAXINTEGER (0..3)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "The EKS value for the current (active) generation of
                  the two TEKs that are configured for this SA."
    ::= { wranIfBsCpeScmSaConfigEntry 7 }

  wranIfBsCpeActiveTekLifetimeOBJECT-TYPE
    SYNTAXInteger32 (0..604800)
    UNITS          "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "The remaining lifetime, in units of time (e.g.,
                  seconds), for the current (active) generation of the
                  two TEKs that are configured for this SA."
    ::= { wranIfBsCpeScmSaConfigEntry 8 }

  wranIfBsCpeActiveTekPnOBJECT-TYPE
    SYNTAXInteger32 (0..4294967295)
    MAX-ACCESSread-only
```

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```
    STATUScurrent
    DESCRIPTION
      "Current value of the PN counter for the current
                  (active) generation of the two TEKs that are
                  configured for this SA."
    ::= { wranIfBsCpeScmSaConfigEntry 9 }

  wranIfBsCpeActiveTekExpireTimeOBJECT-TYPE
    SYNTAXDateAndTime
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Time at which current (active) generation of the two
                  TEKs configured for an SA will expire. This time is
                  calculated as a function of the (Reception Time of
                  Key Reply with Active Tek) +
                  (wranIfBsCpeActiveTekLifetime)."
    ::= { wranIfBsCpeScmSaConfigEntry 10 }

  wranIfBsCpeNonActiveTekSequenceNumberOBJECT-TYPE
    SYNTAXINTEGER (0..3)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "The EKS value for the second (non-active) generation
                  of the two TEKs that are configured for this SA."
    ::= { wranIfBsCpeScmSaConfigEntry 11 }

  wranIfBsCpeNonActiveTekLifetimeOBJECT-TYPE
    SYNTAXInteger32 (0..604800)
    UNITS         "seconds"
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "The remaining lifetime, in units of time (e.g.,
                  seconds), for the second (non-active) generation of
                  the two TEKs that are configured for this SA."
    ::= { wranIfBsCpeScmSaConfigEntry 12 }

  wranIfBsCpeNonActiveTekPnOBJECT-TYPE
    SYNTAXInteger32 (0..4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Current value of the PN counter for the second
                  (non-active) generation of the two TEKs that are
                  configured for this SA."
    ::= { wranIfBsCpeScmSaConfigEntry 13 }
```

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```
wranIfBsCpeNonActiveTekExpireTimeOBJECT-TYPE
  SYNTAXDateAndTime
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Time at which current (active) generation of the two
                TEKs configured for an SA will expire. This time is
                calculated as a function of the (Reception Time of
                Key Reply with Non-Active Tek) +
                (wranIfBsCpeNonActiveTekLifetime)."
  ::= { wranIfBsCpeScmSaConfigEntry 14 }

wranIfBsCpeTekRefreshTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfBsCpeTekRefreshEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB object provides a table to track
                information related to ongoing Key-Request
                transactions. This table has one entry for each
                current SCM Key-Request transaction. Each entry is
                defined by wranIfBsCpeTekRefreshEntry."
  ::= { wranIfBsScm 3 }

wranIfBsCpeTekRefreshEntryOBJECT-TYPE
  SYNTAXwranIfBsCpeTekRefreshEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object is a compound object that defines an
                entry in wranIfBsCpeTekRefreshTable."
  INDEX{ wranIfBsCpeTekRefreshIndex }
  ::= { wranIfBsCpeTekRefreshTable 1 }

wranIfBsCpeTekRefreshEntry::= SEQUENCE {
  wranIfBsCpeTekRefreshIndexInteger32,
  wranIfBsCpeScmReqId Integer32,
  wranIfBsCpeScmKeyReqKeySeqNumINTEGER,
  wranIfBsCpeScmKeyReqSaidInteger32,
  wranIfBsCpeScmKeyReqGroupKeyIndicatorINTEGER,
  wranIfBsCpeScmKeyReqCpeRandomCounter64 }

wranIfBsCpeTekRefreshIndexOBJECT-TYPE
  SYNTAXInteger32 (1..131070)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
```

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```
      "Index of entry in the table."
    ::= { wranIfBsCpeTekRefreshEntry 1 }

  wranIfBsCpeScmReqIdOBJECT-TYPE
    SYNTAXINTEGER (0..65535)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Value of Transaction ID field of SCM REQ that
                  carried the corresponding Key-Request message (see
                  Table 160)."
    ::= { wranIfBsCpeTekRefreshEntry 2 }

  wranIfBsCpeScmKeyReqKeySeqNumOBJECT-TYPE
    SYNTAXINTEGER (0..15)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Key Sequence Number of Key-Request message (see
                  Table 165)."
    ::= { wranIfBsCpeTekRefreshEntry 3 }

  wranIfBsCpeScmKeyReqSaidOBJECT-TYPE
    SYNTAXInteger32 (1..65535)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Key Sequence Number of Key-Request message (see
                  Table 165)."
    ::= { wranIfBsCpeTekRefreshEntry 4 }

  wranIfBsCpeScmKeyReqGroupKeyIndicatorOBJECT-TYPE
    SYNTAXINTEGER { unicastTransportSA(0), groupSA(1) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Indication of whether Key-Request was for a Unicast Transport or
                  GSA."
    ::= { wranIfBsCpeTekRefreshEntry 5 }

  wranIfBsCpeScmKeyReqCpeRandomOBJECT-TYPE
    SYNTAXCounter64 (0..18446744073709551615)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Random number generated by CPE and sent in the Key-
                  Request."
    ::= { wranIfBsCpeTekRefreshEntry 6 }
```

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```
wranIfBsCBPAuthCACertTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfBsCBPAuthCACertEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object provides a table to CA root certificates
                (see 8.6.2.3) used to validate CBP BS implicit
                certificates. There will be one entry for each CA
                for which a root certificate is installed. Each
                entry is defined by wranIfBsCBPAuthCACertEntry."
  ::= { wranIfBsScm 4 }

wranIfBsCBPAuthCACertEntryOBJECT-TYPE
  SYNTAXwranIfBsCBPAuthCACertEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object is a compound object that defines an
                entry in wranIfBsCBPAuthCACertTable."
  INDEX{ wranIfBsCBPAuthCACertIndex }
  ::= { wranIfBsCBPAuthCACertTable 1 }

wranIfBsCBPAuthCACertEntry::= SEQUENCE {
  wranIfBsCBPAuthCACertIndex  INTEGER,
  wranIfBsCBPAuthCACertCAID  INTEGER,
  wranIfBsCBPAuthCACertKeyID  Integer32,
  wranIfBsCBPAuthCACertKeyValidityDate  DateAndTime,
  wranIfBsCBPAuthCACertKeyValidityTimePeriod  INTEGER,
  wranIfBsCBPAuthCACertVersion  INTEGER,
  wranIfBsCBPAuthCACertECDomainParameters     INTEGER,
  wranIfBsCBPAuthCACertCAPubKrdSize  Integer32,
  wranIfBsCBPAuthCACertCAPubKrd               OCTET STRING }

wranIfBsCBPAuthCACertIndexOBJECT-TYPE
  SYNTAXINTEGER (1..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in the table."
  ::= { wranIfBsCBPAuthCACertEntry 1 }

wranIfBsCBPAuthCACertCAIDOBJECT-TYPE
  SYNTAXINTEGER (1..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
```

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```
      "CA ID, identifier of CA in CA root certificate."
    ::= { wranIfBsCBPAuthCACertEntry 2 }

  wranIfBsCBPAuthCACertKeyIDOBJECT-TYPE
    SYNTAXInteger32 (1..512)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Key ID, identifier of assigned of public key
                  reconstruction data in CA root certificate."
    ::= { wranIfBsCBPAuthCACertEntry 3 }

  wranIfBsCBPAuthCACertKeyValidityDateOBJECT-TYPE
    SYNTAXDateAndTime
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Key Validity Date (Not Before), date/time at which
                  CA root certificate becomes valid."
    ::= { wranIfBsCBPAuthCACertEntry 4 }

  wranIfBsCBPAuthCACertKeyValidityTimePeriodOBJECT-TYPE
    SYNTAXINTEGER (1..128)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Key Validity Time Period, length of time from Key
                  Validity Date (Not Before) in 6-month increments,
                  during which CA root certificate is valid."
    ::= { wranIfBsCBPAuthCACertEntry 5 }

  wranIfBsCBPAuthCACertVersionOBJECT-TYPE
    SYNTAXINTEGER (1..64)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Version of CBP Authentication being applied that CA
                  root certificate supports."
    ::= { wranIfBsCBPAuthCACertEntry 6 }

  wranIfBsCBPAuthCACertECDomainParametersOBJECT-TYPE
    SYNTAXINTEGER (0..15)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Indication of which EC Domain parameters are
                  associated with this CA root certificate (see Table
                  197)."
```

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```
    ::= { wranIfBsCBPAuthCACertEntry 7 }

  wranIfBsCBPAuthCACertCAPubKrdSizeOBJECT-TYPE
    SYNTAXINTEGER (1..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Size of wranIfBsCBPAuthCACertCAPubKrd in octets."
    DEFVAL { 31 }
    ::= { wranIfBsCBPAuthCACertEntry 8 }

  wranIfBsCBPAuthCACertCAPubKrdOBJECT-TYPE
    SYNTAX
         OCTET STRING (SIZE(wranIfBsCBPAuthCACertCAPubKrdSize))
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Public Key Reconstruction Data that can be used to
                  generate the public key associated with CA Root
                  certificate."
    ::= { wranIfBsCBPAuthCACertEntry 9 }

  wranIfBsCBPAuthBsImplicitCertTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsCBPAuthBsImplicitCertEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object provides a table to store BS implicit
                  certificates for neighbor WRANs that use CBP
                  authentication. There will be one entry for each BS
                  whose implicit certificate is installed (via this
                  object) on the BS or received by CERT-REQ/RSP. A BS
                  make keep an entry for its own implicit certificate
                  in this object. Each is defined
                  wranIfBsCBPAuthBsImplicitCertEntry."
    ::= { wranIfBsScm 5 }

  wranIfBsCBPAuthBsImplicitCertEntryOBJECT-TYPE
    SYNTAXwranIfBsCBPAuthBsImplicitCertEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object is a compound object that defines an
                  entry in wranIfBsCBPAuthBsImplicitCertTable."
    INDEX{ wranIfBsCBPAuthBsImplicitCertIndex }
    ::= { wranIfBsCBPAuthBsImplicitCertTable 1 }

  wranIfBsCBPAuthBsImplicitCertEntry::= SEQUENCE {
```

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```
    wranIfBsCBPAuthBsImplicitCertIndex  Integer32,
    wranBsCBPAuthBsImplicitCertBsID  MacAddress,
    wranIfBsCBPAuthBsImplicitCertCAID  INTEGER,
    wranIfBsCBPAuthBsImplicitKeyID  Integer32,
    wranIfBsCBPAuthBsImplicitKeyValidityDate  DateAndTime,
    wranIfBsCBPAuthBsImplicitKeyValidityTimePeriod  INTEGER,
    wranIfBsCBPAuthBsImplicitCertVersion  INTEGER,
    wranIfBsCBPAuthBsImplicitPubKrdSize  Integer32,
    wranIfBsCBPAuthBsImplicitPubKrd             OCTET STRING }

  wranIfBsCBPAuthBsImplicitCertIndexOBJECT-TYPE
    SYNTAXInteger32 (1..4080)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index of entry in the table."
    ::= { wranIfBsCBPAuthBsImplicitCertEntry 1 }

  wranBsCBPAuthBsImplicitCertBsIDOBJECT-TYPE
    SYNTAXMacAddress
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "BS ID (MAC Address) of BS that implicit certificates
                  belongs to."
    ::= { wranIfBsCBPAuthBsImplicitCertEntry 2 }

  wranIfBsCBPAuthBsImplicitCertCAIDOBJECT-TYPE
    SYNTAXINTEGER (1..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "CA ID, identifier of CA in BS implicit certificate."
    ::= { wranIfBsCBPAuthBsImplicitCertEntry 3 }

  wranIfBsCBPAuthBsImplicitKeyIDOBJECT-TYPE
    SYNTAXInteger32 (1..512)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Key ID, identifier of assigned of public key
                  reconstruction data in BS implicit certificate."
    ::= { wranIfBsCBPAuthBsImplicitCertEntry 4 }

  wranIfBsCBPAuthBsImplicitKeyValidityDateOBJECT-TYPE
    SYNTAXDateAndTime
    MAX-ACCESSread-only
    STATUScurrent
```

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```
    DESCRIPTION
      "Key Validity Date (Not Before), date/time at which
                  BS implicit certificate becomes valid."
    ::= { wranIfBsCBPAuthBsImplicitCertEntry 5 }

  wranIfBsCBPAuthBsImplicitKeyValidityTimePeriodOBJECT-TYPE
    SYNTAXINTEGER (1..128)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Key Validity Time Period, length of time from Key
                  Validity Date (Not Before) in 6-month increments,
                  during which BS implicit certificate is valid."
    ::= { wranIfBsCBPAuthBsImplicitCertEntry 6 }

  wranIfBsCBPAuthBsImplicitCertVersionOBJECT-TYPE
    SYNTAXINTEGER (1..64)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Version of CBP Authentication being applied that BS
                  implicit certificate supports."
    ::= { wranIfBsCBPAuthBsImplicitCertEntry 7 }

  wranIfBsCBPAuthBsImplicitPubKrdSizeOBJECT-TYPE
    SYNTAXINTEGER (1..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Size of wranIfBsCBPAuthCACertCAPubKrd in octets."
    DEFVAL { 31 }
    ::= { wranIfBsCBPAuthBsImplicitCertEntry 8 }

  wranIfBsCBPAuthBsImplicitPubKrdOBJECT-TYPE
    SYNTAX
      OCTET STRING (SIZE(wranIfBsCBPAuthBsImplicitPubKrdSize))
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Public Key Reconstruction Data that can be used to
                  generate the public key associated with BS implicit
                  certificate."
    ::= { wranIfBsCBPAuthBsImplicitCertEntry 9 }

  wranIfBsWiMicAuthCertTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsWiMicAuthCertEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
```

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```
    DESCRIPTION
      "This object provides a table to store wireless
                  microphone implicit certificates contained in MSF3
                  of decoded wireless microphone beacons. This table
                  is made up of multiple entries, one defined for each
                  unique wireless microphone beacon implicit
                  certificate. Each entry is defined by
                  wranIfBsWiMicAuthCertEntry. Entries are added to
                  this table when a wireless microphone beacon
                  (MSF1+MSF2+MSF3) has been successfully received and
                  decoded."
    ::= { wranIfBsScm 6 }

  wranIfBsWiMicAuthCertEntryOBJECT-TYPE
    SYNTAXwranIfBsWiMicAuthCertEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object is a compound object that defines an
                  entry in wranIfBsWiMicAuthCertTable."
    INDEX{ wranIfBsWiMicAuthCertIndex }
    ::= { wranIfBsWiMicAuthCertTable 1 }

  wranIfBsWiMicAuthCertEntry::= SEQUENCE {
    wranIfBsWiMicAuthCertIndex  Integer32,
    wranIfBsWiMicAuthSrcAddress  MacAddress,
    wranIfBsWiMicAuthImplicitCertSize  Integer32,
    wranIfBsWiMicAuthImplicitCert  OCTET STRING }

  wranIfBsWiMicAuthCertIndexOBJECT-TYPE
    SYNTAXInteger32 (1..4080)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index of entry in the table."
    ::= { wranIfBsWiMicAuthCertEntry 1 }

  wranIfBsWiMicAuthSrcAddressOBJECT-TYPE
    SYNTAXMacAddress
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Source Address from MSF1 of received wireless
                  microphone beacon. It is stored as a 48-bit IEEE
                  conformant MAC address that identifies the beaconing
                  device associated with the implicit certificate."
    ::= { wranIfBsWiMicAuthCertEntry 2 }
```

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```
  wranIfBsWiMicAuthImplicitCertSizeOBJECT-TYPE
    SYNTAXINTEGER (1..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Size of wranIfBsWiMicAuthImplicitCert in octets."
    DEFVAL { 31 }
    ::= { wranIfBsWiMicAuthCertEntry 3 }

  wranIfBsWiMicAuthImplicitCertOBJECT-TYPE
    SYNTAX
         OCTET STRING (SIZE(wranIfBsWiMicAuthImplicitCertSize))
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Wireless microphone beacon implicit certificate
                  obtained form MSF3 of received wireless microphone
                  beacon. Format of implicit certificate is defined in
                  7.5.5 of IEEE Std 802.22.1-2010."
    ::= { wranIfBsWiMicAuthCertEntry 4 }

-- wranIfBsScmMibGroups: This object helps define which MIB groups are
-- available within this module and which MIB objects are part of each
-- group.

  wranIfBsScmMibGroupsOBJECT IDENTIFIER
                              ::= { wranIfBsPm 7 }
  wranIfBsScmAuthStatusGroupOBJECT IDENTIFIER
                              ::= { wranIfBsScmMibGroups 1 }
  wranIfBsScmSaConfigGroupOBJECT IDENTIFIER
                              ::= { wranIfBsScmMibGroups 2 }
  wranIfBsScmTekGroupOBJECT IDENTIFIER
                              ::= { wranIfBsScmMibGroups 3 }
  wranIfBsScmCBPAuthCACertGroupOBJECT IDENTIFIER
                              ::= { wranIfBsScmMibGroups 4 }
  wranIfBsScmCBPBsCertGroupOBJECT IDENTIFIER
                              ::= { wranIfBsScmMibGroups 5 }
  wranIfBsScmWiMicAuthGroupOBJECT IDENTIFIER
                              ::= { wranIfBsScmMibGroups 6 }

  wranIfBsScmAuthStatusGroupOBJECT-GROUP
    OBJECTS{ wranIfBsCpeAuthStatusIndex,
                  wranIfBsCpeScmAuthStatus,
                  wranIfBsCpeScmAuthRecentEvent,
                  wranIfBsCpeScmNumAuthAttempts,
                  wranIfBsCpeAuthRecentMsgSize,
                  wranIfBsCpeScmAuthRecentMsg,
                  wranIfBsCpeScmAuthEapAuthTimerExpiration,
```

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```
                    wranIfBsCpeAuthGraceTimer1,
                    wranIfBsCepAuthGraceTimer2,
                    wranIfBsCpeScmAk1Lifetime,
                    wranIfBsCpeScmAk2Lifetime,
                    wranIfBsCpeScmConfigRequestSize,
                    wranIfBsCpeScmConfigRequest,
                    wranIfBsCpeScmConfigReplySize,
                    wranIfBsCpeScmConfigReply }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                tracking the current state of a CPEs
                authentication state machine."
    ::= { wranIfBsScmMibGroups 1 }

  wranIfBsScmSaConfigGroupOBJECT-GROUP
    OBJECTS{ wranIfBsCpeScmSaConfigIndex,
                    wranIfBsCpeMacAddress,
                    wranIfBsCpeSaid,
                    wranIfBsCpeSaType,
                    wranIfBsCpeCryptoSuiteListSize,
                    wranIfBsCpeCryptoSuiteList,
                    wranIfBsCpeActiveTekSequenceNumber,
                    wranIfBsCpeActiveTekLifetime,
                    wranIfBsCpeActiveTekPn,
                    wranIfBsCpeActiveTekExpireTime,
                    wranIfBsCpeNonActiveTekSequenceNumber,
                    wranIfBsCpeNonActiveTekLifetime,
                    wranIfBsCpeNonActiveTekPn,
                    wranIfBsCpeNonActiveTekExpireTime }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                tracking the configuration of SAs configured
                on CPEs."
    ::= { wranIfBsScmMibGroups 2 }

  wranIfBsScmTekGroupOBJECT-GROUP
    OBJECTS{ wranIfBsCpeTekRefreshIndex,
                    wranIfBsCpeScmReqId,
                    wranIfBsCpeScmKeyReqKeySeqNum,
                    wranIfBsCpeScmKeyReqSaid,
                    wranIfBsCpeScmKeyReqGroupKeyIndicator,
                    wranIfBsCpeScmKeyReqCpeRandom }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                tracking on going Key-Request transactions."
```

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```
    ::= { wranIfBsScmMibGroups 3 }

  wranIfBsScmCBPAuthCACertGroupOBJECT-GROUP
    OBJECTS{ wranIfBsCBPAuthCACertIndex,
                    wranIfBsCBPAuthCACertCAID,
                    wranIfBsCBPAuthCACertKeyID,
                    wranIfBsCBPAuthCACertKeyValidityDate,
                    wranIfBsCBPAuthCACertKeyValidityTimePeriod,
                    wranIfBsCBPAuthCACertVersion,
                    wranIfBsCBPAuthCACertECDomainParameters,
                    wranIfBsCBPAuthCACertCAPubKrdSize,
                    wranIfBsCBPAuthCACertCAPubKrd }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                storing CA Root certificates that used to
                validate BS Implicit Certificates."
    ::= { wranIfBsScmMibGroups 4 }

  wranIfBsScmCBPBsCertGroupOBJECT-GROUP
    OBJECTS{ wranIfBsCBPAuthCACertIndex,
                    wranIfBsCBPAuthCACertCAID,
                    wranIfBsCBPAuthCACertKeyID,
                    wranIfBsCBPAuthCACertKeyValidityDate,
                    wranIfBsCBPAuthCACertKeyValidityTimePeriod,
                    wranIfBsCBPAuthCACertVersion,
                    wranIfBsCBPAuthCACertECDomainParameters,
                    wranIfBsCBPAuthCACertCAPubKrdSize,
                    wranIfBsCBPAuthCACertCAPubKrd }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                storing BS implicit certificates used in CBP
                authentication."
    ::= { wranIfBsScmMibGroups 5 }

  wranIfBsScmWiMicAuthGroupOBJECT-GROUP
    OBJECTS{ wranIfBsWiMicAuthCertIndex,
                    wranIfBsWiMicAuthSrcAddress,
                    wranIfBsWiMicAuthImplicitCertSize,
                    wranIfBsWiMicAuthImplicitCert }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                storing wireless microphone beacon (IEEE Std
                802.22.1-2010) certificates transmitted in
                MSF3 of wireless microphone beacons."
    ::= { wranIfBsScmMibGroups 6 }
```

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```
  wranIfBsScmMibComplianceMODULE-COMPLIANCE
    STATUScurrent
    DESCRIPTION
      "MIB objects that are optional and mandatory for
                  wranIfBsScm compliance."
    MODULEwranIfBsCm
    MANDATORY-GROUPS{ wranIfBsScmAuthStatusGroup,
                   wranIfBsScmSaConfigGroup,
                   wranIfBsScmTekGroup }
    -- OPTIONAL-GROUPS{ wranIfBsScmCBPAuthCACertGroup,
                         wranIfBsScmCBPBsCertGroup,
                         wranIfBsScmWiMicAuthGroup }
    ::= { wranIfBsScm 8 }



END
```

14.2.3 wranIfBsSfMgmtMib

```
IEEE802dot22-WRAN-IF-BS-SF-MGMT-MIB::=BEGIN

      IMPORTS
            MODULE-IDENTITY,
            OBJECT-TYPE,
            NOTIFICATION-TYPE,
            Unsigned32, Integer32, Counter32,
            Counter64
                  FROM SNMPv2-SMI
            SnmpAdminString
                  FROM SNMP-FRAMEWORK-MIB
            TEXTUAL-CONVENTION,
            MacAddress, RowStatus, TruthValue,
            TimeStamp, DateAndTime
                  FROM SNMPv2-TC
            InetAddressType, InetAddress
                  FROM INET-ADDRESS-MIB
            OBJECT-GROUP,
            MODULE-COMPLIANCE,
            NOTIFICATION-GROUP
                  FROM SNMPV2-CONF

      wranIfBsSfMgmtMibMODULE-IDENTITY
            LAST-UPDATED"201405300000Z"-- May 30, 2014
            ORGANIZATION"IEEE 802.22"
            CONTACT-INFO
                  "WG E-mail:STDS-802-22@LISTSERV.IEEE.ORG
```

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```
                    WG Chair:Apurva N. Mody
                    E-mail:apurva.mody@ieee.org

                    TGa Chair/Editor:  Ranga Reddy
                    E-mail:      ranga.reddy@ieee.org"
              DESCRIPTION
                   "This material is from IEEE Std 802.22a-2014
                    Copyright (c) 2014. This MIB Module Defines managed
                    objects for Service Flow management based on
                    IEEE Std 802.22-2011 and is under iso(1).std(0)
                    .iso8802(8802).wran(22).wranIfBsSfMgmtMib(3)"
    REVISION        "201405300000Z"
    DESCRIPTION
      "The first version of IEEE802dot22-WRAN-IF-BS-SF-
                    MGMT-MIB that provides for management of service
                    flows."
    ::= {iso std(0) iso8802(8802) wran(22) 3}

  wranIfBsProvSfTableOBJECT IDENTIFIER
                            ::= { wranIfBsSfMgmtMib 1 }
  wranIfBsScTable     OBJECT IDENTIFIER
                            ::= { wranIfBsSfMgmtMib 2 }
  wranIfBsSfActiveTableOBJECT IDENTIFIER
                            ::= { wranIfBsSfMgmtMib 3 }
  wranIfBsProvClassifierRuleTable OBJECT IDENTIFIER
                            ::= { wranIfBsSfMgmtMib 4 }
  wranIfBsClassifierRuleTableOBJECT IDENTIFIER
                            ::= { wranIfBsSfMgmtMib 5 }
  wranIfBsSfTrapControlOBJECT IDENTIFIER
                            ::= { wranIfBsSfMgmtMib 6 }
  wranIfBsSfTrapDefinitionOBJECT IDENTIFIER
                            ::= { wranIfBsSfMgmtMib 7 }
  wranIfBsSfNotificationObjectsTableOBJECT IDENTIFIER
                            ::= { wranIfBsSfMgmtMib 8 }
  wranIfBsSfMibGroupsOBJECT IDENTIFIER
                            ::= { wranIfBsSfMgmtMib 9 }
  wranIfBsSfMibComplianceOBJECT IDENTIFIER
                            ::= { wranIfBsSfMgmtMib 10 }

  wranIfBsProvSfTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsProvSfEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This MIB object defines the profiles for services
                    that are provisioned by the NCMS. Service flow that
                    are provisioned for a particular CPE are tied to
```

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```
                that CPE via that CPE's MAC Address. This table is
                made up of multiple entries, each specific to a
                particular provisioned service flow. Each entry is
                defined by wranfBsProvSfEntry. The QoS parameters
                for provisioned service flows are mapped to
                information in wranIfBsScTable. Classification rules
                for provisioned service flows are defined in
                wranIfBsProvClassifierRuleTable."
  ::= { wranIfBsSfMgmtMib 1 }

wranIfBsProvSfEntryOBJECT-TYPE
  SYNTAXwranIfBsProvSfEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object is a compound object that defines an
                entry in wranIfBsProvSfTable."
  INDEX{ wranIfBsProvEntryIndex }
  ::= { wranIfBsProvSfTable 1 }

wranIfBsProvSfEntry::= SEQUENCE {
  wranIfBsProvEntryIndexInteger32,
  wranIfBsCpeProvMacAddressMacAddress,
  wranIfBsProvSfId    Integer32,
  wranIfBsProvSfDirectionINTEGER,
  wranIfBsProvScIndexInteger32,
  wranIfBsProvCsSpecificationINTEGER,
  wranIfBsProvSfStatusINTEGER,
  wranIfBsProvSfProvisioningTimeDateAndTime,
  wranIfBsProvTargetSaidINTEGER,
  wranIfBsProvClsRuleListSizeINTEGER
  wranIfBsProvClsRuleListOCTET STRING }

wranIfBsProvEntryIndexOBJECT-TYPE
  SYNTAXInteger32 (1.. 2048)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in this table, defaults to 1."
  ::= { wranIfBsProvSfEntry 1 }

wranIfBsCpeProvMacAddressOBJECT-TYPE
  SYNTAXMacAddress
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "MAC Address of CPE with which the service flow is
                created."
```

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```
    ::= { wranIfBsProvSfEntry 2 }

  wranIfBsProvSfIdOBJECT-TYPE
    SYNTAXInteger32 (1.. 4294967295)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Unique identifier for the SF that is provisioned
                  between a BS and a particular CPE."
    ::= { wranIfBsProvSfEntry 3 }

  wranIfBsProvSfDirectionOBJECT-TYPE
    SYNTAXINTEGER { ds(0),
                        us(1) }
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Indication of whether the SF is an US SF or a
                  DS SF."
    ::= { wranIfBsProvSfEntry 4 }

  wranIfBsProvScIndexOBJECT-TYPE
    SYNTAXInteger32 (1.. 4294967295)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Index into a wranIfBsScTable entry that indicates
                  the QoS parameter set for this service flow."
    ::= { wranIfBsProvSfEntry 5 }

  wranIfBsProvCsSpecificationOBJECT-TYPE
    SYNTAXINTEGER { noCS(0),
                        ethCS(1),
                        ipCS(2) }
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Indication of which convergence sublayer has been
                  used to encapsulate the higher-layer SDU (see
                  7.9.8.9.18.1)."
    ::= { wranIfBsProvSfEntry 6 }

  wranIfBsProvSfStatusOBJECT-TYPE
    SYNTAXINTEGER { provisioned(0),
                        admitted(1),
                        active(2) }
    MAX-ACCESSread-write
    STATUScurrent
```

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```
    DESCRIPTION
      "Indication of whether the provisioned service
                  flow is currently provisioned, admitted, or active
                  (see 7.9.8.9.4 and 7.18.2)."
    ::= { wranIfBsProvSfEntry 7 }

  wranIfBsProvSfProvisioningTimeOBJECT-TYPE
    SYNTAXDateAndTime
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "If currently active (see 14.1.3.1.1.7), the time at
                  which the service flow was provisioned."
    ::= { wranIfBsProvSfEntry 8 }

  wranIfBsProvTargetSaidOBJECT-TYPE
    SYNTAXINTEGER { primarySA(0),
                          secondarySA(1) }
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "SAID of SA to which service flow is being mapped.
                  Provisioned services flows can be mapped to the
                  Primary or Secondary SA."
    ::= { wranIfBsProvSfEntry 9 }

  wranIfBsProvClsRuleListSizeOBJECT-TYPE
    SYNTAXINTEGER (1..255)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Number of wranIfBsProvClsfrRuleIndex values in
       wranIfBsProvClsRuleList."
    ::= { wranIfBsProvSfEntry 10 }

  wranIfBsProvClsRuleListOBJECT-TYPE
    SYNTAX
      OCTET STRING (SIZE(wranIfBsProvClsRuleListSize))
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "List of wranIfBsProvClsfrRuleIndexValues pointing to
                  entries in the wranIfBsProvClassifierRuleTable that
                  contain packet classification rules assigned to this
                  service flow."
    ::= { wranIfBsProvSfEntry 11 }

  wranIfBsScTableOBJECT-TYPE
```

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```
    SYNTAXSEQUENCE OF wranIfBsScEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This MIB object provides a table that describes
                  attributes of provisioned and dynamic service flows,
                  such as QoS Parameter Set. This table is made up of
                  multiple entries, one for each service class. Each
                  entry is defined by wranIfBsScEntry."
    ::= { wranIfBsSfMgmtMib 2 }

  wranIfBsScEntryOBJECT-TYPE
    SYNTAXwranIfBsScEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object is a compound object that defines an
                  entry in wranIfBsScTable."
    INDEX{ wranIfBsScIndex }
    ::= { wranIfBsScTable 1 }

  wranIfBsScEntry::= SEQUENCE {
    wranIfBsScIndex       Integer32,
    wranIfBsQosSfSfid     Integer32,
    wranIfBsQosSfFt       INTEGER,
    wranIfBsQosServiceClassNameSizeINTEGER,
    wranIfBsQosServiceClassNameOCTET STRING,
    wranIfBsQosParameterSetTypeINTEGER,
    wranIfBsQosMaxSustainedRateInteger32,
    wranIfBsQoSTrafficSizeInteger32,
    wranIfBsQosMinReservedRateInteger32,
    wranIfBsQosToleratedJitterInteger32,
    wranIfBsQosMaxLatencyINTEGER,
    wranIfBsQosEnableVariableLengthSdusTruthValue,
    wranIfBsQosSchedulingTypeINTEGER,
    wranIfBsQosArqEnableTruthValue,
    wranIfBsQosArqWindowSizeInteger32,
    wranIfBsQosArqTxRetryTimeoutInteger32,
    wranIfBsQosArqRxRetryTimeoutInteger32,
    wranIfBsQosArqBlockLifetimeInteger32,
    wranIfBsQosArqSyncLossTimeoutInteger32,
    wranIfBsQosArqDeliverInOrderEnableTruthValue,
    wranIfBsQosArqRxPurgeTimeoutInteger32,
    wranIfBsQosArqBlockSizeReqInteger32,
    wranIfBsQosArqBlockSizeRspInteger32,
    wranIfBsQosReqTxPolicyBITS }

  wranIfBsScIndexOBJECT-TYPE
```

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```
    SYNTAXInteger32 (1..4096)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index value to uniquely identify an entry in
                  wranIfBsScTable."
    ::= { wranIfBsScEntry 1 }

  wranIfBsQosSfSfidOBJECT-TYPE
    SYNTAXInteger32 (1..4294967295)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "SFID of service flow."
    ::= { wranIfBsScEntry 2 }

  wranIfBsQosSfFtOBJECT-TYPE
    SYNTAXINTEGER { be(2), nrtPS(3), rtPS(4),
                          ugs(5), reserved(6) }
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "FT to which service flow is mapped."
    ::= { wranIfBsScEntry 3 }

  wranIfBsQosServiceClassNameSizeOBJECT-TYPE
    SYNTAXINTEGER (1..255)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Size, e.g., number of octets, of
                  wranIfBsQosServiceClassName."
    ::= { wranIfBsScEntry 4 }

  wranIfBsQosServiceClassNameOBJECT-TYPE
    SYNTAX
      OCTET STRING (SIZE(wranIfBsQosServiceClassNameSize))
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Defines the name of the service class associated
                  with this entry. If service class is not assigned,
                  this will be blank."
    ::= { wranIfBsScEntry 5 }

  wranIfBsQosParameterSetTypeOBJECT-TYPE
    SYNTAXINTEGER (0..7)
    MAX-ACCESSread-write
```

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```
    STATUScurrent
    DESCRIPTION
      "Indication of whether the QoS parameter set
                  defined by this entry is applied to the Provisioned,
                  Admitted, or Active Parameter Set of the service
                  flow (see Table 77)."
    ::= { wranIfBsScEntry 6 }

  wranIfBsQosMaxSustainedRateOBJECT-TYPE
    SYNTAXInteger32 (1.. 16777216)
    UNITS          "bytes per second"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Peak information/data rate of SDUs carried by the
                  service flow, defined in units of bits per second."
    ::= { wranIfBsScEntry 7 }

  wranIfBsQosTrafficSizeOBJECT-TYPE
    SYNTAXInteger32 (1.. 16777216)
    UNITS          "bytes"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "If fixed-length SDUs (see 14.1.3.2.1.10) are
                  enabled, this represents the size of the SDU
                  assigned to the service flow. If variable-length
                  SDUs (see 14.1.3.2.1.10) are enabled, this
                  represents the average size of SDU assigned the
                  service flow."
    ::= { wranIfBsScEntry 8 }

  wranIfBsQosMinReservedRateOBJECT-TYPE
    SYNTAXInteger32 (1.. 16777216)
    UNITS          "bytes per second"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Minimum required information/data rate of SDUs
                  carried by the service flow, defined in units of
                  bits per second."
    ::= { wranIfBsScEntry 9 }

  wranIfBsQosToleratedJitterOBJECT-TYPE
    SYNTAXInteger32 (1.. 16777216)
    UNITS          "milliseconds"
    MAX-ACCESSread-write
    STATUScurrent
```

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```
    DESCRIPTION
      "The maximum jitter (variation in delay) that can be
                  suffered by the traffic assigned to the service
                  flow."
    ::= { wranIfBsScEntry 10 }

  wranIfBsQosMaxLatencyOBJECT-TYPE
    SYNTAXInteger32 (1.. 16777216)
    UNITS          "milliseconds"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "The maximum delay that can be suffered by traffic
                  assigned to the service flow."
    ::= { wranIfBsScEntry 11 }

  wranIfBsQosEnableVariableLengthSdusOBJECT-TYPE
    SYNTAXTruthValue
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Setting this object allows the turning on/off of
                  variable-length SDU support. Default is to allow use
                  of variable-length SDUs, Truth(1)."
    ::= { wranIfBsScEntry 12 }

  wranIfBsQosSchedulingTypeOBJECT-TYPE
    SYNTAXINTEGER { be(0), nrtPS(1), rtPS(2), ugs(3) }
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Setting this object allows the turning on/off of
                  variable-length SDU support. Default is to allow use
                  of variable-length SDUs."
    ::= { wranIfBsScEntry 13 }

  wranIfBsQosArqEnableOBJECT-TYPE
    SYNTAXTruthValue
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Setting this object enables/disables ARQ for a
                  service flow. Default is that ARQ is enabled,
                  Truth(1)."
    ::= { wranIfBsScTable 14 }

  wranIfBsQosArqWindowSizeOBJECT-TYPE
    SYNTAXInteger32 (1..65535)
```

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```
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Indication of the maximum number of unacknowledged
                  fragments at any given time. Only valid if
                  wranIfBsQosArqEnable is set."
    ::= { wranIfBsScEntry 15 }

  wranIfBsQosArqTxRetryTimeoutOBJECT-TYPE
    SYNTAXInteger32 (0..655350)
    UNITS           "microseconds"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Total time before timing out retransmissions of ARQ
                  blocks (in 10-microsecond blocks). For BS, this
                  should include time to compensate for scheduling and
                  the propagation time for transmission."
    ::= { wranIfBsScEntry 16 }

  wranIfBsQosArqRxRetryTimeoutOBJECT-TYPE
    SYNTAXInteger32 (0..655350)
    UNITS           "microseconds"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Total time before timing out receptions of ARQ block
       retransmission (in 10-microsecond blocks). For BS,
                  this should include time to compensate for
                  scheduling and the propagation
       time for transmission."
    ::= { wranIfBsScEntry 17 }

  wranIfBsQosArqBlockLifetimeOBJECT-TYPE
    SYNTAXInteger32 (0..655350)
    UNITS           "microseconds"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "The maximum amount of time that an ARQ block can be
                  held in the ARQ state machine before it is dropped
                  (in 10-microsecond blocks). Setting this to 0,
                  indicates an indefinite lifetime."
    ::= { wranIfBsScEntry 18 }

  wranIfBsQosArqSyncLossTimeoutOBJECT-TYPE
    SYNTAXInteger32 (0..655350)
    UNITS           "microseconds"
```

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```
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Timeout for determining the that transmitter and
                  receiver state machines have become unsynchronized
                  (in 10-microsecond blocks). Setting this to 0,
                  indicates an indefinite lifetime."
    ::= { wranIfBsScEntry 19 }

  wranIfBsQosArqDeliverInOrderEnableOBJECT-TYPE
    SYNTAXTruthValue
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Disable/enable ability to deliver ARQ blocks to
                  higher layer at receiver in the same order they were
                  transmitted by the transmitter."
    ::= { wranIfBsScEntry 20 }

  wranIfBsQosArqRxPurgeTimeoutOBJECT-TYPE
    SYNTAXInteger32 (0..655350)
    UNITS           "microseconds"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "How much the ARQ window is advanced after an ARQ
                  fragment is received (in 10-microsecond blocks)."
    ::= { wranIfBsScEntry 21 }

  wranIfBsQosArqBlockSizeReqOBJECT-TYPE
    SYNTAXInteger32 (1..2048)
    UNITS           "bytes"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "This object defines the value of the ARQ block size
                  included in DSA-REQ and REG-REQ messages."
    ::= { wranIfBsScEntry 22 }

  wranIfBsQosArqBlockSizeRspOBJECT-TYPE
    SYNTAXInteger32 (1..2048)
    UNITS           "bytes"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "This object defines the value of the ARQ block size
                  included in DSA-RSP and REG-RSP messages."
    ::= { wranIfBsScEntry 23 }
```

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```
wranIfBsQosReqTxPolicyOBJECT-TYPE
  SYNTAXBITS { noUseOfBroadcastBwReqOpportunities(0),
                    reserved(1),
                    noPiggyReqWithData(2),
                    noFragmentationOfData(3),
                    noSuppressionOfPayloadHeaders(4),
                    noPacking(5),
                    reserved(6),
                    reserved(7) }
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "This value is a bitmap that enables/disables the
                following capabilities for a service flow: Use of
                broadcast BW request for US, use of multicast BW
                request for US only, piggyback BW requests on data
                for US transmissions, enable/disable fragmentation,
                enable/disable packing, and use of CRC for MAC PDU
                (See Table 83). Bits #1, #6, and #7, are reserved
                and should default to 0."
  ::= { wranIfBsScEntry 24 }

wranIfBsActiveSfTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfBsActiveSfEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB object provides a table that is used to
                manage service flows that are currently active
                between the BS and CPEs. This table is made up of
                multiple entries, one for each service flow mapped
                to a particular CPE. Each entry is defined by
                wranIfBsActiveSfEntry."
  ::= { wranIfBsSfMgmtMib 3 }

wranIfBsActiveSfEntryOBJECT-TYPE
  SYNTAXwranIfBsActiveSfEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object is a compound object that defines an
                entry in wranIfBsActiveSfTable."
  INDEX{ wranIfBsActiveSfIndex }
  ::= { wranIfBsActiveSfTable 1 }

wranIfBsActiveSfEntry::= SEQUENCE {
  wranIfBsActiveSfIndexInteger32,
```

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```
    wranIfBsActiveSfSfid Integer32,
    wranIfBsActiveSfMacAddressMacAddress,
    wranIfBsActiveSfSid  Integer32,
    wranIfBsActiveSfDirectionINTEGER,
    wranIfBsActiveSfStatusINTEGER,
    wranIfBsActiveScIndexInteger32,
    wranIfBsActiveCsSpecificationINTEGER,
    wranIfBsActiveTargetSaidInteger32,
    wranIfBsActiveSfClsRuleListSizeINTEGER,
    wranIfBsActiveSfClsRuleListOCTET STRING }

  wranIfBsActiveSfIndexOBJECT-TYPE
    SYNTAXInteger32 (1..4096)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index value to uniquely identify an entry in
       wranIfBsActiveSfTable."
    ::= { wranIfBsActiveSfEntry 1 }

  wranIfBsActiveSfSfidOBJECT-TYPE
    SYNTAXInteger32 (1.. 4294967296)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "SFID of active service flow that is assigned to a
                  particular CPE."
    ::= { wranIfBsActiveSfEntry 2 }

  wranIfBsActiveSfMacAddressOBJECT-TYPE
    SYNTAXMacAddress
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
                  "48-bit IEEE MAC Address assigned to CPE to which
                   this service flow is mapped."
    ::= { wranIfBsActiveSfEntry 3 }

  wranIfBsActiveSfSidOBJECT-TYPE
    SYNTAXInteger32 (0..511)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
                  "SID of CPE assigned to service flow. If
                  wranIfBsActiveSfSid is a multicast SID, there will be
                  multiple entries in this table, one for each
                  wranIfBsActiveSfMacAddress assigned to this service
                  flow with the same wranIfBsActiveSfSid."
```

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```
    ::= { wranIfBsActiveSfEntry 4 }

  wranIfBsActiveSfDirectionOBJECT-TYPE
    SYNTAXINTEGER { ds(0), us(1) }
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Direction of service flow: BS to CPE (DS), CPE to BS
                  (US)."
    ::= { wranIfBsActiveSfEntry 5 }

  wranIfBsActiveSfStatusOBJECT-TYPE
    SYNTAXINTEGER { inactive(0), provisioned(1),
                          admitted(2), active(3) }
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Current sate of service flow. Service flow can be in
                  one of four states: inactive, provisioned, admitted
                  (service flow initiated but not received BW yet), or
                  active (service flow initiated and there has been BW
                  assigned to use on service flow)."
    ::= { wranIfBsActiveSfEntry 6 }

  wranIfBsActiveScIndexOBJECT-TYPE
    SYNTAXInteger32 (1..4096)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Index into wranIfBsScTable entry that indicates the
                  QoS parameter set for this service flow."
    ::= { wranIfBsActiveSfEntry 7 }

  wranIfBsActiveCsSpecificationOBJECT-TYPE
    SYNTAXINTEGER { noCS(0), ethCS(1), ipCS(2) }
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "The CS used for encapsulating SDUs for this service
                  flow (see 7.9.8.9.18.1)."
    ::= { wranIfBsActiveSfEntry 8 }

  wranIfBsActiveTargetSaidOBJECT-TYPE
    SYNTAXInteger32 (1..4096)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "The CS used for encapsulating SDUs for this service
```

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```
                    flow (see 7.9.8.9.18.1)."
    ::= { wranIfBsActiveSfEntry 9 }

  wranIfBsActiveSfClsRuleListSizeOBJECT-TYPE
    SYNTAXINTEGER (1..255)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Number of items in wranIfBsActiveSfClsRuleList."
    ::= { wranIfBsActiveSfEntry 10 }

  wranIfBsActiveSfClsRuleListOBJECT-TYPE
    SYNTAX
      OCTET STRING (SIZE(wranIfBsActiveSfClsRuleListSize))
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "List of wranIfBsClsfrRuleIndex values pointing to
                    entries in the wranIfBsClassifierRuleTable that
                    contain packet classification rules assigned to this
                    service flow."
    ::= { wranIfBsActiveSfEntry 11 }

  wranIfBsProvClassifierRuleTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsProvClassifierRuleEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This table contains classifier rules that are to be
                    applied to service flows for CPEs that are
                    provisioned by the NCMS. There are multiple entries
                    in this table, one for each classifier rule. Each
                    entry is defined by
                    wranIfBsProvClassifierRuleEntry."
    ::= { wranIfBsSfMgmtMib 4 }

  wranIfBsProvClassifierRuleEntryOBJECT-TYPE
    SYNTAXwranIfBsProvClassifierRuleEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object is a compound object that provides the
                    definition of entries in
                    wranIfBsProvClassifierRuleTable."
    INDEX{ wranIfBsProvClsfrRuleIndex }
    ::= { wranIfBsProvClassifierRuleTable 1 }

  wranIfBsProvClassifierRuleEntry::= SEQUENCE {
```

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```
    wranIfBsProvClsfrRuleIndexInteger32,
    wranIfBsProvClsfrRuleMapBITS,
    wranIfBsProvClsfrRulePriorityINTEGER,
    wranIfBsProvClsfrRuleProtocolINTEGER,
    wranIfBsProvClsfrRuleIpSrcAddrTypeInetAddressType,
    wranIfBsProvClsfrRuleIpSrcAddrInetAddress,
    wranIfBsProvClsfrRuleIpSrcMaskInetAddress,
    wranIfBsProvClsfrRuleIpDestAddrTypeInetAddressType,
    wranIfBsProvClsfrRuleIpDestAddrInetAddress,
    wranIfBsProvClsfrRuleIpDestMaskInetAddress,
    wranIfBsProvClsfrRuleSrcPortStartInteger32,
    wranIfBsProvClsfrRuleSrcPortEndInteger32,
    wranIfBsProvClsfrRuleDestPortStartInteger32,
    wranIfBsProvClsfrRuleDestPortEndInteger32,
    wranIfBsProvClsfrRuleDestMacAddrMacAddress,
    wranIfBsProvClsfrRuleDestMacAddrMaskMacAddress,
    wranIfBsProvClsfrRuleSrcMacAddrMacAddress,
    wranIfBsProvClsfrRuleSrcMacAddrMaskMacAddress,
    wranIfBsProvClsfrRuleEnetProtTypeINTEGER,
    wranIfBsProvClsfrRuleEnetProtocolInteger32,
    wranIfBsProvClsfrRuleUserPriLowINTEGER,
    wranIfBsProvClsfrRuleUserPriHighINTEGER,
    wranIfBsProvClsfrRuleVlanIdInteger32,
    wranIfBsProvClsfRuleIpv6FlowLabelOCTET STRING,
    wranIfBsProvClsfrRuleIpTypeOfServiceOCTET STRING }

  wranIfBsProvClsfrRuleIndexOBJECT-TYPE
    SYNTAXInteger32 (1..65535)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index value to uniquely identify an entry in
       wranIfBsProvClassifierRuleTable."
    ::= { wranIfBsProvClassifierRuleEntry 1 }

  wranIfBsProvClsfrRuleMapOBJECT-TYPE
    SYNTAXBITS { priority(0),
                 protocol(1),
                 ipSrcAddrType(2),
                 ipSrcAddr(3),
                 ipSrcMask(4),
                 ipDestAddrType(5),
                 ipDestAddr(6),
                 ipDestMask(7),
                 srcPortStart(8),
                 srcPortEnd(9),
                 destPortStart(10),
                 destPortEnd(11),
```

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```
                    destMacAddr(12),
                    destMacAddrMask(13),
                    srcMacAddr(14),
                    srcMacAddrMask(15),
                    enetProtType(16),
                    enetProtocol(17),
                    userPriLow(18),
                    userPriHigh(19),
                    vlanId(20),
                    ipv6FlowLabel(21),
                    ipTypeOfService(22) }
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "A bitmap that indicates which classification
                parameters are included in the classification rule.
                A parameter exists in this rule if the corresponding
                bit is set to 1."
  ::= { wranIfBsProvClassifierRuleEntry 2 }

wranIfBsProvClsfrRulePriorityOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Priority of the classification rule. This determines
                the order in which classification rules are
                applied."
  ::= { wranIfBsProvClassifierRuleEntry 3 }

wranIfBsProvClsfrRuleIpProtocolOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Value of IP Protocol field. For IPv6 headers, this
                refers to the next header entry in the last header
                of the IP header list. The value of this field
                follows the "Protocol Numbers" specification
     defined by IANA."
  ::= { wranIfBsProvClassifierRuleEntry 4 }

wranIfBsProvClsfrRuleIpSrcAddrTypeOBJECT-TYPE
  SYNTAXInetAddressType
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Type of IP address that Source IP address
```

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```
      from IP header is."
   ::= { wranIfBsProvClassifierRuleEntry 5 }

wranIfBsProvClsfrRuleIpSrcAddrOBJECT-TYPE
   SYNTAXInetAddress
   MAX-ACCESSread-write
   STATUScurrent
   DESCRIPTION
     "Source IP address from IP header."
   ::= { wranIfBsProvClassifierRuleEntry 6 }

wranIfBsProvClsfrRuleIpSrcMaskOBJECT-TYPE
   SYNTAXInetAddress
   MAX-ACCESSread-write
   STATUScurrent
   DESCRIPTION
     "IP address mask. IP source address
                 (wranIfBsProvClsfrRuleIpSrcAddr) is matched when
                 output of applying (bitwise AND) this value to IP
                 source address from IP packet."
   ::= { wranIfBsProvClassifierRuleEntry 7 }

wranIfBsProvClsfrRuleIpDestAddrTypeOBJECT-TYPE
   SYNTAXInetAddressType
   MAX-ACCESSread-write
   STATUScurrent
   DESCRIPTION
     "Type of IP address that Destination IP
      address from IP header is."
   ::= { wranIfBsProvClassifierRuleEntry 8 }

wranIfBsProvClsfrRuleIpDestAddrOBJECT-TYPE
   SYNTAXInetAddress
   MAX-ACCESSread-write
   STATUScurrent
   DESCRIPTION
     "Destination IP address from IP header."
   ::= { wranIfBsProvClassifierRuleEntry 9 }

wranIfBsProvClsfrRuleIpDestMaskOBJECT-TYPE
   SYNTAXInetAddress
   MAX-ACCESSread-write
   STATUScurrent
   DESCRIPTION
     "IP address mask. IP destination address
                 (wranIfBsProvClsfrRuleIpDestAddr) is matched when
                 output of applying (bitwise AND) this value to IP
                 destination address from IP packet."
```

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```
    ::= { wranIfBsProvClassifierRuleEntry 10 }

  wranIfBsProvClsfrRuleSrcPortStartOBJECT-TYPE
    SYNTAXInteger32 (0..65535)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Start (inclusive) of range of source ports against
       which that packet will be compared."
    ::= { wranIfBsProvClassifierRuleEntry 11 }

  wranIfBsProvClsfrRuleSrcPortEndOBJECT-TYPE
    SYNTAXInteger32 (0..65535)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "End (inclusive) of range of source ports against
       which that packet will be compared."
    ::= { wranIfBsProvClassifierRuleEntry 12 }

  wranIfBsProvClsfrRuleDestPortStartOBJECT-TYPE
    SYNTAXInteger32 (0..65535)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Start (inclusive) of range of destination ports
                  against which that packet will be compared."
    ::= { wranIfBsProvClassifierRuleEntry 13 }

  wranIfBsProvClsfrRuleDestPortEndOBJECT-TYPE
    SYNTAXInteger32 (0..65535)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "End (inclusive) of range of destination ports
                  against which that packet will be compared."
    ::= { wranIfBsProvClassifierRuleEntry 14 }

  wranIfBsProvClsfrRuleDestMacAddrOBJECT-TYPE
    SYNTAXMacAddress
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Destination MAC address to be matched against
                  destination MAC address in Ethernet header."
    ::= { wranIfBsProvClassifierRuleEntry 15 }

  wranIfBsProvClsfrRuleDestMacAddrMaskOBJECT-TYPE
```

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```
    SYNTAXMacAddress
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "MAC address mask. A destination MAC address
                  (wranIfBsProvClsfrRuleDestMacAddr) is matched when
                  the destination MAC address from Ethernet header is
                  applied (bitwise AND) with this mask."
    ::= { wranIfBsProvClassifierRuleEntry 16 }

  wranIfBsProvClsfrRuleSrcMacAddrOBJECT-TYPE
    SYNTAXMacAddress
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Source MAC address to be matched against source MAC
       address in Ethernet header."
    ::= { wranIfBsProvClassifierRuleEntry 17 }

  wranIfBsProvClsfrRuleSrcMacAddrMaskOBJECT-TYPE
    SYNTAXMacAddress
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "MAC address mask. A source MAC address
                  (wranIfBsProvClsfrRuleDestMacAddr) is matched when
                  the source MAC address from Ethernet header is
                  applied (bitwise AND) with this mask."
    ::= { wranIfBsProvClassifierRuleEntry 18 }

  wranIfBsProvClsfrRuleEnetProtTypeOBJECT-TYPE
    SYNTAXINTEGER { noProtocol(0),
                    ethertype(1),
                    dsap(2) }
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Identifier of layer 3 protocol type in an Ethernet
                  frame. There are three types defined in Ethernet
                  frame classification: no layer 3 protocol type in
                  Ethernet frame, EtherType in DIX/SNAP based frames,
                  and DSAP in IEEE 802.3 frames. If 802.1Q is
                  supported, the EtherType value in the 802.1Q header
                  is used."
    ::= { wranIfBsProvClassifierRuleEntry 19 }

  wranIfBsProvClsfrRuleEnetProtocolOBJECT-TYPE
    SYNTAXInteger32 (0..65535)
```

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```
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Ethernet protocol type value that is used for
                  classification. When
                  wranIfBsProvClsfrRuleEnetProtType is set to
                  EtherType, the value of this object is matched
                  against the 16-bit EtherType value in an Ethernet
                  header or 802.1Q header (if 802.1Q is supported).
                  When wranIfBsProvClsfrRuleEnetProtType is set to
                  DSAP, the DSAP byte in IEEE 802.3 frames is
                  matched against the 8 LSB of this object's value."
    ::= { wranIfBsProvClassifierRuleEntry 20 }

  wranIfBsProvClsfrRuleUserPriLowOBJECT-TYPE
    SYNTAXINTEGER (0..7)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Low value (inclusive) in range of 3-bit user
                  priority value. This field is part of 16 bit tag of
                  a 802.1Q header. Only valid if 802.1Q is being
                  used."
    ::= { wranIfBsProvClassifierRuleEntry 21 }

  wranIfBsProvClsfrRuleUserPriHighOBJECT-TYPE
    SYNTAXINTEGER (0..7)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "High value (inclusive) in range of 3-bit user
                  priority value. This field is part of 16 bit tag of
                  a 802.1Q header. Only valid if 802.1Q is being
                  used."
    ::= { wranIfBsProvClassifierRuleEntry 22 }

  wranIfBsProvClsfrRuleVlanIdOBJECT-TYPE
    SYNTAXInteger32 (0..4095)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "VLAN Id from Ethernet frame. Only valid if 802.1Q is
                  being used."
    ::= { wranIfBsProvClassifierRuleEntry 23 }

  wranIfBsProvClsfrRuleIpv6FlowLabelOBJECT-TYPE
    SYNTAXOCTET STRING (SIZE(3))
    MAX-ACCESSread-write
```

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```
    STATUScurrent
    DESCRIPTION
      "Flow label field from IPv6 header. The IPv6 Flow
                  Label field is mapped to the 20 LSB of this object;
                  the first 4 MSB are set to 0."
    ::= { wranIfBsProvClassifierRuleEntry 24 }

  wranIfBsProvClsfrRuleIpTypeOfServiceOBJECT-TYPE
    SYNTAXOCTET STRING (SIZE(1))
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "The value to match the IP TOS octet from IP header.
                  The 6 MSBs of the value contained in this object are
                  read in as the DSCP (RFC 2474), the 2 LSB are
                  ignored."
    ::= { wranIfBsProvClassifierRuleEntry 25 }


  wranIfBsClassifierRuleTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsClassifierRuleEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This MIB object provides a table to contain
                  classification rules for service flows that are
                  dynamically created/destroyed. There are multiple
                  entries in this table, one for each classifier rule.
                  Each entry is defined by
                  wranIfBsClassifierRuleEntry."
    ::= { wranIfBsSfMgmtMib 5 }

  wranIfBsClassifierRuleEntryOBJECT-TYPE
    SYNTAXwranIfBsClassifierRuleEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object is a compound object that provides the
                  definition of entries in
                  wranIfBsClassifierRuleTable."
    INDEX{ wranIfBsClsfrRuleIndex }
    ::= { wranIfBsClassifierRuleTable 1 }

  wranIfBsClassifierRuleEntry::= SEQUENCE {
    wranIfBsClsfrRuleIndexInteger32,
    wranIfBsClsfrRuleMapBITS,
    wranIfBsClsfrRulePriorityINTEGER,
    wranIfBsClsfrRuleProtocolINTEGER,
```

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```
    wranIfBsClsfrRuleIpSrcAddrTypeInetAddressType,
    wranIfBsClsfrRuleIpSrcAddrInetAddress,
    wranIfBsClsfrRuleIpSrcMaskInetAddress,
    wranIfBsClsfrRuleIpDestAddrTypeInetAddressType,
    wranIfBsClsfrRuleIpDestAddrInetAddress,
    wranIfBsClsfrRuleIpDestMaskInetAddress,
    wranIfBsClsfrRuleSrcPortStartInteger32,
    wranIfBsClsfrRuleSrcPortEndInteger32,
    wranIfBsClsfrRuleDestPortStartInteger32,
    wranIfBsClsfrRuleDestPortEndInteger32,
    wranIfBsClsfrRuleDestMacAddrMacAddress,
    wranIfBsClsfrRuleDestMacAddrMaskMacAddress,
    wranIfBsClsfrRuleSrcMacAddrMacAddress,
    wranIfBsClsfrRuleSrcMacAddrMaskMacAddress,
    wranIfBsClsfrRuleEnetProtTypeINTEGER,
    wranIfBsClsfrRuleEnetProtocolInteger32,
    wranIfBsClsfrRuleUserPriLowINTEGER,
    wranIfBsClsfrRuleUserPriHighINTEGER,
    wranIfBsClsfrRuleVlanIdInteger32,
    wranIfBsClsfRuleIpv6FlowLabelOCTET STRING,
    wranIfBsClsfrRuleIpTypeOfServiceOCTET STRING }

  wranIfBsClsfrRuleIndexOBJECT-TYPE
    SYNTAXInteger32 (0..65535)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index value to uniquely identify an entry in
       wranIfBsClassifierRuleTable."
    ::= { wranIfBsClassifierRuleEntry 1 }

  wranIfBsClsfrRuleMapOBJECT-TYPE
    SYNTAXBITS { priority(0),
                 protocol(1),
                 ipSrcAddrType(2),
                 ipSrcAddr(3),
                 ipSrcMask(4),
                 ipDestAddrType(5),
                 ipDestAddr(6),
                 ipDestMask(7),
                 srcPortStart(8),
                 srcPortEnd(9),
                 destPortStart(10),
                 destPortEnd(11),
                 destMacAddr(12),
                 destMacAddrMask(13),
                 srcMacAddr(14),
                 srcMacAddrMask(15),
```

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```
                    enetProtType(16),
                    enetProtocol(17),
                    userPriLow(18),
                    userPriHigh(19),
                    vlanId(20),
                    ipv6FlowLabel(21),
                    ipTypeOfService(22) }
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "A bitmap that indicates which classification
                parameters are included in the classification rule.
                A parameter exists in this rule if the corresponding
                bit is set to 1."
    ::= { wranIfBsClassifierRuleEntry 2 }

  wranIfBsClsfrRulePriorityOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Priority of the classification rule. This determines
                the order in which classification rules are
                applied."
    ::= { wranIfBsClassifierRuleEntry 3 }

  wranIfBsClsfrRuleIpProtocolOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Value of IP Protocol field. For IPv6 headers, this
                refers to the next header entry in the last header
                of the IP header list. The value of this field
                follows the "Protocol Numbers" specification defined
                by IANA."
    ::= { wranIfBsClassifierRuleEntry 4 }

  wranIfBsClsfrRuleIpSrcAddrTypeOBJECT-TYPE
    SYNTAXInetAddressType
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Type of IP address that Source IP address
       from IP header is."
    ::= { wranIfBsClassifierRuleEntry 5 }

  wranIfBsClsfrRuleIpSrcAddrOBJECT-TYPE
```

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```
    SYNTAXInetAddress
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Source IP address from IP header."
    ::= { wranIfBsClassifierRuleEntry 6 }

  wranIfBsClsfrRuleIpSrcMaskOBJECT-TYPE
    SYNTAXInetAddress
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "IP address mask. IP source address
                  (wranIfBsClsfrRuleIpSrcAddr) is matched when output
                  of applying (bitwise AND) this value to IP source
                  address from IP packet."
    ::= { wranIfBsClassifierRuleEntry 7 }

  wranIfBsClsfrRuleIpDestAddrTypeOBJECT-TYPE
    SYNTAXInetAddressType
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Type of IP address that Destination IP
       address from IP header is."
    ::= { wranIfBsClassifierRuleEntry 8 }

  wranIfBsClsfrRuleIpDestAddrOBJECT-TYPE
    SYNTAXInetAddress
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Destination IP address from IP header."
    ::= { wranIfBsClassifierRuleEntry 9 }

  wranIfBsClsfrRuleIpDestMaskOBJECT-TYPE
    SYNTAXInetAddress
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "IP address mask. IP destination address
                  (wranIfBsClsfrRuleIpDestAddr) is matched when output
                  of applying (bitwise AND) this value to IP
                  destination address from IP packet."
    ::= { wranIfBsClassifierRuleEntry 10 }

  wranIfBsClsfrRuleSrcPortStartOBJECT-TYPE
    SYNTAXInteger32 (0..65535)
```

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```
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Start (inclusive) of range of source ports against
       which that packet will be compared."
    ::= { wranIfBsClassifierRuleEntry 11 }

  wranIfBsClsfrRuleSrcPortEndOBJECT-TYPE
    SYNTAXInteger32 (0..65535)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "End (inclusive) of range of source ports against
       which that packet will be compared."
    ::= { wranIfBsClassifierRuleEntry 12 }

  wranIfBsClsfrRuleDestPortStartOBJECT-TYPE
    SYNTAXInteger32 (0..65535)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Start (inclusive) of range of destination ports
                  against which that packet will be compared."
    ::= { wranIfBsClassifierRuleEntry 13 }

  wranIfBsClsfrRuleDestPortEndOBJECT-TYPE
    SYNTAXInteger32 (0..65535)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "End (inclusive) of range of destination ports
                  against which that packet will be compared."
    ::= { wranIfBsClassifierRuleEntry 14 }

  wranIfBsClsfrRuleDestMacAddrOBJECT-TYPE
    SYNTAXMacAddress
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Destination MAC address to be matched against
                  destination MAC address in Ethernet header."
    ::= { wranIfBsClassifierRuleEntry 15 }

  wranIfBsClsfrRuleDestMacAddrMaskOBJECT-TYPE
    SYNTAXMacAddress
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
```

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```
      "MAC address mask. A destination MAC address
                  (wranIfBsClsfrRuleDestMacAddr) is matched when the
                  destination MAC address from Ethernet header is
                  applied (bitwise AND) with this mask."
   ::= { wranIfBsClassifierRuleEntry 16 }

wranIfBsClsfrRuleSrcMacAddrOBJECT-TYPE
   SYNTAXMacAddress
   MAX-ACCESSread-write
   STATUScurrent
   DESCRIPTION
      "Source MAC address to be matched against source MAC
       address in Ethernet header."
   ::= { wranIfBsClassifierRuleEntry 17 }

wranIfBsClsfrRuleSrcMacAddrMaskOBJECT-TYPE
   SYNTAXMacAddress
   MAX-ACCESSread-write
   STATUScurrent
   DESCRIPTION
      "MAC address mask. A source MAC address
                  (wranIfBsClsfrRuleDestMacAddr) is matched when the
                  source MAC address from Ethernet header is applied
                  (bitwise AND) with this mask."
   ::= { wranIfBsClassifierRuleEntry 18 }

wranIfBsClsfrRuleEnetProtTypeOBJECT-TYPE
   SYNTAXINTEGER { noProtocol(0),
                   ethertype(1),
                   dsap(2) }
   MAX-ACCESSread-write
   STATUScurrent
   DESCRIPTION
      "Identifier of layer 3 protocol type in an Ethernet
                  frame. There are three types defined in Ethernet
                  frame classification: no layer 3 protocol type in
                  Ethernet frame, EtherType in DIX/SNAP based frames,
                  and DSAP in IEEE 802.3 frames. If 802.1Q is
                  supported, the EtherType value in the 802.1Q header
                  is used."
   ::= { wranIfBsClassifierRuleEntry 19 }

wranIfBsClsfrRuleEnetProtocolOBJECT-TYPE
   SYNTAXInteger32 (0..65535)
   MAX-ACCESSread-write
   STATUScurrent
   DESCRIPTION
      "Ethernet protocol type value that is used for
```

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```
                    classification. When wranIfBsClsfrRuleEnetProtType
                    is set to EtherType, the value of this object is
                    matched against the 16-bit EtherType value in an
                    Ethernet header or 802.1Q header (if 802.1Q is
                    supported). When wranIfBsClsfrRuleEnetProtType is
                    set to DSAP, the DSAP byte in IEEE 802.3 frames
                    is matched against the 8 LSB of this object's
                    value."
    ::= { wranIfBsClassifierRuleEntry 20 }

wranIfBsClsfrRuleUserPriLowOBJECT-TYPE
    SYNTAXINTEGER (0..7)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Low value (inclusive) in range of 3-bit user
                    priority value. This field is part of 16 bit tag of
                    a 802.1Q header. Only valid if 802.1Q is being
                    used."
    ::= { wranIfBsClassifierRuleEntry 21 }

wranIfBsClsfrRuleUserPriHighOBJECT-TYPE
    SYNTAXINTEGER (0..7)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "High value (inclusive) in range of 3-bit user
                    priority value. This field is part of 16 bit tag of
                    a 802.1Q header. Only valid if 802.1Q is being
                    used."
    ::= { wranIfBsClassifierRuleEntry 22 }

wranIfBsClsfrRuleVlanIdOBJECT-TYPE
    SYNTAXInteger32 (0..4095)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "VLAN Id from Ethernet frame. Only valid if 802.1Q is
                    being used."
    ::= { wranIfBsClassifierRuleEntry 23 }

wranIfBsClsfrRuleIpv6FlowLabelOBJECT-TYPE
    SYNTAXOCTET STRING (SIZE(3))
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Flow label field from IPv6 header. The IPv6 Flow
                    Label field is mapped to the 20 LSB of this object;
```

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```
                    the first 4 MSB are set to 0."
    ::= { wranIfBsClassifierRuleEntry 24 }

  wranIfBsClsfrRuleIpTypeOfServiceOBJECT-TYPE
    SYNTAXOCTET STRING (SIZE(1))
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "The value to match the IP TOS octet from IP header.
                    The 6 MSBs of the value contained in this object are
                    read in as the DSCP (RFC 2474), the 2 LSB are
                    ignored."
    ::= { wranIfBsClassifierRuleEntry 25 }

  wranIfBsSfTrapControlOBJECT-TYPE
    SYNTAXBITS      { wranIfBsProvSfChange(0),
                      wranIfBsScChange(1),
                      wranIfBsActiveSfChange(2),
                      wranIfBsProvClassifierRuleChange(3),
                      wranIfBsClassifierRuleChange (4) }
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Defines control elements for traps related to
                    management of service flows. This is a 5-bit field
                    that enables setting a trap for particular Service
                    Flow events: wranIfBsProvSfChange, wranIfBsScChange,
                    wranIfBsActiveSfChange,
                    wranIfBsProvClassifierRuleChange,
                    wranIfBsClassifierRuleChange."
    ::= { wranIfBsSfMgmtMib 6 }

  wranIfBsSfTrapDefinition OBJECT IDENTIFIER
                        ::= { wranIfBsSfMgmtMib 7 }
  wranIfBsProvSfChangeTrap OBJECT IDENTIFIER
                        ::= { wranIfBsSfTrapDefinition 1 }
  wranIfBsScChangeTrap OBJECT IDENTIFIER
                        ::= { wranIfBsSfTrapDefinition 2 }
  wranIfBsActiveSfChangeTrap OBJECT IDENTIFIER
                        ::= { wranIfBsSfTrapDefinition 3 }
  wranIfBsProvClassifierRuleChangeTrapOBJECT IDENTIFIER
                        ::= { wranIfBsSfTrapDefinition 4 }
  wranIfBsClassifierRuleChangeTrap OBJECT IDENTIFIER
                        ::= { wranIfBsSfTrapDefinition 5 }

  wranIfBsProvSfChangeTrapNOTIFICATION-TYPE
    OBJECTS{ wranIfBsProvSfStatus,
                      wranIfBsProvEntryIndex }
```

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```
    STATUScurrent
    DESCRIPTION
      "This trap contains the information related to the
                  status of provisioned service flows."
    ::= { wranIfBsSfTrapDefinition 1 }

  wranIfBsScChangeTrapNOTIFICATION-TYPE
    OBJECTS{ wranIfBsScIndex }
    STATUScurrent
    DESCRIPTION
      "This trap contains the information related to the
                  status of the configuration of service flow
                  parameters."
    ::= { wranIfBsSfTrapDefinition 2 }

  wranIfBsActiveSfChangeTrapNOTIFICATION-TYPE
    OBJECTS{ wranIfBsActiveSfIndex,
                   wranIfBsActiveSfStatus }
    STATUScurrent
    DESCRIPTION
      "This trap contains the information related to the
                  status of dynamic service flows."
    ::= { wranIfBsSfTrapDefinition 3 }

  wranIfBsProvClassifierRuleChangeTrapNOTIFICATION-TYPE
    OBJECTS{ wranIfBsProvClsfrRuleIndex,
                   wranIfBsProvClsfrRuleMap }
    STATUScurrent
    DESCRIPTION
      "This trap contains information related to the status
                  of classifier rules for provisioned service flows."
    ::= { wranIfBsSfTrapDefinition 4 }

  wranIfBsClassifierRuleChangeTrapNOTIFICATION-TYPE
    OBJECTS{ wranIfBsClsfrRuleIndex,
                   wranIfBsClsfrRuleMap }
    STATUScurrent
    DESCRIPTION
      "This trap contains information relate to the status
                  of classifier rules for dynamic service flows."
    ::= { wranIfBsSfTrapDefinition 5 }

  wranIfBsSfNotificationObjectsTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfBsSfNotificationObjectsEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This MIB provides a table to track notification
```

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```
                objects that have been reported by the traps related
                to the management of service flows. It is made up of
                one entry containing objects related to the most
                recent trap/event. The entry is defined by
        wranIfBsSfNotificationObjectsEntry."
    ::= { wranIfBsSfMgmtMib 8 }

  wranIfBsSfNotificationObjectsEntryOBJECT-TYPE
    SYNTAXwranIfBsSfNotificationObjectsEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object defines an entry in
                wranIfBsSfNotificationObjectsTable."
    INDEX{ wranIfBsNotificationIndex }
    ::= { wranIfBsSfNotificationObjectsTable 1 }

  wranIfBsSfNotificationObjectsEntry::= SEQUENCE {
    wranIfBsSfNotificationIndexINTEGER,
    wranIfBsSfNotificationProvSfStatusINTEGER,
    wranIfBsSfNotificationProvEntryIndexInteger32,
    wranIfBsSfNotificationScEntryIndexInteger32,
    wranIfBsSfNotificationActiveSfIndexInteger32,
    wranIfBsSfNotificationActiveSfStatusINTEGER,
    wranIfBsSfNotificationProvClsfrRuleIndexInteger32,
    wranIfBsSfNotificationProvClsfrRuleMap
                        wranIfBsProvClsfrRuleMap,
    wranIfBsSfNotificationClsfrRuleIndexInteger32,
    wranIfBsSfNotificationClsfrRuleMap    wranIfBsClsfrRuleMap }

  wranIfBsSfNotificationIndexOBJECT-TYPE
    SYNTAXINTEGER (1..1)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index of entry in table."
    ::= { wranIfBsSfNotificationObjectsEntry 1 }

  wranIfBsSfNotificationProvSfStatusOBJECT-TYPE
    SYNTAXINTEGER (0..2)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Status of provisioned service flow trap is enabled
                for, see wranIfBsProvSfStatus."
    ::= { wranIfBsSfNotificationObjectsEntry 2 }

  wranIfBsSfNotificationProvEntryIndexOBJECT-TYPE
```

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```
    SYNTAXInteger32 (1..2048)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index into wranIfBsProvSfTable that contains
                  information on provisioned service flow that was
                  recently modified."
    ::= { wranIfBsSfNotificationObjectsEntry 3 }

  wranIfBsSfNotificationScEntryIndexOBJECT-TYPE
    SYNTAXInteger32 (1.. 4294967295)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index into wranIfBsScTable entry that contains
                  information on modified service flow parameters."
    ::= { wranIfBsSfNotificationObjectsEntry 4 }

  wranIfBsSfNotificationActiveSfIndexOBJECT-TYPE
    SYNTAXInteger32 (1.. 4096)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index into wranIfBsActiveSfTable entry that contains
                  information on an active service flow whose
                  configuration has been updated."
    ::= { wranIfBsSfNotificationObjectsEntry 5 }

  wranIfBsSfNotificationActiveSfStatusOBJECT-TYPE
    SYNTAXINTEGER (0..3)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Current status of dynamic service flow, see
       wranIfBsActiveSfStatus "
    ::= { wranIfBsSfNotificationObjectsEntry 6 }

  wranIfBsSfNotificationProvClsfrRuleIndexOBJECT-TYPE
    SYNTAXInteger32 (0..65535)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index of entry in wranIfBsProvClassifierRuleTable
                  that contains entry pertaining to a classifier rule
                  for a provisioned service flow that was recently
                  modified."
    ::= { wranIfBsSfNotificationObjectsEntry 7 }
```

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```
  wranIfBsSfNotificationProvClsfrRuleMapOBJECT-TYPE
    SYNTAXwranIfBsProvClsfrRuleMap
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Value of wranIfBsProvClsfrRuleMap that contains the
       configuration of which classifier rules are part of
                  the classifier rule set of a provisioned service
                  flow that was recently modified."
    ::= { wranIfBsSfNotificationObjectsEntry 8 }

  wranIfBsSfNotificationClsfrRuleIndexOBJECT-TYPE
    SYNTAXInteger32 (0..65535)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index of entry in wranIfBsClassifierRuleTable that
       contains entry pertaining to a classifier rule for a
                  dynamic service flow that was recently modified."
    ::= { wranIfBsSfNotificationObjectsEntry 9 }

  wranIfBsSfNotificationClsfrRuleMapOBJECT-TYPE
    SYNTAXwranIfBsClsfrRuleMap
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Value of wranIfBsClsfrRuleMap that contains the
       configuration of which classifier rules are part of
                  the classifier rule set of a dynamic service flow
                  that was recently modified."
    ::= { wranIfBsSfNotificationObjectsEntry 10 }

-- wranIfBsSfMibGroups: This object helps define which MIB groups are
-- available within this module and which MIB objects are part of each -
- group.

  wranIfBsSfMibGroups OBJECT IDENTIFIER
                        ::= { wranIfBsSfMgmtMib 9 }
  wranIfBsProvSfMibGroupOBJECT IDENTIFIER
                        ::= { wranIfBsSfMibGroups 1 }
  wranIfBsScMibGroup  OBJECT IDENTIFIER
                        ::= { wranIfBsSfMibGroups 2 }
  wranIfBsActiveSfMibGroup OBJECT IDENTIFIER
                        ::= { wranIfBsSfMibGroups 3 }
  wranIfBsProvClassifierRuleMibGroup OBJECT IDENTIFIER
                        ::= { wranIfBsSfMibGroups 4 }
  wranIfBsClassifierRuleMibGroup OBJECT IDENTIFIER
                        ::= { wranIfBsSfMibGroups 5 }
```

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```
wranIfBsSfTrapControlGroup OBJECT IDENTIFIER
                        ::= { wranIfBsSfMibGroups 6 }
wranIfBsSfNotificationMibGroup OBJECT IDENTIFIER
                        ::= { wranIfBsSfMibGroups 7 }

wranIfBsProvSfMibGroupOBJECT-GROUP
  OBJECTS{ wranIfBsProvEntryIndex,
                   wranIfBsCpeProvMacAddress,
                   wranIfBsProvSfId, wranIfBsProvSfDirection,
                   wranIfBsProvScIndex,
                   wranIfBsProvCsSpecification,
                   wranIfBsProvSfStatus,
                   wranIfBsProvSfProvisioningTime,
                   wranIfBsProvTargetSaid,
                   wranIfBsProvClsRuleListSize,
                   wranIfBsProvClsRuleList }
  STATUScurrent
  DESCRIPTION
    "This group contains objects related to the
                configuration of provisioned service flows."
  ::= { wranIfBsSfMibGroups 1 }

wranIfBsScMibGroupOBJECT-GROUP
  OBJECTS{ wranIfBsScIndex,
                   wranIfBsQosSfsfid, wranIfBsQosSfFt,
                   wranIfBsQosServiceClassNameSize,
                   wranIfBsQosServiceClassName,
                   wranIfBsQosParameterSetType,
                   wranIfBsQosMaxSustainedRate,
                   wranIfBsQoSTrafficSize,
                   wranIfBsQosMinReservedRate,
                   wranIfBsQosToleratedJitter,
                   wranIfBsQosMaxLatency,
                   wranIfBsQosEnableVariableLengthSdus,
                   wranIfBsQosSchedulingType,
                   wranIfBsQosArqEnable,
                   wranIfBsQosArqWindowSize,
                   wranIfBsQosArqTxRetryTimeout,
                   wranIfBsQosArqRxRetryTimeout,
                   wranIfBsQosArqBlockLifetime,
                   wranIfBsQosArqSyncLossTimeout,
                   wranIfBsQosArqDeliverInOrderEnable,
                   wranIfBsQosArqRxPurgeTimeout,
                   wranIfBsQosArqBlockSizeReq,
                   wranIfBsQosArqBlockSizeRsp,
                   wranIfBsQosReqTxPolicy }
  STATUScurrent
  DESCRIPTION
```

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```
      "This group contains objects related to the
                  configuration of QoS Parameters for
                  provisioned and dynamic service flows."
   ::= { wranIfBsSfMibGroups 2 }

wranIfBsActiveSfMibGroupOBJECT-GROUP
   OBJECTS{ wranIfBsActiveSfIndex, wranIfBsActiveSfSfid,
                  wranIfBsActiveSfMacAddress,
                  wranIfBsActiveSfSid,
                  wranIfBsActiveSfDirection,
                  wranIfBsActiveSfStatus,
                  wranIfBsActiveScIndex,
                  wranIfBsActiveCsSpecification,
                  wranIfBsActiveTargetSaid,
                  wranIfBsActiveSfClsRuleListSize,
                  wranIfBsActiveSfClsRuleList }
   STATUScurrent
   DESCRIPTION
      "This group contains objects related to the
                  configuration of dynamic service flows."
   ::= { wranIfBsSfMibGroups 3 }

wranIfBsProvClassifierRuleMibGroupOBJECT-GROUP
   OBJECTS{ wranIfBsProvClsfrRuleIndex,
                  wranIfBsProvClsfrRuleMap,
                  wranIfBsProvClsfrRulePriority,
                  wranIfBsProvClsfrRuleProtocol,
                  wranIfBsProvClsfrRuleIpSrcAddrType,
                  wranIfBsProvClsfrRuleIpSrcAddr,
                  wranIfBsProvClsfrRuleIpSrcMask,
                  wranIfBsProvClsfrRuleIpDestAddrType,
                  wranIfBsProvClsfrRuleIpDestAddr,
                  wranIfBsProvClsfrRuleIpDestMask,
                  wranIfBsProvClsfrRuleSrcPortStart,
                  wranIfBsProvClsfrRuleSrcPortEnd,
                  wranIfBsProvClsfrRuleDestPortStart,
                  wranIfBsProvClsfrRuleDestPortEnd,
                  wranIfBsProvClsfrRuleDestMacAddr,
                  wranIfBsProvClsfrRuleDestMacAddrMask,
                  wranIfBsProvClsfrRuleSrcMacAddr,
                  wranIfBsProvClsfrRuleSrcMacAddrMask,
                  wranIfBsProvClsfrRuleEnetProtType,
                  wranIfBsProvClsfrRuleEnetProtocol,
                  wranIfBsProvClsfrRuleUserPriLow,
                  wranIfBsProvClsfrRuleUserPriHigh,
                  wranIfBsProvClsfrRuleVlanId,
                  wranIfBsProvClsfRuleIpv6FlowLabel,
                  wranIfBsProvClsfrRuleIpTypeOfService }
```

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```
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to the
                  configuration of classifier rules for
                  provisioned service flows."
    ::= { wranIfBsSfMibGroups 4 }

  wranIfBsClassifierRuleMibGroupOBJECT-GROUP
    OBJECTS{ wranIfBsClsfrRuleIndex, wranIfBsClsfrRuleMap,
                   wranIfBsClsfrRulePriority,
                   wranIfBsClsfrRuleProtocol,
                   wranIfBsClsfrRuleIpSrcAddrType,
                   wranIfBsClsfrRuleIpSrcAddr,
                   wranIfBsClsfrRuleIpSrcMask,
                   wranIfBsClsfrRuleIpDestAddrType,
                   wranIfBsClsfrRuleIpDestAddr,
                   wranIfBsClsfrRuleIpDestMask,
                   wranIfBsClsfrRuleSrcPortStart,
                   wranIfBsClsfrRuleSrcPortEnd,
                   wranIfBsClsfrRuleDestPortStart,
                   wranIfBsClsfrRuleDestPortEnd,
                   wranIfBsClsfrRuleDestMacAddr,
                   wranIfBsClsfrRuleDestMacAddrMask,
                   wranIfBsClsfrRuleSrcMacAddr,
                   wranIfBsClsfrRuleSrcMacAddrMask,
                   wranIfBsClsfrRuleEnetProtType,
                   wranIfBsClsfrRuleEnetProtocol,
                   wranIfBsClsfrRuleUserPriLow,
                   wranIfBsClsfrRuleUserPriHigh,
                   wranIfBsClsfrRuleVlanId,
                   wranIfBsClsfRuleIpv6FlowLabel,
                   wranIfBsClsfrRuleIpTypeOfService }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to the
                  configuration of classifier rules for dynamic
                  service flows."
    ::= { wranIfBsSfMibGroups 5 }

  wranIfBsSfTrapControlGroupOBJECT-GROUP
    OBJECTS{ wranIfBsSfTrapControl }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to
                  enabling/disabling traps used for  service
                  flow management."
    ::= { wranIfBsSfMibGroups 6 }
```

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```
  wranIfBsSfNotificationMibGroupOBJECT-GROUP
    OBJECTS{ wranIfBsProvSfChangeTrap,
                    wranIfBsScChangeTrap,
                    wranIfBsActiveSfChangeTrap,
                    wranIfBsProvClassifierRuleChangeTrap,
                    wranIfBsClassifierRuleChangeTrap,
                    wranIfBsSfNotificationIndex,
                    wranIfBsSfNotificationProvSfStatus,
                    wranIfBsSfNotificationProvEntryIndex,
                    wranIfBsSfNotificationScIndex,
                    wranIfBsSfNotificationActiveSfIndex,
                    wranIfBsSfNotificationActiveSfStatus,
                    wranIfBsSfNotificationProvClsfrRuleIndex,
                    wranIfBsSfNotificationProvClsfrRuleMap,
                    wranIfBsSfProvClsfrRuleMap,
                    wranIfBsSfNotificationClsfrRuleIndex,
                    wranIfBsSfNotificationClsfrRuleMap }
    STATUScurrent
    DESCRIPTION
      "This group contains objects related to traps
                  used for service flow management."
    ::= { wranIfBsSfMibGroups 7 }

  wranIfBsSfMibComplianceMODULE-COMPLIANCE
    STATUScurrent
    DESCRIPTION
      "MIB objects that are optional and mandatory for
                  service flow management compliance."
    MODULEwranIfBsSfMgmtMib
    MANDATORY-GROUPS{ wranIfBsProvSfMibGroup,
                    wranIfBsScMibGroup,
                    wranIfBsSfMibGroup,
                    wranIfBsProvClassifierRuleMibGroup,
                    wranIfBsClassifierRuleMibGroup,
                    wranIfBsSfTrapControlGroup }
    -- OPTIONAL-GROUPS{ wranIfBsSfNotificationMibGroup }
    ::= { wranIfBsSfMgmtMib 10 }

END
```

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14.2.4 wranIfCpeMib

```
IEEE802dot22-WRAN-IF-CPE-MIB::=BEGIN

      IMPORTS
            MODULE-IDENTITY,
            OBJECT-TYPE,
```


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```
            NOTIFICATION-TYPE,
            Unsigned32, Integer32, Counter32,
            Counter64
                  FROM SNMPv2-SMI
            SnmpAdminString
                  FROM SNMP-FRAMEWORK-MIB
            TEXTUAL-CONVENTION,
            MacAddress, RowStatus, TruthValue,
            TimeStamp, DateAndTime
                  FROM SNMPv2-TC
            InetAddressType, InetAddress
                  FROM INET-ADDRESS-MIB
            OBJECT-GROUP,
            MODULE-COMPLIANCE,
            NOTIFICATION-GROUP
                  FROM SNMPV2-CONF

      wranIfCpeMibMODULE-IDENTITY
            LAST-UPDATED"201405300000Z"-- May 30, 2014
            ORGANIZATION"IEEE 802.22"
            CONTACT-INFO
                  "WG E-mail:STDS-802-22@LISTSERV.IEEE.ORG
                   WG Chair:Apurva N. Mody
                   E-mail:apurva.mody@ieee.org

                   TGa Chair/Editor:  Ranga Reddy
                   E-mail:      ranga.reddy@ieee.org"
            DESCRIPTION
                  "This material is from IEEE Std 802.22a-2014
                   Copyright (c) 2014. This MIB Module Defines managed
                   objects for Customer Premise Equipment based on
                   IEEE Std 802.22-2011 and is under iso(1).std(0)
                   .iso8802(8802).wran(22).wranIfCpeMib(4)"
    REVISION"201405300000Z"
    DESCRIPTION
      "The first version of IEEE802dot22-WRAN-IF-CPE-MIB."
    ::= {iso std(0) iso8802(8802) wran(22) 4}

  wranIfCpeConfigurationTableOBJECT IDENTIFIER
                  ::= { wranIfCpeMib 1 }
  wranIfCpeTrapControlOBJECT IDENTIFIER
                  ::= { wranIfCpeMib 2 }
  wranIfCpeThresholdConfigTableOBJECT IDENTIFIER
                  ::= { wranIfCpeMib 3 }
  wranIfCpeTrapDefinitionOBJECT IDENTIFIER
                  ::= { wranIfCpeMib 4 }
  wranIfCpeNotificationObjectsTableOBJECT IDENTIFIER
                  ::= { wranIfCpeMib 5 }
```

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```
wranIfCpeMibGroupsOBJECT IDENTIFIER
                  ::= { wranIfCpeMib 6 }
wranIfCpeMibComplianceOBJECT IDENTIFIER
                  ::= { wranIfCpeMib 7 }

wranIfCpeConfigurationTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfCpeConfigurationEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB provides a table that provides the values
                  for system parameters. The parameters in this table
                  are applied to all CPEs in the network, hence there
                  is on entry in the table, defined by
     wranIfCpeConfigurationEntry."
  ::= { wranIfCpeMib 1 }

wranIfCpeConfigurationEntryOBJECT-TYPE
  SYNTAXwranIfCpeConfigurationEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "Definition of an entry in
                  wranIfCpeConfigurationTable. There is only one entry
                  in each CPE."
  ::= { wranIfCpeConfigurationTable 1 }

wranIfCpeConfigurationEntry ::= SEQUENCE {
  wranIfCpeConfigurationIndexINTEGER,
  wranIfCpeLostDsMapIntervalInteger32,
  wranIfCpeLostUsMapIntervalInteger32,
  wranIfCpeContentionRangingRetriesInteger32,
  wranIfCpeContentionBwRetriesInteger32,
  wranIfCpeReqReqRetriesINTEGER,
  wranIfCpeTftpBackoffStartInteger32,
  wranIfCpeTftpBackoffEndInteger32,
  wranIfCpeTftpReqRetriesInteger32,
  wranIfCpeTftpDownloadRetriesInteger32,
  wranIfCpeTftpWaitInteger32,
  wranIfCpeToDRetriesInteger32,
  wranIfCpeToDRetryPeriodInteger32
  wranIfCpeCBCReqRetriesINTEGER,
  wranIfCpeTftpCpltRetriesINTEGER,
  wranIfCpeInvitedRangRetriesInteger32,
  wranIfCpeDSxReqRetriesINTEGER,
  wranIfCpeDSxRspRetriesINTEGER }

wranIfCpeConfigurationIndexOBJECT-TYPE
```

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```
  SYNTAXINTEGER (1..1)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in this table, defaults to 1."
  ::= { wranIfCpeConfigurationEntry 1 }

wranIfCpeLostDsMapIntervalOBJECT-TYPE
  SYNTAXInteger32 (0..600)
  UNITS "milliseconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Amount of time (in milliseconds) since reception of
                last DS-MAP before DS synchronization was lost."
  ::= { wranIfCpeConfigurationEntry 2 }

wranIfCpeLostUsMapIntervalOBJECT-TYPE
  SYNTAXInteger32 (0..600)
  UNITS "milliseconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Amount of time (in milliseconds) since reception of
                last US-MAP before US synchronization is considered
                lost."
  ::= { wranIfCpeConfigurationEntry 3 }

wranIfCpeContentionRangingRetriesOBJECT-TYPE
  SYNTAXInteger32 (16..65535)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Number of retries on contention ranging requests."
  ::= { wranIfCpeConfigurationEntry 4 }

wranIfCpeContentionBwRetriesOBJECT-TYPE
  SYNTAXInteger32 (16..65535)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Number of retries on contention bandwidth requests."
  ::= { wranIfCpeConfigurationEntry 5 }

wranIfCpeRegReqRetriesOBJECT-TYPE
  SYNTAXINTEGER (1..255)
  MAX-ACCESSread-write
  STATUScurrent
```

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```
    DESCRIPTION
      "Maximum number of retries allowed for registration
                  requests."
    ::= { wranIfCpeConfigurationEntry 6 }

  wranIfCpeTftpBackoffStartOBJECT-TYPE
    SYNTAXInteger32 (1..65535)
    UNITS          "seconds"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Initial backoff for TFTP Start."
    ::= { wranIfCpeConfigurationEntry 7 }

  wranIfCpeTftpBackoffEndOBJECT-TYPE
    SYNTAXInteger32 (1..65535)
    UNITS "seconds"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Last value for TFTP backoff."
    ::= { wranIfCpeConfigurationEntry 8 }

  wranIfCpeTftpReqRetriesOBJECT-TYPE
    SYNTAXInteger32 (16..65535)
    MAC-ACCESSread-write
    STATUScurrent
    DESCRIPTION
                  "Maximum number of retires allowed for attempting
                   TFTP to get CPE configuration."
    ::= { wranIfCpeConfigurationEntry 9 }

  wranIfCpeTftpDownloadRetriesOBJECT-TYPE
    SYNTAXInteger32 (3..65535)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Maximum number of retries allowed for re-attempting
                  TFTP (after failed/corrupted download) to get CPE
                  configuration."
    ::= { wranIfCpeConfigurationEntry 10 }

wranIfCpeTftpWaitOBJECT-TYPE
    SYNTAXInteger32 (2..65535)
    UNITS          "minutes"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
```

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```
    "Time to wait before consecutive attempts to obtain
                configuration via TFTP."
  ::= { wranIfCpeConfigurationEntry 11 }

wranIfCpeToDRetriesOBJECT-TYPE
  SYNTAXInteger32 (3..65535)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Number of retries allowed for establishing Time of
                Day, per network entry procedures."
  ::= { wranIfCpeConfigurationEntry 12 }

wranIfCpeToDRetryPeriodOBJECT-TYPE
  SYNTAXInteger32 (5..65535)
  UNITS "minutes"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Amount of time to wait before retrying establishment
                of time of day after failed attempt."
  ::= { wranIfCpeConfigurationEntry 13 }

wranIfCpeCBCReqRetriesOBJECT-TYPE
  SYNTAXINTEGER (3..16)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Maximum number of retries for sending CBC request."
  DEFVAL { 3 }
  ::= { wranIfCpeConfigurationEntry 14 }

wranIfCpeTftpCpltRetriesOBJECT-TYPE
  SYNTAXINTEGER (3..16)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Maximum number of retries allowed for sending TFTP-
                CPLT messages to BS."
  ::= { wranIfCpeConfigurationEntry 15 }

wranIfCpeInvitedRangRetriesOBJECT-TYPE
  SYNTAXInteger32 (16..65535)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Maximum time number of retries on invited ranging
                requests."
```

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```
  ::= { wranIfCpeConfigurationEntry 16 }

 wranIfCpeDSxReqRetriesOBJECT-TYPE
  SYNTAXINTEGER (1..255)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Number of timeout retries on DSx-REQ."
  DEFVAL { 3 }
  ::= { wranIfCpeConfigurationEntry 17 }

 wranIfCpeDSxRspRetriesOBJECT-TYPE
  SYNTAXINTEGER (1..255)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Number of timeout retries on DSx-RSP."
  DEFVAL { 3 }
  ::= { wranIfCpeConfigurationEntry 17 }

 wranIfCpeTrapControlOBJECT-TYPE
  SYNTAXBITS{ wranIfCpeDhcpSuccess(0),
                wranIfCpeRssiStatusChange(1),
                wranIfCpeEirpPerScStatusChange(2),
                wranIfCpeMaxEirpStatusChange(3),
                wranIfCpeScmStateChange(4) }
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Defines control elements for traps related to CPE
                operation. This is a 5-bit field that enables
                setting a trap for particular CPE events:
                wranIfCpeDhcpSuccess, wranIfCpeRssiStatusChange,
                wranIfCpeEirpPerScStatusChange,
                wranIfCpeMaxEirpStatusChange and
     wranIfCpeScmStateChange."
  ::= { wranIfCpeMib 2 }

 wranIfCpeThresholdConfigTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfCpeThresholdConfigEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB provides a table that allows the setting of
                thresholds that can be used to detect the crossing
                of RSSI and EIRP thresholds. Each table is made of
                one entry defined by wranIfCpeThresholdConfigEntry."
  ::= { wranIfCpeMib 3 }
```

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```
wranIfCpeThresholdConfigEntryOBJECT-TYPE
  SYNTAXwranIfCpeThresholdConfigEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "Definition of an entry in
                wranIfCpeConfigurationTable. There is only one entry
                in each CPE."
  ::= { wranIfCpeThresholdConfigTable 1 }

wranIfCpeThresholdConfigEntry::= SEQUENCE {
  wranIfCpeThresholdConfigIndexINTEGER,
  wranIfCpeRssiLowThresholdINTEGER,
  wranIfCpeRssiHighThresholdINTEGER,
  wranIfCpeEirpPerScLowThresholdINTEGER,
  wranIfCpeEirpPerScHighThresholdINTEGER,
  wranIfCpeMaxEirpLowThresholdINTEGER,
  wranIfCpeMaxEirpHighThresholdINTEGER }

wranIfCpeThresholdConfigIndexOBJECT-TYPE
  SYNTAXINTEGER (1..1)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in this table, defaults to 1."
  ::= { wranIfCpeThresholdConfigEntry 1 }

wranIfCpeRssiLowThresholdOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  UNITS "dBm"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Low threshold for RSSI alarm trap (between -104 dBm
                to +23.5 dBm in 0.5 dB steps)."
  ::= { wranIfCpeThresholdConfigEntry 2 }

wranIfCpeRssiHighThresholdOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  UNITS "dBm"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "High threshold for RSSI alarm trap (between -104 dBm
                to +23.5 dBm in 0.5 dB steps)."
  ::= { wranIfCpeThresholdConfigEntry 3 }
```

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```
  wranIfCpeEirpPerScLowThresholdOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    UNITS "dBm"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Low threshold for EIRP per subcarrier alarm trap
                  (between -104 dBm to +23.5 dBm in 0.5 dB steps)."
    ::= { wranIfCpeThresholdConfigEntry 4 }

  wranIfCpeEirpPerScHighThresholdOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    UNITS "dBm"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "High threshold for EIRP per subcarrier alarm trap
                  (between -104 dBm to +23.5 dBm in 0.5 dB steps)."
    ::= { wranIfCpeThresholdConfigEntry 5 }

  wranIfCpeMaxEirpLowThresholdOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    UNITS "dBm"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Low threshold for maximum EIRP (over all 60
                  subchannels) alarm trap (between -64 dBm to +63.5
                  dBm in 0.5 dB steps)."
    ::= { wranIfCpeThresholdConfigEntry 6 }

  wranIfCpeMaxEirpHighThresholdOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    UNITS "dBm"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "High threshold for maximum EIRP (over all 60
                  subchannels) alarm trap (between -64 dBm to +63.5
                  dBm in 0.5 dB steps).
    ::= { wranIfCpeThresholdConfigEntry 7 }

-- wranIfCpeTrapDefinition: This MIB group specifies the definition of
-- CPE traps that can be enabled/disable in wranIfCpeTrapControl.

  wranIfCpeTrapDefinitionOBJECT IDENTIFIER
                  ::= { wranIfCpeMib 4 }
  wranIfCpeRssiStatusChangeTrap OBJECT IDENTIFIER
```

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```
                    ::= { wranIfCpeTrapDefinition 1 }
wranIfCpeEirpPerScStatusChangeTrap OBJECT IDENTIFIER
                    ::= { wranIfCpeTrapDefinition 2 }
wranIfCpeDhcpSuccessTrap OBJECT IDENTIFIER
                    ::= { wranIfCpeTrapDefinition 3 }
wranIfCpeScmStateChangeTrap OBJECT IDENTIFIER
                    ::= { wranIfCpeTrapDefinition 4 }
wranIfCpeMaxEirpStatusChangeTrap OBJECT IDENTIFIER
                    ::= { wranIfCpeTrapDefinition 5 }

wranIfCpeRssiStatusChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfCpeMacAddress,
           wranIfCpeRssiStatus }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to the
                 RSSI alarm that is contained in
                 wranIfCpeNotificationObjectsTable."
  ::= { wranIfCpeTrapDefinition 1 }

wranIfCpeEirpPerScStatusChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfCpeMacAddress,
           wranIfCpeEirpPerScStatus }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to the
                 EIRP per subcarrier alarm that is contained in
     wranIfCpeNotificationObjectsTable."
  ::= { wranIfCpeTrapDefinition 2 }

wranIfCpeDhcpSuccessTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfCpeMacAddress,
           wranIfCpeDhcpStatus }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to the
                 DHCP alarm that is contained in
                 wranIfCpeNotificationObjectsTable."
  ::= { wranIfCpeTrapDefinition 3 }

wranIfCpeScmStateChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfCpeMacAddress,
           wranIfCpeScmStatus }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to the
                 SCM state change alarm that is contained in
     wranIfCpeNotificationObjectsTable."
```

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```
  ::= { wranIfCpeTrapDefinition 4 }

wranIfCpeMaxEirpStatusChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfCpeMacAddress,
           wranIfCpeMaxEirpStatus }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to the
                 maximum EIRP (over all 60 subchannels) subcarrier
                 alarm that is contained in
     wranIfCpeNotificationObjectsTable."
  ::= { wranIfCpeTrapDefinition 5 }

wranIfCpeNotificationObjectsTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfCpeNotificationObjectsEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB provides a table to track notification
                 objects that have been reported by the traps on a
                 particular CPE. There is one entry in this table,
                 defining the notification objects for that
                 particular CPE. Each entry is defined by
                 wranIfCpeNotificationObjectsEntry."
  ::= { wranIfCpeMib 5 }

wranIfCpeNotificationObjectsEntryOBJECT-TYPE
  SYNTAXwranIfCpeNotificationObjectsEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "Definition of an entry in
                 wranIfCpeNotificationObjectsTable. There is only one
                 entry in each CPE."
  INDEX { wranIfCpeNotificationMacAddress }
  ::= { wranIfCpeNotificationObjectsTable 1 }

wranIfCpeNotificationObjectsEntry::= SEQUENCE {
  wranIfCpeNotificationObjectsEntyIndexINTEGER,
  wranIfCpeNotificationMacAddressMacAddress,
  wranIfCpeRssiStatusINTEGER,
  wranIfCpeEirpPerScStatusINTEGER,
  wranIfCpeDhcpStatusINTEGER,
  wranIfCpeScmIdleStatusINTEGER,
  wranIfCpeMaxEirpStatusINTEGER }

wranIfCpeNotificationObjectsEntyIndexOBJECT-TYPE
  SYNTAXINTEGER (1..1)
```

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```
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in this table, defaults to 1."
  ::= { wranIfCpeNotificationObjectsEntry 1 }

wranIfCpeNotificationMacAddressOBJECT-TYPE
  SYNTAXMacAddress
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "MAC Address of the CPE generating the trap."
  ::= { wranIfCpeNotificationObjectsEntry 2 }

wranIfCpeRssiStatusOBJECT-TYPE
  SYNTAXINTEGER { lowThresholdAlarm(0),
                  highThresholdAlarm(1),
                  noAlarm(2) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Indication if RSSI alarm was for an RSSI value below
     wranIfCpeRssiLowThreshold, for an RSSI value above
     wranIfCpeRssiHighThreshold, or the RSSI as returned
                 to within the bounds set by
                 wranIfCpeRssiLowThreshold and
                 wranIfCpeRssiHighThreshold."
  ::= { wranIfCpeNotificationObjectsEntry 3 }

wranIfCpeEirpPerScStatusOBJECT-TYPE
  SYNTAXINTEGER { lowThresholdAlarm(0),
                  highThresholdAlarm(1),
                  noAlarm(2) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Indication if EIRP per subcarrier alarm was for an
                 EIRP value below wranIfCpeEirpPerScLowThreshold, for
                 an EIRP value above wranIfCpeEirpPerScHighThreshold,
                 or the EIRP as returned to within the bounds set by
                 wranIfCpeEirpPerScLowThreshold and
                 wranIfCpeEirpPerScHighThreshold."
  ::= { wranIfCpeNotificationObjectsEntry 4 }

wranIfCpeDhcpStatusOBJECT-TYPE
  SYNTAXINTEGER { failure(0),
                  successful(1) }
  MAX-ACCESSread-only
```

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```
    STATUScurrent
    DESCRIPTION
      "An DHCP alarm is generated when a CPE is
                  successfully able to obtain an IP address or fails
                  to obtain an IP address."
    ::= { wranIfCpeNotificationObjectsEntry 5 }

  wranIfCpeScmStatusOBJECT-TYPE
    SYNTAXINTEGER { idle(0),
                    notAuthenticated(1),
                    authenticated(2),
                    reAuthWait(3) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "An SCM alarm is generated when a CPE changes to a
                  different state in the SCM Authentication state
                  machine."
    ::= { wranIfCpeNotificationObjectsEntry 6 }

  wranIfCpeMaxEirpStatusOBJECT-TYPE
    SYNTAXINTEGER { lowThresholdAlarm(0),
                    highThresholdAlarm(1),
                    noAlarm(2) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Indication if maximum EIRP (over all 60 subchannels)
                  was for an EIRP value below
                  wranIfCpeMaxEirpLowThreshold, for an EIRP value
                  above wranIfCpeMaxEirpHighThreshold, or the EIRP as
                  returned to within the bounds set by
                  wranIfCpeMaxEirpLowThreshold and
                  wranIfCpeMaxEirpHighThreshold."
    ::= { wranIfCpeNotificationObjectsEntry 7 }

-- wranIfCpeMibGroups: This object helps define which MIB groups are
-- available within this module and which MIB objects are part of each
-- group.

  wranIfCpeMibGroupsOBJECT IDENTIFIER
                              ::= { wranIfCpeMib 6 }
  wranIfCpeMibConfigGroupOBJECT IDENTIFIER
                              ::= { wranIfCpeMibGroups 1 }
  wranIfCpeTrapControlGroup OBJECT IDENTIFIER
                              ::= { wranIfCpeMibGroups 2 }
  wranIfCpeMibNotificationGroup OBJECT IDENTIFIER
                              ::= { wranIfCpeMibGroups 3 }
```

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```
wranIfCpeMibConfigGroupOBJECT-GROUP
  OBJECTS{ wranIfCpeConfigurationIndex,
           wranIfCpeLostDsMapInterval,
           wranIfCpeLostUsMapInterval,
           wranIfCpeContentionRangingRetries,
           wranIfCpeContentionBwRetries,
           wranIfCpeRegReqRetries,
           wranIfCpeTftpBackoffStart,
           wranIfCpeTftpBackoffEnd,
           wranIfCpeTftpReqRetries,
           wranIfCpeTftpDownloadRetries,
           wranIfCpeTftpWait, wranIfCpeToDRetries,
           wranIfCpeToDRetryPeriod,
           wranIfCpeCBCReqRetries,
           wranIfCpeTftpCpltRetries,
           wranIfCpeInvitedRangRetries,
           wranIfCpeInvitedRangRetries,
           wranIfCpeDSxReqRetries,
           wranIfCpeDSxRspRetries }
  STATUScurrent
  DESCRIPTION
    "This group contains configuration objects for
                 the CPE."
  ::= { wranIfCpeMibGroups 1 }

wranIfCpeTrapControlGroupOBJECT-GROUP
  OBJECTS{ wranIfCpeTrapControl }
  STATUScurrent
  DESCRIPTION
    "This group contains configuration objects
                 related to enabling/disabling traps for the
                 CPE."
  ::= { wranIfCpeMibGroups 2 }

wranIfCpeMibNotificationsGroupOBJECT-TYPE
  OBJECTS{ wranIfCpeThresholdConfigIndex,
           wranIfCpeRssiLowThreshold,
           wranIfCpeRssiHighThreshold,
           wranIfCpeEirpPerScLowThreshold,
           wranIfCpeEiprPerScHighThreshold,
           wranIfCpeMaxEirpLowThreshold,
           wranIfCpeMaxEirpHighThreshold,
           wranIfCpeNotificationMacAddress,
           wranIfCpeRssiStatus,
           wranIfCpeEirpPerScStatus,
           wranIfCpeMaxEirpStatus,
           wranIfCpeDhcpStatus,
```

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```
            wranIfCpeScmIdleStatus,
            wranIfCpeRssiStatusChangeTrap,
            wranIfCpeEirpPerScStatusChangeTrap,
            wranIfCpeDhcpSuccessTrap,
            wranIfCpeScmStateChangeTrap,
            wranIfCpeMaxEirpStatusChangeTrap }
    STATUScurrent
    DESCRIPTION
      "This group contains CPE event notifications."
    ::= {wranIfCpeMibGroups 3 }

  wranIfCpeMibComplianceMODULE-COMPLIANCE
    STATUScurrent
    DESCRIPTION
      "MIB objects that are optional and mandatory for CPE
       conformance."
    MODULEwranIfCpeMib
    MANDATORY-GROUPS{ wranIfCpeMibConfigGroup,
                      wranIfCpeTrapControlGroup }
    -- OPTIONAL-GROUPS{ wranIfCpeMibNotificationsGroup }
    ::= { wranIfCpeMib 7 }

END
```

14.2.5 wranIfSmMib

```
IEEE802dot22-WRAN-IF-SM-MIB::=BEGIN

      IMPORTS
            MODULE-IDENTITY,
            OBJECT-TYPE,
            NOTIFICATION-TYPE,
            Unsigned32, Integer32, Counter32,
            Counter64
                  FROM SNMPv2-SMI
            SnmpAdminString
                  FROM SNMP-FRAMEWORK-MIB
            TEXTUAL-CONVETION,
            MacAddress, RowStatus, TruthValue,
            TimeStamp, DateAndTime
                  FROM SNMPv2-TC
            InetAddressType, InetAddress
                  FROM INET-ADDRESS-MIB
            OBJECT-GROUP,
            MODULE-COMPLIANCE,
            NOTIFICATION-GROUP
                  FROM SNMPV2-CONF
```

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```
      wranIfSmMibMODULE-IDENTITY
            LAST-UPDATED"201405300000Z"-- May 30, 2014
            ORGANIZATION"IEEE 802.22"
            CONTACT-INFO
                  "WG E-mail:STDS-802-22@LISTSERV.IEEE.ORG
                   WG Chair:Apurva N. Mody
                   E-mail:apurva.mody@ieee.org

                   TGa Chair/Editor:  Ranga Reddy
                   E-mail:      ranga.reddy@ieee.org"
            DESCRIPTION
                  "This material is from IEEE Std 802.22a-2014
                   Copyright (c) 2014. This MIB Module object is
                   related to configuration, operation and monitoring
                   of the Spectrum Manager (SM). Objects in this module
                   are based on IEEE Std 802.22-2011 and is under
                   iso(1).std(0).iso8802(8802).wran(22).wranIfSmMib(5)"
    REVISION    "201405300000Z"
    DESCRIPTION
      "The first version of IEEE802dot22-WRAN-IF-SM-MIB."
    ::= {iso std(0) iso8802(8802) wran(22) 5}

    wranIfSmConfigTableOBJECT IDENTIFIER
                        ::= { wranIfSmMib 1 }
    wranIfSmPendingBlmReqTableOBJECT IDENTIFIER
                        ::= { wranIfSmMib 2 }
    wranIfSmBlmRepTableOBJECT IDENTIFIER
                        ::= { wranIfSmMib 3 }
    wranIfSmChClassificationStatusTableOBJECT IDENTIFIER
                        ::= { wranIfSmMib 4 }
    wranIfSmChannelSetTableOBJECT IDENTIFIER
                        ::= { wranIfSmMib 5 }
    wranIfSmCurrentStatusTableOBJECT IDENTIFIER
                        ::= { wranIfSmMib 6 }
    wranIfSmRegTrackingTableOBJECT IDENTIFIER
                        ::= { wranIfSmMib 7 }
    wranIfSmTrapControlOBJECT IDENTIFIER
                        ::= { wranIfSmMib 8 }
    wranIfSmTrapDefinitionOBJECT IDENTIFIER
                        ::= { wranIfSmMib 9 }
    wranIfSmNotificationObjectsTableOBJECT IDENTIFIER
                        ::= { wranIfSmMib 10 }
    wranIfSmMibGroups    OBJECT IDENTIFIER
                        ::= { wranIfSmMib 11 }
    wranIfSmMibComplianceOBJECT IDENTIFIER
                        ::= { wranIfSmMib 12 }

-- NOTE: In this module "Sm" or "SM" refers to Spectrum Manager, while
```

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```
-- "Ssa" or "SSA" refers to Spectrum Sensing Automaton.

  wranIfSmConfigTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfSmConfigEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This MIB object represents a table that tracks the
                  default configuration of SM timers and constants. It
                  is made up of one entry, defined by
                  wranIfSmConfigEntry."
    ::= { wranIfSmMib 1 }

  wranIfSmConfigEntryOBJECT-TYPE
    SYNTAXwranIfSmConfigEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object defines an entry in wranIfSmConfigTable.
                  Each entry is identified by wranIfSmConfigIndex."
    INDEX{ wranIfSmConfigIndex }
    ::= { wranIfSmConfigTable 1 }

  wranIfSmConfigEntry::= SEQUENCE {
    wranIfSmConfigIndexINTEGER,
    wranIfSmT31                INTEGER,
    wranIfSmChAvailabilityCheckTimeInteger32,
    wranIfSmNonOccupancyPeriodInteger32,
    wranIfSmChannelDetectionTimeINTEGER,
    wranIfSmChannelSetupTimeINTEGER,
    wranIfSmChannelOpeningTxTimeInteger32,
    wranIfSmChannelMoveTimeINTEGER,
    wranIfSmChannelClosingTxTimeInteger32,
    wranIfSmMicProtectionRadiusInteger32,
    wranIfSmT41                INTEGER,
    wranIfSmT42                INTEGER,
    wranIfSmT43                INTEGER,
    wranIfSmT44                INTEGER,
    wranIfSmT45                Integer32,
    wranIfSmT46                Integer32,
    wranIfSmT59                Integer32,
    wranIfSmT47                Integer32,
    wranIfSmT48                Integer32,
    wranIfSmT49                Integer32,
    wranIfSmT50                Integer32,
    wranIfSmT51                Integer32,
    wranIfSmT53                Integer32,
    wranIfSmT54                Integer32,
```

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```
  wranIfSmT55                INTEGER,
  wranIfSmT60                INTEGER }

wranIfSmConfigIndexOBJECT-TYPE
  SYNTAXINTEGER (1..1)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in the table, defaults to 1."
  ::= { wranIfSmConfigEntry 1 }

wranIfSmT31   OBJECT-TYPE
  SYNTAXINTEGER (1..64)
  UNITS       "frames"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Wait for BLM-REP timeout."
  ::= { wranIfSmConfigEntry 2 }

wranIfSmChAvailabilityCheckTimeOBJECT-TYPE
  SYNTAXInteger32 (30..3600)
  UNITS       "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Time during which a TV channel shall be checked for
                the presence of licensed incumbent signals having a
                level above the incumbent detection threshold prior
                to commencement of WRAN operation in the channel,
                and in the case of TV, a related channel at an EIRP
                level that can affect the measured TV channel."
  ::= { wranIfSmConfigEntry 3 }

wranIfSmNonOccupancyPeriodOBJECT-TYPE
  SYNTAXInteger32 (10..60)
  UNITS       "minutes"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The required period during which WRAN device
                transmissions SHALL NOT occur in a given TV channel
                because of the detected presence of an incumbent
                signal in that channel above the Incumbent detection
                threshold, or in the case of TV, above a given EIRP
                level."
  ::= { wranIfSmConfigEntry 4 }
```

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```
wranIfSmChannelDetectionTimeOBJECT-TYPE
  SYNTAXINTEGER (2..128)
  UNITS       "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Maximum time taken by a WRAN device to detect a
                licensed incumbent signal above the Incumbent
                Detection Threshold within a given TV channel during
                normal WRAN operation."
  ::= { wranIfSmConfigEntry 5 }

wranIfSmChannelSetupTimeOBJECT-TYPE
  SYNTAXINTEGER (2..128)
  UNITS       "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The window of time that may be taken by a WRAN CPE
                to transmit control information to a WRAN base
                station in order to establish operation with that
                base station at the prescribed power or, in the case
                of TV, at or below the allowable EIRP within a given
                TV channel."
  ::= { wranIfSmConfigEntry 6 }

wranIfSmChannelOpeningTxTimeOBJECT-TYPE
  SYNTAXInteger32 (100..480)
  UNITS       "milliseconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The aggregate duration of control transmissions by
                WRAN devices during the Channel Setup Time that
                starts at the end of the Channel Availability Check
                Time."
  ::= { wranIfSmConfigEntry 7 }

wranIfSmChannelMoveTimeOBJECT-TYPE
  SYNTAXINTEGER (2..60)
  UNITS       "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The time taken by WRAN system to cease all
                interfering transmissions on the current TV channel
                upon detection of a license incumbent signal above
                the relevant Incumbent Detection Threshold, or in
```

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```
                    the case of TV, to alternatively reduces its EIRP to
                    which is allowable within a given TV channel upon
                    detection of a TV signal in the same or a related
                    channel."
  ::= { wranIfSmConfigEntry 8 }

wranIfSmChannelClosingTxTimeOBJECT-TYPE
  SYNTAXInteger32 (100..480)
  UNITS       "milliseconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The aggregate duration of control transmissions by
                    the WRAN devices during the Channel Move EIRP
                    Reduction Time that starts upon detection of a
                    licensed incumbent signal above the relevant
                    Incumbent Detection Threshold."
  ::= { wranIfSmConfigEntry 9 }

wranIfSmMicProtectionRadiusOBJECT-TYPE
  SYNTAXInteger32 (100..100000)
  UNITS       "meters"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Radius of contour within which the WRAN system
                    cannot operate due to potential interference with
                    the microphone."
  ::= { wranIfSmConfigEntry 10 }

wranIfSmT41   OBJECT-TYPE
  SYNTAXINTEGER (1..10)
  UNITS       "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Maximum time interval allowed before sensing is
                    performed on the candidate channel to determine that
                   no
                    incumbents are detected."
  ::= { wranIfSmConfigEntry 11 }

wranIfSmT42   OBJECT-TYPE
  SYNTAXINTEGER (1..10)
  UNITS       "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
```

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```
      "Maximum time interval allowed before sensing is
                  performed on the backup channel to determine that no
                  incumbents are detected."
    ::= { wranIfSmConfigEntry 12 }

  wranIfSmT43   OBJECT-TYPE
    SYNTAXINTEGER (1..100)
    UNITS       "seconds"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Minimum time duration without detection of any
                  incumbent for a candidate channel to transition to
                  the backup channel."
    ::= { wranIfSmConfigEntry 13 }

  wranIfSmT44   OBJECT-TYPE
    SYNTAXINTEGER (1..100)
    UNITS       "seconds"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Maximum time to determine that the channel move
                  information is successfully conveyed to all the
                  associated CPEs and BS (self-coexistence mode)."
    ::= { wranIfSmConfigEntry 14 }

  wranIfSmT45   OBJECT-TYPE
    SYNTAXInteger32 (0..720)
    UNITS       "hours"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Maximum WRAN operation time without access to the
                  incumbent database service, from 0 to 72 h in
                  0.1-h steps."
    ::= { wranIfSmConfigEntry 15 }

  wranIfSmT46   OBJECT-TYPE
    SYNTAXInteger32 (1..4096)
    UNITS       "frames"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Waiting time before which the BS moves to the first
                  backup channel. This is used to make sure that all
                  the CPEs are ready to move to the backup channel
                  before BS switches operation to this backup
```

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```
                    channel."
  ::= { wranIfSmConfigEntry 16 }

wranIfSmT59   OBJECT-TYPE
  SYNTAXInteger32 (1..4096)
  UNITS       "frames"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Waiting time before which the CPE moves to its
                    backup channels if it no longer hears from its BS.
                    This is used to make sure that the CPE waits long
                    enough after UCS Notification so that BS has had
                    time to move to the backup channel, it decided to do
                    so."
  ::= { wranIfSmConfigEntry 17 }

wranIfSmT47   OBJECT-TYPE
  SYNTAXInteger32 (0..720)
  UNITS       "hours"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The prescribed time by the WRAN operator to refresh
                    the incumbent database service."
  ::= { wranIfSmConfigEntry 18 }

wranIfSmT48   OBJECT-TYPE
  SYNTAXInteger32 (0..600)
  UNITS       "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Lapse timer keeps track of whether the Operating
                    Channel N has been cleared using spectrum sensing,
                    from 0 to 60 s in 0.1 s steps."
  ::= { wranIfSmConfigEntry 19 }

wranIfSmT49   OBJECT-TYPE
  SYNTAXInteger32 (0..600)
  UNITS       "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Lapse timer keeps track of whether the Adjacent
                    Channel N-1 has been cleared using spectrum sensing,
                    from 0 to 60 s in 0.1 s steps."
  ::= { wranIfSmConfigEntry 20 }
```

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```
wranIfSmT50   OBJECT-TYPE
  SYNTAXInteger32 (0..600)
  UNITS       "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Lapse timer keeps track of whether the Adjacent
                Channel N+1 has been cleared using spectrum
                sensing, from 0 to 60 s in 0.1 s steps."
  ::= { wranIfSmConfigEntry 21 }

wranIfSmT51   OBJECT-TYPE
  SYNTAXInteger32 (1..600)
  UNITS       "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Initiated when SSA loses contact with the SM."
  ::= { wranIfSmConfigEntry 22 }

wranIfSmT53   OBJECT-TYPE
  SYNTAXInteger32 (1..600)
  UNITS       "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The parameter TINsens is used to verify that in-band
                sensing has been done within the required In-service
                monitoring period. The TINsens parameter is driven
                by regulatory domain requirements (Annex A), from 0
                to 60 s in 0.1 s steps."
  ::= { wranIfSmConfigEntry 23 }

wranIfSmT54   OBJECT-TYPE
  SYNTAXInteger32 (1..600)
  UNITS       "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The parameter TOUTsens is used to verify that out-
                of-band sensing has been done within the required
                "Acquiring a channel monitoring period" specified in
                Annex A. This value would be used to initialize a
                lapse timer for each channel in the backup candidate
                channel list at each CPE so that it is compared to
                Tsensout, from 0 to 60 s in 0.1 s steps."
  ::= { wranIfSmConfigEntry 24 }
```

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```
wranIfSmT55   OBJECT-TYPE
  SYNTAXINTEGER (1..160)
  UNITS       "milliseconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The T55 or Tsensin parameter corresponds to the
                maximum length of time required to carry out the
                sensing process on an in-band channel (see Figure
                176). Manufacturers need to specify the sensing time
                required to detect the specified signals with
                required accuracy, from 0 to 60 s in 0.1 s
                steps."
  ::= { wranIfSmConfigEntry 25 }

wranIfSmT60   OBJECT-TYPE
  SYNTAXINTEGER (20..160)
  UNITS       "milliseconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The T60 or Tsensout parameter corresponds to the
                maximum length of time required to carry out the
                out-of-band sensing process to clear one channel
                (see Figure 178). Manufacturers need to specify the
                sensing time required to detect the specified
                signals with required accuracy for out-of-band
                sensing."
  ::= { wranIfSmConfigEntry 26 }

wranIfSmPendingBlmReqTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfSmPendingBlmReqEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB object represents a table that tracks the
                status of the execution of ongoing sensing requests
                (BLM-REQ). For each BLM-REQ there is a corresponding
                BLM-RSP to indicate that REQ message was received by
                the SSA. When an SSA is done with the sensing it
                will send a BLM-REP to the SM. This table keeps
                track of any BLM-REP messages that are pending
                transmission from the SSA. When a report is received
                a response is acknowledgement is sent to the SSA,
                and then the entry corresponding to the report and
                request will be cleared. Each entry is defined by
                wranIfSmPendingBlmReqEntry."
```

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```
  ::= { wranIfSmMib 2 }

wranIfSmPendingBlmReqEntryOBJECT-TYPE
  SYNTAXwranIfSmPendingBlmReqEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                 wranIfSmPendingBlmReqTable. Each entry is identified
                 by wranIfSmPendingBlmReqIndex."
  INDEX{ wranIfSmPendingBlmReqIndex }
  ::= { wranIfSmPendingBlmReqTable 1 }

wranIfSmPendingBlmReqEntry::= SEQUENCE {
  wranIfSmPendingBlmReqIndexINTEGER,
  wranIfSmPendingBlmReqTransactionIdInteger32,
  wranIfSmPendingBlmReqMsgSizeInteger32,
  wranIfSmPendingBlmReqMsgOCTET STRING,
  wranIfSmPendingBlmRspReceivedTruthValue,
  wranIfSmPendingBlmRspMulticastReceivedTruthValue,
  wranIfSmPendingBlmRepTimeoutInteger32,
  wranIfSmPendingBlmRepReceivedTruthValue,
  wranIfSmPendingBlmRepMulticastReceivedTruthValue,
  wranIfSmPendingBlmRepAckTruthValue }

wranIfSmPendingBlmReqIndexOBJECT-TYPE
  SYNTAXINTEGER (1..100)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in the table."
  ::= { wranIfSmPendingBlmReqEntry 1 }

wranIfSmPendingBlmReqTransactionIdOBJECT-TYPE
  SYNTAXInteger32 (0..65535)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Transaction ID of BLM-REQ."
  ::= { wranIfSmPendingBlmReqEntry 2 }

wranIfSmPendingBlmReqMsgSizeOBJECT-TYPE
  SYNTAXInteger32 (SIZE(1..65535))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Size of BLM-REQ pending a report."
  ::= { wranIfSmPendingBlmReqEntry 3 }
```

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```
wranIfSmPendingBlmReqMsgOBJECT-TYPE
  SYNTAX
    OCTET STRING (SIZE(wranIfSmPendingBlmReqMsgSize))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Contents of BLM-REQ pending a report."
  ::= { wranIfSmPendingBlmReqEntry 4 }

wranIfSmPendingBlmRspReceivedOBJECT-TYPE
  SYNTAXTruthValue
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Indication of whether (Truth(1)) or not (Truth(0))
                BLM-RSP pertaining to BLM-REQ has been received from
                SSA."
  ::= { wranIfSmPendingBlmReqEntry 5 }

wranIfSmPendingBlmRspMulticastReceivedOBJECT-TYPE
  SYNTAXTruthValue
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "If BLM-REQ was multicast, indication of whether
                (Truth(1)) or not (Truth(0)) BLM-RSP pertaining to
                BLM-REQ has been received from each SSA (CPE) in the
                multicast group."
  ::= { wranIfSmPendingBlmReqEntry 6 }

wranIfSmPendingBlmRepTimeoutOBJECT-TYPE
  SYNTAXInteger32 (1..640)
  UNITS       "milliseconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Indication of current value of T31 set for this BLM-
                REP."
  ::= { wranIfSmPendingBlmReqEntry 7 }

wranIfSmPendingBlmRepReceivedOBJECT-TYPE
  SYNTAXTruthValue
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Indication of whether (Truth(1)) or not (Truth(0))
                BLM-REP pertaining to BLM-REQ has been received from
```

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```
                    SSA."
  ::= { wranIfSmPendingBlmReqEntry 8 }

wranIfSmPendingBlmRepMulticastReceivedOBJECT-TYPE
  SYNTAXTruthValue
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "If BLM-REQ was multicast, indication of whether
                    (Truth(1)) or not (Truth(0)) BLM-REP pertaining to
                    BLM-REQ has been received from each SSA (CPE) in the
                    multicast group."
  ::= { wranIfSmPendingBlmReqEntry 9 }

wranIfSsaPendingBlmRepAckOBJECT-TYPE
  SYNTAXTruthValue
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Indication of whether (Truth(1)) or not (Truth(0))
                    BLM-ACK, has been sent to acknowledge all
                    transmitters of BLM-REP messages pertaining to BLM-
                    REQ that was issued."
  ::= { wranIfSmPendingBlmReqEntry 10 }

wranIfSmBlmRepTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfSmBlmRepEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object contains BLM-REP messages received in
                    response to BLM-REQ; it is made up of multiple
                    entries, one for each BLM-REP that pertains to a
                    BLM-REQ. Once a BLM-REP has been processed the entry
                    will be removed. Each entry is defined by
                    wranIfSmBlmRepEntry."
  ::= { wranIfSmMib 3 }

wranIfSmBlmRepEntryOBJECT-TYPE
  SYNTAXwranIfSmBlmRepEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in wranIfSmBlmRepTable.
                    Each entry is identified by wranIfSmBlmReqIndex."
  INDEX{ wranIfSmBlmReqIndex }
  ::= { wranIfSmBlmRepTable 1 }
```

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```
wranIfSmBlmRepEntry::= SEQUENCE {
  wranIfSmBlmRepIndexINTEGER,
  wranIfSmBlmRepSid   INTEGER,
  wranIfSmBlmRepTransactionIdInteger32,
  wranIfSmBlmRepMsgSizeInteger32,
  wranIfSmBlmRepMsg   OCTET STRING }

wranIfSmBlmRepIndexOBJECT-TYPE
  SYNTAXINTEGER (1..100)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in the table."
  ::= { wranIfSmBlmRepEntry 1 }

wranIfSmBlmRepSidOBJECT-TYPE
  SYNTAXINTEGER (1..512)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "SID of CPE that sent the BLM-REP."
  ::= { wranIfSmBlmRepEntry 2 }

wranIfSmBlmRepTransactionIdOBJECT-TYPE
  SYNTAXInteger32 (0..65535)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Transaction ID of BLM-REP, it should match a
                transaction ID of an entry in
                wranIfSmPendingBlmReqTable."
  ::= { wranIfSmBlmRepEntry 3 }

wranIfSmBlmRepMsgSizeOBJECT-TYPE
  SYNTAXInteger32 (SIZE(1..65535))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Size of BLM-REP msg."
  ::= { wranIfSmBlmRepEntry 4 }

wranIfSmBlmRepMsgOBJECT-TYPE
  SYNTAXOCTET STRING (SIZE(wranIfSmBlmRepMsgSize))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Contents of BLM-REP msg."
  ::= { wranIfSmBlmRepEntry 5 }
```

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```
wranIfSmChClassificationStatusTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfSmChClassificationStatusEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB object represents a table that the status
                for channels that the SM is managing. It is made up
                of multiple entries, one for each channel, as
                defined in wranIfSmChClassificationStatusEntry."
  ::= { wranIfSmMib 4 }

wranIfSmChClassificationStatusEntryOBJECT-TYPE
  SYNTAXwranIfSmChClassificationStatusEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                wranIfSmChClassificationStatusTable. Each entry is
                identified by wranIfSmChClassificationStatusIndex."
  INDEX{ wranIfSmChClassificationStatusIndex }
  ::= { wranIfSmChClassificationStatusTable 1 }

wranIfSmChClassificationStatusEntry::= SEQUENCE {
  wranIfSmChClassificationStatusIndexINTEGER,
  wranIfSmManagedChannelINTEGER,
  wranIfSmManagedChannelStatusINTEGER,
  wranIfSmManagedChannelRecentEventINTEGER }

wranIfSmChClassificationStatusIndexOBJECT-TYPE
  SYNTAXINTEGER (1..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in the table."
  ::= { wranIfSmChClassificationStatusEntry 1 }

wranIfSmManagedChannelOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    " Channel number of channel being managed."
  ::= { wranIfSmChClassificationStatusEntry 2 }

wranIfSmManagedChannelStatusOBJECT-TYPE
  SYNTAXINTEGER { unclassified(0),
                  candidate(1),
```

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```
                    protected(2),
                    operating(3),
                    backup(4),
                    disallowed(5) }
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The state of the channel as set by the states in the
                SM Channel Set Transition Diagram (Figure 162) or
                disallowed state (if channel is in IPC-UPD)."
  ::= { wranIfSmChClassificationStatusEntry 3 }

wranIfSmManagedChannelRecentEventOBJECT-TYPE
  SYNTAXINTEGER { disallowed(0),
                    event1(1),
                    event2(2),
                    event3(3),
                    event4(4),
                    event5(5),
                    event6(6),
                    event7(7),
                    event8(8) }
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Most recent event (see 10.2.3.1) that dictated a
                transition to the current state. disallowed(0)
                pertains to reception of IPC-UPD."
  ::= { wranIfSmChClassificationStatusEntry 4 }

wranIfSmChannelSetTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfSmChannelSetEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB object represents a table that stores
                information related to the contents of the Occupied,
                Backup Channel, and Local Priority channel sets used
                by the Spectrum Manager (see 10.2.3.2)."
  ::= { wranIfSmMib 5 }

wranIfSmChannelSetEntryOBJECT-TYPE
  SYNTAXwranIfSmChannelSetEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                wranIfSmChannelSetTable. There is only one entry in
```

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```
                    this table."
  INDEX{ wranIfSmChannelSetIndex }
  ::= { wranIfSmChannelSetTable 1 }

wranIfSmChannelSetEntry::= SEQUENCE {
  wranIfSmChannelSetIndexINTEGER,
  wranIfSmSizeWranOccupiedChannelSetINTEGER,
  wranIfSmWranOccupiedChannelSetOCTET STRING,
  wranIfSmSizeNghbrWranBackupChannelSetINTEGER,
  wranIfSmNghbrWranBackupChannelSetOCTET STRING,
  wranIfSmSizeLocalPrioritySet1INTEGER,
  wranIfSmLocalPrioritySet1OCTET STRING,
  wranIfSmSizeLocalPrioritySet2INTEGER,
  wranIfSmLocalPrioritySet2OCTET STRING,
  wranIfSmSizeLocalPrioritySet3INTEGER,
  wranIfSmLocalPrioritySet3OCTET STRING }

wranIfSmChannelSetIndexOBJECT-TYPE
  SYNTAXINTEGER (1..1)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in the table."
  ::= { wranIfSmChannelSetEntry 1 }

wranIfSmSizeWranOccupiedChannelSetOBJECT-TYPE
  SYNTAXINTEGER (1..256)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Number of channels in WRAN Occupied Channel Set."
  ::= { wranIfSmChannelSetEntry 2 }

wranIfSmWranOccupiedChannelSetOBJECT-TYPE
  SYNTAX
    OCTET STRING
              (SIZE(wranIfSmSizeWranOccupiedChannelSet))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Vector of channels of length 8 bits ×
                wranIfSmSizeWranOccupiedChannelSet that indicate the
                channels that occupy the WRAN Occupied Channel Set
                used by the Spectrum Etiquette procedure (see
                10.2.3.2)."
  ::= { wranIfSmChannelSetEntry 3 }

wranIfSmSizeNghbrWranBackupChannelSetOBJECT-TYPE
```

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```
    SYNTAXINTEGER (1..256)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Number of channels in Neighbor WRAN Backup Channel
                  Set."
    ::= { wranIfSmChannelSetEntry 4 }

  wranIfSmNghbrWranBackupChannelSetOBJECT-TYPE
    SYNTAX
      OCTET STRING
                (SIZE(wranIfSmSizeNghbrWranBackupChannelSet))
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Vector of channels of length 8 bits ×
                  wranIfSmSizeNghbrWranBackupChannelSet that indicate
                  the channels that occupy the Neighbor WRAN Backup
                  Channel Set used by the Spectrum Etiquette procedure
                  (see 10.2.3.2)."
    ::= { wranIfSmChannelSetEntry 5 }

  wranIfSmSizeLocalPrioritySet1OBJECT-TYPE
    SYNTAXINTEGER (1..256)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Number of channels in Local Priority Set 1."
    ::= { wranIfSmChannelSetEntry 6 }

  wranIfSmLocalPrioritySet1OBJECT-TYPE
    SYNTAX
      OCTET STRING (SIZE(wranIfSmSizeLocalPrioritySet1))
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Vector of channels of length 8 bits ×
                  wranIfSmSizeLocalPrioritySet1 that indicate the
                  channels that occupy the Local Priority Set 1 used
                  by the Spectrum Etiquette procedure (see 10.2.3.2)."
    ::= { wranIfSmChannelSetEntry 7 }

  wranIfSmSizeLocalPrioritySet2OBJECT-TYPE
    SYNTAXINTEGER (1..256)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Number of channels in Local Priority Set 2."
```

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```
  ::= { wranIfSmChannelSetEntry 8 }

wranIfSmLocalPrioritySet2OBJECT-TYPE
  SYNTAX
    OCTET STRING (SIZE(wranIfSmSizeLocalPrioritySet2))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Vector of channels of length 8 bits ×
                wranIfSmSizeLocalPrioritySet2 that indicate the
                channels that occupy the Local Priority Set 2 used
                by the Spectrum Etiquette procedure (see 10.2.3.2)."
  ::= { wranIfSmChannelSetEntry 9 }

wranIfSmSizeLocalPrioritySet3OBJECT-TYPE
  SYNTAXINTEGER (1..256)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Number of channels in Local Priority Set 3, should
                be the same size as
                wranIfSmSizeWranOccupiedChannelSet."
  ::= { wranIfSmChannelSetEntry 10 }

wranIfSmLocalPrioritySet3OBJECT-TYPE
  SYNTAX
    OCTET STRING (SIZE(wranIfSmSizeLocalPrioritySet3))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Vector of channels of length 8 bits ×
                wranIfSmSizeLocalPrioritySet3 that indicate the
                channels that occupy the Local Priority Set 3 used
                by the Spectrum Etiquette procedure (see 10.2.3.2).
                Should contain the same channel set as
                wranIfSmWranOccupiedChannelSet."
  ::= { wranIfSmChannelSetEntry 11 }

wranIfSmCurrentStatusTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfSmCurrentStatusEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB object represents a table that the records
                the current status of the SM. This includes the
                state the SM is in, the event that triggered a move
                into that state, as well as the current state of any
                relevant timers. There is one entry in this table
```

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```
                    defined in wranIfSmCurrentStatusEntry."
  ::= { wranIfSmMib 6 }

wranIfSmCurrentStatusEntryOBJECT-TYPE
  SYNTAXwranIfSmCurrentStatusEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                    wranIfSmCurrentStatusTable. There is only one entry
                    in this table."
  INDEX{ wranIfSmCurrentStatusIndex }
  ::= { wranIfSmCurrentStatusTable 1 }

wranIfSmCurrentStatusEntry::= SEQUENCE {
  wranIfSmCurrentStatusIndexINTEGER,
  wranIfSmCurrentStateINTEGER,
  wranIfSmRecentEventINTEGER,
  wranIfSmRecentActionINTEGER,
  wranIfSmInitiateChannelMoveTruthValue,
  wranIfSmSelfCoexistenceModeTruthValue,
  wranIfSmCurrentOperatingChannelINTEGER,
  wranIfSmRecentSignalTypeINTEGER,
  wranIfSmCurrentT47Integer32,
  wranIfSmCurrentT46Integer32 }

wranIfSmCurrentStatusIndexOBJECT-TYPE
  SYNTAXINTEGER (1..1)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in the table."
  ::= { wranIfSmCurrentStatusEntry 1 }

wranIfSmCurrentStateOBJECT-TYPE
  SYNTAXINTEGER { init(0),
                  operation(1) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "The state (see Figure 164) that the SM is in. A
                    value of 0 indicates that the SM is in the 'Spectrum
                    Manager at Network Initialization State', a value of
                    1 indicates that the SM is in the 'Spectrum Manager
                    at Network Operation' state."
  ::= { wranIfSmCurrentStatusEntry 2 }

wranIfSmRecentEventOBJECT-TYPE
```

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```
    SYNTAXINTEGER { timeT46expires(0),
                    operatingChannelIdentified(1),
                    initiateChannelMoveSet(2),
                    newCpeRegRequest(3),
                    timerT47expires(4),
                    signalDetected(5),
                    selfCoexistenceModeSet(6) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Recent event that triggered a transition into the
                  current state as given in 10.2.6.1 "
    ::= { wranIfSmCurrentStatusEntry 3 }

  wranIfSmRecentActionOBJECT-TYPE
    SYNTAX
      INTEGER {   smFindOperatingChannel(0),
                  smEstablishNetwork(1),
                  smInitiateChannelMove(2),
                  smNewCpeVerification(3),
                  smDatabaseUpdate(4),
                  smDetermineSignalTypeExecutePolicies(5),
                  smSelfCoexistenceMode(6) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Recent action that was taken when transitioning into
                  the current state as given in 10.2.6.1."
    ::= { wranIfSmCurrentStatusEntry 4 }

  wranIfSmInitiateChannelMoveOBJECT-TYPE
    SYNTAXTruthValue
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Current value of Initiate_Channel_Move flag.
                  Truth(1) if the flag is set to 1, Truth(0) if
                  the flag is set to 0."
    ::= { wranIfSmCurrentStatusEntry 5 }

  wranIfSmSelfCoexistenceModeOBJECT-TYPE
    SYNTAXTruthValue
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Current value of Self_Coexistence_Mode flag.
                  Truth(1) if the flag is set to 1, Truth(0) if
                  the flag is set to 0."
```

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```
  ::= { wranIfSmCurrentStatusEntry 6 }

wranIfSmCurrentOperatingChannelOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Current operating channel."
  ::= { wranIfSmCurrentStatusEntry 7 }

wranIfSmRecentSignalTypeOBJECT-TYPE
  SYNTAXINTEGER { undetermined(0),
                  ieee802dot22wran(1),
                  atsc(2),
                  dvbt(3),
                  isdbt(4),
                  ntsc(5),
                  pal(6),
                  secam(7),
                  wirelessMicrophone(8),
                  ieee802dot22dot1Sync(9),
                  ieee802dot22dot1Msf1(10),
                  ieee802dot22dot1Msf2(11),
                  ieee802dot22dot1Msf3(12) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Type of signal recently detected (see Table 237)."
  ::= { wranIfSmCurrentStatusEntry 8 }

wranIfSmCurrentT47OBJECT-TYPE
  SYNTAXInteger32 (1..720)
  UNITS       "hours"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Current value of T47, in 0.1 h increments from 0 to
                  72 h."
  ::= { wranIfSmCurrentStatusEntry 9 }

wranIfSmCurrentT46OBJECT-TYPE
  SYNTAXInteger32 (1..4096)
  UNITS       "frames"
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Current value of T46."
  ::= { wranIfSmCurrentStatusEntry 10 }
```

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```
wranIfSmRegTrackingTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfSmRegTrackingEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB object represents a table that records the
                SM's monitoring of CPEs associated with the BS. It
                contains the location data string and current value
                of T30 for each CPE. There are multiple entries in
                this table (one for each CPE) defined in
                wranIfSmRegTrackingEntry."
  ::= { wranIfSmMib 7 }

wranIfSmRegTrackingEntryOBJECT-TYPE
  SYNTAXwranIfSmRegTrackingEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                wranIfSmRegTrackingTable."
  INDEX{ wranIfSmRegTrackingIndex }
  ::= { wranIfSmRegTrackingTable 1 }

wranIfSmRegTrackingEntry::= SEQUENCE {
  wranIfSmRegTrackingIndexINTEGER,
  wranIfSmRegTrackingCpeSidINTEGER,
  wranIfSmRegTrackingCurrentT30Integer32,
  wranIfSmRegTrackingLocStringSizeINTEGER,
  wranIfSmRegTrackingLocStringOCTET STRING }

wranIfSmRegTrackingIndexOBJECT-TYPE
  SYNTAXINTEGER (1..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in the table."
  ::= { wranIfSmRegTrackingEntry 1 }

wranIfSmRegTrackingCpeSidOBJECT-TYPE
  SYNTAXINTEGER (1..8192)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "SID of CPE whose location is being tracked."
  ::= { wranIfSmRegTrackingEntry 2 }

wranIfSmRegTrackingCurrentT30OBJECT-TYPE
```

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```
  SYNTAXInteger32 (1..65535)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Current value of CPE's T30, as known by SM. From
                0.16 s to 10 485.6 s in 0.16 s increments."
  ::= { wranIfSmRegTrackingEntry 3 }

wranIfSmRegTrackingLocStringSizeOBJECT-TYPE
  SYNTAXINTEGER (1..512)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Size of the location string
                (wranIfSmRegTrackingLocString) in octets."
  ::= { wranIfSmRegTrackingEntry 4 }

wranIfSmRegTrackingLocStringOBJECT-TYPE
  SYNTAX
    OCTET STRING(SIZE(wranIfSmRegTrackingLocStringSize))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Size of the location string
                (wranIfSmRegTrackingLocString) in octets."
  ::= { wranIfSmRegTrackingEntry 5 }

wranIfSmTrapControlOBJECT-TYPE
  SYNTAXBITS  { wranIfSmBlmReqChange(0),
                wranIfSmBlmRepChange(1),
                wranIfSmOccupiedChannelSetChange(2),
                wranIfSmNghbrBackupChannelSetChange(3),
                wranIfSmLocalPrioritySet1Change(4),
                wranIfSmLocalPrioritySet2Change(5),
                wranIfSmLocalPrioritySet3Change(6),
                wranIfSmCurrentStatusChange(7),
                wranIfSmRegTrackingChange(8) }
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Defines control elements for traps related to
                operation of the spectrum manager. This is a 9-bit
                field that enables setting a trap for particular SM
                events: wranIfSmBlmReqChange,
                wranIfSmBlmRepChange,
                wranIfSmOccupiedChannelSetChange,
     wranIfSmNghbrBackupChannelSetChange,
     wranIfSmLocalPrioritySet1Change,
```

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```
      wranIfSmLocalPrioritySet2Change,
      wranIfSmLocalPrioritySet3Change,
                  wranIfSmCurrentStatusChange,
      and wranIfSmRegTrackingChange."
  ::= { wranIfSmMib 8 }

wranIfSmTrapDefinition OBJECT IDENTIFIER
                      ::= { wranIfSmMib 9 }
wranIfSmBlmReqChangeTrap OBJECT IDENTIFIER
                      ::= { wranIfSmTrapDefinition 1 }
wranIfSmBlmRepChangeTrap OBJECT IDENTIFIER
                      ::= { wranIfSmTrapDefinition 2 }
wranIfSmOccupiedChannelSetChangeTrap OBJECT IDENTIFIER
                      ::= { wranIfSmTrapDefinition 3 }
wranIfSmNghbrBackupChannelSetChangeTrapOBJECT IDENTIFIER
                      ::= { wranIfSmTrapDefinition 4 }
wranIfSmLocalPrioritySet1ChangeTrap OBJECT IDENTIFIER
                      ::= { wranIfSmTrapDefinition 5 }
wranIfSmLocalPrioritySet2ChangeTrap OBJECT IDENTIFIER
                      ::= { wranIfSmTrapDefinition 6 }
wranIfSmLocalPrioritySet3ChangeTrap OBJECT IDENTIFIER
                      ::= { wranIfSmTrapDefinition 7 }
wranIfSmCurrentStatusChangeTrap OBJECT IDENTIFIER
                      ::= { wranIfSmTrapDefinition 8 }
wranIfSmRegTrackingChangeTrap OBJECT IDENTIFIER
                      ::= { wranIfSmTrapDefinition 9 }

wranIfSmBlmReqChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfSmPendingBlmReqTransactionId,
                wranIfSmPendingBlmReqStatus }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to a BLM-
                  REQ that is pending in the SM."
  ::= { wranIfSmTrapDefinition 1 }

wranIfSmBlmRepChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfSmBlmRepTransactionId,
                wranIfSmBlmRepStatus }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to a BLM-
                  REP that is received by the SM."
  ::= { wranIfSmTrapDefinition 2 }

wranIfSmOccupiedChannelSetChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfSmSizeWranOccupiedChannelSet,
                wranIfSmWranOccupiedChannelSet,
```

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```
                wranIfSmOccupiedChannelSetStatus }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to the
                current state of the Occupied Channel Set in the
                SM."
  ::= { wranIfSmTrapDefinition 3 }

wranIfSmNghbrBackupChannelSetChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfSmSizeNghbrWranBackupChannelSet,
                wranIfSmNghbrWranBackupChannelSet,
                wranIfSmNghbrBackupChannelSetStatus }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to the
                current state of the Neighbor WRAN Backup Channel
                Set in the SM."
  ::= { wranIfSmTrapDefinition 4 }

wranIfSmLocalPrioritySet1ChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfSmSizeLocalPrioritySet1,
                wranIfSmLocalPrioritySet1,
                wranIfSmLocalPrioritySet1Status }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to the
                current state of the Local Priority Set 1 in the
                SM."
  ::= { wranIfSmTrapDefinition 5 }

wranIfSmLocalPrioritySet2ChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfSmSizeLocalPrioritySet2,
                wranIfSmLocalPrioritySet2,
                wranIfSmLocalPrioritySet2Status }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to the
                current state of the Local Priority Set 2 in the
                SM."
  ::= { wranIfSmTrapDefinition 6 }

wranIfSmLocalPrioritySet3ChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfSmSizeLocalPrioritySet3,
                wranIfSmLocalPrioritySet3,
                wranIfSmLocalPrioritySet3Status }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to the
```

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```
                current state of the Local Priority Set 3 in the
                SM."
  ::= { wranIfSmTrapDefinition 7 }

wranIfSmCurrentStatusChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfSmRecentAction,
              wranIfSmCurrentStateStatus }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to the
                current state the SM is in."
  ::= { wranIfSmTrapDefinition 8 }

wranIfSmRegTrackingChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfSmRegTrackingCpeSid,
              wranIfSmRegTrackingStatus }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to the
                tracking of the location of CPEs within the purview
                of the BS."
  ::= { wranIfSmTrapDefinition 9 }

wranIfSmNotificationObjectsTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfSmNotificationObjectsEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB provides a table to track notification
                objects that have been reported by the traps related
                to the operation of the SM. It is made up of one
                entry containing objects related to the most recent
                trap/event. The entry is defined by
                wranIfSmNotificationObjectsEntry."
  ::= { wranIfSmMib 10 }

wranIfSmNotificationObjectsEntryOBJECT-TYPE
  SYNTAXwranIfSmNotificationObjectsEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                wranIfSmNotificationObjectsTable."
  INDEX{ wranIfSmNotificationSid }
  ::= { wranIfSmNotificationObjectsTable 1 }

wranIfSmNotificationObjectsEntry::= SEQUENCE {
  wranIfSmNotificationObjectsEntryIndexINTEGER,
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```
  wranIfSmNotificationSid   INTEGER,
  wranIfSmNotificationBlmTransactionIdInteger32,
  wranIfSmNotificationSizeOccupiedChannelSetINTEGER,
  wranIfSmNotificationOccupiedChannelSetOCTET STRING,
  wranIfSmNotificationSizeBackupChannelSetINTEGER,
  wranIfSmNotificationBackupChannelSetOCTET STRING,
  wranIfSmNotificationSizeLocalPrioritySet1INTEGER,
  wranIfSmNotificationLocalPrioritySet1OCTET STRING,
  wranIfSmNotificationSizeLocalPrioritySet2INTEGER,
  wranIfSmNotificationLocalPrioritySet2OCTET STRING,
  wranIfSmNotificationSizeLocalPrioritySet3INTEGER,
  wranIfSmNotificationLocalPrioritySet3OCTET STRING,
  wranIfSmNotificationRecentActionINTEGER,
  wranIfSmPendingBlmReqStatusINTEGER,
  wranIfSmBlmRepStatus      INTEGER,
  wranIfSmOccupiedChannelSetStatusINTEGER,
  wranIfSmNghbrBackupChannelSetStatusINTEGER,
  wranIfSmLocalPrioritySet1StatusINTEGER,
  wranIfSmLocalPrioritySet2StatusInteger32,
  wranIfSmLocalPrioritySet3StatusInteger32,
  wranIfSmCurrentStateStatusInteger32,
  wranIfSmRegTrackingStatusInteger32 }

wranIfSmNotificationObjectsEntryIndexOBJECT-TYPE
  SYNTAXINTEGER (1..1)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "The transaction ID of the bulk measurement
                transaction. Only pertinent when
                wranIfSmBlmReqChangeTrap or wranIfSmBlmRepChangeTrap
                is enabled."
  ::= { wranIfSmNotificationObjectsEntry 1 }

wranIfSmNotificationSidOBJECT-TYPE
  SYNTAXINTEGER (0..511)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "SID of station generating trap.
                wranIfSmNotificationSid set == 0 is reserved for
                traps dealing with channel set management (see
                wranIfSmOccupiedChannelSetChangeTrap,
                wranIfSmNghbrBackupChannelSetChangeTrap,
     wranIfSmLocalPrioritySet1ChangeTrap,
     wranIfSmLocalPrioritySet2ChangeTrap,
     wranIfSmLocalPrioritySet3ChangeTrap) and the current
                state of the SM (see
```

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```
                wranIfSmCurrentStatusChangeTrap).
                wranIfSmNotificationSid set == 1..8192 when dealing
                with traps for bulk measurement (see
                wranIfSmBlmReqChangeTrap, wranIfSmBlmRepChangeTrap)
                or CPE registration tracking (see
                wranIfSmRegTrackingChangeTrap)."
  ::= { wranIfSmNotificationObjectsEntry 2 }

wranIfSmNotificationBlmTransactionIdOBJECT-TYPE
  SYNTAXInteger32 (0..65535)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "The transaction ID of the bulk measurement
                transaction. Only pertinent when
                wranIfSmBlmReqChangeTrap or wranIfSmBlmRepChangeTrap
                is enabled."
  ::= { wranIfSmNotificationObjectsEntry 3 }

wranIfSmNotificationSizeOccupiedChannelSetOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Size of the current/new WRAN Occupied Channel Set
                (only pertinent when
                wranIfSmOccupiedChannelSetChangeTrap is enabled)."
  ::= { wranIfSmNotificationObjectsEntry 4 }

wranIfSmNotificationOccupiedChannelSetOBJECT-TYPE
  SYNTAX
    STRING
       (SIZE(wranIfSmNotificationSizeOccupiedChannelSet))
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "The current/new contents of the WRAN Occupied
                Channel Set (only pertinent when
                wranIfSmOccupiedChannelSetChangeTrap is enabled)."
  ::= { wranIfSmNotificationObjectsEntry 5 }

wranIfSmNotificationSizeBackupChannelSetOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Size of the current/new Neighbor WRAN Backup Channel
     Set (only pertinent when
```

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```
                    wranIfSmNghbrBackupChannelSetChangeTrap is
                    enabled)."
  ::= { wranIfSmNotificationObjectsEntry 6 }

wranIfSmNotificationBackupChannelSetOBJECT-TYPE
  SYNTAX
    OCTET STRING
         (SIZE(wranIfSmNotificationSizeBackupChannelSet))
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "The current/new contents of the Neighbor WRAN Backup
                    Channel Set (only pertinent when
                    wranIfSmNghbrBackupChannelSetChangeTrap is
                    enabled)."
  ::= { wranIfSmNotificationObjectsEntry 7 }

wranIfSmNotificationSizeLocalPrioritySet1OBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Size of the current/new Local Priority Set 1 (only
     pertinent when wranIfSmLocalPrioritySet1ChangeTrap
                    is enabled)."
  ::= { wranIfSmNotificationObjectsEntry 8 }

wranIfSmNotificationLocalPrioritySet1OBJECT-TYPE
  SYNTAX
    OCTET STRING
        (SIZE(wranIfSmNotificationSizeLocalPrioritySet1))
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "The current/new contents of the Local Priority Set 1
                    (only pertinent when
                    wranIfSmLocalPrioritySet1ChangeTrap is enabled)."
  ::= { wranIfSmNotificationObjectsEntry 9 }

wranIfSmNotificationSizeLocalPrioritySet2OBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Size of the current/new Local Priority Set 2 (only
                    pertinent when wranIfSmLocalPrioritySet2ChangeTrap
                    is enabled)."
  ::= { wranIfSmNotificationObjectsEntry 10 }
```

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```
wranIfSmNotificationLocalPrioritySet2OBJECT-TYPE
  SYNTAX
    OCTET STRING
        (SIZE(wranIfSmNotificationSizeLocalPrioritySet2))
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "The current/new contents of the Local Priority Set 2
                 (only pertinent when
                 wranIfSmLocalPrioritySet2ChangeTrap is enabled)."
  ::= { wranIfSmNotificationObjectsEntry 11 }

wranIfSmNotificationSizeLocalPrioritySet3OBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Size of the current/new Local Priority Set 3 (only
     pertinent when wranIfSmLocalPrioritySet3ChangeTrap
                 is enabled)."
  ::= { wranIfSmNotificationObjectsEntry 12 }

wranIfSmNotificationLocalPrioritySet3OBJECT-TYPE
  SYNTAX
    OCTET STRING
        (SIZE(wranIfSmNotificationSizeLocalPrioritySet3))
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "The current/new contents of the Local Priority Set 3
                 (only pertinent when
                 wranIfSmLocalPrioritySet3ChangeTrap is enabled)."
  ::= { wranIfSmNotificationObjectsEntry 13 }

wranIfSmNotificationRecentActionOBJECT-TYPE
  SYNTAXINTEGER (0..6)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Value of wranIfSmRecentAction that triggered
                 transition to current state of SM (only pertinent
                 when wranIfSmCurrentStatusChangeTrap is enabled)."
  ::= { wranIfSmNotificationObjectsEntry 14 }

wranIfSmPendingBlmReqStatusOBJECT-TYPE
  SYNTAXINTEGER { blmRspUnicastReceived(0),
                  blmRspMulticastReceived(1) }
```

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```
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Indicates BLM-RSP pertaining to bulk measurement
                  transaction (defined by
                  wranIfSmNotificationBlmTransactionId) was received
                  from wranIfSmNotificationSid, if
                  wranIfSmNotificationSid is a unicast SID, or if all
                  BLM-RSP received from members of multicast group
                  identified by wranIfSmNotificationSid."
    ::= { wranIfSmNotificationObjectsEntry 15 }

  wranIfSmBlmRepStatusOBJECT-TYPE
    SYNTAXINTEGER { blmRepAcknowledged(0),
                    blmRepUnAcknowledged(1) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Indicates whether BLM-ACK has been sent,
                  pertaining to BLM-REP received in bulk measurement
                  transaction defined by
                  wranIfSmNotificationBlmTransactionId."
    ::= { wranIfSmNotificationObjectsEntry 16 }

  wranIfSmOccupiedChannelSetStatusOBJECT-TYPE
    SYNTAXINTEGER { channelsAdded(0),
                    channelsRemoved(1) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Indication of whether channels have been
                  added or removed when the WRAN Occupied Channel Set
                  is modified."
    ::= { wranIfSmNotificationObjectsEntry 17 }

  wranIfSmNghbrBackupChannelSetStatusOBJECT-TYPE
    SYNTAXINTEGER { channelsAdded(0),
                    channelsRemoved(1) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Indication of whether channels have been
                  added or removed when the Neighbor WRAN Backup
                  Channel Set is modified."
    ::= { wranIfSmNotificationObjectsEntry 18 }

  wranIfSmLocalPrioritySet1StatusOBJECT-TYPE
    SYNTAXINTEGER { channelsAdded(0),
```

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```
                    channelsRemoved(1) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Indication of whether channels have been
                added or removed when the Local Priority Set 1 is
                modified."
  ::= { wranIfSmNotificationObjectsEntry 19 }

wranIfSmLocalPrioritySet2StatusOBJECT-TYPE
  SYNTAXINTEGER { channelsAdded(0),
                    channelsRemoved(1) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Indication of whether channels have been
                added or removed when the Local Priority Set 2 is
                modified."
  ::= { wranIfSmNotificationObjectsEntry 20 }

wranIfSmLocalPrioritySet3StatusOBJECT-TYPE
  SYNTAXINTEGER { channelsAdded(0),
                    channelsRemoved(1) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Indication of whether channels have been
                added or removed when the Local Priority Set 3 is
                modified."
  ::= { wranIfSmNotificationObjectsEntry 21 }

wranIfSmCurrentStateStatusOBJECT-TYPE
  SYNTAXBITS { initiateChannelMoveSet(0),
               coexistenceModeSet(1),
               currentOperatingChannelChange(2),
               signalDetectionClassificationSuccess(3),
               expirationT47(4),
               expirationT46(5) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Bitmap indicating current value of
                Initiate_Channel_Move has bit set (bit 0); whether
                Self_Coexistence_Mode flag is set (bit 1);
                whether the operating channel assignment has
                changed (bit 2); whether recently detected signal
                was properly classified, e.g., signal type ==
                undetermined (bit 3); whether T47
```

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```
                    has expired (bit 4); whether T46 has expired
                    (bit 5). Setting the bit to 0 makes the condition
                    false, setting the bit to 1 makes the condition
                    true."
    ::= { wranIfSmNotificationObjectsEntry 22 }

  wranIfSmRegTrackingStatusOBJECT-TYPE
    SYNTAXINTEGER { locationChanged(0),
                      locationNotChanged(1) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Indication of whether CPE location,
                    pertaining to CPE SID identified by
                    wranIfSmNotificationSid, has changed."
    ::= { wranIfSmNotificationObjectsEntry 23 }

-- wranIfSmMibGroups: this object helps define which MIB groups are
-- available within this module and which MIB objects are a part of
-- each group

  wranIfSmMibGroupsOBJECT IDENTIFER
                               ::= { wranIfSmMib 11 }
  wranIfSmConfigGroupOBJECT IDENTIFIER
                               ::= { wranIfSmMibGroups 1 }
  wranIfSmPendingBlmReqGroupOBJECT IDENTIFIER
                               ::= { wranIfSmMibGroups 2 }
  wranIfSmBlmRepGroupOBJECT IDENTIFIER
                               ::= { wranIfSmMibGroups 3 }
  wranIfSmChClassificationGroupOBJECT IDENTIFIER
                               ::= { wranIfSmMibGroups 4 }
  wranIfSmChannelSetGroupOBJECT IDENTIFIER
                               ::= { wranIfSmMibGroups 5 }
  wranIfSmCurrentStatusGroupOBJECT IDENTIFIER
                               ::= { wranIfSmMibGroups 6 }
  wranIfSmRegTrackingGroupOBJECT IDENTIFIER
                               ::= { wranIfSmMibGroups 7 }
  wranIfSmTrapControlGroupOBJECT IDENTIFIER
                               ::= { wranIfSmMibGroups 8 }
  wranIfSmNotificationsGroupOBJECT IDENTIFIER
                               ::= { wranIfSmMibGroups 9 }

  wranIfSmConfigGroupOBJECT-GROUP
    OBJECTS{ wranIfSmConfigIndex, wranIfSmT31,
                  wranIfSmChAvailabilityCheckTime,
                  wranIfSmNonOccupancyPeriod,
                  wranIfSmChannelDetectionTime,
                  wranIfSmChannelSetupTime,
```

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```
                wranIfSmChannelOpeningTxTime,
                wranIfSmChannelMoveTime,
                wranIfSmChannelClosingTxTime,
                wranIfSmMicProtectionRadius,
                wranIfSmT41, wranIfSmT42,
                wranIfSmT43, wranIfSmT44,
                wranIfSmT45, wranIfSmT46, wranIfSmT59,
                wranIfSmT47, wranIfSmT48,
                wranIfSmT49, wranIfSmT50,
                wranIfSmT51, wranIfSmT53,
                wranIfSmT54, wranIfSmT55,
                wranIfSmT60 }
  STATUScurrent
  DESCRIPTION
    "This group contains objects related to
                configuration of the Spectrum Manager."
  ::= { wranIfSmMibGroups 1 }

wranIfSmPendingBlmReqGroupOBJECT-GROUP
  OBJECTS{ wranIfSmPendingBlmReqIndex,
                wranIfSmPendingBlmReqTransactionId,
                wranIfSmPendingBlmReqMsgSize,
                wranIfSmPendingBlmReqMsg,
                wranIfSmPendingBlmRspReceived,
                wranIfSmPendingBlmRspMulticastReceived,
                wranIfSmPendingBlmRepTimeout,
                wranIfSmPendingBlmRepReceived,
                wranIfSmPendingBlmRepMulticastReceived,
                wranIfSmPendingBlmRepAck }
  STATUScurrent
  DESCRIPTION
    "This group contains objects related to
                tracking pending BLM-REQs."
  ::= { wranIfSmMibGroups 2 }

wranIfSmBlmRepGroupOBJECT-GROUP
  OBJECTS{ wranIfSmBlmRepIndex, wranIfSmBlmRepSid,
                wranIfSmBlmRepTransactionId,
                wranIfSmBlmRepMsgSize,
                wranIfSmPendingBlmRspReceived,
                wranIfSmBlmRepMsg }
  STATUScurrent
  DESCRIPTION
    "This group contains objects related to
                tracking received BLM-REPs."
  ::= { wranIfSmMibGroups 3 }

wranIfSmChClassificationGroupOBJECT-GROUP
```

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```
  OBJECTS{ wranIfSmChClassificationStatusIndex,
                wranIfSmManagedChannel,
                wranIfSmManagedChannelStatus,
                wranIfSmManagedChannelRecentEvent }
  STATUScurrent
  DESCRIPTION
    "This group contains objects used to track how
                channels the SM is managing have been
                classified."
  ::= { wranIfSmMibGroups 4 }

wranIfSmChannelSetGroupOBJECT-GROUP
  OBJECTS{ wranIfSmChannelSetIndex,
                wranIfSmSizeWranOccupiedChannelSet,
                wranIfSmWranOccupiedChannelSet,
                wranIfSmSizeNghbrWranBackupChannelSet,
                wranIfSmNghbrWranBackupChannelSet,
                wranIfSmSizeLocalPrioritySet1,
                wranIfSmLocalPrioritySet1,
                wranIfSmSizeLocalPrioritySet2,
                wranIfSmLocalPrioritySet2,
                wranIfSmSizeLocalPrioritySet3,
                wranIfSmLocalPrioritySet3 }
  STATUScurrent
  DESCRIPTION
    "This group contains objects used to track the
                various channel sets with which the SM operates."
  ::= { wranIfSmMibGroups 5 }

wranIfSmCurrentStatusGroupOBJECT-GROUP
  OBJECTS{ wranIfSmCurrentStatusIndex,
                wranIfSmCurrentState, wranIfSmRecentEvent,
                wranIfSmRecentAction,
                wranIfSmInitiateChannelMove,
                wranIfSmSelfCoexistenceMode,
                wranIfSmCurrentOperatingChannel,
                wranIfSmRecentSignalType, wranIfSmCurrentT47,
                wranIfSmCurrentT46 }
  STATUScurrent
  DESCRIPTION
    "This group contains objects used to track the
                current state of the SM."
  ::= { wranIfSmMibGroups 6 }

wranIfSmRegTrackingGroupOBJECT-GROUP
  OBJECTS{ wranIfSmRegTrackingIndex,
                wranIfSmRegTrackingCpeSid,
                wranIfSmRegTrackingCurrentT30,
```

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```
                wranIfSmRegTrackingLocStringSize,
                wranIfSmRegTrackingLocString }
  STATUScurrent
  DESCRIPTION
    "This group contains objects the SM uses to
                keep track of the location of registered
                CPEs."
  ::= { wranIfSmMibGroups 7 }

wranIfSmTrapControlGroupOBJECT-GROUP
  OBJECTS{ wranIfSmTrapControl }
  STATUScurrent
  DESCRIPTION
    "This group contains objects related to
                enabling/disabling traps related to SM
                operation."
  ::= { wranIfSmMibGroups 8 }

wranIfSmNotificationsGroupOBJECT-GROUP
  OBJECTS{ wranIfSmBlmReqChangeTrap,
                wranIfSmBlmRepChangeTrap,
                wranIfSmOccupiedChannelSetChangeTrap,
                wranIfSmNghbrBackupChannelSetChangeTrap,
                wranIfSmLocalPrioritySet1ChangeTrap,
                wranIfSmLocalPrioritySet2ChangeTrap,
                wranIfSmLocalPrioritySet3ChangeTrap,
                wranIfSmCurrentStatusChangeTrap,
                wranIfSmRegTrackingChangeTrap,
                wranIfSmNotificationSid,
                wranIfSmNotificationBlmTransactionId,
                wranIfSmNotificationSizeOccupiedChannelSet,
                wranIfSmNotificationOccupiedChannelSet,
                wranIfSmNotificationSizeBackupChannelSet,
                wranIfSmNotificationBackupChannelSet,
                wranIfSmNotificationSizeLocalPrioritySet1,
                wranIfSmNotificationLocalPrioritySet1,
                wranIfSmNotificationSizeLocalPrioritySet2,
                wranIfSmNotificationLocalPrioritySet2,
                wranIfSmNotificationSizeLocalPrioritySet3,
                wranIfSmNotificationLocalPrioritySet3,
                wranIfSmNotificationRecentAction,
                wranIfSmPendingBlmReqStatus,
                wranIfSmBlmRepStatus,
                wranIfSmOccupiedChannelSetStatus,
                wranIfSmNghbrBackupChannelSetStatus,
                wranIfSmLocalPrioritySet1Status,
                wranIfSmLocalPrioritySet2Status,
                wranIfSmLocalPrioritySet3Status,
```

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```
                wranIfSmCurentStateStatus }
    STATUScurrent
    DESCRIPTION
      "This group contains notification objects
                related to traps configured for the SM."
    ::= { wranIfSmMibGroups 9 }

  wranIfSmMibComplianceMODULE-COMPLIANCE
    STATUScurrent
    DESCRIPTION
      "MIB objects that are optional and mandatory for SM
                compliance."
    MODULEwranIfSmMib
    MANDATORY-GROUPS{ wranIfSmConfigGroup, ,
                wranIfSmChClassificationGroup,
                wranIfSmChannelSetGroup,
                wranIfSmCurrentStatusGroup,
                wranIfSmRegTrackingGroup,
                wranIfSmTrapControlGroup }
    -- OPTIONAL-GROUPS{ wranIfSmPendingBlmReqGroup,
                        wranIfSmBlmRepGroup,
                        wranIfSmNotificationsGroup }
    ::= { wranIfSmMib 12 }

END
```

14.2.6 wranIfSsaMib

```
IEEE802dot22-WRAN-IF-SSA-MIB::=BEGIN

      IMPORTS
            MODULE-IDENTITY,
            OBJECT-TYPE,
            NOTIFICATION-TYPE,
            Unsigned32, Integer32, Counter32,
            Counter64
                  FROM SNMPv2-SMI
            SnmpAdminString
                  FROM SNMP-FRAMEWORK-MIB
            TEXTUAL-CONVETION,
            MacAddress, RowStatus, TruthValue,
            TimeStamp, DateAndTime
                  FROM SNMPv2-TC
            InetAddressType, InetAddress
                  FROM INET-ADDRESS-MIB
            OBJECT-GROUP,
            MODULE-COMPLIANCE,
```

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```
            NOTIFICATION-GROUP
                  FROM SNMPV2-CONF

      wranIfSsaMibMODULE-IDENTITY
            LAST-UPDATED"201405300000Z"-- May 30, 2014
            ORGANIZATION"IEEE 802.22"
            CONTACT-INFO
                  "WG E-mail:STDS-802-22@LISTSERV.IEEE.ORG
                   WG Chair:Apurva N. Mody
                   E-mail:apurva.mody@ieee.org

                   TGa Chair/Editor:  Ranga Reddy
                   E-mail:      ranga.reddy@ieee.org"
            DESCRIPTION
                  "This material is from IEEE Std 802.22a-2014
                   Copyright (c) 2014. This MIB Module object is
                   related to configuration, operation and monitoring
                   of the Spectrum Sensing Automaton (SSA). Objects in
                   this module are based on IEEE Std 802.22-2011 and is
                   under iso(1).std(0).iso8802(8802).wran(22)
                   .wranIfSsaMib(6)"
    REVISION      "201405300000Z"
    DESCRIPTION
      "The first version of IEEE802dot22-WRAN-IF-SSA-MIB."
    ::= {iso std(0) iso8802(8802) wran(22) 6}

  wranIfSsaSensingCapTableOBJECT IDENTIFIER
                  ::= { wranIfSsaMib 1 }
  wranIfSsaStatusTableOBJECT IDENTIFIER
                  ::= { wranIfSsaMib 2 }
  wranIfSsaConfigTableOBJECT IDENTIFIER
                  ::= { wranIfSsaMib 3 }
  wranIfSsaPendingBlmRepTableOBJECT IDENTIFIER
                  ::= { wranIfSsaMib 4 }
  wranIfSsaSensingRecordTableOBJECT IDENTIFIER
                  ::= { wranIfSsaMib 5 }
  wranIfSsaSsfMode0OutputTableOBJECT IDENTIFIER
                  ::= { wranIfSsaMib 6 }
  wranIfSsaSsfMode1OutputTableOBJECT IDENTIFIER
                  ::= { wranIfSsaMib 7 }
  wranIfSsaSsfMode2OutputTableOBJECT IDENTIFIER
                  ::= { wranIfSsaMib 8 }
  wranIfSsaSsfWiMicMSFTableOBJECT IDENTIFIER
                  ::= { wranIfSsaMib 9 }
  wranIfSsaGeolocationTableOBJECT IDENTIFIER
                  ::= { wranIfSsaMib 10 }
  wranIfSsaTrapControlOBJECT IDENTIFIER
```

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```
                ::= { wranIfSsaMib 11 }
wranIfSsaTrapDefinitionOBJECT IDENTIFIER
                ::= { wranIfSsaMib 12 }
wranIfSsaNotificationObjectsTableOBJECT IDENTIFIER
                ::= { wranIfSsaMib 13 }
wranIfSsaMibGroupsOBJECT IDENTIFIER
                ::= { wranIfSsaMib 14 }
wranIfSsaMibComplianceOBJECT IDENTIFIER
                ::= { wranIfSsaMib 15 }

wranIfSsaSensingCapTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfSsaSensingCapEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB object represents a table that stores the
                current sensing capabilities for a SSA under control
                of the SM. There is one entry in this table for a
                SSA, defined by wranIfSsaSensingCapEntry. This MIB
                is stored at the BS and CPE. These values are also
                stored in wranIfBsCpeRegCapabilityRspTable (see
                14.1.2.2.7) at the BS, in an entry specific to a
                particular CPE."
  ::= { wranIfSsaMib 1 }

wranIfSsaSensingCapEntryOBJECT-TYPE
  SYNTAXwranIfSsaSensingCapEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                wranIfSsaSensingCapTable. The entry is identified by
                wranIfSsaSensingCapIndex."
  INDEX{ wranIfSsaSensingCapIndex }
  ::= { wranIfSsaSensingCapTable 1 }

wranIfSsaSensingCapEntry::= SEQUENCE {
  wranIfSsaSensingCapIndexINTEGER,
  wranIfSsaSensingThresholdINTEGER,
  wranIfSsaSensRecContigPeriodDurationInteger32,
  wranIfSsaSensRecNumPeriodsINTEGER,
  wranIfSsaSensRecPeriodIntervalInteger32 }

wranIfSsaSensingCapIndexOBJECT-TYPE
  SYNTAXINTEGER (1..1)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
```

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```
    "Index of entry in the table, defaults to 1."
  ::= { wranIfSsaSensingCapEntry 1 }

wranIfSsaSensingThresholdOBJECT-TYPE
  SYNTAXINTEGER (1..255)
  UNITS          "dBm"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "This object is the recommended sensing threshold
                that the CPE is capable of supporting. It is in
                units of dBm, encoded in a single, integer byte
                value that is assumed to be negative (e.g., 0x01 =
                -1 dBm, 0x72 = -114 dBm)."
  ::= { wranIfSsaSensingCapEntry 2 }

wranIfSsaSensRecContigPeriodDurationOBJECT-TYPE
  SYNTAXInteger32 (0..1023)
  UNITS          "symbols"
  MAX-ACCESSread- write
  STATUScurrent
  DESCRIPTION
    "This object is the recommended contiguous sensing
                period duration that the CPE is capable of
                supporting. It is in integer, in units of symbols.
                This value ranges from 0 to 1023 and is encoded in
                a 2-octet length value."
  ::= { wranIfSsaSensingCapEntry 3 }

wranIfSsaSensRecNumPeriodsOBJECT-TYPE
  SYNTAXINTEGER (1..255)
  MAX-ACCESSread- write
  STATUScurrent
  DESCRIPTION
    "This object is the recommended number of sensing
                periods that a CPE can support. It is an integer
                value, encoded in 1-octet length value."
  ::= { wranIfSsaSensingCapEntry 4 }

wranIfSsaSensRecPeriodIntervalOBJECT-TYPE
  SYNTAXInteger32 (0..2047)
  UNITS          "frames"
  MAX-ACCESSread- write
  STATUScurrent
  DESCRIPTION
    "This object is the recommended interval between
                sensing periods that a CPE can support. It is an
                integer value, in units of frames. It is encoded in
```

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```
                    a 2-octet length value."
  ::= { wranIfSsaSensingCapEntry 5 }

wranIfSsaStatusTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfSsaStatusEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB object represents a table that tracks what
                    the current state the SSA is in. There is only one
                    entry in this table, to define the current state of
                    the SSA, as well as any parameters of interest for
                    current SSA procedures. This entry is defined by
                    wranIfSsaStatusEntry."
  ::= { wranIfSsaMib 2 }

wranIfSsaStatusEntryOBJECT-TYPE
  SYNTAXwranIfSsaStatusEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                    wranIfSsaStatusTable. The entry is identified by
                    wranIfSsaStatusIndex."
  INDEX{ wranIfSsaStatusIndex }
  ::= { wranIfSsaStatusTable 1 }

wranIfSsaStatusEntry::= SEQUENCE {
  wranIfSsaStatusIndex     INTEGER,
  wranIfSsaCurrentState    INTEGER,
  wranIfSsaRecentEvent     INTEGER,
  wranIfSsaRecentAction    INTEGER,
  wranIfSsaIpcUpdChannelsSizeINTEGER,
  wranIfSsaIpcUpdChannels  OCTET STRING,
  wranIfSsaCurrentT48      Integer32,
  wranIfSsaCurrentT49      Integer32,
  wranIfSsaCurrentT50      Integer32,
  wranIfSsaIntraFrameQpCycleLengthINTEGER,
  wranIfSsaIntraFrameQpCycleOffsetINTEGER,
  wranIfSsaIntraFrameQpCycleFrameBitmapBITS,
  wranIfSsaIntraFrameQpDurationINTEGER,
  wranIfSsaInterFrameQpDurationINTEGER,
  wranIfSsaInterFrameQpOffsetInteger32 }

wranIfSsaStatusIndexOBJECT-TYPE
  SYNTAXINTEGER (1..1)
  MAX-ACCESSread-only
  STATUScurrent
```

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```
  DESCRIPTION
    "Index of entry in the table, defaults to 1."
  ::= { wranIfSsaStatusEntry 1 }

wranIfSsaCurrentStateOBJECT-TYPE
  SYNTAXINTEGER { inBandSensing(0),
                  outOfBandSensing(1) }
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The current state of the SSA is in (see 10.3.1,
                Figure 173), either “SSA In-band Sensing” or “SSA
                Out-of-band Sensing."
  ::= { wranIfSsaStatusEntry 2 }

wranIfSsaRecentEventOBJECT-TYPE
  SYNTAX
    INTEGER { blmReqInBandChannelMeasurements(0),
                  quietPeriodEnds(1),
                  quietPeriodCommences(2),
                  ssaIdleTime(3),
                  ssaInitialization(4),
                  blmReqOutOfBandChannelMeasurements(5),
                  lossOfContactWithSm(6) }
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The recent event that caused entry in the current
                state (see 10.3.1, Figure 173). "
  ::= { wranIfSsaStatusEntry 3 }

wranIfSsaRecentActionOBJECT-TYPE
  SYNTAXINTEGER { ssaBlmRepGeneration(0),
                  ssaReportSensingResults(1),
                  ssaInBandSensing(2),
                  ssaIdleTime(3),
                  ssaInitialization(4),
                  lossOfContactWithSm(5) }
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The recent action, triggered by recent event, that
                was undertaken while entering into the current state
                (see 10.3.1, Figure 173)."
  ::= { wranIfSsaStatusEntry 4 }

wranIfSsaIpcUpdChannelsSizeOBJECT-TYPE
  SYNTAXINTEGER (1..255)
```

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```
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Number of channels in
                    wranIfSsaIpcUpdChannels."
    ::= { wranIfSsaStatusEntry 5 }

  wranIfSsaIpcUpdChannelsOBJECT-TYPE
    SYNTAX
      OCTET STRING
                   (SIZE(wranIfSsaIpcUpdChannelsSize))
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Contents of most recent IPC-UPD message received
                    from SM."
    ::= { wranIfSsaStatusEntry 6 }

  wranIfSsaCurrentT48OBJECT-TYPE
    SYNTAXInteger32 (1..600)
    UNITS          "seconds"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Current value of T48 in in 0.1 s increments from 0
                    to 60 s."
    ::= { wranIfSsaStatusEntry 7 }

  wranIfSsaCurrentT49OBJECT-TYPE
    SYNTAXInteger32 (1..600)
    UNITS          "seconds"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Current value of T49 in in 0.1 s increments from 0
                    to 60 s."
    ::= { wranIfSsaStatusEntry 8 }

  wranIfSsaCurrentT50OBJECT-TYPE
    SYNTAXInteger32 (1..600)
    UNITS          "seconds"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Current value of T50 in in 0.1 s increments from 0
                    to 60 s."
    ::= { wranIfSsaStatusEntry 9 }
```

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```
wranIfSsaIntraFrameQpCycleLengthOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  UNITS         "superframes"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Obtained from CHQ-REQ or SCH. Specified in number of
     superframes, it indicates the spacing between the
                  superframes for which the intra-frame quiet period
                  specification is valid. For example, if this field
                  is set 1, the Quiet Period Cycle repeats every
                  superframe; if it is set to 2, the Quiet Period
                  Cycle repeats every 2 superframes, etc. When = 0, no
                  intra-frame quiet period is scheduled or the current
                  intra-frame quiet period is canceled."
  ::= { wranIfSsaStatusEntry 10 }

wranIfSsaIntraFrameQpCycleOffsetOBJECT-TYPE
  SYNTAXINTEGER (1..255)
  UNITS         "superframes"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Obtained from CHQ-REQ or SCH. Valid only if intra-
                  frame Sensing Cycle Length > 0. Used for in-band
                  intra-frame sensing. Specified in number of
                  superframes, it indicates the offset from this SCH
                  transmission to the beginning of the first
                  superframe in the current intra-frame sensing
                  cycle."
  ::= { wranIfSsaStatusEntry 11 }

wranIfSsaIntraFrameQpCycleFrameBitmapOBJECT-TYPE
  SYNTAXBITS { frame1(1), frame2(2), frame3(3),
               frame4(4), frame5(5), frame6(6),
               frame7(7), frame8(8), frame9(9),
               frame10(10), frame11(11), frame12(12),
               frame13(13), frame14(14), frame15(15),
               frame16(16) }
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Obtained from CHQ-REQ or SCH. Valid only if intra-
                  frame Quiet Period Cycle Length > 0. Valid for each
                  superframe identified by the Intra-frame Quiet
                  Period Cycle Length, each bit in the bitmap
                  corresponds to one frame within the superframe. If
                  the bit is set to 0, no intra-frame quiet period
```

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```
                shall be scheduled in the corresponding frame. If
                the bit is set to 1, an intra-frame quiet period
                shall be scheduled within the corresponding frame
                for the duration specified by Intra-frame Quiet
                period Duration."
  ::= { wranIfSsaStatusEntry 12 }

wranIfSsaIntraFrameQpDurationOBJECT-TYPE
  SYNTAXINTEGER (1..16)
  UNITS         "symbols"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Obtained from CHQ-REQ or SCH. Valid only if Intra-
                frame Quiet Period Cycle Length > 0. If this field
                is set to a value different from 0 (zero): it
                indicates the number of symbols starting from the
                end of the frame during which no transmission shall
                take place."
  ::= { wranIfSsaStatusEntry 13 }

wranIfSsaInterFrameQpDurationOBJECT-TYPE
  SYNTAXINTEGER (1..16)
  UNITS         "frames"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Obtained from CHQ-REQ or SCH. Used for in-band
                inter-frame sensing, it indicates the duration of
                the next scheduled quiet period. When > 0, it
                indicates the number of frames starting from Inter-
                frame Quiet Period Offset that shall be used to
                perform inter-frame sensing. When == 0, it cancels
                the next scheduled quiet period for inter-frame
                sensing or indicates that no inter-frame sensing are
                currently scheduled."
  ::= { wranIfSsaStatusEntry 14 }

wranIfSsaInterFrameQpOffsetOBJECT-TYPE
  SYNTAXInteger32 (0..4096)
  UNITS         "frames"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Obtained from CHQ-REQ or SCH. Used for in-band
                inter-frame sensing, it indicates the time span
                between the transmission of this information and the
                next scheduled quiet period for inter-frame sensing.
```

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```
                Bit 31-12: set to 0. Bit 11-4: index the superframe
                number, Bit 3-0: index the frame number when the
                next scheduled quiet period for inter-frame sensing
                will start."
  ::= { wranIfSsaStatusEntry 15 }

wranIfSsaConfigTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfSsaConfigEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB object represents a table that tracks what
                the default configuration of SSA timers and
                constants. There is only one entry in this table, to
                define the default configuration of the SSA. This
                entry is defined by wranIfSsaConfigEntry."
  ::= { wranIfSsaMib 3 }

wranIfSsaConfigEntryOBJECT-TYPE
  SYNTAXwranIfSsaConfigEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                wranIfSsaConfigTable. The entry is identified by
                wranIfSsaConfigIndex."
  INDEX{ wranIfSsaConfigIndex }
  ::= { wranIfSsaConfigTable 1 }

wranIfSsaConfigEntry::= SEQUENCE {
  wranIfSsaConfigIndexINTEGER,
  wranIfSsaT19                Integer32,
  wranIfSsaT29                Integer32,
  wranIfSsaMaxBlmRepRetriesINTEGER,
  wranIfSsaChAvailabilityCheckTimeINTEGER,
  wranIfSsaNonOccupancyPeriodInteger32,
  wranIfSsaChannelDetectionTimeINTEGER,
  wranIfSsaChannelSetupTimeINTEGER,
  wranIfSsaChannelOpeningTxTimeInteger32,
  wranIfSsaChannelMoveTimeINTEGER,
  wranIfSsaChannelClosingTxTimeINTEGER,
  wranIfSsaMicProtectionRadiusInteger32,
  wranIfSsaT41                INTEGER,
  wranIfSsaT42                INTEGER,
  wranIfSsaT43                INTEGER,
  wranIfSsaT44                INTEGER,
  wranIfSsaT45                Integer32,
  wranIfSsaT59                Integer32,
```

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```
  wranIfSsaT47              Integer32,
  wranIfSsaT48              Integer32,
  wranIfSsaT49              Integer32,
  wranIfSsaT50              Integer32,
  wranIfSsaT51              Integer32,
  wranIfSsaT53              Integer32,
  wranIfSsaT54              Integer32,
  wranIfSsaT55              INTEGER,
  wranIfSsaT60              INTEGER }

wranIfSsaConfigIndexOBJECT-TYPE
  SYNTAXINTEGER (1..1)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in the table, defaults to 1."
  ::= { wranIfSsaConfigEntry 1 }

wranIfSsaT19OBJECT-TYPE
  SYNTAXInteger32 (30..86400)
  UNITS          "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Time DS-channel remains unusable."
  ::= { wranIfSsaConfigEntry 2 }

wranIfSsaT29OBJECT-TYPE
  SYNTAXInteger32 (10..300)
  UNITS          "milliseconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Wait for BLM-ACK timeout."
  ::= { wranIfSsaConfigEntry 3 }

wranIfSsaMaxBlmRepRetriesOBJECT-TYPE
  SYNTAXINTEGER (3..16)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Maximum number of retry attempts allowed for sending
                  BLM-REP."
  ::= { wranIfSsaConfigEntry 4 }

wranIfSsaChAvailabilityCheckTimeOBJECT-TYPE
  SYNTAXINTEGER (30..255)
  UNITS          "seconds"
```

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```
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Time during which a TV channel shall be checked for
                    the presence of licensed incumbent signals having a
                    level above the incumbent detection threshold prior
                    to commencement of WRAN operation in the channel
                    and, in the case of TV, a related channel at an EIRP
                    level that can affect the measured TV channel."
    ::= { wranIfSsaConfigEntry 5 }

  wranIfSsaNonOccupancyPeriodOBJECT-TYPE
    SYNTAXINTEGER (10..1440)
    UNITS         "minutes"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "The required period during which WRAN device
                    transmissions SHALL NOT occur in a given TV channel
                    because of the detected presence of an incumbent
                    signal in that channel above the Incumbent detection
                    threshold or, in the case of TV, above a given EIRP
                    level."
    ::= { wranIfSsaConfigEntry 6 }

  wranIfSsaChannelDetectionTimeOBJECT-TYPE
    SYNTAXINTEGER (2..255)
    UNITS         "seconds"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Maximum time taken by a WRAN device to detect a
                    licensed incumbent signal above the Incumbent
                    Detection Threshold within a given TV channel during
                    normal WRAN operation."
    ::= { wranIfSsaConfigEntry 7 }

  wranIfSsaChannelSetupTimeOBJECT-TYPE
    SYNTAXINTEGER (2..255)
    UNITS         "seconds"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "The window of time that may be taken by a WRAN CPE
                    to transmit control information to a WRAN base
                    station in order to establish operation with that
                    base station at the prescribed power or, in the case
                    of TV, at or below the allowable EIRP within a given
```

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```
                    TV channel."
  ::= { wranIfSsaConfigEntry 8 }

wranIfSsaChannelOpeningTxTimeOBJECT-TYPE
  SYNTAXInteger32 (100..1000)
  UNITS          "milliseconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The aggregate duration of control transmissions by
                    WRAN devices during the Channel Setup Time, which
                    starts at the end of the Channel Availability Check
                    Time."
  ::= { wranIfSsaConfigEntry 9 }

wranIfSsaChannelMoveTimeOBJECT-TYPE
  SYNTAXINTEGER (2..255)
  UNITS          "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The time taken by WRAN system to cease all
                    interfering transmissions on the current TV channel
                    upon detection of a license incumbent signal above
                    the relevant Incumbent Detection Threshold or, in
                    the case of TV, to alternatively reduces its EIRP to
                    which is allowable within a given TV channel upon
                    detection of a TV signal in the same or a related
                    channel."
  ::= { wranIfSsaConfigEntry 10 }

wranIfSsaChannelClosingTxTimeOBJECT-TYPE
  SYNTAXInteger32 (100..1000)
  UNITS          "milliseconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The aggregate duration of control transmissions by
                    the WRAN devices during the Channel Move/EIRP
                    Reduction Time, which starts upon detection of a
                    licensed incumbent signal above the relevant
                    Incumbent Detection Threshold."
  ::= { wranIfSsaConfigEntry 11 }

wranIfSsaMicProtectionRadiusOBJECT-TYPE
  SYNTAXInteger32 (100..100000)
  UNITS          "meters"
  MAX-ACCESSread-write
```

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```
    STATUScurrent
    DESCRIPTION
      "Radius of contour within which the WRAN system
                  cannot operate due to potential interference with
                  the microphone."
    ::= { wranIfSsaConfigEntry 12 }

  wranIfSsaT41OBJECT-TYPE
    SYNTAXINTEGER (1..10)
    UNITS         "seconds"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Maximum time interval allowed before sensing is
                  performed on the candidate channel to determine that
                 no
                  incumbents are detected."
    ::= { wranIfSsaConfigEntry 13 }

  wranIfSsaT42OBJECT-TYPE
    SYNTAXINTEGER (1..10)
    UNITS         "seconds"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Maximum time interval allowed before sensing is
                  performed on the backup channel to determine that no
                  incumbents are detected."
    ::= { wranIfSsaConfigEntry 14 }

  wranIfSsaT43OBJECT-TYPE
    SYNTAXINTEGER (1..100)
    UNITS         "seconds"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Minimum time duration without detection of any
                  incumbent for a candidate channel to transition to
                  the backup channel."
    ::= { wranIfSsaConfigEntry 15 }

  wranIfSsaT44OBJECT-TYPE
    SYNTAXINTEGER (1..10)
    UNITS         "seconds"
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Maximum time to determine that the channel move
```

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```
                information is successfully conveyed to all the
                associated CPEs and BS (self-coexistence mode)."
  ::= { wranIfSsaConfigEntry 16 }

wranIfSsaT45OBJECT-TYPE
  SYNTAXInteger32 (1..720)
  UNITS         "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Maximum WRAN operation time without access to the
                incumbent database service from 0.1 h to 72 h in
                0.1 h increments."
  ::= { wranIfSsaConfigEntry 17 }

wranIfSsaT59OBJECT-TYPE
  SYNTAXInteger32 (1..4096)
  UNITS         "frames"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Waiting time before which the CPE moves to its
                backup channels if it no longer hears from its BS.
                This is used to make sure that the CPE waits long
                enough after UCS notification so that BS has had
                time to move to the backup channel, it decided to do
                so."
  ::= { wranIfSsaConfigEntry 18 }

wranIfSsaT47OBJECT-TYPE
  SYNTAXInteger32 (1..4096)
  UNITS         "hours"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The prescribed time by the WRAN operator to refresh
                the incumbent database service, from 0.1 h to 72
                h in 0.1 h increments."
  ::= { wranIfSsaConfigEntry 19 }

wranIfSsaT48OBJECT-TYPE
  SYNTAXInteger32 (1..600)
  UNITS         "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Lapse timer keeps track of whether the Operating
                Channel N has been cleared using spectrum sensing,
```

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```
                    from 0.1 s to 60 s in 0.1 s increments."
  ::= { wranIfSsaConfigEntry 20 }

wranIfSsaT49OBJECT-TYPE
  SYNTAXInteger32 (1..600)
  UNITS          "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Lapse timer keeps track of whether the Operating
                    Channel N-1 has been cleared using spectrum sensing,
                    from 0.1 s to 60 s in 0.1 s increments."
  ::= { wranIfSsaConfigEntry 21 }

wranIfSsaT50OBJECT-TYPE
  SYNTAXInteger32 (1..600)
  UNITS          "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Lapse timer keeps track of whether the Operating
                    Channel N+1 has been cleared using spectrum sensing,
                    from 0.1 s to 60 s in 0.1 s increments."
  ::= { wranIfSsaConfigEntry 22 }

wranIfSsaT51OBJECT-TYPE
  SYNTAXInteger32 (1..600)
  UNITS          "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Initiated when SSA loses contact with the SM, from
                    0.1 s to 60 s in 0.1 s increments."
  ::= { wranIfSsaConfigEntry 23 }

wranIfSsaT53OBJECT-TYPE
  SYNTAXInteger32 (1..600)
  UNITS          "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The parameter TINsens is used to verify that in-band
                    sensing has been done within the required In-service
                    monitoring period. The TINsens parameter is driven
                    by regulatory domain requirements (Annex A), from
                    0.1 s to 60 s in 0.1 s increments."
  ::= { wranIfSsaConfigEntry 24 }
```

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```
wranIfSsaT54OBJECT-TYPE
  SYNTAXInteger32 (1..600)
  UNITS          "seconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The parameter TOUTsens is used to verify that out-
                of-band sensing has been done within the required
                “Acquiring a channel monitoring period” specified in
                Annex A. This value would be used to initialize
                a lapse timer for each channel in the backup
                candidate channel list at each CPE so that it
                compared to Tsens, from 0.1 s to 60 s in 0.1 s
                increments."
  ::= { wranIfSsaConfigEntry 25 }

wranIfSsaT55OBJECT-TYPE
  SYNTAXINTEGER (1..160)
  UNITS          "milliseconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The T55 or Tsensin parameter corresponds to the
                maximum length of time required to carry out the in-
                band sensing process (see Figure 176). Manufacturers
                need to specify the sensing time required to detect
                the specified signals with required accuracy for in-
                band sensing."
  ::= { wranIfSsaConfigEntry 26 }

wranIfSsaT60OBJECT-TYPE
  SYNTAXINTEGER (20..160)
  UNITS          "milliseconds"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "The T60 or Tsensout parameter corresponds to the
                maximum length of time required to carry out the
                out-of-band sensing process (see  Figure 178).
                Manufacturers need to specify the sensing time
                required to detect the specified signals with
                required accuracy for out-of-band sensing."
  ::= { wranIfSsaConfigEntry 27 }

wranIfSsaPendingBlmRepTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfSsaPendingBlmRepEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
```

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```
  DESCRIPTION
    "This MIB object represents a table that tracks the
                status of the execution of ongoing reporting (BLM-
                REP) in response to BLM-REQs. For each BLM-REQ there
                is a corresponding BLM-RSP to indicate that REQ
                message was received by the SSA. When an SSA is done
                with the sensing, it will send a BLM-REP to the SM.
                This table keeps track of any BLM-REP messages that
                are pending acknowledgement from the SM. When a
                report sent in a response is acknowledged, then the
                entry corresponding to the report and request will
                be cleared. This entry is defined by
                wranIfSsaPendingBlmRepEntry."
  ::= { wranIfSsaMib 4 }

wranIfSsaPendingBlmRepEntryOBJECT-TYPE
  SYNTAXwranIfSsaPendingBlmRepEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                wranIfSsaPendingBlmRepTable. The entry is identified
                by wranIfSsaPendingBlmRepIndex."
  INDEX{ wranIfSsaPendingBlmRepIndex }
  ::= { wranIfSsaPendingBlmRepTable 1 }

wranIfSsaPendingBlmRepEntry::= SEQUENCE {
  wranIfSsaPendingBlmRepIndexINTEGER,
  wranIfSsaPendingBlmReqTransactionIdInteger32,
  wranIfSsaPendingBlmReqMsgSizeInteger32,
  wranIfSsaPendingBlmReqMsgOCTET STRING,
  wranIfSsaPendingBlmRspSentTruthValue,
  wranIfSsaPendingBlmRepGeneratedTruthValue,
  wranIfSsaPendingBlmRepMsgSizeInteger32,
  wranIfSsaPendingBlmRepMsgOCTET STRING,
  wranIfSsaPendingBlmRepSentTruthValue,
  wranIfSsaPendingBlmRepAckTruthValue,
  wranIfSsaPendingBlmRepNumTxINTEGER }

wranIfSsaPendingBlmRepIndexOBJECT-TYPE
  SYNTAXINTEGER (1..10)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in the table."
  ::= { wranIfSsaPendingBlmRepEntry 1 }

wranIfSsaPendingBlmReqTransactionIdOBJECT-TYPE
```

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```
    SYNTAXInteger32 (0..65535)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Transaction ID for pending BLM-REQ."
    ::= { wranIfSsaPendingBlmRepEntry 2 }

  wranIfSsaPendingBlmReqMsgSizeOBJECT-TYPE
    SYNTAXInteger32 (1..65535)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Size of BLM-REQ message stored in
                    wranIfSsaPendingBlmReqMsg."
    ::= { wranIfSsaPendingBlmRepEntry 3 }

  wranIfSsaPendingBlmReqMsgOBJECT-TYPE
    SYNTAX
      OCTET STRING (SIZE(wranIfSsaPendingBlmReqMsgSize))
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Contents of pending BLM-REQ message stored in
       wranIfSsaPendingBlmReqMsg."
    ::= { wranIfSsaPendingBlmRepEntry 4 }

  wranIfSsaPendingBlmRspSentOBJECT-TYPE
    SYNTAXTruthValue
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Indication of whether (Truth(1)) or not (Truth(0))
                    BLM-RSP pertaining to BLM-REQ has been sent."
    ::= { wranIfSsaPendingBlmRepEntry 5 }

  wranIfSsaPendingBlmRepGeneratedOBJECT-TYPE
    SYNTAXTruthValue
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Indication of whether (Truth(1)) or not (Truth(0))
                    BLM-REP corresponding to BLM-REQ has been generated,
                    i.e., sensing has been executed."
    ::= { wranIfSsaPendingBlmRepEntry 6 }

  wranIfSsaPendingBlmRepMsgSizeOBJECT-TYPE
    SYNTAXInteger32 (1..65535)
    MAX-ACCESSread-write
```

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```
    STATUScurrent
    DESCRIPTION
      "Size of BLM-REP message stored in
                    wranIfSsaPendingBlmRepMsg."
    ::= { wranIfSsaPendingBlmRepEntry 7 }

  wranIfSsaPendingBlmRepMsgOBJECT-TYPE
    SYNTAX
      OCTET STRING (SIZE(wranIfSsaPendingBlmRepMsgSize))
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Contents of BLM-REP message that corresponds to the
                    BLM-REQ."
    ::= { wranIfSsaPendingBlmRepEntry 8 }

  wranIfSsaPendingBlmRepSentOBJECT-TYPE
    SYNTAXTruthValue
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Indication of whether (Truth(1)) or not (Truth(0))
                    BLM-REP pertaining to BLM-REQ has been sent. "
    ::= { wranIfSsaPendingBlmRepEntry 9 }

  wranIfSsaPendingBlmRepAckOBJECT-TYPE
    SYNTAXTruthValue
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Indication of whether (Truth(1)) or not (Truth(0))
                    BLM-REP pertaining to BLM-REQ has been acknowledged
                    (via BLM-ACK)."
    ::= { wranIfSsaPendingBlmRepEntry 10 }

  wranIfSsaPendingBlmRepNumTxOBJECT-TYPE
    SYNTAXINTEGER (1..16)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Current number of times that BLM-REP has been
                    resent."
    ::= { wranIfSsaPendingBlmRepEntry 11 }

  wranIfSsaSensingRecordTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfSsaSensingRecordEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
```

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```
  DESCRIPTION
    "This object contains information the sensing status
                of each channel. It is made of multiple entries, one
                for each channel, as defined by
                wranIfSsaSensingRecordEntry."
  ::= { wranIfSsaMib 5 }

wranIfSsaSensingRecordEntryOBJECT-TYPE
  SYNTAXwranIfSsaSensingRecordEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                wranIfSsaSensingRecordTable. The entry is identified
                by wranIfSsaSensingRecordIndex."
  INDEX{ wranIfSsaSensingRecordIndex }
  ::= { wranIfSsaSensingRecordTable 1 }

wranIfSsaSensingRecordEntry::= SEQUENCE {
  wranIfSsaSensingRecordIndexINTEGER,
  wranIfSsaSensingChannelINTEGER,
  wranIfSsaTimeLastSensingDateAndTime,
  wranIfSsaTimeLastPositiveDateAndTime,
  wranIfSsaSensingPathRssiINTEGER,
  wranIfSsaWranPathRssiINTEGER,
  wranIfSsaSignalTypeINTEGER,
  wranIfSsaWranServiceAdvertisementMacAddress,
  wranIfSsaIdcUpdIndicationTruthValue }

wranIfSsaSensingRecordIndexOBJECT-TYPE
  SYNTAXINTEGER (1..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in the table."
  ::= { wranIfSsaSensingRecordEntry 1 }

wranIfSsaSensingChannelOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Channel that sensing has been conducted on, or not
                conducted on if in IPC-UPD."
  ::= { wranIfSsaSensingRecordEntry 2 }

wranIfSsaTimeLastSensingOBJECT-TYPE
  SYNTAXDateAndTime
```

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```
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Last time that this channel was sensed."
  ::= { wranIfSsaSensingRecordEntry 3 }

wranIfSsaTimeLastPositiveOBJECT-TYPE
  SYNTAXDateAndTime
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Last time that signal was positively confirmed on
                 this channel."
  ::= { wranIfSsaSensingRecordEntry 4 }

wranIfSsaSensingPathRssiOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  UNITS         "dBm"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "RSSI on sensing path, between -104 dBm to +23.5 dBm
                 in 0.5 dB steps."
  ::= { wranIfSsaSensingRecordEntry 5 }

wranIfSsaWranPathRssiOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  UNITS         "dBm"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "RSSI on WRAN signal path., between -104 dBm to
                 +23.5 dBm in 0.5 dB steps."
  ::= { wranIfSsaSensingRecordEntry 6 }

wranIfSsaSignalTypeOBJECT-TYPE
  SYNTAXINTEGER { undetermined(0),
                  ieee802dot22wran(1),
                  atsc(2),
                  dvbt(3),
                  isdbt(4),
                  ntsc(5),
                  pal(6),
                  secam(7),
                  wirelessMicrophone(8),
                  ieee802dot22dot1Sync(9),
                  ieee802dot22dot1Msf1(10),
                  ieee802dot22dot1Msf2(11),
```

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```
                    ieee802dot22dot1Msf3(12) }
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Type of signal that was sensed on the channel."
  ::= { wranIfSsaSensingRecordEntry 7 }

wranIfSsaWranServiceAdvertisementOBJECT-TYPE
  SYNTAXMacAddress
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "If signal type was for WRAN, this indicates the BS
                ID of the captured SCH from neighbor WRAN."
  ::= { wranIfSsaSensingRecordEntry 8 }

wranIfSsaIdcUpdIndicationOBJECT-TYPE
  SYNTAXTruthValue
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    " Indication if channel is on IPC-UPD."
  ::= { wranIfSsaSensingRecordEntry 9 }

wranIfSsaSsfMode0OutputTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfSsaSsfMode0OutputEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object contains the current output of SSF Mode
                0 sensing. It is made up of multiple entries, one
                for each signal type that was sensed. Each entry is
                defined by wranIfSsaSsfMode0OutputEntry."
  ::= { wranIfSsaMib 6 }

wranIfSsaSsfMode0OutputEntryOBJECT-TYPE
  SYNTAXwranIfSsaSsfMode0OutputEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                wranIfSsaSsfMode0OutputTable. The entry is
                identified by wranIfSsaSsfMode0OutputIndex."
  INDEX{ wranIfSsaSsfMode0OutputIndex }
  ::= { wranIfSsaSsfMode0OutputTable 1 }

wranIfSsaSsfMode0OutputEntry::= SEQUENCE {
  wranIfSsaSsfMode0OutputIndexINTEGER,
```

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```
    wranIfSsaSsfMode0SignalTypeINTEGER,
    wranIfSsaSsfMode0SignalPresentTruthValue }

  wranIfSsaSsfMode0OutputIndexOBJECT-TYPE
    SYNTAXINTEGER (1..32)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index of entry in the table."
    ::= { wranIfSsaSsfMode0OutputEntry 1 }

  wranIfSsaSsfMode0SignalTypeOBJECT-TYPE
    SYNTAXINTEGER { undetermined(0),
                    ieee802dot22wran(1),
                    atsc(2),
                    dvbt(3),
                    isdbt(4),
                    ntsc(5),
                    pal(6),
                    secam(7),
                    wirelessMicrophone(8),
                    ieee802dot22dot1Sync(9),
                    ieee802dot22dot1Msf1(10),
                    ieee802dot22dot1Msf2(11),
                    ieee802dot22dot1Msf3(12) }
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Type of signal that was sensed."
    ::= { wranIfSsaSsfMode0OutputEntry 2 }

  wranIfSsaSsfMode0SignalPresentOBJECT-TYPE
    SYNTAXTruthValue
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Indication of whether (Truth(1)) or not (Truth(0)) a
                  signal of signal type was detected."
    ::= { wranIfSsaSsfMode0OutputEntry 3 }

  wranIfSsaSsfMode1OutputTableOBJECT-TYPE
    SYNTAXSEQUENCE OF wranIfSsaSsfMode1OutputEntry
    MAX-ACCESSnot-accessible
    STATUScurrent
    DESCRIPTION
      "This object contains the current output of SSF Mode
                  1 sensing. It is made up of multiple entries, one
                  for each signal type that was sensed. Each entry is
```

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```
                    defined by wranIfSsaSsfMode1OutputEntry."
  ::= { wranIfSsaMib 7 }

wranIfSsaSsfMode1OutputEntryOBJECT-TYPE
  SYNTAXwranIfSsaSsfMode1OutputEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                    wranIfSsaSsfMode1OutputTable. The entry is
                    identified by wranIfSsaSsfMode1OutputIndex."
  INDEX{ wranIfSsaSsfMode1OutputIndex }
  ::= { wranIfSsaSsfMode1OutputTable 1 }

wranIfSsaSsfMode1OutputEntry::= SEQUENCE {
  wranIfSsaSsfMode1OutputIndexINTEGER,
  wranIfSsaSsfMode1SignalTypeINTEGER,
  wranIfSsaSsfMode1SignalPresentTruthValue,
  wranIfSsaSsfMode1SignalConfidenceINTEGER }

wranIfSsaSsfMode1OutputIndexOBJECT-TYPE
  SYNTAXINTEGER (1..32)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in the table."
  ::= { wranIfSsaSsfMode1OutputEntry 1 }

wranIfSsaSsfMode1SignalTypeOBJECT-TYPE
  SYNTAXINTEGER { undetermined(0),
                  ieee802dot22wran(1),
                  atsc(2),
                  dvbt(3),
                  isdbt(4),
                  ntsc(5),
                  pal(6),
                  secam(7),
                  wirelessMicrophone(8),
                  ieee802dot22dot1Sync(9),
                  ieee802dot22dot1Msf1(10),
                  ieee802dot22dot1Msf2(11),
                  ieee802dot22dot1Msf3(12) }
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Type of signal that was sensed."
  ::= { wranIfSsaSsfMode1OutputEntry 2 }
```

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```
wranIfSsaSsfMode1SignalPresentOBJECT-TYPE
  SYNTAXTruthValue
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Indication of whether (Truth(1)) or not (Truth(0)) a
                signal of signal type was detected."
  ::= { wranIfSsaSsfMode1OutputEntry 3 }

wranIfSsaSsfMode1SignalConfidenceOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Confidence level in signal present decision, where
                0x00 represents no confidence and 0xFF represents
                total confidence (see Table 241)."
  ::= { wranIfSsaSsfMode1OutputEntry 4 }

wranIfSsaSsfMode2OutputTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfSsaSsfMode2OutputEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object contains the current output of SSF Mode
                2 sensing. It is made up of multiple entries, one
                for each signal type that was sensed. Each entry is
                defined by wranIfSsaSsfMode2OutputEntry."
  ::= { wranIfSsaMib 8 }

wranIfSsaSsfMode2OutputEntryOBJECT-TYPE
  SYNTAXwranIfSsaSsfMode2OutputEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                wranIfSsaSsfMode2OutputTable. The entry is
                identified by wranIfSsaSsfMode2OutputIndex."
  INDEX{ wranIfSsaSsfMode2OutputIndex }
  ::= { wranIfSsaSsfMode2OutputTable 1 }

wranIfSsaSsfMode2OutputEntry::= SEQUENCE {
  wranIfSsaSsfMode2OutputIndexINTEGER,
  wranIfSsaSsfMode2SignalTypeINTEGER,
  wranIfSsaSsfMode2SignalRssiMeanINTEGER,
  wranIfSsaSsfMode2SignalStdDevRssiINTEGER }

wranIfSsaSsfMode2OutputIndexOBJECT-TYPE
```

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```
  SYNTAX INTEGER (1..32)
  MAX-ACCESS read-only
  STATUS current
  DESCRIPTION
    "Index of entry in the table."
  ::= { wranIfSsaSsfMode2OutputEntry 1 }

wranIfSsaSsfMode2SignalType OBJECT-TYPE
  SYNTAX INTEGER { undetermined(0),
                   ieee802dot22wran(1),
                   atsc(2),
                   dvbt(3),
                   isdbt(4),
                   ntsc(5),
                   pal(6),
                   secam(7),
                   wirelessMicrophone(8),
                   ieee802dot22dot1Sync(9),
                   ieee802dot22dot1Msf1(10),
                   ieee802dot22dot1Msf2(11),
                   ieee802dot22dot1Msf3(12) }
  MAX-ACCESS read-write
  STATUS current
  DESCRIPTION
    "Type of signal that was sensed."
  ::= { wranIfSsaSsfMode2OutputEntry 2 }

wranIfSsaSsfMode2SignalRssiMean OBJECT-TYPE
  SYNTAX INTEGER (0..255)
  MAX-ACCESS read-write
  STATUS current
  DESCRIPTION
    "Mean of RSSI signal measurements, between -104 dBm
                to +23.5 dBm in 0.5 dB steps."
  ::= { wranIfSsaSsfMode2OutputEntry 3 }

wranIfSsaSsfMode2SignalStdDevRssi OBJECT-TYPE
  SYNTAX INTEGER (0..255)
  MAX-ACCESS read-write
  STATUS current
  DESCRIPTION
    "Standard Deviation of RSSI signal measurements,
     between -104 dBm to +23.5 dBm in 0.5 dB steps."
  ::= { wranIfSsaSsfMode2OutputEntry 4 }

wranIfSsaSsfWiMicMSFTable OBJECT-TYPE
  SYNTAX SEQUENCE OF wranIfSsaSsfWiMicMSFEntry
  MAX-ACCESS not-accessible
```

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```
  STATUScurrent
  DESCRIPTION
    "This object contains the current output payload of
                 MSF1, MSF1+MSF2, or MSF1+MSF2+MSF3 of IEEE Std
                 802.22.1-2010 beacon on recently sensed channels. It
                 is made up of multiple entries for each channel one
                 or more MSFs have been sensed on. Each entry is
                 defined by wranIfSsaSsfWiMicMSFEntry."
  ::= { wranIfSsaMib 9 }

wranIfSsaSsfWiMicMSFEntryOBJECT-TYPE
  SYNTAXwranIfSsaSsfWiMicMSFEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                 wranIfSsaSsfWiMicMSFTable. The entry is identified
                 by wranIfSsaSsfWiMicMSFIndex."
  INDEX{ wranIfSsaSsfWiMicMSFIndex }
  ::= { wranIfSsaSsfWiMicMSFTable 1 }

wranIfSsaSsfWiMicMSFEntry::= SEQUENCE {
  wranIfSsaSsfWiMicMSFIndexINTEGER,
  wranIfSsaSsfWiMicMSFChannelINTEGER,
  wranIfSsaSsfWiMicMSFPayloadSizeINTEGER,
  wranIfSsaSsfWiMicMSFPayloadOCTET STRING,
  wranIfSsaSsfWiMicMSFCrc1StatusTruthValue,
  wranIfSsaSsfWiMicMSFCrc2StatusTruthValue,
  wranIfSsaSsfWiMicMSFCrc3StatusTruthValue }

wranIfSsaSsfWiMicMSFIndexOBJECT-TYPE
  SYNTAXINTEGER (1..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in the table."
  ::= { wranIfSsaSsfWiMicMSFEntry 1 }

wranIfSsaSsfWiMicMSFChannelOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Type of signal that was sensed."
  ::= { wranIfSsaSsfWiMicMSFEntry 2 }

wranIfSsaSsfWiMicMSFPayloadSizeOBJECT-TYPE
  SYNTAXINTEGER { msf1(0), msf12(1), msf123(2) }
```

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```
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Size of MSF payload stored in
                    wranIfSsaSsfWiMicMSFPayload. Indicates whether MSF1
                    by itself (15 octets), MSF1+MSF2 (64 octets), or
                    MSF1+MSF2+MSF3 (95 octets) have been captured (see
                    Figure 16, 7.2.1, 7.2.2, and 7.2.3 of IEEE
                    Std 802.22.1-2010). This size does not include
                    CRC1/CRC2/CRC3 from the MSFs."
    ::= { wranIfSsaSsfWiMicMSFEntry 3 }

  wranIfSsaSsfWiMicMSFPayloadOBJECT-TYPE
    SYNTAX
      OCTET STRING (SIZE(wranIfSsaSsfWiMicMSFPayloadSize))
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Payload of MSF1, MSF1+MSF2, or MSF1+MSF2+MSF3, not
                    including CRC1/CRC2/CRC3 fields (see 7.2.1, 7.2.2,
                    7.2.3 of IEEE Std 802.22.1-2010)."
    ::= { wranIfSsaSsfWiMicMSFEntry 4 }

  wranIfSsaSsfWiMicMSFCrc1StatusOBJECT-TYPE
    SYNTAXTruthValue
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Indication of whether (Truth(1)) or not (Truth(0))
                    MSF1 passed verification of CRC1."
    ::= { wranIfSsaSsfWiMicMSFEntry 5 }

  wranIfSsaSsfWiMicMSFCrc2StatusOBJECT-TYPE
    SYNTAXTruthValue
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Indication of whether (Truth(1)) or not (Truth(0))
                    MSF2 passed verification of CRC2."
    ::= { wranIfSsaSsfWiMicMSFEntry 6 }

  wranIfSsaSsfWiMicMSFCrc3StatusOBJECT-TYPE
    SYNTAXTruthValue
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Indication of whether (Truth(1)) or not (Truth(0))
                    MSF3 passed verification of CRC3."
```

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```
  ::= { wranIfSsaSsfWiMicMSFEntry 7 }

wranIfSsaGeolocationTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfSsaGeolocationEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object contains the current parameters and
                calculations being used by the Geolocation component
                of the SSA. It is made up of one entry to contain
                current values being used/calculated in the BS-to-
                CPE fine-ranging, CPE-to-CPE fine ranging,
                geolocation calculation functions. It is made up of
                one entry, defined by wranIfSsaGeoLocationEntry. "
  ::= { wranIfSsaMib 10 }

wranIfSsaGeoLocationEntryOBJECT-TYPE
  SYNTAXwranIfSsaGeoLocationEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                wranIfSsaGeolocationTable. The entry is identified
                by wranIfSsaGeoLocationIndex."
  INDEX{ wranIfSsaGeoLocationIndex }
  ::= { wranIfSsaGeolocationTable 1 }

wranIfSsaGeoLocationEntry::= SEQUENCE {
  wranIfSsaGeolocationIndexINTEGER,
  wranIfSsaGeolocationVernier1SizeInteger32,
  wranIfSsaGeolocationVernier1OCTET STRING
  wranIfSsaGeoLocationVernier2SizeInteger32,
  wranIfSsaGeolocationVernier2OCTET STRING,
  wranIfSsaGeolocationVernier3SizeInteger32,
  wranIfSsaGeolocationVernier3OCTET STRING,
  wranIfSsaGeolocationTRange1Integer32,
  wranIfSsaGeolocationTACbpInteger32 }

wranIfSsaGeoLocationIndexOBJECT-TYPE
  SYNTAXINTEGER (1..1)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in the table."
  ::= { wranIfSsaGeoLocationEntry 1 }

wranIfSsaGeolocationVernier1SizeOBJECT-TYPE
  SYNTAXInteger32 (1..65535)
```

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```
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Size of Vernier1 data recorded only at the CPE."
    ::= { wranIfSsaGeoLocationEntry 2 }

  wranIfSsaGeolocationVernier1OBJECT-TYPE
    SYNTAX
      OCTET STRING (SIZE(wranIfSsaGeolocationVernier1Size))
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Vernier1, recorded only at the CPE."
    ::= { wranIfSsaGeoLocationEntry 3 }

  wranIfSsaGeolocationVernier2SizeOBJECT-TYPE
    SYNTAXInteger32 (1..65535)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Size of Vernier2 data recorded only at the BS."
    ::= { wranIfSsaGeoLocationEntry 4 }

  wranIfSsaGeolocationVernier2OBJECT-TYPE
    SYNTAX
      OCTET STRING (SIZE(wranIfSsaGeolocationVernier2Size))
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Vernier2, recorded only at the BS."
    ::= { wranIfSsaGeoLocationEntry 5 }

  wranIfSsaGeolocationVernier3SizeOBJECT-TYPE
    SYNTAXInteger32 (1..65535)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Size of Vernier3 data recorded only at the CPE."
    ::= { wranIfSsaGeoLocationEntry 6 }

  wranIfSsaGeolocationVernier3OBJECT-TYPE
    SYNTAX
      OCTET STRING (SIZE(wranIfSsaGeolocationVernier3Size))
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Vernier3, recorded only at the CPE."
    ::= { wranIfSsaGeoLocationEntry 7 }
```

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```
wranIfSsaGeolocationTRange1OBJECT-TYPE
  SYNTAXInteger32 (1..1000)
  UNITS          "TU"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "TRange1, also known as T52. Set by BS when
                 downstream bust leaves the BS, i.e., at start of
                 frame preamble."
  ::= { wranIfSsaGeoLocationEntry 5 }

wranIfSsaGeolocationTACbpOBJECT-TYPE
  SYNTAXInteger32 (-1024..+1024)
  UNITS          "TU"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "TACBP, Timing advance for CBP burst used in ranging
     calculations."
  ::= { wranIfSsaGeoLocationEntry 6 }

wranIfSsaTrapControlOBJECT-TYPE
  SYNTAXBITS     { wranIfSsaSensingCapChange(0),
                   wranIfSsaStatusChange(1),
                   wranIfSsaBlmRepChange(2),
                   wranIfSsaSensingRecordChange(3),
                   wranIfSsaSsfMode0Change(4),
                   wranIfSsaSsfMode1Change(5),
                   wranIfSsaSsfMode2Change(6),
                   wranIfSsaSsfWiMicMSFChange(7),
                   wranIfSsaGeolocationChange(9) }
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Defines control elements for traps related to
                 interaction with the Spectrum Sensing Automaton.
                 This is a 9-bit field that enables setting a trap
                 for particular CPE events:
                 wranIfSsaSensingCapChange, wranIfSsaStatusChange,
                 wranIfSsaBlmRepChange, wranIfSsaSensingRecordChange,
                 wranIfSsaSsfMode0Change, wranIfSsaSsfMode1Change,
                 wranIfSsaSsfMode2Change, wranIfSsaSsfWiMicMSFChange,
                 wranIfSsaGeolocationChange."
  ::= { wranIfSsaMib 11 }


wranIfSsaTrapDefinitionOBJECT IDENTIFIER
```

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```
                                ::= { wranIfSsaMib 12 }
wranIfSsaSensingCapChangeTrapOBJECT IDENTIFIER
                                ::= { wranIfSsaTrapDefinition 1 }
wranIfSsaStatusChangeTrap OBJECT IDENTIFIER
                                ::= { wranIfSsaTrapDefinition 2 }
wranIfSsaBlmRepChangeTrap OBJECT IDENTIFIER
                                ::= { wranIfSsaTrapDefinition 3 }
wranIfSsaSensingRecordChangeTrap OBJEEC IDENTIFIER
                                ::= { wranIfSsaTrapDefinition 4 }
wranIfSsaSsfMode0ChangeTrap OBJECT IDENTIFIER
                                ::= { wranIfSsaTrapDefinition 5 }
wranIfSsaSsfMode1ChangeTrap OBJECT IDENTIFIER
                                ::= { wranIfSsaTrapDefinition 6 }
wranIfSsaSsfMode2ChangeTrap OBJECT IDENTIFIER
                                ::= { wranIfSsaTrapDefinition 7 }
wranIfSsaSsfWiMicMSFChangeTrap OBJECT IDENTIFIER
                                ::= { wranIfSsaTrapDefinition 8 }
wranIfSsaGeolocationChangeTrap OBJECT IDENTIFIER
                                ::= { wranIfSsaTrapDefinition 9 }

wranIfSsaSensingCapChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfSsaSensingCapibilityStatus }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to
                configuration of SSA sensing capabilities."
  ::= { wranIfSsaTrapDefinition 1 }

wranIfSsaStatusChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfSsaCurrentState, wranIfSsaRecentEvent,
                wranIfSsaRecentAction, wranIfSsaStatus }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to
                current state of the SSA."
  ::= { wranIfSsaTrapDefinition 2 }

wranIfSsaBlmRepChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfSsaPendingBlmRepIndex,
                wranIfSsaBlmRepStatus }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to
                pending BLM transactions at the SSA."
  ::= { wranIfSsaTrapDefinition 3 }

wranIfSsaSensingRecordChangeTrapNOTIFICATION-TYPE
```

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```
  OBJECTS{ wranIfSsaSensingRecordIndex,
                  wranIfSsaSensingRecordStatus }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to
                  sensing records maintained by the SSA."
  ::= { wranIfSsaTrapDefinition 4 }

wranIfSsaSsfMode0ChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfSsaSsfMode0OutputIndex,
                  wranIfSsaSsfMode0Status }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to
                  sensing output using Mode 0."
  ::= { wranIfSsaTrapDefinition 5 }

wranIfSsaSsfMode1ChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfSsaSsfMode1OutputIndex,
                  wranIfSsaSsfMode1SignalConfidence,
                  wranIfSsaSsfMode1Status }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to
                  sensing output using Mode 1."
  ::= { wranIfSsaTrapDefinition 6 }

wranIfSsaSsfMode2ChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfSsaSsfMode2OutputIndex,
                  wranIfSsaSsfMode2SignalRssiMean,
                  wranIfSsaSsfMode2SignalStdDevRssi,
                  wranIfSsaSsfMode2Status }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to
                  sensing output using Mode 2."
  ::= { wranIfSsaTrapDefinition 7 }

wranIfSsaSsfWiMicMSFChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfSsaSsfWiMicMSFIndex,
                  wranIfSsaSsfWiMicMSFStatus }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to
                  sensing and capturing wireless microphone beacons
                  (see IEEE Std 802.22.1-2010)."
  ::= { wranIfSsaTrapDefinition 8 }
```

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```
wranIfSsaGeolocationChangeTrapNOTIFICATION-TYPE
  OBJECTS{ wranIfSsaGeolocationStatus }
  STATUScurrent
  DESCRIPTION
    "This trap contains the information related to
                terrestrial geolocation."
  ::= { wranIfSsaTrapDefinition 9 }

wranIfSsaNotificationObjectsTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfSsaNotificationObjectsEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This MIB provides a table to track notification
                objects that have been reported by the traps related
                to operation of the SSA. It is made up of one entry,
                containing the objects related to the most recent
                trap/event. The entry is defined by
                wranIfSsaNotificationObjectsEntry."
  ::= { wranIfSsaMib 13 }

wranIfSsaNotificationObjectsEntryOBJECT-TYPE
  SYNTAXwranIfSsaNotificationObjectsEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "Definition of an entry in
                wranIfSsaNotificationObjectsTable. Each entry is
                identified by wranIfSsaNotificationIndex."
  INDEX { wranIfSsaNotificationIndex }
  ::= { wranIfSsaNotificationObjectsTable 1 }

wranIfSsaNotificationObjectsEntry::= SEQUENCE {
  wranIfSsaNotificationIndexINTEGER,
  wranIfSsaNotificationCurrentStateINTEGER,
  wranIfSsaNotificationRecentEventINTEGER,
  wranIfSsaNotificationRecentActionINTEGER,
  wranIfSsaNotificationPendingBlmRepIndexINTEGER,
  wranIfSsaNotificationSensingRecordIndexINTEGER,
  wranIfSsaSsfNotificationMode0OutputIndexINTEGER,
  wranIfSsaSsfNotificationMode1OutputIndexINTEGER,
  wranIfSsaSsfNotificationMode1ConfidenceINTEGER,
  wranIfSsaSsfNotificationMode2OutputIndexINTEGER,
  wranIfSsaSsfNotificationMode2RssiMeanINTEGER,
  wranIfSsaSsfNotificationMode2StdDevRssiINTEGER,
  wranIfSsaSsfNotificationWiMicMSFIndexINTEGER,
  wranIfSsaSensingCapibilityStatusBITS,
  wranIfSsaStatus                BITS,
```

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```
  wranIfSsaBlmRepStatus          INTEGER,
  wranIfSsaSensingRecordStatusBITS,
  wranIfSsaSsfMode0Status        INTEGER,
  wranIfSsaSsfMode1Status   INTEGER,
  wranIfSsaSsfMode2Status   BITS,
  wranIfSsaSsfWiMicMSFStatus INTEGER,
  wranIfSsaGeolocationStatus INTEGER }

wranIfSsaNotificationIndexOBJECT-TYPE
  SYNTAXINTEGER (1..1)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in the table."
  ::= { wranIfSsaNotificationObjectsEntry 1 }

wranIfSsaNotificationCurrentStateOBJECT-TYPE
  SYNTAXINTEGER (0..1)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Current state that SSA is in as defined by current
                  value of wranIfSsaCurrentState."
  ::= { wranIfSsaNotificationObjectsEntry 2 }

wranIfSsaNotificationRecentEventOBJECT-TYPE
  SYNTAXINTEGER (0..6)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
                "Recent event that occurred for SSA as defined by
                  current value of wranIfSsaRecentEvent."
  ::= { wranIfSsaNotificationObjectsEntry 3 }

wranIfSsaNotificationRecentActionOBJECT-TYPE
  SYNTAXINTEGER (0..5)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Recent action SSA has taken as defined by current
                  value of wranIfSsaRecentAction."
  ::= { wranIfSsaNotificationObjectsEntry 4 }

wranIfSsaNotificationPendingBlmRepIndexOBJECT-TYPE
  SYNTAXINTEGER (1..10)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
```

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```
    "Index of entry in wranIfSsaPendingBlmRepTable that
                indicates the handling of which pending BLM-REP has
                triggered a trap."
  ::= { wranIfSsaNotificationObjectsEntry 5 }

wranIfSsaNotificationSensingRecordIndexOBJECT-TYPE
  SYNTAXINTEGER (1..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in wranIfSsaSensingRecordTable that
                indicates the handling of which sensing record
                triggered a trap."
  ::= { wranIfSsaNotificationObjectsEntry 6 }

wranIfSsaSsfNotificationMode0OutputIndexOBJECT-TYPE
  SYNTAXINTEGER (1..32)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in wranIfSsaSsfMode0OutputTable
                that indicates the handling of which signal type
                detected by Mode 0 triggered a trap."
  ::= { wranIfSsaNotificationObjectsEntry 7 }

wranIfSsaSsfNotificationMode1OutputIndexOBJECT-TYPE
  SYNTAXINTEGER (1..32)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Index of entry in wranIfSsaSsfMode1OutputTable
                that indicates the handling of which signal type
                detected by Mode 1 triggered a trap."
  ::= { wranIfSsaNotificationObjectsEntry 8 }

wranIfSsaSsfNotificaionMode1ConfidenceOBJECT-TYPE
  SYNTAXINTEGER (0..255)
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Confidence value of entry indexed by
                wranIfSsaSsfNotificationMode1OutputIndex in
                wranIfSsaSsfMode1OutputTable that indicates the
                handling of which signal type detected by Mode 1
                triggered a trap."
  ::= { wranIfSsaNotificationObjectsEntry 9 }

wranIfSsaSsfNotificationMode2OutputIndexOBJECT-TYPE
```

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```
    SYNTAXINTEGER (1..32)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index of entry in wranIfSsaSsfMode2OutputTable
                  that indicates the handling of which signal type
                  detected by Mode 2 triggered a trap."
    ::= { wranIfSsaNotificationObjectsEntry 10 }

  wranIfSsaSsfNotificationMode2SignalRssiMeanOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Current Mean of RSSI signal measurements, between
                  -104 dBm to +23.5 dBm in 0.5 dB steps, for which
                  trap was caught."
    ::= { wranIfSsaNotificationObjectsEntry 11 }

  wranIfSsaSsfNotificationMode2SignalStdDevRssiOBJECT-TYPE
    SYNTAXINTEGER (0..255)
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Current Standard Deviation of RSSI signal
       measurements, between -104 dBm to +23.5 dBm in
                  0.5 dB steps, for which trap was caught."
    ::= { wranIfSsaNotificationObjectsEntry 12 }

  wranIfSsaSsfNotificationWiMicMSFIndexOBJECT-TYPE
    SYNTAXINTEGER (1..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index of entry in wranIfSsaSsfWiMicMSFTable that
                  indicates which channel the capture of a wireless
                  microphone beacon MSF has triggered a trap."
    ::= { wranIfSsaNotificationObjectsEntry 13 }

  wranIfSsaSensingCapibilityStatusOBJECT-TYPE
    SYNTAXBITS { thresholdIncrease(0),
                  thresholdDecrease(1),
                  recContigPeriodDurationIncrease(2),
                  recContigPeriodDurationDecrease(3),
                  recNumPeriodsIncrease(4),
                  recNumPeriodsDecrease(5),
                  recPeriodIntervalIncrease(6),
                  recPeriodIntervalDecrease(7) }
```

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```
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "8-bit bitmap that indicates the following changes to
                  the sensing capabilities defined in
                  wranIfSsaSensingCapTable: Sensing Threshold Increase
                  (Bit0), Sensing Threshold Decrease (Bit1),
                  Contiguous Recording Period Duration Increase
                  (Bit2), Contiguous Recording Period Duration
                  Decrease (Bit3), Number of Recording Periods
                  Increase (Bit4), Number f Recording Periods Decrease
                  (Bit5) Recording Period Interval Increase (Bit6),
                  Recording Interval Period Decrease (Bit7). More than
                  one bit can be set simultaneously. However, if Bit0
                  is set, Bit1 cannot be set. Same goes for the
                  relationship between Bit2/Bit3, Bit4/Bit5, and
                  Bit6/Bit7."
    ::= { wranIfSsaNotificationObjectsEntry 14 }

  wranIfSsaStatusOBJECT-TYPE
    SYNTAXBITS { t48expired(0),
                  t49expired(1),
                  t50expired(2),
                  intraFrameQpCycleLengthChanged(3),
                  intraFrameQpCycleOffsetChanged(4),
                  intraFramQpCycleFrameBitmapChanged(5),
                  intraFrameQpDurationChanged(6),
                  interFrameQpDurationChanged(7)
                  interFrameQpOffsetChanged(8)
                  incProhibitedChannelsChanged(9) }
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Concerning the current state of the SSA, this 10-bit
                  bitmap indicates whether T48/T49/T50 have
                  expired, whether any of the Quiet Period
                  parameters have been affected, or whether the
                  prohibited channel list has been updated. More than
                  one bit in this bitmap can be set at the same time."
    ::= { wranIfSsaNotificationObjectsEntry 15 }

  wranIfSsaBlmRepStatusOBJECT-TYPE
    SYNTAXINTEGER { blmRspSent(0),
                     blmRepGenerated(1),
                     blmRepSent(2),
                     blmRepAckReceived(3),
                     blmNumTxInc(4)
                     blmNumTxExpired(5) }
```

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```
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Concerning the current state of pending BLM-REQ
                  messages, this object indicates how far along the
                  sensing and report generation process is the SSA.
                  When == 5, that indicates that the BLM-REP that
                  corresponds to entry in wranIfSsaPendingBlmRepTable
                  indexed by wranIfSsaNotificationPendingBlmRepIndex
                  has been transmitted to the SM == to the maximum
                  number of retries as indicated by
                  wranIfSsaMaxBlmRepRetries."
  ::= { wranIfSsaNotificationObjectsEntry 16 }

wranIfSsaSensingRecordStatusOBJECT-TYPE
  SYNTAXBITS { timeLastSensedUpdate(0),
                  timeLastPositiveUpdate(1),
                  sensingPathRssiUpdate(2),
                  wranPathRssiUpdate(3),
                  signalTypeUpdate(4) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "5-bit bitmap concerning the update of an entry in
                  wranIfSsaSensingRecordTable as indexed by
                  wranIfSsaNotificationSensingRecordIndex. More than
                  one bit can set simultaneously."
  ::= { wranIfSsaNotificationObjectsEntry 17 }

wranIfSsaSsfMode0StatusOBJECT-TYPE
  SYNTAXINTEGER { signalNotPresent(0),
                  signalPresent(1) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "wranIfSsaSsfNotificationMode0OutputIndex indexes an
                  entry in wranIfSsaSsfMode0OutputTable that has been
                  updated. For the signal type in that entry
                  (=wranIfSsaSsfNotificationMode0OutputIndex-1), this
                  status indicates whether a signal is
                  present."
  ::= { wranIfSsaNotificationObjectsEntry 18 }

wranIfSsaSsfMode1StatusOBJECT-TYPE
  SYNTAXINTEGER { signalNotPresent(0),
                     signalPresent(1) }
  MAX-ACCESSread-only
  STATUScurrent
```

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```
  DESCRIPTION
    "wranIfSsaSsfNotificationMode1OutputIndex indexes an
                  entry in wranIfSsaSsfMode1OutputTable that has been
                  updated. For the signal type in that entry
                  (=wranIfSsaSsfNotificationMode1OutputIndex-1), this
                  status indicates whether a signal is
                  present."
  ::= { wranIfSsaNotificationObjectsEntry 19 }

wranIfSsaSsfMode2StatusOBJECT-TYPE
  SYNTAXBITS { meanRssiIncrease(0),
                  meanRssiDecrease(1),
                  stdDevRssiIncrease(2),
                  stdDevRssiDecrease(3) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "4-bit bitmap that indicates what changes to Mean
                  RSSI or Standard Deviation of RSSI for a detected
                  signal whose entry in wranIfSsaSsfMode2OutputTable
                  is indexed by
                  wranIfSsaSsfNotificationMode2OutputIndex. More than
                  one bit can be set simultaneously. However if Bit0
                  is set, Bit1 cannot be set. Same relationship goes
                  for Bit2 and Bit3."
  ::= { wranIfSsaNotificationObjectsEntry 20 }

wranIfSsaSsfWiMicMSFStatusOBJECT-TYPE
  SYNTAXINTEGER { crc1OnlyPassed(0),
                    crc1And2Passed(1),
                    crc1And2And3Passed(2) }
  MAX-ACCESSread-only
  STATUScurrent
  DESCRIPTION
    "Given entry in wranIfSsaSsfWiMicMSFTable  as indexed
                  by wranIfSsaSsfNotificationWiMicMSFIndex, this
                  status details how much of the microphone beacon has
                  been captured and whether all relevant MSF
                  CRC verifications have passed. "
  ::= { wranIfSsaNotificationObjectsEntry 21 }

wranIfSsaGeolocationStatus OBJECT-TYPE
  SYNTAXBITS { vernier1Updated(0),
                    vernier2Updated(1),
                    vernier3Updated(2),
                    tRange1Updated(3),
                    taCBPUpdated(4) }
  MAX-ACCESSread-only
```

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```
    STATUScurrent
    DESCRIPTION
      "5-bit bitmap indicating which aspects of the
                  Geolocation measurement have been updated. More than
                  one bit in this bitmap can be set simultaneously.
                  However, if bit1 (Vernier2 indicator) is set, than
                  Bit0 (Vernier1 indicator) and Bit1 (Vernier3
                  indicator) cannot be set.
    ::= { wranIfSsaNotificationObjectsEntry 22 }

-- wranIfSsaMibGroups: this object helps define which MIB groups are
-- available within this module and which MIB objects are part of each
-- group.

  wranIfSsaMibGroupsOBJECT IDENTIFIER
                                    ::= { wranIfSsaMib 14 }
  wranIfSsaSensingCapGroupOBJECT IDENTIFIER
                                    ::= { wranIfSsaMibGroups 1 }
  wranIfSsaStatusGroupOBJECT IDENTIFIER
                                    ::= { wranIfSsaMibGroups 2 }
  wranIfSsaConfigGroupOBJECT IDENTIFIER
                                    ::= { wranIfSsaMibGroups 3 }
  wranIfSsaPendingBlmRepGroupOBJECT IDENTIFIER
                                    ::= { wranIfSsaMibGroups 4 }
  wranIfSsaSensingRecordGroupOBJECT IDENTIFIER
                                    ::= { wranIfSsaMibGroups 5 }
  wranIfSsaSsfMode0OutputGroupOBJECT IDENTIFIER
                                    ::= { wranIfSsaMibGroups 6 }
  wranIfSsaSsfMode1OutputGroupOBJECT IDENTIFIER
                                    ::= { wranIfSsaMibGroups 7 }
  wranIfSsaSsfMode2OutputGroupOBJECT IDENTIFIER
                                    ::= { wranIfSsaMibGroups 8 }
  wranIfSsaSsfWiMicMSFGroupOBJECT IDENTIFIER
                                    ::= { wranIfSsaMibGroups 9 }
  wranIfSsaGeolocationGroupOBJECT IDENTIFER
                                    ::= { wranIfSsaMibGroups 10 }
  wranIfSsaTrapControlGroupOBJECT IDENTIFER
                                    ::= { wranIfSsaMibGroups 11 }
  wranIfSsaNotificationsGroupOBJECT IDENTIFIER
                                    ::= { wranIfSsaMibGroups 12 }

  wranIfSsaSensingCapGroupOBJECT-GROUP
    OBJECTS{ wranIfSsaSensingCapIndex,
                  wranIfSsaSensingThreshold,
                  wranIfSsaSensRecContigPeriodDuration,
                  wranIfSsaSensRecNumPeriods,
                  wranIfSsaSensRecPeriodInterval }
    STATUScurrent
```

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```
  DESCRIPTION
    "This group represents objects related to the
                  sensing capabilities supported by the SSA."
  ::= { wranIfSsaMibGroups 1 }

wranIfSsaStatusGroupOBJECT-GROUP
  OBJECTS{ wranIfSsaStatusIndex, wranIfSsaCurrentState,
                  wranIfSsaRecentEvent, wranIfSsaRecentAction,
                  wranIfSsaIpcUpdChannelsSize,
                  wranIfSsaIpcUpdChannels, wranIfSsaCurrentT48,
                  wranIfSsaCurrentT49, wranIfSsaCurrentT50,
                  wranIfSsaIntraFrameQpCycleLength,
                  wranIfSsaIntraFrameQpCycleOffset,
                  wranIfSsaIntraFrameQpCycleFrameBitmap,
                  wranIfSsaIntraFrameQpDuration,
                  wranIfSsaInterFrameQpDuration,
                  wranIfSsaInterFrameQpOffset }
  STATUScurrent
  DESCRIPTION
    "This group represents objects related to the
                  current state of the SSA."
  ::= { wranIfSsaMibGroups 2 }

wranIfSsaConfigGroupOBJECT-GROUP
  OBJECTS{ wranIfSsaConfigIndex, wranIfSsaT19,
                  wranIfSsaT29, wranIfSsaMaxBlmRepRetries,
                  wranIfSsaChAvailabilityCheckTime,
                  wranIfSmSsaNonOccupancyPeriod,
                  wranIfSsaChannelDetectionTime,
                  wranIfSsaChannelSetupTime,
                  wranIfSsaChannelOpeningTxTime,
                  wranIfSsaChannelMoveTime,
                  wranIfSsaChannelClosingTxTime,
                  wranIfSsaMicProtectionRadius, wranIfSsaT41,
                  wranIfSsaT42, wranIfSsaT43, wranIfSsaT44,
                  wranIfSsaT45, wranIfSsaT59, wranIfSsaT47,
                  wranIfSsaT48, wranIfSsaT49, wranIfSsaT50,
                  wranIfSsaT51, wranIfSsaT53, wranIfSsaT54,
                  wranIfSsaT55 , wranIfSsaT60 }
  STATUScurrent
  DESCRIPTION
    "This group represents objects related to the
                  configuration of the SSA."
  ::= { wranIfSsaMibGroups 3 }

wranIfSsaPendingBlmRepGroupOBJECT-GROUP
  OBJECTS{ wranIfSsaPendingBlmRepIndex,
                  wranIfSsaPendingBlmReqTransactionId,
```

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```
                    wranIfSsaPendingBlmReqMsgSize,
                    wranIfSsaPendingBlmReqMsg,
                    wranIfSsaPendingBlmRspSent,
                    wranIfSsaPendingBlmRepGenerated,
                    wranIfSsaPendingBlmRepMsgSize,
                    wranIfSsaPendingBlmRepMsg,
                    wranIfSsaPendingBlmRepSent,
                    wranIfSsaPendingBlmRepAck,
                    wranIfSsaPendingBlmRepNumTx }
  STATUScurrent
  DESCRIPTION
    "This group represents objects related to the
                  pending BLM transactions and sensing reports
                  (BLM-REP) that are to be generated."
  ::= { wranIfSsaMibGroups 4 }

wranIfSsaSensingRecordGroupOBJECT-GROUP
  OBJECTS{ wranIfSsaSensingRecordIndex,
                    wranIfSsaSensingChannel,
                    wranIfSsaTimeLastSensing,
                    wranIfSsaTimeLastPositive,
                    wranIfSsaSensingPathRssi,
                    wranIfSsaWranPathRssi,
                    wranIfSsaSignalType,
                    wranIfSsaWranServiceAdvertisement,
                    wranIfSsaIdcUpdIndication }
  STATUScurrent
  DESCRIPTION
    "This group represents objects related to the
                  sensing status of each channel."
  ::= { wranIfSsaMibGroups 5 }

wranIfSsaSsfMode0OutputGroupOBJECT-GROUP
  OBJECTS{ wranIfSsaSsfMode0OutputIndex,
                    wranIfSsaSsfMode0SignalType,
                    wranIfSsaSsfMode0SignalPresent }
  STATUScurrent
  DESCRIPTION
    "This group represents objects related to
                  output of Mode 0 sensing."
  ::= { wranIfSsaMibGroups 6 }

wranIfSsaSsfMode1OutputGroupOBJECT-GROUP
  OBJECTS{ wranIfSsaSsfMode1OutputIndex,
                    wranIfSsaSsfMode1SignalType,
                    wranIfSsaSsfMode1SignalPresent,
                    wranIfSsaSsfSignalConfidence }
  STATUScurrent
```

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```
  DESCRIPTION
    "This group represents objects related to
                output of Mode 1 sensing."
  ::= { wranIfSsaMibGroups 7 }

wranIfSsaSsfMode2OutputGroupOBJECT-GROUP
  OBJECTS{ wranIfSsaSsfMode2OutputIndex,
                wranIfSsaSsfMode2SignalType,
                wranIfSsaSsfMode2SignalRssiMean,
                wranIfSsaSsfMode2SignalStdDevRssi }
  STATUScurrent
  DESCRIPTION
    "This group represents objects related to
                output of Mode 2 sensing."
  ::= { wranIfSsaMibGroups 8 }

wranIfSsaSsfWiMicMSFGroupOBJECT-GROUP
  OBJECTS{ wranIfSsaSsfWiMicMSFIndex,
                wranIfSsaSsfWiMicMSFChannel,
                wranIfSsaSsfWiMicMSFPayloadSize,
                wranIfSsaSsfWiMicMSFPayload,
                wranIfSsaSsfWiMicMSFCrc1Status,
                wranIfSsaSsfWiMicMSFCrc2Status,
                wranIfSsaSsfWiMicMSFCrc3Status }
  STATUScurrent
  DESCRIPTION
    "This groups contains objects related to the
                detection of wireless microphone beacons as
                defined by IEEE Std 802.22.1-2010."
  ::= { wranIfSsaMibGroups 9 }

wranIfSsaSsfGeolocationGroupOBJECT-GROUP
  OBJECTS{ wranIfSsaGeolocationIndex,
                wranIfSsaGeolocationVernier1Size,
                wranIfSsaGeolocationVernier1,
                wranIfSsaGeoLocationVernier2Size,
                wranIfSsaGeolocationVernier2,
                wranIfSsaGeoLocationVernier3Size,
                wranIfSsaGeolocationVernier3,
                wranIfSsaGeolocationTRange1,
   wranIfSsaGeolocationTACbp }
  STATUScurrent
  DESCRIPTION
    "This groups contains objects related to the
                geolocation function of the SSA."
  ::= { wranIfSsaMibGroups 10 }

wranIfSsaTrapControlGroupOBJECT-GROUP
```

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```
  OBJECTS{ wranIfSsaTrapControl }
  STATUScurrent
  DESCRIPTION
    "This groups contains objects related to
                 enabling/disabling traps on the SSA."
  ::= { wranIfSsaMibGroups 11 }

wranIfSsaNotificationsGroupOBJECT-GROUP
  OBJECTS{ wranIfSsaSensingCapChangeTrap,
                 wranIfSsaStatusChangeTrap,
                 wranIfSsaBlmRepChangeTrap,
                 wranIfSsaSensingRecordChangeTrap,
                 wranIfSsaSsfMode0ChangeTrap,
                 wranIfSsaSsfMode1ChangeTrap,
                 wranIfSsaSsfMode2ChangeTrap,
                 wranIfSsaSsfWiMicMSFChangeTrap,
                 wranIfSsaGeolocationChangeTrap,
                 wranIfSsaNotificationIndex,
                 wranIfSsaNotificationCurrentState,
                 wranIfSsaNotificationRecentEvent,
                 wranIfSsaNotificationRecentAction,
                 wranIfSsaNotificationPendingBlmRepIndex,
                 wranIfSsaNotificationSensingRecordIndex,
                 wranIfSsaSsfNotificationMode0OutputIndex,
                 wranIfSsaSsfNotificationMode1OutputIndex,
                 wranIfSsaSsfNotificaionMode1Confidence,
                 wranIfSsaSsfNotificationMode2OutputIndex,
                 wranIfSsaSsfNotificationMode2RssiMean,
                 wranIfSsaSsfNotificationMode2StdDevRssi,
                 wranIfSsaSsfNotificationWiMicMSFIndex,
                 wranIfSsaSensingCapibilityStatus,
                 wranIfSsaStatus, wranIfSsaBlmRepStatus,
                 wranIfSsaSensingRecordStatus,
                 wranIfSsaSsfMode0Status,
                 wranIfSsaSsfMode1Status,
                 wranIfSsaSsfMode2Status,
                 wranIfSsaSsfWiMicMSFStatus,
                 wranIfSsaGeolocationStatus }
  STATUScurrent
  DESCRIPTION
    "This groups contains objects related to traps
                 that are configured for the SSA."
  ::= { wranIfSsaMibGroups 12 }

wranIfSsaMibComplianceMODULE-COMPLIANCE
  STATUScurrent
  DESCRIPTION
    "MIB objects that are optional and mandatory for SSA
```

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```
                    compliance."
    MODULEwranIfSsaMib
    MANDATORY-GROUPS{ wranIfSsaSensingCapGroup,
                      wranIfSsaStatusGroup,
                      wranIfSsaConfigGroup,
                      wranIfSsaSsfWiMicGroup,
                      wranIfSsaGeolocationGroup,
                      wranIfSsaTrapControlGroup }
    -- OPTIONAL-GROUPS{ wranIfSsaPendingBlmRepGroup,
                        wranIfSsaSsfSensingRecordGroup,
                        wranIfSsaSsfMode0Group,
                        wranIfSsaSsfMode1Group,
                        wranIfSsaSsfMode2Group,
                        wranIfSsaNotificationsGroup }
    ::= { wranIfSsaMib 15 }


END
```

14.2.7 wranIfDatabaseServiceMib

```
IEEE802dot22-WRAN-IF-DATABASESERVICE-MIB::=BEGIN

      IMPORTS
            MODULE-IDENTITY,
            OBJECT-TYPE,
            NOTIFICATION-TYPE,
            Unsigned32, Integer32, Counter32,
            Counter64
                  FROM SNMPv2-SMI
            SnmpAdminString
                  FROM SNMP-FRAMEWORK-MIB
            TEXTUAL-CONVETION,
            MacAddress, RowStatus, TruthValue,
            TimeStamp, DateAndTime
                  FROM SNMPv2-TC
            InetAddressType, InetAddress
                  FROM INET-ADDRESS-MIB
            OBJECT-GROUP,
            MODULE-COMPLIANCE,
            NOTIFICATION-GROUP
                  FROM SNMPV2-CONF

      wranIfDatabaseServiceMibMODULE-IDENTITY
            LAST-UPDATED"201405300000Z"-- May 30, 2014
            ORGANIZATION"IEEE 802.22"
            CONTACT-INFO
                  "WG E-mail:STDS-802-22@LISTSERV.IEEE.ORG
```

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```
                    WG Chair:Apurva N. Mody
                    E-mail:apurva.mody@ieee.org

                    TGa Chair/Editor:  Ranga Reddy
                    E-mail:      ranga.reddy@ieee.org"
              DESCRIPTION
                    "This material is from IEEE Std 802.22a-2014
                    Copyright (c) 2014. This MIB Module defines managed
                    objects related to the configuration of access to,
                    as well as interaction with the database service.
                    Objects in this module are based on IEEE Std 802.22-
                    2011 and is under iso(1).std(0).iso8802(8802)
                    .wran(22).wranIfDatabaseServiceMib(7)"
  REVISION      "201405300000Z"
  DESCRIPTION
    "The first version of IEEE802dot22-WRAN-IF-
                    DATABASESERVICE-MIB, that contains objects related
                    to management of the interface with the database
                    service."
  ::= {iso std(0) iso8802(8802) wran(22) 7}

wranIfBsMgmtInfoTableOBJECT IDENTIFIER
                            ::= { wranIfDatabaseServiceMib 1 }
wranIfBsDeviceEnlistmentTableOBJECT IDENTIFIER
                            ::= { wranIfDatabaseServiceMib 2 }
wranIfDbsChannelIndicationTableOBJECT IDENTIFIER
                            ::= { wranIfDatabaseServiceMib 3 }
wranIfDbsAccessTableOBJECT IDENTIFIER
                            ::= { wranIfDatabaseServiceMib 4 }
wranIfDbsTrapControlOBJECT IDENTIFIER
                            ::= { wranIfDatabaseServiceMib 5 }
wranIfDbsTrapDefinitionOBJECT IDENTIFIER
                            ::= { wranIfDatabaseServiceMib 6 }
wranIfDbsNotificationObjectsTable OBJECT IDENTIFIER
                            ::= { wranIfDatabaseServiceMib 7 }
wranIfDbsMibGroupsOBJECT IDENTIFIER
                            ::= { wranIfDatabaseServiceMib 8 }
wranIfDbsMibComplianceOBJECT IDENTIFIER
                            ::= { wranIfDatabaseServiceMib 9 }

wranIfBsMgmtInfoTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfBsMgmtInfoEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object stores information regarding information
                    on the BS management interface the DBS can access.
                    It is made up of one entry, defined by
```

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```
                    wranIfBsMgmtInfoEntry."
  ::= { wranIfDatabaseServiceMib 1 }

wranIfBsMgmtInfoEntryOBJECT-TYPE
  SYNTAXwranIfBsMgmtInfoEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                    wranIfBsMgmtInfoTable. Each entry is identified by
                    wranIfBsMgmtInfoIndex."
          INDEX { wranIfBsMgmtInfoIndex }
          ::= { wranIfBsMgmtInfoTable 1 }

    wranIfBsMgmtInfoEntry::= SEQUENCE {
          wranIfBsMgmtInfoIndexINTEGER,
          wranIfBsSizeMgmtUrlINTEGER,
          wranIfBsMgmtUrl          OCTET STRING,
          wranIfBsSizeMgmtDeviceIdINTEGER,
          wranIfBsMgmtDeviceIdOCTET STRING,
          wranIfBsSizeMgmtSnINTEGER,
          wranIfBsMgmtSn           OCTET STRING,
          wranIfBsSizeMgmtLocationINTEGER,
          wranIfBsMgmtLocationOCTET STRING,
          wranIfBsMgmtAntennaHeightINTEGER,
          wranIfBsSizeMgmtContactNameINTEGER,
          wranIfBsMgmtContactNameOCTET STRING,
          wranIfBsSizeMgmtContactPhysAddressINTEGER,
          wranIfBsMgmtContactPhysAddressOCTET STRING,
          wranIfBsSizeMgmtEmailAddressINTEGER,
          wranIfBsMgmtEmailAddressOCTET STRING,
          wranIfBsSizeMgmtPhoneNumberINTEGER,
          wranIfBsMgmtPhoneNumberOCTET STRING,
          wranIfBsSizeAccessUrlINTEGER,
          wranIfBsAccessUrl        OCTET STRING }

    wranIfBsMgmtInfoIndexOBJECT-TYPE
          SYNTAXINTEGER (1..1)
          MAX-ACCESSread-only
          STATUScurrent
          DESCRIPTION
                "Index of entry in the table, defaults to 1."
          ::= { wranIfBsMgmtInfoEntry 1 }

    wranIfBsSizeMgmtUrlOBJECT-TYPE
          SYNTAXINTEGER (2..512)
          MAX-ACCESSread-write
          STATUScurrent
```

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```
        DESCRIPTION
              "Size of Base Station Management URL, see "
        ::= { wranIfBsMgmtInfoEntry 2 }

    wranIfBsMgmtUrlOBJECT-TYPE
        SYNTAXOCTET STRING (SIZE(wranIfBsSizeMgmtUrl))
        MAX-ACCESSread-write
        STATUScurrent
        DESCRIPTION
              "Base Station Management URL, see "
        ::= { wranIfBsMgmtInfoEntry 3 }

    wranIfBsSizeMgmtDeviceIdOBJECT-TYPE
        SYNTAXINTEGER (2..256)
        MAX-ACCESSread-write
        STATUScurrent
        DESCRIPTION
              "Size of BS FCC Device ID (see )."
        ::= { wranIfBsMgmtInfoEntry 4 }

    wranIfBsMgmtDeviceIdOBJECT-TYPE
        SYNTAXOCTET STRING (SIZE(wranIfBsSizeMgmtDeviceId))
        MAX-ACCESSread-write
        STATUScurrent
        DESCRIPTION
              "BS FCC Device ID (see )."
        ::= { wranIfBsMgmtInfoEntry 5 }

    wranIfBsSizeMgmtSnOBJECT-TYPE
        SYNTAXINTEGER (2..256)
        MAX-ACCESSread-write
        STATUScurrent
        DESCRIPTION
              "Size of BS serial number (see )."
        ::= { wranIfBsMgmtInfoEntry 5 }

    wranIfBsMgmtSnOBJECT-TYPE
        SYNTAXOCTET STRING (SIZE(wranIfBsSizeMgmtSn))
        MAX-ACCESSread-write
        STATUScurrent
        DESCRIPTION
              "BS serial number (see )."
        ::= { wranIfBsMgmtInfoEntry 6 }

    wranIfBsSizeMgmtLocationOBJECT-TYPE
        SYNTAXINTEGER (2..256)
        MAX-ACCESSread-write
        STATUScurrent
```

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```
            DESCRIPTION
                  "BS Location data string of BS (see )."
            ::= { wranIfBsMgmtInfoEntry 7 }

      wranIfBsMgmtLocationOBJECT-TYPE
            SYNTAXOCTET STRING (SIZE(wranIfBsSizeMgmtLocation))
            MAX-ACCESSread-write
            STATUScurrent
            DESCRIPTION
                  "BS Location data string of BS (see )."
            ::= { wranIfBsMgmtInfoEntry 8 }

      wranIfBsMgmtAntennaHeightOBJECT-TYPE
            SYNTAXINTEGER (0..100)
            UNITS       "meters"
            MAX-ACCESSread-write
            STATUScurrent
            DESCRIPTION
                  "Antenna height at the BS (see )."
            ::= { wranIfBsMgmtInfoEntry 9 }

      wranIfBsSizeMgmtContactNameOBJECT-TYPE
            SYNTAXINTEGER (2..256)
            MAX-ACCESSread-write
            STATUScurrent
            DESCRIPTION
                  "Size of Contact Name for person(s) who has ownership
of the BS (see )."
      ::= { wranIfBsMgmtInfoEntry 10 }

 wranIfBsMgmtContactNameOBJECT-TYPE
      SYNTAX
        OCTET STRING (SIZE(wranIfBsSizeMgmtContactName))
      MAX-ACCESSread-write
      STATUScurrent
      DESCRIPTION
        "Contact Name for person(s) who has ownership of the
BS (see )."
      ::= { wranIfBsMgmtInfoEntry 11 }

 wranIfBsSizeMgmtContactPhysAddressOBJECT-TYPE
      SYNTAXINTEGER (2..256)
      MAX-ACCESSread-write
      STATUScurrent
      DESCRIPTION
        "Size of Physical address for contacting the owner of
the BS (see ). "
      ::= { wranIfBsMgmtInfoEntry 12 }
```

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```
wranIfBsMgmtContactPhysAddressOBJECT-TYPE
  SYNTAX
    OCTET STRING
                (SIZE(wranIfBsSizeMgmtContactPhysAddress))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Physical address for contacting the owner of the BS
(see ). "
  ::= { wranIfBsMgmtInfoEntry 13 }

wranIfBsSizeMgmtEmailAddressOBJECT-TYPE
  SYNTAXINTEGER (2..256)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Size of E-mail address for contacting the owner of
the BS (see )."
  ::= { wranIfBsMgmtInfoEntry 14 }

wranIfBsMgmtEmailAddressOBJECT-TYPE
  SYNTAX
    OCTET STRING (SIZE(wranIfBsSizeMgmtEmailAddress))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "E-mail address for contacting the owner of the BS
(see )."
  ::= { wranIfBsMgmtInfoEntry 15 }

wranIfBsSizeMgmtPhoneNumberOBJECT-TYPE
  SYNTAXINTEGER (2..128)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Size of Telephone # for contacting the owner of the
BS (see )."
  ::= { wranIfBsMgmtInfoEntry 16 }

wranIfBsMgmtPhoneNumberOBJECT-TYPE
  SYNTAX
    OCTET STRING (SIZE(wranIfBsSizeMgmtPhoneNumber))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Telephone # for contacting the owner of the BS (see
)."
```

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```
  ::= { wranIfBsMgmtInfoEntry 17 }

 wranIfBsSizeAccessUrlOBJECT-TYPE
  SYNTAXINTEGER (2..512)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Size of Base Station Database Access Service URL,
see "
  ::= { wranIfBsMgmtInfoEntry 18 }

 wranIfBsAccessUrlOBJECT-TYPE
  SYNTAXOCTET STRING (SIZE(wranIfBsSizeAccessUrl))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Base Station Database Access Service URL, see
"
  ::= { wranIfBsMgmtInfoEntry 19 }

 wranIfDbsDeviceEnlistmentTableOBJECT-TYPE
  SYNTAXSEQUENCE OF wranIfDbsDeviceEnlistmentEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object stores information regarding information
                on devices entering the network that the BS has
                attempted to enlist/register with the database
                service. It is made up of multiple values, defined
                by wranIfDbsDeviceEnlistmentEntry"
  ::= { wranIfDatabaseServiceMib 2 }

 wranIfDbsDeviceEnlistmentEntryOBJECT-TYPE
  SYNTAXwranIfDbsDeviceEnlistmentEntry
  MAX-ACCESSnot-accessible
  STATUScurrent
  DESCRIPTION
    "This object defines an entry in
                wranIfDbsDeviceEnlistmentTable. Each entry is
                identified by wranIfDbsDeviceEnlistmentIndex."
  INDEX{ wranIfDbsDeviceEnlistmentIndex }
  ::= { wranIfDbsDeviceEnlistmentTable 1 }

 wranIfBsDeviceEnlistmentEntry::= SEQUENCE {
  wranIfDbsDeviceEnlistmentIndexINTEGER,
  wranIfDbsDeviceEnlistmentConfirmedTruthValue,
  wranIfDbsConfirmedDeviceTypeINTEGER,
  wranIfDbsSizeConfirmedDevceIDINTEGER,
```

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```
    wranIfDbsConfirmedDeviceIdOCTET STRING,
    wranIfDbsSizeConfirmedDeviceSnINTEGER,
    wranIfDbsConfirmedDeviceSnOCTET STRING,
    wranIfDbsSizeConfirmedDeviceLocationINTEGER,
    wranIfDbsConfirmedDeviceLocationOCTET STRING,
    wranIfDbsSizeProxyDeviceIdINTEGER,
    wranIfDbsProxyDeviceId OCTET STRING,
    wranIfDbsSizeProxySn   INTEGER,
    wranIfDbsProxySn          OCTET STRING,
    wranIfDbsSizeRespPartyNameINTEGER,
    wranIfDbsRespPartyName OCTET STRING,
    wranIfDbsConfirmedDeviceAntennaHeightINTEGER,
    wranIfDbsSizeConfirmedDeviceContactNameINTEGER,
    wranIfDbsConfirmedDeviceContactNameOCTET STRING,
    wranIfDbsSizeConfirmedDeviceContactPhysAddressINTEGER,
    wranIfDbsConfirmedDeviceContactPhysAddress OCTET STRING,
    wranIfDbsSizeConfirmedDeviceEmailAddress INTEGER,
    wranIfDbsConfirmedDeviceEmailAddress OCTET STRING,
    wranIfDbsSizeConfirmedDevicePhoneNumber INTEGER,
    wranIfDbsConfirmedDevicePhoneNumber OCTET STRING,
    wranIfDbsConfirmedDeviceAntennaInformation OCTET STRING,
    wranIfDbsConfirmedDeviceAntennaAzimuth INTEGER,
    wranIfDbsDeviceConfirmationMsgTime DateAndTime }

  wranIfDbsDeviceEnlistmentIndexOBJECT-TYPE
    SYNTAXINTEGER (1..255)
    MAX-ACCESSread-only
    STATUScurrent
    DESCRIPTION
      "Index of entry in the table."
    ::= { wranIfDbsDeviceEnlistmentEntry 1 }

  wranIfDbsDeviceEnlistmentConfirmedOBJECT-TYPE
    SYNTAXTruthValue
    MAX-ACCESSread-write
    STATUScurrent
    DESCRIPTION
      "Truth(1) indicates this enlistment been confirmed
                  via receipt of M-DB-ENLISTMENT-CONFIRMATION (see
                  14.2.1.3.4) from the database service."
    ::= { wranIfDbsDeviceEnlistmentEntry 2 }

  wranIfDbsConfirmedDeviceTypeOBJECT-TYPE
    SYNTAXINTEGER { fixedBS(0),
                        fixedCpe(1),
                        personalPortable(2) }
    MAX-ACCESSread-write
    STATUScurrent
```

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```
  DESCRIPTION
    "Type of device being registered, fixed BS(0), fixed
                CPE(1), personal/portable(2) (see 14.2.1.3.4). 3-255
                are reserved."
  ::= { wranIfDbsDeviceEnlistmentEntry 3 }

wranIfDbsSizeConfirmedDeviceIdOBJECT-TYPE
  SYNTAXINTEGER (2..256)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Size of Device ID for the device that is being
                enlisted/registered with the database service."
  ::= { wranIfDbsDeviceEnlistmentEntry 4 }

wranIfDbsConfirmedDeviceIdOBJECT-TYPE
  SYNTAX
    OCTET STRING (SIZE(wranIfDbsSizeConfirmedDeviceId))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Device ID for the device that is being
                enlisted/registered with the database service."
  ::= { wranIfDbsDeviceEnlistmentEntry 5 }

wranIfDbsSizeConfirmedDeviceSnOBJECT-TYPE
  SYNTAXINTEGER (2..256)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Size of Serial number of the device that is being
     enlisted/registered with the database service. "
  ::= { wranIfDbsDeviceEnlistmentEntry 6 }

wranIfDbsConfirmedDeviceSnOBJECT-TYPE
  SYNTAX
    OCTET STRING (SIZE(wranIfDbsSizeConfirmedDeviceSn))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Serial number of the device that is being
                enlisted/registered with the database service. "
  ::= { wranIfDbsDeviceEnlistmentEntry 7 }

wranIfDbsSizeConfirmedDeviceLocationOBJECT-TYPE
  SYNTAXINTEGER (2..256)
  MAX-ACCESSread-write
  STATUScurrent
```

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```
  DESCRIPTION
    "Size of Location string of the device requesting
                enlistment."
  ::= { wranIfDbsDeviceEnlistmentEntry 8 }

wranIfDbsConfirmedDeviceLocationOBJECT-TYPE
  SYNTAX
    OCTET STRING
                (SIZE(wranIfDbsSizeConfirmedDeviceLocation))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Location string of the device requesting
                enlistment."
  ::= { wranIfDbsDeviceEnlistmentEntry 9 }

wranIfDbsSizeProxyDeviceIdOBJECT-TYPE
  SYNTAXINTEGER (2..256)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Size of Device ID of proxy device BS may use to send
                queries to the database. "
  ::= { wranIfDbsDeviceEnlistmentEntry 10 }

wranIfDbsProxyDeviceIdOBJECT-TYPE
  SYNTAXOCTET STRING (SIZE(wranIfDbsSizeProxyDeviceId))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Device ID of proxy device BS may use to send queries
                to the database. "
  ::= { wranIfDbsDeviceEnlistmentEntry 11 }

wranIfDbsSizeProxySnOBJECT-TYPE
  SYNTAXINTEGER (2..256)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Size of Serial number of proxy device BS may use to
                send queries to the database "
  ::= { wranIfDbsDeviceEnlistmentEntry 12 }

wranIfDbsProxySnOBJECT-TYPE
  SYNTAXOCTET STRING (SIZE(2..256))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
```

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```
    "Serial number of proxy device BS may use to send
                queries to the database "
  ::= { wranIfDbsDeviceEnlistmentEntry 13 }

wranIfDbsSizeRespPartyNameOBJECT-TYPE
  SYNTAXINTEGER (2..256)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Name of the party responsible for the device
                enlistment/registration"
  ::= { wranIfDbsDeviceEnlistmentEntry 14 }

wranIfDbsRespPartyNameOBJECT-TYPE
  SYNTAXOCTET STRING (SIZE(wranIfDbsSizeRespPartyName))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Name of the party responsible for the device
     enlistment/registration"
  ::= { wranIfDbsDeviceEnlistmentEntry 15 }

wranIfDbsConfirmedDeviceAntennaHeightOBJECT-TYPE
  SYNTAXINTEGER (0..100)
  UNITS         "meters"
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    " Antenna height of the device being enlisted."
  ::= { wranIfDbsDeviceEnlistmentEntry 16 }

wranIfDbsSizeConfirmedDeviceContactNameOBJECT-TYPE
  SYNTAXINTEGER (2..256)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Size of Contact Name for person(s) who has ownership
                of device, only pertinent if device type is fixed BS
                or CPE."
  ::= { wranIfDbsDeviceEnlistmentEntry 17 }

wranIfDbsConfirmedDeviceContactNameOBJECT-TYPE
  SYNTAX
    OCTET STRING
                (SIZE(wranIfDbsSizeConfirmedDeviceContactName))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
```

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```
    "Contact Name for person(s) who has ownership of
                device, only pertinent if device type is fixed BS or
                CPE."
  ::= { wranIfDbsDeviceEnlistmentEntry 18 }

wranIfDbsSizeConfirmedDeviceContactPhysAddressOBJECT-TYPE
  SYNTAXINTEGER (2..256)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Size of Physical address for contacting the owner of
                the BS; the only pertinent device types are fixed BS
                and fixed CPE."
  ::= { wranIfDbsDeviceEnlistmentEntry 19 }

wranIfDbsConfirmedDeviceContactPhysAddressOBJECT-TYPE
  SYNTAX
    OCTET STRING
    SIZE(wranIfDbsSizeConfirmedDeviceContactPhysAddress))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Physical address for contacting the owner of the BS;
                the only pertinent device types are fixed BS and
                fixed CPE."
  ::= { wranIfDbsDeviceEnlistmentEntry 20 }

wranIfDbsSizeConfirmedDeviceEmailAddressOBJECT-TYPE
  SYNTAXINTEGER (2..256)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Size of E-mail address for contacting the owner of
                the BS; the only pertinent device types are fixed BS
                and fixed CPE."
  ::= { wranIfDbsDeviceEnlistmentEntry 21 }

wranIfDbsConfirmedDeviceEmailAddressOBJECT-TYPE
  SYNTAX
    OCTET STRING
         (SIZE(wranIfDbsSizeConfirmedDeviceEmailAddress))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "E-mail address for contacting the owner of the BS;
                the only pertinent device types are fixed BS and
                fixed CPE."
  ::= { wranIfDbsDeviceEnlistmentEntry 22 }
```

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```
wranIfDbsSizeConfirmedDevicePhoneNumberOBJECT-TYPE
  SYNTAXINTEGER (2..128)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Size of Telephone number for contacting the owner of
                the BS; the only pertinent device types are fixed BS
                and fixed CPE."
  ::= { wranIfDbsDeviceEnlistmentEntry 23 }

wranIfDbsConfirmedDevicePhoneNumberOBJECT-TYPE
  SYNTAX
    OCTET STRING
                (SIZE(wranIfDbsSizeConfirmedDevicePhoneNumber))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Telephone number for contacting the owner of the BS;
                the only pertinent device types are fixed BS and
                fixed CPE."
  ::= { wranIfDbsDeviceEnlistmentEntry 24 }

wranIfDbsConfirmedDeviceAntennaInformationOBJECT-TYPE
  SYNTAXOCTET STRING (SIZE(72))
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
                "Antenna information of device; only applicable if
                transmission of antenna information is supported by
                the database service."
  ::= { wranIfDbsDeviceEnlistmentEntry 25 }

wranIfDbsConfirmedDeviceAntennaAzimuthOBJECT-TYPE
  SYNTAXINTEGER (0..360)
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
    "Antenna azimuth of device; only applicable if
                transmission of antenna information is supported by
                the database service."
  ::= { wranIfDbsDeviceEnlistmentEntry 26 }

wranIfDbsDeviceConfirmationMsgTimeOBJECT-TYPE
  SYNTAXDateAndTime
  MAX-ACCESSread-write
  STATUScurrent
  DESCRIPTION
```

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