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Building automation and control systems —

Part 5: Data communication protocol

Systèmes d'automatisation et de gestion technique du bâtiment —

Partie 5: Protocole de communication de données

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Tel. + 41 22 749 01 11
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16484-5 was prepared by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) (as ANSI/ASHRAE 135-2010) and was adopted without modifications by Technical Committee ISO/TC 205, *Building environment design*.

This fourth edition cancels and replaces the third edition (ISO 16484-5:2010), which has been technically revised, as detailed in the enclosed ANSI/ASHRAE publication, pages 993 to 1002.

ISO 16484 consists of the following parts, under the general title *Building automation and control systems (BACS)*:

— *Part 1: Project specification and implementation*

— *Part 2: Hardware*

— *Part 3: Functions*

— *Part 5: Data communication protocol*

— *Part 6: Data communication conformance testing*

Applications and project implementation are to form the subjects of future Parts 4 and 7.

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Building automation and control systems —

Part 5:
Data communication protocol

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1 Scope

This part of ISO 16484 defines data communication services and protocols for computer equipment used for monitoring and control of heating, ventilation, air-conditioning and refrigeration (HVAC&R) and other building systems. It defines, in addition, an abstract, object-oriented representation of information communicated between such equipment, thereby facilitating the application and use of digital control technology in buildings. The scope and field of application are furthermore detailed in Clause 2 of the enclosed ANSI/ASHRAE publication.

2 Requirements

Requirements are the technical recommendations made in the following publication (reproduced on the following pages), which is adopted as an International Standard:

> ANSI/ASHRAE 135-2010, *A Data Communication Protocol for Building Automation and Control Networks*

The text on the back of the title page of the ANSI/ASHRAE standard and the policy statement on the last page are not relevant for the purposes of international standardization.

The following International Standards are cited in the text:

ISO/IEC 7498 (all parts), *Information technology — Open Systems Interconnection — Basic Reference Model*

ISO/TR 8509, *Information processing systems — Open Systems Interconnection — Service conventions*

ISO/IEC 8649, *Information technology — Open Systems Interconnection — Service definition for the Association Control Service Element*

ISO/IEC 8802-2, *Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements — Part 2: Logical link control*

ISO/IEC 8802-3, *Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements — Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

ISO/IEC 8822, *Information technology — Open Systems Interconnection — Presentation service definition*

ISO/IEC 8824 (all parts), *Information technology — Abstract Syntax Notation One (ASN.1)*

ISO/IEC 8825 (all parts), *Information technology — ASN.1 encoding rules*

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ISO/IEC 8859-1, *Information technology — 8-bit single-byte coded graphic character sets — Part 1: Latin alphabet No. 1*

ISO/IEC 9545, *Information technology — Open Systems Interconnection — Application Layer structure*

ISO/IEC 10646, *Information technology — Universal Coded Character Set (UCS)*

3 Revision of ANSI/ASHRAE 135

It has been agreed with the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) that Technical Committee ISO/TC 205 will be consulted in the event of any revision or amendment of ANSI/ASHRAE 135. To this end, ANSI will act as a liaison body between ASHRAE and ISO.

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ANSI/ASHRAE Standard 135-2010
(Supersedes ANSI/ASHRAE Standard 135-2008)
Includes ANSI/ASHRAE addenda listed in the History of Revisions

ASHRAE STANDARD

BACnet®

A Data Communication Protocol for Building Automation and Control Networks

PDF of ISO 16484-5:2012

See the History of Revisions at the end of this standard for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, and the American National Standards Institute.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE Web site (www.ashrae.org) or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in US and Canada). For reprint permission, go to www.ashrae.org/permissions.

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CONTENTS

FOREWORD vii
1 PURPOSE 1
2 SCOPE 1
3 DEFINITIONS 1
3.1 Terms Adopted from International Standards 1
3.2 Terms Defined for this Standard 2
3.3 Abbreviations and Acronyms Used in this Standard 6
4 BACnet PROTOCOL ARCHITECTURE 9
4.1 The BACnet Collapsed Architecture 10
4.2 BACnet Network Topology 12
4.3 Security 14
5 THE APPLICATION LAYER 15
5.1 The Application Layer Model 15
5.2 Segmentation of BACnet Messages 19
5.3 Transmission of BACnet APDUs 20
5.4 Application Protocol State Machines 24
5.5 Application Protocol Time Sequence Diagrams 41
5.6 Application Layer Service Conventions 50
6 THE NETWORK LAYER 52
6.1 Network Layer Service Specification 52
6.2 Network Layer PDU Structure 54
6.3 Messages for Multiple Recipients 59
6.4 Network Layer Protocol Messages 60
6.5 Network Layer Procedures 63
6.6 BACnet Routers 65
6.7 Point-To-Point Half-Routers 70
7 DATA LINK/PHYSICAL LAYERS: ISO 8802-3 ("Ethernet") LAN 75
7.1 The Use of ISO 8802-2 Logical Link Control (LLC) 75
7.2 Parameters Required by the LLC Primitives 75
7.3 Parameters Required by the MAC Primitives 75
7.4 Physical Media 75
8 DATA LINK/PHYSICAL LAYERS: ARCNET LAN 77
8.1 The Use of ISO 8802-2 Logical Link Control (LLC) 77
8.2 Parameters Required by the LLC Primitives 77
8.3 Mapping the LLC Services to the ARCNET MAC Layer 77
8.4 Parameters Required by the MAC Primitives 77
8.5 Physical Media 77
9 DATA LINK/PHYSICAL LAYERS: MASTER-SLAVE/TOKEN PASSING (MS/TP) LAN 79
9.1 Service Specification 79
9.2 Physical Layer 81
9.3 MS/TP Frame Format 92
9.4 Overview of the MS/TP Network 93
9.5 MS/TP Medium Access Control 94
9.6 Cyclic Redundancy Check (CRC) 111
9.7 Interfacing MS/TP LANs with Other BACnet LANs 112
9.8 Responding BACnet User Processing of Messages from MS/TP 112
9.9 Repeaters 112
10 DATA LINK/PHYSICAL LAYERS: POINT-TO-POINT (PTP) 114
10.1 Overview 114
10.2 Service Specification 114
10.3 Point-to-Point Frame Format 119
10.4 PTP Medium Access Control Protocol 121
11 DATA LINK/PHYSICAL LAYERS: EIA/CEA-709.1 ("LonTalk") LAN 142
11.1 The Use of ISO 8802-2 Logical Link Control (LLC) 142
11.2 Parameters Required by the LLC Primitives 142

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11.3 Mapping the LLC Services to the LonTalk Application Layer 142
11.4 Parameters Required by the Application Layer Primitives 142
11.5 Physical Media 143
12 MODELING CONTROL DEVICES AS A COLLECTION OF OBJECTS 144
12.1 Accumulator Object Type 148
12.2 Analog Input Object Type 156
12.3 Analog Output Object Type 161
12.4 Analog Value Object Type 166
12.5 Averaging Object Type 171
12.6 Binary Input Object Type 174
12.7 Binary Output Object Type 179
12.8 Binary Value Object Type 185
12.9 Calendar Object Type 190
12.10 Command Object Type 192
12.11 Device Object Type 196
12.12 Event Enrollment Object Type 205
12.13 File Object Type 211
12.14 Group Object Type 214
12.15 Life Safety Point Object Type 216
12.16 Life Safety Zone Object Type 223
12.17 Loop Object Type 230
12.18 Multi-state Input Object Type 237
12.19 Multi-state Output Object Type 242
12.20 Multi-state Value Object Type 246
12.21 Notification Class Object Type 251
12.22 Program Object Type 254
12.23 Pulse Converter Object Type 259
12.24 Schedule Object Type 266
12.25 Trend Log Object Type 271
12.26 Access Door Object Type 279
12.27 Event Log Object Type 286
12.28 Load Control Object Type 292
12.29 Structured View Object Type 301
12.30 Trend Log Multiple Object Type 304
12.31 Access Point Object Type 312
12.32 Access Zone Object Type 327
12.33 Access User Object Type 335
12.34 Access Rights Object Type 338
12.35 Access Credential Object Type 343
12.36 Credential Data Input Object Type 351
12.37 CharacterString Value Object Type 355
12.38 DateTime Value Object Type 360
12.39 Large Analog Value Object Type 363
12.40 BitString Value Object Type 368
12.41 OctetString Value Object Type 372
12.42 Time Value Object Type 374
12.43 Integer Value Object Type 377
12.44 Positive Integer Value Object Type 382
12.45 Date Value Object Type 387
12.46 DateTime Pattern Value Object Type 390
12.47 Time Pattern Value Object Type 393
12.48 Date Pattern Value Object Type 396
12.49 Network Security Object Type 399
12.50 Global Group Object Type 402
13 ALARM AND EVENT SERVICES 408
13.1 Change of Value Reporting 409
13.2 Intrinsic Reporting 412

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13.3 Algorithmic Change Reporting 419
13.4 Alarm and Event Occurrence and Notification 430
13.5 AcknowledgeAlarm Service 432
13.6 ConfirmedCOVNotification Service 434
13.7 UnconfirmedCOVNotification Service 435
13.8 ConfirmedEventNotification Service 437
13.9 UnconfirmedEventNotification Service 440
13.10 GetAlarmSummary Service 442
13.11 GetEnrollmentSummary Service 444
13.12 GetEventInformation Service 447
13.13 LifeSafetyOperation Service 449
13.14 SubscribeCOV Service 451
13.15 SubscribeCOVProperty Service 454
14 FILE ACCESS SERVICES 457
14.1 AtomicReadFile Service 458
14.2 AtomicWriteFile Service 461
15 OBJECT ACCESS SERVICES 464
15.1 AddListElement Service 464
15.2 RemoveListElement Service 466
15.3 CreateObject Service 468
15.4 DeleteObject Service 471
15.5 ReadProperty Service 472
15.6 Deleted Clause 474
15.7 ReadPropertyMultiple Service 475
15.8 ReadRange Service 478
15.9 WriteProperty Service 482
15.10 WritePropertyMultiple Service 484
16 REMOTE DEVICE MANAGEMENT SERVICES 487
16.1 DeviceCommunicationControl Service 487
16.2 ConfirmedPrivateTransfer Service 489
16.3 UnconfirmedPrivateTransfer Service 491
16.4 ReinitializeDevice Service 492
16.5 ConfirmedTextMessage Service 494
16.6 UnconfirmedTextMessage Service 496
16.7 TimeSynchronization Service 497
16.8 UTCTimeSynchronization Service 498
16.9 Who-Has and I-Have Services 499
16.10 Who-Is and I-Am Services 501
17 VIRTUAL TERMINAL SERVICES 503
17.1 Virtual Terminal Model 503
17.2 VT-Open Service 507
17.3 VT-Close Service 509
17.4 VT-Data Service 510
17.5 Default-terminal Characteristics 512
18 ERROR, REJECT, and ABORT CODES 516
18.1 Error Class - DEVICE 516
18.2 Error Class - OBJECT 516
18.3 Error Class - PROPERTY 517
18.4 Error Class - RESOURCES 518
18.5 Error Class - SECURITY 518
18.6 Error Class - SERVICES 520
18.7 Error Class - COMMUNICATION 521
18.8 Error Class - VT 523
18.9 Reject Reason 524
18.10 Abort Reason 524
18.11 Confirmed Service Common Errors 525
19 BACnet PROCEDURES 526

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19.1 Backup and Restore 526
19.2 Command Prioritization 530
19.3 Device Restart Procedure 533
20 ENCODING BACnet PROTOCOL DATA UNITS 535
20.1 Encoding the Fixed Part of BACnet APDUs 535
20.2 Encoding the Variable Part of BACnet APDUs 546
21 FORMAL DESCRIPTION OF APPLICATION PROTOCOL DATA UNITS 559
22 CONFORMANCE AND INTEROPERABILITY 629
22.1 Conformance to BACnet 629
22.2 BACnet Interoperability 630
23 EXTENDING BACnet TO ACCOMMODATE VENDOR PROPRIETARY INFORMATION 632
23.1 Extending Enumeration Values 632
23.2 Using the PrivateTransfer Services to Invoke Non-Standardized Services 633
23.3 Adding Proprietary Properties to a Standardized Object 633
23.4 Adding Proprietary Object Types to BACnet 634
23.5 Restrictions on Extending BACnet 634
24 NETWORK SECURITY 635
24.1 Overview 635
24.2 Security Wrapper 639
24.3 Security Messages 643
24.4 Securing an APDU 658
24.5 Securing an NPDU 660
24.6 Securing a BVLL 660
24.7 Securing Messages 662
24.8 Network Security Network Trust Levels 664
24.9 Network Security Policies 665
24.10 Network Security 665
24.11 End-to-End Security 666
24.12 Wrapping and Unwrapping Secure Messages 667
24.13 Authenticating Messages 669
24.14 User Authentication 671
24.15 Time Synchronization Requirements 672
24.16 Integrating the Security Layer into the BACnet Stack 673
24.17 BACnet Security In A NAT Environment 680
24.18 BACnet Security Proxy 680
24.19 Deploying Secure Device on Non-Security Aware Networks 681
24.20 Deploying Secure Single Network Installations 681
24.21 Security Keys 681
24.22 Key Server 683
25 REFERENCES 687
ANNEX A - PROTOCOL IMPLEMENTATION CONFORMANCE STATEMENT (NORMATIVE) 690
ANNEX B - GUIDE TO SPECIFYING BACnet DEVICES (INFORMATIVE) 693
ANNEX C - FORMAL DESCRIPTION OF OBJECT TYPE STRUCTURES (INFORMATIVE) 694
ANNEX D - EXAMPLES OF STANDARD OBJECT TYPES (INFORMATIVE) 719
ANNEX E - EXAMPLES OF BACnet APPLICATION SERVICES (INFORMATIVE) 754
E.1 Alarm and Event Services 754
E.2 File Access Services 758
E.3 Object Access Services 760
E.4 Remote Device Management Services 765
E.5 Virtual Terminal Services 769
ANNEX F - EXAMPLES OF APDU ENCODING (INFORMATIVE) 771
F.1 Example Encodings for Alarm and Event Services 771
F.2 Example Encodings for File Access Services 780
F.3 Example Encodings for Object Access Services 782
F.4 Example Encodings for Remote Device Management Services 791
F.5 Example Encodings for Virtual Terminal Services 795
ANNEX G - CALCULATION OF CRC (INFORMATIVE) 798

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G.1 Calculation of the Header CRC 798
G.2 Calculation of the Data CRC 804
ANNEX H - COMBINING BACnet NETWORKS WITH NON-BACnet NETWORKS (NORMATIVE) 809
H.1 Mapping Non-BACnet Networks onto BACnet Routers 809
H.2 Multiple "Virtual" BACnet Devices in a Single Physical Device 809
H.3 Using BACnet with the DARPA Internet Protocols 809
H.4 Using BACnet with the IPX Protocol 810
H.5 Using BACnet with EIB/KNX 812
H.6 Using BACnet with the BACnet/WS Web Services Interface (Annex N) 823
H.7 Virtual MAC Addressing 825
ANNEX I - COMMANDABLE PROPERTIES WITH MINIMUM ON AND OFF TIMES (INFORMATIVE) 826
ANNEX J - BACnet/IP (NORMATIVE) 828
J.1 General 828
J.2 BACnet Virtual Link Layer 828
J.3 BACnet/IP Directed Messages 832
J.4 BACnet/IP Broadcast Messages 832
J.5 Addition of Foreign B/IP Devices to an Existing B/IP Network 834
J.6 Routing Between B/IP and non-B/IP BACnet Networks 836
J.7 Routing Between Two B/IP BACnet Networks 837
J.8 Use of IP Multicast within BACnet/IP 842
J.9 Sources for Internet Information 843
ANNEX K - BACnet INTEROPERABILITY BUILDING BLOCKS (BIBBs) (NORMATIVE) 844
K.1 Data Sharing BIBBs 844
K.2 Alarm and Event Management BIBBs 851
K.3 Scheduling BIBBs 857
K.4 Trending BIBBs 860
K.5 Device and Network Management BIBBs 864
ANNEX L - DESCRIPTIONS AND PROFILES OF STANDARDIZED BACnet DEVICES (NORMATIVE) 872
L.1 Operator Interfaces 872
L.2 BACnet Building Controller (B-BC) 874
L.3 BACnet Advanced Application Controller (B-AAC) 874
L.4 BACnet Application Specific Controller (B-ASC) 875
L.5 BACnet Smart Actuator (B-SA) 875
L.6 BACnet Smart Sensor (B-SS) 876
L.7 Profiles of the Standard BACnet Devices 877
ANNEX M - GUIDE TO EVENT NOTIFICATION PRIORITY ASSIGNMENTS (INFORMATIVE) 878
ANNEX N - BACnet/WS WEB SERVICES INTERFACE (NORMATIVE) 882
N.1 Data Model 882
N.2 Paths 883
N.3 Normalized Points 883
N.4 Reference Nodes 884
N.5 Localization 884
N.6 Security 884
N.7 Sessions 885
N.8 Attributes 885
N.9 Standard Nodes 891
N.10 Encodings 892
N.11 Service Options 893
N.12 Services 896
N.13 Errors 914
N.14 Extending BACnet/WS 915
ANNEX O - BACnet OVER ZigBee AS A DATA LINK LAYER (NORMATIVE) 916
O.1 General 916
O.2 ZigBee Overview 916
O.3 Definitions 917
O.4 Unicast Addressing 917
O.5 Broadcast Addressing 917

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O.6 BACnet/ZigBee Data Link Layer (BZLL) 918
O.7 Maximum Payload Size 921
O.8 Vendor Specific Commands 921
ANNEX P - BACnet ENCODING OF STANDARD AUTHENTICATION FACTOR FORMATS (NORMATIVE) 922
ANNEX Q - XML DATA FORMATS (NORMATIVE) 928
Q.1 Introduction 928
Q.2 Document Structure 931
Q.3 Expressing BACnet Datatypes in XML 932
Q.4 Expressing BACnet Objects and Properties in XML 966
Q.5 Definitions, Types, Instances, and Inheritance 966
Q.7 Extensibility 973
ANNEX R - MAPPING NETWORK LAYER ERRORS (NORMATIVE) 976
ANNEX S - EXAMPLES OF SECURE BACnet MESSAGES (INFORMATIVE) 978
HISTORY OF REVISIONS 993

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FOREWORD

BACnet, the ASHRAE building automation and control networking protocol, has been designed specifically to meet the communication needs of building automation and control systems for applications such as heating, ventilating, and air-conditioning control, lighting control, access control, and fire detection systems. The BACnet protocol provides mechanisms by which computerized equipment of arbitrary function may exchange information, regardless of the particular building service it performs. As a result, the BACnet protocol may be used by head-end computers, general-purpose direct digital controllers, and application specific or unitary controllers with equal effect.

The motivation for this Standard was the widespread desire of building owners and operators for "interoperability," the ability to integrate equipment from different vendors into a coherent automation and control system - and to do so competitively. To accomplish this, the Standard Project Committee (SPC) solicited and received input from dozens of interested firms and individuals; reviewed all relevant national and international data communications standards, whether de facto or the result of committee activity; and spent countless hours in debate and discussion of the pros and cons of each element of the protocol.

What has emerged from the committee deliberations is a network protocol model with these principal characteristics:

(a) All network devices (except MS/TP slaves) are peers, but certain peers may have greater privileges and responsibilities than others.

(b) Each network device is modeled as a collection of network-accessible, named entities called "objects." Each object is characterized by a set of attributes or "properties." While this Standard prescribes the most widely applicable object types and their properties, implementors are free to create additional object types if desired. Because the object model can be easily extended, it provides a way for BACnet to evolve in a backward compatible manner as the technology and building needs change.

(c) Communication is accomplished by reading and writing the properties of particular objects and by the mutually acceptable execution of other protocol "services." While this Standard prescribes a comprehensive set of services, mechanisms are also provided for implementors to create additional services if desired.

(d) Because of this Standard's adherence to the ISO concept of a "layered" communication architecture, the same messages may be exchanged using various network access methods and physical media. This means that BACnet networks may be configured to meet a range of speed and throughput requirements with commensurately varying cost. Multiple BACnet networks can be interconnected within the same system forming an internetwork of arbitrarily large size. This flexibility also provides a way for BACnet to embrace new networking technologies as they are developed.

BACnet was designed to gracefully improve and evolve as both computer technology and demands of building automation systems change. Upon its original publication in 1995, a Standing Standards Project Committee was formed to deliberate enhancements to the protocol under ASHRAE rules for "continuous maintenance." Much has happened since the BACnet standard was first promulgated. BACnet has been translated into Chinese, Japanese, and Korean, and embraced across the globe. BACnet devices have been designed, built and deployed on all seven continents. Suggestions for enhancements and improvements have been continually received, deliberated, and, ultimately, subjected to the same consensus process that produced the original standard. This publication is the result of those deliberations and brings together all of the corrections, refinements, and improvements that have been adopted.

Among the features that have been added to BACnet are: increased capabilities to interconnect systems across wide area networks using internet protocols, new objects and services to support fire detection and other life safety applications, capabilities to backup and restore devices, standard ways to collect trend data, new tools to make specifying BACnet systems easier, a mechanism for making interoperable extensions to the standard visible, and many others. The successful addition of these features demonstrates that the concept of a protocol deliberately crafted to permit extension of its capabilities over time as technology and needs change is viable and sound.

All communication protocols are, in the end, a collection of arbitrary solutions to the problems of information exchange and all are subject to change as time and technology advance. BACnet is no exception. Still, it is the hope of those who have contributed their time, energies, and talents to this work that BACnet will help to fulfill, in the area of building automation and control, the promise of the information age for the public good!

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1 PURPOSE

The purpose of this standard is to define data communication services and protocols for computer equipment used for monitoring and control of HVAC&R and other building systems and to define, in addition, an abstract, object-oriented representation of information communicated between such equipment, thereby facilitating the application and use of digital control technology in buildings.

2 SCOPE

2.1 This protocol provides a comprehensive set of messages for conveying encoded binary, analog, and alphanumeric data between devices including, but not limited to:

(a) hardware binary input and output values,
(b) hardware analog input and output values,
(c) software binary and analog values,
(d) text string values,
(e) schedule information,
(f) alarm and event information,
(g) files, and
(h) control logic.

2.2 This protocol models each building automation and control computer as a collection of data structures called "objects," the properties of which represent various aspects of the hardware, software, and operation of the device. These objects provide a means of identifying and accessing information without requiring knowledge of the details of the device's internal design or configuration.

3 DEFINITIONS

3.1 Terms Adopted from International Standards

The following terms used in this standard are defined by international standards or draft standards for open system interconnection (OSI). The definitions are repeated here and a reference to the appropriate standard is provided. Clause 25 contains the titles of all national and international standards referenced in this clause and elsewhere in this standard. Words or phrases in italics refer to terms defined elsewhere in this clause.

abstract syntax: the specification of application layer data or *application-protocol-control-information* by using notation rules which are independent of the encoding technique used to represent them (ISO 8822).

application: a set of a USER's information processing requirements (ISO 8649).

application-entity: the aspects of an *application-process* pertinent to OSI (ISO 7498).

application-process: an element within a *real open system* which performs the information processing for a particular *application* (ISO 7498).

application-protocol-control-information: information exchanged between *application-entities*, using presentation services, to coordinate their joint operation (ISO 9545).

application-protocol-data-unit: a unit of data specified in an application protocol and consisting of *application-protocol-control-information* and possibly application-user-data (ISO 9545).

application-service-element: that part of an *application-entity* which provides an OSI environment capability, using underlying services when appropriate (ISO 7498).

concrete syntax: those aspects of the rules used in the formal specification of data which embody a specific representation of that data (ISO 7498).

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confirm (primitive): a representation of an interaction in which a *service-provider* indicates, at a particular *service-access-point*, completion of some procedure previously invoked, at that *service-access-point*, by an interaction represented by a *request* primitive (ISO TR 8509).

indication (primitive): a representation of an interaction in which a *service-provider* either
(a) indicates that it has, on its own initiative, invoked some procedure; or
(b) indicates that a procedure has been invoked by the *service-user* at the peer *service-access-point* (ISO TR 8509).

peer-entities: *entities* within the same layer (ISO 7498).

real open system: a *real system* which complies with the requirements of OSI standards in its communication with other *real systems* (ISO 7498).

real system: a set of one or more computers, the associated software, peripherals, terminals, human operators, physical processes, information transfer means, etc., that forms an autonomous whole capable of performing information processing and/or information transfer (ISO 7498).

request (primitive): a representation of an interaction in which a *service-user* invokes some procedure (ISO TR 8509).

response (primitive): a representation of an interaction in which a *service-user* indicates that it has completed some procedure previously invoked by an interaction represented by an *indication* primitive (ISO TR 8509).

(N)-service-access-point: the point at which (N)-services are provided by an (N)-*entity* to an (N+1)-*entity* (ISO 7498).

(N)-service-data-unit: an amount of (N)-interface-data whose identity is preserved from one end of an (N)-connection to the other (ISO 7498).

service-user: an *entity* in a single open system that makes use of a service through *service-access-points* (ISO TR 8509).

service-primitive; **primitive**: an abstract, implementation-independent representation of an interaction between the *service-user* and the *service-provider* (ISO TR 8509).

service-provider: an abstract of the totality of those entities which provide a service to peer *service-users* (ISO TR 8509).

transfer-syntax: that *concrete syntax* used in the transfer of data between open systems (ISO 7498).

user element: the representation of that part of an *application-process* which uses those *application-service-elements* needed to accomplish the communications objectives of that *application-process* (ISO 7498).

3.2 Terms Defined for this Standard

access control: a method for regulating or restricting access to *network resources*.

access rights (physical access control): the access privileges granted to a credential.

access user (physical access control): the person or asset holding one or more credentials.

alarm: 1. An annunciation, either audible or visual or both, that alerts an operator to an off-normal condition that may require corrective action. **2.** An abnormal condition detected by a device or controller that implements a rule or logic specifically designed to look for that condition.

algorithmic change reporting: the detection and reporting of an alarm or event, based on an algorithm specified in an Event Enrollment object. See *intrinsic reporting*.

authentication: the act of verifying identity

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authentication factor: a data element of the credential which is used to verify a credential's identity.

authorization (network security): the control of access to network resources based on known identity and access rules.

authorization (physical access control): the process of determining whether the access user is permitted to enter a protected zone through an access controlled point.

BACnet device: any device, real or virtual, that supports digital communication using the BACnet protocol.

BACnet-user: that portion of an *application-process* that is represented by the BACnet *user element*.

bridge: a device that connects two or more *segments* at the physical and data link layers. This device may also perform message filtering based upon MAC layer addresses.

broadcast: a message sent as a single unit, which may apply to more than one device.

change of state: an event that occurs when a measured or calculated Boolean or discrete enumerated value changes.

change of value: an event that occurs when a measured or calculated analog value changes by a predefined amount.

client: a system or device that makes use of another device for some particular purpose via a service *request* instance. A client requests service from a *server*.

context: a set of data or information that completely describes a particular communication environment at a particular point in time.

controller: a device for regulation or management of a system or component.

credential (physical access control): the combination of authentication factors and access rights.

data confidentiality: the property that information is not made available or disclosed to unauthorized individuals, entities, or processes.

data integrity: the property that data has not been altered or destroyed in an unauthorized manner.

data origin authentication: the corroboration that the source of data received is as claimed.

date pattern: a date that may contain one or more unspecified octets or special date values.

directly connected network: a network that is accessible from a router without messages being relayed through an intervening router. A PTP connection is to a directly connected network if the PTP connection is currently active and no intervening router is used.

download: a particular type of file transfer that refers to the transfer of an executable program or database to a remote device where it may be executed.

encrypted message: a message that is wrapped in a security header, signed, and encrypted.

entity: something that has a separate and distinct existence. An identifiable item that is described by a set or collection of properties.

error detection: a procedure used to identify the presence of errors in a communication.

error recovery: a procedure invoked in response to a detected error that permits the information exchange to continue.

gateway: a device that connects two or more dissimilar *networks*, permitting information exchange between them.

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global: pertaining to all devices or nodes on a communication *internetwork*.

global broadcast: a message addressed to all devices or *nodes* on all *networks* in a BACnet *internet*.

half router: a device or *node* that can participate as one partner in a PTP connection. The two half-router partners that form an active PTP connection together make up a single *router*.

incapable device: a device that is inherently incapable, or has been configured to be appear to be incapable, of producing or consuming secure BACnet messages. All incapable devices are plain devices.

initialization: the process of establishing a known state, usually from a power up condition. Initialization may require re-establishment of a node's logical or physical address.

internetwork: a set of two or more *networks* interconnected by *routers*. In a BACnet *internetwork*, there exists exactly one message path between any two nodes.

intrinsic reporting: the detection and reporting of an alarm or event, based on an algorithm defined as part of the *object type* specification. No external reference to an Event Enrollment is involved. See *algorithmic change reporting*.

inverted network: a BACnet internetwork where two or more networks are connected by a network with an NPDU size smaller than the networks it joins.

key: a sequence of symbols that controls the operations of encipherment and decipherment.

local: pertaining to devices on the same *network* as the referenced device.

local broadcast: a message addressed to all devices or *nodes* on the same *network* as the originator.

medium: the physical transmission *entity*. Typical media are twisted-pair wire, fiber optic cable, and coaxial cable.

medium access control: a process used to maintain order and provide access to the communication *medium*.

network: a set of one or more *segments* interconnected by *bridges* that have the same network address.

network resource: any physical or logical *entity* that may be accessed via a communication *medium*.

node: an addressable device connected to the communication *medium*.

object: a specific instance of an *object type*. While an object type is identified by a unique Object_Type property, an object is identified by its Object_Identifier property.

object profile: an object profile is a means of defining objects beyond those defined in Clause 12. A profile defines the set of properties, behavior, and/or requirements for a proprietary object, or for proprietary extensions to a standard object.

object type: a generic classification of data that is defined by a set of *properties*.

operator authentication: the corroboration that the operator logging on to a device is as claimed.

peer entity authentication: the corroboration that a peer entity in an association is the one claimed.

physical access control (PACS): an electronic system that controls the ability of people or vehicles to enter a protected area, by means of authentication and authorization at access control points.

physical segment: a single contiguous *medium* to which BACnet nodes are attached.

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physically insecure: not physically secure.

physically secure: a device or network that is protected from physical access by unauthorized individuals.

plain device: a device that does not normally produce or consume secure BACnet messages. All incapable devices are plain devices. However, a plain device that is not an incapable device is capable of producing or consuming secure BACnet messages when communicating with another device that requires it.

plain network: a network that does not require signed or encrypted traffic.

plain message: a message that is not secured by a BACnet security wrapper.

printable character: a character that represents a printable symbol as opposed to a device control character. Printable characters include, but are not limited to, upper- and lowercase letters, punctuation marks, and mathematical symbols. The exact set depends upon the character set being used.

property: a particular characteristic of an *object type*.

proprietary: within the context of BACnet, any extension of or addition to *object types*, *properties*, PrivateTransfer services, or enumerations specified in this standard.

receiving BACnet-user: the *BACnet-user* that receives an *indication* or *confirm* service primitive.

remote: pertaining to devices or *nodes* on a different *network* than the referenced device.

remote broadcast: a message addressed to all devices or *nodes* on a different *network* than the originator.

repeater: a device that connects two or more *physical segments* at the physical layer.

requesting BACnet-user: the *BACnet-user* that assumes the role of a *client* in a confirmed service.

responding BACnet-user: the *BACnet-user* that assumes the role of a *server* in a confirmed service.

role-based access control (RBAC): access privileges that are assigned to specific roles. Access users acquire privileges through their assigned role.

router: a device that connects two or more *networks* at the network layer.

secure network: a network on which all traffic is required to be signed or encrypted.

security: any of a variety of procedures used to ensure that information exchange is guarded to prevent disclosure to unauthorized individuals. Security measures are intended to prevent disclosure of sensitive information even to those who have valid access to the communication *network*. Security is distinct from access control, although some security can be provided by limiting physical access to the communication medium itself.

segment: a segment consists of one or more *physical segments* interconnected by repeaters.

sending BACnet-user: the *BACnet-user* that issues a *request* or *response* service primitive.

server: a system or device that responds to a service *request* instance for some particular purpose. The server provides service to a *client*.

signed message: a message that is wrapped in a security header, signed, and not encrypted.

special date value: a date value that is one of the special values such as "even months", "last day of month", etc. These special date values are used in subcomponents (octets) of a value of type Date.

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specific date: a fully specified date. For example, January 24, 1991, Day of week = Thursday. A specific date shall contain no unspecified octets or Special Date Values.

specific datetime: a BACnetDateTime construct composed of a specific date and a specific time.

specific time: a fully specified time. For example, 17:35:45.17 (= 5:35:45.17 P.M.). A specific time shall contain no unspecified octets.

standard object type: an object type defined by this standard where the numerical value is within the range reserved for ASHRAE.

standard property: a required or optional property of a standard object type where the numerical value of the property identifier is within the range reserved for ASHRAE and the property is listed in the object type's properties table in Clause 12.

synchronization: a facility that allows processes to define and identify specific places in a transmission or exchange that can be used to reset a communication session to a predefined state.

time pattern: a time that may contain one or more unspecified octets.

timestamp: the indication of the point in time recorded for and accompanying the record of an event or operation.

trusted: a term used to refer to devices or networks from which messages are believed to be authentic, either through the use of secure messages or based on the physical security of that device or network.

unit_time: the length of time required to transmit one octet with a start bit and a single stop bit. Ten bit-times.

unspecified date: a date composed entirely of unspecified octets (A value of X'FF' = D'255').

unspecified datetime: a BACnetDateTime construct composed of an unspecified date and an unspecified time.

unspecified octet: an octet used in the context of date, time or BACnetWeekNDay values that contains the value X'FF' = D'255'.

unspecified time: a time composed entirely of unspecified octets (A value of X'FF' = D'255').

upload: the process of transferring an executable program image or a database from a remote device in such a manner as to allow subsequent download.

3.3 Abbreviations and Acronyms Used in this Standard

A application layer (prefix)
ABA American Bankers Association
AE application entity
ANSI American National Standards Institute
APCI application protocol control information
APDU application layer protocol data unit
API application program interface
ARCNET attached resource computer network
ASE application service element
ASN.1 Abstract Syntax Notation One (ISO 8824)
B' ' denotes that binary notation is used between the single quotes
BAC building automation and control
BBMD BACnet/IP broadcast management device
BDT broadcast distribution table
B/IP BACnet/IP
B/IP-M BACnet/IP multicast
BVLC BACnet virtual link control

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BVLCI	BACnet virtual link control information
BVLL	BACnet virtual link layer
C	conditional
C(=)	conditional (The parameter is semantically equivalent to the parameter in the service primitive to its immediate left in the table.)
CNF	confirm primitive
COV	change of value
CRC	cyclic redundancy check
D' '	denotes that decimal notation is used between the single quotes
DA	local destination MAC layer address
DADR	ultimate destination MAC layer address
DER	data expecting reply
DES	Data Encryption Standard (FIPS 46-1)
DESFire	Data Encryption Standard Fast, Innovative, Reliable and Secure
DID	ARCNET destination MAC address
DLEN	1-octet length of ultimate destination MAC layer address
DNET	2-octet ultimate destination network number
DSAP	LLC destination service access point (X'82' for BACnet)
EIB	European Installation Bus
EIBA	European Installation Bus Association
EXEC	capable of executing a service request
FDT	foreign device table
ICI	interface control information
IL	ARCNET information length field
IND	indication primitive
INF	"Infinity", a unique binary pattern representing positive infinity (see ANSI/IEEE 754-1985)
-INF	"Negative infinity", a unique binary pattern representing negative infinity (see ANSI/IEEE 754-1985)
IEEE	Institute of Electrical and Electronics Engineers
INIT	capable of initiating a service request
IP	Internet Protocol - RFC 791
ISO	International Organization for Standardization
KNX	The Konnex System Specification: EIB is the core protocol of the Konnex standard. The Konnex System Specification reflects the current status for EIB.
L	data link (prefix)
LAN	local area network
LLC	logical link control (ISO 8802-2)
LPCI	link protocol control information
LPDU	link protocol data unit
LRC	Longitudinal Redundancy Check
LSAP	link service access point (X'82' for BACnet)
LSDU	link service data unit
M	mandatory
M(=)	mandatory (The parameter is semantically equivalent to the parameter in the service primitive to its immediate left in the table.)
MA	medium access (prefix)
MAC	medium access control
MPCI	MAC protocol control information
MPDU	MAC layer protocol data unit
MSDU	MAC service data unit
MS/TP	master-slave/token-passing
N	network layer (prefix)
NaN	"Not a Number", a unique binary pattern representing an invalid number (see ANSI/IEEE 754-1985)
NAT	Network Address Translation - RFC 2663
NP	network priority
NPCI	network protocol control information
NPDU	network layer protocol data unit

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NRZ	non-return to zero
NSAP	network service access point
NSDU	network service data unit
O	indicates that support of a property is optional
OSI	open systems interconnection
P	physical layer (prefix)
PAC	ARCNET data packet header octet
PCI	protocol control information
PDU	protocol data unit
PICS	protocol implementation conformance statement
PK	Private Key
PPCI	physical layer protocol control information
PPDU	physical protocol data unit
PPP	Point-To-Point protocol - RFC 1661
PSDU	physical service data unit
PTP	point-to-point
R	indicates that a property shall be supported and readable using BACnet services
REQ	request primitive
RFC	request for comment
RSP	response primitive
S	selection
S(=)	selection (The parameter is semantically equivalent to the parameter in the service primitive to its immediate left in the table.)
SA	local network source MAC layer address
SAP	service access point
SC	ARCNET system code (X'CD' for BACnet)
SDU	service data unit
SIA	Security Industry Association
SID	ARCNET source MAC address
SK	Session Key
SLEN	1-octet length of original source MAC layer address
SLIP	Serial Line Internet Protocol -RFC 1055
SNET	2-octet original source network number
SPC	standard project committee
SSAP	LLC source service access point (X'82' for BACnet)
TSM	transaction state machine
U	user option
U(=)	user option (The parameter is semantically equivalent to the parameter in the service primitive to its immediate left in the table.)
UART	universal asynchronous receiver/transmitter
UDP	User Datagram Protocol - RFC 768
UTC	Universal Time Coordinated
VT	virtual terminal
W	indicates that a property shall be supported, readable, and writable using BACnet services
X'	denotes that hexadecimal notation is used between the single quotes
XID	eXchange IDentification (ISO 8802-2)

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4 BACnet PROTOCOL ARCHITECTURE

The Open System Interconnection (OSI) - Basic Reference Model (ISO 7498) is an international standard that defines a model for developing multi-vendor computer communication protocol standards. The OSI model addresses the general problem of computer-to-computer communication and breaks this very complex problem into seven smaller, more manageable sub-problems, each of which concerns itself with a specific communication function. Each of these sub-problems forms a "layer" in the protocol architecture.

The seven layers are arranged in a hierarchical fashion as shown in Figure 4-1. A given layer provides services to the layers above and relies on services provided to it by the layers below. Each layer can be thought of as a black box with carefully defined interfaces on the top and bottom. An application process connects to the OSI application layer and communicates with a second, remote application process. This communication appears to take place between the two processes as if they were connected directly through their application layer interfaces. Minimal knowledge or understanding of the other layers is required. In a similar manner, each layer of the protocol relies on lower layers to provide communication services and establishes a virtual peer-to-peer communication with its companion layer on the other system. The only real connection takes place at the physical layer.

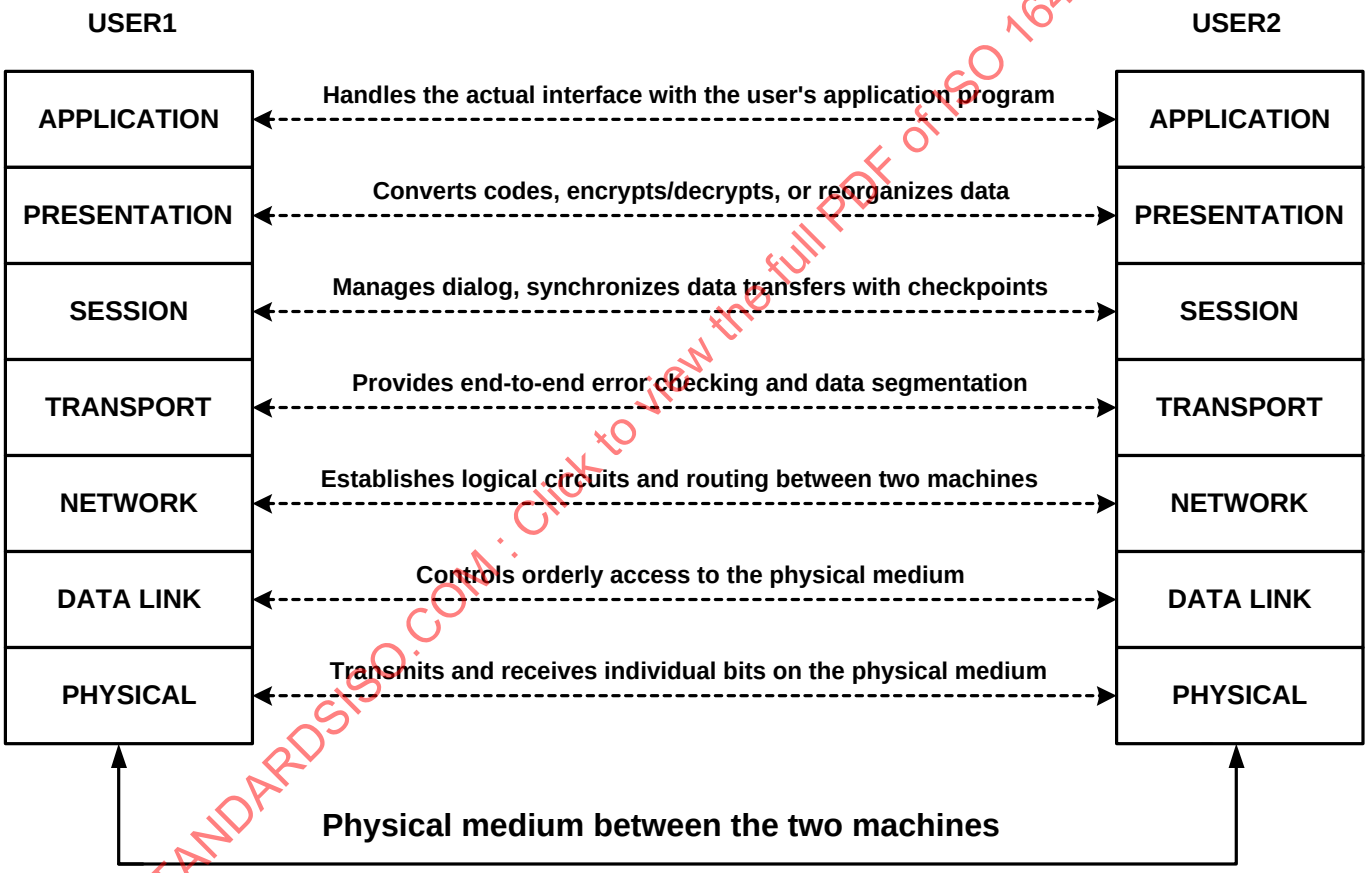

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Figure 4-1. The ISO Open Systems Interconnection Basic Reference Model.

The OSI model addresses computer-to-computer communication from a very general perspective. It was designed to deal with the problems associated with computers in large, complex networks communicating with other computers in networks anywhere in the world. In this environment, computers can be separated by long distances and the messages might pass through several intermediate points, each of which may have to make routing decisions or perform some type of translation. Complex synchronization and error recovery schemes may also be needed.

The cost of implementing such a protocol today is prohibitively high for most building automation applications and is not generally required. Nevertheless, the OSI model is a good one to use for a building automation protocol if consideration is

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given to including only the OSI functionality that is actually needed, thereby collapsing the seven-layer architecture. In a collapsed architecture, only selected layers of the OSI model are included. The other layers are effectively null, thus reducing message length and communication processing overhead. Such a collapsed architecture permits the building automation industry to take advantage of lower cost, mass-produced processor and local area network technologies such as have been developed for the process control and office automation industries. The use of readily available, widespread technologies, such as Ethernet,[1] ARCNET,[2] and LonTalk,[3] will lower the cost, increase performance, and open new doors to system integration.

4.1 The BACnet Collapsed Architecture

BACnet is based on a four-layer collapsed architecture that corresponds to the physical, data link, network, and application layers of the OSI model as shown in Figure 4-2. The application layer and a simple network layer are defined in the BACnet standard. BACnet provides seven options that correspond to the OSI data link and physical layers. Option 1 is the logical link control (LLC) protocol defined by ISO 8802-2 Type 1, combined with the ISO 8802-3 medium access control (MAC) and physical layer protocol. ISO 8802-2 Type 1 provides unacknowledged connectionless service only. ISO 8802-3 is the international standard version of the well-known "Ethernet" protocol. Option 2 is the ISO 8802-2 Type 1 protocol combined with ARCNET (ATA 878.1). Option 3 is a Master-Slave/Token-Passing (MS/TP) protocol designed specifically for building automation and control devices as part of the BACnet standard. The MS/TP protocol provides an interface to the network layer that looks like the ISO 8802-2 Type 1 protocol and controls access to an EIA-485 physical layer. Option 4, the Point-To-Point protocol, provides mechanisms for hardwired or dial-up serial, asynchronous communication. Option 5 is the LonTalk protocol. Option 6, BACnet/IP, permits BACnet devices to use standard Internet Protocols (UDP and IP) as a virtual data link layer. Option 7, ZigBee, provides a wireless datalink. Collectively these options provide a master/slave MAC, deterministic token-passing MAC, high-speed contention MAC, dial-up access, star and bus topologies, and a choice of twisted-pair, coax, or fiber optic media, in addition to wireless connectivity. The details of these options are described in Clauses 7 through 11 Annex J, and Annex O.

A four-layer collapsed architecture was chosen after careful consideration of the particular features and requirements of BAC networks, including a constraint that protocol overhead needed to be as small as possible. The reasoning behind the selection of the physical, data link, network, and application layers for inclusion in the BACnet architecture is outlined in this subclause.

What layers are required for the proper operation of a BAC network? BAC networks are local area networks. This is true even though in some applications it is necessary to exchange information with devices in a building that is very far away. This long-distance communication is done through telephone networks. The routing, relaying, and guaranteed delivery issues are handled by the telephone system and can be considered external to the BAC network. BAC devices are static. They don't move from place to place and the functions that they are asked to perform do not change in the sense that a manufacturing device may make one kind of part today and some very different part tomorrow. These are among the features of BAC networks that can be used to evaluate the appropriateness of the layers in the OSI model.

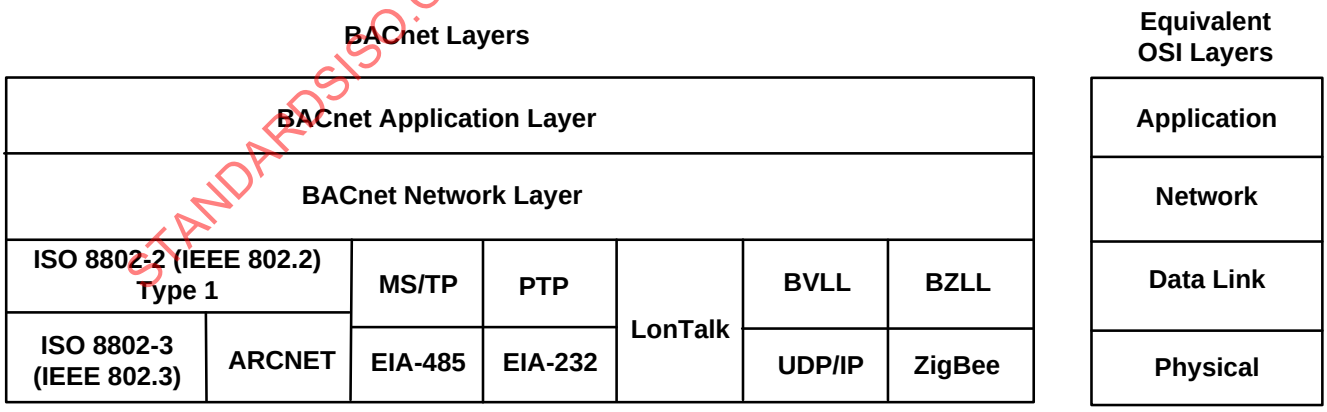

Figure 4-2. BACnet collapsed architecture.

[1] Ethernet is a registered trademark of Digital Equipment Corporation, Intel, and Xerox and is the basis for international standard ISO 8802-3.
[2] ARCNET is a registered trademark of Datapoint Corporation.
[3] LonTalk is a registered trademark of Echelon Corporation.

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The physical layer provides a means of connecting the devices and transmitting the electronic signals that convey the data. Clearly the physical layer is needed in a BAC protocol.

The data link layer organizes the data into frames or packets, regulates access to the medium, provides addressing, and handles some error recovery and flow control. These are all functions that are required in a BAC protocol. The conclusion is that the data link layer is needed.

Functions provided by the network layer include translation of global addresses to local addresses, routing messages through one or more networks, accommodating differences in network types and in the maximum message size permitted by those networks, sequencing, flow control, error control, and multiplexing. BACnet is designed so that there is only one logical path between devices, thus eliminating the need for optimal path routing algorithms. A network is made up of one or more physical segments connected by repeaters or bridges but with a single local address space. In the case of a single network, most network layer functions are either unnecessary or duplicate data link layer functions. For some BACnet systems, however, the network layer is a necessity. This is the case when two or more networks in a BACnet internet use different MAC layer options. When this occurs, there is a need to recognize the difference between local and global addresses and to route messages to the appropriate networks. BACnet provides this limited network layer capability by defining a network layer header that contains the necessary addressing and control information.

The transport layer is responsible for guaranteeing end-to-end delivery of messages, segmentation, sequence control, flow control, and error recovery. Most of the functions of the transport layer are similar to functions in the data link layer, though different in scope. The scope of transport layer services is end-to-end whereas the scope of data link services is point-to-point across a single network. Since BACnet supports configurations with multiple networks, the protocol must provide the end-to-end services of the transport layer. Guaranteed end-to-end delivery and error recovery are provided in the BACnet application layer via message retry and timeout capabilities. Message segmentation and end-to-end flow control is required for buffer and processor resource management. This is because potentially large amounts of information may be returned for even simple BACnet requests. These functions are provided in the BACnet application layer. Last, sequence control is required in order to properly reassemble segmented messages. This is provided in the BACnet application layer within the segmentation procedure. Since BACnet is based on a connectionless communication model, the scope of the required services is limited enough to justify implementing these at a higher layer, thus saving the communication overhead of a separate transport layer.

The session layer is used to establish and manage long dialogues between communicating partners. Session layer functions include establishing synchronization checkpoints and resetting to previous checkpoints in the event of error conditions to avoid restarting an exchange from the beginning. Most communications in a BAC network are very brief. For example, reading or writing one or a few values, notifying a device about an alarm or event, or changing a setpoint. Occasionally longer exchanges take place, such as uploading or downloading a device. The few times when the services of this layer would be helpful do not justify the additional overhead that would be imposed on the vast majority of transactions, which are very brief and do not need them.

The presentation layer provides a way for communicating partners to negotiate the transfer syntax that will be used to conduct the communication. This transfer syntax is a translation from the abstract user view of data at the application layer to sequences of octets treated as data at the lower layers. If only one transfer syntax is permitted, then the presentation layer function reduces to an encoding scheme for representing the application data. BACnet defines such a fixed encoding scheme and includes it in the application layer, making an explicit presentation layer unnecessary.

The application layer of the protocol provides the communication services required by the applications to perform their functions, in this case monitoring and control of HVAC&R and other building systems. Clearly an application layer is needed in the protocol.

In summary:

(a) The resource and overhead costs for implementing a full OSI seven-layer architecture make it impractical for current building automation devices.

(b) Following the OSI model offers advantages in terms of adopting existing computer networking technology. This can result in cost savings and make integration with other computer network systems easier.

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(c) The expectations and environment of building automation systems permit simplification of the OSI model by eliminating the functionality of some of the layers.

(d) A collapsed architecture made up of the physical, data link, network, and application layers is the optimum solution for today's building automation systems.

4.2 BACnet Network Topology

In the interest of application flexibility, BACnet does not prescribe a rigid network topology. Rather, BACnet devices are physically connected to one of four types of local area networks (LANs) or via dedicated or dial-up serial, asynchronous lines. These networks may then be further interconnected by BACnet routers as described in Clause 6.

In terms of LAN topology, each BACnet device is attached to an electrical medium or *physical segment*. A BACnet *segment* consists of one or more physical segments connected at the physical layer by *repeaters*. A BACnet *network* consists of one or more segments interconnected by *bridges*, devices that connect the segments at the physical and data link layers and may perform message filtering based upon MAC addresses; a network forms a single MAC address domain. Multiple networks, possibly employing different LAN technologies, may be interconnected by BACnet *routers* to form a BACnet *internetwork*. In a BACnet internetwork, there exists exactly one message path between any two nodes. These concepts are shown graphically in Figure 4-3.

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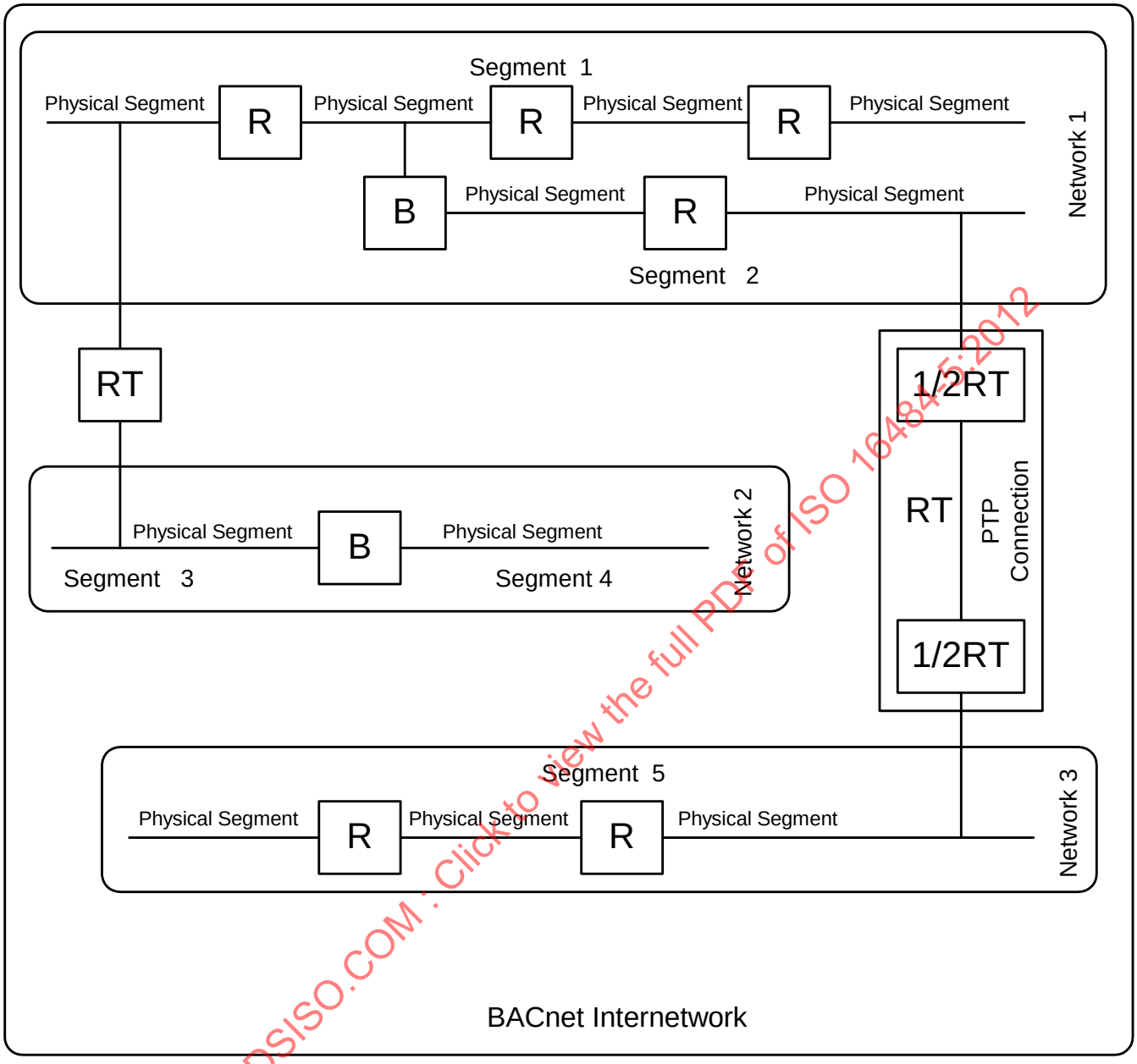

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Figure 4-3. A BACnet internetwork illustrating the concepts of Physical Segments, Repeaters, Segments, Bridges, Networks, Half Routers, and Routers.

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4.3 Security

The principal security threats to BACnet systems are people who, intentionally or by accident, modify a device's configuration or control parameters. Problems due to an errant computer are outside the realm of security considerations. One important place for security measures is the operator-machine interface. Since the operator-machine interface is not part of the communication protocol, vendors are free to include password protection, audit trails, or other controls to this interface as needed. In addition, write access to any properties that are not explicitly required to be "writable" by this standard may be restricted to modifications made only in virtual terminal mode or be prohibited entirely. This permits vendors to protect key properties with a security mechanism that is as sophisticated as they consider appropriate. BACnet also defines services that can be used to provide peer entity, data origin, and operator authentication. See Clause 24.

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5 THE APPLICATION LAYER

5.1 The Application Layer Model

This clause presents a model of the BACnet application layer. The purpose of the model is to describe and illustrate the interaction between the application layer and application programs, the relationship between the application layer and lower layers in the protocol stack, and the peer-to-peer interactions with a remote application layer. This model is not an implementation specification.

An Application Process is that functionality within a system that performs the information processing required for a particular application. All parts of the Application Process outside the Application Layer, (i.e., those that do not concern the communication function) are outside the scope of BACnet. The part of the Application Process that is within the Application Layer is called the Application Entity. In other words, an Application Entity is that part of the Application Process related to the BACnet communication function. An application program interacts with the Application Entity through the Application Program Interface (API). This interface is not defined in BACnet, but it would probably be a function, procedure, or subroutine call in an actual implementation. These concepts are illustrated in Figure 5-1. The shaded region indicates the portion of the Application Process that is within the BACnet Application Layer.

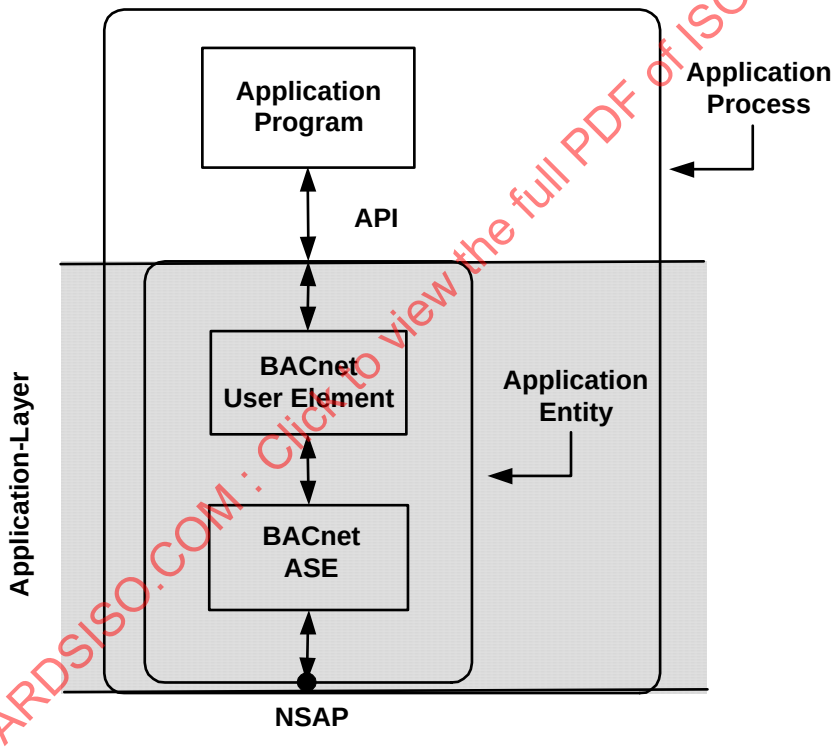

Figure 5-1. Model of a BACnet Application Process.

The Application Entity is itself made up of two parts: the BACnet User Element and the BACnet Application Service Element (ASE). The BACnet ASE represents the set of functions or application services specified in Clauses 13 through 17 and Clause 24. The BACnet User Element carries out several functions in addition to supporting the local API. It represents the implementation of the "service procedure" portion of each application service. It is responsible for maintaining information about the context of a transaction, including generating invoke IDs and remembering which invoke ID goes with which application service request (response) to (from) which device. It is also responsible for maintaining the time-out counters that are required for the retrying of a transmission. The BACnet User Element also presides over the mapping of a device's activities into BACnet objects.

Information exchanged between two peer application processes is represented in BACnet as an exchange of abstract service primitives, following the ISO conventions contained in the OSI technical report on service conventions, ISO TR 8509. These

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primitives are used to convey service-specific parameters that are defined in Clauses 13 through 17 and Clause 24. Four service primitives are defined: request, indication, response, and confirm. The information contained in the primitives is conveyed using a variety of protocol data units (PDUs) defined in this standard. In order to make clear which BACnet PDU is being used, the notation will be as follows:

CONF_SERV.request	CONF_SERV.indication	CONF_SERV.response	CONF_SERV.confirm
UNCONF_SERV.request	UNCONF_SERV.indication		
SEGMENT_ACK.request	SEGMENT_ACK.indication		
REJECT.request	REJECT.indication		
ABORT.request	ABORT.indication		
	SEC_ERR.indication		

The designation CONF_SERV indicates that BACnet confirmed service PDUs are being used. Similarly, the designations UNCONF_SERV, SEGMENT_ACK, ERROR, REJECT, and ABORT indicate that unconfirmed service PDUs, segment acknowledge PDUs, error PDUs, reject PDUs, and abort PDUs, respectively, are being used. The designation SEC_ERR indicates that an error occurred in the BACnet security layer and is being indicated up to the BACnet application program. The format of a SEC_ERR.indication is a local matter.

An application program that needs to communicate with a remote application process accesses the local BACnet User Element through the API. Some of the API parameters, such as the identity (address) of the device to which the service request is to be sent and protocol control information, is passed directly down to the network or data link layers. The remainder of the parameters make up an application service primitive that is passed from the BACnet User Element to the BACnet ASE. Conceptually, the application service primitive results in the generation of an APDU that becomes the data portion of a network service primitive, which is passed to the network layer through the Network Service Access Point (NSAP). Similarly this request passes down through the lower layers of the protocol stack in the local device. This process is illustrated in Figure 5-2. The message is then transmitted to the remote device, where it is passed up through the protocol stack in the remote device, eventually appearing as an indication primitive passed from the remote BACnet ASE to the remote BACnet User Element. The response from the remote device, if any, returns to the initiator of the service in a similar fashion (see Clause 5.5).

In addition to the service primitives and the service specific parameters, the application entity exchanges interface control information (ICI) parameters with the application program via the API. The content of the ICI is dependent upon the service primitive type. The ICI parameters received by the application entity provide the information that is passed on to the lower layers (as ICI across layer interfaces) to help them construct their PDUs. The ICI parameters that are provided by the application entity to the application programs contain information recovered by the lower layers from their respective PDUs.

The following ICI parameters are exchanged with the various service primitives across an API:

'destination_address' (DA): the address of the device(s) intended to receive the service primitive. Its format (device name, network address, etc.) is a local matter. This address may also be a multicast, local broadcast or global broadcast type.

'source_address' (SA): the address of the device from which the service primitive was received. Its format (device name, network address, etc.) is a local matter.

'network_priority' (NP): a four-level network priority parameter described in 6.2.2.

'data_expecting_reply' (DER): a Boolean parameter that indicates whether (TRUE) or not (FALSE) a reply service primitive is expected for the service being issued.

'security_parameters' (SEC): The optional security parameters for the request to send, or from the received request. It indicates the level of security (Key Id, Plain/Signed/Encrypted, User Authentication data, End-To-End, etc) and its format is a local matter.

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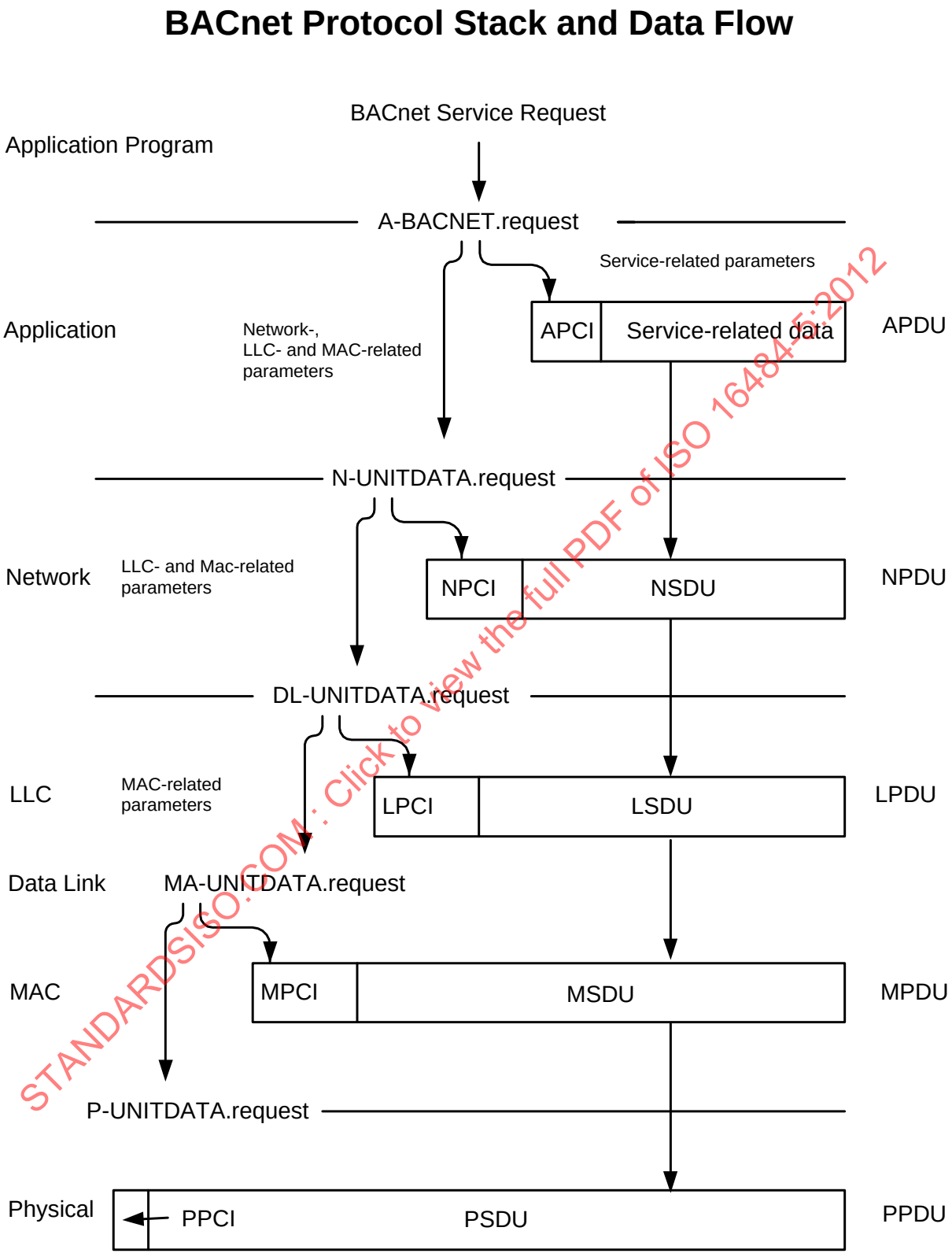

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Figure 5-2. BACnet protocol stack and data flow.

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Table 5-1 describes the applicability of the ICI parameters to the service primitives.

Table 5-1. Applicability of ICI Parameters for Abstract Service Primitives

Service Primitive	DA	SA	NP	DER	SEC
CONF_SERV.request	Yes	No	Yes	Yes	Yes
CONF_SERV.indication	Yes	Yes	Yes	Yes	Yes
CONF_SERV.response	Yes	No	Yes	Yes	Yes
CONF_SERV.confirm	Yes	Yes	Yes	No	Yes
UNCONF_SERV.request	Yes	No	Yes	No	Yes
UNCONF_SERV.indication	Yes	Yes	Yes	No	Yes
REJECT.request	Yes	No	Yes	No	Yes
REJECT.indication	Yes	Yes	Yes	No	Yes
SEGMENT_ACK.request	Yes	No	Yes	No	Yes
SEGMENT_ACK.indication	Yes	Yes	Yes	No	Yes
ABORT.request	Yes	No	Yes	No	Yes
ABORT.indication	Yes	Yes	Yes	No	Yes
SEC_ERR.indication	Yes	Yes	No	No	Yes

A "BACnetDevice" is any device, real or virtual, that supports digital communication using the BACnet protocol. Each BACnet Device contains exactly one Device object, as defined in 12.11. A BACnet Device is uniquely located by an NSAP, which consists of a network number and a MAC address.

In most cases, a physical device will implement a single BACnet Device. It is possible, however, that a single physical device may implement a number of "virtual" BACnet Devices. This is described in Annex H.

5.1.1 Confirmed Application Services

BACnet defines confirmed application services based on a client and server communication model. A client requests service from a server via a particular service request instance. The server provides service to a client and responds to the request. This relationship is illustrated in Figure 5-3. The BACnet-user that assumes the role of a client is called the "requesting BACnet-user" and the BACnet-user that assumes the role of the server is called the "responding BACnet-user."

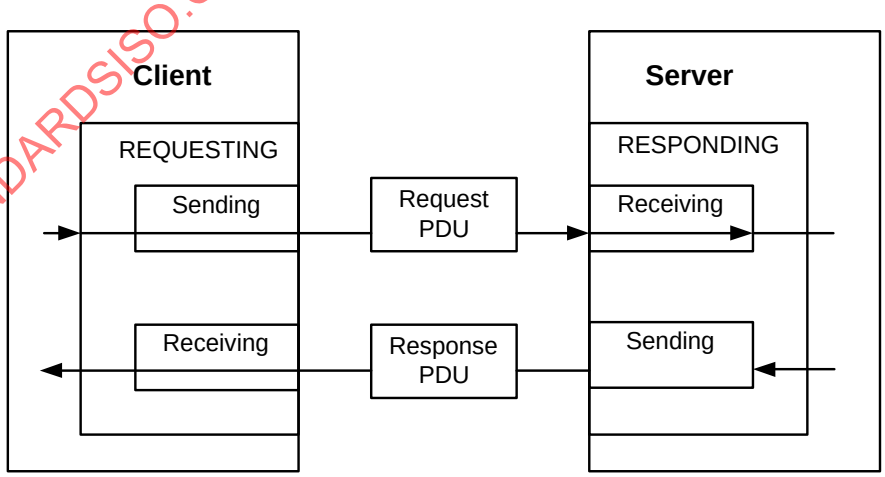

Figure 5-3. Relationship of a client and server.

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A requesting BACnet-user issues a CONF_SERV.request primitive, which causes a request PDU to be sent. When a response PDU arrives, the requesting BACnet-user receives a CONF_SERV.confirm primitive. When a request PDU arrives, the responding BACnet-user receives a CONF_SERV.indication primitive. The responding BACnet-user issues a CONF_SERV.response primitive, which causes a response PDU to be sent. Thus, the requesting BACnet-user and the responding BACnet-user play a role in both sending and receiving PDUs. The term "sending BACnet-user" applies to a BACnet user that initiates the sending of a PDU. The term "receiving BACnet-user" applies to a BACnet-user that receives an indication that a PDU has arrived.

5.1.2 Unconfirmed Application Services

The client and server model, and the terms "requesting BACnet-user" and "responding BACnet-user," do not apply to unconfirmed services. The terms "sending BACnet-user" and "receiving BACnet-user" do apply, however, and they are used to define the service procedure for unconfirmed services.

In some cases, errors will be encountered when sending unconfirmed requests. While the standard does not provide a mechanism for reporting such errors to the application program, it is acceptable for an implementation to provide such a mechanism, if desired.

5.2 Segmentation of BACnet Messages

To provide for messages that are longer than the maximum length supported by a communications network, or by the sending or receiving device, BACnet provides a method to perform application layer segmentation. In BACnet, only Confirmed-Request and ComplexACK messages may be segmented. Segmentation is an optional feature of BACnet.

5.2.1 Message Segmentation Rules

This subclause prescribes rules for dividing a message into segments.

5.2.1.1 Rules for Segmenting APDU Data Streams

Each BACnet message is encoded into a sequence of tags and values according to the relevant ASN.1 definitions in Clause 21 and the encoding rules of Clause 20. The following rules apply to segmenting this data stream:

(a) If possible, an entire message shall be sent in a single APDU.

(b) If an entire message cannot be sent in a single APDU, the message shall be segmented into the minimum number of APDUs possible.

(c) Messages shall be segmented only at octet boundaries.

5.2.1.2 Maximum APDU Length

The maximum length of a BACnet APDU shall be the smallest of

(a) the maximum APDU size transmittable by a device, which may be restricted by local buffer limitations and is a local matter;

(b) the maximum APDU size conveyable by the internetwork to the remote device, which is constrained by the maximum NPDU length permitted by the data links used by the local, remote, and any intervening networks, as specified in Clause 6;

(c) the maximum APDU size accepted by the remote peer device, which must be at least 50 octets.

If the sending device is the requesting BACnet-user, i.e., the APDU to be sent is a BACnet-Confirmed-Request-PDU or a BACnet-Unconfirmed-Request-PDU, then the maximum APDU size accepted by the remote peer is specified by the Max_APDU_Length_Accepted property of the remote peer's Device object. The value of this property may be read using the read property services described in Clause 15 or the value may be obtained from the 'Max APDU Length Accepted' parameter of an I-Am service request received from the remote device. The remote peer may be solicited to transmit an I-Am service request by sending it a Who-Is service request, as described in 16.9

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If the sending device is not the requesting BACnet-user, i.e., the APDU to be sent is a BACnet-ComplexACK-PDU, then the maximum APDU size accepted by the remote peer is specified in the 'Max APDU Length Accepted' parameter of the BACnet-Confirmed-Request-PDU for which this is a response.

The value determined by the above constraints will be designated the maximum-transmittable-length. Note that maximum-transmittable-length will in general not be a constant unless minimum values are used for each constraint.

5.2.1.3 Maximum Segments Accepted

The maximum number of segments transmitted in a Confirmed-Request or ComplexACK message shall be the smallest of:

(a) the maximum number of segments transmittable by a device, which may be restricted by local limitations and is a local matter;

(b) the maximum number of segments accepted by the remote peer device.

If the sending device is the requesting BACnet-user, i.e., the message to be sent is a Confirmed-Request, then the maximum number of segments accepted by the remote peer device is specified in the Max_Segments_Accepted property of the remote peer's Device object.

If the sending device is not the requesting BACnet-user, i.e., the message to be sent is a ComplexACK, then the maximum number of segments accepted by the remote peer device is specified in the 'Max Segments Accepted' parameter of the BACnet-Confirmed-Request-PDU for which this is a response.

5.2.2 Segmentation Protocol Control Information (PCI)

To provide for the possibility of segmented messages, the headers of the BACnet-Confirmed-Request-PDU and BACnet-ComplexACK-PDU contain two Boolean parameters called 'Segmented Message' and 'More Follows.'

If the length of a fully encoded message of the type conveyed by one of the above APDUs results in an APDU whose length is less than or equal to the maximum-transmittable-length as determined according to 5.2.1, the 'Segmented Message' and 'More Follows' parameters shall both be set to FALSE.

If, however, the encoded length of a message would result in an APDU length greater than the maximum-transmittable-length as determined according to 5.2.1, the 'Segmented Message' parameter shall be set to TRUE for all segments, and the 'More Follows' parameter shall be set to TRUE for all segments except the last.

Two additional parameters are also present, conditionally, in the header of each APDU carrying a segment of a Confirmed-Request message or a ComplexACK message. The first conditional parameter is the 'Sequence Number.' This one-octet unsigned integer is used by the segment transmitter to indicate the position of the current segment in the series of segments composing the complete message. The second conditional parameter is the 'Proposed Window Size.' This one-octet unsigned integer is used by the segment transmitter to indicate the maximum number of message segments that it is prepared to transmit before it must receive a SegmentACK. The use of these parameters in the transmission of segmented messages is described in 5.3 and 5.4.

The 'Sequence Number' of the initial segment shall be zero. The segment receiver may request the transmission of the next segment or group of segments by sending a SegmentACK-PDU containing the 'Sequence Number' parameter of the last successfully received segment. Such a request shall also serve as an acknowledgment of this segment. If the Window Size is greater than one, such a SegmentACK-PDU shall also serve to acknowledge any previously transmitted but unacknowledged segments.

If either party in a segmented transaction wishes to terminate the transaction, that party may issue an Abort-PDU.

5.3 Transmission of BACnet APDUs

The formal description of the transmission and reception protocol for BACnet APDUs is contained in the Transaction State Machine description given in 5.4. This subclause is intended only as an overview of the protocol.

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5.3.1 Confirmed-Request Message Transmission

Upon transmitting a complete unsegmented Confirmed-Request message or upon receiving the SegmentACK acknowledging the final segment of a segmented Confirmed-Request message, a client device shall start a timer that indicates the length of time the message has been outstanding. The timer shall be canceled upon the receipt of an Error, Reject, Abort, SimpleACK, or ComplexACK APDU for the outstanding Confirmed-Request message, and the client application shall be notified. If the timer exceeds the value of the APDU_Timeout property in the client's Device object, then the complete Confirmed-Request message shall be retransmitted and the timer shall be reset to zero. All retransmitted Confirmed-Request messages shall follow this same procedure until the message has been retransmitted the number of times indicated in the Number_Of_APDU_Retries property of the client's Device object. If, after the Confirmed-Request message is retransmitted the appropriate number of times, a response is still not received, the message shall be discarded and the client application shall be notified.

5.3.2 Segmented Confirmed-Request Message Transmission

Before sending the first segment of a segmented Confirmed-Request-PDU, a client device shall choose a Proposed Window Size to indicate the maximum number of message segments it is prepared to transmit before it must receive a SegmentACK. The means of choosing the Proposed Window Size are a local matter, except that the value shall be in the range 1 to 127, inclusive. The Proposed Window Size shall be carried by the parameter of that name in each segment of the Confirmed-Request-PDU. The value of Proposed Window Size shall be the same in each segment of the Confirmed-Request-PDU.

Upon transmitting the first segment of a Confirmed-Request message, a client device shall start a timer that indicates the length of time this message segment has been outstanding. The timer shall be canceled upon the receipt of a Reject, Abort, or SegmentACK APDU for the outstanding Confirmed-Request message segment. If the timer exceeds the value of the APDU_Segment_Timeout property in the client's Device object, then the segment shall be retransmitted and the timer shall be reset to zero. All retransmitted segments shall follow this same procedure until the message segment has been retransmitted the number of times indicated in the Number_Of_APDU_Retries property of the client's Device object. If, after the message segments are retransmitted the appropriate number of times, a response is still not received, the message shall be discarded and the client application shall be notified.

Upon receipt of the first segment of a segmented Confirmed-Request-PDU, the server device shall choose an Actual Window Size to indicate the number of sequential message segments it expects to receive before it transmits a SegmentACK. The means of choosing the Actual Window Size are a local matter, except that the value shall be less than or equal to the 'proposed-window-size' parameter contained in the Confirmed-Request-PDU and shall be in the range 1 to 127, inclusive. The value of Actual Window Size shall be the same in each SegmentACK sent in response to a given Confirmed-Request. Regardless of the value of Actual Window Size, a SegmentACK shall be sent in response to the first segment of a Confirmed-Request.

Upon receipt of a SegmentACK APDU, the client device shall set its Actual Window Size equal to the value associated with the 'actual-window-size' parameter in the SegmentACK APDU. After this point, the client has authorization to send as many segments as the 'actual-window-size' parameter indicates before waiting for a SegmentACK APDU. No more than T_{seg} may be allowed to elapse between the receipt of a SegmentACK APDU and the transmission of a segment. No more than T_{seg} may be allowed to elapse between the transmission of successive segments of a group. After transmitting a set of segments that fills the window or completes the message, a client device shall start a timer that indicates the length of time these message segments have been outstanding. The timer shall be canceled upon receipt of a Reject, Abort, or SegmentACK APDU for some or all of the outstanding Confirmed-Request message segments. If the timer exceeds the value of the APDU_Segment_Timeout property in the client's Device object, then the segments shall be retransmitted and the timer shall be reset to zero. All retransmitted segments shall follow this same procedure until the message segments have been retransmitted the number of times indicated in its Device object's Number_Of_APDU_Retries property. If, after the Confirmed-Request message segments are retransmitted the appropriate number of times, a response is still not received, the message shall be discarded and the client application shall be notified.

It is possible to receive a Reject, Abort, or SegmentACK APDU during the sending of a sequence of Confirmed-Request segments even though the number of outstanding segments is less than indicated by the Actual Window Size. In this case, receipt of a Reject or Abort APDU shall terminate the Confirmed-Request transaction. Receipt of a SegmentACK APDU shall be considered as an acknowledgment for the segments up to and including the number indicated in the 'sequence-number' parameter of the SegmentACK APDU. Any unacknowledged segments shall be retransmitted following the above procedure.

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It is recognized that in some cases where a Reject, Abort, or SegmentACK APDU is received, the client device may have sent, or irretrievably queued for sending, one or more (but less than Actual Window Size) additional Confirmed-Request-PDU segments.

5.3.3 Segmented ComplexACK Message Transmission

Before sending the first segment of a segmented ComplexACK-PDU, a server device shall choose a Proposed Window Size to indicate the maximum number of message segments it is prepared to transmit before it must receive a SegmentACK. The means of choosing the Proposed Window Size are a local matter, except that the value shall be in the range 1 to 127, inclusive. The Proposed Window Size shall be carried by the parameter of that name in each segment of the Confirmed-Request-PDU. The value of Proposed Window Size shall be the same in each segment of the ComplexACK-PDU.

Upon transmitting the first segment of a ComplexACK message, a server device shall start a timer that indicates the length of time this message segment has been outstanding. The timer shall be canceled upon the receipt of an Abort or SegmentACK APDU for the outstanding ComplexACK message segment. If the timer exceeds the value of the APDU_Segment_Timeout property in the server's Device object, then the segment shall be retransmitted and the timer shall be reset to zero. All retransmitted segments shall follow this same procedure until the message segment has been retransmitted the number of times indicated in the Number_Of_APDU_Retries property of the server's Device object. If, after the message segments are retransmitted the appropriate number of times, a response is still not received, the message shall be discarded.

Upon receipt of the first segment of a segmented ComplexACK-APDU, the client device shall choose an Actual Window Size to indicate the number of sequential message segments it expects to receive before it transmits a SegmentACK. The means of choosing the Actual Window Size are a local matter, except that the value shall be less than or equal to the 'proposed-window-size' parameter contained in the ComplexACK-PDU and shall be in the range 1 to 127, inclusive. The value of Actual Window Size shall be the same in each SegmentACK sent in response to a given ComplexACK. Regardless of the value of Actual Window Size, a SegmentACK shall be sent in response to the first segment of a ComplexACK.

Upon receipt of a SegmentACK APDU, the server device shall set its Actual Window Size equal to the value associated with the 'actual-window-size' parameter in the SegmentACK APDU. After this point, the server has authorization to send as many segments as the 'actual-window-size' parameter indicates before waiting for a SegmentACK APDU. No more than T_{seg} may be allowed to elapse between the receipt of a SegmentACK APDU and the transmission of a segment. No more than T_{seg} may be allowed to elapse between the transmission of successive segments of a group. After transmitting a set of segments that fills the window or completes the message, a server device shall start a timer that indicates the length of time these message segments have been outstanding. The timer shall be canceled upon receipt of an Abort or SegmentACK APDU for some or all of the outstanding ComplexACK message segments. If the timer exceeds the value of the APDU_Segment_Timeout property in the server's Device object, then the segments shall be retransmitted and the timer shall be reset to zero. All retransmitted segments shall follow this same procedure until the message segments have been retransmitted the number of times indicated in the Number_Of_APDU_Retries property of the server's Device object. If, after the ComplexACK message segments are retransmitted the appropriate number of times, a response is still not received, the message shall be discarded.

It is possible to receive an Abort or SegmentACK APDU during the sending of a sequence of ComplexACK segments even though the number of outstanding segments is less than indicated by the Actual Window Size. In this case, receipt of an Abort APDU shall terminate the ComplexACK transaction. Receipt of a SegmentACK APDU shall be considered as an acknowledgment for the segments up to and including the number indicated in the 'sequence-number' parameter of the SegmentACK APDU. Any unacknowledged segments shall be retransmitted following the above procedure.

It is recognized that in some cases where an Abort or SegmentACK APDU is received, the server device may have sent, or irretrievably queued for sending, one or more (but less than Actual Window Size) additional ComplexACK segments.

5.3.4 SegmentACK APDU Transmission

A device shall transmit a SegmentACK upon any of the following conditions:

(a) The device receives the initial segment of a segmented message. In this case, the 'negative-ACK' parameter of the SegmentACK shall have a value of FALSE, indicating that this is a positive acknowledgment, and the 'sequence-number' parameter of the SegmentACK shall have a value of zero, indicating that the first segment has been

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acknowledged and that the segment transmitter may continue sending, commencing with the next sequential segment.

(b) The device receives a quantity of unacknowledged, sequentially numbered segments for this transaction equal to the Actual Window Size. In this case, the 'negative-ACK' parameter of the SegmentACK shall have a value of FALSE, indicating that this is a positive acknowledgment, and the 'sequence-number' parameter of the SegmentACK shall have a value equal to the 'sequence-number' parameter of the last received segment, indicating that all segments up to and including 'sequence-number' have been acknowledged and that the segment transmitter may continue sending, commencing with the next sequential segment.

(c) The device receives a segment out of order (possibly indicating that a segment has been missed). In this case, the segment receiver shall discard the out-of-order segment. In this context, "out of order" means a segment whose 'sequence-number' is not equal to the next expected 'sequence-number.' The 'negative-ACK' parameter of the SegmentACK shall have a value of TRUE, indicating that this is a negative acknowledgment. The 'sequence-number' parameter of the SegmentACK shall have a value equal to the 'sequence-number' parameter of the last received correctly ordered segment, indicating that all segments up to and including 'sequence-number' have been acknowledged and that the segment transmitter should resend, commencing with the next sequential segment after that indicated by the 'sequence-number' parameter contained in the SegmentACK.

(d) The device receives the final segment of a message. In this case, the 'negative-ACK' parameter of the SegmentACK shall have a value of FALSE, indicating that this is a positive acknowledgment, and the 'sequence-number' parameter of the SegmentACK shall have a value equal to the 'sequence-number' parameter of the final message segment, indicating that all segments up to and including the final segment have been acknowledged.

5.3.5 Duplicate APDUs and Message Segments

5.3.5.1 Terminating Client TSMs

When using the BACnet error recovery procedures there is a possibility of the reception of duplicate messages or message segments during a transaction. At the client, a transaction begins, and a Transaction State Machine is created, when the first or only segment of a Confirmed-Request APDU is sent. The transaction ends when the client discards the Transaction State Machine due to one of the following circumstances:

(a) after reception from the server of a SimpleACK, unsegmented ComplexACK, Error, Reject, or Abort APDU containing the transaction's invokeID;

(b) after transmission to the server of a SegmentACK APDU for the final segment of a segmented ComplexACK APDU received from the server;

(c) after exhausting the timeout and retry logic described in the previous subclauses;

(d) after transmission to the server of an Abort APDU containing the transaction's invokeID (i.e., the client aborts the transaction).

5.3.5.2 Terminating Server TSMs

At the server, a transaction begins, and a Transaction State Machine is created when the first or only segment of a Confirmed-Request APDU is received. The transaction ends when the server discards the Transaction State Machine due to one of the following circumstances:

(a) after transmission to the client of a SimpleACK, unsegmented ComplexACK, Error, Reject, or Abort APDU containing the transaction's invokeID;

(b) after reception from the client of a SegmentACK APDU for the final segment of a segmented ComplexACK APDU transmitted by the server;

(c) after reception from the client of an Abort APDU containing the transaction's invokeID;

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(d) after exhausting the timeout and retry logic described in the previous subclauses during the transmission of a segmented ComplexACK APDU.

5.3.5.3 Duplicate Message Procedures

The procedure for handling duplicate messages and message segments is as follows:

(a) The server receives a duplicate Confirmed-Request message. If the server has the capability of detecting a duplicate Confirmed-Request message, the message shall be discarded. If the server cannot distinguish between duplicate and non-duplicate messages, then the Confirmed-Request message shall be serviced. In this case, the client shall discard the server's response since the Invoke ID of the response will not bind to an active state transaction state machine.

(b) The server receives a duplicate Confirmed-Request message segment, that is, one that has already been acknowledged with a SegmentACK. In this case, the server shall discard the duplicate segment but shall return an appropriate SegmentACK APDU. A segment can be identified uniquely by the peer address, Invoke ID, and Sequence Number of the segment.

(c) The client receives a duplicate ComplexACK segment, that is, one that has already been acknowledged with a SegmentACK. In this case, the client shall discard the duplicate segment but shall return an appropriate SegmentACK APDU. A segment can be identified uniquely by the peer address, Invoke Id, and Sequence Number of the segment.

(d) A Device receives a duplicate SegmentACK APDU. In this case, the device shall discard the duplicate SegmentACK APDU. Other actions, including the possible re-sending of message segments, shall occur as specified in 5.4.

5.3.6 Stale Resource Disposal

The error recovery procedure described here requires resources from both the server and the client. In the event that the error recovery process fails, the resources dedicated to this process need to be freed. In general, the resources that need to be freed are transaction specific and consist of a Transaction State Machine (TSM), timers, and APDU or APDU segment buffers. The exact time period before the resources should be freed is a local matter dependent upon the system design. As a design suggestion, it is recommended that resources should be considered stale and consequently freed:

(a) at the client, when a complete response to the Confirmed-Request APDU is received;

(b) at the client, when a Confirmed-Request APDU has been retransmitted the number of times specified in the Number_Of_APDU_Retries property without success;

(c) at the client, when a Confirmed-Request APDU segment has been retransmitted the number of times specified in the Number_Of_APDU_Retries property without success;

(d) at the server, when a complete response to a Confirmed-Request APDU has been transmitted and any associated SegmentACK received;

(e) at the server, when a ComplexACK APDU segment has been retransmitted the number of times specified in the Number_Of_APDU_Retries property without success;

(f) at any device, when a SegmentACK APDU has been transmitted and additional segments have not been received before the segment timeout expires.

5.4 Application Protocol State Machines

BACnet APDUs may be divided into two classes: those sent by requesting BACnet-users (clients) and those sent by responding BACnet-users (servers). All BACnet devices shall be able to act as responding BACnet-users and therefore shall be prepared to receive APDUs sent by requesting BACnet-users. Many devices will also be able to act as requesting BACnet-users, and such devices shall be prepared to receive APDUs sent by responding BACnet-users.

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APDUs sent by requesting BACnet-users (clients):

BACnet-Unconfirmed-Request-PDU
BACnet-Confirmed-Request-PDU
BACnet-SegmentACK-PDU with 'server' = FALSE
BACnet-Abort-PDU with 'server' = FALSE

APDUs sent by responding BACnet-users (servers):

BACnet-SimpleACK-PDU
BACnet-ComplexACK-PDU
BACnet-Error-PDU
BACnet-Reject-PDU
BACnet-SegmentACK-PDU with 'server' = TRUE
BACnet-Abort-PDU with 'server' = TRUE

Both the requesting and the responding BACnet-user shall create and maintain a Transaction State Machine (TSM) for each transaction. The TSM shall be created when the transaction begins and shall be disposed of when the transaction ends. In the state machine descriptions that follow, the creation of a TSM is represented by a transition out of the IDLE state, and the disposal of a TSM is represented by a transition into the IDLE state. A transaction is uniquely identified by the client BACnetAddress, the server BACnetAddress, and the Invoke ID (if any).

When a PDU is received from the network layer, the PDU type, the source and destination BACnetAddresses, and the Invoke ID (if any) of the PDU shall be examined to determine the type (requesting BACnet-user or responding BACnet-user) and the identity of the TSM to which the PDU shall be passed. If no such TSM exists, one shall be created.

When a request is received from the application program, the request type, the source and destination BACnetAddresses, and the Invoke ID (if any) of the request shall be examined to determine the type (requesting BACnet-user or responding BACnet-user) and the identity of the TSM to which the request shall be passed. If no such TSM exists, one shall be created.

In order to simplify the state machine description, only the case of segmentation by the Application Entity is shown. Segmentation by the Application Program is possible as well. In this case, wherever the current TSM receives a segment or group of segments and sends SegmentACK, the modified TSM would instead pass the segments to the Application Program, and SegmentACK would be sent only upon direction from the Application Program via the SEGMENT_ACK.request primitive. Reception by the modified state machine of a SegmentACK-PDU would cause it to pass a SEGMENT_ACK.indication primitive to the Application Program.

5.4.1 Variables And Parameters

The following variables are defined for each instance of Transaction State Machine:

RetryCount used to count APDU retries

SegmentRetryCount used to count segment retries

DuplicateCount used to count duplicate segments

SentAllSegments used to control APDU retries and the acceptance of server replies

LastSequenceNumber stores the sequence number of the last segment received in order

InitialSequenceNumber stores the sequence number of the first segment of a sequence of segments that fill a window

ActualWindowSize stores the current window size

ProposedWindowSize stores the window size proposed by the segment sender

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SegmentTimer used to perform timeout on PDU segments

RequestTimer used to perform timeout on Confirmed Requests

The following parameters are used in the description:

$\mathbf{T_{seg}}$ This parameter is the length of time a node shall wait for a SegmentACK-PDU after sending the final segment of a sequence. Its value is the value of the APDU_Segment_Timeout property of the node's Device object.

$\mathbf{T_{wait\_for\_seg}}$ This parameter is the length of time a node shall wait after sending a SegmentACK-PDU for an additional segment of the message. Its value is equal to four times the value of the APDU_Segment_Timeout property of the node's Device object.

$\mathbf{T_{out}}$ This parameter represents the value of the APDU_Timeout property of the node's Device object.

$\mathbf{N_{retry}}$ This parameter represents the value of the Number_Of_APDU_Retries property of the node's Device object.

$\mathbf{N_{dup}}$ This parameter represents the number of duplicates that will be silently dropped per window before a negative segment ack is returned. This parameter shall be equal to ActualWindowSize.

5.4.2 Window Query Functions

5.4.2.1 Function InWindow

The function "InWindow" performs a modulo 256 compare of two unsigned eight-bit sequence numbers. All computations and comparisons are modulo 256 operations on unsigned eight-bit quantities.

function InWindow(seqA, seqB)

(1) if seqA minus seqB, modulo 256, is less than ActualWindowSize, then return TRUE
(2) else return FALSE.

Example (not normative): if ActualWindowSize is equal to 4, then
InWindow(0, 0) returns TRUE
InWindow(1, 0) returns TRUE
InWindow(3, 0) returns TRUE
InWindow(4, 0) returns FALSE
InWindow(4, 5) returns FALSE (since the modulo 256 difference 4 - 5 = 255)
InWindow(0, 255) returns TRUE (since the modulo 256 difference 0 - 255 = 1)

5.4.2.2 Function DuplicateInWindow

The function "DuplicateInWindow" determines whether a value, seqA, is within the range firstSeqNumber through lastSequenceNumber, modulo 256. All computations and comparisons are modulo 256 operations on unsigned eight-bit quantities.

function DuplicateInWindow(seqA, firstSeqNumber, lastSequenceNumber)

(1) Set local variable receivedCount to lastSeqNumber minus firstSeqNumber, modulo 256.
(2) If receivedCount is greater than ActualWindowSize, then return FALSE.
(3) If seqA minus firstSeqNumber, modulo 256, is less than or equal to receivedCount, then return TRUE.
(4) Else return FALSE.

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Example (not normative): if ActualWindowSize is equal to 4, then
DuplicateInWindow(0, 0, 1) returns TRUE
DuplicateInWindow(1, 0, 1) returns TRUE
DuplicateInWindow(2, 0, 1) returns FALSE
DuplicateInWindow(3, 0, 1) returns FALSE

5.4.3 Function FillWindow

The function "FillWindow" sends PDU segments either until the window is full or until the last segment of a message has been sent. No more than $\mathbf{T}_{seg}$ may be allowed to elapse between the receipt of a SegmentACK APDU and the transmission of a segment. No more than $\mathbf{T}_{seg}$ may be allowed to elapse between the transmission of successive segments of a sequence.

function FillWindow(sequenceNumber)

(a) Set local variable ix to zero.

(b) If the next segment to transmit (the segment numbered sequenceNumber plus ix) is the final segment, goto step (g).

(c) Issue an N-UNITDATA.request with 'data_expecting_reply' = TRUE to transmit the next BACnet APDU segment, with 'segmented-message' = TRUE, 'more-follows' = TRUE, 'proposed-window-size' equal to ProposedWindowSize, and 'sequence-number' = sequenceNumber plus ix, modulo 256.

(d) Set ix equal to ix plus one.

(e) If ix is less than ActualWindowSize, goto step (b).

(f) Goto step (i).

(g) Issue an N-UNITDATA.request with 'data_expecting_reply' = TRUE to transmit the final BACnet APDU segment with 'segmented-message' = TRUE, 'more-follows' = FALSE, 'proposed-window-size' = ProposedWindowSize, and 'sequence-number' = sequenceNumber plus ix, modulo 256.

(h) Set SentAllSegments to TRUE, indicating that all segments have been transmitted at least once.

(i) Return to the caller.

5.4.4 State Machine for Requesting BACnet User (client)

5.4.4.1 IDLE

In the IDLE state, the device waits for the local application program to request a service.

SendUnconfirmed
If UNCONF_SERV.request is received from the local application program,

then issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Unconfirmed-Request-PDU, and enter the IDLE state.

SendConfirmedUnsegmented
If CONF_SERV.request is received from the local application program and the length of the APDU is less than or equal to maximum-transmittable-length as determined according to 5.2.1,

then assign an 'invokeID' to this transaction; set SentAllSegments to TRUE; set RetryCount to zero; start RequestTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = TRUE to transmit a BACnet-Confirmed-Request-PDU with 'segmented-message' = FALSE; and enter the AWAIT_CONFIRMATION state to await a reply.

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CannotSend

If CONF_SERV.request is received from the local application program and the length of the APDU is greater than maximum-transmittable-length as determined according to 5.2.1 and the Max_Segments_Accepted property of the destination's Device object is known and the total APDU cannot be transmitted without exceeding the maximum number of segments accepted,

then send an ABORT.indication with 'server' = FALSE and 'abort-reason' =APDU_TOO_LONG to the local application program and enter the IDLE state.

SendConfirmedSegmented

If CONF_SERV.request is received from the local application program and the length of the APDU is greater than maximum-transmittable-length as determined according to 5.2.1, and the Max_Segments_Accepted property of the destination's Device object is not known, or Max_Segments_Accepted is known and the total APDU can be transmitted without exceeding the maximum number of segments accepted,

then assign an 'invokeID' to this transaction; set SentAllSegments to FALSE; set RetryCount to zero; set SegmentRetryCount to zero; set InitialSequenceNumber to zero; set ProposedWindowSize to whatever value is desired; set ActualWindowSize to 1; start SegmentTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = TRUE to transmit a BACnet-Confirmed-Request-PDU containing the first segment of the message, with 'segmented-message' = TRUE, 'more-follows' = TRUE, 'sequence-number' = zero, and 'proposed-window-size' = ProposedWindowSize; and enter the SEGMENTED_REQUEST state to await an acknowledgment. (The method used to determine ProposedWindowSize is a local matter, except that the value shall be in the range 1 to 127, inclusive.)

UnexpectedSegmentInfoReceived

If an unexpected PDU indicating the existence of an active server TSM (BACnet-ComplexACK-PDU with 'segmented-message' = TRUE or BACnet-SegmentACK-PDU with 'server' = TRUE) is received from the network layer,

then issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = FALSE and enter the IDLE state.

UnexpectedPDU_Received

If an unexpected PDU not indicating the existence of an active server TSM (BACnet-SimpleACK-PDU, BACnet-ComplexACK-PDU with 'segmented-message' = FALSE, BACnet-Error-PDU, BACnet-Reject-PDU, or BACnet-Abort-PDU with 'server' = TRUE) is received from the network layer,

then enter the IDLE state. (There is no reason to issue REJECT.indication, ABORT.indication, etc., as the client has no knowledge of the transaction in question.)

SecurityError_Received

If a security error is received via an N-REPORT.indication from the network layer for which there is no active TSM associated with it,

then enter the IDLE state.

5.4.4.2 SEGMENTED_REQUEST

In the SEGMENTED_REQUEST state, the device waits for a BACnet-SegmentACK-PDU for one or more segments of a BACnet-Confirmed-Request-PDU.

SecurityError_Received

If a security error is received via an N-REPORT.indication from the network layer,

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then stop SegmentTimer; send SEC_ERR.indication with the appropriate security error information to the local application program; and enter the IDLE state.

InsufficientSecurity_Received

If a PDU is received from the network layer and the security parameters do not match the initial request,

then stop SegmentTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = FALSE and an 'abort-reason' = INSUFFICIENT_SECURITY describing the security error; send SEC_ERR.indication indicating insufficient security to the local application program; and enter the IDLE state.

DuplicateACK_Received

If a BACnet-SegmentACK-PDU that has sufficient security parameters and whose 'server' parameter is TRUE is received from the network layer and InWindow ('sequence-number' parameter of the BACnet-SegmentACK-PDU, InitialSequenceNumber) returns a value of FALSE,

then restart SegmentTimer and enter the SEGMENTED_REQUEST state to await an acknowledgment.

NewACK_Received

If a BACnet-SegmentACK-PDU that has sufficient security parameters and whose 'server' parameter is TRUE is received from the network layer and InWindow ('sequence-number' parameter of the BACnet-SegmentACK-PDU, InitialSequenceNumber) returns a value of TRUE and there is at least one segment remaining to send,

then set InitialSequenceNumber equal to the 'sequence-number' parameter of the BACnet-SegmentACK-PDU plus one, modulo 256; set ActualWindowSize equal to the 'actual-window-size' parameter of the BACnet-SegmentACK-PDU; set SegmentRetryCount to zero; call FillWindow (InitialSequenceNumber) to transmit one or more BACnet-Confirmed-Request-PDUs containing the next ActualWindowSize segments of the message; restart SegmentTimer; and enter the SEGMENTED_REQUEST state to await an acknowledgment.

FinalACK_Received

If a BACnet-SegmentACK-PDU that has sufficient security parameters and whose 'server' parameter is TRUE is received from the network layer and InWindow ('sequence-number' parameter of the BACnet-SegmentACK-PDU, InitialSequenceNumber) returns a value of TRUE and there are no more segments to send,

then stop SegmentTimer; start RequestTimer; and enter the AWAIT_CONFIRMATION state to await a reply.

Timeout

If SegmentTimer becomes greater than T_{seg} and SegmentRetryCount is less than N_{retry},

then increment SegmentRetryCount; call FillWindow(InitialSequenceNumber) to retransmit one or more BACnet-Confirmed-Request-PDUs containing the next ActualWindowSize segments of the message; restart SegmentTimer; and enter the SEGMENTED_REQUEST state to await an acknowledgment.

FinalTimeout

If SegmentTimer becomes greater than T_{seg} and SegmentRetryCount is greater than or equal to N_{retry},

then stop SegmentTimer; send ABORT.indication with 'server' = FALSE and 'abort-reason' = TSM_TIMEOUT to the local application program; and enter the IDLE state.

AbortPDU_Received

If a BACnet-Abort-PDU that has sufficient security parameters and whose 'server' parameter is TRUE is received from the network layer,

then stop SegmentTimer; send ABORT.indication to the local application program; and enter the IDLE state.

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SimpleACK_Received

If a BACnet-SimpleACK-PDU that has sufficient security parameters is received from the network layer and SentAllSegments is TRUE,

then stop SegmentTimer; send CONF_SERV.confirm(+) to the local application program; and enter the IDLE state.

UnsegmentedComplexACK_Received

If a BACnet-ComplexACK-PDU that has sufficient security parameters is received from the network layer whose 'segmented-message' parameter is FALSE and SentAllSegments is TRUE,

then stop SegmentTimer; send CONF_SERV.confirm(+) to the local application program; and enter the IDLE state.

SegmentedComplexACK_Received

If a BACnet-ComplexACK-PDU that has sufficient security parameters is received from the network layer whose 'segmented-message' parameter is TRUE and whose 'sequence-number' parameter is zero and this device supports segmentation and SentAllSegments is TRUE,

then stop SegmentTimer; compute ActualWindowSize based on the 'proposed-window-size' parameter of the received BACnet-ComplexACK-PDU and on local conditions; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-SegmentACK-PDU with 'negative-ACK' = FALSE, 'server' = FALSE, and 'actual-window-size' = ActualWindowSize; start SegmentTimer; set LastSequenceNumber to zero; set InitialSequenceNumber to zero; set DuplicateCount to zero; and enter the SEGMENTED_CONF state to receive the remaining segments. (The method used to determine ActualWindowSize is a local matter, except that the value shall be less than or equal to the 'proposed-window-size' parameter of the received BACnet-ComplexACK-PDU and shall be in the range 1 to 127, inclusive.)

ErrorPDU_Received

If a BACnet-Error-PDU that has sufficient security parameters is received from the network layer and SentAllSegments is TRUE,

then stop SegmentTimer; send CONF_SERV.confirm(-) to the local application program; and enter the IDLE state.

RejectPDU_Received

If a BACnet-Reject-PDU that has sufficient security parameters is received from the network layer,

then stop SegmentTimer; send REJECT.indication to the local application program; and enter the IDLE state.

UnexpectedPDU_Received

If a BACnet-SimpleACK-PDU, BACnet-ComplexACK-PDU, or BACnet-Error-PDU that has sufficient security parameters is received from the network layer and SentAllSegments is FALSE,

or if a BACnet-ComplexACK-PDU that has sufficient security parameters is received from the network layer whose 'segmented-message' parameter is TRUE and this device does not support segmentation,

or if a BACnet-ComplexACK-PDU that has sufficient security parameters is received from the network layer whose 'segmented-message' parameter is TRUE and whose 'sequence-number' parameter is not zero,

then stop SegmentTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = FALSE; send ABORT.indication with 'server' = FALSE and 'abort-reason' = INVALID_APDU_IN_THIS_STATE to the local application program; and enter the IDLE state.

SendAbort

If ABORT.request is received from the local application program,

then stop SegmentTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = FALSE; and enter the IDLE state.

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5.4.4.3 AWAIT_CONFIRMATION

In the AWAIT_CONFIRMATION state, the device waits for a response to a BACnet-Confirmed-Request-PDU.

SecurityError_Received

If a security error is received via an N-REPORT.indication from the network layer,

then stop RequestTimer; send SEC_ERR.indication with the appropriate security error information to the local application program; and enter the IDLE state.

InsufficientSecurity_Received

If a PDU is received from the network layer and the security parameters do not match the initial request,

then stop RequestTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = FALSE and an 'abort-reason' = INSUFFICIENT_SECURITY; send SEC_ERR.indication indicating insufficient security to the local application program; and enter the IDLE state.

SimpleACK_Received

If a BACnet-SimpleACK-PDU that has sufficient security parameters is received from the network layer,

then stop RequestTimer; send CONF_SERV.confirm(+) to the local application program; and enter the IDLE state.

UnsegmentedComplexACK_Received

If a BACnet-ComplexACK-PDU that has sufficient security parameters is received from the network layer whose 'segmented-message' parameter is FALSE,

then stop RequestTimer; send CONF_SERV.confirm(+) to the local application program; and enter the IDLE state.

SegmentedComplexACK_Received

If a BACnet-ComplexACK-PDU that has sufficient security parameters is received from the network layer whose 'segmented-message' parameter is TRUE, and whose 'sequence-number' parameter is zero and this device supports segmentation,

then stop RequestTimer; compute ActualWindowSize based on the 'proposed-window-size' parameter of the received BACnet-ComplexACK-PDU and on local conditions; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-SegmentACK-PDU with 'negative-ACK' = FALSE, 'server' = FALSE, and 'actual-window-size' = ActualWindowSize; start SegmentTimer; set LastSequenceNumber to zero; set InitialSequenceNumber to zero; set DuplicateCount to zero; and enter the SEGMENTED_CONF state to receive the remaining segments. (The method used to determine ActualWindowSize is a local matter, except that the value shall be less than or equal to the 'proposed-window-size' parameter of the received BACnet-ComplexACK-PDU and shall be in the range 1 to 127, inclusive.)

ErrorPDU_Received

If a BACnet-Error-PDU that has sufficient security parameters is received from the network layer,

then stop RequestTimer; send CONF_SERV.confirm(-) to the local application program; and enter the IDLE state.

RejectPDU_Received

If a BACnet-Reject-PDU that has sufficient security parameters is received from the network layer,

then stop RequestTimer; send REJECT.indication to the local application program; and enter the IDLE state.

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AbortPDU_Received

If a BACnet-Abort-PDU that has sufficient security parameters and whose 'server' parameter is TRUE is received from the network layer,

then stop RequestTimer; send ABORT.indication to the local application program; and enter the IDLE state.

SegmentACK_Received

If a BACnet-SegmentACK-PDU that has sufficient security parameters and whose 'server' parameter is TRUE is received from the network layer,

then discard the PDU as a duplicate, and re-enter the current state.

UnexpectedPDU_Received

If an unexpected PDU (BACnet-ComplexACK-PDU with 'segmented-message' = TRUE and 'sequence-number' not equal to zero or 'segmented-message' = TRUE and this device does not support segmentation) that has sufficient security parameters is received from the network layer,

then stop RequestTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = FALSE; send ABORT.indication with 'server' = FALSE and 'abort-reason' = INVALID_APDU_IN_THIS_STATE to the local application program; and enter the IDLE state.

TimeoutUnsegmented

If RequestTimer becomes greater than $\mathbf{T_{out}}$ and RetryCount is less than Number_Of_APDU_Retries and the length of the Confirmed Request APDU is less than or equal to maximum-transmittable-length as determined according to Clause 5.2.1,

then stop RequestTimer; increment RetryCount; issue an N-UNITDATA.request with 'data_expecting_reply' = TRUE to transmit a BACnet-Confirmed-Request-PDU with 'segmented-message' = FALSE; start RequestTimer; and enter the AWAIT_CONFIRMATION state to await a reply.

TimeoutSegmented

If RequestTimer becomes greater than $\mathbf{T_{out}}$ and RetryCount is less than Number_Of_APDU_Retries and the length of the Confirmed-Request APDU is greater than maximum-transmittable-length as determined according to Clause 5.2.1,

then stop RequestTimer; increment RetryCount; set SegmentRetryCount to zero; set SentAllSegments to FALSE; start SegmentTimer; set InitialSequenceNumber to zero; set ActualWindowSize to 1; issue an N-UNITDATA.request with 'data_expecting_reply' = TRUE to transmit a BACnet-Confirmed-Request-PDU containing the first segment of the message, with 'segmented-message' = TRUE, 'more-follows' = TRUE, and 'sequence-number' = zero; and enter the SEGMENTED_REQUEST state to await an acknowledgment.

FinalTimeout

If RequestTimer becomes greater than $\mathbf{T_{out}}$ and RetryCount is greater than or equal to Number_Of_APDU_Retries,

then stop RequestTimer; send ABORT.indication with 'server' = FALSE and 'abort-reason' = TSM_TIMEOUT to the local application program; and enter the IDLE state.

SendAbort

If ABORT.request is received from the local application program,

then stop RequestTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = FALSE; and enter the IDLE state.

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5.4.4.4 SEGMENTED_CONF

In the SEGMENTED_CONF state, the device waits for one or more segments in response to a BACnet-SegmentACK-PDU.

SecurityError_Received

If a security error is received via an N-REPORT.indication from the network layer,

then stop SegmentTimer; send SEC_ERR.indication with the appropriate security error information to the local application program; and enter the IDLE state.

InsufficientSecurity_Received

If a PDU is received from the network layer and the security parameters that do not match the initial request,

then stop SegmentTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = FALSE and an 'abort-reason' = INSUFFICIENT_SECURITY; send SEC_ERR.indication indicating insufficient security to the local application program; and enter the IDLE state.

NewSegmentReceived_NoSpace

If a BACnet-ComplexACK-PDU that has sufficient security parameters is received from the network layer whose 'segmented-message' parameter is TRUE; whose 'sequence-number' parameter is equal to LastSequenceNumber plus 1, modulo 256; and the segment cannot be saved due to local conditions,

then stop SegmentTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = FALSE and 'abort-reason' = BUFFER_OVERFLOW; send ABORT.indication with 'server' = FALSE and 'abort-reason' = BUFFER_OVERFLOW to the local application program; and enter the IDLE state.

NewSegmentReceived

If a BACnet-ComplexACK-PDU that has sufficient security parameters is received from the network layer whose 'segmented-message' parameter is TRUE; whose 'more-follows' parameter is TRUE; whose 'sequence-number' parameter is equal to LastSequenceNumber plus 1, modulo 256; and whose 'sequence-number' parameter is not equal to InitialSequenceNumber plus ActualWindowSize, modulo 256,

then save the BACnet-ComplexACK-PDU segment; increment LastSequenceNumber, modulo 256; restart SegmentTimer; and enter the SEGMENTED_CONF state to receive additional segments.

LastSegmentOfGroupReceived

If a BACnet-ComplexACK-PDU that has sufficient security parameters is received from the network layer whose 'segmented-message' parameter is TRUE; whose 'sequence-number' parameter is equal to LastSequenceNumber plus 1, modulo 256; whose 'more-follows' parameter is TRUE; and whose 'sequence-number' parameter is equal to InitialSequenceNumber plus ActualWindowSize, modulo 256,

then save the BACnet-ComplexACK-PDU segment; increment LastSequenceNumber, modulo 256; set InitialSequenceNumber to LastSequenceNumber; set DuplicateCount to zero; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-SegmentACK-PDU with 'negative-ACK' = FALSE, server = FALSE, and 'actual-window-size' = ActualWindowSize; restart SegmentTimer; and enter the SEGMENTED_CONF state to receive additional segments.

LastSegmentOfComplexACK_Received

If a BACnet-ComplexACK-PDU that has sufficient security parameters is received from the network layer whose 'segmented-message' parameter is TRUE; whose 'sequence-number' parameter is equal to LastSequenceNumber plus 1, modulo 256; and whose 'more-follows' parameter is FALSE (i.e., the final segment),

then stop SegmentTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-SegmentACK-PDU with 'negative-ACK' = FALSE, 'server = FALSE', and 'actual-window-size' = ActualWindowSize; send CONF_SERV.confirm(+) containing all of the received segments to the local application program; and enter the IDLE state.

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DuplicateSegmentReceived

If a BACnet-ComplexACK-PDU is received from the network layer whose 'segmented-message' parameter is TRUE and whose 'sequence-number' parameter is not equal to LastSequenceNumber plus 1, modulo 256, and DuplicateInWindow('sequence-number' parameter of the BACnet-SegmentACK-PDU, InitialSequenceNumber+1 modulo 256, LastSequenceNumber) returns a value of TRUE and DuplicateCount is less than Ndup,

then discard the BACnet-ComplexACK-PDU segment; restart SegmentTimer; increment DuplicateCount, and enter the SEGMENTED_CONF state to receive the remaining segments.

TooManyDuplicateSegmentsReceived

If a BACnet-ComplexACK-PDU is received from the network layer whose 'segmented-message' parameter is TRUE and whose 'sequence-number' parameter is not equal to LastSequenceNumber plus 1, modulo 256, and DuplicateInWindow('sequence-number' parameter of the BACnet-SegmentACK-PDU, InitialSequenceNumber+1 modulo 256, LastSequenceNumber) returns a value of TRUE and DuplicateCount is equal to Ndup,

then discard the BACnet-ComplexACK-PDU segment; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-SegmentACK-PDU with 'negative-ACK' = TRUE, 'server' = FALSE, 'sequence-number' = LastSequenceNumber, and 'actual-window-size' = ActualWindowSize; restart SegmentTimer; set DuplicateCount to zero; and enter the SEGMENTED_CONF state to receive the remaining segments.

SegmentReceivedOutOfOrder

If a BACnet-ComplexACK-PDU that has sufficient security parameters is received from the network layer whose 'segmented-message' parameter is TRUE and whose 'sequence-number' parameter is not equal to LastSequenceNumber plus 1, modulo 256, and DuplicateInWindow('sequence-number' parameter of the BACnet-SegmentACK-PDU, InitialSequenceNumber+1 modulo 256, LastSequenceNumber) returns a value of FALSE,

then discard the BACnet-ComplexACK-PDU segment; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-SegmentACK-PDU with 'negative-ACK' = TRUE, 'server' = FALSE, 'sequence-number' = LastSequenceNumber, and 'actual-window-size' = ActualWindowSize; restart SegmentTimer; set InitialSequenceNumber = LastSequenceNumber; set DuplicateCount to zero; and enter the SEGMENTED_CONF state to receive the remaining segments.

AbortPDU_Received

If a BACnet-Abort-PDU that has sufficient security parameters and whose 'server' parameter is TRUE is received from the network layer,

then stop SegmentTimer; send ABORT.indication to the local application program; and enter the IDLE state.

UnexpectedPDU_Received

If an unexpected PDU (BACnet-SimpleACK-PDU, BACnet-ComplexACK-PDU with 'segmented-message' = FALSE, BACnet-Error-PDU, BACnet-Reject-PDU, or BACnet-SegmentACK-PDU with 'server' = TRUE) that has sufficient security parameters is received from the network layer,

then stop SegmentTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = FALSE; send ABORT.indication with 'server' = FALSE and 'abort-reason' = INVALID_APDU_IN_THIS_STATE to the local application program; and enter the IDLE state.

Timeout

If SegmentTimer becomes greater than T_{seg} times four,

then stop SegmentTimer; send ABORT.indication with 'server' = FALSE and 'abort-reason' = TSM_TIMEOUT to the local application program; and enter the IDLE state.

SendAbort

If ABORT.request is received from the local application program,

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then stop SegmentTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = FALSE; and enter the IDLE state.

5.4.5 State Machine for Responding BACnet User (server)

5.4.5.1 IDLE

In the IDLE state, the device waits for a PDU from the network layer.

SecurityError_Received

If a security error is received via an N-REPORT.indication from the network layer,

then enter the IDLE state.

UnconfirmedReceived

If a BACnet-Unconfirmed-Request-PDU is received from the network layer,

then send an UNCONF_SERV.indication to the local application program, and enter the IDLE state.

ConfirmedBroadcastReceived

If a BACnet-Confirmed-Request-PDU whose destination address is a multicast or broadcast address is received from the network layer,

then enter the IDLE state.

ConfirmedUnsegmentedReceived

If a BACnet-Confirmed-Request-PDU whose 'segmented-message' parameter is FALSE is received from the network layer,

then send a CONF_SERV.indication to the local application program, start RequestTimer; and enter the AWAIT_RESPONSE state.

ConfirmedSegmentedReceivedNotSupported

If a BACnet-Confirmed-Request-PDU whose 'segmented-message' parameter is TRUE is received from the network layer, and this device does not support the reception of segmented messages,

then issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = TRUE and 'abort-reason' = SEGMENTATION_NOT_SUPPORTED, and enter the IDLE state.

ConfirmedSegmentedReceived

If a BACnet-Confirmed-Request-PDU whose 'segmented-message' parameter is TRUE, whose 'sequence-number' parameter is zero, and whose 'proposed-window-size' is greater than zero and less than or equal to 127 is received from the network layer and the local device supports the reception of segmented messages,

then compute ActualWindowSize based on the 'proposed-window-size' parameter of the received BACnet-Confirmed-Request-PDU and on local conditions; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-SegmentACK-PDU with 'negative-ACK' = FALSE, 'server' = TRUE, and 'actual-window-size' = ActualWindowSize; start SegmentTimer; set LastSequenceNumber to zero; set InitialSequenceNumber to zero; set DuplicateCount to zero; and enter the SEGMENTED_REQUEST state to receive the remaining segments. (The method used to determine ActualWindowSize is a local matter, except that the value shall be less than or equal to the 'proposed-window-size' parameter of the received BACnet-Confirmed-Request-PDU and shall be in the range 1 to 127, inclusive.)

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ConfirmedSegmentedReceivedWindowSizeOutOfRange

If a BACnet-Confirmed-Request-PDU whose 'segmented-message' parameter is TRUE, whose 'sequence-number' parameter is zero, and whose 'proposed-window-size' is zero or greater than 127 is received from the network layer and the local device supports the reception of segmented messages,

then issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = TRUE and 'abort-reason' = WINDOW_SIZE_OUT_OF_RANGE, and enter the IDLE state.

AbortPDU_Received

If a BACnet-Abort-PDU whose 'server' parameter is FALSE is received from the network layer,

then enter the IDLE state.

UnexpectedPDU_Received

If an unexpected PDU (BACnet-Confirmed-Request-PDU with 'segmented-message' = TRUE and 'sequence-number' not equal to zero or BACnet-SegmentACK-PDU with 'server' = FALSE) is received from the network layer,

then issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = TRUE; and enter the IDLE state.

5.4.5.2 SEGMENTED_REQUEST

In the SEGMENTED_REQUEST state, the device waits for segments of a BACnet-Confirmed-Request-PDU.

IncorrectSecurityPdu_Received

If a PDU is received that is not secured with the same settings as the original PDU,

then issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = TRUE and 'abort-reason' = INSUFFICIENT_SECURITY; and enter the IDLE state.

SecurityError_Received

If a security error is received via an N-REPORT.indication from the network layer,

then stop SegmentTimer and enter the IDLE state.

NewSegmentReceived

If a BACnet-Confirmed-Request-PDU that is secured with the same settings as the original PDU is received from the network layer whose 'segmented-message' parameter is TRUE; whose 'more-follows' parameter is TRUE; whose 'sequence-number' parameter is equal to LastSequenceNumber plus 1, modulo 256; and whose 'sequence-number' parameter is not equal to InitialSequenceNumber plus ActualWindowSize, modulo 256,

then save the BACnet-Confirmed-Request-PDU segment; increment LastSequenceNumber, modulo 256; restart SegmentTimer; and enter the SEGMENTED_REQUEST state to receive the remaining segments.

LastSegmentOfGroupReceived

If a BACnet-Confirmed-Request-PDU that is secured with the same settings as the original PDU is received from the network layer whose 'segmented-message' parameter is TRUE; whose 'sequence-number' parameter is equal to LastSequenceNumber plus 1, modulo 256; whose 'more-follows' parameter is TRUE; and whose 'sequence-number' parameter is equal to InitialSequenceNumber plus ActualWindowSize, modulo 256,

then save the BACnet-Confirmed-Request-PDU segment; increment LastSequenceNumber, modulo 256; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-SegmentACK-PDU with 'negative-ACK' = FALSE, 'server' = TRUE, 'sequence-number' = LastSequenceNumber, and 'actual-window-size' = ActualWindowSize; restart SegmentTimer; set InitialSequenceNumber = LastSequenceNumber; set DuplicateCount to zero; and enter the SEGMENTED_REQUEST state to receive the remaining segments.

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LastSegmentOfMessageReceived

If a BACnet-Confirmed-Request-PDU that is secured with the same settings as the original PDU is received from the network layer whose 'segmented-message' parameter is TRUE; whose 'sequence-number' parameter is equal to LastSequenceNumber plus 1, modulo 256; and whose 'more-follows' parameter is FALSE (i.e., the final segment),

then save the BACnet-Confirmed-Request-PDU segment; increment LastSequenceNumber, modulo 256; stop SegmentTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-SegmentACK-PDU with 'negative-ACK' = FALSE, 'server' = TRUE, 'sequence-number' = LastSequenceNumber, and 'actual-window-size' = ActualWindowSize; set InitialSequenceNumber = LastSequenceNumber; send CONF_SERV.indication(+) containing all of the received segments to the local application program; start RequestTimer; and enter the AWAIT_RESPONSE state.

DuplicateSegmentReceived

If a BACnet-Confirmed-Request-PDU is received from the network layer whose 'segmented-message' parameter is TRUE and whose 'sequence-number' parameter is not equal to LastSequenceNumber plus 1, modulo 256, and DuplicateInWindow('sequence-number' parameter of the BACnet-SegmentACK-PDU, InitialSequenceNumber+1 modulo 256, LastSequenceNumber) returns a value of TRUE and DuplicateCount is less than Ndup,

then discard the BACnet-Confirmed-Request-PDU segment; restart SegmentTimer; increment DuplicateCount; and enter the SEGMENTED_REQUEST state to receive the remaining segments.

TooManyDuplicateSegmentsReceived

If a BACnet-Confirmed-Request-PDU is received from the network layer whose 'segmented-message' parameter is TRUE and whose 'sequence-number' parameter is not equal to LastSequenceNumber plus 1, modulo 256, and DuplicateInWindow('sequence-number' parameter of the BACnet-SegmentACK-PDU, InitialSequenceNumber+1 modulo 256, LastSequenceNumber) returns a value of TRUE and DuplicateCount is equal to Ndup,

then discard the BACnet-Confirmed-Request-PDU segment; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-SegmentACK-PDU with 'negative-ACK' = TRUE, 'server' = TRUE, 'sequence-number' = LastSequenceNumber, and 'actual-window-size' = ActualWindowSize; restart SegmentTimer; set InitialSequenceNumber = LastSequenceNumber; set DuplicateCount to zero; and enter the SEGMENTED_REQUEST state to receive the remaining segments.

SegmentReceivedOutOfOrder

If a BACnet-Confirmed-Request-PDU that is secured with the same settings as the original PDU is received from the network layer whose 'segmented-message' parameter is TRUE and whose 'sequence-number' parameter is not equal to LastSequenceNumber plus 1, modulo 256, and DuplicateInWindow('sequence-number' parameter of the BACnet-SegmentACK-PDU, InitialSequenceNumber+1 modulo 256, LastSequenceNumber) returns a value of FALSE,

then discard the BACnet-Confirmed-Request-PDU segment; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-SegmentACK-PDU with 'negative-ACK' = TRUE, 'server' = TRUE, 'sequence-number' = LastSequenceNumber, and 'actual-window-size' = ActualWindowSize; restart SegmentTimer; set InitialSequenceNumber = LastSequenceNumber; set DuplicateCount to zero; and enter the SEGMENTED_REQUEST state to receive the remaining segments.

AbortPDU_Received

If a BACnet-Abort-PDU that is secured with the same settings as the original PDU and whose server parameter is FALSE is received from the network layer,

then stop SegmentTimer and enter the IDLE state.

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UnexpectedPDU_Received

If an unexpected PDU (BACnet-Confirmed-Request-PDU with 'segmented-message' = FALSE or BACnet-SegmentACK-PDU with 'server' = FALSE) that is secured with the same settings as the original PDU is received from the network layer,

then stop SegmentTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = TRUE; and enter the IDLE state.

Timeout

If SegmentTimer becomes greater than $\mathbf{T}_{seg}$ times four,

then stop SegmentTimer and enter the IDLE state.

SendAbort

If ABORT.request is received from the local application program,

then stop SegmentTimer, issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = TRUE, and enter the IDLE state.

5.4.5.3 AWAIT_RESPONSE

In the AWAIT_RESPONSE state, the device waits for the local application program to respond to a BACnet-Confirmed-Request-PDU. See 9.8 for specific considerations in MS/TP networks.

SecurityError_Received

If a security error is received via an N-REPORT.indication from the network layer,

then send SEC_ERR.indication with the appropriate security error information to the local application program; and enter the IDLE state.

IncorrectSecurityPdu_Received

If a PDU is received that is not secured with the same settings as the original PDU,

then discard the PDU, and re-enter the current state.

SendSimpleACK

If a CONF_SERV.response(+) is received from the local application program, which is to be conveyed via a BACnet-SimpleACK-PDU,

then issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-SimpleACK-PDU and enter the IDLE state.

SendUnsegmentedComplexACK

If a CONF_SERV.response(+) is received from the local application program, which is to be conveyed via a BACnet-ComplexACK-PDU, and the length of the APDU is less than or equal to maximum-transmittable-length as determined according to 5.2.1,

then issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-ComplexACK-PDU with 'segmented-message' = FALSE and enter the IDLE state.

CannotSendSegmentedComplexACK

If a CONF_SERV.response(+) is received from the local application program, which is to be conveyed via a BACnet-ComplexACK-PDU, and the length of the APDU is greater than maximum-transmittable-length as determined according to 5.2.1, and either

(a) this device does not support the transmission of segmented messages or

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(b) the client will not accept a segmented response (the 'segmented-response-accepted' parameter in BACnet-ConfirmedRequest-PDU is FALSE), or

(c) the client's max-segments-accepted parameter in the BACnet-ConfirmedRequest-PDU is fewer than required to transmit the total APDU when total size is known or,

(d) the number of segments transmittable by this device is fewer than required to transmit the total APDU when total size is known,

then issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = TRUE and 'abort-reason' = SEGMENTATION_NOT_SUPPORTED for case (a) and (b), or BUFFER_OVERFLOW for case (c) and (d), and enter the IDLE state.

SendSegmentedComplexACK

If a CONF_SERV.response(+) is received from the local application program that is to be conveyed via a BACnet-ComplexACK-PDU, and the length of the APDU is greater than maximum-transmittable-length as determined according to 5.2.1, and the device supports the transmission of segmented messages, and the client will accept a segmented response ('segmented-response-accepted' parameter in BACnet-ConfirmedRequest-PDU is TRUE),

then set SegmentRetryCount to zero; set InitialSequenceNumber to zero; set ProposedWindowSize to whatever value is desired; set ActualWindowSize to 1; start SegmentTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = TRUE to transmit a BACnet-ComplexACK-PDU containing the first segment of the message, with 'segmented-message' = TRUE, 'more-follows' = TRUE, 'sequence-number' = zero, and 'proposed-window-size' = ProposedWindowSize; and enter the SEGMENTED_RESPONSE state to await an acknowledgment.

SendErrorPDU

If a CONF_SERV.response(-) is received from the local application program,

then issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Error-PDU and enter the IDLE state.

SendAbort

If ABORT.request is received from the local application program,

then stop SegmentTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = TRUE; and enter the IDLE state.

SendReject

If REJECT.request is received from the local application program,

then stop SegmentTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Reject-PDU; and enter the IDLE state.

AbortPDU_Received

If a BACnet-Abort-PDU that is secured with the same settings as the original PDU and whose 'server' parameter is FALSE is received from the network layer,

then send ABORT.indication to the local application program; and enter the IDLE state.

DuplicateRequestReceived

If a BACnet-Confirmed-Request-PDU that is secured with the same settings as the original PDU and whose 'segmented-message' parameter is FALSE is received from the network layer,

then discard the PDU as a duplicate request, and re-enter the current state.

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DuplicateSegmentReceived

If a BACnet-Confirmed-Request-PDU that is secured with the same settings as the original PDU and whose 'segmented-message' parameter is TRUE is received from the network layer,

then discard the PDU as a duplicate segment; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-SegmentACK-PDU with 'negative-ACK' = FALSE, 'server' = TRUE, 'sequence-number' = LastSequenceNumber, and 'actual-window-size' = ActualWindowSize; and re-enter the current state.

UnexpectedPDU_Received

If an unexpected PDU (BACnet-SegmentACK-PDU that is secured with the same settings as the original PDU and whose 'server' parameter is FALSE) is received from the network layer,

then issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = TRUE; send ABORT.indication with 'server' = TRUE and 'abort-reason' = INVALID_APDU_IN_THIS_STATE to the local application program; and enter the IDLE state.

Timeout

If RequestTimer becomes greater than $\mathbf{T_{out}}$,

then issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = TRUE and 'abort-reason' = APPLICATION_EXCEEDED_REPLY_TIME; send ABORT.indication with 'server' = TRUE and 'abort-reason' = APPLICATION_EXCEEDED_REPLY_TIME to the local application program; and enter the IDLE state.

5.4.5.4 SEGMENTED_RESPONSE

In the SEGMENTED_RESPONSE state, the device waits for a BACnet-SegmentACK-PDU for a segment or segments of a BACnet-ComplexACK-PDU.

SecurityError_Received

If a security error is received via an N-REPORT.indication from the network layer,

then stop SegmentTimer; send SEC_ERR.indication with the appropriate security error information to the local application program; and enter the IDLE state.

IncorrectSecurityPdu_Received

If a PDU is received that is not secured with the same settings as the original PDU,

then issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = TRUE; and enter the IDLE state.

DuplicateACK_Received

If a BACnet-SegmentACK-PDU that is secured with the same settings as the original PDU and whose 'server' parameter is FALSE is received from the network layer and InWindow('sequence-number' parameter of the BACnet-SegmentACK-PDU, InitialSequenceNumber) returns a value of FALSE,

then restart SegmentTimer and enter the SEGMENTED_RESPONSE state to await an acknowledgment or timeout.

NewACK_Received

If a BACnet-SegmentACK-PDU that is secured with the same settings as the original PDU and whose 'server' parameter is FALSE is received from the network layer and InWindow('sequence-number' parameter of the BACnet-SegmentACK-PDU, InitialSequenceNumber) returns a value of TRUE and there is at least one segment remaining to send,

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then set InitialSequenceNumber equal to the 'sequence-number' parameter of the BACnet-SegmentACK-PDU plus one, modulo 256; set ActualWindowSize equal to the 'actual-window-size' parameter of the BACnet-SegmentACK-PDU; set SegmentRetryCount to zero; call FillWindow(InitialSequenceNumber) to issue an N-UNITDATA.request with 'data_expecting_reply' = TRUE to transmit one or more BACnet-ComplexACK-PDUs containing the next ActualWindowSize segments of the message; restart SegmentTimer; and enter the SEGMENTED_RESPONSE state to await an acknowledgment.

FinalACK_Received

If a BACnet-SegmentACK-PDU that is secured with the same settings as the original PDU and whose 'server' parameter is FALSE is received from the network layer and InWindow('sequence-number' parameter of the BACnet-SegmentACK-PDU, InitialSequenceNumber) returns a value of TRUE and there are no more segments to send,

then stop SegmentTimer and enter the IDLE state.

Timeout

If SegmentTimer becomes greater than $\mathbf{T}_{seg}$ and SegmentRetryCount is less than Number_Of_APDU_Retries,

then increment SegmentRetryCount; call FillWindow(InitialSequenceNumber) to reissue an N-UNITDATA.request with 'data_expecting_reply' = TRUE to transmit one or more BACnet-ComplexACK-PDUs containing the next ActualWindowSize segments of the message; restart SegmentTimer; and enter the SEGMENTED_RESPONSE state to await an acknowledgment.

FinalTimeout

If SegmentTimer becomes greater than $\mathbf{T}_{seg}$ and SegmentRetryCount is greater than or equal to Number_Of_APDU_Retries,

then stop the SegmentTimer, and enter the IDLE state.

AbortPDU_Received

If a BACnet-Abort-PDU that is secured with the same settings as the original PDU and whose 'server' parameter is FALSE is received from the network layer,

then stop SegmentTimer; send ABORT.indication to the local application program; and enter the IDLE state.

UnexpectedPDU_Received

If an unexpected PDU (BACnet-Confirmed-Request-PDU) that is secured with the same settings as the original PDU is received from the network layer,

then stop SegmentTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = TRUE; and enter the IDLE state.

SendAbort

If ABORT.request is received from the local application program,

then stop SegmentTimer; issue an N-UNITDATA.request with 'data_expecting_reply' = FALSE to transmit a BACnet-Abort-PDU with 'server' = TRUE; and enter the IDLE state.

5.5 Application Protocol Time Sequence Diagrams

The flow sequence of service primitives can be represented by time-sequence diagrams. Each diagram is partitioned into three or four fields. The field labeled "Provider" represents the service-provider and the two fields labeled "User" represent the two service-users. The fourth field, if present, represents an application program. For the application layer, the vertical lines between user and provider represent the interface between the BACnet User Element and the BACnet ASE. For lower layers these vertical lines represent the service-access-points between the service-users and the service-provider. Moving from top to bottom in the diagram represents the passage of time. Arrows, placed in the areas representing the service-user,

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indicate the main flow of information during the execution of an interaction described by a service-primitive (i.e., to or from the service-user). Figures 5-4 through 5-13 illustrate the various sequences of application service primitives defined in BACnet.

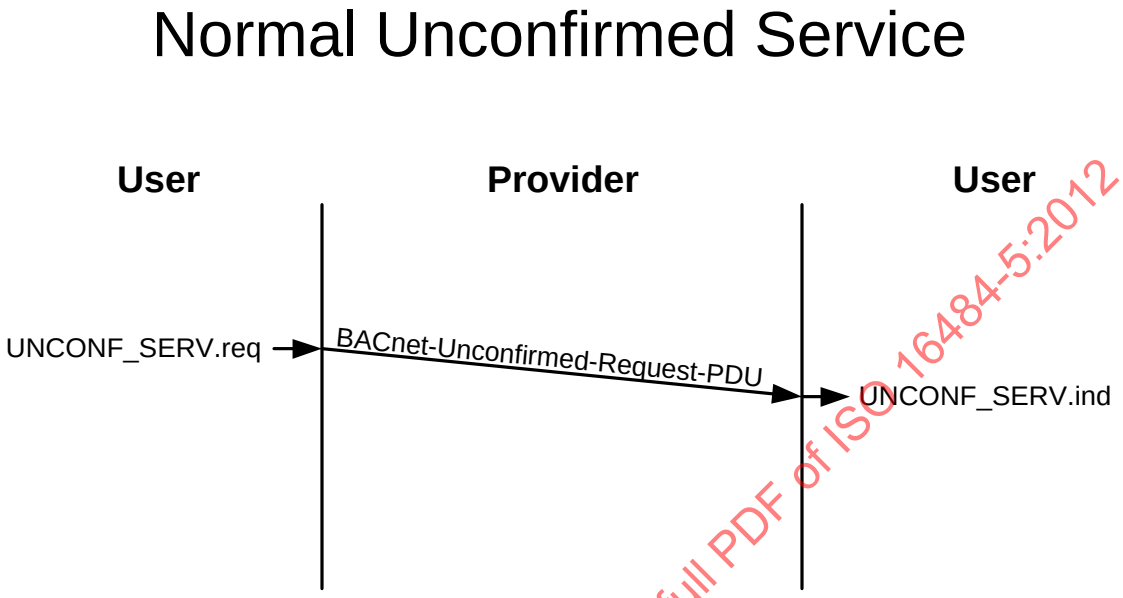

Figure 5-4. Time sequence diagram for a normal unconfirmed service.

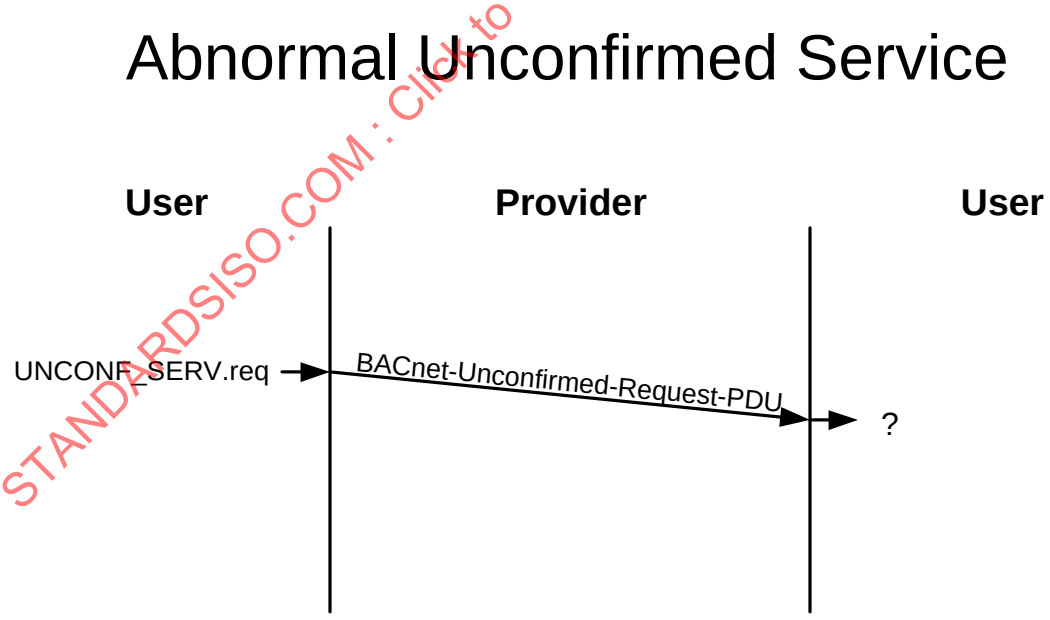

Figure 5-5. Time sequence diagram for an abnormal unconfirmed service. Unconfirmed service requests that are in some way flawed are ignored by the receiving user as indicated by the symbol "?".

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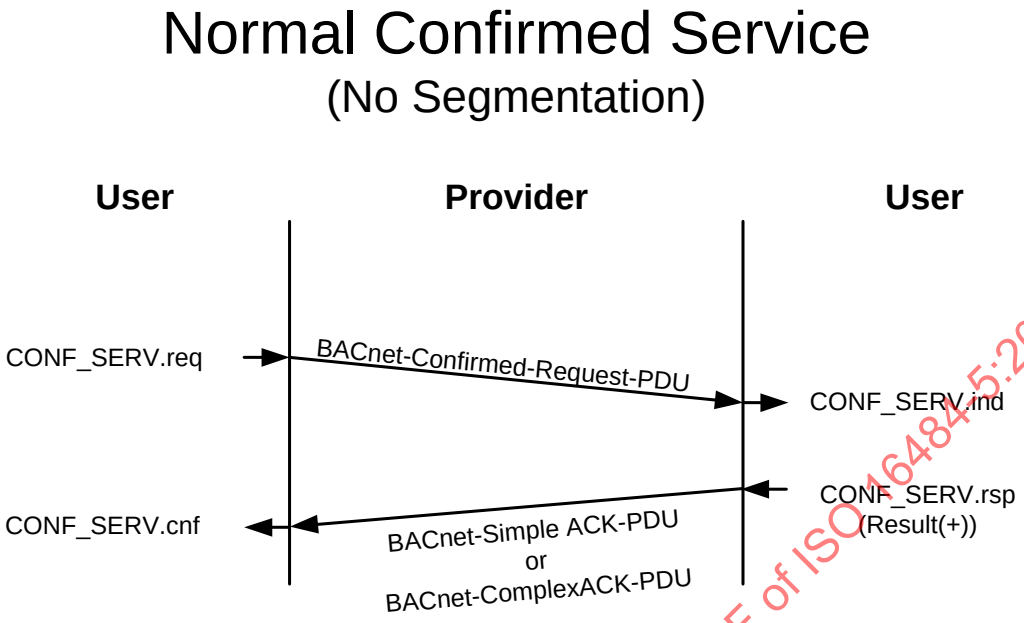

Figure 5-6. Time sequence diagram for normal confirmed services.

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Normal Confirmed Service
(Segmented Request)

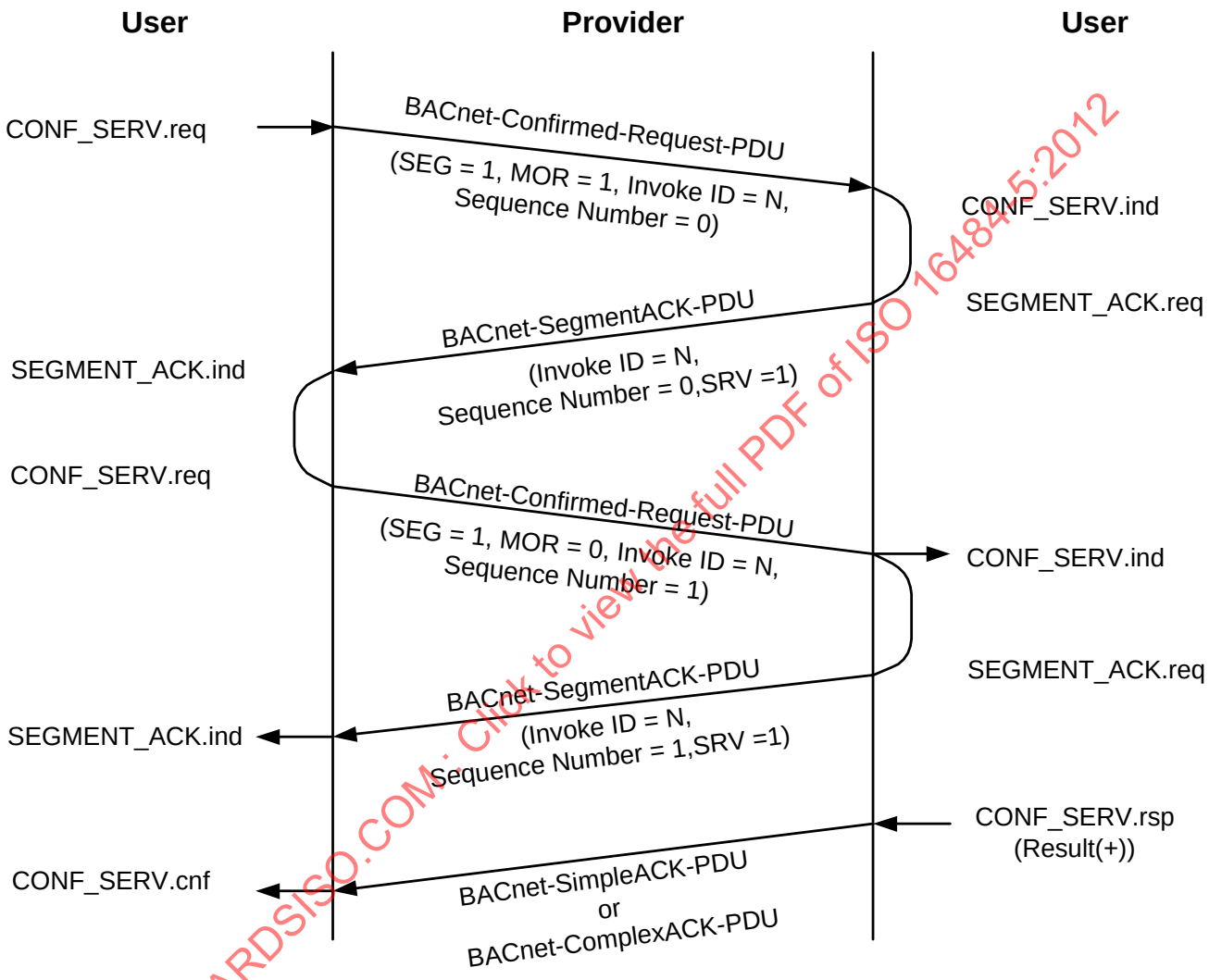

Figure 5-7. Time sequence diagram for a normal confirmed service with a segmented request.

Figure 5-7 illustrates two separate, interleaved exchanges of service primitives. One exchange is the usual confirmed service request, indication, response, and confirm sequence. Because the request is segmented it takes several CONF_SERV.request primitives to convey the entire request. The segment acknowledge service primitives, which are an independent exchange, are used to signal the client that the server is ready for the next segment.

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Normal Confirmed Service
(Segmented Response)

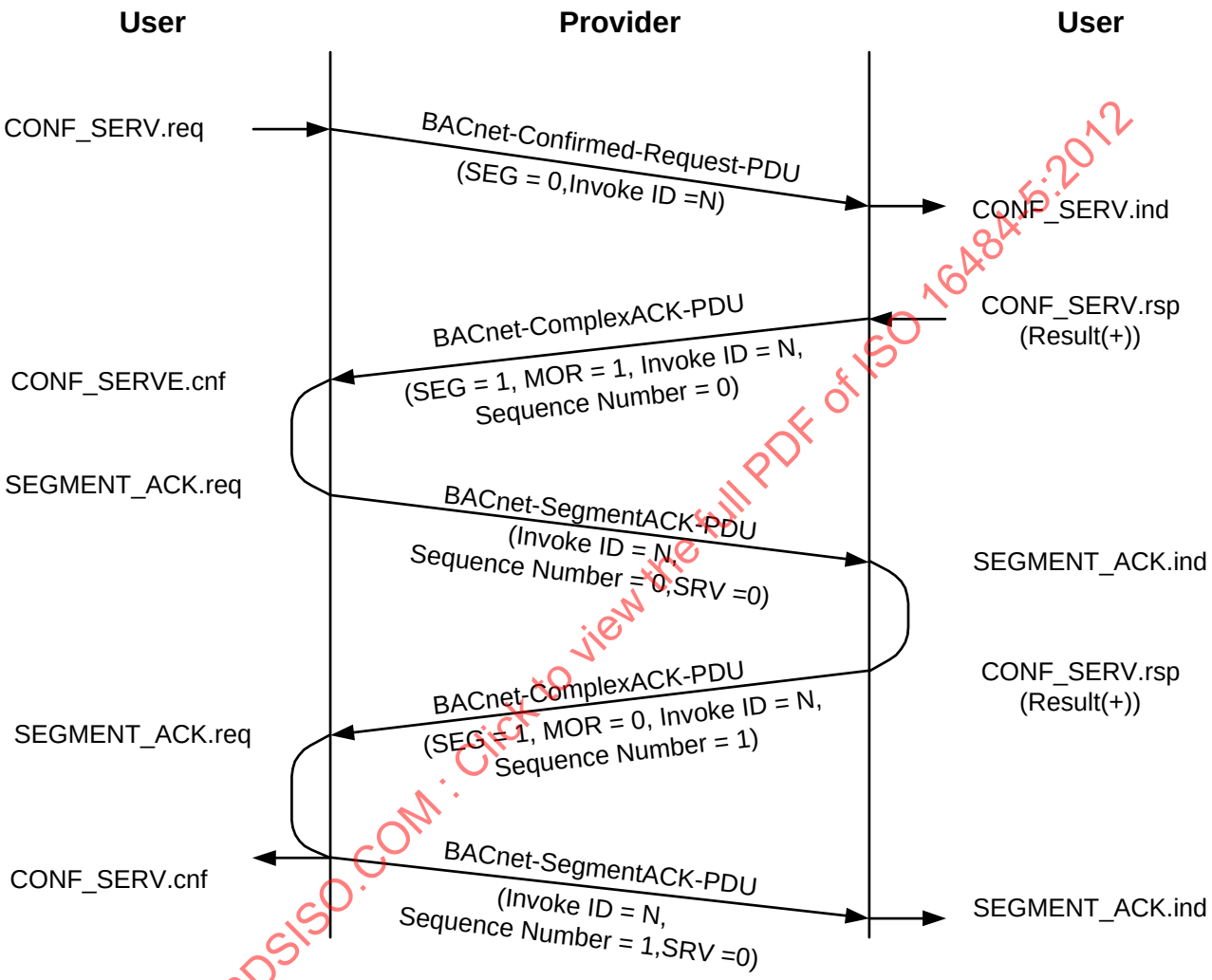

Figure 5-8. Time sequence diagram for a normal confirmed service with segmented response.

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Normal Confirmed Service

(Segmented Response, with Application Program Flow Control)

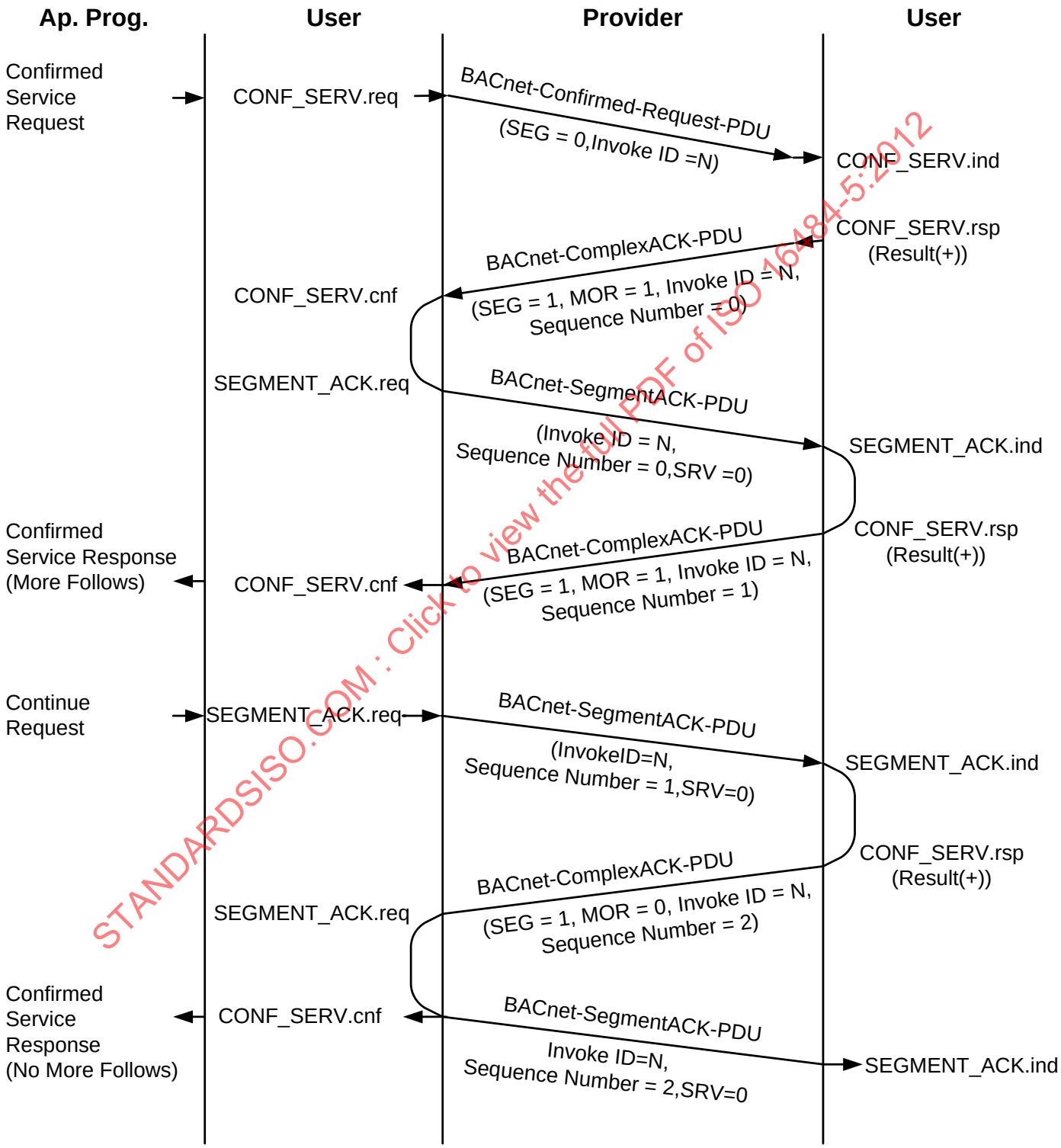

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Figure 5-9. Time sequence diagram for a normal confirmed service with application flow control.

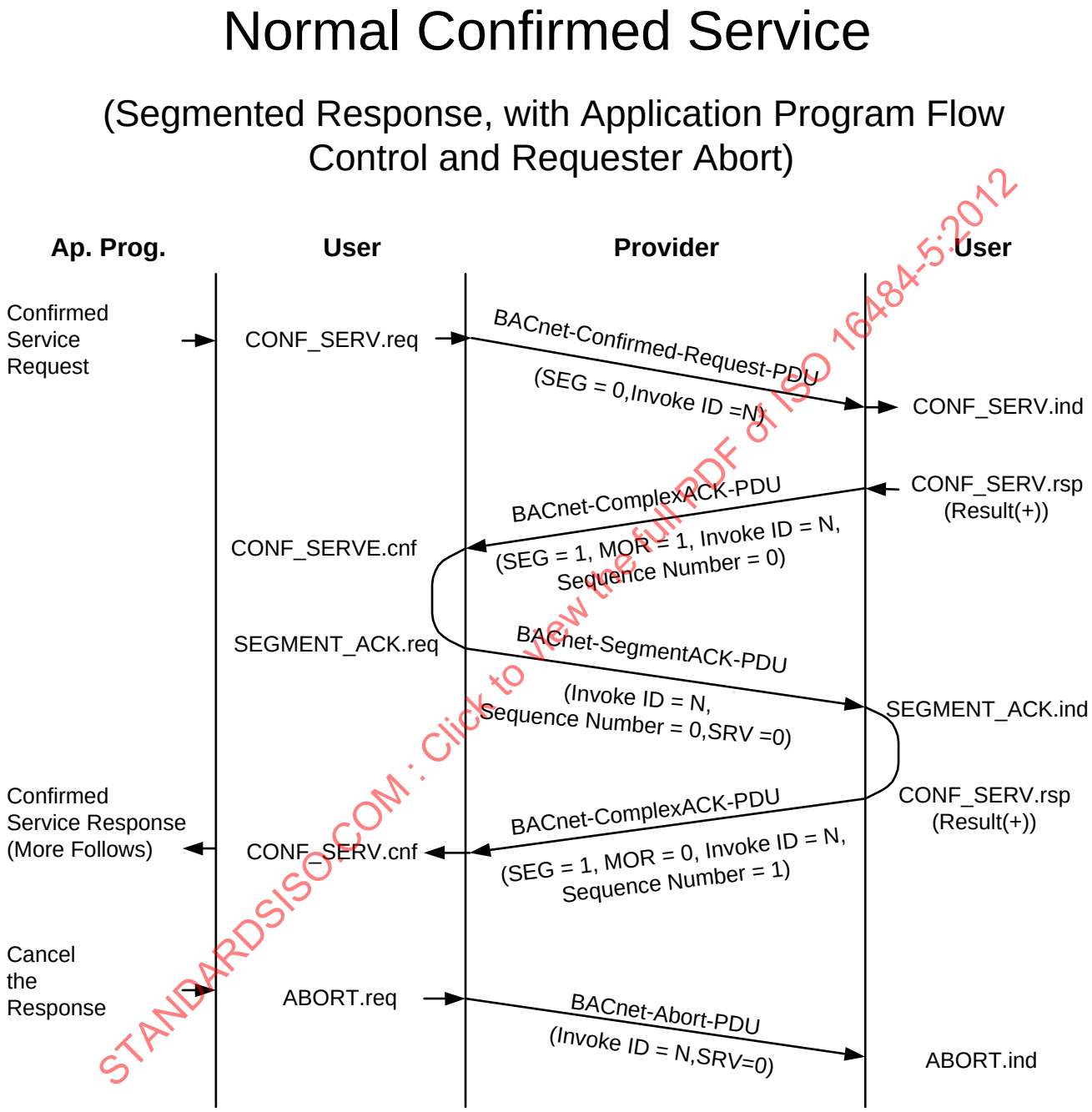

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Figure 5-10. Time sequence diagram for a normal confirmed service with segmented response, application program flow control, and response cancellation.

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Abnormal Confirmed Service

(Segmented Response and Requester Abort)

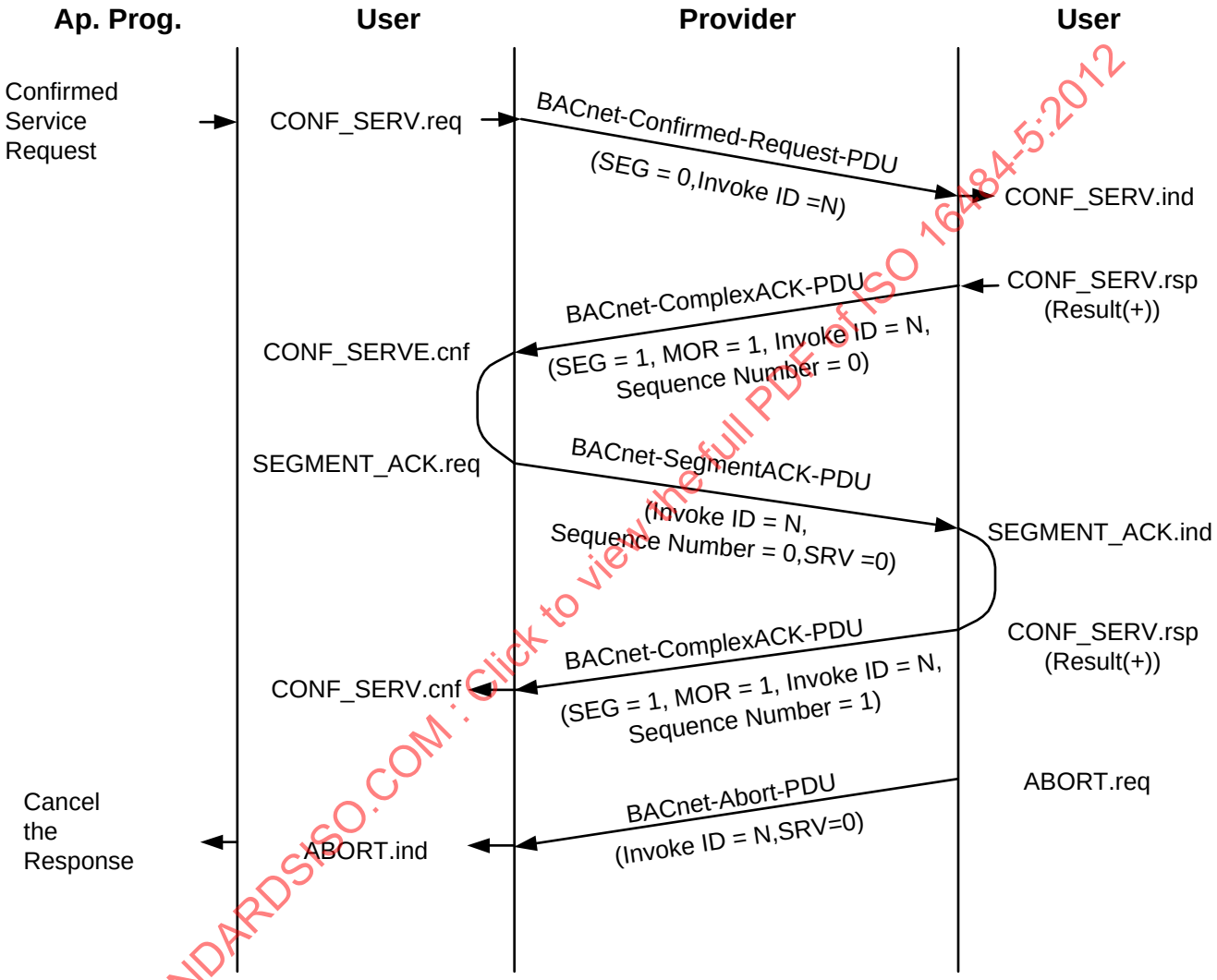

Figure 5-11. Time sequence diagram for an abnormal confirmed service.

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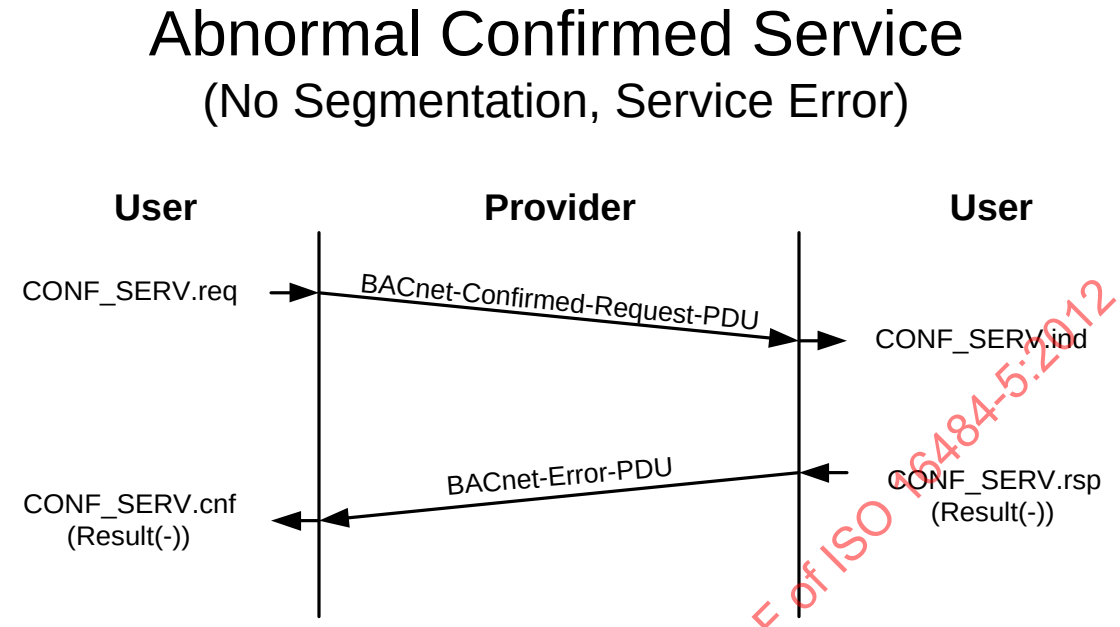

Figure 5-12. Time sequence diagram for an abnormal confirmed service.

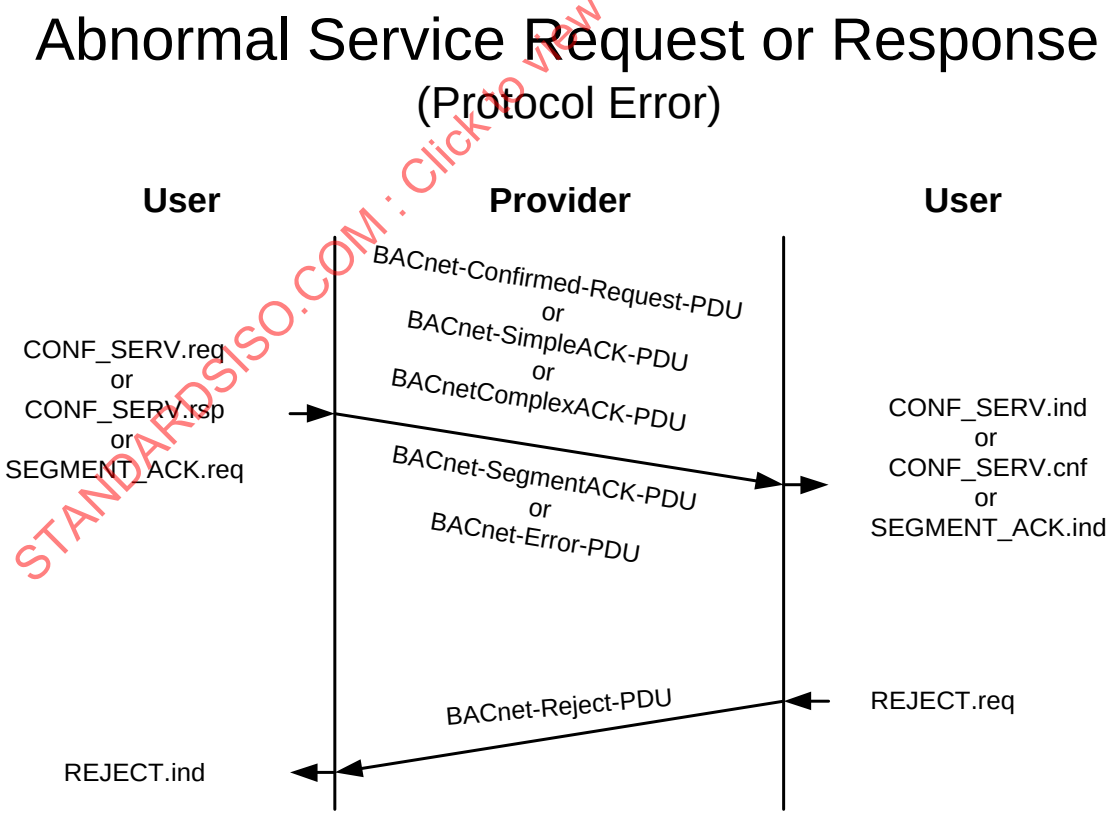

Figure 5-13. Time sequence diagram for an abnormal service request or response with a protocol error.

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5.6 Application Layer Service Conventions

This standard uses the descriptive conventions contained in the OSI technical report on service conventions, ISO TR 8509. The OSI conventions define the interactions between a protocol service user and a protocol service provider. Information passed between the protocol service user and the protocol service provider is represented abstractly as an exchange of "service primitives." The service primitives are an abstraction of the functional specification and the user-layer interaction. The abstract definition does not contain local detail of the user/provider interaction. Each primitive has a set of zero or more parameters, representing data elements that are passed to qualify the functions invoked by the primitive. Parameters indicate information available in a user/provider interaction; in any particular interface, some parameters may be explicitly stated (even though not explicitly defined in the primitive) or implicitly associated with the service access point. Similarly, in any particular protocol specification, functions corresponding to a service primitive may be explicitly defined or implicitly available.

Clauses 13 through 17 and 24 use a tabular format to describe the component parameters of the BACnet service primitives. Each table consists of five columns, containing the name of the service parameter and a column each for the request ("Req"), indication ("Ind"), response ("Rsp"), and confirm ("Cnf") primitives. The "Rsp" and "Cnf" columns are absent for unconfirmed services. Each row of the table contains one parameter or subparameter. Under the appropriate service primitive columns, a code is used to specify the type of use of the parameter on the primitive specified in the vertical column. These codes follow the conventions suggested in the ISO technical report on conventions, ISO TR 8509, namely:

M - parameter is Mandatory for the primitive.
U - parameter is a User option and may not be provided.
C - parameter is Conditional upon other parameters.
S - parameter is a Selection from a collection of two or more possible parameters. The parameters that make up this collection are indicated in the table as follows:

(a) each parameter in the collection is specified with the code "S";

(b) the name of each parameter in the collection is at the same table indentation from the beginning of the parameter column in the table; and

(c) either

1. each parameter is at the leftmost (outer) indentation in the table or

2. each parameter is part of the same parameter group. A parameter group is a collection of parameters where each member has a common parent parameter. The parent parameter for any group member is the first parameter above the member that is not indented as far as that member. In the following example, ParameterA and ParameterB form a parameter group:

```
ParameterX
        ParameterA
        ParameterB
ParameterY
        ParameterC
```

Informally, for parameters involved in a selection, the indentation in the service tables signifies which parameters are involved in a selection. All parameters at the same level of indentation under a common "higher level" parameter are part of the same selection.

The code "(=)" following one of the codes M, U, C, or S indicates that the parameter is semantically equivalent to the parameter in the service primitive to its immediate left in the table. For instance, an "M(=)" code in the indication service primitive column and "M" in the request service primitive column means that the parameter in the indication primitive is semantically equivalent to that in the request primitive.

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Some parameters may contain subparameters. Subparameters are indicated by indenting them with respect to the parent parameter. The presence of subparameters is always dependent on the presence of the parent parameter. In the example above, ParameterA and ParameterB are subparameters of ParameterX and ParameterC is a subparameter of ParameterY. If ParameterX is optional and is not supplied in a service primitive, then the subparameters (ParameterA and ParameterB) shall not be supplied.

Some service parameters are named using a "List of ..." convention. Unless otherwise noted, all parameters whose name begins with "List of ..." specify a list of zero or more of the item specified after the "List of" keyword phrase.

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6 THE NETWORK LAYER

The purpose of the BACnet network layer is to provide the means by which messages can be relayed from one BACnet network to another, regardless of the BACnet data link technology in use on that network. Whereas the data link layer provides the capability to address messages to a single device or broadcast them to all devices on the local network, the network layer allows messages to be directed to a single remote device, broadcast on a remote network, or broadcast globally to all devices on all networks. A BACnet Device is uniquely located by a network number and a MAC address.

Devices that interconnect two disparate BACnet LANs, e.g., ISO 8802-3 and ARCNET, and provide the relay function described in this clause are called "BACnet routers." Devices that interconnect two disparate BACnet networks through a point-to-point (PTP) connection (see Clause 10) are also BACnet routers. BACnet routers build and maintain their routing tables automatically using the network layer protocol messages defined in this clause. Network layer protocol messages facilitate both the auto-configuration of routers and the flow of messages to, and between, routers. BACnet routing capability may be implemented in stand-alone devices or, alternatively, in devices that carry out other building automation and control functions.

Some functions assigned to the network layer by the OSI Basic Reference Model are not required in BACnet. One such function involves selecting a communications path between source and destination machines based on an optimization algorithm. This is not required because BACnet internetworks shall be designed and installed with at most a single, active path between any two devices, a constraint that greatly reduces the complexity of the network layer. Another common network layer function is message segmentation and reassembly. To obviate the need for these capabilities at the network layer, BACnet imposes a limitation on the length of the NPDU in messages passed through a BACnet router. The maximum NPDU length shall not exceed the capability of any data link technology encountered along the path from source to destination. A list of the maximum NPDU lengths for BACnet data link technologies is given in Table 6-1.

Table 6-1. Maximum NPDU Lengths When Routing Through Different BACnet Data Link Layers

Data Link Technology	Maximum NPDU Length
ISO 8802-3 ("Ethernet"), as defined in Clause 7	1497 octets
ARCNET, as defined in Clause 8	501 octets
MS/TP, as defined in Clause 9	501 octets
Point-To-Point, as defined in Clause 10	501 octets
LonTalk, as defined in Clause 11	228 octets
BACnet/IP, as defined in Annex J	1497 octets
ZigBee, as defined in Annex O	501 octets

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6.1 Network Layer Service Specification

Conceptually, the BACnet network layer provides an unacknowledged connectionless form of data unit transfer service to the application layer. The primitives associated with the interaction are the N-UNITDATA request and indication, and the N-REPORT indication. These primitives provide parameters as follows:

N-UNITDATA.request (
destination_address,
data,
network_priority,
data_expecting_reply,
security_parameters
)

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N-UNITDATA.indication (
source_address,
destination_address,
data,
network_priority,
data_expecting_reply,
security_parameters
)

N-REPORT.indication (
peer_address,
error_condition,
error_parameters,
security_parameters
)

The 'destination_address' and 'source_address' parameters provide the logical concatenation of 1) an optional network number, 2) the MAC address appropriate to the underlying LAN technology, and the 3) the link service access point. A network number of X'FFFF' indicates that the message is to be broadcast "globally" to all devices on all currently reachable networks. Currently reachable networks are those networks to which an active connection is already established within the BACnet internet. In particular, a global broadcast shall not trigger any attempts to establish PTP connections. The 'data' parameter is the network service data unit (NSDU) passed down from the application layer and is composed of a fully encoded BACnet APDU. The 'network_priority' is a numeric value used by the network layer in BACnet routers to determine any possible deviations from a first-in-first-out approach to managing the queue of messages awaiting relay. The data_expecting_reply parameter indicates whether (TRUE) or not (FALSE) a reply data unit is expected for the data unit being transferred. The optional parameter 'security_parameters' contains the security information used to secure the request and context information required for security related N-REPORT.indication primitives to be related to application TSMs.

Upon receipt of an N-UNITDATA.request primitive from the application layer, the network layer shall attempt to send an NSDU using the procedures described in this clause. Upon receipt of an NSDU from a peer network entity, a network entity shall either 1) send the NSDU to its destination on a directly connected network, 2) send the NSDU to the next BACnet router en route to its destination, and/or 3) if the destination address matches that of one of its own application entities, issue an N-UNITDATA.indication primitive to the appropriate entity in its own application layer to signal the arrival of the NSDU.

The N-REPORT.indication primitive is used by the local network layer to indicate failures to transmit N-UNITDATA.requests to peer devices. The errors may be locally detected error conditions, or error conditions reported by a peer device via a network layer message. This primitive is used extensively by the network security wrapper to indicate security errors up the stack. The 'peer_address' parameter is of the same form as the 'destination_address' or 'source_address' parameters of the N-UNITDATA primitives and indicates the peer with which the error condition arose. The optional parameter 'security_parameters' conveys information describing the security failure and context required to relate the error to a previous N-UNITDATA.request or N-UNITDATA.indication primitive.

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6.2 Network Layer PDU Structure

6.2.1 Protocol Version Number

Each NPDU shall begin with a single octet that indicates the version number of the BACnet protocol, encoded as an 8-bit unsigned integer. The present version number of the BACnet protocol is one (1).

6.2.2 Network Layer Protocol Control Information

The second octet in an NPDU shall be a control octet that indicates the presence or absence of particular NPCI fields. Figure 6-1 shows the order of the NPCI fields in an encoded NPDU. Use of the bits in the control octet is as follows.

Bit 7: 1 indicates that the NSDU conveys a network layer message. Message Type field is present.
0 indicates that the NSDU contains a BACnet APDU. Message Type field is absent.

Bit 6: Reserved. Shall be zero.

Bit 5: Destination specifier where:
0 = DNET, DLEN, DADR, and Hop Count absent
1 = DNET, DLEN, and Hop Count present
DLEN = 0 denotes broadcast MAC DADR and DADR field is absent
DLEN > 0 specifies length of DADR field

Bit 4: Reserved. Shall be zero.

Bit 3: Source specifier where:
0 = SNET, SLEN, and SADR absent
1 = SNET, SLEN, and SADR present
SLEN = 0 Invalid
SLEN > 0 specifies length of SADR field

Bit 2: The value of this bit corresponds to the data_expecting_reply parameter in the N-UNITDATA primitives.

1 indicates that a BACnet-Confirmed-Request-PDU, a segment of a BACnet-ComplexACK-PDU, or a network layer message expecting a reply is present.

0 indicates that other than a BACnet-Confirmed-Request-PDU, a segment of a BACnet-ComplexACK-PDU, or a network layer message expecting a reply is present.

Bits 1,0: Network priority where:
B'11' = Life Safety message
B'10' = Critical Equipment message
B'01' = Urgent message
B '00' = Normal message

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Version	1 octet
Control	1 octet
DNET	2 octets
DLEN	1 octet
DADR	variable
SNET	2 octets
SLEN	1 octet
SADR	variable
Hop Count	1 octet
Message Type	1 octet
Vendor ID	2 octets
APDU	N octets

Figure 6-1. NPDU field format. Which fields are present is determined by the bits in the control octet.

In this standard:

DNET = 2-octet ultimate destination network number.
DLEN = 1-octet length of ultimate destination MAC layer address (A value of 0 indicates a broadcast on the destination network.)
DADR = Ultimate destination MAC layer address.
DA = Local network destination MAC layer address.
SNET = 2-octet original source network number.
SLEN = 1-octet length of original source MAC layer address.
SADR = Original source MAC layer address.
SA = Local network source MAC layer address.

Figures 6-2(a) - 6-2(e) provide examples of NPDUs containing APDUs for various combinations of addressing information.

Version = X'01'	1 octet
Control = X'04'	1 octet
APDU	N octets

Figure 6-2(a). Example of a typical "Local" BACnet NPDU for which a reply is expected.

Version = X'01'	1 octet
Control = X'24'	1 octet
DNET	2 octets
DLEN = M	1 octet
DADR	M octets
Hop Count	1 octet
APDU	N octets

Figure 6-2(b). Example of a typical "Remote" BACnet NPDU directed to a router. Network Priority is NORMAL and a reply is expected.

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Version = X'01'	1 octet
Control = X'29'	1 octet
DNET	2 octets
DLEN	1 octet
DADR	1 octet
SNET	2 octets
SLEN = 6	1 octet
SADR	6 octets
Hop Count	1 octet
APDU	N octets

Figure 6-2(c). Example of a typical BACnet NPDU as passed between routers. Network Priority is URGENT, original MAC Address is 6 octets, and the ultimate Destination MAC Address is 1 octet.

Version =X'01'	1 octet
Control = X'28'	1 octet
DNET = X'FFFF'	2 octets
DLEN = 0	1 octet
SNET	2 octets
SLEN	1 octet
SADR	1 octet
Hop Count	1 octet
APDU	N octets

Figure 6-2(e). Example of a typical Broadcast message of NORMAL Network Priority as broadcast by a Router.

Version = X'01'	1 octet
Control = X'0B'	1 octet
SNET	2 octets
SLEN = 6	1 octet
SADR	6 octets
APDU	N octets

Figure 6-2(d). Example of a typical "Remote" BACnet NPDU as sent from a Router to its ultimate destination on a directly connected network. Network Priority is LIFE SAFETY.

SLEN = 2	1 octet
SrcSubnet	1 octet
SrcNode	1 octet

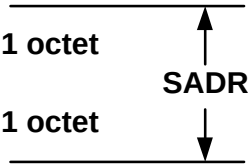

Figure 6-3. Encoding of the SLEN and SADR for NPDUs destined for LonTalk devices being routed through BACnet.

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6.2.2.1 DNET, SNET, and Vendor ID Encoding

The multi-octet fields, DNET, SNET, and Vendor ID, shall be conveyed with the most significant octet first. Allowable network number values for DNET shall be from 1 to 65535 and for SNET from 1 to 65534.

6.2.2.2 DADR and SADR Encoding

The DADR and SADR fields are encoded as shown in Table 6-2, Figure 6-3, and Figure 6-4.

Table 6-2. BACnet DADR and SADR Encoding Rules Based Upon Data Link Layer Technology

BACnet Data Link Layer	DLEN	SLEN	Encoding Rules
ISO 8802-3 ("Ethernet"), as defined in Clause 7	6	6	Encoded as in their MAC layer representations
ARCNET, as defined in Clause 8	1	1	Encoded as in their MAC layer representations
MS/TP, as defined in Clause 9	1	1	Encoded as in their MAC layer representations
LonTalk domain wide broadcast	2	2	The encoding for the SADR is shown in Figure 6-3 The encoding for the DADR is shown in Figure 6-4
LonTalk multicast	2	2	
LonTalk unicast	2	2	
LonTalk, unique Neuron_ID	7	2	
BACnet/IP, as defined in Annex J	6	6	Encoded as specified in J.1.2
ZigBee, as defined in Annex O	3	3	A VMAC Address encoded as a device instance as shown in Annex H.7 Virtual MAC Addressing

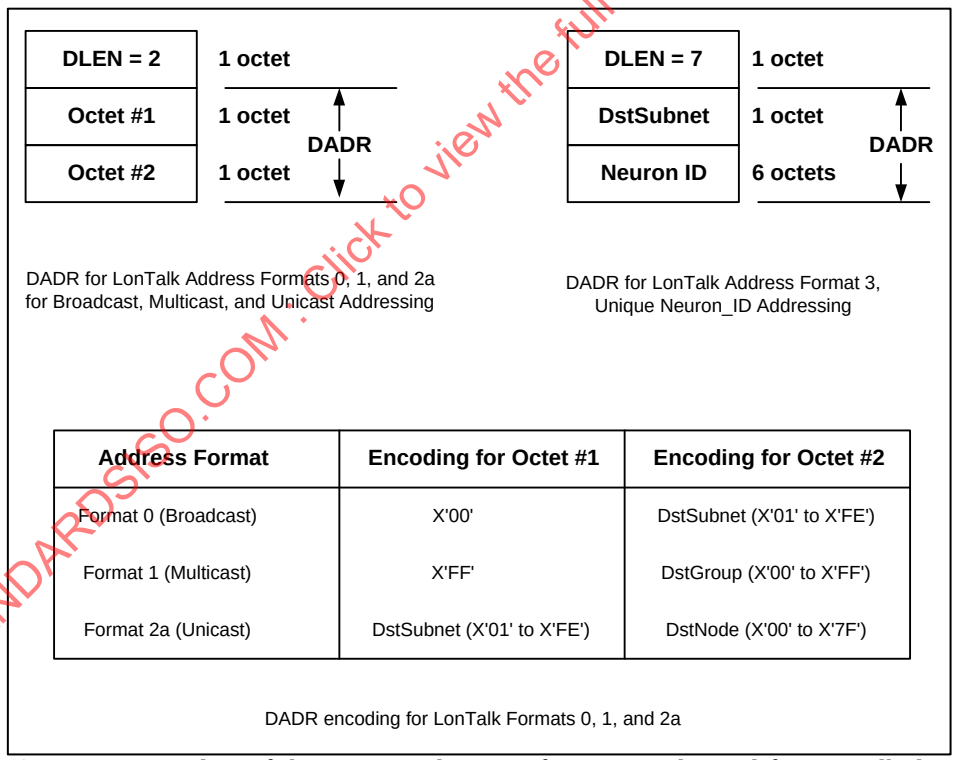

Figure 6-4. Encoding of the DLEN and DADR for NPDUs destined for LonTalk devices being routed through BACnet. The different LonTalk address formats are encoded as shown.

6.2.3 Hop Count

The Hop Count is a decrementing counter value used to ensure that a message cannot be routed in a circular path indefinitely. Such a circular path can only occur if the configuration rule that allows only a single path between any two BACnet nodes is violated. See 4.2.

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The Hop Count field shall be present only if the message is destined for a remote network, i.e., if DNET is present. This is a one-octet field that is initialized to a value of X'FF'. Each router the message passes through shall decrement the Hop Count by at least one but not more than the current value of Hop Count. If the Hop Count reaches a value of zero, the router shall discard the message and not forward it to the next router.

6.2.4 Network Layer Message Type

If Bit 7 of the control octet described in Clause 6.2.2 is 1, a message type octet shall be present as shown in Figure 6-1. The following message types are indicated:

X'00': Who-Is-Router-To-Network
X'01': I-Am-Router-To-Network
X'02': I-Could-Be-Router-To-Network
X'03': Reject-Message-To-Network
X'04': Router-Busy-To-Network
X'05': Router-Available-To-Network
X'06': Initialize-Routing-Table
X'07': Initialize-Routing-Table-Ack
X'08': Establish-Connection-To-Network
X'09': Disconnect-Connection-To-Network
X'0A': Challenge-Request
X'0B': Security-Payload
X'0C': Security-Response
X'0D': Request-Key-Update
X'0E': Update-Key-Set
X'0F': Update-Distribution-Key
X'10': Request-Master-Key
X'11': Set-Master-Key
X'12': What-Is-Network-Number
X'13': Network-Number-Is
X'14' to X'7F': Reserved for use by ASHRAE
X'80' to X'FF': Available for vendor proprietary messages

Figures 6-5 through 6-10 provide examples of NPDUs containing network layer messages.

6.2.5 Vendor Proprietary Network Layer Messages

If Bit 7 of the control octet is 1 and the Message Type field contains a value in the range X'80' - X'FF', then a Vendor ID field shall be present as shown in Figure 6-1. Otherwise, the Vendor ID shall be omitted. The Vendor ID is defined in Clause 23. The Vendor ID shall be encoded in two octets.

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Version = X'01'	1 octet
Control = X'80'	1 octet
Message Type = X'00'	1 octet
DNET	2 octets (optional)

Figure 6-5. Example of a Who-Is-Router-To-Network message. If DNET is omitted, a router receiving this message shall return a list of all reachable DNETs.

Version = X'01'	1 octet
Control = X'80'	1 octet
Message Type = X'08'	1 octet
DNET	2 octets
Termination Time Value	1 octet

Figure 6-6. Example of an Establish-Connection-To-Network message directed to a local router.

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Version = X'01'	1 octet
NPCI = X'80'	1 octet
Message Type = X'03'	1 octet
Rejection Reason	1 octet
DNET	2 octets

Figure 6-7. Example of a Reject-Message-To-Network DNET.

Version = X'01'	1 octet
Control = X'80'	1 octet
Message Type = X'05'	1 octet
List of DNETs	2N octets (optional)

Figure 6-8. Example of a Router-Available-To-Network for one or more DNETs. If the list of DNETs is not present, flow control is being eased on all networks normally reached through the router.

Version = X'01'	1 octet
Control = X'80'	1 octet
Message Type = X'04'	1 octet
List of DNETs	2N octets (optional)

Figure 6-9. Example of a Router-Busy-To-Network for one or more DNETs. If the list of DNETs is not present, flow control is being imposed on all networks normally reachable through the router.

Version = X'01'	1 octet
Control = X'80'	1 octet
Message Type = X'02'	1 octet
DNET	2 octets
Performance Index	1 octet

Figure 6-10. Example of an I-Could-Be-Router-To-Network Message.

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6.2.6 Network Layer Messages Conveying Data

If there are data octets to be conveyed for the message type specified in 6.2.4, these data octets shall follow the message type octet in the manner prescribed for each message type.

6.3 Messages for Multiple Recipients

BACnet supports the transmission of messages to multiple recipients through the use of multicast and broadcast addresses. Multicasting results in a message being processed by a group of recipients. Broadcasting results in a message being processed by all of the BACnet Devices on the local network, a remote network, or all networks. The use of broadcast or multicast addressing for network layer protocol messages is described in 6.5. Of the BACnet APDUs, only the BACnet-Unconfirmed-Request-PDU may be transmitted using a multicast or broadcast address.

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6.3.1 Multicast Messages

At present, only ISO 8802-3, LonTalk, and BACnet/IP (as defined in Annex J) support multicast addresses. The method by which a BACnet Device is assigned to a specific multicast group shall be a local matter.

6.3.2 Broadcast Messages

Three forms of broadcast transmission are provided by BACnet: local, remote, and global. A local broadcast is received by all stations on the local network. A remote broadcast is received by all stations on a single remote network. A global broadcast is received by all stations on all networks comprising the BACnet internetwork.

A local broadcast makes use of the broadcast MAC address appropriate to the local network's LAN technology, i.e., X'FFFFFFFFFFFF' for ISO 8802-3, X'00' for ARCNET, X'FF' for MS/TP, or X'00' in the DstSubnet field of Address Format 0 in LonTalk.

A remote broadcast is made on behalf of the source device on a specific distant network by a router directly connected to that network. In this case, DNET shall specify the network number of the remote network and DLEN shall be set to zero.

A global broadcast, indicated by a DNET of X'FFFF', is sent to all networks through all routers. Upon receipt of a message with the global broadcast DNET network number, a router shall decrement the Hop Count. If the Hop Count is still greater than zero, then the router shall broadcast the message on all directly connected networks except the network of origin, using the broadcast MAC address appropriate for each destination network. If the Hop Count is zero, then the router shall discard the message. In order for the message to be disseminated globally, the originating device shall use a broadcast MAC address on the originating network so that all attached routers may receive the message and propagate it further.

If a router has one or more ports that represent PTP connections as defined in Clause 10, global broadcasts shall be processed as follows. If the PTP connection is currently established, that is, the Connection State Machine is in the Connected state (see 10.4.9), then the global broadcast message shall be transmitted through the PTP connection. If the PTP connection is not currently established, then no action shall be taken by the router to transmit the broadcast message through the PTP connection.

6.4 Network Layer Protocol Messages

This subclause describes the format and purpose of the ten BACnet network layer protocol messages. These messages provide the basis for router auto-configuration, router table maintenance, and network layer congestion control.

6.4.1 Who-Is-Router-To-Network

This message is indicated by a Message Type of X'00' optionally followed by a 2-octet network number. Who-Is-Router-To-Network is used by both routing and non-routing nodes to ascertain the next router to a specific destination network or, in the case of routers, as an aid in building an up-to-date routing table. See Figure 6-5.

6.4.2 I-Am-Router-To-Network

This message is indicated by a Message Type of X'01' followed by one or more 2-octet network numbers. It is used to indicate the network numbers of the networks accessible through the router generating the message. It shall always be transmitted with a broadcast MAC address.

6.4.3 I-Could-Be-Router-To-Network

This message is used to respond to a Who-Is-Router-To-Network message containing a specific 2-octet network number when the responding half-router has the capability of establishing a PTP connection that can be used to reach the desired network but this PTP connection is not currently established.

This message is indicated by a Message Type of X'02'. The complete format of the NPDU is shown in Figure 6-10. The 2-octet network number indicates the DNET that could be reached by this half-router. The 1-octet "Performance Index" is a locally determined number that gives an indication of the quality and performance of this proposed connection. A low value in this field indicates a high performance index. Typically, the Performance Index would be established at installation time and set relative to the performance of other PTP half-routers in the system.

6.4.4 Reject-Message-To-Network

This message is indicated by a Message Type of X'03' followed by an octet indicating the reason for the rejection and a 2-

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octet network number (see Figure 6-7). It is directed to the node that originated the message being rejected, as indicated by the source address information in that message. The rejection reason octet shall contain an unsigned integer with one of the following values:

0: Other error.

1: The router is not directly connected to DNET and cannot find a router to DNET on any directly connected network using Who-Is-Router-To-Network messages.

2: The router is busy and unable to accept messages for the specified DNET at the present time.

3: It is an unknown network layer message type.

4: The message is too long to be routed to this DNET.

5. The source message was rejected due to a BACnet security error and that error cannot be forwarded to the source device. See Clause 24.12.1.1 for more details on the generation of Reject-Message-To-Network messages indicating this reason.

6. The source message was rejected due to errors in the addressing. The length of the DADR or SADR was determined to be invalid.

6.4.5 Router-Busy-To-Network

This message is indicated by a Message Type of X'04' optionally followed by a list of 2-octet network numbers. It shall always be transmitted with a broadcast MAC address appropriate to the network on which it is broadcast. Router-Busy-To-Network is used by a router to curtail the receipt of messages for specific DNETs or all DNETs. See Figure 6-9.

6.4.6 Router-Available-To-Network

This message is indicated by a Message Type of X'05' optionally followed by a list of 2-octet network numbers. It shall always be transmitted with a broadcast MAC address. Router-Available-To-Network is used by a router to enable or re-enable the receipt of messages for a specific list of DNETs or all DNETs. See Figure 6-8.

6.4.7 Initialize-Routing-Table

This message is indicated by a Message Type of X'06'. It is used to initialize the routing table of a router or to query the contents of the current routing table.

The format of the data portion of the Initialize-Routing-Table message is shown in Figure 6-11.

The Number of Ports field of this NPDU indicates how many port mappings are being provided in this NPDU. This field permits routing tables to be incrementally updated as the network changes. Valid entries in this field are 0-255. Following this field are sets of data indicating the DNET directly connected to this port or accessible through a dial-up PTP connection, Port ID, Port Info Length, and, in the case Port Info Length is non-zero, Port Info. If an Initialize-Routing-Table message is sent with the Number of Ports equal to zero, the responding device shall return its complete routing table in an Initialize-Routing-Table-Ack message without updating its routing table. If the Port ID field has a value of zero, then all

Number of Ports	1 octet
Connected DNET	2 octets
Port ID	1 octet
Port Info Length	1 octet
Port Info	J octets
. . .	. . .
Connected DNET	2 octets
Port ID	1 octet
Port Info Length	1 octet
Port Info	K octets

Figure 6-11. Format of the data portion of an Initialize-Routing-Table or Initialize-Routing-Table-Ack.

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table entries for the specified DNET shall be purged from the table. If the Port ID field has a non-zero value, then the routing information for this DNET shall either replace any previous entry for this DNET in the routing table or, if no such entry exists, be appended to the routing table.

The Port Info Length is an unsigned integer indicating the length of the Port Info field.

The Port Info field, if present, shall contain an octet string. A typical use would be to convey modem control and dial information for accessing a remote network via a dial-up PTP connection.

The Initialize-Routing-Table message shall be transmitted with the DER = TRUE.

6.4.8 Initialize-Routing-Table-Ack

This message is indicated by a Message Type of X'07'. It is used to indicate that the routing table of a router has been changed or the table has been queried through the receipt of an Initialize-Routing-Table message with the Number of Ports field set equal to zero. The data portion of this message, returned only in response to a routing table query, conveys the routing table information, and it has the same format as the data portion of an Initialize-Routing-Table message. See 6.4.7 and Figure 6-11.

6.4.9 Establish-Connection-To-Network

This message is used to instruct a half-router to establish a new PTP connection that creates a path to the indicated network.

This message is indicated by a Message Type of X'08'. The complete format of the NPDU is shown in Figure 6-6. The 2-octet network number indicates the DNET that should be connected to by this half-router. The 1-octet "Termination Time Value" specifies the time, in seconds, that the connection shall remain established in the absence of NPDUs being sent on this connection. A value of 0 indicates that the connection should be considered to be permanent. See 6.7.1.4.

6.4.10 Disconnect-Connection-To-Network

This message is indicated by a Message Type of X'09' followed by a 2-octet network number. This message is used to instruct a router to disconnect an established PTP connection. The disconnection process shall follow the procedures described in Clause 10.

6.4.11 Challenge-Request

This message is indicated by a Message Type of X'0A'. It is described in Clause 24.

6.4.12 Security-Payload

This message is indicated by a Message Type of X'0B'. It is described in Clause 24.

6.4.13 Security-Response

This message is indicated by a Message Type of X'0C'. It is described in Clause 24.

6.4.14 Request-Key-Update

This message is indicated by a Message Type of X'0D'. It is described in Clause 24.

6.4.15 Update-Key-Set

This message is indicated by a Message Type of X'0E'. It is described in Clause 24.

6.4.16 Update-Distribution-Key

This message is indicated by a Message Type of X'0F'. It is described in Clause 24.

6.4.17 Request-Master-Key

This message is indicated by a Message Type of X'10'. It is described in Clause 24.

6.4.18 Set-Master-Key

This message is indicated by a Message Type of X'11'. It is described in Clause 24.

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6.4.19 What-Is-Network-Number

This message is indicated by a Message Type of X'12'. It is used to request the local network number from other devices on the local network. This message may be transmitted with a local broadcast or a local unicast address. This message shall never be routed. Devices shall ignore What-Is-Network-Number messages that contain SNET/SADR or DNET/DADR information in the NPCI.

Upon receipt of a What-Is-Network-Number message, a device that knows the local network number shall transmit a local broadcast Network-Number-Is message back to the source device. If the What-Is-Network-Number message was broadcast, then a non-routing device may optionally wait for up to 10 seconds before sending the Network-Number-Is message. If during that time, a different device broadcasts the Network-Number-Is message, the non-routing device may choose to not send a Network-Number-Is message..

Upon receipt of a What-Is-Network-Number message, a device that does not know the local network number shall discard the message.

A device shall cache its local network number, and not repeatedly issue this service.

6.4.20 Network-Number-Is

This message is indicated by a Message Type of X'13' followed by a 2-octet network number (most significant octet first), followed by a 1-octet flag, where a value of 1 indicates that the network number was configured, and a value of 0 indicates that the network number was learned by receipt of a previous Network-Number-Is message. This message is used to indicate the local network number to other devices on the local network. It shall be transmitted with a local broadcast address, and shall never be routed. Devices shall ignore Network-Number-Is messages that contain SNET/SADR or DNET/DADR information in the NPCI or that are sent with a local unicast address.

For a device that has not been configured to know its network number, when it receives this message indicating a configured network number, it shall set its network number from this message. If it receives this message indicating a learned network number, then it shall set its network number only if it has not previously received a message indicating a configured network number. If a device resets, it shall reduce the quality of its last received network number to "learned".

For a device that has been configured to know its network number, when it receives this message indicating a configured network number that is in conflict with its configuration, it should report the conflict to a local or remote management entity.

Upon startup, routers that have been configured to know their network numbers shall broadcast out each port a Network-Number-Is message containing the network number for the port and indicate that this number is configured, not learned.

6.5 Network Layer Procedures

This subclause describes the network layer procedures to be followed by BACnet router and non-router nodes for both local and remote data transfer. "Local" means that the source and destination devices are on the same BACnet network. "Remote" means that the source and destination devices are on different BACnet networks. The source and destination networks are interconnected by zero or more intervening networks joined by BACnet routers to form a BACnet internetwork. See Figure 4-3.

6.5.1 Network Layer Procedures for the Transmission of Local Traffic

Upon receipt of an N-UNITDATA.request primitive, the network entity (NE) shall inspect the DNET portion of the 'destination_address' parameter. The absence of DNET indicates that the destination device resides on the same BACnet network as the device issuing this transmission request. The value of the 'network_priority' parameter shall be included in the NPCI control octet although its use by receiving non-router entities is unspecified. The NE shall prepare a control NPCI octet indicating the absence of DNET, DADR, HOP COUNT, SNET, and SADR, concatenate it with the 'data' parameter conveyed in the N-UNITDATA.request primitive, and issue a DL-UNITDATA data link request primitive. The concatenation of the NPCI and the NSDU (the 'data' parameter from the N-UNITDATA.request), the NPDU, is passed as the 'data' parameter of the data link primitive.

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6.5.2 Network Layer Procedures for the Receipt of Local Traffic

Upon receipt of an NPDU from the data link layer (conveyed by the 'data' parameter of the DL-UNITDATA data link indication primitive) whose first octet indicates BACnet version one, the destination NE shall interpret the second octet of the NPDU as control NPCI. If bit 7 of the control NPCI indicates that the message contains an APDU, then the procedure in 6.5.2.1 is followed. Otherwise, a network layer message is being conveyed and the procedure in 6.5.2.2 applies.

6.5.2.1 Receipt of Local APDUs

If the control NPCI octet indicates the absence of a DNET field or a DNET field is present and contains the global broadcast address X'FFFF', the NE shall attempt to locate a BACnet application entity. If a BACnet application entity is found, the NE shall issue an N-UNITDATA.indication primitive with the portion of the data link data following the NPCI as the 'data' parameter. If the application entity is not found and the NE resides in a non-routing node, the data link data shall be discarded. If the DNET is present and not equal to the global broadcast address X'FFFF' and the NE resides in a non-routing node, the data link data shall likewise be discarded and no further action taken. If the DNET is present and the NE resides in a BACnet router, the NE shall take the actions specified in 6.5.4.

6.5.2.2 Receipt of Local Network Layer Messages

If the control NPCI octet indicates the absence of a DNET field or a DNET field is present and contains the global broadcast address X'FFFF', the NE shall attempt to interpret the network layer message. If the DNET field is absent and the message cannot be interpreted and the message was directed specifically at the router, a Reject-Message-To-Network shall be returned to the device that sent the message.

If the DNET is present and not equal to the global broadcast address X'FFFF' and the NE resides in a non-routing node, the data link data shall be discarded and no further action taken. If the DNET is present and the NE resides in a BACnet router, the NE shall take the actions specified in 6.5.4.

6.5.3 Network Layer Procedures for the Transmission of Remote Traffic

Upon receipt of an N-UNITDATA.request primitive, the NE shall inspect the DNET portion of the 'destination_address' parameter. The presence of a DNET signifies that the destination device resides on a different BACnet network than the device issuing this transmission. A DNET value of X'FFFF' signifies a global broadcast and indicates that the message is to be directed to all local routers via a broadcast message on the local network. The NE shall prepare an NPCI control octet indicating the presence of DNET, DADR, and Hop Count but the absence of SNET and SADR. The NE shall also fill in the network priority field using the supplied parameter. The resulting control, priority, and address information shall then be concatenated with the 'data' parameter conveyed in the N-UNITDATA.request primitive and issued as a DL-UNITDATA data link request primitive. The concatenation of the NPCI and the 'data' parameter from the N-UNITDATA.request (the NSDU), the NPDU, is passed as the 'data' parameter of the data link primitive. The DA portion of the 'destination_address' parameter passed to the data link layer shall be the MAC address of the BACnet router corresponding to the DNET parameter or the appropriate broadcast DA if the address of the router is initially unknown. The broadcast DA is also to be used if the DNET global broadcast network number is present.

Note that five methods exist for establishing the address of a BACnet router for a particular DNET: 1) the address may be established manually at the time a device is configured, 2) the address may be learned by issuing a Who-Is request and noting the SA associated with the subsequent I-Am message (assuming the device specified in the Who-Is is located on a remote DNET and the I-Am message was handled by a router on the local network), 3) by using the network layer message Who-Is-Router-To-Network, 4) by using the local broadcast MAC address in the initial transmission to a device on a remote DNET and noting the SA associated with any subsequent responses from the remote device, and 5) by noting the SA associated with any requests received from the remote DNET. Which method is used shall be a local matter.

The local broadcast MAC address may be used in response messages, although it is discouraged. It is preferable that a device note the SA associated with the original request and reuse that SA in the response. For MS/TP networks, in order for MS/TP master devices to use the local broadcast MAC address in a response, a Reply Postponed MAC frame shall be sent in response to the BACnet Data Expecting Reply frame and the response may then be sent when the MS/TP master device receives the token. MS/TP slave devices are unable to use the local broadcast MAC address for responses because they never receive the token.

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6.5.4 Network Layer Procedures for the Receipt of Remote Traffic

Upon receipt of an NPDU from the data link layer (conveyed by the 'data' parameter of the DL-UNITDATA indication primitive) whose first octet indicates BACnet version one, the NE shall interpret the second octet of the NPDU as control NPCI. If the NPCI control octet indicates the presence of a DNET field whose value is not X'FFFF' and the NE resides in a BACnet device that is not a router, the message shall be discarded. If the NPCI control octet indicates the presence of a DNET field and the NE resides in a BACnet router, it shall place the NPDU in its message queue (or queues, if separate queues are maintained for each DNET), arranged in order by priority. Within each priority, the messages shall be arranged in first-in-first-out order. If the NPCI control octet indicates that the NPDU contains a network layer message, the NE shall, in addition, inspect the Message Type field. If this field indicates the presence of a Reject-Message-To-Network message, the NE shall carry out the processing specified in 6.6.3.5. If the SNET and SADR fields are present, the message has arrived from a peer router. If the SNET and SADR fields are absent, the message originated on a network directly connected to the router. In the latter case, the router shall add the SNET and SADR to the NPCI based on the router's knowledge of the network number of the network from which the message arrived, alleviating the requirement that the originating station know its own network number. The SADR field shall be set equal to the SA of the incoming NPDU.

Three possibilities exist: either the router is directly connected to the network referred to by DNET, the message must be relayed to another router for further transmission, or a global broadcast is required. In the first case, DNET, DADR, and Hop Count shall be removed from the NPCI and the message shall be sent directly to the destination device with DA set equal to DADR. The control octet shall be adjusted accordingly to indicate only the presence of SNET and SADR. In the second case, if the Hop Count is greater than zero, the message shall be sent to the next router on the path to the destination network. If the next router is unknown, an attempt shall be made to identify it using a Who-Is-Router-To-Network message. If the Hop Count is zero, then the message shall be discarded. If the DNET global broadcast network number is present and the Hop Count is greater than zero, the router shall broadcast the message on each network to which the router is directly connected, except the network of origin, using the broadcast address appropriate to each data link. If the DNET global broadcast network number is present and the Hop Count is zero, then the message shall be discarded.

6.6 BACnet Routers

BACnet routers are devices that interconnect two or more BACnet networks to form a BACnet internetwork. A router may, or may not, provide BACnet application layer functionality. BACnet routers make use of BACnet network layer protocol messages to maintain their routing tables. Routers perform the routing tasks described in 6.5. See Figure 6-12 for a flow chart of router operation.

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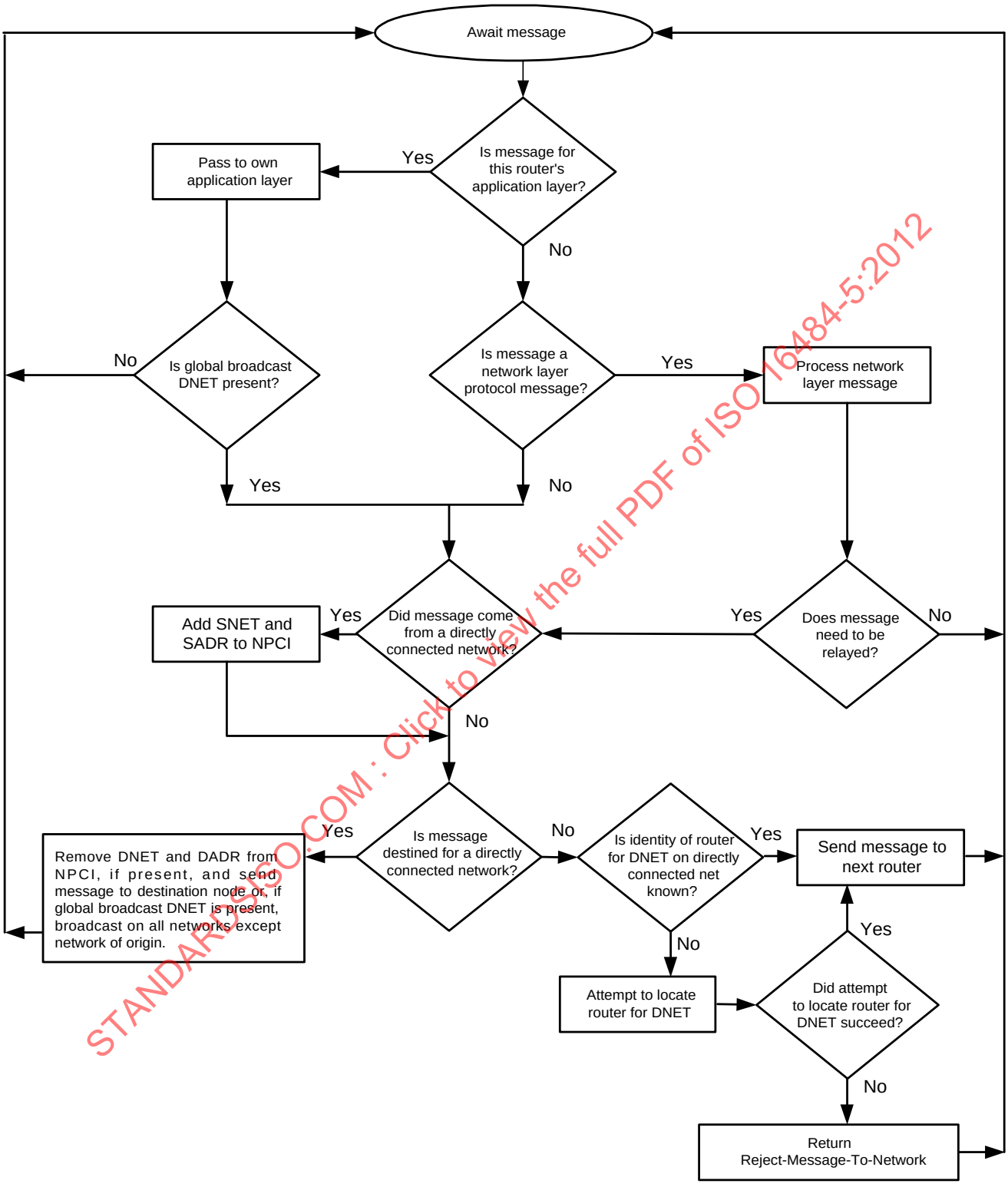

Figure 6-12. BACnet message routing.

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6.6.1 Routing Tables

By definition, a router is a device that is connected to at least two BACnet networks. Each attachment is through a "port." A "routing table" consists of the following information for each port:

(a) the MAC address of the port's connection to its network;

(b) the 2-octet network number of the directly connected network;

(c) a list of network numbers reachable through the port along with the MAC address of the next router on the path to each network number and the reachability status of each such network.

The "reachability status" is an implementation-dependent value that indicates whether the associated network is able to receive traffic. The reachability status shall be able to distinguish, at a minimum, between "permanent" failures of a route, such as might result from the failure of a router, and "temporary" unreachability due to the imposition of a congestion control restriction.

6.6.2 Start-up Procedures

Upon start-up, each router shall broadcast out each port an I-Am-Router-To-Network message containing the network numbers of each accessible network except the networks reachable via the network on which the broadcast is being made. This enables routers to build or update their routing table entries for each of the network numbers contained in the message.

6.6.3 Router Operation

This subclause describes the operation of BACnet routers.

6.6.3.1 BACnet NPDUs - General

If a BACnet NPDU is received with NPCI indicating that the message should be relayed by virtue of the presence of a non-broadcast DNET, the router shall search its routing table for the indicated network number. Normal routing procedures are described in 6.5. If, however, the network number cannot be found in the routing table or through the use of the Who-Is-Router-To-Network message, the router shall generate a Reject-Message-To-Network message and send it to the node that originated the BACnet NPDU. If the NPCI indicates either a remote or global broadcast, the message shall be processed as described in 6.3.2.

6.6.3.2 Who-Is-Router-To-Network

This message may be generated by a non-routing BACnet node or by a BACnet router. If the message is broadcast with a specific network number, one I-Am-Router-To-Network message should be returned at most, originating at the router on the local network that is the next router to the specified destination network. If the 2-octet network number is omitted, each responding router shall reply with an I-Am-Router-To-Network message containing all networks reachable through it, including those that may be temporarily unreachable due to the imposition of a congestion control restriction and excluding the networks reachable through the port from which the Who-Is-Router-To-Network message was received. Who-Is-Router-To-Network will generally be broadcast but may be directed to a specific router to learn the contents of its router table. In the event a router receives multiple I-Am-Router-To-Network messages pertaining to the same network, the router shall assume that each new I-Am-Router-To-Network message represents a modification in the system configuration and shall update its routing information. If the router has an established PTP connection (see Clause 10) that conflicts with this new information, the PTP connection shall be terminated using the disconnect procedures defined in Clause 10. Thus the last message received shall take precedence over all previous messages.

When a router receives a Who-Is-Router-To-Network message specifying a particular network number, it shall search its routing table for the network number contained in the message. If the specified network number is found in its table and the port through which it is reachable is not the port from which the Who-Is-Router-To-Network message was received, the router shall construct an I-Am-Router-To-Network message containing the specified network number and send it to the node that generated the request using a broadcast MAC address, thus allowing other nodes on this network to take advantage of the routing information.

If the network number is not found in the routing table, the router shall attempt to discover the next router on the path to the indicated destination network by generating a Who-Is-Router-To-Network message containing the specified destination network number and broadcasting it out all its ports other than the one from which the Who-Is-Router-To-Network message

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arrived. Two cases are possible. In case one the received Who-Is-Router-To-Network message was from the originating device. For this case, the router shall add SNET and SADR fields before broadcasting the subsequent Who-Is-Router-To-Network. This permits an I-Could-Be-Router-To-Network message to be directed to the originating device. The second case is that the received Who-Is-Router-To-Network message came from another router and it already contains SNET and SADR fields. For this case, the SNET and SADR shall be retained in the newly generated Who-Is-Router-To-Network message.

If the Who-Is-Router-To-Network message does not specify a particular destination network number, the router shall construct an I-Am-Router-To-Network message containing a list of all the networks it is able to reach through other than the port from which the Who-Is-Router-To-Network message was received and transmit it in the same manner as described above. The message shall list all networks not flagged as permanently unreachable, including those that are temporarily unreachable due to the imposition of congestion control restrictions. Networks that may be reachable through a PTP connection shall be listed only if the connection is currently established.

6.6.3.3 I-Am-Router-To-Network

At router start-up, each router shall broadcast locally an I-Am-Router-To-Network message on each directly connected network as specified in 6.6.2. Each such message shall list each accessible network number except the number of the network on which the broadcast is being made. This broadcast allows other routers to update their routing tables whenever a new router joins the internetwork. In addition, an I-Am-Router-To-Network message shall be broadcast locally upon the receipt of a Who-Is-Router-To-Network message containing a network number matching a network number contained in the router's routing table, provided that the port through which it is reachable is not the port from which the Who-Is-Router-To-Network message was received.

If one or more of the reachable networks listed in the I-Am-Router-To-Network message is reached through a directly connected PTP connection, transmitting the I-Am-Router-To-Network message shall start or restart a connection termination delay timer. The PTP connection shall not be terminated before this delay timer expires. The connection termination delay timer shall be configurable with a default value of sixty seconds.

Upon receipt of an I-Am-Router-To-Network message, the router shall search its routing table for entries corresponding to each network number contained in the message. If no entry is found for a particular network number, a new entry shall be created. If an entry is found but the MAC address or port of the next router on the path to the indicated network differs from that found in the table, the MAC address in the table shall be replaced with that of the router originating the I-Am-Router-To-Network message. This ensures that all routers will have the most current information in their tables. Whether the router table was updated or not, the router shall then generate an I-Am-Router-To-Network message for all the network numbers contained in the received I-Am-Router-To-Network message and broadcast the new message, using the local broadcast MAC address, out all ports other than the one from which the previous message was received.

6.6.3.4 I-Could-Be-Router-To-Network

This message is generated by a half-router in response to a Who-Is-Router-To-Network message containing a specific 2-octet network number when the responding half-router has the capability of establishing a PTP connection that can be used to reach the desired network but this PTP connection is not currently established. In the event that a Who-Is-Router-To-Network message is received in which the 2-octet network number field is absent, such as is used to determine lists of networks reachable through active routers, the I-Could-Be-Router-To-Network message shall not be returned. The I-Could-Be-Router-To-Network message shall be directed to the device that originated the Who-Is-Router-To-Network message. The procedures to be used to establish a PTP connection are described in 6.7 and Clause 10.

6.6.3.5 Reject-Message-To-Network

Reject-Message-To-Network is generated by a router when it receives a message that it is unable to relay to the DNET specified in the NPCI or if it receives an unknown network layer message directed specifically to that router. The reasons for rejecting the message are set forth in 6.4.4.

When a router receives a Reject-Message-To-Network message with a rejection reason octet containing a value of 1or 2, it shall search its routing table for the network number specified in the Reject-Message-To-Network message. If the network number is found, the status information for this network number shall be updated to indicate that the network is permanently unreachable if the reject reason was 1 or unreachable due to flow control if the reject reason was 2. In addition, regardless of the contents of the rejection reason octet, the router shall relay the message in the normal manner to the originating node

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specified in the NPCI using the procedures of 6.5. A rejection reason of 1 is to be considered a serious error condition and should be reported to a local or remote network management entity. The nature of this reporting procedure is a local matter.

6.6.3.6 Router-Busy-To-Network

If a router wishes to curtail the receipt of messages for specific DNETs or all DNETs, it shall generate a Router-Busy-To-Network message.

If a router temporarily wishes to receive no more traffic for one or more specific DNETs, it shall broadcast a Router-Busy-To-Network message with a list of the 2-octet network numbers corresponding to these DNETs. If the 2-octet network numbers are omitted, it means the router wishes to stop the flow of messages to all the networks it normally serves.

Each router receiving a Router-Busy-To-Network message shall update its routing table to indicate that the specified DNETs are not reachable, set or reset a 30-second timer for this status, and broadcast a Router-Busy-To-Network message out each port other than the one on which it was received so that all routers may learn of the congestion control restriction. The congestion control indication shall be cleared upon expiration of the 30-second timer. Upon receiving a message whose destination is on one of the temporarily unreachable DNETs, a router shall send a Reject-Message-To-Network message with a reject reason of 2 to the originating node.

Normally, a Router-Busy-To-Network message should be followed in a short time by a Router-Available-To-Network message indicating that the congestion control restriction has been lifted. In the event that a router receives a message while it is still requiring congestion control and the router is able to accept the message, it shall do so and, at its discretion, again broadcast a Router-Busy-To-Network message for the benefit of this node and any others that may not have received the previous transmission. If the router is unable to accept the message, it shall immediately return a Reject-Message-To-Network to the sender. It may then also broadcast another Router-Busy-To-Network message for the reasons cited above.

6.6.3.7 Router-Available-To-Network

When a router wishes to re-enable the receipt of messages for a specific list of DNETs, or all DNETs, previously curtailed by a Router-Busy-To-Network message, it shall broadcast a Router-Available-To-Network message. If the message is broadcast with a list of 2-octet network numbers, it means that the router is now able to receive traffic for these specific DNETs. If the 2-octet network numbers are omitted, the router wishes to re-enable the flow of messages to all the networks it serves.

Each router receiving a Router-Available-To-Network message shall update its routing table to indicate that the specified DNETs are now reachable and broadcast a Router-Available-To-Network message out each port other than the one on which it arrived so that all routers may learn of the lifting of the congestion control restriction.

6.6.3.8 Initialize-Routing-Table

The Initialize-Routing-Table message is generated by any node that has been programmed to provide the initial routing table information to one or more BACnet routers or wishes to query the contents of the current routing tables. The establishment of the contents of the routing table and the circumstances under which Initialize-Routing-Table messages are generated are local matters. In addition, an Initialize-Routing-Table message with Number of Ports set equal to zero shall cause the responding device to return its complete routing table in an Initialize-Routing-Table-Ack message without updating its routing table.

When a router receives this message containing a routing table, indicated by a non-zero value in the Number of Ports field, it shall update its current port-to-network-number mappings for each network specified in the NPDU with the information contained in the NPDU and return an Initialize-Routing-Table-Ack message without any routing table data to the source. When a router receives this message in the form of a routing table query, indicated by a zero value in the Number of Ports field, it shall return an Initialize-Routing-Table-Ack message to the source containing a complete copy of its routing table as described in 6.6.3.9.

6.6.3.9 Initialize-Routing-Table-Ack

This message is sent by a router after the reception and servicing of an Initialize-Router-Table message. If the router is acknowledging a table update message, signified by a non-zero value in the Number of Ports field, it shall return an Initialize-Routing-Table-Ack without data. If the router is acknowledging a table query message, indicated by a zero value in the Number of Ports field, it shall return a complete copy of its routing table. If a complete copy of the table cannot be returned in a single acknowledgment, the router shall send multiple acknowledgments, each containing a portion of the routing table until the entire table has been sent.

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6.6.3.10 Establish-Connection-To-Network

Upon receipt of an Establish-Connection-To-Network message, a half-router shall attempt to establish a PTP connection using the procedures described in 6.7 and Clause 10.

6.6.3.11 Disconnect-Connection-To-Network

Upon receipt of a Disconnect-Connection-To-Network message, a half-router shall terminate an established PTP connection using the procedures described in 6.7 and Clause 10.

6.6.4 Router Congestion Control

Routers may wish to temporarily suspend the receipt of messages destined for a specific network or, possibly, all networks. Normally, this would be the result of impending buffer overflow in the router itself but could also occur because of a buffer problem with a downstream router on the path to a particular network. The messages used to impose and remove congestion control restrictions are Router-Busy-To-Network and Router-Available-To-Network. The algorithm for determining that congestion control should be imposed or removed is not specified in this standard but would most likely involve such factors as the percentage of buffer space currently occupied and, possibly, the rate at which new messages have been arriving at the router.

6.7 Point-To-Point Half-Routers

In BACnet networks that are interconnected across PTP connections (as defined in Clause 10), the procedures for half-router establishment and synchronization are different from those for normal routers. This is due to two unique characteristics of this type of connection. First, since a PTP connection may be established over a wide area network, such as the public telephone network, it is sometimes advantageous to limit the duration of these connections. This causes temporary half-router connections that must be controlled by BACnet. Secondly, PTP connections are always established between two half-routers that together form a single router. A diagram of this router architecture is shown in Figure 6-13. When a connection is established, both half-routers also need to update their routing tables to reflect any new or updated routing information stored by the partner half-router.

To control the link establishment, link termination, and route-learning functions of a PTP half-router, BACnet has defined five network layer messages. The I-Could-Be-Router-To-Network message announces that a half-router has the capability to connect to a requested network but does not have an active connection. The Establish-Connection-To-Network message requests that a connection be established. The Disconnect-Connection-To-Network message requests that an active connection be disconnected. Routing table initialization may be performed using the Initialize-Routing-Table and Initialize-Routing-Table-ACK messages. Thereafter, the half-router maintains its table using the same procedures as other active routers regardless of whether any active PTP connections exist.

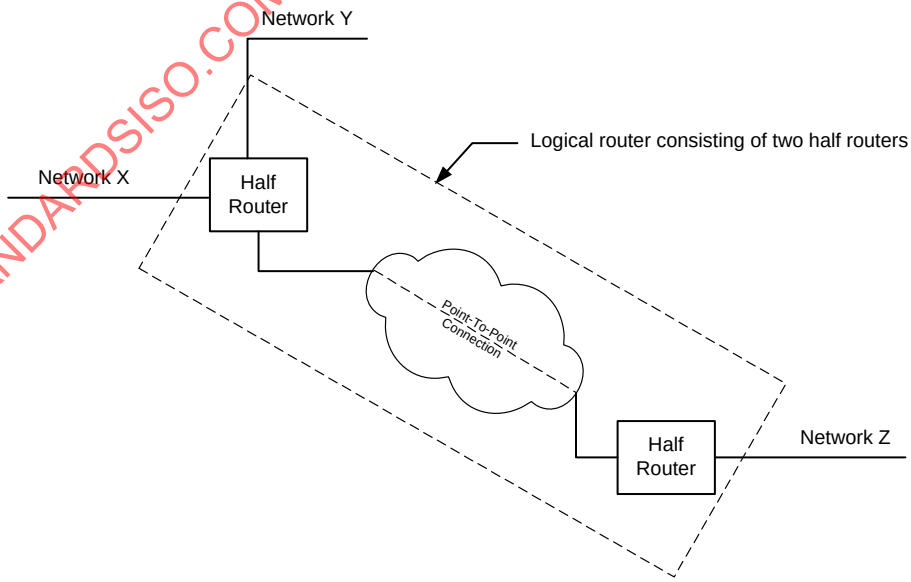

Figure 6-13. Upon a PTP connection, two half-routers combine to become a router.

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6.7.1 Procedures for Establishing a New PTP Connection Between Two Half-Routers

As specified in 6.5.3, one of the methods of establishing the address of a BACnet router for a particular DNET is by having the initiating Network Entity (NE) send a Who-Is-Router-To-Network message for the DNET. A router that has an active connection to the DNET, either directly connected or over an established PTP connection, shall respond with an I-Am-Router-To-Network message. A half-router that does not have an active connection but could initiate a PTP connection to the requested DNET shall respond with an I-Could-Be-Router-To-Network message.

6.7.1.1 Initiating Network Entity (NE) Procedure

To determine a new route, the NE shall issue a Who-Is-Router-To-Network message for the unknown DNET. After a locally specified time period, the initiating NE shall determine the most suitable half-router to the DNET. The algorithm for selecting the most suitable half-router is a local matter. As an aid to help select the most suitable half-router, each I-Could-Be-Router-To-Network message has a 1-octet field to indicate the expected performance of the half router's PTP connection. Upon selection of a suitable half-router, the initiating NE shall send an Establish-Connection-To-Network message to this half-router and wait to receive an I-Am-Router-To-Network message for this DNET. When the I-Am-Router-To-Network message is received, the initiating NE may send NPDUs for this DNET. If, after a locally specified time period, an I-Am-Router-To-Network message is not received by the initiating NE, the initiating NE shall send a Disconnect-Connection-To-Network to the selected half-router and may try this procedure again to find another half-router.

6.7.1.2 Initiating Half-Router Procedure

Upon receipt of an Establish-Connection-To-Network message, a half-router shall try to establish the requested connection. If the connection is established, the initiating half-router shall forward the Establish-Connection-To-Network message to the answering half-router, synchronize its routing table with the routing table of the answering half-router partner using the procedures in 6.7.3, broadcast an I-Am-Router-To-Network message containing all of the DNETs accessible through the answering half-router to all directly connected networks, and start an activity timer (T_{active}).

When the connection is established, the initiating half-router shall adjust its routing table to indicate that any DNETs accessible from the answering half-router have a "reachability status" that is "reachable" and continue with other normal operations.

If the connection cannot be established, the initiating half-router shall adjust its routing table to indicate that any DNETs accessible from the answering half-router have a "reachability status" that is "temporarily unreachable" and continue with other normal operations. If a Disconnect-Connection-To-Network message is received, the half-router shall ignore the message.

If the connection is in the process of being established and a Disconnect-Connection-To-Network message is received, the half-router shall immediately end the connection establishment procedure.

If the connection is in the process of being established and a Who-Is-Router-To-Network message is received for a DNET accessible through the PTP connection, the half-router shall respond with an I-Am-Router-To-Network, followed by a Router-Busy-To-Network message. If a message is received for the DNET before the connection is established, it shall be rejected with a rejection reason = 2. When the connection is established, the initiating half-router shall issue a Router-Available-To-Network message. If the connection cannot be established, the half-router shall issue a Router-Available-To-Network message but reject, with a rejection reason = 1, any message received for the DNET. The reason for rejecting the message is to expedite error handling.

If the connection is in the process of being established and a I-Am-Router-To-Network message is received for the DNET to which the initiating half-router is attempting a connection, the connection establishment shall be immediately terminated.

If the connection is in the process of being established and an Establish-Connection-To-Network message to the same DNET is received, the Termination Time Value shall be evaluated. If the new Termination Time Value is greater than the Termination Time Value of the original Establish-Connection-To-Network message, the new Termination Time Value shall be used by the Activity Timer. The connection process shall then proceed normally.

6.7.1.3 Answering Half-Router Procedure

Upon connection establishment from a PTP half-router, the answering half-router shall set an activity timer (T_{active}) based upon a received Establish-Connection-To-Network message from the initiating half-router, synchronize its routing table with

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the routing table of the initiating half-router partner using the procedures in 6.7.3, and broadcast an I-Am-Router-To-Network message containing all of the DNETs accessible through the initiating half-router to all directly connected networks. If the connection is terminated, the answering half-router's routing table shall be adjusted to indicate that any DNET accessible from the initiating half-router has a "reachability status" that is "temporarily unreachable," if the answering half-router is able to re-establish the connection or "permanently unreachable" if the answering half-router is unable to re-establish the connection. If the connection is established, the answering half-router's routing table shall be adjusted to indicate that any DNET accessible from the initiating half-router has a "reachability status" that is "reachable."

6.7.1.4 Activity Timer (T_{active})

The activity timer (T_{active}) is the time that a half-router shall wait for the absence of any messages being routed over its PTP connection before it attempts to automatically disconnect the connection. This timer shall be set to the Termination Time Value field from the Establish-Connection-To-Network message. If the Termination Time Value is set to zero, the activity time shall be considered infinite.

6.7.1.4.1 Initiating Half-Router Procedure

Upon receipt of an Establish-Connection-To-Network message, an initiating half-router shall set the activity timer (T_{active}) to the Termination Time Value field from the Establish-Connection-To-Network message. If the Termination Time Value is set to zero, the activity time shall be considered infinite.

6.7.1.4.2 Answering Half-Router Procedure

Upon receipt of an Establish-Connection-To-Network message from the initiating half-router, the answering half-router shall set the activity timer (T_{active}) to the Termination Time Value field from the Establish-Connection-To-Network message. If the Termination Time Value is set to zero, the activity time shall be considered infinite.

6.7.2 Procedures for Disconnecting a PTP Connection in a Half-Router

There are three bases for disconnecting a PTP connection established by a half-router. The first is by a Network Entity (NE) initiating a Disconnect-Connection-To-Network message. The second is by a timer expiration indicating that the connection has been inactive for an abnormal period of time. The third basis for disconnecting a connection is to compensate for a configuration error. The specification of this procedure is given in 6.7.4.

6.7.2.1 Active Disconnection of a PTP Connection

6.7.2.1.1 Initiating Network Entity (NE) Procedure

If the initiating NE determines that the half-router connection is no longer needed, it may send a Disconnect-Connection-To-Network message to the half-router. The routing table entry for this DNET shall be immediately set to "disconnected."

6.7.2.1.2 Initiating/Answering Half-Router Procedure

Upon receipt of a Disconnect-Connection-To-Network message, a half-router shall disconnect the PTP connection as specified in Clause 10. When the connection is terminated, the half-router shall adjust its routing table to indicate that any DNETs accessible from the previously connected half-router have a "reachability status" that is "temporarily unreachable" if the half-router is able to re-establish the connection, or "permanently unreachable" if the half-router is unable to re-establish the connection.

6.7.2.2 Timed Disconnection of a PTP Connection

If the activity timer (T_{active}) expires, a half-router shall disconnect the PTP connection as specified in Clause 10. When the connection is terminated, the half-router shall adjust its routing table to indicate that any DNETs accessible from the previously connected half-router have a "reachability status" that is "temporarily unreachable" if the half-router is able to re-establish the connection, or "permanently unreachable" if the half-router is unable to re-establish the connection.

6.7.2.3 Restarting of the Activity Timer (T_{active})

The Activity Timer (T_{active}) in each half-router shall be restarted to its original value contained in the initiating Establish-Connection-To-Network whenever an NPDU is transferred over the PTP link.

6.7.3 Procedures for Synchronizing Half-Router Routing Tables

Upon the establishment of a PTP connection between two half-routers, the routing tables of the half-routers shall be synchronized. This is accomplished using the I-Am-Router-To-Network message.

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Upon connection establishment, the two half-routers shall exchange I-Am-Router-To-Network messages. Each message shall contain all of the reachable (before the connection was established) DNETs connected through this router. In the event that a duplicate network connection is discovered by the procedure specified in 6.7.4.2, synchronization of routing tables shall fail, causing the routing table entry for any DNET accessible from the peer half-router to have a reachability status of "temporarily unreachable."

6.7.4 Error Recovery Procedures

6.7.4.1 Recovering from Routing Requests to Unconnected Networks

Since PTP connections may be temporary in nature, there is a possibility that a half-router may receive a message bound for a DNET connection that has been disconnected. If another route is not in place through a different port than the one from which the message was received, this is considered an error. To recover from this situation, the receiving half-router shall reject this message with a Reject-Message-To-Network message using rejection reason = 1. The initiating Network Entity shall recover from this error by initiating the procedure for establishing a new PTP connection through a half-router as described in 6.7.1.

6.7.4.1.1 Disconnected Half-Router Procedure

Upon receipt of a message that is requested to be routed across a PTP connection that is disconnected, the half-router shall determine if another route is in place. If no other route is in place or if the next hop of this route is identical to the path from which the message was received, the half-router shall issue a Reject-Message-To-Network for this message with a rejection reason = 1 and discard the message. If another acceptable route is in place, the message shall be forwarded on this route.

6.7.4.1.2 Initiating Network Entity (NE) Procedure

If the initiating NE receives a Reject-Message-To-Network, it shall attempt to determine a new route to the DNET after waiting for a random back-off period. The random back-off period, in seconds, is determined by the initiating NE through the generation of a random number of either 0 or 1 and then multiplying this number by 40. The initiating NE shall not try to re-establish the network connection until the back-off period has expired. If during the back-off period the initiating NE learns of a valid route to the required DNET, the initiating NE shall use this path and consider the network connection re-established. Upon expiration of the back-off period, if the network connection has not been re-established, the initiating NE shall attempt to determine a new route to the DNET using the procedure for establishing a new PTP connection through a half-router as described in 6.7.1.

6.7.4.2 Recovering from Duplicate Network Connections

In the unlikely event that two or more PTP connections are made to single DNET, at least one of the connections shall be terminated and the routing tables in all routers shall be made consistent. The procedure to ensure that no loop exists consists of having every half-router examine each received I-Am-Router-To-Network message for another path to any of the half-router's directly connected networks. The existence of a second path to a directly connected network indicates that a loop is formed. If a loop is detected, the half-router shall disconnect its PTP connection thereby breaking the loop.

6.7.4.2.1 Half-Router Procedure for Receipt of Conflicting I-Am-Router-To-Network Messages

If during the initialization or lifetime of a PTP connection a half-router hears an I-Am-Router-To-Network message from the PTP connection containing a DNET to one of the half-router's directly connected networks, the half-router shall immediately terminate the connection.

6.7.4.2.2 Half-Router Procedure for Initiation of I-Am-Router-To-Network Messages

As an added safety measure to ensure that duplicate paths are discovered in a timely manner, a half-router shall broadcast one or more I-Am-Router-To-Network message(s) once every five minutes when a PTP connection is in place. The DNETs in this message shall be all of the DNETs accessible through the PTP connection. In the event this list of DNETs would exceed the maximum NPDU length of the network being utilized, the list shall be divided into segments that fit on the network and sent in consecutive I-Am-Router-To-Network messages.

6.7.4.2.3 Half-Router Procedure for Decrementing the Hop Count

To reduce the number of circularly routed messages in a misconfigured system, BACnet NPDUs contain a hop count that limits the number of routers that shall forward the NPDU. In routers that provide the capability to configure the amount that the Hop Count field shall be decremented when an NPDU is forwarded, a network administrator may optimize the damping

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of looping messages. One method to do this is to find the path in the network that requires the maximum number of router hops. The amount to decrement the NPDU Hop Count field in every router on the network is then calculated as the integer division of 255/(maximum number of router hops). On a PTP connection, the half of the router that forwards the NPDU onto a non-PTP network shall decrement the Hop Count field.

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7 DATA LINK/PHYSICAL LAYERS: ISO 8802-3 ("Ethernet") LAN

This clause describes the transport of BACnet LSDUs using the services of the data link and physical mechanisms described in International Standards ISO 8802-2: *Information processing systems- Local area networks- Part 2: Logical link control* and ISO/IEC 8802-3: *Information processing systems- Local area networks- Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*. The clauses of ISO 8802-2 pertaining to Class I LLC and Type 1 Unacknowledged Connectionless-Mode Service as well as all of ISO/IEC 8802-3, as amended and extended by the International Organization for Standardization, are deemed to be included in this standard by reference.

7.1 The Use of ISO 8802-2 Logical Link Control (LLC)

Standard BACnet networks may pass BACnet link service data units (LSDUs) using the data link services of ISO 8802-2 Logical Link Control (LLC). A BACnet LSDU consists of an NPDU constructed as described in Clause 6. BACnet devices using ISO 8802-3 LAN technology shall conform to the requirements of LLC Class I, subject to the constraints specified in this clause. Class I LLC consists of Type 1 LLC - Unacknowledged Connectionless-Mode service. LLC parameters shall be conveyed using the DL-UNITDATA primitives as described in the referenced standards.

All BACnet devices conforming to this section shall be capable of accepting properly formed Unnumbered Information (UI) commands and responding to XID Exchange Identification and TEST commands.

7.2 Parameters Required by the LLC Primitives

The DL-UNITDATA primitive requires source address, destination address, data, and priority parameters. The source and destination addresses each consist of the logical concatenation of a medium access control (MAC) address and a link service access point (LSAP). The MAC address is a 6-octet value determined by the network interface hardware. The LSAP is the single-octet value X'82' and is used to indicate that an LSDU contains BACnet data. The data parameter is the NPDU from the network layer. Since the ISO 8802-3 MAC layer only operates at a single priority with only one class of service, the value of the priority parameter is not specified in this standard.

7.3 Parameters Required by the MAC Primitives

The ISO/IEC 8802-3 MAC layer primitives are the MA-DATA.request and MA-DATA.indication. These convey the encoded LLC data using the source and destination MAC addresses described above. Again, since only one class of service is provided, the value of the 'service_class' parameter is unspecified. See Figure 7-1.

7.4 Physical Media

The physical media specified by ISO 8802-3 and subsequent addenda are equally acceptable.

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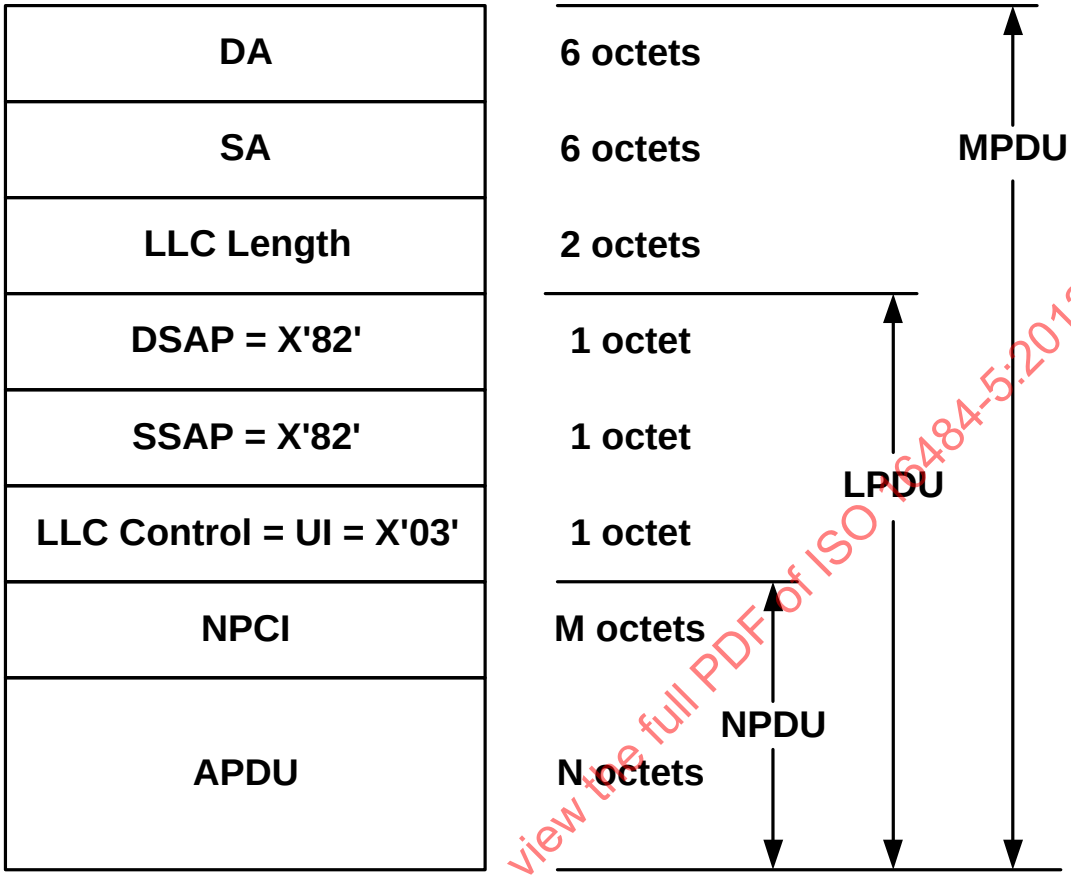

Figure 7-1. Format of an MPDU on an ISO 8802-3 LAN.

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8 DATA LINK/PHYSICAL LAYERS: ARCNET LAN

This clause describes the transport of BACnet LSDUs using the services of the data link and physical mechanisms described in ATA 878.1, *ARCNET Local Area Network Standard*. The *ARCNET Local Area Network Standard*, as amended and extended by the ARCNET Trade Association, is deemed to be included in this standard by reference.

8.1 The Use of ISO 8802-2 Logical Link Control (LLC)

Standard BACnet networks may pass BACnet link service data units (LSDUs) using the data link services of ISO 8802-2 LLC. A BACnet LSDU consists of an NPDU constructed as described in Clause 6. BACnet devices using ARCNET LAN technology shall conform to the requirements of LLC Class I, subject to the constraints specified in this clause. Class I LLC service consists of Type 1 LLC - Unacknowledged Connectionless-Mode service. LLC parameters shall be conveyed using the DL-UNITDATA primitives as described in the referenced standards.

The mapping of these primitives onto the ARCNET MAC layer primitives is described in 8.3.

All BACnet devices conforming to this section shall be capable of accepting and responding to XID Exchange Identification and TEST commands.

8.2 Parameters Required by the LLC Primitives

The DL-UNITDATA primitive requires source address, destination address, data, and priority parameters. The source and destination addresses each consist of the logical concatenation of a medium access control (MAC) address, link service access point (LSAP), and a system code (SC). The MAC address is a 1-octet value determined by the network interface hardware; the LSAP used to indicate that an LSDU contains BACnet data is the single octet value X'82'; and the SC used to indicate a BACnet frame is the single-octet value X'CD'. The data parameter is the NPDU from the network layer. Since the ARCNET MAC sublayer only operates at a single priority with only one class of service, the value of the priority parameter is not specified in this standard.

8.3 Mapping the LLC Services to the ARCNET MAC Layer

The Type 1 Unacknowledged Connectionless LLC service shall map directly onto the ARCNET MA_DATA request primitive. Although a successful transmission results in an acknowledgment from the destination MAC sublayer, no indication is expected, or provided, to the LLC sublayer.

ARCNET does not permit MSDUs of length 253, 254, or 255 octets. A BACnet LPDU of length 0 to 252 octets shall be conveyed as the entire MSDU of an ARCNET MPDU (frame) with a single Information length (IL) octet. A BACnet LPDU of length 253 to 504 octets shall be conveyed as the initial octets of the MSDU of an ARCNET MPDU with two Information length (IL) octets. In this case, the LPDU shall be followed by three octets of unspecified value, such that the net length of the MSDU is 256 to 507 octets. When an ARCNET MPDU with two Information length octets is received, the final 3 octets of the MSDU shall be ignored.

An LPDU longer than 504 octets cannot be conveyed via ARCNET.

8.4 Parameters Required by the MAC Primitives

The ARCNET MAC layer primitives are MA-DATA.request, MA-DATA.indication, and MA-DATA.confirmation. These convey the encoded LLC data (MSDU) using the source and destination MAC addresses described above in conjunction with the BACnet system code. See Figure 8-1.

8.5 Physical Media

The physical media specified by the ARCNET standard are equally acceptable.

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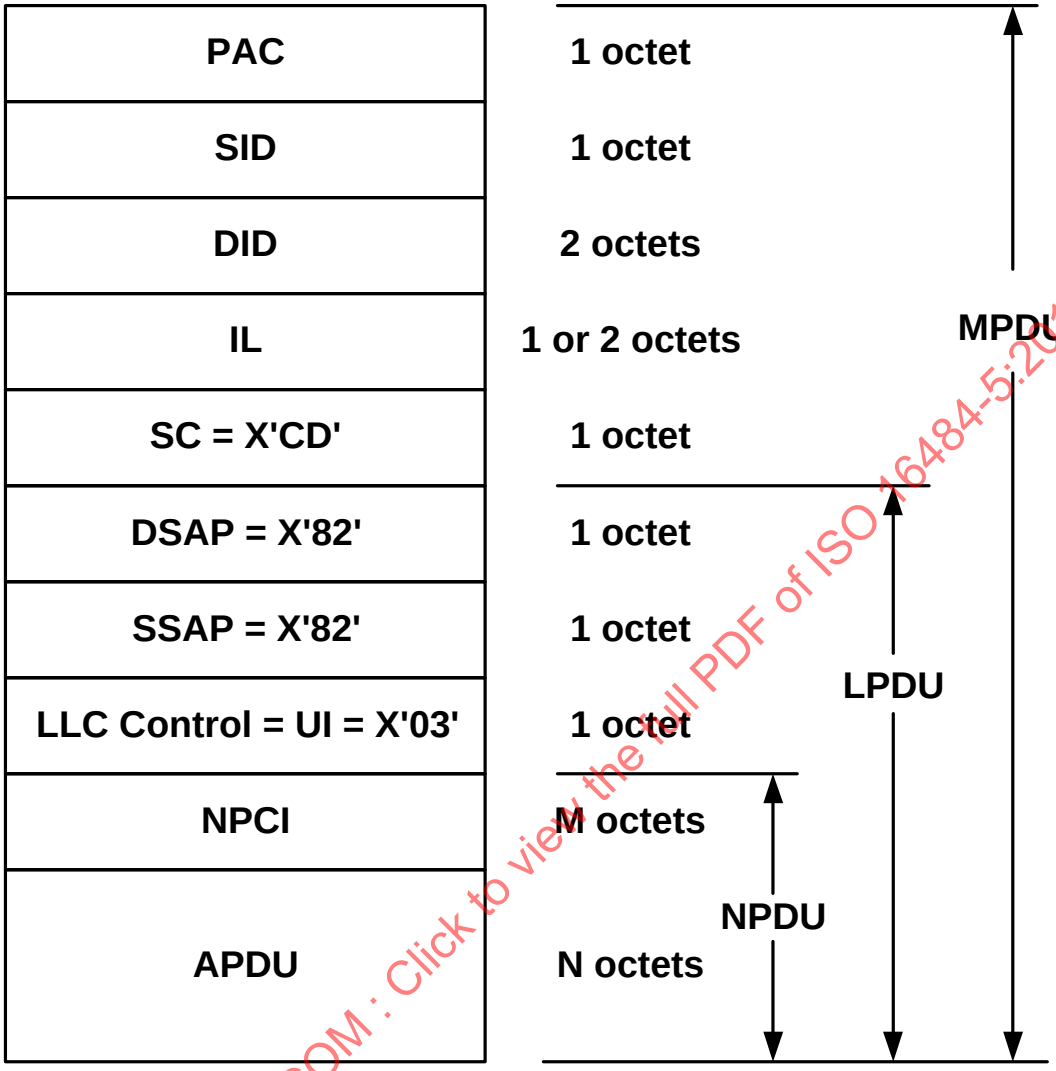

Figure 8-1. Format of an MPDU on an ARCNET LAN.

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9 DATA LINK/PHYSICAL LAYERS: MASTER-SLAVE/TOKEN PASSING (MS/TP) LAN

This clause describes a Master-Slave/Token-Passing (MS/TP) data link protocol, which provides the same services to the network layer as ISO 8802-2 Logical Link Control. It uses services provided by the EIA-485 physical layer. Relevant clauses of EIA-485 are deemed to be included in this standard by reference. The following hardware is assumed:

(a) A UART (Universal Asynchronous Receiver/Transmitter) capable of transmitting and receiving eight data bits with one stop bit and no parity.

(b) An EIA-485 transceiver whose driver may be disabled.

(c) A timer with a resolution of five milliseconds or less.

9.1 Service Specification

MS/TP is not intended to be a general purpose LAN under ISO 8802-2. Instead, MS/TP includes a data link layer sufficient to provide to the BACnet network layer the same services as are offered by ISO 8802-2 Type 1.

This subclause describes the primitives and parameters associated with the provided services. The parameters are described in an abstract sense, which does not constrain the implementation method. Primitives and their parameters are described in a form that echoes their specification in ISO 8802-2. This is intended to provide a consistent interface to the BACnet network layer.

9.1.1 DL-UNITDATA.request

9.1.1.1 Function

This primitive is the service request primitive for the unacknowledged connectionless-mode data transfer service.

9.1.1.2 Semantics of the Service Primitive

The primitive shall provide parameters as follows:

```
DL-UNITDATA.request (
                    source_address,
                    destination_address,
                    data,
                    priority,
                    data_expecting_reply
                    )
```

Each source and destination address consists of the logical concatenation of a medium access control (MAC) address and a link service access point (LSAP). For the case of MS/TP devices, since MS/TP supports only the BACnet network layer, the LSAP is omitted and these parameters consist of only the device MAC address.

The 'data' parameter specifies the link service data unit (LSDU) to be transferred by the MS/TP entity.

The 'priority' parameter specifies the priority desired for the data unit transfer. The priority parameter is ignored by MS/TP.

The 'data_expecting_reply' parameter specifies whether or not the data unit to be transferred expects a reply.

9.1.1.3 When Generated

This primitive is passed from the network layer to the MS/TP entity to request that a network protocol data unit (NPDU) be sent to one or more remote LSAPs using unacknowledged connectionless-mode procedures.

9.1.1.4 Effect on Receipt

Receipt of this primitive causes the MS/TP entity to attempt to send the NPDU using unacknowledged connectionless-mode procedures.

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9.1.2 DL-UNITDATA.indication

9.1.2.1 Function

This primitive is the service indication primitive for the unacknowledged connectionless-mode data transfer service.

9.1.2.2 Semantics of the Service Primitive

DL-UNITDATA.indication (
source_address,
destination_address,
data,
priority,
data_expecting_reply
)

Each source and destination address consists of the logical concatenation of a medium access control (MAC) address and a link service access point (LSAP). For the case of MS/TP devices, since MS/TP supports only the BACnet network layer, the LSAP is omitted and these parameters consist of only the device MAC address.

The 'data' parameter specifies the link service data unit that has been received by the MS/TP entity.

The 'priority' parameter specifies the priority desired for the data unit transfer. The priority parameter is ignored by MS/TP.

The 'data_expecting_reply' parameter specifies whether or not the data unit that has been received expects a reply.

9.1.2.3 When Generated

This primitive is passed from the MS/TP entity to the network layer to indicate the arrival of an NPDU from the specified remote entity.

9.1.2.4 Effect on Receipt

The effect of receipt of this primitive by the network layer is unspecified.

9.1.3 Test_Request and Test_Response

ISO 8802-2 Type 1 defines XID and TEST PDUs and procedures but does not define an interface to invoke them from the network layer. Test_Request and Test_Response PDUs and procedures have been defined for MS/TP to accomplish the same functions. Because MS/TP supports only the equivalent of a single LSAP, these PDUs are sufficient to implement the relevant aspects of XID as well.

The response with Test_Response to a received Test_Request PDU is mandatory for all MS/TP nodes. The origination of a Test_Request PDU is optional.

9.1.3.1 Use of Test_Request and Test_Response for ISO 8802-2 TEST Functions

The TEST function provides a facility to conduct loopback tests of the MS/TP to MS/TP transmission path. Successful completion of the test consists of sending a Test_Request PDU with a particular information field to the designated destination and receiving, in return, the identical information field in a Test_Response PDU.

If a receiving node can successfully receive and return the information field, it shall do so. If it cannot receive and return the entire information field but can detect the reception of a valid Test_Request frame (for example, by computing the CRC on octets as they are received), then the receiving node shall discard the information field and return a Test_Response containing no information field. If the receiving node cannot detect the valid reception of frames with overlength information fields, then no response shall be returned.

9.1.3.2 Use of Test_Request and Test_Response for ISO 8802-2 XID Functions

ISO 8802-2 describes seven possible uses of XID:

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(a) XID can be used with a null DSAP and null SSAP as an "Are You There" test. Since MS/TP supports only the equivalent of a single LSAP, the Test_Request PDU with no data can perform this function.

(b) XID can be used with a group or global DSAP to identify group members or all active stations. Since MS/TP supports only the equivalent of a single LSAP, the Test_Request PDU with no data can perform this function.

(c) XID can be used for a duplicate address check. This function is not applicable to MS/TP. EIA-485 token bus networks such as MS/TP will generally not achieve reliable operation if multiple nodes exist with the same address, since collisions will occur during token passing.

(d) Class II LLCs may use XID to determine window size. MS/TP does not support Class II operation.

(e) XID may be used to identify the class of each LLC. Since MS/TP supports only Class I operation, this is a trivial operation.

(f) XID may be used to identify the service types supported by each LSAP. Since MS/TP supports only Class I operation, this is a trivial operation.

(g) An LLC can announce its presence by broadcasting an XID with global DSAP. Since MS/TP supports only one LSAP, the equivalent may be accomplished by broadcasting a Test_Response PDU.

9.2 Physical Layer

9.2.1 Medium

An MS/TP EIA-485 network shall use shielded, twisted-pair cable for data signaling with characteristic impedance between 100 and 130 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot). Distributed capacitance between conductors and shield shall be less that 200 pF per meter (60 pF per foot). Foil or braided shields are acceptable. The maximum recommended length of an MS/TP segment with AWG 18 (0.82 mm^2 conductor area) cable is specified in Clause 9.2.3. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.

9.2.2 Connections and Terminations

The maximum number of nodes per segment shall be 32 (as specified by the EIA-485 standard). Additional nodes may be accommodated by the use of repeaters, as described in 9.9.

Because MS/TP uses NRZ encoding, the polarity of the connection to the cable is important. The non-inverting input of the EIA-485 transceiver is designated in this specification as "plus" or "+" and the inverting input as "minus" or "-". It is recommended, but not required, that the black or red insulated wire of the twisted pair be designated as "plus" and the white, clear, or green insulated wire be designated as "minus." The method of connection between the interface and the cable is not part of this specification.

An MS/TP EIA-485 network shall have no T connections. A termination resistance of 120 ohms plus or minus 5% shall be connected at each of the two ends of the segment medium. No other termination resistors are allowed at intermediate nodes.

Each MS/TP segment shall be provided with network bias resistors, connected as shown in Figure 9-1, such that an undriven communications line will be held in a guaranteed logical one state. The bias provides a reliable way for stations to detect the presence or absence of signals on the line. An unbiased line will take an indeterminate state in the absence of any driving node. Under some conditions, noise or cross-talk might result in some nodes receiving spurious octets from the undriven idle line.

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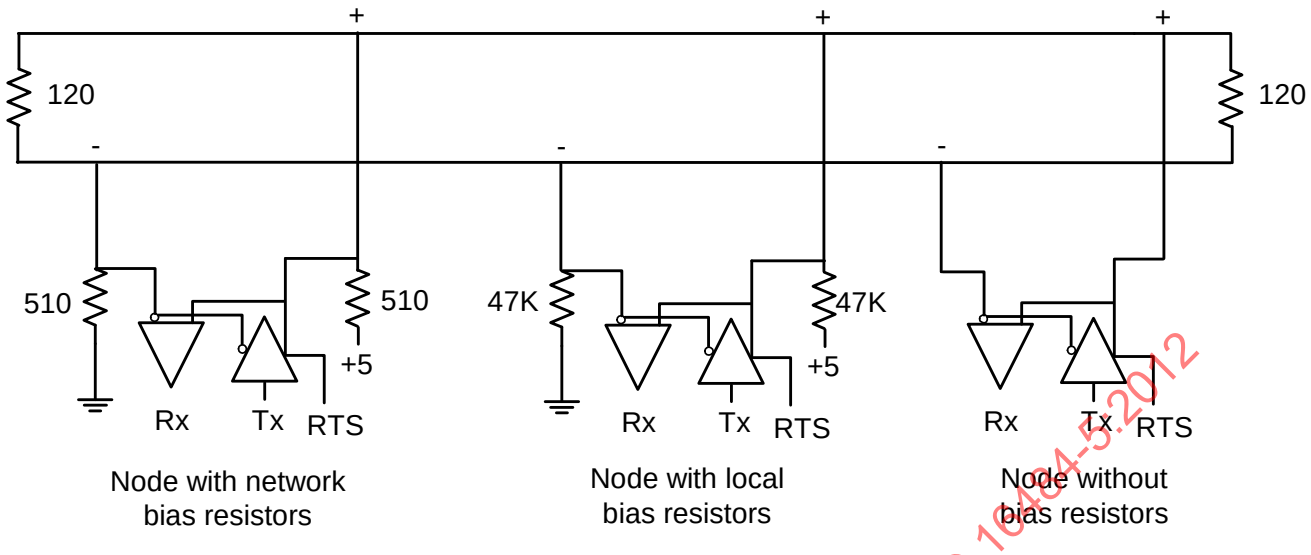

Figure 9-1. EIA-485 network showing three types of nodes.

At least one set, and no more than two sets, of network bias resistors shall exist for each segment. Each set of network bias resistors shall consist of two resistors, each having a value of 510 ohms, plus or minus 5%, connected as shown in Figure 9-1. If two sets of network bias resistors are provided, they shall be placed at two distinct nodes, preferably at the ends of the segment, so that proper bias levels can be maintained even if one of the bias nodes loses power. Other nodes may be provided with local bias resistors as long as each local bias resistor value is 47K ohms or greater. The use of local bias resistors is optional.

For any physical segment that runs between buildings there shall be at least 1500 V of electrical isolation between the EIA-485 signal conductors and the digital ground of any node on that physical segment.

The shield shall be grounded at one end only to prevent ground currents from being created.

9.2.2.1 Device Wiring

There are a variety of permitted device wiring arrangements, depending on the particular needs of the devices used and the installation requirements. Some MS/TP devices are designed with a third-wire Reference connection in addition to the signaling connections and some are two-wire only, depending on the particular application being addressed. All device wiring arrangements shall meet the Connections and Terminations restrictions and requirements described in Clause 9.2.2.

9.2.2.1.1 Single Buildings

Within a single building, there is generally a limited ground voltage offset from one MS/TP device to another, thus permitting a simple installation in most cases. The following clauses describe several common methods for wiring devices within a single building using different device wiring arrangements.

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9.2.2.1.1.1 Twisted-pair Only with Non-isolated Devices

For many installations, a simple twisted pair wire with shield is sufficient to allow reliable communications. In Figure 9-1.1, all of the devices use two-wire connections with the reference level between devices established by an internal earth ground connection made through some impedance (Z) at each device. This is generally the lowest cost solution and is sufficient for installations where electrical noise, ground noise, and stray fields are low. EIA-485 is designed to operate with voltages on the signaling wires between -7 and +12 volts. If the voltage between any two earth ground connections combined with the noise picked up by the twisted pair signaling wire is well within this range, the EIA-485 requirements for signaling levels have been met.

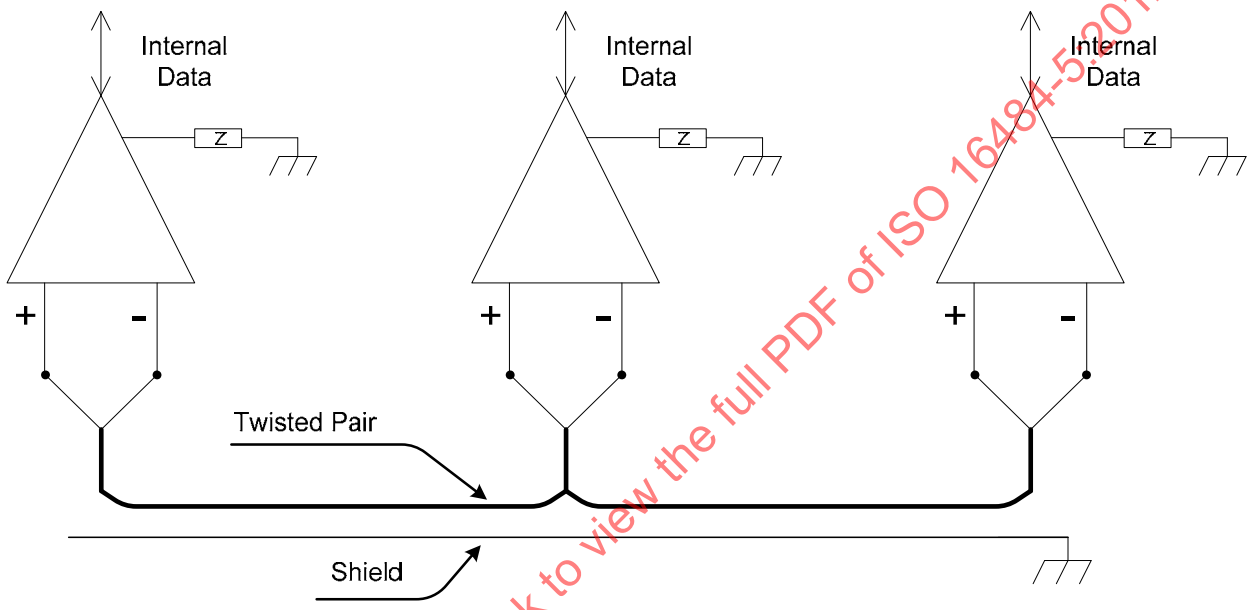

Figure 9-1.1. Simple Twisted Pair with Shield.

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9.2.2.1.1.2 Twisted-pair Only with Mixed Devices

Some EIA-485 devices provide a third-wire reference connection and use internal isolation. The third-wire reference shall be electrically connected to the other devices' reference to meet EIA-485 requirements. When such a device is used in a low-electrical-noise installation, it is sufficient to connect the third-wire reference to earth using a 100 ohm current limiting resistor (R) as shown in Figure 9-1.2. The earth connection may be made using either the shield of the communication cable since it is tied to earth ground at one point (this is the preferred approach) or a local earth grounding point such as the device case. This type of connection does not take full advantage of the electrical noise rejection capability of the third-wire reference.

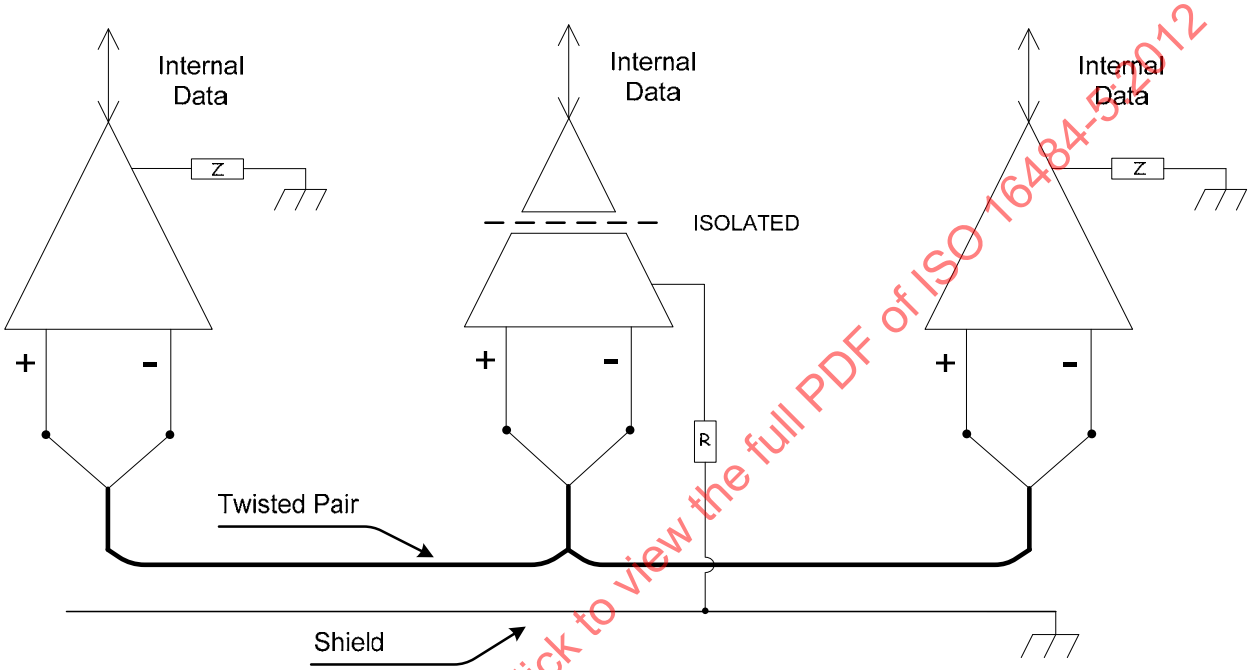

Figure 9-1.2. Mixed Devices on Twisted Pair with Shield.

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9.2.2.1.1.3 Twisted-pair and Reference with Isolated Devices

If the installation exclusively uses EIA-485 devices with third-wire reference connections, electrical noise rejection is best if a third conductor in the same cable is used to connect all of the reference connections together as shown in Figure 9-1.3. This nearly eliminates earth-ground voltage differences and allows the differential input of each EIA-485 device to float with the electrical noise and stray fields picked up by the signal cable, resulting in better noise rejection. If there are more than three wires in the cable chosen, the third conductor shall be made up of all of the extra wires (outside of the twisted pair used for signaling) connected together. If desired, the third-wire reference conductor may be tied to earth ground at one point where electrical noise is low through a 100-ohm current-limiting resistor in order to limit voltage excursions and to simplify adding two-wire devices in the future.

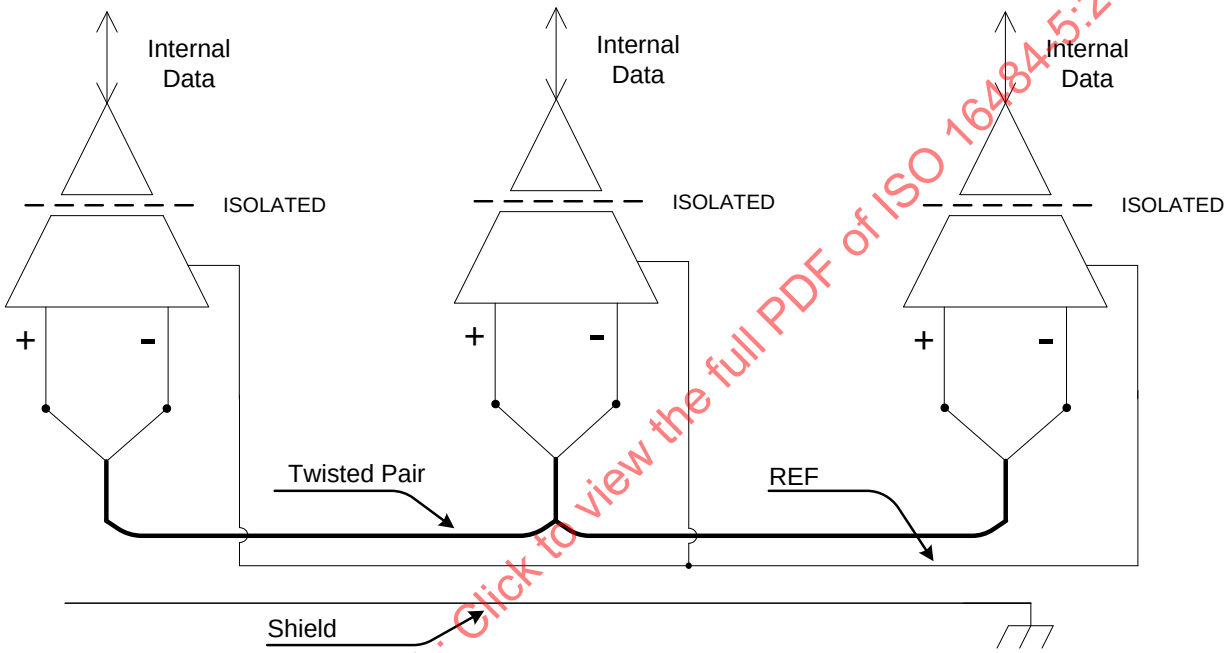

Figure 9-1.3. All Isolated Devices on 3-Conductor Cable with Shield.

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9.2.2.1.1.4 Twisted-pair and Reference with Mixed Devices

If the installation includes a mixture of two-wire non-isolated devices and three-wire isolated devices, they may be used together in the configuration of Figure 9-1.4 if the two-wire devices are installed in areas with low electrical noise or if high levels of electrical noise are generated locally at the three-wire isolated devices and the remainder of the installation is electrically quiet. In this installation, a third conductor in the same cable is used to connect all of the reference connections together. Three-wire devices with a reference connection shall be directly tied to the third conductor and two-wire device reference connections are made indirectly through a single 100-ohm current-limiting resistor tied between the reference conductor and earth ground in a low-noise area, preferably near the supervisory controller.

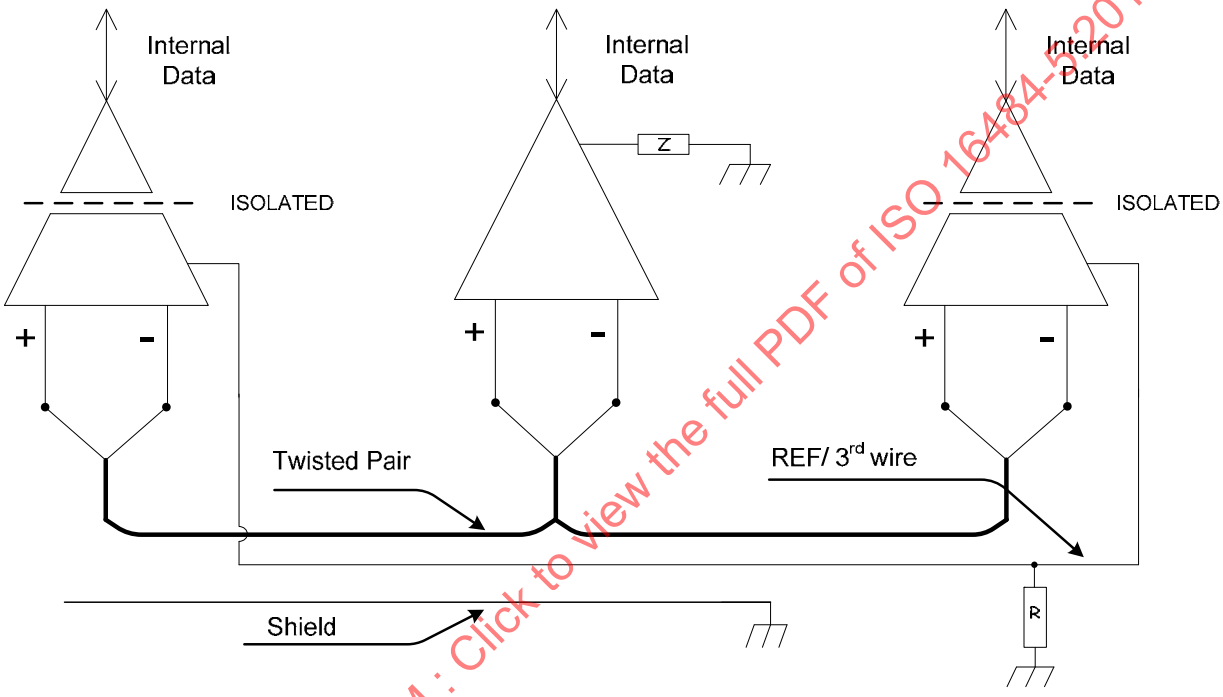

Figure 9-1.4. Mixed Devices on 3-Conductor Cable with Shield.

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9.2.2.1.1.5 Extending Twisted-pair with Reference

If the installation includes existing two-wire non-isolated devices that are to be extended with three-wire isolated devices, they may be connected together in the configuration of Figure 9-1.5. In this installation, a third conductor in the extended cable is used to connect all of the reference connections together. Three-wire devices with a reference connection shall be directly tied to the third conductor and two-wire device reference connections are made indirectly through a single 100-ohm current-limiting resistor tied between the reference conductor and earth ground in a low noise area, preferably where the extended cable is connected to the existing twisted-pair cable.

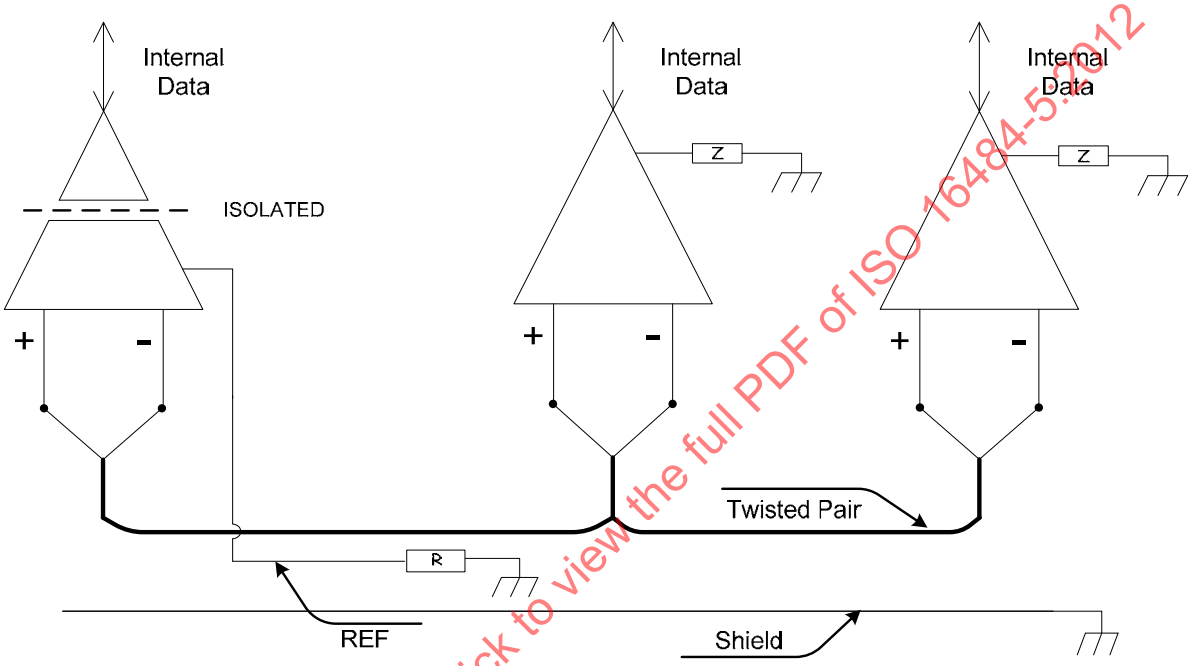

Figure 9-1.5. Extending Existing Twisted-pair with Isolated Devices.

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9.2.2.1.2 Multiple Buildings

Connecting multiple buildings using MS/TP shall have at least 1500 V of electrical isolation as specified in Clause 9.2.2. The following clauses describe ways to provide the required isolation.

9.2.2.1.2.1 Isolated Devices

Installations that connect multiple buildings using a single cable are permitted if the secondary buildings contain only three-wire isolated devices with 1500-volt electrical isolation capability and there are no earth ground connections in the secondary buildings to the reference conductor or the shield as shown in Figure 9-1.6. When the primary building contains only two-wire non-isolated devices, the reference conductor shall be connected to earth ground at one location through a 100-ohm current-limiting resistor (R) in that building and the shield shall be tied to earth ground in a single location in the same building. The use of surge arrestors near each building's cable entrance to protect all of the conductors is recommended.

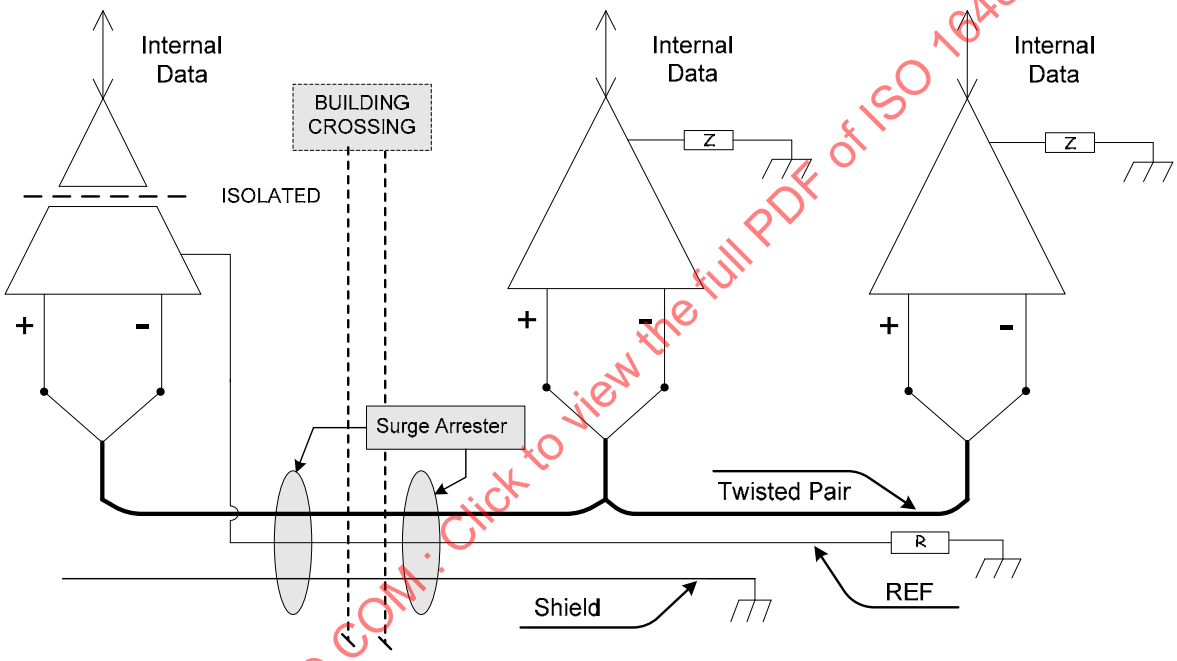

Figure 9-1.6. Two Buildings with All Isolated Devices in One Building.

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9.2.2.1.2.2 Isolated Repeater

If the installation includes a mixture of three-wire isolated and two-wire non-isolated devices in each of two buildings on a single communications line, it is possible to connect the buildings using an isolated repeater so that each building is electrically isolated from the other building as shown in Figure 9-1.7. The isolated repeater must provide complete three-way electrical isolation between the wiring on either side and ground. In this case, the communication wiring within each building is configured like that of a single building since the isolated repeater provides the required 1500-volt electrical isolation. The cable connecting the buildings is an extension of the cable in one of the buildings and shall be electrically isolated from the other building by the isolated repeater and shall not have any connections to other devices or to ground within the other building.

An isolated repeater may also be used on both sides of the cable connecting the buildings. This may be needed for extra isolation or for cable length. In this case the cable connecting the buildings shall be separately shielded, terminated, and biased and shall not have any connections to other devices within either building. If the pair of isolated repeaters provides a reference connection, the two reference connections shall be joined by a third conductor within the cable connecting the buildings and shall not be connected to any other device or to ground.

The use of surge arrestors near each building's cable entrance to protect all of the conductors is recommended.

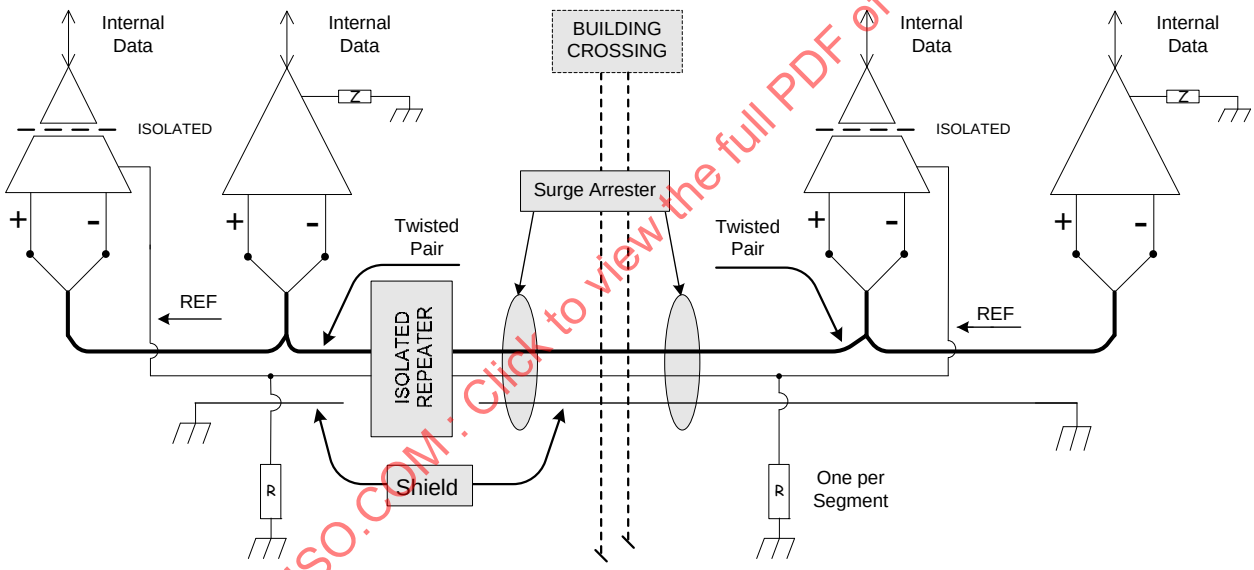

Figure 9-1.7. Isolated Repeater between Two Buildings with Surge Arresters.

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9.2.2.1.2.3 Fiber Optic Isolation

If the installation includes a mixture of three-wire isolated and two-wire non-isolated devices in each of two buildings on a single communications line, it is best to connect the buildings using EIA-485 half-duplex compatible fiber optic modems so that each building is electrically isolated from the other building and there are no conductors outside the buildings as shown in Figure 9-1.8. In this case, the communication wiring within each building is configured like that of a single building since the fiber optic modems provide the required 1500-volt electrical isolation.

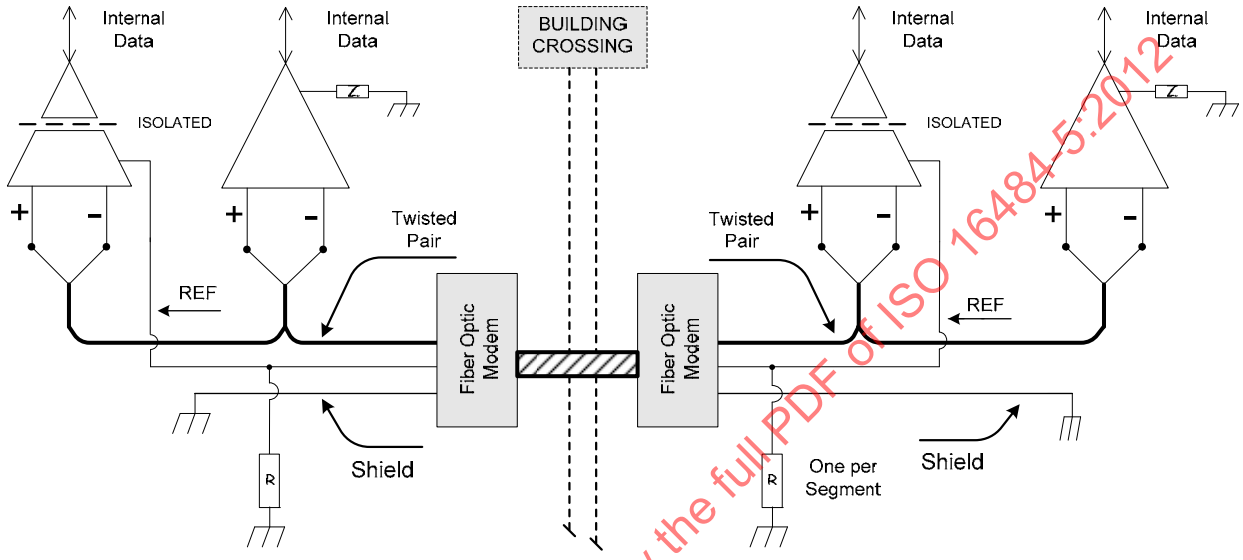

Figure 9-1.8. Fiber Optic Modems between Two Buildings.

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9.2.2.1.2.4 No Isolation (not permitted)

Directly connecting two buildings with a single EIA-485 communications cable where there are two-wire non-isolated devices in each building shall not be permitted since the required 1500-V electrical isolation between signal conductors and digital ground cannot be maintained. Device wiring such as that shown in Figure 9-1.9 is not allowed.

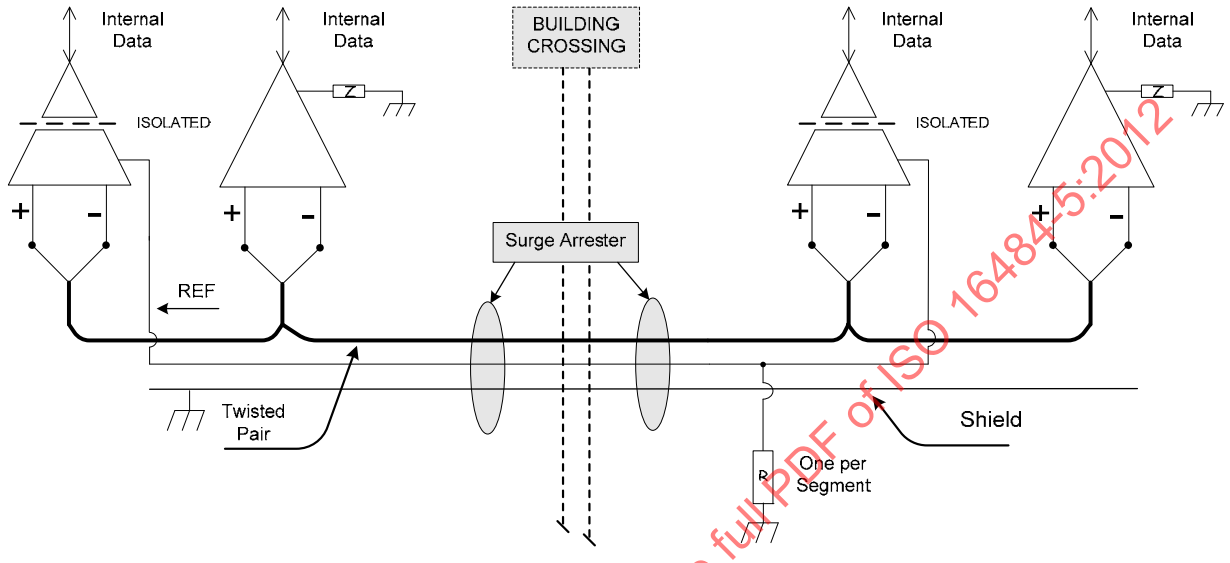

Figure 9-1.9. Two Buildings with Mixed Devices - No Isolation (Not Allowed).

9.2.3 Timing

Octets shall be transmitted using non-return to zero (NRZ) encoding with one start bit, eight data bits, no parity, and one stop bit. The start bit shall have a value of zero, while the stop bit shall have a value of one. The data bits shall be transmitted with the least significant bit first. This is illustrated in Figure 9-2.

Although asynchronous framing is used, there shall be no more than T_{frame_gap} of idle line (logical ones or stop bits) between any two octets of a frame.

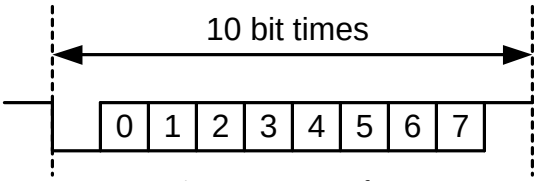

Figure 9-2. Octet framing.

'The standard baud rates are shown in the table below. The required baud rates, plus or minus 1%, shall be supported. Any or all of the optional baud rates, plus or minus 1%, may be supported at the vendor's option.

Baud Rate	Requirement	Recommended Maximum Distance
9600	Required	1200 meters (4000 feet)
19200	Optional	1200 meters (4000 feet)
38400	Required	1200 meters (4000 feet)
57600	Optional	1200 meters (4000 feet)
76800	Optional	1200 meters (4000 feet)
115200	Optional	1000 meters (3280 feet)

Transmitter enable: A node shall enable its EIA-485 driver before it generates the leading edge of the first start bit of a frame. The node shall drive the line to the logical one state during the time between the enable and the leading edge of the first start bit of a frame.

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Transmitter disable: A node shall not disable its EIA-485 driver until the stop bit of the final octet of a frame has been generated. The node shall disable its EIA-485 driver within $\mathbf{T}_{\mathbf{postdrive}}$ after the beginning of the stop bit of the final octet of a frame in order that it not interfere with any subsequent frame transmitted by another node. This specification allows, but does not encourage, the use of a "padding" octet after the final octet of a frame in order to facilitate the use of common UART transmit interrupts for driver disable control. If a "padding" octet is used, its value shall be X'FF'. The "padding" octet is not considered part of the frame, that is, it shall be included within $\mathbf{T}_{\mathbf{postdrive}}$.

Receive to Transmit turn-around: A node shall not enable its EIA-485 driver for at least $\mathbf{T}_{\mathbf{turnaround}}$ after the node receives the final stop bit of any octet.

9.3 MS/TP Frame Format

All frames are of the following format:

Preamble	two octet preamble: X'55', X'FF'
Frame Type	one octet
Destination Address	one octet address
Source Address	one octet address
Length	two octets, most significant octet first
Header CRC	one octet
Data	(present only if Length is non-zero)
Data CRC	(present only if Length is non-zero) two octets, least significant octet first
(pad)	(optional) at most one octet of padding: X'FF'

The Frame Type is used to distinguish between different types of MAC frames. Defined types are:

00	Token
01	Poll For Master
02	Reply To Poll For Master
03	Test_Request
04	Test_Response
05	BACnet Data Expecting Reply
06	BACnet Data Not Expecting Reply
07	Reply Postponed

Frame Types 8 through 127 are reserved by ASHRAE. Frame Types 128 through 255 are available to vendors for proprietary (non-BACnet) frames. Use of proprietary frames might allow a Brand-X controller, for example, to send proprietary frames to other Brand-X controllers that do not implement BACnet while using the same medium to send BACnet frames to a Brand-Y panel that does implement BACnet. Token, Poll For Master, and Reply To Poll For Master frames shall be understood by both proprietary and BACnet master nodes.

The Destination and Source Addresses are one octet each. A Destination Address of 255 (X'FF') denotes broadcast. A Source Address of 255 is not allowed. Addresses 0 to 127 are valid for both master and slave nodes. Addresses 128 to 254 are valid only for slave nodes.

The Length field specifies the length in octets of the Data field.

The Data and Data CRC fields are conditional on the Frame Type and the Length, as specified in the description of each Frame Type. If the Length field is zero, that is, if both length octets are zero, then the Data and Data CRC fields shall not be present.

The length of the Data field shall be between 0 and 501 octets.

Subclause 9.6 and Annex G describe in detail the generation and checking of the Header and Data CRC octets.

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9.3.1 Frame Type 00: Token

The Token frame is used to pass network mastership to the destination node. The use of the Token frame is described in detail in 9.5.

There are no data octets in Token frames.

9.3.2 Frame Type 01: Poll For Master

The Poll For Master frame is transmitted by master nodes during configuration and periodically during normal network operation. It is used to discover the presence of other master nodes on the network and to determine a successor node in the token ring. The use of the Poll For Master frame in the token network is described in detail in 9.5.

There are no data octets in Poll For Master frames.

Both master and slave nodes shall expect to receive Poll For Master frames. Master nodes shall respond to Poll For Master Frames as described in 9.5.6.2. Slave nodes shall ignore Poll For Master frames, as described in 9.5.7.2.

9.3.3 Frame Type 02: Reply To Poll For Master

This frame is transmitted as a reply to the Poll For Master frame. It is used to indicate that the node sending the frame wishes to enter the token ring. The use of this frame in the token network is described in detail in 9.5.

There are no data octets in Reply To Poll For Master frames.

9.3.4 Frame Type 03: Test_Request

This frame is used to initiate a loopback test of the MS/TP to MS/TP transmission path. The use of this frame in the token network is described in detail in 9.1.3. The length of the data portion of a Test_Request frame may range from 0 to 501 octets.

9.3.5 Frame Type 04: Test_Response

This frame is used to reply to Test_Request frames. The use of this frame in the token network is described in detail in 9.1.3. The length of the data portion of a Test_Response frame may range from 0 to 501 octets. The data, if present, shall be that which was present in the initiating Test_Request.

9.3.6 Frame Type 05: BACnet Data Expecting Reply

This frame is used by master nodes to convey the data parameter of a DL_UNITDATA.request whose DER parameter is TRUE. The length of the data portion of a BACnet Data Expecting Reply frame may range from 0 to 501 octets.

9.3.7 Frame Type 06: BACnet Data Not Expecting Reply

This frame is used to convey the data parameter of a DL_UNITDATA.request whose DER parameter is FALSE. The length of the data portion of a BACnet Data Not Expecting Reply frame may range from 0 to 501 octets.

9.3.8 Frame Type 07: Reply Postponed

This frame is used by master nodes to defer sending a reply to a previously received BACnet Data Expecting Reply frame. The use of this frame in the token network is described in detail in 9.5.6.

There are no data octets in Reply Postponed frames.

9.3.9 Frame Types 128 through 255: Proprietary Frames

These frames are available to vendors as proprietary (non-BACnet) frames. The first two octets of the Data field shall specify the unique vendor identification code, most significant octet first, for the type of vendor-proprietary frame to be conveyed. The length of the data portion of a Proprietary frame shall be in the range of 2 to 501 octets.

9.4 Overview of the MS/TP Network

MS/TP uses a token to control access to a bus network. A master node may initiate the transmission of a data frame when it holds the token. Both master and slave nodes may transmit data frames in response to requests from master nodes. After sending at most $\mathbf{N}_{\mathbf{max\_info\_frames}}$ data frames (and awaiting any expected replies), a master node shall pass the token to the next master node.

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It is generally easier to deal with a lost token than with the presence of two tokens in a ring: a simple timeout will detect token loss, and regeneration of the token and recovery of the ring may proceed in an orderly fashion. If more than one token exists, however, collisions are likely. These will disrupt communications and slow throughput but may not be severe enough to cause loss of the tokens. In such a case, a persistent reduction in throughput might result. For this reason, the ring maintenance rules in this clause favor the loss of the token over the creation of a second token.

Token frames are not acknowledged. If the acknowledgment of a token were lost, the token's sender might retry, resulting in the creation of two tokens. Instead, after a node passes the token, it listens to see if the intended receiver node begins using the token. Usage in this case is defined as the reception of $\mathbf{N}_{\mathbf{min\_octets}}$ octets from the network within $\mathbf{T}_{\mathbf{usage\_timeout}}$ after the final octet of the token frame is transmitted.

Most token bus networks, such as ARCNET, do not distinguish between requests and replies: both are passed in the same type of frames, which are sent only when the sending node has the token. Since MS/TP defines slave nodes that never hold the token, a means must be provided to allow replies to be returned from slave devices. For simplicity, the same mechanism is used for replies returned from master nodes.

When a request that expects a reply is sent to an MS/TP node, the sender shall wait for the reply to be returned before passing the token. If the responding node is a master, it may return the reply or it may return a Reply Postponed frame, indicating that the actual reply will be returned later, when the replying node holds the token.

9.5 MS/TP Medium Access Control

The description that follows defines variables and procedures that may in some ways resemble the variables and procedures used in various computer languages. This description is in no way intended to prescribe the method of implementation. An implementation may be constructed in any fashion desired as long as it matches the behavior described by this standard. The description that follows is intended only to specify that behavior clearly and precisely.

9.5.1 UART Receiver Model

In this subclause, we present a model of the receiver interface to a UART as a data register and two Boolean flags. These are intended to closely resemble the functions of commercial UART chips but in a generic and non-prescriptive fashion. The model is used by the procedural and state machine descriptions.

9.5.1.1 DataRegister

The DataRegister holds the octet most recently received. The contents of this register after the occurrence of a framing or overrun error are not specified.

9.5.1.2 DataAvailable

The flag DataAvailable is TRUE if an octet is available in DataRegister. A means of setting this flag to FALSE when the associated data have been read from DataRegister shall be provided. Many common UARTs set DataAvailable FALSE automatically when DataRegister is read.

9.5.1.3 ReceiveError

The flag ReceiveError is TRUE if an error is detected during the reception of an octet. Many common UARTs detect several types of receive errors, in particular framing errors and overrun errors. ReceiveError shall be TRUE if any of these errors is detected.

A framing error occurs if a logical zero is received when a stop bit (logical one) is expected.

An overrun error occurs if an octet is received before an earlier octet is read from DataRegister. In general, the occurrence of overrun errors is evidence of improper design. However, it is recognized that critical system events may cause overrun errors to occur from time to time. The inclusion of this error in the state machine processing ensures that such errors are handled in a well-defined fashion.

A means of setting ReceiveError to FALSE when the associated error has been recognized shall be provided.

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9.5.2 Variables

A number of variables and timers are used in the descriptions that follow:

DataCRC Used to accumulate the CRC on the data field of a frame.

DataLength Used to store the data length of a received frame.

DestinationAddress Used to store the destination address of a received frame.

EventCount Used to count the number of received octets or errors. This is used in the detection of link activity.

FrameType Used to store the frame type of a received frame.

FrameCount The number of frames sent by this node during a single token hold. When this counter reaches the value $\mathbf{N}_{\mathbf{max\_info\_frames}}$, the node must pass the token.

HeaderCRC Used to accumulate the CRC on the header of a frame.

Index Used as an index by the Receive State Machine, up to the value of DataLength+1.

InputBuffer[] An array of octets, used to store octets as they are received. InputBuffer is indexed from 0 to InputBufferSize-1. The maximum size of a frame is 501 octets. A smaller value for InputBufferSize may be used by some implementations.

InputBufferSize The number of elements in the array InputBuffer[].

NS "Next Station," the MAC address of the node to which This Station passes the token. If the Next Station is unknown, NS shall be equal to TS.

PS "Poll Station," the MAC address of the node to which This Station last sent a Poll For Master. This is used during token maintenance.

ReceivedInvalidFrame A Boolean flag set to TRUE by the Receive State Machine if an error is detected during the reception of a frame. Set to FALSE by the main state machine.

ReceivedValidFrame A Boolean flag set to TRUE by the Receive State Machine if a valid frame is received. Set to FALSE by the main state machine.

RetryCount A counter of transmission retries used for Token and Poll For Master transmission.

SilenceTimer A timer with nominal 5 millisecond resolution used to measure and generate silence on the medium between octets. It is incremented by a timer process and is cleared by the Receive State Machine when activity is detected and by the SendFrame procedure as each octet is transmitted. Since the timer resolution is limited and the timer is not necessarily synchronized to other machine events, a timer value of N will actually denote intervals between N-1 and N.

SoleMaster A Boolean flag set to TRUE by the master machine if this node is the only known master node.

SourceAddress Used to store the Source Address of a received frame.

TokenCount The number of tokens received by this node. When this counter reaches the value $\mathbf{N}_{\mathbf{poll}}$, the node polls the address range between **TS** and **NS** for additional master nodes. **TokenCount** is set to one at the end of the polling process.

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TS "This Station," the MAC address of this node. TS is generally read from a hardware DIP switch, or from nonvolatile memory. Valid values for TS are 0 to 254. The value 255 is used to denote broadcast when used as a destination address but is not allowed as a value for TS.

9.5.3 Parameters

Parameter values used in the description:

$N_{max\_info\_frames}$ This parameter represents the value of the Max_Info_Frames property of the node's Device object. The value of Max_Info_Frames specifies the maximum number of information frames the node may send before it must pass the token. Max_Info_Frames may have different values on different nodes. This may be used to allocate more or less of the available link bandwidth to particular nodes. If Max_Info_Frames is not writable in a node, its value shall be 1.

N_{max_master} This parameter represents the value of the Max_Master property of the node's Device object. The value of Max_Master specifies the highest allowable address for master nodes. The value of Max_Master shall be less than or equal to 127. If Max_Master is not writable in a node, its value shall be 127.

N_{poll} The number of tokens received or used before a Poll For Master cycle is executed: 50.

N_{retry_token} The number of retries on sending Token: 1.

N_{min_octets} The minimum number of DataAvailable or ReceiveError events that must be seen by a receiving node in order to declare the line "active": 4.

T_{frame_abort} The minimum time without a DataAvailable or ReceiveError event within a frame before a receiving node may discard the frame: 60 bit times. (Implementations may use larger values for this timeout, not to exceed 100 milliseconds.)

T_{frame_gap} The maximum idle time a sending node may allow to elapse between octets of a frame the node is transmitting: 20 bit times.

T_{no_token} The time without a DataAvailable or ReceiveError event before declaration of loss of token: 500 milliseconds.

$T_{postdrive}$ The maximum time after the end of the stop bit of the final octet of a transmitted frame before a node must disable its EIA-485 driver: 15 bit times.

T_{reply_delay} The maximum time a node may wait after reception of a frame that expects a reply before sending the first octet of a reply or Reply Postponed frame: 250 milliseconds.

$T_{reply\_timeout}$ The minimum time without a DataAvailable or ReceiveError event that a node must wait for a station to begin replying to a confirmed request: 255 milliseconds. (Implementations may use larger values for this timeout, not to exceed 300 milliseconds.)

T_{roff} Repeater turnoff delay. The duration of a continuous logical one state at the active input port of an MS/TP repeater after which the repeater will enter the IDLE state: 29 bit times < T_{roff} < 40 bit times.

T_{slot} The width of the time slot within which a node may generate a token: 10 milliseconds.

$T_{turnaround}$ The minimum time after the end of the stop bit of the final octet of a received frame before a node may enable its EIA-485 driver: 40 bit times.

T_{usage_delay} The maximum time a node may wait after reception of the token or a Poll For Master frame before sending the first octet of a frame: 15 milliseconds.

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$T_{usage\_timeout}$ The minimum time without a DataAvailable or ReceiveError event that a node must wait for a remote node to begin using a token or replying to a Poll For Master frame: 20 milliseconds. (Implementations may use larger values for this timeout, not to exceed 100 milliseconds.)

9.5.4 Receive Frame Finite State Machine

This section describes the reception of an MS/TP frame by a BACnet device. The description of operation is as a finite state machine. Figure 9-3 shows the Receive Frame state machine, which is described fully in this clause. Each state is given a name, specified in all capital letters. Transitions are also named, in mixed upper- and lowercase letters. Transitions are described as a series of conditions followed by a series of actions to be taken if the conditions are met. The final action in each transition is entry into a new state, which may be the same as the current state.

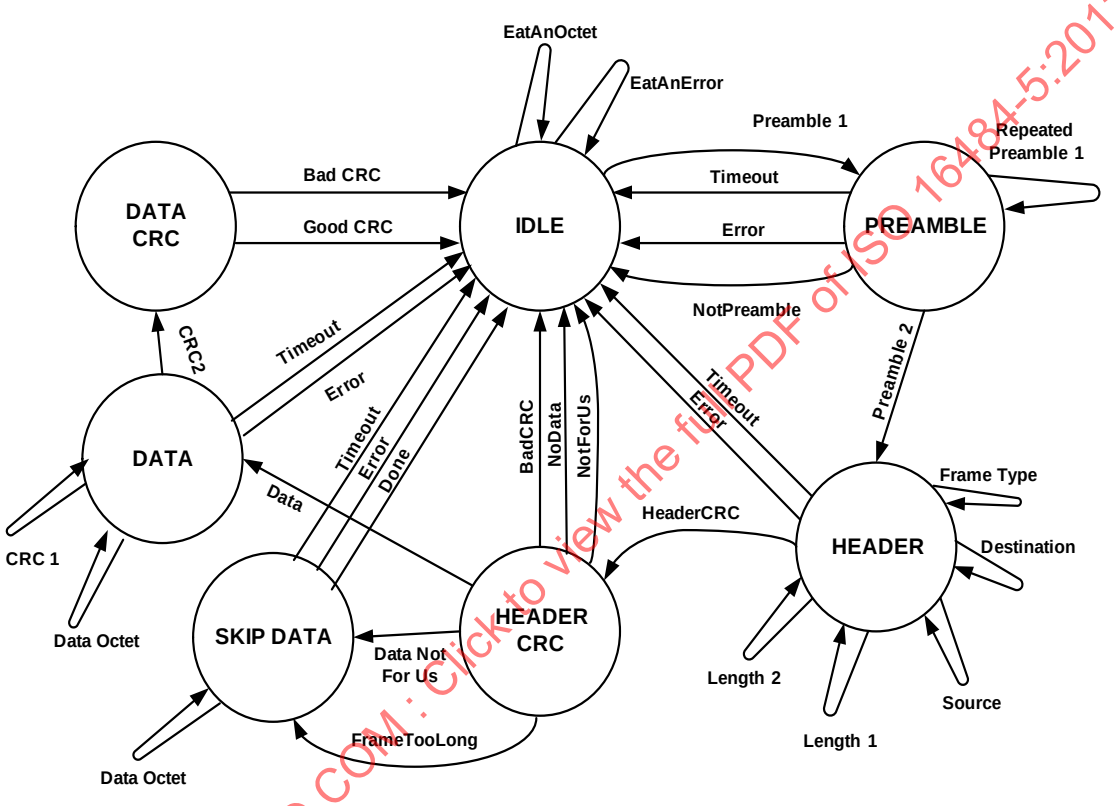

Figure 9-3. Receive Frame State Machine.

The Receive Frame state machine operates independently from the MS/TP Master Node or Slave Node machine, communicating with it by means of flags and other variables. The description assumes that the Master Node or Slave Node state machine can process received frames and other indications from the Receive Frame state machine before the next frame begins. The means by which this behavior is implemented are a local matter.

This description assumes that the node will not receive its own transmissions. If a given implementation does receive its own transmissions, then the implementation shall be constructed so that the Receive Frame machine will ignore the transmissions.

9.5.4.1 IDLE

In the IDLE state, the node waits for the beginning of a frame.

EatAnError

If ReceiveError is TRUE,

then set ReceiveError to FALSE; set SilenceTimer to zero; increment EventCount; and enter the IDLE state to wait for the start of a frame.

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EatAnOctet

If ReceiveError is FALSE and DataAvailable is TRUE and the content of DataRegister is not X'55',

then set DataAvailable to FALSE; set SilenceTimer to zero; increment EventCount; and enter the IDLE state to wait for the start of a frame.

Preamble1

If ReceiveError is FALSE and DataAvailable is TRUE and the content of DataRegister is X '55',

then set DataAvailable to FALSE; set SilenceTimer to zero; increment EventCount; and enter the PREAMBLE state to receive the remainder of the frame.

9.5.4.2 PREAMBLE

In the PREAMBLE state, the node waits for the second octet of the preamble.

Timeout

If SilenceTimer is greater than $\mathbf{T}_{\mathbf{frame\_abort}}$,

then a correct preamble has not been received. Enter the IDLE state to wait for the start of a frame.

Error

If ReceiveError is TRUE,

then set ReceiveError to FALSE; set SilenceTimer to zero; increment EventCount; and enter the IDLE state to wait for the start of a frame.

RepeatedPreamble1

If ReceiveError is FALSE and DataAvailable is TRUE and the content of DataRegister is X'55',

then set DataAvailable to FALSE; set SilenceTimer to zero; increment EventCount; and enter the PREAMBLE state to wait for the second preamble octet.

NotPreamble

If ReceiveError is FALSE and DataAvailable is TRUE and the content of DataRegister is not X'FF' or X '55',

then set DataAvailable to FALSE; set SilenceTimer to zero; increment EventCount; and enter the IDLE state to wait for the start of a frame.

Preamble2

If ReceiveError is FALSE and DataAvailable is TRUE and the content of DataRegister is X'FF',

then set DataAvailable to FALSE; set SilenceTimer to zero; increment EventCount; set Index to zero; set HeaderCRC to X'FF'; and enter the HEADER state to receive the remainder of the frame.

9.5.4.3 HEADER

In the HEADER state, the node waits for the fixed message header.

Timeout

If SilenceTimer is greater than $\mathbf{T}_{\mathbf{frame\_abort}}$,

then set ReceivedInvalidFrame to TRUE to indicate that an error has occurred during the reception of a frame, and enter the IDLE state to wait for the start of a frame.

Error

If ReceiveError is TRUE,

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then set ReceiveError to FALSE; set SilenceTimer to zero; increment EventCount; set ReceivedInvalidFrame to TRUE to indicate that an error has occurred during the reception of a frame; and enter the IDLE state to wait for the start of a frame.

FrameType

If ReceiveError is FALSE and DataAvailable is TRUE and Index is 0,

then set DataAvailable to FALSE; set SilenceTimer to zero; increment EventCount; accumulate the contents of DataRegister into HeaderCRC; save the contents of DataRegister as FrameType; set Index to 1; and enter the HEADER state.

Destination

If ReceiveError is FALSE and DataAvailable is TRUE and Index is 1

then set DataAvailable to FALSE; set SilenceTimer to zero; increment EventCount; accumulate the contents of DataRegister into HeaderCRC; save the contents of DataRegister as DestinationAddress; set Index to 2; and enter the HEADER state.

Source

If ReceiveError is FALSE and DataAvailable is TRUE and Index is 2,

then set DataAvailable to FALSE; set SilenceTimer to zero; increment EventCount; accumulate the contents of DataRegister into HeaderCRC; save the contents of DataRegister as SourceAddress; set Index to 3; and enter the HEADER state.

Length1

If ReceiveError is FALSE and DataAvailable is TRUE and Index is 3,

then set DataAvailable to FALSE; set SilenceTimer to zero; increment EventCount; accumulate the contents of DataRegister into HeaderCRC; multiply the contents of DataRegister by 256 and save the result as DataLength; set Index to 4; and enter the HEADER state.

Length2

If ReceiveError is FALSE and DataAvailable is TRUE and Index is 4,

then set DataAvailable to FALSE; set SilenceTimer to zero; increment EventCount; accumulate the contents of DataRegister into HeaderCRC; add the contents of DataRegister to DataLength and save the result as DataLength; set Index to 5; and enter the HEADER state.

HeaderCRC

If ReceiveError is FALSE and DataAvailable is TRUE and Index is 5,

then set DataAvailable to FALSE; set SilenceTimer to zero; increment EventCount; accumulate the contents of DataRegister into HeaderCRC; and enter the HEADER_CRC state.

9.5.4.4 HEADER_CRC

In the HEADER_CRC state, the node validates the CRC on the fixed message header.

BadCRC

If the value of HeaderCRC is not X '55',

then set ReceivedInvalidFrame to TRUE to indicate that an error has occurred during the reception of a frame, and enter the IDLE state to wait for the start of the next frame.

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NotForUs

If the value of the HeaderCRC is X '55' and DataLength is zero and the value of DestinationAddress is not equal to either TS (this station) or 255 (broadcast),

then enter the IDLE state to wait for the start of the next frame.

DataNotForUs

If the value of the HeaderCRC is X '55' and DataLength is not zero and the value of DestinationAddress is not equal to either TS (this station) or 255 (broadcast),

then set Index to zero and enter the SKIP_DATA state to consume the data and data CRC portions of the frame.

FrameTooLong

If the value of the HeaderCRC is X '55' and the value of DestinationAddress is equal to either TS (this station) or 255 (broadcast) and DataLength is greater than InputBufferSize,

then set ReceivedInvalidFrame to TRUE to indicate that a frame with an illegal or unacceptable data length has been received, set Index to zero, and enter the SKIP_DATA state to consume the data and data CRC portions of the frame.

NoData

If the value of HeaderCRC is X '55' and the value of DestinationAddress is equal to either TS (this station) or 255 (broadcast) and DataLength is zero,

then set ReceivedValidFrame to TRUE to indicate that a frame with no data has been received, and enter the IDLE state to wait for the start of the next frame.

Data

If the value of HeaderCRC is X'55' and the value of DestinationAddress is equal to either TS (this station) or 255 (broadcast) and DataLength is not zero and DataLength is less than or equal to InputBufferSize,

then set Index to zero; set DataCRC to X'FFFF'; and enter the DATA state to receive the data portion of the frame.

9.5.4.5 DATA

In the DATA state, the node waits for the data portion of a frame.

Timeout

If SilenceTimer is greater than T_{frame_abort},

then set ReceivedInvalidFrame to TRUE to indicate that an error has occurred during the reception of a frame, and enter the IDLE state to wait for the start of the next frame.

Error

If ReceiveError is TRUE,

then set ReceiveError to FALSE; set SilenceTimer to zero; set ReceivedInvalidFrame to TRUE to indicate that an error has occurred during the reception of a frame; and enter the IDLE state to wait for the start of the next frame.

DataOctet

If ReceiveError is FALSE and DataAvailable is TRUE and Index is less than DataLength,

then set DataAvailable to FALSE; set SilenceTimer to zero; accumulate the contents of DataRegister into DataCRC; save the contents of DataRegister at InputBuffer[Index]; increment Index by 1; and enter the DATA state.

CRC1

If ReceiveError is FALSE and DataAvailable is TRUE and Index is equal to DataLength,

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then set DataAvailable to FALSE; set SilenceTimer to zero; accumulate the contents of DataRegister into DataCRC; increment Index by 1; and enter the DATA state.

CRC2

If ReceiveError is FALSE and DataAvailable is TRUE and Index is equal to DataLength plus 1,

then set DataAvailable to FALSE; set SilenceTimer to zero; accumulate the contents of DataRegister into DataCRC; and enter the DATA_CRC state.

9.5.4.6 DATA_CRC

In the DATA_CRC state, the node validates the CRC of the message data.

BadCRC

If the value of DataCRC is not X'F0B8',

then set ReceivedInvalidFrame to TRUE to indicate that an error has occurred during the reception of a frame, and enter the IDLE state to wait for the start of the next frame.

GoodCRC

If the value of DataCRC is X'F0B8',

then set ReceivedValidFrame to TRUE to indicate the complete reception of a valid frame, and enter the IDLE state to wait for the start of the next frame.

9.5.4.7 SKIP_DATA

In the SKIP_DATA state, the node waits for the data portion of a frame to be received so that its contents can be ignored.

Timeout

If SilenceTimer is greater than Tframe_abort,

then set ReceivedInvalidFrame to TRUE to indicate that an error has occurred during the reception of a frame, and enter the IDLE state to wait for the start of the next frame.

Error

If ReceiveError is TRUE,

then set ReceiveError to FALSE; set SilenceTimer to zero; set ReceivedInvalidFrame to TRUE to indicate that an error has occurred during the reception of a frame; and enter the IDLE state to wait for the start of the next frame.

DataOctet

If ReceiveError is FALSE and DataAvailable is TRUE and Index is less than DataLength+1,

then set DataAvailable to FALSE; set SilenceTimer to zero; increment Index by 1; and enter the SKIP_DATA state.

Done

If ReceiveError is FALSE and DataAvailable is TRUE and Index is equal to DataLength+1,

then set DataAvailable to FALSE; set SilenceTimer to zero; and enter the IDLE state to wait for the start of the next frame.

9.5.5 The SendFrame Procedure

The transmission of an MS/TP frame proceeds as follows:

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Procedure SendFrame

(a) If SilenceTimer is less than $\mathbf{T}_{\mathbf{turnaround}}$, wait ($\mathbf{T}_{\mathbf{turnaround}}$ - SilenceTimer).

(b) Disable the receiver, and enable the transmit line driver.

(c) Transmit the preamble octets X'55', X'FF'. As each octet is transmitted, set SilenceTimer to zero.

(d) Initialize HeaderCRC to X'FF'.

(e) Transmit the Frame Type, Destination Address, Source Address, and Data Length octets. Accumulate each octet into HeaderCRC. As each octet is transmitted, set SilenceTimer to zero.

(f) Transmit the ones-complement of HeaderCRC. Set SilenceTimer to zero.

(g) If there are data octets, initialize DataCRC to X'FFFF'.

(h) Transmit any data octets. Accumulate each octet into DataCRC. As each octet is transmitted, set SilenceTimer to zero.

(i) Transmit the ones-complement of DataCRC, least significant octet first. As each octet is transmitted, set SilenceTimer to zero.

(j) Wait until the final stop bit of the most significant CRC octet has been transmitted but not more than $\mathbf{T}_{\mathbf{postdrive}}$.

(k) Disable the transmit line driver.

(l) Return.

9.5.6 Master Node Finite State Machine

The description of operation is as a finite state machine. Figure 9-4 shows the Master Node state machine, which is described fully in this clause. Each state is given a name, specified in all capital letters. Transitions are also named, in mixed upper- and lowercase letters. Transitions are described as a series of conditions followed by a series of actions to be taken if the conditions are met. The final action in each transition is entry into a new state, which may be the same as the current state.

A master node that supports segmentation shall not use a segmentation window size greater than one.

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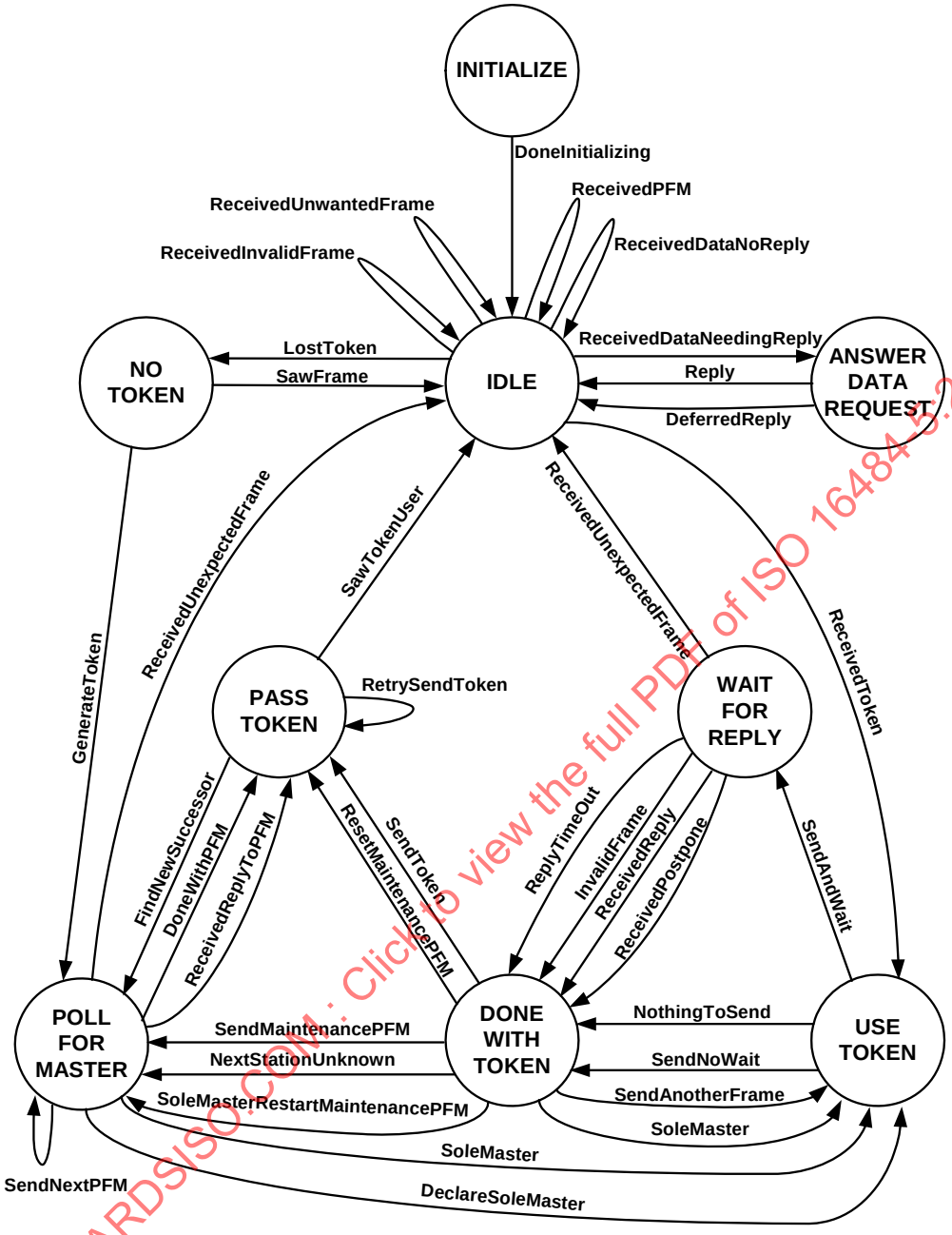

Figure 9-4. Master Node State Machine.

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9.5.6.1 INITIALIZE

When a master node is powered up or reset, it shall unconditionally enter the INITIALIZE state.

DoneInitializing

Unconditionally,

set TS to the node's station address, set NS equal to TS (indicating that the next station is unknown), set PS equal to TS, set TokenCount to $\mathbf{N_{poll}}$ (thus causing a Poll For Master to be sent when this node first receives the token), set SoleMaster to FALSE, set ReceivedValidFrame and ReceivedInvalidFrame to FALSE, and enter the IDLE state.

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9.5.6.2 IDLE

In the IDLE state, the node waits for a frame.

LostToken

If SilenceTimer is greater than or equal to $\mathbf{T_{no\_token}}$,

then assume that the token has been lost. Set EventCount to zero and enter the NO_TOKEN state.

ReceivedInvalidFrame

If ReceivedInvalidFrame is TRUE,

then an invalid frame was received. Set ReceivedInvalidFrame to FALSE, and enter the IDLE state to wait for the next frame.

ReceivedUnwantedFrame

If ReceivedValidFrame is TRUE and either

(a) DestinationAddress is not equal to either TS (this station) or 255 (broadcast) or

(b) DestinationAddress is equal to 255 (broadcast) and FrameType has a value of Token, Test_Request, or a proprietary type known to this node that expects a reply (such frames may not be broadcast) or

(c) FrameType has a value that indicates a standard or proprietary type that is not known to this node,

then an unexpected or unwanted frame was received. Set ReceivedValidFrame to FALSE, and enter the IDLE state to wait for the next frame.

ReceivedToken

If ReceivedValidFrame is TRUE and DestinationAddress is equal to TS (this station) and FrameType is equal to Token,

then set ReceivedValidFrame to FALSE; set FrameCount to zero; set SoleMaster to FALSE; and enter the USE_TOKEN state.

ReceivedPFM

If ReceivedValidFrame is TRUE and DestinationAddress is equal to TS (this station) and FrameType is equal to Poll For Master,

then call SendFrame to transmit a Reply To Poll For Master frame to the node whose address is specified by SourceAddress (Source Address of the Poll); set ReceivedValidFrame to FALSE; and enter the IDLE state.

ReceivedDataNoReply

If ReceivedValidFrame is TRUE and DestinationAddress is equal to either TS (this station) or 255 (broadcast) and FrameType is equal to BACnet Data Not Expecting Reply, Test_Response, or a proprietary type known to this node that does not expect a reply,

then indicate successful reception to the higher layers; set ReceivedValidFrame to FALSE; and enter the IDLE state.

ReceivedDataNeedingReply

If ReceivedValidFrame is TRUE and DestinationAddress is equal to TS (this station) and FrameType is equal to BACnet Data Expecting Reply, Test Request, or a proprietary type known to this node that expects a reply,

then indicate successful reception to the higher layers (management entity in the case of Test_Request); set ReceivedValidFrame to FALSE; and enter the ANSWER_DATA_REQUEST state.

BroadcastDataNeedingReply

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If ReceivedValidFrame is TRUE and DestinationAddress is equal to 255 (broadcast) and FrameType is equal to BACnet Data Expecting Reply,

then indicate successful reception to the higher layers; set ReceivedValidFrame to FALSE; and enter the IDLE state to wait for the next frame.

9.5.6.3 USE_TOKEN

In the USE_TOKEN state, the node is allowed to send one or more data frames. These may be BACnet Data frames or proprietary frames.

NothingToSend

If there is no data frame awaiting transmission,

then set FrameCount to $\mathbf{N}_{\mathbf{max\_info\_frames}}$ and enter the DONE_WITH_TOKEN state.

SendNoWait

If the next frame awaiting transmission is of type Test_Response, BACnet Data Not Expecting Reply, a proprietary type that does not expect a reply, or a frame of type BACnet Data Expecting Reply with a DestinationAddress that is equal to 255 (broadcast),

then call SendFrame to transmit the frame; increment FrameCount; and enter the DONE_WITH_TOKEN state.

SendAndWait

If the next frame awaiting transmission is of type Test_Request, BACnet Data Expecting Reply, a proprietary type that expects a reply, or a frame of type BACnet Data Expecting Reply with a DestinationAddress that is not equal to 255 (broadcast),

then call SendFrame to transmit the data frame; increment FrameCount; and enter the WAIT_FOR_REPLY state.

9.5.6.4 WAIT_FOR_REPLY

In the WAIT_FOR_REPLY state, the node waits for a reply from another node.

ReplyTimeout

If SilenceTimer is greater than or equal to $\mathbf{T}_{\mathbf{reply\_timeout}}$,

then assume that the request has failed. Set FrameCount to $\mathbf{N}_{\mathbf{max\_info\_frames}}$ and enter the DONE_WITH_TOKEN state. Any retry of the data frame shall await the next entry to the USE_TOKEN state. (Because of the length of the timeout, this transition will cause the token to be passed regardless of the initial value of FrameCount.)

InvalidFrame

If SilenceTimer is less than $\mathbf{T}_{\mathbf{reply\_timeout}}$ and ReceivedInvalidFrame is TRUE,

then there was an error in frame reception. Set ReceivedInvalidFrame to FALSE and enter the DONE_WITH_TOKEN state.

ReceivedReply

If SilenceTimer is less than $\mathbf{T}_{\mathbf{reply\_timeout}}$ and ReceivedValidFrame is TRUE and DestinationAddress is equal to TS (this station) and FrameType is equal to Test_Response, BACnet Data Not Expecting Reply, or a proprietary type that indicates a reply,

then indicate successful reception to the higher layers; set ReceivedValidFrame to FALSE; and enter the DONE_WITH_TOKEN state.

ReceivedPostpone

If SilenceTimer is less than $\mathbf{T}_{\mathbf{reply\_timeout}}$ and ReceivedValidFrame is TRUE and DestinationAddress is equal to TS (this station) and FrameType is equal to Reply Postponed,

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then the reply to the message has been postponed until a later time. Set ReceivedValidFrame to FALSE and enter the DONE_WITH_TOKEN state.

ReceivedUnexpectedFrame

If SilenceTimer is less than $\mathbf{T}_{\mathbf{reply\_timeout}}$ and ReceivedValidFrame is TRUE and either

(a) DestinationAddress is not equal to TS (the expected reply should not be broadcast) or

(b) FrameType has a value other than Test_Response, BACnet Data Not Expecting Reply, or proprietary reply frame,

then an unexpected frame was received. This may indicate the presence of multiple tokens. Set ReceivedValidFrame to FALSE, and enter the IDLE state to synchronize with the network. This action drops the token.

9.5.6.5 DONE_WITH_TOKEN

The DONE_WITH_TOKEN state either sends another data frame, passes the token, or initiates a Poll For Master cycle.

SendAnotherFrame

If FrameCount is less than $\mathbf{N}_{\mathbf{max\_info\_frames}}$,

then this node may send another information frame before passing the token. Enter the USE_TOKEN state.

NextStationUnknown

If FrameCount is greater than or equal to $\mathbf{N}_{\mathbf{max\_info\_frames}}$, SoleMaster is FALSE and NS is equal to TS,

then the next station to which the token should be sent is unknown. Set PS to (TS+1) modulo ($\mathbf{N}_{\mathbf{max\_master}}$+1); call SendFrame to transmit a Poll For Master frame to PS; set RetryCount to zero; and enter the POLL_FOR_MASTER state.

SoleMaster

If FrameCount is greater than or equal to $\mathbf{N}_{\mathbf{max\_info\_frames}}$ and TokenCount is less than $\mathbf{N}_{\mathbf{poll}}$-1 and SoleMaster is TRUE,

then there are no other known master nodes to which the token may be sent (true master-slave operation). Set FrameCount to zero, increment TokenCount, and enter the USE_TOKEN state.

SendToken

If FrameCount is greater than or equal to $\mathbf{N}_{\mathbf{max\_info\_frames}}$ and TokenCount is less than $\mathbf{N}_{\mathbf{poll}}$-1 and SoleMaster is FALSE, or if NS is equal to (TS+1) modulo ($\mathbf{N}_{\mathbf{max\_master}}$+1),

then increment TokenCount; call SendFrame to transmit a Token frame to NS; set RetryCount and EventCount to zero; and enter the PASS_TOKEN state. (The comparison of NS and TS+1 eliminates the Poll For Master if there are no addresses between TS and NS, since there is no address at which a new master node may be found in that case).

SendMaintenancePFM

If FrameCount is greater than or equal to $\mathbf{N}_{\mathbf{max\_info\_frames}}$ and TokenCount is greater than or equal to $\mathbf{N}_{\mathbf{poll}}$-1 and (PS+1) modulo ($\mathbf{N}_{\mathbf{max\_master}}$+1) is not equal to NS,

then set PS to (PS+1) modulo ($\mathbf{N}_{\mathbf{max\_master}}$+1); call SendFrame to transmit a Poll For Master frame to PS; set RetryCount to zero; and enter the POLL_FOR_MASTER state.

ResetMaintenancePFM

If FrameCount is greater than or equal to $\mathbf{N}_{\mathbf{max\_info\_frames}}$ and TokenCount is greater than or equal to $\mathbf{N}_{\mathbf{poll}}$-1 and (PS+1) modulo ($\mathbf{N}_{\mathbf{max\_master}}$+1) is equal to NS, and SoleMaster is FALSE,

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then set PS to TS; call SendFrame to transmit a Token frame to NS; set RetryCount and EventCount to zero; set TokenCount to one; and enter the PASS_TOKEN state.

SoleMasterRestartMaintenancePFM

If FrameCount is greater than or equal to $\mathbf{N}_{max\_info\_frames}$, and TokenCount is greater than or equal to $\mathbf{N}_{poll}$-1, and (PS+1) modulo ($\mathbf{N}_{max\_master}$+1) is equal to NS, and SoleMaster is TRUE,

then set PS to (NS +1) modulo ($\mathbf{N}_{max\_master}$+1) ; call SendFrame to transmit a Poll For Master to PS; set NS to TS (no known successor node); set RetryCount and TokenCount to zero; set TokenCount to one; and enter the POLL_FOR_MASTER state to find a new successor to TS.

9.5.6.6 PASS_TOKEN

The PASS_TOKEN state listens for a successor to begin using the token that this node has just attempted to pass.

SawTokenUser

If SilenceTimer is less than $\mathbf{T}_{usage\_timeout}$ and EventCount is greater than $\mathbf{N}_{min\_octets}$,

then assume that a frame has been sent by the new token user. Enter the IDLE state to process the frame.

RetrySendToken

If SilenceTimer is greater than or equal to $\mathbf{T}_{usage\_timeout}$ and RetryCount is less than $\mathbf{N}_{retry\_token}$,

then increment RetryCount; call SendFrame to transmit a Token frame to NS; set EventCount to zero; and re-enter the current state to listen for NS to begin using the token.

FindNewSuccessor

If SilenceTimer is greater than or equal to $\mathbf{T}_{usage\_timeout}$ and RetryCount is greater than or equal to $\mathbf{N}_{retry\_token}$,

then assume that NS has failed. Set PS to (NS+1) modulo ($\mathbf{N}_{max\_master}$+1); call SendFrame to transmit a Poll For Master frame to PS; set NS to TS (no known successor node); set RetryCount and TokenCount to zero; and enter the POLL_FOR_MASTER state to find a new successor to TS.

9.5.6.7 NO_TOKEN

The NO_TOKEN state is entered if SilenceTimer becomes greater than $\mathbf{T}_{no\_token}$, indicating that there has been no network activity for that period of time. The timeout is continued to determine whether or not this node may create a token.

SawFrame

If SilenceTimer is less than $\mathbf{T}_{no\_token}$+($\mathbf{T}_{slot}$*TS) and EventCount is greater than $\mathbf{N}_{min\_octets}$,

then some other node exists at a lower address. Enter the IDLE state to receive and process the incoming frame.

GenerateToken

If SilenceTimer is greater than or equal to $\mathbf{T}_{no\_token}$+($\mathbf{T}_{slot}$*TS) and SilenceTimer is less than $\mathbf{T}_{no\_token}$+($\mathbf{T}_{slot}$*(TS+1)),

then assume that this node is the lowest numerical address on the network and is empowered to create a token. Set PS to (TS+1) modulo ($\mathbf{N}_{max\_master}$+1); call SendFrame to transmit a Poll For Master frame to PS; set NS to TS (indicating that the next station is unknown); set RetryCount and TokenCount to zero; and enter the POLL_FOR_MASTER state to find a new successor to TS.

9.5.6.8 POLL_FOR_MASTER

In the POLL_FOR_MASTER state, the node listens for a reply to a previously sent Poll For Master frame in order to find a successor node.

ReceivedReplyToPFM

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If ReceivedValidFrame is TRUE and DestinationAddress is equal to TS (this station) and FrameType is equal to Reply To Poll For Master,

then set SoleMaster to FALSE; set NS equal to SourceAddress; set EventCount to zero; call SendFrame to transmit a Token frame to NS; set PS to the value of TS; set TokenCount and RetryCount to zero; set ReceivedValidFrame to FALSE; and enter the PASS_TOKEN state.

ReceivedUnexpectedFrame

If ReceivedValidFrame is TRUE and either

(a) DestinationAddress is not equal to TS or

(b) FrameType is not equal to Reply To Poll For Master,

then an unexpected frame was received. This may indicate the presence of multiple tokens. Set ReceivedValidFrame to FALSE and enter the IDLE state to synchronize with the network. This action drops the token.

SoleMaster

If SoleMaster is TRUE and either

(a) SilenceTimer is greater than or equal to $\mathbf{T}_{usage\_timeout}$ or

(b) ReceivedInvalidFrame is TRUE,

then there was no valid reply to the periodic poll by the sole known master for other masters. Set FrameCount to zero, set ReceivedInvalidFrame to FALSE, and enter the USE_TOKEN state.

DoneWithPFM

If SoleMaster is FALSE and NS is not equal to TS and either:

(a) SilenceTimer is greater than or equal to $\mathbf{T}_{usage\_timeout}$ or

(b) ReceivedInvalidFrame is TRUE,

then there was no valid reply to the maintenance poll for a master at address PS. Set EventCount to zero; call SendFrame to transmit a Token frame to NS; set RetryCount to zero; set ReceivedInvalidFrame to FALSE; and enter the PASS_TOKEN state.

SendNextPFM

If SoleMaster is FALSE and NS is equal to TS (no known successor node) and (PS+1) modulo ($\mathbf{N}_{max\_master}$+1) is not equal to TS and either:

(a) SilenceTimer greater than or equal to $\mathbf{T}_{usage\_timeout}$ or

(b) ReceivedInvalidFrame is TRUE,

then set PS to (PS+1) modulo ($\mathbf{N}_{max\_master}$+1); call SendFrame to transmit a Poll For Master frame to PS; set RetryCount to zero; set ReceivedInvalidFrame to FALSE; and re-enter the current state.

DeclareSoleMaster

If SoleMaster is FALSE and NS is equal to TS (no known successor node) and (PS+1) modulo ($\mathbf{N}_{max\_master}$+1) is equal to TS and either

(a) SilenceTimer is greater than or equal to $\mathbf{T}_{usage\_timeout}$ or

(b) ReceivedInvalidFrame is TRUE,

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then set SoleMaster TRUE to indicate that this station is the only master; set FrameCount to zero; set ReceivedInvalidFrame to FALSE; and enter the USE_TOKEN state.

9.5.6.9 ANSWER_DATA_REQUEST

The ANSWER_DATA_REQUEST state is entered when a BACnet Data Expecting Reply, a Test_Request, or a proprietary frame that expects a reply is received.

Reply

If a reply is available from the higher layers within $\mathbf{T}_{\text{reply\_delay}}$ after the reception of the final octet of the requesting frame (the mechanism used to determine this is a local matter),

then call SendFrame to transmit the reply frame and enter the IDLE state to wait for the next frame.

DeferredReply

If no reply will be available from the higher layers within $\mathbf{T}_{\text{reply\_delay}}$ after the reception of the final octet of the requesting frame (the mechanism used to determine this is a local matter),

then an immediate reply is not possible. Any reply shall wait until this node receives the token. Call SendFrame to transmit a Reply Postponed frame, and enter the IDLE state.

9.5.7 Slave Node Finite State Machine

The state machine for a slave node is similar to, but considerably simpler than, that for a master node. A slave node shall neither transmit nor receive segmented messages. If a slave node receives a segmented BACnet-Confirmed-Request-PDU, the node shall respond with a BACnet-Abort-PDU specifying abort-reason "segmentation not supported." Figure 9-5 shows the Slave Node state machine, which is described fully in the following text.

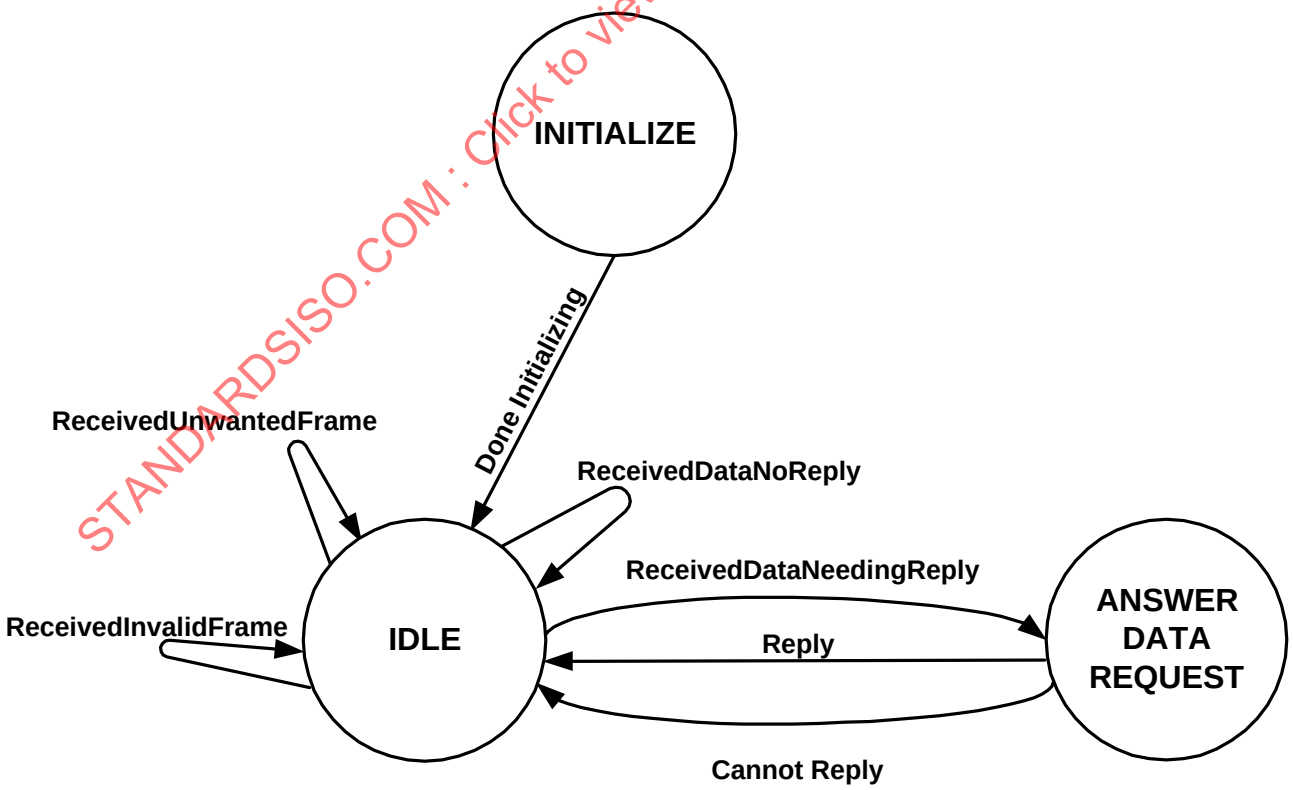

Figure 9-5. Slave Node State Machine

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9.5.7.1 INITIALIZE

When a slave node is powered up or reset, it shall unconditionally enter the INITIALIZE state.

DoneInitializing
Unconditionally,

set TS to the node's station address; set ReceivedValidFrame and ReceivedInvalidFrame to FALSE; and enter the IDLE state.

9.5.7.2 IDLE

In the IDLE state, the node waits for a frame.

ReceivedInvalidFrame
If ReceivedInvalidFrame is TRUE,

then an invalid frame was received. Set ReceivedInvalidFrame to FALSE, and enter the IDLE state to wait for the next frame.

ReceivedUnwantedFrame
If ReceivedValidFrame is TRUE and either

(a) DestinationAddress is not equal to either TS (this station) or 255 (broadcast) or

(b) DestinationAddress is equal to 255 (broadcast) and FrameType has a value of BACnet Data Expecting Reply, Test Request, or a proprietary type known to this node that expects a reply (such frames may not be broadcast) or

(c) FrameType has a value of Token, Poll For Master, Reply To Poll For Master, Reply Postponed, or a standard or proprietary frame type not known to this node,

then an unexpected or unwanted frame was received. Set ReceivedValidFrame to FALSE, and enter the IDLE state to wait for the next frame.

ReceivedDataNoReply
If ReceivedValidFrame is TRUE and DestinationAddress is equal to either TS (this station) or 255 (broadcast) and FrameType is equal to BACnet Data Not Expecting Reply, Test_Response, or a proprietary type known to this node that does not expect a reply,

then indicate successful reception to the higher layers, set ReceivedValidFrame to FALSE, and enter the IDLE state.

ReceivedDataNeedingReply
If ReceivedValidFrame is TRUE and DestinationAddress is equal to TS (this station) and FrameType is equal to BACnet Data Expecting Reply, Test Request, or a proprietary type known to this node that expects a reply,

then indicate successful reception to the higher layers (management entity in the case of Test_Request), set ReceivedValidFrame to FALSE, and enter the ANSWER_DATA_REQUEST state.

9.5.7.3 ANSWER_DATA_REQUEST

The ANSWER_DATA_REQUEST state is entered when a BACnet Data Expecting Reply, a Test_Request, or a proprietary frame that expects a reply is received.

Reply
If a reply is available from the higher layers within $\mathbf{T}_{\text{reply\_delay}}$ after the reception of the final octet of the requesting frame (the mechanism used to determine this is a local matter),

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then call SendFrame to transmit the reply frame, and enter the IDLE state to wait for the next frame.

CannotReply

If no reply will be available from the higher layers within $\mathbf{T}_{\mathbf{reply\_delay}}$ after the reception of the final octet of the requesting frame (the mechanism used to determine this is a local matter),

then no reply is possible. Enter the IDLE state.

9.6 Cyclic Redundancy Check (CRC)

MS/TP uses Cyclic Redundancy Checks (CRC) to provide error-detection. CRCs have a number of advantages over simpler error detection methods, such as parity or checksums, which are commonly used with UART-based networks. The major drawbacks of parity are that it adds one bit of overhead to each transmitted octet and that it will not detect an even number of errors within one octet. Exclusive OR checksums, sometimes called longitudinal parity, offer reduced overhead over octet parity but suffer from the same inability to detect an even number of errors in a given bit position. Additive checksums are similar but the exact error detection characteristics are dependent on bit position.

ISO 8802-3, ARCNET, and many other standard and proprietary communications systems use more robust CRCs. Mathematically, a CRC is the remainder that results when a data stream (such as a frame) taken as a binary number is divided modulo two by a generator polynomial. The proof of the error-detecting properties of the CRC and the selection of appropriate polynomials are beyond the scope of this document.

The MS/TP frame header CRC uses the polynomial

$$G(X) = X^8 + X^7 + 1$$

In operation, at the transmitter, the initial content of the CRC register of the device computing the remainder of the division is preset to all ones. The register is then modified by division by the generator polynomial G(x) of the Frame Type, Destination Address, Source Address, and Length fields. The ones-complement of the resulting remainder is transmitted as the 8-bit Header CRC.

At the receiver, the initial content of the CRC register of the device computing the remainder of the division is preset to all ones. The register is then modified by division by the generator polynomial G(x) of the Frame Type, Destination Address, Source Address, Length, and Header CRC fields of the incoming message. In the absence of transmission errors, the resultant remainder will be:

0101 0101 (x^0 through x^7, respectively).

The MS/TP data CRC uses the CRC-CCITT polynomial

$$G(X) = X^{16} + X^{12} + X^5 + 1$$

In operation, at the transmitter, the initial content of the CRC register of the device computing the remainder of the division is preset to all ones. The register is then modified by division by the generator polynomial G(x) of the Data field. The ones-complement of the resulting remainder is transmitted, least significant octet first, as the 16 bit Data CRC.

At the receiver, the initial content of the CRC register of the device computing the remainder of the division is preset to all ones. The register is then modified by division by the generator polynomial G(x) of the Data and Data CRC fields of the incoming message. In the absence of transmission errors, the resultant remainder will be

1111 0000 1011 1000 (x^0 through x^{15}, respectively).

NOTE: The initialization of the CRC register to all ones and the complementing of the register before transmission prevent the CRC from having a value of zero if the covered field is all zeros.

Annex G describes the implementation of the CRC algorithms in software.

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9.7 Interfacing MS/TP LANs with Other BACnet LANs

9.7.1 Routing of Messages from MS/TP

When a network entity with routing capability receives from a directly connected MS/TP data link an NPDU whose 'data_expecting_reply' parameter is TRUE and the NPDU is to be routed to another network according to the procedures of Clause 6, the network entity shall direct the MS/TP data link to transmit a Reply Postponed frame before attempting to route the NPDU. This allows the routing node to leave the ANSWER_DATA_REQUEST state and the sending node to leave the WAIT_FOR_REPLY state before the potentially lengthy process of routing the NPDU is begun.

9.7.2 Routing of Messages to MS/TP

When a network entity issues a DL_UNITDATA.request to a directly connected MS/TP data link, it shall set the 'data_expecting_reply' parameter of the DL-UNITDATA.request equal to the value of the 'data_expecting_reply' parameter of the network protocol control information of the NPDU, which is transferred in the 'data' parameter of the request.

9.8 Responding BACnet User Processing of Messages from MS/TP

In 5.4.5.3, AWAIT_RESPONSE, the following transition shall be added:

PostponeReply

> If a CONF_SERV.response will not be received from the local application layer early enough that a reply MS/TP frame would be received by the remote node within $\mathbf{T}_{\text{reply\_timeout}}$ (defined in 9.5.3) after the transmission of the original BACnet-Confirmed-Request-PDU (the means of this determination are a local matter),
>
> then direct the MS/TP data link to transmit a Reply Postponed frame and enter the AWAIT_RESPONSE state.

In 5.4.5.3, AWAIT_RESPONSE, in the transition SendSegmentedComplexACK, the text "transmit a BACnet-ComplexACK-PDU..." shall be replaced by "direct the MS/TP data link to transmit a Reply Postponed frame; transmit a BACnet-ComplexACK-PDU...." (It is necessary to postpone the reply because transmission of the segmented ComplexACK cannot begin until the node holds the token.)

9.9 Repeaters

If any of the limits in 9.2.1 and 9.2.2 are exceeded, one or more repeaters is required. An MS/TP EIA-485 Repeater is defined as an active device that provides selective interconnection between two or more segments of MS/TP cable. The repeater contains logic that detects and passes signals received from one segment onto all other segments. The segment from which signals are received is determined according to a priority algorithm.

The method used by a repeater to detect signals and to distinguish them from noise is a local matter, subject to the following constraints:

(a) The repeater may not lengthen or shorten the duration of any bit of the output data stream by more than 2% relative to the input data stream.

(b) The repeater may not delay the output data stream by more than two bit times relative to the input data stream.

No more than 10 bit times of delay shall exist in the path between any two nodes of an MS/TP network. This corresponds to five repeaters with worst-case delays (if delay by the medium is negligible, as it will be at all except the highest baud rates) or a greater number of repeaters with smaller delays.

The minimum value of repeater turnoff delay $\mathbf{T}_{\text{roff}}$ is dictated by the maximum amount of idle line allowed during a single frame, $\mathbf{T}_{\text{frame\_gap}}$. If the value of the octet immediately preceding the idle is X'FF', then there may be up to $9+\mathbf{T}_{\text{frame\_gap}} = 29$ bit times of one state between zero (start) bits. Thus, $\mathbf{T}_{\text{roff}}$ must be larger than 29 bit times if it is not to turn off during the transmission of a frame.

In order to avoid contention between repeater turnoff and the beginning of the next frame, the repeater turnoff delay $\mathbf{T}_{\text{roff}}$ may be no larger than $\mathbf{T}_{\text{turnaround}}$ bit times, and a node may not enable its driver until a minimum of $\mathbf{T}_{\text{turnaround}}$ after the end of the previous frame. Thus

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29 bit times < $\mathbf{T_{roff}}$ < 40 bit times.

An N-way repeater may be represented by an N+1 state finite state machine. One state is the IDLE state, and the others each receive from one segment and re-transmit on all other segments. The repeater state machine uses the timer PortIdle to control the return to the IDLE state. PortIdle shall have a resolution of one bit time or finer.

9.9.1 IDLE

In the IDLE state, all receivers are enabled and all transmitters are disabled. The repeater remains in the IDLE state until a logical zero (i.e., the beginning of a start bit) is detected on some port.

When a zero is detected, the repeater disables all receivers, except the one on which the zero was detected, and enables all transmitters, except the one associated with the port on which the zero was detected. The repeater then enters the state associated with the active receiver port. If a zero is detected simultaneously on more than one port, the method used to arbitrate between them is a local matter.

Port1Active
If a zero is detected on Port 1,

then disable all receivers except Port 1; enable all transmitters except Port 1; pass the zero to all enabled transmitters; set PortIdle to zero; and enter the PORT_1_ACTIVE state.

Port2Active
If a zero is detected on Port 2,

then disable all receivers except Port 2; enable all transmitters except Port 2; pass the zero to all enabled transmitters; set PortIdle to zero; and enter the PORT_2_ACTIVE state.

This may be extended to as many ports as desired simply by adding transitions and PORT_N_ACTIVE states.

9.9.2 PORT_i_ACTIVE

In the PORT_i_ACTIVE state, the Repeater passes signals from Port i to all other ports. The Repeater will remain in this state until Port i becomes idle. Idleness is defined as the absence of the logical zero state at Port i for more than $\mathbf{T_{roff}}$ bit times.

When idleness is detected, all transmitters are disabled, all receivers are enabled, and the Repeater enters the IDLE state to await renewed activity.

PortActive0
If a zero is detected on Port i,

then pass the zero to all other ports, set PortIdle to zero, and re-enter the current state.

PortActive1
If PortIdle is less than $\mathbf{T_{roff}}$ and a one is detected at Port i,

then pass the one to all other ports and re-enter the current state.

PortInactive
If PortIdle is greater than or equal to $\mathbf{T_{roff}}$,

then disable all transmitters, enable all receivers, and enter the IDLE state.

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10 DATA LINK/PHYSICAL LAYERS: POINT-TO-POINT (PTP)

This clause defines a data link layer protocol by which two BACnet devices may communicate using a variety of point-to-point (PTP) communication mechanisms. These mechanisms may be accessed through an EIA-232 or bus-level interface to modems, line drivers, or other data communication equipment. The specific physical connection composing the PTP connection is a local matter.

This clause does not attempt to specify the means by which the virtual or physical connection is established. Rather, it specifies a protocol that allows two BACnet network layer entities to establish a BACnet PTP data link connection, reliably exchange BACnet PDUs, and perform an orderly termination of a BACnet PTP connection using an already established physical connection.

This data link layer protocol addresses the particular characteristics associated with a PTP connection. A PTP connection differs from other BACnet data link/physical layer options in several ways: it is capable of full duplex operation, it may be temporary in nature, and it may be significantly slower. The PTP protocol is only used between devices that are half- routers. See 6.7.

This protocol does not assume that the answering device is in a state where it can accept BACnet PDUs containing binary information. For instance, the same serial device port that is dialed into by a BACnet device may also be dialed into and logged onto by a human operator using a simple ANSI X3.4 terminal. Therefore, the connection establishment procedure is initiated using an ANSI X3.4 printable character sequence.

The connection process also provides for optional password protection. The configuration and checking of the password parameter is considered to be a local matter.

10.1 Overview

Once a physical connection has been established between the calling device and the answering device, a sequence of frames are exchanged to establish a BACnet connection. If the connection is established, the two devices may freely exchange BACnet PDUs. Either the calling device or the answering device may initiate a termination of the connection. The connection remains until a request for termination has been issued by either device, either device determines that the physical layer connection has been lost, or until a local timer expires, indicating that the peer device is no longer active. Unlike other BACnet data link protocols, the PTP protocol is acknowledged using an alternating bit approach. It should be noted that the protocol allows PDUs to be exchanged between the two devices simultaneously to take advantage of full duplex operation.

Note that it is also possible that two devices are permanently connected at the physical layer in which case the BACnet connect sequence is performed only once, at initialization time. In this case both devices would be running the PTP data link layer and would always be capable of sending and receiving BACnet PTP data link frames.

10.2 Service Specification

PTP includes a data link layer sufficient to provide to the BACnet network layer the same services as are offered by ISO 8802-2 Type 1. Because PTP is a connection-oriented data link layer, additional primitives are needed to manage the connection establishment and termination phases. PTP does not provide all of the functionality of ISO 8802-2 Type 2.

This subclause describes the primitives and parameters associated with the provided services. The parameters are described in an abstract sense, which does not constrain the implementation method. These primitives provide an interface to the BACnet network layer consistent with the other BACnet data link options except for the addition of connection management primitives.

10.2.1 DL-UNITDATA.request

10.2.1.1 Function

This primitive is the service request primitive for the unacknowledged connectionless-mode data transfer service.

10.2.1.2 Semantics of the Service Primitive

The primitive shall provide parameters as follows:

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DL-UNITDATA.request (
source_address,
destination_address,
data,
priority
)

Each source and destination address consists of the logical concatenation of a medium access control (MAC) address and a link service access point (LSAP). However, since PTP does not define or use MAC addresses and since it supports only the BACnet network layer, the 'source_address' and 'destination_address' parameters are ignored.

The 'data' parameter specifies the link service data unit (LSDU) to be transferred by the PTP entity.

The 'priority' parameter specifies the priority desired for the data unit transfer. The priority parameter is ignored by PTP.

10.2.1.3 When Generated

This primitive is passed from the network layer to the PTP entity to request that a network protocol data unit (NPDU) be sent to one or more remote LSAPs using unacknowledged connectionless-mode procedures.

10.2.1.4 Effect on Receipt

Receipt of this primitive causes the PTP entity to attempt to send the NPDU using unacknowledged connectionless-mode procedures.

10.2.2 DL-UNITDATA.indication

10.2.2.1 Function

This primitive is the service indication primitive for the unacknowledged connectionless-mode data transfer service.

10.2.2.2 Semantics of the Service Primitive

The primitive shall provide the following parameters:

DL-UNITDATA.indication (
source_address,
destination_address,
data,
priority
)

Each source and destination address consists of the logical concatenation of a medium access control (MAC) address and a link service access point (LSAP). However, since PTP does not define or use MAC addresses, and since it supports only the BACnet network layer, the 'source_address' and 'destination_address' parameters are ignored.

The 'data' parameter specifies the link service data unit that has been received by the PTP entity.

The 'priority' parameter specifies the priority desired for the data unit transfer. The priority parameter is ignored by PTP.

10.2.2.3 When Generated

This primitive is passed from the PTP entity to the network layer to indicate the arrival of an NPDU from the specified remote entity.

10.2.2.4 Effect on Receipt

The effect of receipt of this primitive by the network layer is unspecified.

10.2.3 Test_Request and Test_Response

ISO 8802-2 Type 1 defines XID and TEST PDUs and procedures but does not define an interface to invoke them from the network layer. Test_Request and Test_Response PDUs and procedures have been defined for PTP to accomplish the same

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functions. Because PTP supports only the equivalent of a single LSAP, these PDUs are sufficient to implement the relevant aspects of XID as well.

The response with Test_Response to a Test_Request PDU is mandatory for all PTP nodes. The origination of a Test_Request PDU is optional.

10.2.3.1 Use of Test_Request and Test_Response for ISO 8802-2 TEST Functions

The TEST function provides a facility to conduct loopback tests of the PTP to PTP transmission path. Successful completion of the test consists of sending a Test_Request PDU with a particular information field to the designated destination, and receiving, in return, the identical information field in a Test_Response PDU.

If a receiving node can successfully receive and return the information field, it shall do so. If it cannot receive and return the entire information field but can detect the reception of a valid Test_Request frame (for example, by computing the CRC on octets as they are received), then the receiving node shall discard the information field and return a Test_Response containing no information field. If the receiving node cannot detect the valid reception of frames with overlength information fields, then no response shall be returned.

10.2.3.2 Use of Test_Request and Test_Response for ISO 8802-2 XID functions

ISO 8802-2 describes seven possible uses of XID:

(a) XID can be used with a null DSAP and null SSAP as an "Are You There" test. Since PTP supports only the equivalent of a single LSAP, the Test_Request PDU with no data can perform this function.

(b) XID can be used with a group or global DSAP to identify group members or all active stations. Since PTP supports only the equivalent of a single LSAP, the Test_Request PDU with no data can perform this function.

(c) XID can be used for a duplicate address check.

(d) Class II LLCs may use XID to determine window size. PTP does not support Class II operation.

(e) XID may be used to identify the class of each LLC. Since PTP supports only Class I operation, this is a trivial operation.

(f) XID may be used to identify the service types supported by each LSAP. Since PTP supports only Class I operation, this is a trivial operation.

(g) An LLC can announce its presence by transmitting an XID with global DSAP. Since PTP supports only one LSAP, the equivalent can be accomplished by transmitting a Test_Response PDU.

10.2.4 DL-CONNECT.request

10.2.4.1 Function

This primitive is the service request primitive for the connection establishment service.

10.2.4.2 Semantics of the Service Primitive

The primitive shall provide the following parameters:

```
DL-CONNECT.request (
        destination_address,
        password
        )
```

The 'destination_address' parameter specifies the information required by the PTP entity to initiate the establishment of a physical connection between the local and remote BACnet devices. Although, as stated at the beginning of this clause, the establishment of the physical connection is a local matter, it is likely that this parameter would convey information such as

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contained in the Port Info field of the Initialize-Routing-Table network layer message and subsequently stored in a node's routing table. See 6.4.7.

The 'password' parameter specifies the password to be used in the PTP connection process described in 10.4.8.

10.2.4.3 When Generated

This primitive is passed from the network layer to the PTP entity to request that a logical link connection be established.

10.2.4.4 Effect on Receipt

The receipt of this primitive causes the PTP entity to initiate establishment of a connection with the remote PTP entity.

10.2.5 DL-CONNECT.indication

10.2.5.1 Function

This primitive is the service indication primitive for the connection establishment service.

10.2.5.2 Semantics of the Service Primitive

The primitive provides no parameters.

10.2.5.3 When Generated

This primitive is passed from the PTP entity to the network layer to indicate that a logical link connection has been established.

10.2.5.4 Effect on Receipt

The network layer entity may use this connection for data unit transfer.

10.2.6 DL-CONNECT.confirm

10.2.6.1 Function

This primitive is the service confirmation primitive for the connection establishment service.

10.2.6.2 Semantics of the Service Primitive

The primitive shall provide the following parameter:

```
DL-CONNECT.confirm (
        status
        )
```

The 'status' parameter specifies whether or the not the connection has been successfully established.

10.2.6.3 When Generated

This primitive is passed from the PTP entity to the network layer to indicate that a logical link connection has been established.

10.2.6.4 Effect on Receipt

The network layer entity may use this connection for data unit transfer if the 'status' parameter indicates the successful establishment of a PTP connection.

10.2.7 DL-DISCONNECT.request

10.2.7.1 Function

This primitive is the service request primitive for the connection termination service.

10.2.7.2 Semantics of the Service Primitive

The primitive shall provide the following parameters:

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DL-DISCONNECT.request (
destination_address
)

The 'destination_address' parameter specifies the information required by the PTP entity to initiate the establishment of a physical connection between the local and remote BACnet devices. The PTP entity uses this same information to identify the particular PTP connection instance that is to be terminated.

10.2.7.3 When Generated

This primitive is passed from the network layer to the PTP entity to request that a logical link connection be terminated.

10.2.7.4 Effect on Receipt

The receipt of this primitive causes the PTP entity to initiate termination of a connection with the remote PTP entity.

10.2.8 DL-DISCONNECT.indication

10.2.8.1 Function

This primitive is the service indication primitive for the connection termination service.

10.2.8.2 Semantics of the Service Primitive

The primitive shall provide the following parameters:

DL-DISCONNECT.indication (
reason
)

The 'reason' parameter specifies the reason for the disconnection. The reasons for disconnection may include a request by the remote entity, loss of physical connection, or an error internal to the PTP sublayer.

10.2.8.3 When Generated

This primitive is passed from the PTP entity to the network layer to indicate that a logical link connection has been terminated.

10.2.8.4 Effect on Receipt

The network layer entity may no longer use this connection for data unit transfer.

10.2.9 DL-DISCONNECT.confirm

10.2.9.1 Function

This primitive is the service confirmation primitive for the connection termination service.

10.2.9.2 Semantics of the Service Primitive

The primitive shall provide the following parameters:

DL-DISCONNECT.confirm (
destination_address
)

The 'destination_address' parameter specifies the information required by the PTP entity to initiate the establishment of a physical connection between the local and remote BACnet devices. The network layer entity uses this same information to identify the particular PTP connection instance that has been terminated.

10.2.9.3 When Generated

This primitive is passed from the PTP entity to the network layer to indicate that a logical link connection has been terminated.

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10.2.9.4 Effect on Receipt

The network layer entity may no longer use this connection for data unit transfer.

10.3 Point-to-Point Frame Format

All PTP data link frames, with the exception of the ANSI X3.4 sequence used to initiate a PTP connection, have the following format:

Preamble	two octet preamble X'55FF'
Frame Type	one octet
Length	length of data field not including CRC, two octets, most significant octet first
Header CRC	one octet
Data	varies with frame type; variable length
Data CRC	(if data is present) two octets, least significant octet first

The Preamble, Frame Type, Length, and Header CRC are collectively known as the header segment of the frame. The Data and Data CRC are collectively known as the data segment of the frame. The Frame Type is used to distinguish between different types of MAC frames. Defined types are:

X'00'	Heartbeat XOFF
X'01'	Heartbeat XON
X'02'	Data 0
X'03'	Data 1
X'04'	Data Ack 0 XOFF
X'05'	Data Ack 1 XOFF
X'06'	Data Ack 0 XON
X'07'	Data Ack 1 XON
X'08'	Data Nak 0 XOFF
X'09'	Data Nak 1 XOFF
X'0A'	Data Nak 0 XON
X'0B'	Data Nak 1 XON
X'0C'	Connect Request
X'0D'	Connect Response
X'0E'	Disconnect Request
X'0F'	Disconnect Response
X'14'	Test_Request
X'15'	Test_Response

Frame Types X'00' through X'7F' are reserved by ASHRAE. Frame types X'10', X'11', and X '13' shall never be used for a valid frame type because of the character transparency method described in 10.3.1. Frame Types X'80' through X'FF' are available to vendors for proprietary (non-BACnet) frames. Proprietary PTP frames shall follow the same state machine transitions defined for Data frames.

The Data field is conditional on the Frame Type, as specified in the description of each Frame Type. If there is no Data field, then the length field shall be zero and the Data and Data CRC (data segment) shall be omitted.

The header CRC octet is the ones complement of the remainder that results when the Frame Type and Length fields are divided by the CRC polynomial

$$G(X) = X^8 + X^7 + 1.$$

The data CRC octets are the ones complement of the remainder that results when the Data field is divided by the CRC-CCITT polynomial

$$G(X) = X^{16} + X^{12} + X^5 + 1.$$

Annex G describes in detail the generation and checking of the CRCs.

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10.3.1 Character Transparency and Flow Control

In order to support modems that respond to flow control or other control characters, character stuffing is used to prevent transmission of these codes as part of the data. Where a value corresponding to a control character would appear in a frame, it shall be prefixed with a data link escape code (X'10') and the high order bit shall be set in the value as transmitted. The control characters listed below shall be encoded in this manner. Implementations shall be able to receive and decode all encoded control characters.

X'10'	(DLE)	=>	X'10' X'90'
X'11'	(XON)	=>	X'10' X'91'
X'13'	(XOFF)	=>	X'10' X'93'

The characters X'11' (XON) and X'13' (XOFF) are never transmitted by the SendFrame procedure described in 10.4.4 and are ignored by the Receive Frame state machine described in 10.4.7. The use of these characters or of Request To Send (RTS), Clear To Send (CTS), or other EIA-232 control lines for flow control purposes is a local matter. The use of such methods of flow control is allowed only between a PTP device and local equipment such as a modem. Flow control between PTP devices shall be implemented using the flow control frames defined in 10.3.

10.3.2 Frame Types X'00' and X'01': Heartbeat Frames

A frame of one of these types is transmitted by each device periodically when no other data are ready to transmit, to indicate to the peer device that the data link is still active. Heartbeat frames contain no data segment. A type X'00' frame is transmitted to indicate to the peer device that the local device is not ready to accept Data frames. A type X'01' frame is transmitted to indicate readiness to receive Data frames.

10.3.3 Frame Types X'02' and X'03': Data Frames

A frame of one of these types is transmitted to convey data (NPDUs) to the peer device. The length of the data field of a Data frame may range from 0 to 501 octets. Successive transmissions alternate frame types; type X'02' corresponds to transmit sequence number 0, and type X'03' corresponds to transmit sequence number 1.

10.3.4 Frame Types X'04' through X'07': Data Ack Frames

A frame of one of these types is transmitted to acknowledge a correctly received Data frame. Data Ack frames contain no data segment. Frame types X'04' and X'06' acknowledge receipt of Data frames with sequence number 0 (type X'02'). Frame types X'05' and X'07' acknowledge receipt of Data frames with sequence number 1 (type X'03'). Frame types X'04' and X'05' indicate that the device is not ready to receive additional Data frames (XOFF). Frame types X'06' and X'07' indicate that the device is ready to receive additional Data frames (XON).

10.3.5 Frame Types X'08' through X'0B': Data Nak Frames

A frame of one of these types is used to reject an incorrectly received Data frame. Data Nak frames are transmitted when the header segment of a Data frame has been correctly received but the data segment of the frame contains an error or when a Data frame cannot be accepted due to receiver buffer limitations. Data Nak frames contain no data segment. Frame types X'08' and X'0A' reject Data frames with sequence number 0 (type X'02'). Frame types X'09' and X'0B' reject Data frames with sequence number 1 (type X'03'). Frame types X'08' and X'09' indicate that the device is not ready to receive additional Data frames (XOFF). Frame types X'0A' and X'0B' indicate that the device is ready to receive additional Data frames (XON).

10.3.6 Frame Type X'0C': Connect Request Frame

The Connect Request frame is issued by the answering device in an attempt to establish a BACnet connection. Connect Request frames contain no data segment.

10.3.7 Frame Type X'0D': Connect Response Frame

The Connect Response frame is issued by a device in response to a received Connect Request frame. The data field of the Connect Response frame, if present, contains a password. The length and content of the optional password field are a local matter.

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10.3.8 Frame Type X'0E': Disconnect Request Frame

The Disconnect Request frame may be issued by either device when it wishes to discontinue the BACnet PTP dialogue. The data field of the frame conveys the reason for requesting a disconnect and shall be one octet in length. The permissible values for the data are:

X'00' no more data needs to be transmitted,
X'01' the peer process is being preempted,
X'02' the received password is invalid,
X'03' other.

10.3.9 Frame Type X'0F': Disconnect Response Frame

The Disconnect Response frame is used to acknowledge a previously received Disconnect Request frame. The Disconnect Response frame indicates that the responding device accepts the request to disconnect. Disconnect Response frames contain no data segment.

10.3.10 Frame Type X'14': Test_Request

This frame is used to initiate a loopback test of the PTP transmission path. The use of this frame is described in detail in 10.2.3. The length of the data field of a Test_Request frame may range from 0 to 501 octets.

10.3.11 Frame Type X'15': Test_Response

This frame is used to reply to a Test_Request frame. The use of this frame is described in detail in 10.2.3. The length of the data field of a Test_Response frame may range from 0 to 501 octets. The data, if present, shall be those that were present in the initiating Test_Request.

10.4 PTP Medium Access Control Protocol

This subclause defines the PTP protocol. The protocol definition has been broken into several discrete parts that collectively describe and define the entire PTP protocol. The first part presents a universal asynchronous receiver transmitter (UART) model of the hardware platform. This is followed by definitions of the variables and constants used to define the protocol. A finite state machine is used to define in detail the process of receiving PTP frames (see 10.4.7). An informal procedure describes in detail the process of transmitting a PTP frame (see 10.4.4). These details are referenced in subsequent subclauses, which define the protocol at a higher level of abstraction.

The process of establishing a PTP connection and terminating a PTP connection is defined by a finite state machine called the Connection State Machine (see 10.4.9). The PTP protocol is full duplex. Thus, when a PTP connection is active, each device may simultaneously play the role of transmitting and receiving PTP messages. Two separate finite-state machines define the aspects of the protocol that pertain to these two roles. These finite state machines are call the Transmission State Machine (see 10.4.10) and the Reception State Machine (see 10.4.11). The Transmission State Machine and the Reception State Machine are assumed to operate concurrently whenever the Connection State Machine is in the CONNECTED state. In this model, the Reception State Machine and the Transmission State Machine exchange information through the use of shared variables. The details of transmitting and receiving a PTP frame are described by the SendFrame, SendHeaderOctet, and SendOctet procedures and the ReceiveFrame state machine respectively.

10.4.1 UART Receiver Model

The receiver interface to a UART is modeled as a data register and two Boolean flags. These are intended to closely resemble the functions of commercial UART chips but in a generic and nonprescriptive fashion. The model is used by both the procedural and state machine descriptions.

10.4.1.1 DataRegister

The DataRegister holds the octet most recently received. The contents of this register after the occurrence of a framing or overrun error are not specified.

10.4.1.2 DataAvailable

The flag DataAvailable is TRUE if an octet is available in DataRegister. A means of setting this flag to FALSE when the associated data have been read from DataRegister shall be provided. Many common UARTs set DataAvailable FALSE automatically when DataRegister is read.

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10.4.1.3 ReceiveError

The flag ReceiveError is TRUE if an error is detected during the reception of an octet. Many common UARTs detect several types of receive errors, in particular framing errors and overrun errors. ReceiveError shall be TRUE if any of these errors is detected.

A framing error occurs if a logical zero is received when a stop bit (logical one) is expected.

An overrun error occurs if an octet is received before an earlier octet is read from DataRegister. In general, the occurrence of overrun errors is evidence of improper design. However, it is recognized that critical system events may cause overrun errors to occur from time to time. The inclusion of this error in the state machine processing ensures that such errors are handled in a deterministic fashion.

A means of setting ReceiveError to FALSE when the associated error has been recognized shall be provided.

10.4.2 Variables

The variables and timers used by the PTP protocol are described in this subclause.

Ack0Received A Boolean flag indicating whether (TRUE) or not (FALSE) the Reception State Machine has received an acknowledgment that a previous Data frame with a sequence number of 0 was correctly received.

Ack1Received A Boolean flag indicating whether (TRUE) or not (FALSE) the Reception State Machine has received an acknowledgment that a previous Data frame with a sequence number of 1 was correctly received.

DataCRC Used to accumulate the CRC on the data field of a frame.

DataLength An unsigned integer in the range from 0 to 501 that indicates the expected number of octets in the Data field of a PTP frame. This value is derived from the Length field of the received PTP frame. The value of DataLength excludes any data link escape octets (X'10') and the octets in the Data CRC.

DLE_Mask A bit mask used to used to process received octets in order to account for the fact that they may be encoded.

FrameType Used by the Receive State Machine to store the frame type of a received frame.

HeaderCRC Used to accumulate the CRC of the header of a frame.

HeartbeatTimer A timer used to initiate Heartbeat frames to keep the link active.

InactivityTimer A timer used to monitor the time since this station received a frame.

Index Indicates the location of the end of the data in the InputBuffer array.

InputBuffer[] An array of octets used to store data octets as they are received. InputBuffer is indexed from 0 to InputBufferSize-1. The maximum size of the data field of a frame is 501 octets.

InputBufferSize The number of elements in the array InputBuffer[].

Nak0Received A Boolean flag indicating whether (TRUE) or not (FALSE) the Reception State Machine has received a reject in response to a previous Data frame with a sequence number of 0.

Nak1Received A Boolean flag indicating whether (TRUE) or not (FALSE) the Reception State Machine has received a reject in response to a previous Data frame with a sequence number of 1.

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ReceivedInvalidFrame A Boolean flag set to TRUE by the Receive Frame Machine if an error of any type is detected. Errors include octet framing, overrun, CRC, and receive buffer overflow.

ReceivedValidFrame A Boolean flag set to TRUE by the Receive Frame Machine if a valid frame has been received.

ReceptionBlocked An enumerated variable indicating whether or not reception of Data frames is blocked. The values of the enumeration are BLOCKED, ALMOST_BLOCKED, and NOT_BLOCKED. The value of this variable is determined by a buffer manager. The buffer manager process is a local matter.

ResponseTimer A timer used to monitor the time spent waiting for a response from the remote device.

RetryCount A counter of transmission retries.

RxSequenceNumber An integer containing the sequence number (0 or 1) expected for the next Data frame to be received.

SendingFrameNow A Boolean flag indicating whether (TRUE) or not (FALSE) an invocation of the SendFrame procedure is currently in the process of transmitting octets.

SilenceTimer A timer used to monitor the time since this station received an octet.

TransmissionBlocked A Boolean flag indicating whether (TRUE) or not (FALSE) frame transmission has been blocked. The value of this flag is determined by the receipt of XON and XOFF frames from the peer device.

TransmitDataCRC Used to accumulate the CRC on the data field of a frame being transmitted.

TransmitHeaderCRC Used to accumulate the CRC on the header of a frame being transmitted.

TxSequenceNumber An integer containing the sequence number (0 or 1) for the next Data frame to be transmitted.

10.4.3 Parameters

The following parameters are used in the PTP data link protocol.

$N_{retries}$ The maximum number of times a frame shall be sent before an error is reported. The value of $N_{retries}$ shall be 3.

T_{conn_rqst} The maximum time allowed by a calling device for an answering device to issue a PTP Connect Request frame once the physical connection has been established and the ANSI X3.4 trigger sequence has been transmitted. The value of T_{conn_rqst} shall be 15 seconds. This represents the processing time required for the answering device to recognize the ANSI X3.4 trigger sequence, prepare the communication port for PTP protocol, and transmit the Connect Request frame.

T_{conn_rsp} The maximum time allowed to respond to a PTP Connect Request frame with a PTP Connect Response frame. The value of T_{conn_rsp} shall be 15 seconds. This represents the time required for the calling device to process the Connect Request frame and the time required to transmit the Connect Response frame.

T_{frame_abort} The maximum time allowed between receipt of octets in a frame after which time the receiving device shall assume a transmission error. The value of T_{frame_abort} shall be 2 seconds.

$T_{heartbeat}$ The maximum delay between frame transmissions before a heartbeat frame must be sent. The value of $T_{heartbeat}$ shall be 15 seconds.

$T_{inactivity}$ The maximum amount of time the InactivityTimer may attain, after which a device may assume that the PTP connection has been disrupted. The value of $T_{inactivity}$ shall be 60 seconds.

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$T_{response}$ The maximum time allowed waiting for a Data Ack frame in response to a Data frame. The value of $T_{response}$ shall be 5 seconds.

10.4.4 SendFrame Procedure

This subclause describes the transmission of PTP data link frames. A mutual exclusion semaphore, SendingFrameNow, synchronizes access to the functionality by multiple, asynchronous invocations. Frames are transmitted in two parts, the header segment and the data segment.

NOTE: At the implementer's option, character-level flow control may be implemented by conditioning the transmission of octets by this procedure based on the reception of the characters XOFF (X'13') and XON (X'11') or by the presence or absence of active levels on certain EIA-232 control lines. Such character-level flow control is a local matter.

(a) If SendingFrameNow is TRUE, then wait for the other invocation of the SendFrame procedure to set SendingFrameNow to FALSE.

(b) Set SendingFrameNow to TRUE.

(c) Transmit the preamble octets X'55' and X'FF'.

(d) Initialize TransmitHeaderCRC to X'FF'.

(e) Call SendHeaderOctet to transmit the frame type and the high and low data length octets.

(f) Call SendOctet to transmit the one's-complement of TransmitHeaderCRC.

(g) If the data length is zero, proceed to step (m). Otherwise, proceed to step (h).

(h) Initialize TransmitDataCRC to X'FFFF'.

(i) Accumulate each data octet into TransmitDataCRC.

(j) Call SendOctet to transmit each data octet.

(k) Call SendOctet to transmit the one's-complement of the least significant octet of TransmitDataCRC.

(l) Call SendOctet to transmit the one's-complement of the most significant octet of TransmitDataCRC.

(m) Set HeartbeatTimer to zero; set SendingFrameNow to FALSE. Transmission is complete.

10.4.5 SendHeaderOctet Procedure

This subclause describes the transmission of the header octets of PTP frames.

(a) Accumulate the header octet into TransmitHeaderCRC.

(b) Call SendOctet to transmit the header octet.

10.4.6 SendOctet Procedure

This subclause describes the transmission of octets of PTP frames.

(a) If the value of the octet is not X'10', X'11', or X'13', then transmit the octet.

(b) If the value of the octet is X'10', X'11', or X'13', then transmit the value X'10', set the high order bit of the octet, and transmit the modified octet.

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10.4.7 Receive Frame State Machine

This subclause describes the reception of a PTP frame by a BACnet device. The description of operation is as a finite state machine. Figure 10-1 shows the Receive Frame state machine, which is described fully in this subclause. Each state is given a name, specified in all capital letters. Transitions are also named, in mixed upper- and lowercase letters. Transitions are described as a series of conditions followed by a series of actions to be taken if the conditions are met. The final action in each transition is entry into a new state, which may be the same as the current state.

The Receive Frame state machine operates independently from the other PTP state machines, communicating with them by means of flags and other variables. The description assumes that the other state machines can process received frames and other indications from the Receive Frame state machine before the next frame begins. The means by which this behavior is implemented are a local matter.

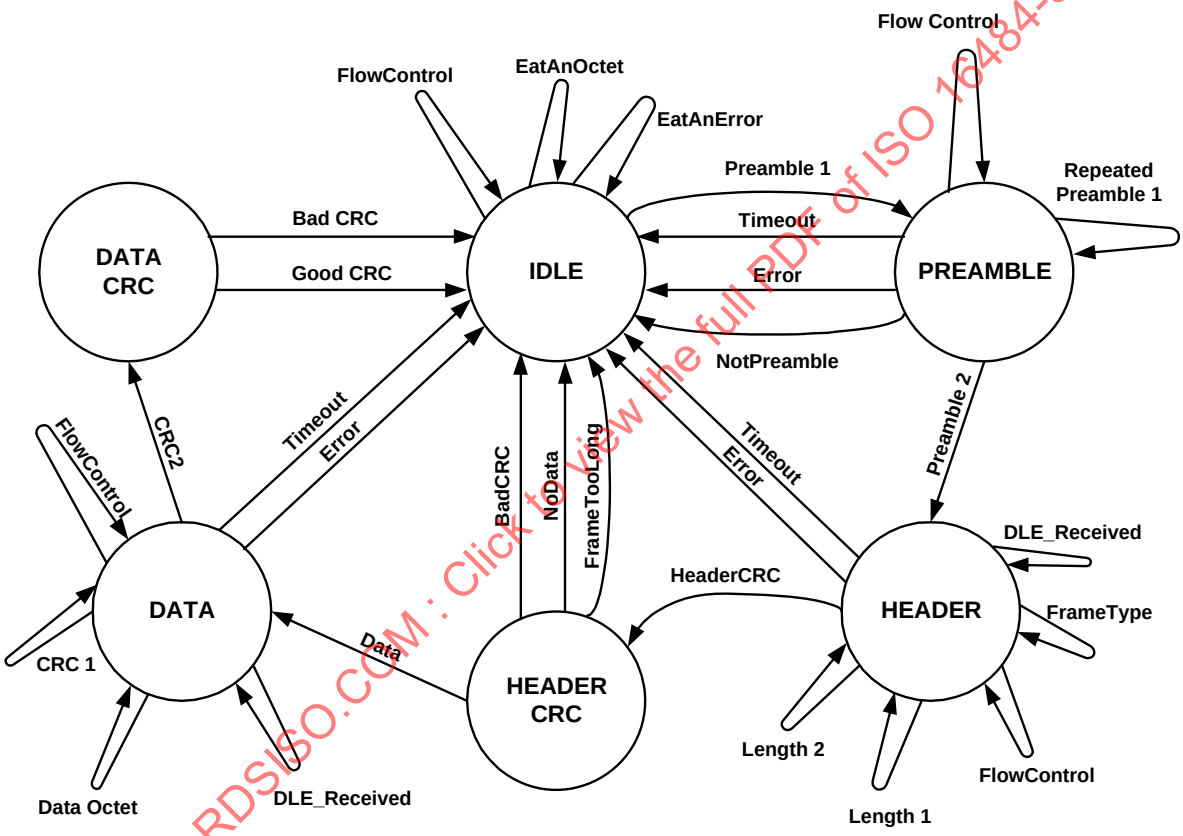

Figure 10-1. Receive Frame State Machine.

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10.4.7.1 IDLE

In the IDLE state, the node waits for the beginning of a frame.

EatAnError

If ReceiveError is TRUE,

then set SilenceTimer to zero; set ReceiveError to FALSE; and enter the IDLE state to wait for the start of a frame.

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FlowControl

If ReceiveError is FALSE and DataAvailable is TRUE and the content of DataRegister is equal to either X'11' or X'13',

then set SilenceTimer to zero; set DataAvailable to FALSE; and enter the IDLE state.

EatAnOctet

If ReceiveError is FALSE and DataAvailable is TRUE and the content of DataRegister is not equal to X'55', X'11', or X'13',

then set SilenceTimer to zero; set DataAvailable to FALSE; and enter the IDLE state to wait for the start of a frame.

Preamble1

If ReceiveError is FALSE and DataAvailable is TRUE and the content of DataRegister is equal to X'55',

then set SilenceTimer to zero; set DataAvailable to FALSE; set ReceivedValidFrame to FALSE; set ReceivedInvalidFrame to FALSE; and enter the PREAMBLE state to receive the remainder of the frame.

10.4.7.2 PREAMBLE

In the PREAMBLE state, the node waits for the second octet of the preamble.

Timeout

If SilenceTimer is greater than $\mathbf{T}_{\mathbf{frame\_abort}}$,

then a correct preamble has not been received. Enter the IDLE state to wait for the start of a frame.

Error

If ReceiveError is TRUE,

then set SilenceTimer to zero; set ReceiveError to FALSE; and enter the IDLE state to wait for the start of a frame.

FlowControl

If ReceiveError is FALSE and DataAvailable is TRUE and the content of DataRegister is equal to either X'11' or X'13',

then set SilenceTimer to zero; set DataAvailable to FALSE; and enter the PREAMBLE state.

RepeatedPreamble1

If ReceiveError is FALSE and DataAvailable is TRUE and the contents of DataRegister is equal to X'55',

then set SilenceTimer to zero; set DataAvailable to FALSE; and enter the PREAMBLE state to wait for the second preamble octet.

NotPreamble

If ReceiveError is FALSE and DataAvailable is TRUE and the content of DataRegister is not equal to X'FF', X'55', X'11', or X'13',

then set SilenceTimer to zero; set DataAvailable to FALSE; and enter the IDLE state to wait for the start of a frame.

Preamble2

If ReceiveError is FALSE and DataAvailable is TRUE and the content of DataRegister is equal to X'FF',

then set SilenceTimer to zero; set DLE_Mask to X'00'; set HeaderCRC to X'FF'; set DataAvailable to FALSE; set Index to zero; and enter the HEADER state to receive the remainder of the frame.

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10.4.7.3 HEADER

In the HEADER state, the node waits for the fixed frame header.

Timeout

If SilenceTimer is greater than $\mathbf{T}_{\text{frame\_abort}}$,

then enter the IDLE state to wait for the start of a frame.

Error

If ReceiveError is TRUE,

then set SilenceTimer to zero; set ReceiveError to FALSE; and enter the IDLE state to wait for the start of a frame.

FlowControl

If ReceiveError is FALSE and DataAvailable is TRUE and the contents of DataRegister is equal to either X'11' or X'13',

then set SilenceTimer to zero; set DataAvailable to FALSE; and enter the HEADER state.

DLE_Received

If ReceiveError is FALSE and DataAvailable is TRUE and the content of the DataRegister is equal to X'10',

then set DLE_Mask to X'80' and enter the HEADER state.

FrameType

If ReceiveError is FALSE and DataAvailable is TRUE and Index is 0 and the content of DataRegister is not equal to X'10', X'11', or X'13',

then perform a bitwise AND of the ones-complement of the DLE_Mask and the contents of DataRegister; save the result as FrameType; accumulate the result into HeaderCRC; set DataAvailable to FALSE; set DLE_Mask to X'00'; set Index to 1; and enter the HEADER state.

Length1

If ReceiveError is FALSE and DataAvailable is TRUE and Index is 1 and the content of DataRegister is not equal to X'10', X'11', or X'13',

then perform a bitwise AND of the ones-complement of the DLE_Mask and the contents of DataRegister; accumulate the result into HeaderCRC; multiply the result by 256 and save this result as DataLength; set DataAvailable to FALSE; set DLE_Mask to X'00'; set Index to 2; and enter the HEADER state.

Length2

If ReceiveError is FALSE and DataAvailable is TRUE and Index is 2 and the content of DataRegister is not equal to X'10', X'11', or X'13',

then perform a bitwise AND of the ones-complement of the DLE_Mask and the contents of DataRegister; accumulate the result into HeaderCRC; add the result to DataLength and save this result as DataLength; set DataAvailable to FALSE; set DLE_Mask to X'00'; set Index to 3; and enter the HEADER state.

HeaderCRC

If ReceiveError is FALSE and DataAvailable is TRUE and Index is 3 and the content of DataRegister is not equal to X'10', X'11', or X'13',

then perform a bitwise AND of the ones-complement of the DLE_Mask and the contents of DataRegister; accumulate the result into HeaderCRC; set DataAvailable to FALSE; set DLE_Mask to X'00'; and enter the HEADER_CRC state.

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10.4.7.4 HEADER_CRC

In the HEADER_CRC state, the node validates the CRC on the fixed frame header.

BadCRC
If the value of HeaderCRC is not X'55',

then enter the IDLE state to wait for the start of the next frame.

FrameTooLong
If the value of HeaderCRC is X'55' and DataLength is greater than InputBufferSize,

then set ReceivedInvalidFrame to TRUE to indicate that a frame cannot be received, and enter the IDLE state to wait for the start of the next frame.

NoData
If the value of HeaderCRC is X'55' and DataLength is zero,

then set ReceivedValidFrame to TRUE to indicate that a frame with no data has been received, and enter the IDLE state to wait for the start of the next frame.

Data
If the value of HeaderCRC is X'55' and DataLength is greater than zero but less than or equal to InputBufferSize,

then set Index to zero; set DataCRC to X'FFFF'; and enter the DATA state to receive the data field of the frame.

10.4.7.5 DATA

In the DATA state, the node waits for the data field of a frame.

Timeout
If SilenceTimer is greater than $\mathbf{T}_{\mathbf{frame\_abort}}$,

then set ReceivedInvalidFrame to TRUE to indicate that an error has occurred during the reception of a frame, and enter the IDLE state to wait for the start of the next frame.

Error
If ReceiveError is TRUE,

then set SilenceTimer to zero; set ReceiveError to FALSE; set ReceivedInvalidFrame to TRUE to indicate that an error has occurred during the reception of a frame; and enter the IDLE state to wait for the start of the next frame.

FlowControl
If ReceiveError is FALSE and DataAvailable is TRUE and the content of DataRegister is equal to either X'11' or X'13',

then set SilenceTimer to zero; set DataAvailable to FALSE; and enter the DATA state.

DLE_Received
If ReceiveError is FALSE and DataAvailable is TRUE and the content of the DataRegister is equal to X'10',

then set DLE_Mask to X'80' and enter the DATA state.

DataOctet
If ReceiveError is FALSE and DataAvailable is TRUE and Index is less than DataLength and the content of DataRegister is not equal to X'10', X'11', or X'13',

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then perform a bitwise AND of the ones-complement of the DLE_Mask and the contents of DataRegister; accumulate the result into DataCRC; save the results at InputBuffer[Index]; increment Index by 1; set DataAvailable to FALSE; set DLE_Mask to X'00'; and enter the DATA state.

CRC1

If ReceiveError is FALSE and DataAvailable is TRUE and Index is equal to DataLength and the content of DataRegister is not equal to X'10', X'11', or X'13',

then perform a bitwise AND of the ones-complement of the DLE_Mask and the contents of DataRegister; accumulate the result into DataCRC; increment Index by 1; set DataAvailable to FALSE; set DLE_Mask to X'00'; and enter the DATA state.

CRC2

If ReceiveError is FALSE and DataAvailable is TRUE and Index is equal to DataLength plus 1 and the content of DataRegister is not equal to X'10', X'11', or X'13',

then perform a bitwise AND of the ones-complement of the DLE_Mask and the contents of DataRegister; accumulate the result into DataCRC; set DataAvailable to FALSE; set DLE_Mask to X'00'; and enter the DATA_CRC state.

10.4.7.6 DATA_CRC

In the DATA_CRC state, the node validates the CRC on the frame data.

BadCRC

If the value of DataCRC is not X'F0B8',

then set ReceivedInvalidFrame to TRUE to indicate that an error has occurred during the reception of a frame, and enter the IDLE state to wait for the start of the next frame.

GoodCRC

If the value of DataCRC is X'F0B8',

then set ReceivedValidFrame to TRUE to indicate the complete reception of a valid frame, and enter the IDLE state to wait for the start of the next frame.

10.4.8 Data Link Connection Establishment and Termination Procedures

This subclause provides an overview of the protocol for establishing and terminating PTP connections. The details for this protocol are defined by the Connection State Machine in 10.4.9.

Upon establishment of a physical connection between BACnet devices, the calling device shall transmit the seven character ANSI X3.4 trigger sequence "BACnet<CR>", where "<CR>" denotes the ANSI X3.4 character X'0D', to inform the answering device that it wishes to establish a BACnet PTP connection. The answering device shall then transmit a Connect Request frame. The calling device shall respond by transmitting a Connect Response frame including a password, if password protection is implemented. After successful completion of this process, including verification of the password, both devices enter the data exchange phase.

Upon completion of the data link establishment procedure, each device shall assume that the other is not yet ready to receive Data frames. When a Heartbeat XON frame is received from a device, data transmission to that device may begin. Upon completion of the data link establishment procedure and when each device is ready to receive Data frames, it shall immediately transmit a Heartbeat XON frame.

When either device wishes to terminate an active PTP connection, it shall transmit a Disconnect Request frame indicating the reason for the disconnection. The peer device shall respond by transmitting a Disconnect Response frame to acknowledge the request. Both devices shall then notify their respective network layers of data link termination.

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If no Disconnect Response is received in reply to the Disconnect Request, an assumption is made that the request was not received by the peer device. The Disconnect Request is retransmitted up to three times. If a Disconnect Response is not received after the third retry, the connection is unilaterally terminated.

If, following transmission of a Disconnect Request, a device receives a Disconnect Request frame from the peer device, the device shall respond by transmitting a Disconnect Response frame and terminating the connection.

If, following transmission of a Disconnect Request, a device receives a Data frame from the peer device, the device shall not acknowledge the Data frame. Thus, a Disconnect Request is an attempt to terminate the connection in an orderly manner, but it is not negotiable. Once a Disconnect Request has been made, the connection shall be terminated. If the peer device needs to continue the communication, a new connection must be established.

10.4.9 Connection State Machine

The operation of the connection establishment state machine is described in this subclause and is depicted in Figure 10-2. The state machine models the actions taken to establish a BACnet PTP data link between two devices and includes the actions required for both the calling and answering devices.

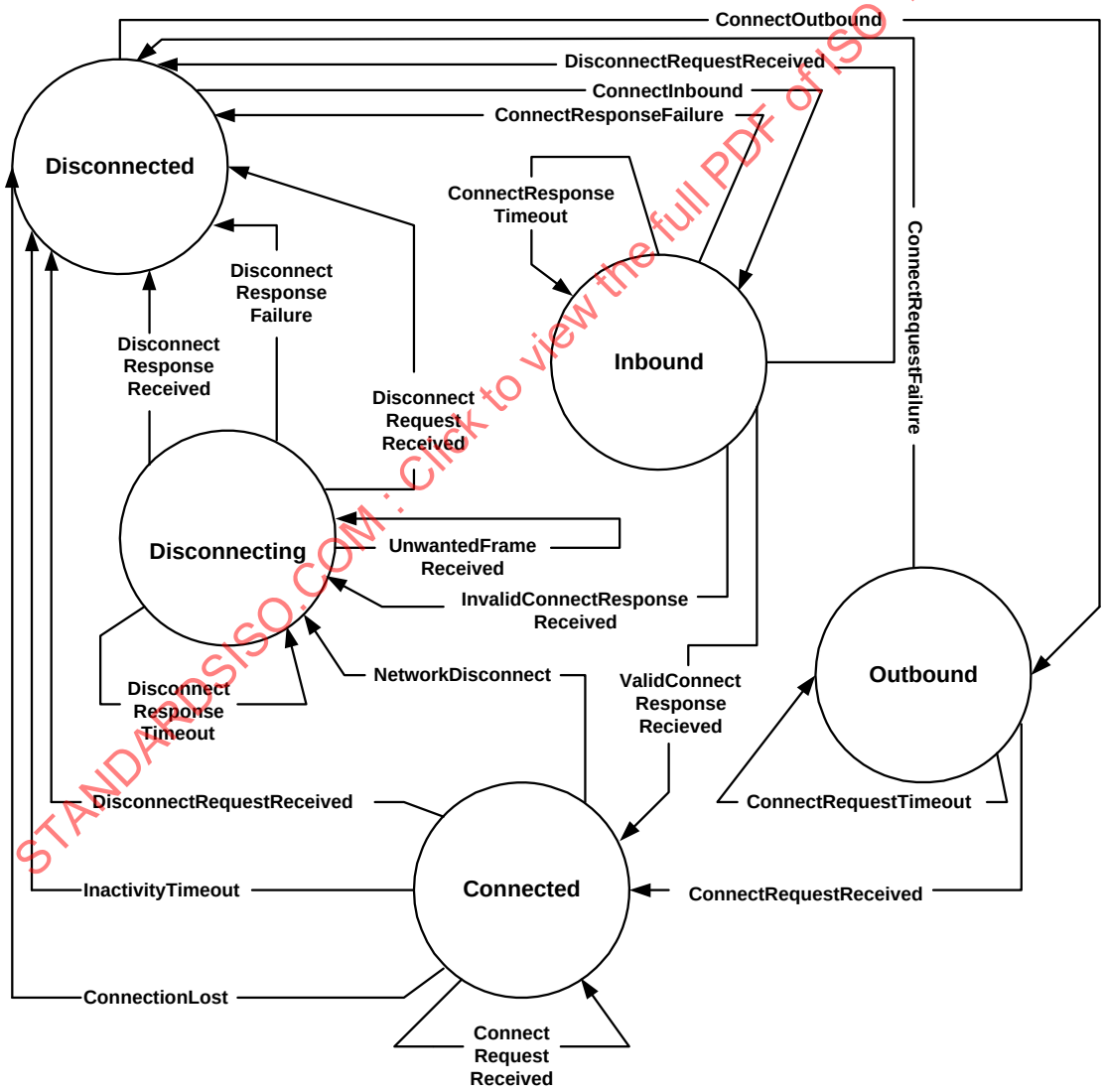

Figure 10-2. Point-To-Point Connection State Machine

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10.4.9.1 DISCONNECTED

In this state, the device waits for the network layer to initiate a PTP data link connection or for the physical layer to indicate the occurrence of a physical layer connection.

ConnectOutbound
If a DL-CONNECT.request is received,

then establish a physical connection; transmit the "BACnet<CR>" trigger sequence; set RetryCount to zero; set ResponseTimer to zero; and enter the OUTBOUND state.

ConnectInbound
If a physical layer connection has been made and the "BACnet<CR>" trigger sequence is received,

then call SendFrame to transmit a Connect Request frame; set RetryCount to zero; set ResponseTimer to zero; and enter the INBOUND state.

10.4.9.2 OUTBOUND

In this state, the network layer has issued a request to start the data link as a caller, and the device is waiting for a Connect Request frame from the answering device.

ConnectRequestReceived
If ReceivedValidFrame is TRUE and FrameType is equal to Connect Request,

then set ReceivedValidFrame to FALSE; call SendFrame to transmit a Connect Response frame containing the password contained in the "data" parameter of the DL-CONNECT.request that initiated the connection; issue a DL-CONNECT.confirm to notify the network layer that a connection has been established; and enter the CONNECTED state.

ConnectRequestTimeout
If ResponseTimer is greater than or equal to $\mathbf{T}_{conn\_rqst}$ and RetryCount is less than $\mathbf{N}_{retries}$,

then set RetryCount to RetryCount + 1; retransmit the "BACnet<CR>" trigger sequence; set the ResponseTimer to zero; and enter the OUTBOUND state.

ConnectRequestFailure
If ResponseTimer is greater than or equal to $\mathbf{T}_{conn\_rqst}$ and RetryCount is greater than or equal to $\mathbf{N}_{retries}$,

then issue a DL-CONNECT.confirm to notify the network layer of the failure and enter the DISCONNECTED state.

10.4.9.3 INBOUND

In this state, the Connection State Machine has recognized that the calling device wishes to establish a BACnet connection, and the local device is waiting for a Connect Response frame from the calling device.

ValidConnectResponseReceived
If ReceivedValidFrame is TRUE and FrameType is equal to Connect Response and a password is not needed or a valid password is present in the data field of the frame,

then set ReceivedValidFrame to FALSE; issue a DL-CONNECT.indication to notify the network layer of the connection; and enter the CONNECTED state.

InvalidConnectResponseReceived
If ReceivedValidFrame is TRUE and FrameType is equal to Connect Response and a password is needed but not present or an invalid password is present in the data field of the frame,

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then set ReceivedValidFrame to FALSE; call SendFrame to transmit a Disconnect Request frame indicating the receipt of an invalid password; set ResponseTimer to zero; set RetryCount to zero; and enter the DISCONNECTING state.

ConnectResponseTimeout

If ResponseTimer is greater than or equal to $\mathbf{T}_{\mathbf{conn\_rsp}}$ and RetryCount is less than $\mathbf{N}_{\mathbf{retries}}$,

then set RetryCount to RetryCount + 1; call SendFrame to transmit a Connect Request frame; set ResponseTimer to zero; and enter the INBOUND state.

ConnectResponseFailure

If ResponseTimer is greater than or equal to $\mathbf{T}_{\mathbf{conn\_rsp}}$ and RetryCount is greater than or equal to $\mathbf{N}_{\mathbf{retries}}$,

then enter the DISCONNECTED state.

DisconnectRequestReceived

If ReceivedValidFrame is TRUE and FrameType is equal to Disconnect Request,

then set ReceivedValidFrame to FALSE; call SendFrame to transmit a Disconnect Response frame; and enter the DISCONNECTED state.

10.4.9.4 CONNECTED

In this state, the connection procedure has been completed, and the two devices may exchange BACnet PDUs. The data link remains in this state until termination.

NetworkDisconnect

If a DL-DISCONNECT.request is received,

then call SendFrame to transmit a Disconnect Request frame; set ResponseTimer to zero; issue a DL-DISCONNECT.confirm to notify the network layer of the disconnection; set RetryCount to zero; and enter the DISCONNECTING state.

DisconnectRequestReceived

If ReceivedValidFrame is TRUE and FrameType is equal to Disconnect Request,

then set ReceivedValidFrame to FALSE; call SendFrame to transmit a Disconnect Response frame; issue a DL-DISCONNECT.indication to notify the network layer of the disconnection; and enter the DISCONNECTED state.

ConnectRequestReceived

If ReceivedValidFrame is TRUE and FrameType is equal to Connect Request,

then set ReceivedValidFrame to FALSE; call SendFrame to transmit a Connect Response frame; issue a DL-CONNECT.indication to notify the network layer of the connection; and enter the CONNECTED state.

InactivityTimeout

If InactivityTimer is greater than $T_{inactivity}$ and ReceivedValidFrame is FALSE,

then issue a DL-DISCONNECT.indication to notify the network layer of the disconnection and enter the DISCONNECTED state.

ConnectionLost

If the physical connection has been terminated, e.g., due to loss of carrier,

then issue a DL-DISCONNECT.indication to notify the network layer of the disconnection and enter the DISCONNECTED state.

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10.4.9.5 DISCONNECTING

In this state, the network layer has requested termination of the data link. The device is waiting for a Disconnect Response frame from the peer device.

DisconnectResponseReceived
If ReceivedValidFrame is TRUE and FrameType is equal to Disconnect Response,

then set ReceivedValidFrame to FALSE and enter the DISCONNECTED state.

DisconnectRequestReceived
If ReceivedValidFrame is TRUE and FrameType is equal to Disconnect Request,

then set ReceivedValidFrame to FALSE; call SendFrame to transmit a Disconnect Response frame; and enter the DISCONNECTED state.

UnwantedFrameReceived
If ReceivedValidFrame is TRUE and FrameType is not equal to either Disconnect Response or Disconnect Request,

then set ReceivedValidFrame to FALSE and enter the DISCONNECTING state. (Note that ResponseTimer is not reset in this case.)

DisconnectResponseTimeout
If ResponseTimer is greater than $\mathbf{T}_{\mathbf{response}}$ and ReceivedValidFrame is FALSE and RetryCount is less than $\mathbf{N}_{\mathbf{retries}}$,

then increment RetryCount; call SendFrame to transmit a Disconnect Request frame; set ResponseTimer to zero; and enter the DISCONNECTING state.

DisconnectResponseFailure
If ResponseTimer is greater than or equal to $\mathbf{T}_{\mathbf{response}}$ and ReceivedValidFrame is FALSE and RetryCount is greater than or equal to $\mathbf{N}_{\mathbf{retries}}$,

then enter the DISCONNECTED state.

10.4.10 Transmission State Machine

The operation of the Transmission State Machine is described in this subclause and is depicted in Figure 10-3. The state machine models the actions taken to transmit data frames and receive corresponding acknowledgments.

10.4.10.1 TRANSMIT IDLE

In this state, the transmitter is waiting for the data link to be established between the local device and the peer device. The transmitter waits to be notified that a peer device is ready to communicate.

ConnectionEstablishedXON
If the Connection State Machine is in the CONNECTED state and ReceptionBlocked is equal to NOT_BLOCKED,

then call SendFrame to transmit a HeartbeatXON frame; set TxSequenceNumber to zero; set HeartbeatTimer to zero; and enter the TRANSMIT BLOCKED state.

ConnectionEstablishedXOFF
If the Connection State Machine is in the CONNECTED state and ReceptionBlocked is equal to ALMOST_BLOCKED or BLOCKED,

then call SendFrame to transmit a HeartbeatXOFF frame; set TxSequenceNumber to zero; and enter the TRANSMIT BLOCKED state.

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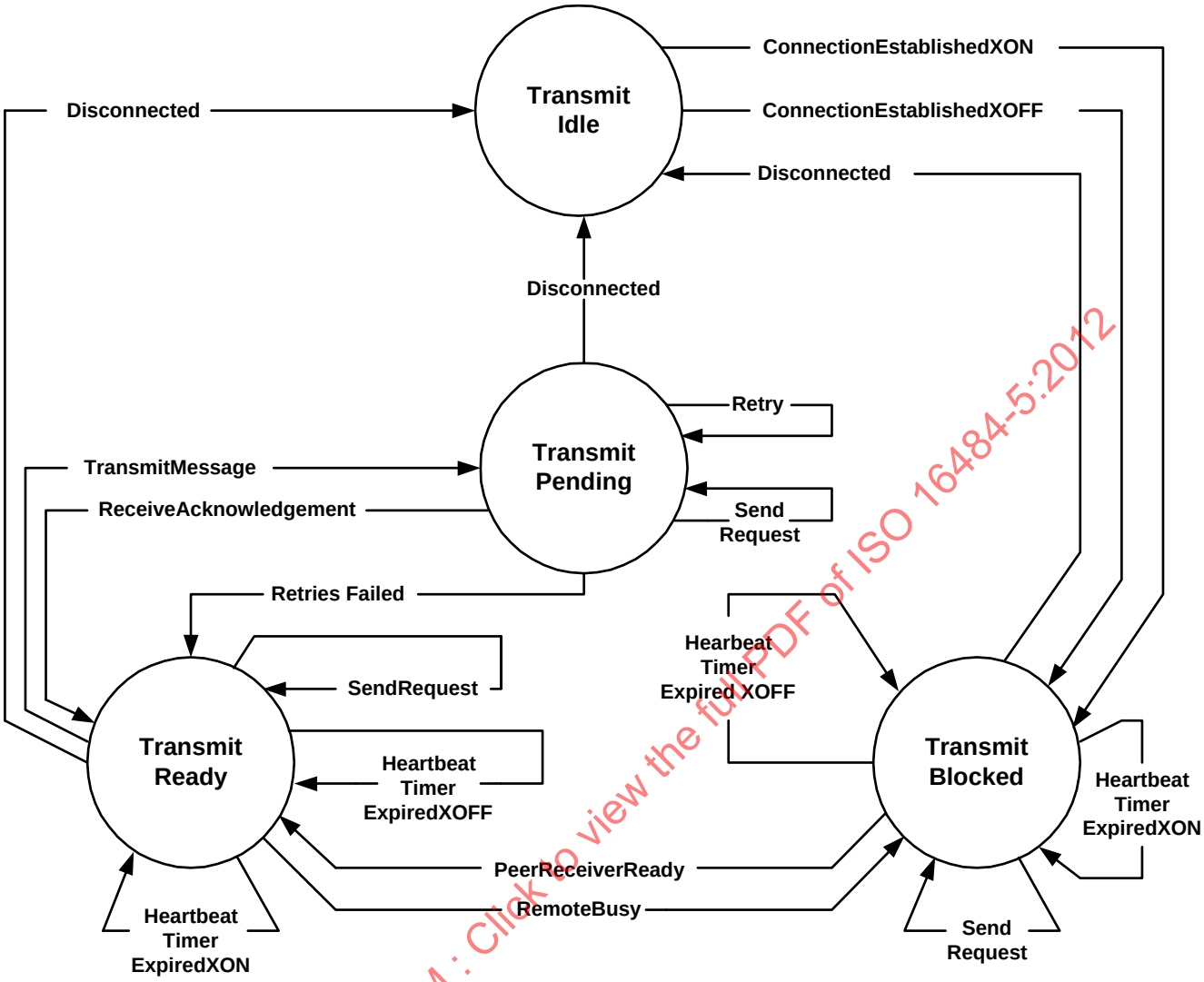

Figure 10-3. Point-To-Point Transmission State Machine.

10.4.10.2 TRANSMIT BLOCKED

In this state, the peer device has indicated that it is not ready to receive data frames. The local device may have data ready to transmit. The local device periodically transmits a Heartbeat frame to maintain the data-link and waits for the peer device to become ready to receive data or for the termination of the data link.

SendRequest

If a DL-UNITDATA.request primitive is received,

then queue the request for later transmission and enter the TRANSMIT BLOCKED state.

PeerReceiverReady

If TransmissionBlocked is equal to FALSE,

then enter the TRANSMIT READY state.

Disconnected

If the Connection State Machine is in the DISCONNECTED state,

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then enter the TRANSMIT IDLE state.

HeartbeatTimerExpiredXON
If HeartbeatTimer is greater than $\mathbf{T_{heartbeat}}$ and ReceptionBlocked is equal to NOT_BLOCKED,

then call SendFrame to transmit a HeartbeatXON frame; set HeartbeatTimer to zero; and enter the TRANSMIT BLOCKED state.

HeartbeatTimerExpiredXOFF
If HeartbeatTimer is greater than $\mathbf{T_{heartbeat}}$ and ReceptionBlocked is equal to BLOCKED or ALMOST_BLOCKED,

then call SendFrame to transmit a HeartbeatXOFF frame; set HeartbeatTimer to zero; and enter the TRANSMIT BLOCKED state.

10.4.10.3 TRANSMIT READY

In this state, the peer device has indicated its readiness to receive Data frames, but the local device has no data ready to transmit. The local device periodically transmits a Heartbeat frame to maintain the data link and waits for a local request to transmit data or for the termination of the data link.

Disconnected
If the Connection State Machine is in the DISCONNECTED state,

then enter the TRANSMIT IDLE state.

SendRequest
If a DL-UNITDATA.request primitive is received,

then queue the request for later transmission and enter the TRANSMIT READY state.

TransmitMessage
If the transmit queue is not empty and TransmissionBlocked is equal to FALSE,

then call SendFrame to transmit the frame at the head of the queue using a Data frame type (Data 0 or Data 1) that indicates TxSequenceNumber; set RetryCount to zero; set ResponseTimer to zero; and enter the TRANSMIT PENDING state.

RemoteBusy
If TransmissionBlocked is equal to TRUE,

then enter the TRANSMIT BLOCKED state.

HeartbeatTimerExpiredXON
If HeartbeatTimer is greater than $\mathbf{T_{heartbeat}}$ and ReceptionBlocked is equal to NOT_BLOCKED,

then call SendFrame to transmit a HeartbeatXON frame; set HeartbeatTimer to zero; and enter the TRANSMIT READY state.

HeartbeatTimerExpiredXOFF
If HeartbeatTimer is greater than $\mathbf{T_{heartbeat}}$ and ReceptionBlocked is equal to BLOCKED or ALMOST_BLOCKED,

then call SendFrame to transmit a HeartbeatXOFF frame; set HeartbeatTimer to zero; and enter the TRANSMIT READY state.

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10.4.10.4 TRANSMIT PENDING

In this state, the local device has transmitted a data frame to the peer device and is waiting for an acknowledgment from the peer device.

Disconnected

If the Connection State Machine is in the DISCONNECTED state,

then enter the TRANSMIT IDLE state.

SendRequest

If a DL-UNITDATA.request primitive is received,

then queue the request for later transmission and enter the TRANSMIT PENDING state.

ReceiveAcknowledgment

If TxSequenceNumber is equal to 0 and Ack0Received is equal to TRUE or if TxSequenceNumber is equal to 1 and Ack1Received is equal to TRUE,

then set TxSequenceNumber = 1 - TxSequenceNumber; set Ack0Received to FALSE; set Ack1Received to FALSE; and enter the TRANSMIT READY state.

Retry

If RetryCount is less than $\mathbf{N}_{\mathbf{retries}}$ and either

(a) TxSequenceNumber is equal to 0 and Nak0Received is equal to TRUE or

(b) TxSequenceNumber is equal to 1 and Nak1Received is equal to TRUE or

(c) ResponseTimer is greater than $\mathbf{T}_{\mathbf{response}}$,

then set RetryCount to RetryCount + 1; set Nak0Received to FALSE; set Nak1Received to FALSE; set ResponseTimer to zero; call SendFrame to retransmit the Data frame; and enter the TRANSMIT PENDING state.

RetriesFailed

If RetryCount is equal to $\mathbf{N}_{\mathbf{retries}}$, and either

(a) TxSequenceNumber is equal to 0 and Nak0Received is equal to TRUE or

(b) TxSequenceNumber is equal to 1 and Nak1Received is equal to TRUE or

(c) ResponseTimer is greater than $\mathbf{T}_{\mathbf{response}}$,

then set RetryCount to 0; set Nak0Received to FALSE; set Nak1Received to FALSE; set ResponseTimer to zero; and enter the TRANSMIT READY state.

10.4.11 Reception State Machine

The operation of the Reception State Machine is described in this subclause and is depicted in Figure 10-4.

10.4.11.1 RECEIVE IDLE

In this state, the receiver is waiting for the data link to be established between the local device and the peer device. The receiver waits to be notified that a peer device is ready to communicate.

ConnectionEstablished

If the Connection State Machine is in the CONNECTED state,

then set RxSequenceNumber to zero and enter the RECEIVE READY state.

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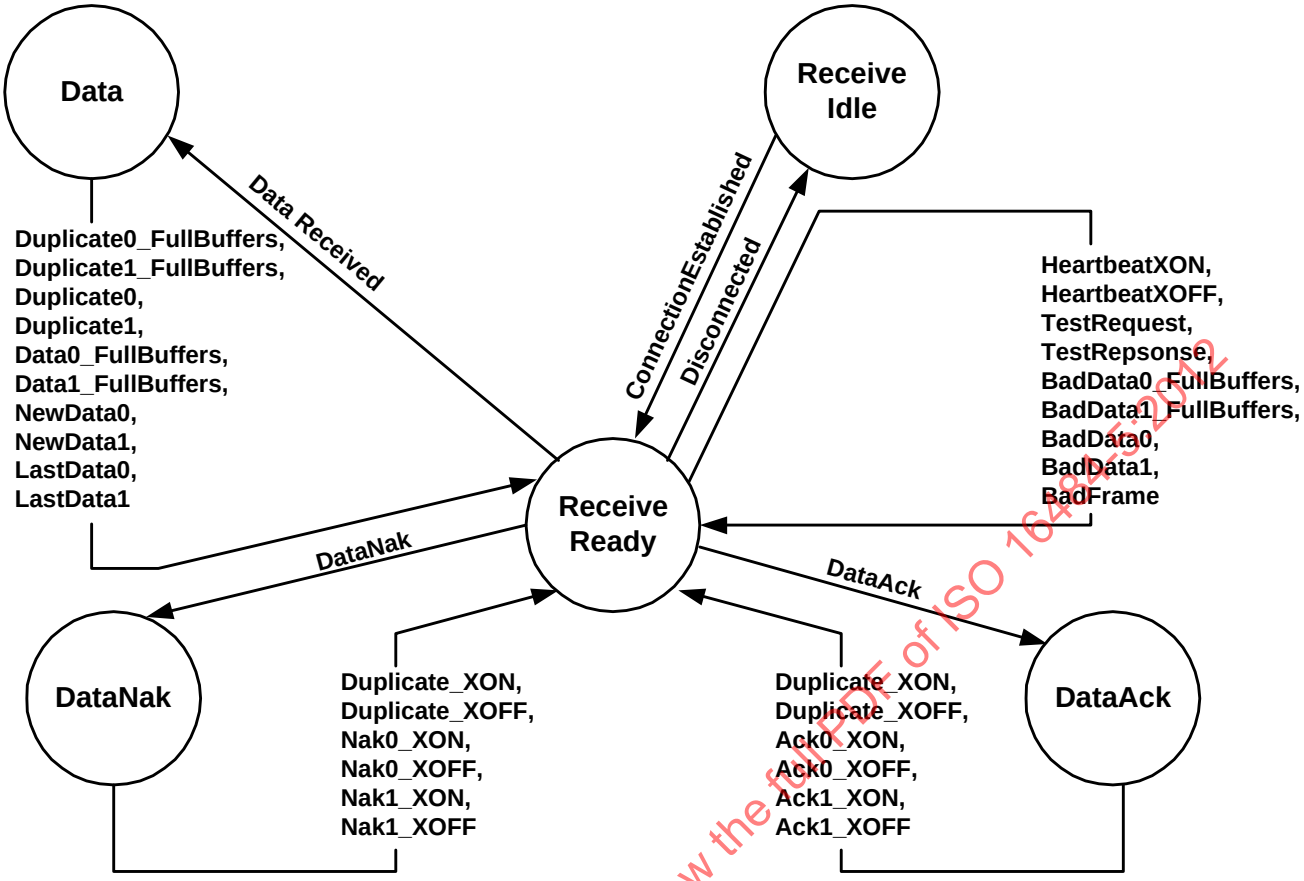

Figure 10-4. Point-To-Point Reception State Machine.

10.4.11.2 RECEIVE READY

In this state, the device is ready to receive frames from the peer device.

DataReceived

If ReceivedValidFrame is TRUE and FrameType is equal to Data 0 or Data 1,

then set ReceivedValidFrame to FALSE; set InactivityTimer to zero; and enter the DATA state.

DataAck

If ReceivedValidFrame is TRUE and FrameType is equal to Data Ack 0 XOFF, Data Ack 0 XON, Data ACK 1 XOFF, or Data Ack 1 XON,

then set ReceivedValidFrame to FALSE; set InactivityTimer to zero; and enter the DATA ACK state.

DataNak

If ReceivedValidFrame is TRUE and FrameType is equal to Data Nak 0 XOFF, Data Nak 0 XON, Data Nak 1 XOFF, or Data Nak 1 XON,

then set ReceivedValidFrame to FALSE; set InactivityTimer to zero; and enter the DATA NAK state.

HeartbeatXON

If ReceivedValidFrame is TRUE and FrameType is equal to Heartbeat XON,

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then set TransmissionBlocked to FALSE; set InactivityTimer to zero; set ReceivedValidFrame to FALSE; and enter the RECEIVE READY state.

HeartbeatXOFF

If ReceivedValidFrame is TRUE and FrameType is equal to Heartbeat XOFF,

then set TransmissionBlocked to TRUE; set InactivityTimer to zero; set ReceivedValidFrame to FALSE; and enter the RECEIVE READY state.

TestRequest

If ReceivedValidFrame is TRUE and FrameType is equal to Test_Request,

then call SendFrame to transmit the Test_Response; set InactivityTimer to zero; set ReceivedValidFrame to FALSE; and enter the RECEIVE READY state.

TestResponse

If ReceivedValidFrame is TRUE and FrameType is equal to Test_Response,

then issue a DL-UNITDATA.indication conveying the Test_Response data; set InactivityTimer to zero; set ReceivedValidFrame to FALSE; and enter the RECEIVE READY state.

BadData0_FullBuffers

If ReceivedInvalidFrame is TRUE and FrameType is equal to Data 0 and ReceptionBlocked is equal to BLOCKED,

then discard the frame; set InactivityTimer to zero; call SendFrame to transmit a Data Nak 0 XOFF frame; set ReceivedInvalidFrame to FALSE; and enter the RECEIVE READY state.

BadData1_FullBuffers

If ReceivedInvalidFrame is TRUE and FrameType is equal to Data 1 and ReceptionBlocked is equal to BLOCKED,

then discard the frame; set InactivityTimer to zero; call SendFrame to transmit a Data Nak 1 XOFF frame; set ReceivedInvalidFrame to FALSE; and enter the RECEIVE READY state.

BadData0

If ReceivedInvalidFrame is TRUE and FrameType is equal to Data 0 and ReceptionBlocked is equal to NOT_BLOCKED or ALMOST_BLOCKED,

then discard the frame; set InactivityTimer to zero; call SendFrame to transmit a Data Nak 0 XON frame; set ReceivedInvalidFrame to FALSE; and enter the RECEIVE READY state.

BadData1

If ReceivedInvalidFrame is TRUE and FrameType is equal to Data 1 and ReceptionBlocked is equal to NOT_BLOCKED or ALMOST_BLOCKED,

then discard the frame; set InactivityTimer to zero; call SendFrame to transmit a Data Nak 1 XON frame; set ReceivedInvalidFrame to FALSE; and enter the RECEIVE READY state.

BadFrame

If ReceivedInvalidFrame is TRUE and FrameType is not equal to either Data 0 or Data 1,

then discard the frame; set InactivityTimer to zero; set ReceivedInvalidFrame to FALSE; and enter the RECEIVE READY state.

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Disconnected

If the Connection State Machine is in the DISCONNECTED state,

then enter the RECEIVE IDLE state.

10.4.11.3 DATA

In this state the device has received a Data frame for processing.

Duplicate0_FullBuffers

If FrameType is equal to Data 0 and RxSequenceNumber is equal to 1 and ReceptionBlocked is equal to BLOCKED,

then discard the frame as a duplicate; call SendFrame to transmit a Data Ack 0 XOFF frame; and enter the RECEIVE READY state.

Duplicate1_FullBuffers

If FrameType is equal to Data 1 and RxSequenceNumber is equal to 0 and ReceptionBlocked is equal to BLOCKED,

then discard the frame as a duplicate; call SendFrame to transmit a Data Ack 1 XOFF frame; and enter the RECEIVE READY state.

Duplicate0

If FrameType is equal to Data 0 and RxSequenceNumber is equal to 1 and ReceptionBlocked is equal to NOT_BLOCKED or ALMOST_BLOCKED,

then discard the frame as a duplicate; call SendFrame to transmit a Data Ack 0 XON frame; and enter the RECEIVE READY state.

Duplicate1

If FrameType is equal to Data 1 and RxSequenceNumber is equal to 0 and ReceptionBlocked is equal to NOT_BLOCKED or ALMOST_BLOCKED,

then discard the frame as a duplicate; call SendFrame to transmit a Data Ack 1 XON frame; and enter the RECEIVE READY state.

Data0_FullBuffers

If FrameType is equal to Data 0 and RxSequenceNumber is equal to 0 and ReceptionBlocked is equal to BLOCKED,

then discard the frame for lack of space; call SendFrame to transmit a Data Nak 0 XOFF frame; and enter the RECEIVE READY state.

Data1_FullBuffers

If FrameType is equal to Data 1 and RxSequenceNumber is equal to 1 and ReceptionBlocked is equal to BLOCKED,

then discard the frame for lack of space; call SendFrame to transmit a Data Nak 1 XOFF frame; and enter the RECEIVE READY state.

NewData0

If FrameType is equal to Data 0 and RxSequenceNumber is equal to 0 and ReceptionBlocked is equal to NOT_BLOCKED,

then issue a DL-UNITDATA.indication conveying the data; call SendFrame to transmit a Data Ack 0 XON frame; set RxSequenceNumber to 1; and enter the RECEIVE READY state.

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NewData1

If FrameType is equal to Data 1 and RxSequenceNumber is equal to 1 and ReceptionBlocked is equal to NOT_BLOCKED,

then issue a DL-UNITDATA.indication conveying the data; call SendFrame to transmit a Data Ack 1 XON frame; set RxSequenceNumber to 0; and enter the RECEIVE READY state.

LastData0

If FrameType is equal to Data 0 and RxSequenceNumber is equal to 0 and ReceptionBlocked is equal to ALMOST_BLOCKED,

then issue a DL-UNITDATA.indication conveying the data; call SendFrame to transmit a Data Ack 0 XOFF frame; set RxSequenceNumber to 1; and enter the RECEIVE READY state.

LastData1

If FrameType is equal to Data 1 and RxSequenceNumber is equal to 1 and ReceptionBlocked is equal to ALMOST_BLOCKED,

then issue a DL-UNITDATA.indication conveying the data; call SendFrame to transmit a Data Ack 1 XOFF frame; set RxSequenceNumber to 0; and enter the RECEIVE READY state.

10.4.11.4 DATA ACK

In this state the device has received a Data Ack frame for processing.

Duplicate_XON

If FrameType is equal to Data Ack 0 XON and TxSequenceNumber is equal to 1, or if FrameType is equal to Data Ack 1 XON and TxSequenceNumber is equal to 0,

then set TransmissionBlocked to FALSE and enter the RECEIVE READY state.

Duplicate_XOFF

If FrameType is equal to Data Ack 0 XOFF and TxSequenceNumber is equal to 1, or if FrameType is equal to Data Ack 1 XOFF and TxSequenceNumber is equal to 0,

then set TransmissionBlocked to TRUE and enter the RECEIVE READY state.

Ack0_XON

If FrameType is equal to Data Ack 0 XON and TxSequenceNumber is equal to 0,

then set Ack0Received to TRUE; set TransmissionBlocked to FALSE; and enter the RECEIVE READY state.

Ack0_XOFF

If FrameType is equal to Data Ack 0 XOFF and TxSequenceNumber is equal to 0,

then set Ack0Received to TRUE; set TransmissionBlocked to TRUE; and enter the RECEIVE READY state.

Ack1_XON

If FrameType is equal to Data Ack 1 XON and TxSequenceNumber is equal to 1,

then set Ack1Received to TRUE; set TransmissionBlocked to FALSE; and enter the RECEIVE READY state.

Ack1_XOFF

If FrameType is equal to Data Ack 1 XOFF and TxSequenceNumber is equal to 1,

then set Ack1Received to TRUE; set TransmissionBlocked to TRUE; and enter the RECEIVE READY state.

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10.4.11.5 DATA NAK

In this state the device has received a Data Nak frame for processing.

Duplicate_XON
: If FrameType is equal to Data Nak 0 XON and TxSequenceNumber is equal to 1, or if FrameType is equal to Data Nak 1 XON and TxSequenceNumber is equal to 0,

  then set TransmissionBlocked to FALSE and enter the RECEIVE READY state.

Duplicate_XOFF
: If FrameType is equal to Data Nak 0 XOFF and TxSequenceNumber is equal to 1, or if FrameType is equal to Data Nak 1 XOFF and TxSequenceNumber is equal to 0,

  then set TransmissionBlocked to TRUE and enter the RECEIVE READY state.

Nak0_XON
: If FrameType is equal to Data Nak 0 XON and TxSequenceNumber is equal to 0,

  then set Nak0Received to TRUE; set TransmissionBlocked to FALSE; and enter the RECEIVE READY state.

Nak0_XOFF
: If FrameType is equal to Data Nak 0 XOFF and TxSequenceNumber is equal to 0,

  then set Nak0Received to TRUE; set TransmissionBlocked to TRUE; and enter the RECEIVE READY state.

Nak1_XON
: If FrameType is equal to Data Nak 1 XON and TxSequenceNumber is equal to 1,

  then set Nak1Received to TRUE; set TransmissionBlocked to FALSE; and enter the RECEIVE READY state.

Nak1_XOFF
: If FrameType is equal to Data Nak 1 XOFF and TxSequenceNumber is equal to 1,

  then set Nak1Received to TRUE; set TransmissionBlocked to TRUE; and enter the RECEIVE READY state.

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11 DATA LINK/PHYSICAL LAYERS: EIA/CEA-709.1 ("LonTalk") LAN

This clause describes the transport of BACnet LSDUs using the services of the LonTalk protocol described in *EIA/CEA-709.1-B-2002 Control Network Protocol Specification*. EIA/CEA-709.1-B-2002, as amended and extended by the Electronic Industries Alliance, is deemed to be included in this standard by reference. Persons desiring to implement BACnet in products containing the LonTalk Protocol may obtain an OEM license to do so, without cost, by contacting Echelon Corporation, San Jose, California.

11.1 The Use of ISO 8802-2 Logical Link Control (LLC)

Standard BACnet networks may pass BACnet link service data units (LSDUs) using the data link services of ISO 8802-2 LLC. A BACnet LSDU consists of an NPDU constructed as described in Clause 6. BACnet devices using LonTalk LAN technology shall conform to the requirements of LLC Class I, subject to the constraints specified in this clause. Class I LLC service consists of Type 1 LLC - Unacknowledged Connectionless-Mode service. LLC parameters shall be conveyed using the DL-UNITDATA primitives as described in the referenced standards.

In a LonTalk implementation, BACnet DL-UNITDATA primitives are mapped into the LonTalk Application Layer Interface. The mapping of these primitives onto the LonTalk Application layer primitives is described in 11.3.

11.2 Parameters Required by the LLC Primitives

The DL-UNITDATA primitive requires source address, destination address, data, and priority parameters. Each source and destination address consists of a LonTalk address, link service access point (LSAP), and a message code (MC). The LonTalk address is a variable-length value determined by the configuration of the BACnet device, and the MC used to indicate a BACnet frame is the single-octet value X'4E'. Since the LonTalk message code identifies the BACnet network layer, the LSAP is not used. The data parameter is the NPDU from the network layer.

11.3 Mapping the LLC Services to the LonTalk Application Layer

The Type 1 Unacknowledged Connectionless LLC service, DL_UNITDATA.request shall map onto the LonTalk msg_send request primitive, while the DL_UNITDATA.indication shall map to the LonTalk msg_receive request primitive.

An LPDU longer than 228 octets cannot be conveyed via LonTalk.

11.4 Parameters Required by the Application Layer Primitives

The LonTalk Application layer primitives are msg_send and msg_receive. These convey the encoded LLC data using the destination LonTalk address described above in conjunction with the BACnet message code. The DL_UNITDATA.request primitive contains the following parameters:

```
DL_UNITDATA.request (
                destination_address,
                data,
                priority,
                message_code
                )
```

The 'destination_address' consists of any form of a LonTalk address except address format 2B (which is used exclusively for multicast acknowledgments and multicast responses). See Figure 6-4. The 'data' parameter specifies the LSDU to be transferred. The 'priority' parameter conveys the priority specified for the data unit. Any BACnet priority other than "Normal message" shall be sent using the LonTalk priority mechanism. The 'message_code' parameter shall be X'4E' for BACnet LPDUs.

LonTalk Authentication is not supported in BACnet.

LonTalk "UNACKD" and "UNACKD_RPT" are the only LonTalk services that shall be allowed within BACnet. The choice between these two LonTalk services and the repeat count for the "UNACKD_RPT" service shall be considered a local matter.

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The DL_UNITDATA.indication primitive contains the following parameters:

DL_UNITDATA.indication (
source_address,
destination_address,
length,
data,
message_code,
priority
)

Except as noted below, the parameters in DL_UNITDATA.indication convey the same information as the parameters in DL_UNITDATA.request.

The 'source_address' always consists of address format 2A.

The 'length' indicates the number of octets contained in the 'data' parameter.

Figure 11-1 illustrates the format of a MPDU on a LonTalk BACnet network destined for a device on the same LonTalk BACnet network.

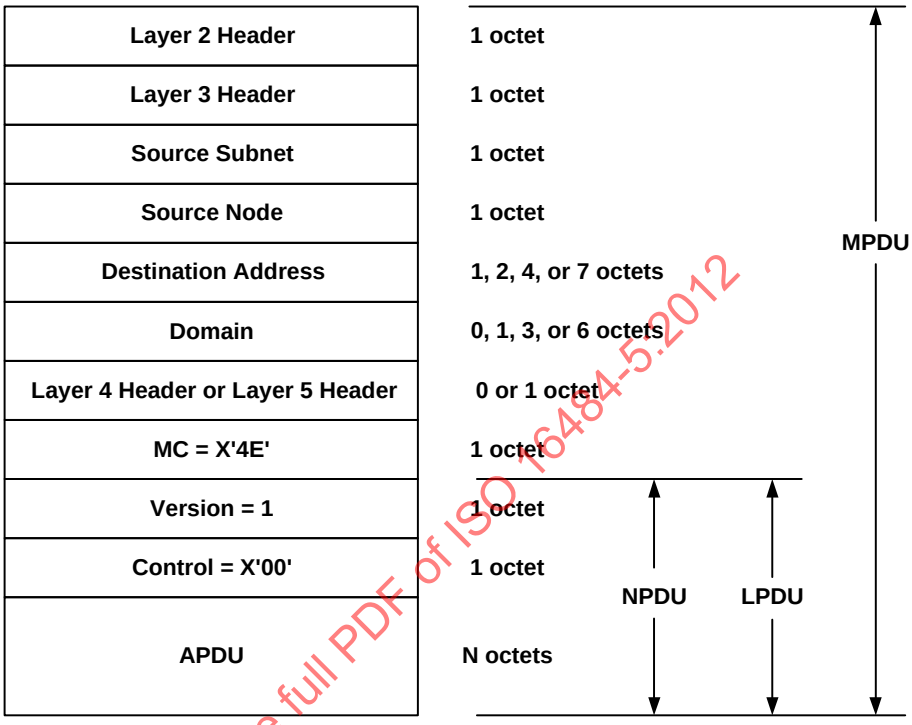

Figure 11-1. Format of an MPDU on a LonTalk network destined for a device on the same LonTalk BACnet network.

11.5 Physical Media

Any of the "Standard Channel Types" defined in the *LonMark™ Layer 1-6 Interoperability Guidelines* is acceptable. Transceivers built for this network technology shall follow the guidelines specified in the *LonMark™ Layer 1-6 Interoperability Guidelines*. The most recent version of the *LonMark™ Layer 1-6 Interoperability Guidelines* as released by the LonMark™ Interoperability Association (currently version 3.3) shall apply.

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12 MODELING CONTROL DEVICES AS A COLLECTION OF OBJECTS

The data structures used in a device to store information are a local matter. In order to exchange that information with another device using this protocol, there must be a "network-visible" representation of the information that is standardized. An object-oriented approach has been adopted to provide this network-visible representation. This clause defines a set of standard object types. These object types define an abstract data structure that provides a framework for building the application layer services. The application layer services are designed, in part, to access and manipulate the properties of these standard object types. Mapping the effect of these services to the real data structures used in the device is a local matter. The number of instances of a particular object type that a device will support is also a local matter.

All objects are referenced by their Object_Identifier property. Each object within a single BACnet Device shall have a unique value for the Object_Identifier property. When combined with the system-wide unique Object_Identifier of the BACnet Device, this provides a mechanism for referencing every object in the control system network. No object shall have an Object_Identifier with an instance number of 4194303. Object properties that contain BACnetObjectIdentifiers may use 4194303 to indicate that the property is not initialized.

Not all object types defined in this standard need to be supported in order to conform to the standard. In addition, some properties of particular object types are optional. At the beginning of each standard object type specification that follows is a summary of the properties of the object type. The summary includes the property identifier, the datatype of the property, and one of the following : **O**, **R**, **W**

where **O** indicates that the property is optional,
R indicates that the property is required to be present and readable using BACnet services,
W indicates that the property is required to be present, readable, and writable using BACnet services.

When a property is designated as required or **R**, this shall mean that the property is required to be present in all BACnet standard objects of that type. When a property is designated as optional or **O**, this shall mean that the property is not required to be present in all standard BACnet objects of that type. The value of **R** or **O** properties may be examined through the use of one or more of the ReadProperty services defined in this standard. Such **R** or **O** properties may also be writable at the implementor's option unless specifically prohibited in the text describing that particular standard object's property. When a property is designated as writable or **W**, this shall mean that the property is required to be present in all BACnet standard objects of that type and that the value of the property can be changed through the use of one or more of the WriteProperty services defined in this standard. The value of **W** properties may be examined through the use of one or more of the ReadProperty services defined in this standard. An **O** property, if present in a particular object, is not required to be writable unless specifically identified as such in the text describing that particular standard object's property.

In some devices, property values may be stored internally in a different form than indicated by the property datatype. For example, real numbers may be stored internally as integers. This may result in the situation where a property value is changed by one of the WriteProperty services but a subsequent read returns a slightly different value. This behavior is acceptable as long as a "best effort" is made to store the written value specified.

It is intended that the collection of object types and their properties defined in this standard be comprehensive, but implementors are free to define additional nonstandard object types or additional nonstandard properties of standard object types. This is the principal means for extending the standard as control technology develops. Innovative changes can be accommodated without waiting for changes in the standard. This extensibility could also be used to adapt this standard to other types of building services. See 23.3 and 23.4.

Nonstandard object types are required to support the following properties:

- Object_Identifier BACnetObjectIdentifier
- Object_Name CharacterString
- Object_Type BACnetObjectType

These properties shall be implemented to behave as they would when present in standard BACnet objects. This means that the Object_Identifier and Object_Name properties shall be unique within the BACnet device that maintains them. The Object_Name string shall be at least one character in length and shall consist only of printable characters.

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A BACnet standard object shall support all required properties specified in the standard. It may support, in addition to these properties, any optional properties specified in the standard or properties not defined in the standard. A required property shall function as specified in the standard for each object of that type. If properties that are defined as optional in the standard are supported, then they shall function as specified in the standard. A required property shall be present in all objects of that type. An optional property, if present in one object of a given type, need not be present in all objects of that type. A supported property, whether required or optional, shall return the datatype specified in the standard. A supported property, whether required or optional, is not required to be able to return the entire range of values for a datatype unless otherwise specified in the property description. Supported properties, whether required or optional, which do not return the entire range of values for a datatype when read or which restrict the range of values that may be written to the property, shall specify those restrictions for each such property in the protocol implementation conformance statement (PICS).

Some of the properties of certain BACnet objects need to represent a collection of data elements of the same type, rather than a single primitive data value or a complex datatype constructed from other datatypes. In some instances, the size of this collection of data elements is fixed, while in other instances the number of elements may be variable. In some cases the elements may need to be accessed individually or their order may be important. BACnet provides two forms of datatypes for properties that represent a collection of data elements of the same type: "BACnetARRAY" and "List of."

A "BACnetARRAY" datatype is a structured datatype consisting of an ordered sequence of data elements, each having the same datatype. The components of an array property may be individually accessed (read or written) using an "array index," which is an unsigned integer value. An index of 0 (zero) shall specify that the count of the number of data elements be returned. If the array index is omitted, it means that all of the elements of the array are to be accessed. An array index N, greater than zero, shall specify the Nth element in the sequence. When array properties are used in BACnet objects, the notation "BACnetARRAY[N] of datatype" shall mean an ordered sequence of N data elements, each of which has that datatype. The datatype of array element 0 is Unsigned. If the size of an array may be changed by writing to the array, then array element 0 shall be writable. If the value of array element 0 is decreased, the array shall be truncated and the elements of the array with an index greater than the new value of array element 0 are deleted. If the value of array element 0 is increased, the new elements of the array, those with an index greater than the old value of array element 0, shall be created; the values that are assigned to those elements shall be a local matter except where otherwise specified. Where the size of an array is allowed to be changed, writing the entire array as a single property with a different number of elements shall cause the array size to be changed. An attempt to write to an array element with an index greater than the size of the array shall result in an error and shall not cause the array to grow to accommodate the element. Arrays whose sizes are fixed by the Standard shall not be resizable.

A "List of" datatype is a structured datatype consisting of a sequence of zero or more data elements, each having the same datatype. The length of each "List of" may be variable. Unless specified for a particular use, no maximum size should be assumed for any "List of" implementation. The notation "List of datatype" shall mean a sequence of zero or more data elements, each of which has the indicated type.

The difference between a "BACnetARRAY" property and a "List of" property is that the elements of the array can be uniquely accessed by an array index while the elements of the "List of" property can only be positionally accessed using the ReadRange service. Moreover, the number of elements in the BACnetARRAY may be ascertained by reading the array index 0, while the number of elements present in a "List of" property can only be determined by reading the entire property value and performing a count.

The ordering of list elements when a list is written or modified is not required to be preserved upon subsequent reading of the same list, even if the set of elements that make up the list has not changed.

In the context of ReadRange 'By Position', the ordering of List elements shall follow the conventions that the first element of the List shall be position 1, and positions 2, 3, 4 and greater shall correspond to list elements in strict sequence. The sequence of list elements shall follow the same ordering that those elements would appear in if the entire list was read using ReadProperty to read the entire list. Assuming that the list has not been written or modified, repeated reading of list elements shall return those elements in the same order each time.

Several object types defined in this clause have one or more properties that are capable of referencing object properties. For example, the Object_Property_Reference property of the Event Enrollment object contains such a reference. The property

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identifier component of these references shall not be any of the special property identifiers ALL, REQUIRED, or OPTIONAL. These are reserved for use in the ReadPropertyMultiple service or in objects and services not defined in this standard.

Several object types defined in this clause have properties that are of type BACnetDateTime, and specify a specific point in time. These properties shall have an unspecified datetime value if the point in time is undefined or a specific datetime value if the point in time is specified.

There are a number of objects defined in this clause that have properties of the type BACnetDateRange, for example the Date_List property in the Calendar object, whose construct includes a startDate and an endDate. Both startDate and endDate may be an unspecified date or a specific date only. For purposes of comparing date ranges, the following logic shall be applied.

The use of an unspecified date in the startDate means "any date up to and including the endDate." The use of an unspecified date in the endDate means "any date after and including the startDate." The use of an unspecified date in both the startDate and the endDate means "any date" or "always."

Several object types defined in this clause have properties that contain timestamp values. If no event or operation has yet occurred, then timestamp values of type BACnetDateTime shall have an unspecified datetime value, timestamp values of type Time shall have an unspecified time value, and timestamp values of type Unsigned shall have a value of zero. If the event or operation has occurred, then the timestamp value shall have a specific datetime value, a specific time value, or a value greater than zero, respectively. If a device supports the Local_Date and Local_Time properties, then all timestamps created by the device shall use the BACnetDateTime form.

Several object types defined in this clause have a property called "Reliability." This property is an enumerated datatype that may have different possible enumerations for different object types. The values defined below are a superset of all possible values of the Reliability property for all object types. The range of possible values returned for each specific object is defined in the appropriate object type definition.

NO_FAULT_DETECTED	The present value is reliable; that is, no other fault (enumerated below) has been detected.
NO_SENSOR	No sensor is connected to the Input object.
OVER_RANGE	The sensor connected to the Input is reading a value higher than the normal operating range. If the object is a Binary Input, this is possible when the Binary state is derived from an analog sensor or a binary input equipped with electrical loop supervision circuits.
UNDER_RANGE	The sensor connected to the Input is reading a value lower than the normal operating range. If the object is a Binary Input, this is possible when the Binary Input is actually a binary state calculated from an analog sensor.
OPEN_LOOP	The connection between the defined object and the physical device is providing a value indicating an open circuit condition.
SHORTED_LOOP	The connection between the defined object and the physical device is providing a value indicating a short circuit condition.
NO_OUTPUT	No physical device is connected to the Output object.

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PROCESS_ERROR	A processing error was encountered.
MULTI_STATE_FAULT	The Present_Value of the Multi-state object is equal to one of the states in the Fault_Values property and no other fault has been detected.
CONFIGURATION_ERROR	The object's properties are not in a consistent state.
COMMUNICATION_FAILURE	Proper operation of the object is dependent on communication with a remote sensor or device and communication with the remote sensor or device has been lost.
UNRELIABLE_OTHER	The controller has detected that the present value is unreliable, but none of the other conditions describe the nature of the problem. A generic fault other than those listed above has been detected, e.g., a Binary Input is not cycling as expected.
MEMBER_FAULT	Indicates that the group includes one or more Status_Flags properties whose FAULT flag value is equal to TRUE.

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12.1 Accumulator Object Type

The Accumulator object type defines a standardized object whose properties represent the externally visible characteristics of a device that indicates measurements made by counting pulses.

This object maintains precise measurement of input count values, accumulated over time. The accumulation of pulses represents the measured quantity in unsigned integer units. This object is also concerned with the accurate representation of values presented on meter read-outs. This includes the ability to initially set the Present_Value property to the value currently displayed by the meter (as when the meter is installed), and to duplicate the means by which it is advanced, including simulating a modulo-N divider prescaling the actual meter display value, as shown in Figure 12-1.

Typical applications of such devices are in peak load management and in accounting and billing management systems. This object is not intended to meet all such applications. Its purpose is to provide information about the quantity being measured, such as electric power, water, or natural gas usage, according to criteria specific to the application.

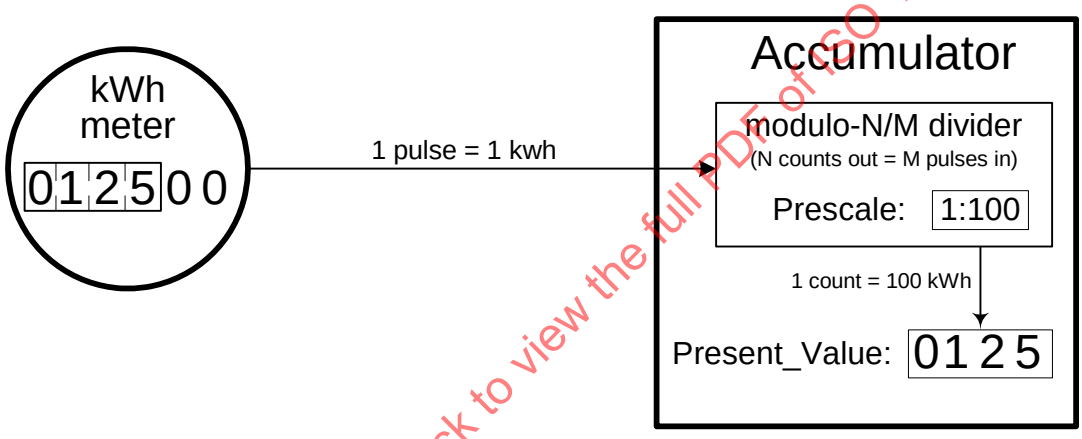

Figure 12-1. Example of an Accumulator object

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The object and its properties are summarized in Table 12-1 and described in detail in this subclause.

Table 12-1. Properties of the Accumulator Object

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Present_Value	Unsigned	R[1]
Description	CharacterString	O
Device_Type	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	R
Scale	BACnetScale	R
Units	BACnetEngineeringUnits	R
Prescale	BACnetPrescale	O
Max_Pres_Value	Unsigned	R
Value_Change_Time	BACnetDateTime	O[2]
Value_Before_Change	Unsigned	O[2,3]
Value_Set	Unsigned	O[2,3]
Logging_Record	BACnetAccumulatorRecord	O
Logging_Object	BACnetObjectIdentifier	O
Pulse_Rate	Unsigned	O[1,4]
High_Limit	Unsigned	O[4]
Low_Limit	Unsigned	O[4]
Limit_Monitoring_Interval	Unsigned	O[4]
Notification_Class	Unsigned	O[4]
Time_Delay	Unsigned	O[4]
Limit_Enable	BACnetLimitEnable	O[4]
Event_Enable	BACnetEventTransitionBits	O[4]
Acked_Transitions	BACnetEventTransitionBits	O[4]
Notify_Type	BACnetNotifyType	O[4]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[4]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[5]
Profile_Name	CharacterString	O

[1] This property is required to be writable when Out_Of_Service is TRUE.
[2] These properties are required if either Value_Before_Change or Value_Set is writable.
[3] Either Value_Before_Change or Value_Set may be writable, but not both.
[4] These properties are required if the object supports intrinsic reporting.
[5] This property, if present, is required to be read only.

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12.1.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.1.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

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12.1.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be ACCUMULATOR.

12.1.4 Present_Value

This property, of type Unsigned, indicates the count of the input pulses, prescaled if the Prescale property is present, acquired since the value was most recently set by writing to the Value_Set property.

The value of this property shall remain in the range from zero through Max_Pres_Value. All operations on the Present_Value property are performed modulo (Max_Pres_Value+1).

This property shall be writable when Out_Of_Service is TRUE.

12.1.5 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.1.6 Device_Type

This property, of type CharacterString, is a text description of the physical device represented by the Accumulator object. It will typically be used to describe the type of sensor represented by the Accumulator.

12.1.7 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of an Accumulator object. Three of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context, "overridden" is taken to mean that the Present_Value and Reliability properties are no longer tracking changes to the physical input. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0).

12.1.8 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting and if the Reliability property is not present, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT. Changes in the Event_State property to the value FAULT are considered to be "fault" events.

12.1.9 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the Present_Value property or the operation of the physical input in question is "reliable" as far as the BACnet Device or operator can determine and, if not, why. The Reliability property for this object type may have any of the following values:

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{NO_FAULT_DETECTED, NO_SENSOR, OVER_RANGE, UNDER_RANGE, OPEN_LOOP, COMMUNICATION_FAILURE, SHORTED_LOOP, UNRELIABLE_OTHER}

12.1.10 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the physical input that the object represents is not in service. This means that the Present_Value and Pulse_Rate properties are decoupled from the physical input and will not track changes to the physical input when the value of Out_Of_Service is TRUE. In addition, the Reliability property and the corresponding state of the FAULT flag of the Status_Flags property shall be decoupled from the physical input when Out_Of_Service is TRUE. While the Out_Of_Service property is TRUE, the Present_Value, Pulse_Rate and Reliability properties may be changed to any value as a means of simulating specific fixed conditions or for testing purposes. Other functions that depend on the state of the Present_Value, Pulse_Rate or Reliability properties shall respond to changes made to these properties while Out_Of_Service is TRUE, as if those changes had occurred in the physical input.

12.1.11 Scale

This property, of type BACnetScale, indicates the conversion factor to be multiplied with the value of the Present_Value property to provide a value in the units indicated by Units. The choice of options for this property determine how the scaling operation (which is performed by the client reading this object) is performed:

Option	Datatype	Indicated Value in Units
floatScale	REAL	Present_Value x Scale
integerScale	INTEGER	Present_Value x 10^{Scale}

12.1.12 Units

This property, of type BACnetEngineeringUnits, indicates the measurement units of the Present_Value when multiplied with the scaling factor indicated by Scale. See the BACnetEngineeringUnits ASN.1 production in Clause 21 for a list of engineering units defined by this standard.

12.1.13 Prescale

This property, of type BACnetPrescale, presents the coefficients that are used for converting the pulse signals generated by the measuring instrument into the value displayed by Present_Value. The conversions are performed using integer arithmetic in such a fashion that no measurement-generated pulse signals are lost in the conversion.

These coefficients might simply document a conversion performed prior to the reception of the input pulses by the Accumulator object, or they might actually be used by the Accumulator to convert input pulses into the value displayed by Present_Value. Whichever is done is a local matter.

The coefficients are as follows:

multiplier	The numerator of the conversion factor expressed as a ratio of integers.
moduloDivide	The denominator of the conversion factor expressed as a ratio of integers.

The conversion algorithm is performed as follows, utilizing a non-displayed variable called an accumulator:

```
For each input pulse:
    Add the value of 'multiplier' to an accumulator and then,
    while the accumulator is greater than or equal to the value of 'moduloDivide':
        Increment the value of Present_Value by one, and
        decrease the value of the accumulator by the value of 'moduloDivide'.
```

This procedure supports non-integral ratios of measurement pulses to Present_Value. For example, in an electrical metering application, the output of the voltage- and current-measuring systems might be 9000/1200 (scale / voltage*current) pulses per kWh, requiring the Accumulator object to accumulate 2/15 kWh/pulse. With this algorithm such pulses can be accurately accumulated and displayed when the units of Present_Value are KILOWATT_HOURS.

12.1.14 Max_Pres_Value

This property, of type Unsigned, indicates the maximum value of the Present_Value property.

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12.1.15 Value_Change_Time

This read-only property, of type BACnetDateTime, shall be present if the Present_Value property is adjustable by writing to the Value_Before_Change or Value_Set properties. It represents the date and time of the most recent occurrence of such a write operation. This property shall have an unspecified datetime to indicate that it is uninitialized; otherwise, it shall have a specific datetime value.

12.1.16 Value_Before_Change

This property, of type Unsigned, indicates the value of the Present_Value property just prior to the most recent write to the Value_Set or Value_Before_Change properties. If no such write has yet occurred, this property shall have the value zero. If this property is writable, the Value_Set property shall be read-only.

If this property is writable, the following series of operations, for which the associated properties are present, shall be performed atomically by the object when this property is written:

(1) The value of Present_Value shall be copied to the Value_Set property.
(2) The value written to Value_Before_Change shall be stored in the Value_Before_Change property.
(3) The current date and time shall be stored in the Value_Change_Time property.

While this series of operations is being performed, it is critical that any other process not change the Present_Value, Value_Set and Value_Before_Change properties.

12.1.17 Value_Set

This property, of type Unsigned, indicates the value of the Present_Value property after the most recent write to the Value_Set or Value_Before_Change properties. If no such write has yet occurred, this property shall have the value zero. If this property is writable, the Value_Before_Change property shall be read-only.

If this property is writable, the following series of operations, for which the associated properties are present, shall be performed atomically by the object when this property is written:

(1) The value of Present_Value shall be copied to the Value_Before_Change property.
(2) The value written to Value_Set shall be stored in both the Value_Set and Present_Value properties.
(3) The current date and time shall be stored in the Value_Change_Time property.

While this series of operations are being performed, it is critical that any other process not change the Present_Value, Value_Set and Value_Before_Change properties.

12.1.18 Logging_Record

This read-only property, of type BACnetAccumulatorRecord, is a list of values that must be acquired and returned "atomically" in order to allow proper interpretation of the data.

If the Logging_Object property is present, then, when Logging_Record is acquired by the object identified by Logging_Object, this list of values shall be saved and returned when read by other objects or devices. If the Logging_Object property is present and Logging_Record has not yet been acquired by the object identified by Logging_Object, 'timestamp' shall contain an unspecified datetime, 'present-value' and 'accumulated-value' shall contain the value zero, and 'accumulator-status' shall indicate STARTING.

The list of values ('timestamp', 'present-value', 'accumulated-value', and 'accumulator-status') shall be acquired from the underlying system when they reflect a stable state of the device (for example, they shall not be acquired when Present_Value has just been incremented but the corresponding increment of 'accumulated-value' has not yet occurred).

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The items returned in the list of values are:

timestamp — The local date and time when the data was acquired.

present-value — The value of the Present_Value property.

accumulated-value — The short term accumulated value of the counter. The algorithm used to calculate accumulated-value is a function of the value of accumulator-status. If this is the initial read, the value returned shall be zero.

accumulator-status — An indication of the reliability of the data in this list of values.

The accumulator-status parameter may take on any of the following values:

{NORMAL, STARTING, RECOVERED, ABNORMAL, FAILED}

where the values are defined as follows:

NORMAL — No event affecting the reliability of the data has occurred during the period from the preceding to the current qualified reads of the Logging_Record property. In this case 'accumulated-value' shall be represented by the expression:

accumulated-value =Present_Value$_{curren}$ - Present_Value$_{previous}$

STARTING — This value indicates that the data in Logging_Records is either the first data to be acquired since startup by the object identified by Logging_Object (if 'timestamp' has a specific datetime) or that no data has been acquired since startup by the object identified by Logging_Object (in which case 'timestamp' has an unspecified datetime).

RECOVERED — One or more writes to Value_Before_Change or Value_Set have occurred since Logging_Record was acquired by the object identified by Logging_Object. For the case of a single write, 'accumulated-value' shall be represented by the expression:

accumulated-value = (Present_Value$_{current}$ - Value_Set) +
(Value_Before_Change - Present_Value$_{previous}$)

ABNORMAL — The accumulation has been carried out, but some unrecoverable event such as the clock's time being changed by a significant amount since Logging_Record was acquired by the object identified by Logging_Object. (How much time is considered significant shall be a local matter.)

FAILED — The 'accumulated-value' item is not reliable due to some problem. The criteria for returning this value are a local matter.

Changes in the value of 'accumulator-status' shall occur only when the Logging_Record is acquired by the object identified by Logging_Object.

12.1.19 Logging_Object

This property, of type BACnetObjectIdentifier, indicates the object in the same device as the Accumulator object which, when it acquires Logging_Record data from the Accumulator object, shall cause the Accumulator object to acquire, present and store the data from the underlying system.

12.1.20 Pulse_Rate

This property, of type Unsigned, shall indicate the number of input pulses received during the most recent period specified by Limit_Monitoring_Interval. The mechanism that associates the input signal with the value indicated by this property is a local matter.

This property shall be writable when Out_Of_Service is TRUE.

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12.1.21 High_Limit

This property, of type Unsigned, shall specify a limit that Pulse_Rate must exceed before an event is generated. This property is required if this object supports intrinsic reporting.

12.1.21.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) Pulse_Rate must exceed High_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the HighLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-OFFNORMAL flag must be set in the Event_Enable property.

12.1.21.2 Conditions for Generating a TO-NORMAL Event

Once exceeded, Pulse_Rate must fall below High_Limit before a TO-NORMAL event is generated under these conditions:

(a) Pulse_Rate must remain below High_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the HighLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-NORMAL flag must be set in the Event_Enable property.

12.1.22 Low_Limit

This property, of type Unsigned, shall specify a limit that Pulse_Rate must fall below before an event is generated. This property is required if this object supports intrinsic reporting.

12.1.22.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) Pulse_Rate must fall below Low_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the LowLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-OFFNORMAL flag must be set in the Event_Enable property.

12.1.22.2 Conditions for Generating a TO-NORMAL Event

Once Pulse_Rate has fallen below the Low_Limit, the Pulse_Rate must become greater than Low_Limit before a TO-NORMAL event is generated under these conditions:

(a) Pulse_Rate must become greater than Low_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the LowLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-NORMAL flag must be set in the Event_Enable property.

12.1.23 Limit_Monitoring_Interval

This property, of type Unsigned, specifies the monitoring period in seconds for determining the value of Pulse_Rate. The use of a fixed or sliding time window for detecting pulse rate is a local matter. This property is required if this object supports intrinsic reporting.

12.1.24 Notification_Class

This property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if this object supports intrinsic reporting.

12.1.25 Time_Delay

This property, of type Unsigned, shall specify the minimum period of time in seconds that Pulse_Rate must remain outside the range from Low_Limit through High_Limit, before a TO-OFFNORMAL event is generated, or within the same band before a TO-NORMAL event is generated. This property is required if this object supports intrinsic reporting.

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12.1.26 Limit_Enable

This property, of type BACnetLimitEnable, shall convey two flags that separately enable and disable reporting of High_Limit and Low_Limit offnormal events and their return to normal. This property is required if this object supports intrinsic reporting.

12.1.27 Event_Enable

This property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. In the context of Accumulator objects, transitions to the High_Limit or Low_Limit Event_States are considered to be "offnormal" events. This property is required if this object supports intrinsic reporting.

12.1.28 Acked_Transitions

This property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgements for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. In the context of Accumulator objects, transitions to High_Limit and Low_Limit Event_State are considered to be "offnormal" events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgement;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgement is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgement is expected).

This property is required if this object supports intrinsic reporting.

12.1.29 Notify_Type

This property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if this object supports intrinsic reporting.

12.1.30 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if this object supports intrinsic reporting.

12.1.31 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.1.32 Profile_Name

This property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.2 Analog Input Object Type

The Analog Input object type defines a standardized object whose properties represent the externally visible characteristics of an analog input. The object and its properties are summarized in Table 12-2 and described in detail in this subclause.

Table 12-2. Properties of the Analog Input Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Present_Value	REAL	R[1]
Description	CharacterString	O
Device_Type	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	R
Update_Interval	Unsigned	O
Units	BACnetEngineeringUnits	R
Min_Pres_Value	REAL	O
Max_Pres_Value	REAL	O
Resolution	REAL	O
COV_Increment	REAL	O[2]
Time_Delay	Unsigned	O[3]
Notification_Class	Unsigned	O[3]
High_Limit	REAL	O[3]
Low_Limit	REAL	O[3]
Deadband	REAL	O[3]
Limit_Enable	BACnetLimitEnable	O[3]
Event_Enable	BACnetEventTransitionBits	O[3]
Acked_Transitions	BACnetEventTransitionBits	O[3]
Notify_Type	BACnetNotifyType	O[3]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[3]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[4]
Profile_Name	CharacterString	O

[1] This property is required to be writable when Out_Of_Service is TRUE.
[2] This property is required if the object supports COV reporting.
[3] These properties are required if the object supports intrinsic reporting.
[4] This property, if present, is required to be read only.

12.2.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it**.**

12.2.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters**.**

12.2.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be ANALOG_INPUT.

12.2.4 Present_Value

This property, of type REAL, indicates the current value, in engineering units, of the input being measured. The Present_Value property shall be writable when Out_Of_Service is TRUE.

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12.2.5 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted**.**

12.2.6 Device_Type

This property, of type CharacterString, is a text description of the physical device connected to the analog input. It will typically be used to describe the type of sensor attached to the analog input.

12.2.7 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of an analog input. Three of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value and Reliability properties are no longer tracking changes to the physical input. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0).

12.2.8 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT. Changes in the Event_State property to the value FAULT are considered to be "fault" events.

12.2.9 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the Present_Value or the operation of the physical input in question is "reliable" as far as the BACnet Device or operator can determine and, if not, why. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, NO_SENSOR, OVER_RANGE, UNDER_RANGE, OPEN_LOOP, SHORTED_LOOP, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.2.10 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the physical input that the object represents is not in service. This means that the Present_Value property is decoupled from the physical input and will not track changes to the physical input when the value of Out_Of_Service is TRUE. In addition, the Reliability property and the corresponding state of the FAULT flag of the Status_Flags property shall be decoupled from the physical input when Out_Of_Service is TRUE. While the Out_Of_Service property is TRUE, the Present_Value and Reliability properties may be changed to any value as a means of simulating specific fixed conditions or for testing purposes. Other functions that depend on the state of the Present_Value or Reliability properties shall respond to changes made to these properties while Out_Of_Service is TRUE, as if those changes had occurred in the physical input.

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12.2.11 Update_Interval

This property, of type Unsigned, indicates the maximum period of time between updates to the Present_Value in hundredths of a second when the input is not overridden and not out-of-service**.**

12.2.12 Units

This property, of type BACnetEngineeringUnits, indicates the measurement units of this object. See the BACnetEngineeringUnits ASN.1 production in Clause 21 for a list of engineering units defined by this standard.

12.2.13 Min_Pres_Value

This property, of type REAL, indicates the lowest number in engineering units that can be reliably obtained for the Present_Value property of this object.

12.2.14 Max_Pres_Value

This property, of type REAL, indicates the highest number in engineering units that can be reliably obtained for the Present_Value property of this object.

12.2.15 Resolution

This property, of type REAL, indicates the smallest recognizable change in Present_Value in engineering units (read-only).

12.2.16 COV_Increment

This property, of type REAL, shall specify the minimum change in Present_Value that will cause a COVNotification to be issued to subscriber COV-clients. This property is required if COV reporting is supported by this object.

12.2.17 Time_Delay

This property, of type Unsigned, shall specify the minimum period of time in seconds that the Present_Value must remain outside the band defined by the High_Limit and Low_Limit properties before a TO-OFFNORMAL event is generated or within the same band, including the Deadband property, before a TO-NORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.2.18 Notification_Class

This property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.2.19 High_Limit

This property, of type REAL, shall specify a limit that the Present_Value must exceed before an event is generated. This property is required if intrinsic reporting is supported by this object.

12.2.19.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must exceed the High_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the HighLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-OFFNORMAL flag must be set in the Event_Enable property, and
(d) the Event_State must not be equal to LOW_LIMIT.

The Analog Input object shall not generate a TO-OFFNORMAL transition from the LOW_LIMIT or HIGH_LIMIT state. When transitioning from LOW_LIMIT to HIGH_LIMIT, the object shall first transition to the NORMAL state.

12.2.19.2 Conditions for Generating a TO-NORMAL Event

Once exceeded, the Present_Value must fall below the High_Limit minus the Deadband before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must fall below the High_Limit minus the Deadband for a minimum period of time, specified in the Time_Delay property, and

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(b) the HighLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-NORMAL flag must be set in the Event_Enable property.

12.2.20 Low_Limit

This property, of type REAL, shall specify a limit that the Present_Value must fall below before an event is generated. This property is required if intrinsic reporting is supported by this object.

12.2.20.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must fall below the Low_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the LowLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-OFFNORMAL flag must be set in the Event_Enable property, and
(d) the Event_State must not be equal to HIGH_LIMIT.

The Analog Input object shall not generate a TO-OFFNORMAL transition from the LOW_LIMIT or HIGH_LIMIT state. When transitioning from HIGH_LIMIT to LOW_LIMIT, the object shall first transition to the NORMAL state.

12.2.20.2 Conditions for Generating a TO-NORMAL Event

Once the Present_Value has fallen below the Low_Limit, the Present_Value must exceed the Low_Limit plus the Deadband before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must exceed the Low_Limit plus the Deadband for a minimum period of time, specified in the Time_Delay property, and
(b) the LowLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-NORMAL flag must be set in the Event_Enable property.

12.2.21 Deadband

This property, of type REAL, shall specify a range between the High_Limit and Low_Limit properties, which the Present_Value must remain within for a TO-NORMAL event to be generated under these conditions:

(a) the Present_Value must fall below the High_Limit minus Deadband, and
(b) the Present_Value must exceed the Low_Limit plus the Deadband, and
(c) the Present_Value must remain within this range for a minimum period of time, specified in the Time_Delay property, and
(d) either the HighLimitEnable or LowLimitEnable flag must be set in the Limit_Enable property, and
(e) the TO-NORMAL flag must be set in the Event_Enable property.

This property is required if intrinsic reporting is supported by this object.

12.2.22 Limit_Enable

This property, of type BACnetLimitEnable, shall convey two flags that separately enable and disable reporting of high limit and low limit offnormal events and their return to normal. This property is required if intrinsic reporting is supported by this object.

12.2.23 Event_Enable

This property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. In the context of Analog Input objects, transitions to High_Limit and Low_Limit Event_States are considered to be "offnormal" events. This property is required if intrinsic reporting is supported by this object.

12.2.24 Acked_Transitions

This property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. In the context of Analog Input objects,

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transitions to High_Limit and Low_Limit Event_States are considered to be "offnormal" events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

12.2.25 Notify_Type

This property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.2.26 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.2.27 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.2.28 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.3 Analog Output Object Type

The Analog Output object type defines a standardized object whose properties represent the externally visible characteristics of an analog output. The object and its properties are summarized in Table 12-3 and described in detail in this subclause.

Table 12-3. Properties of the Analog Output Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Present_Value	REAL	W
Description	CharacterString	O
Device_Type	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	R
Units	BACnetEngineeringUnits	R
Min_Pres_Value	REAL	O
Max_Pres_Value	REAL	O
Resolution	REAL	O
Priority_Array	BACnetPriorityArray	R
Relinquish_Default	REAL	R
COV_Increment	REAL	O[1]
Time_Delay	Unsigned	O[2]
Notification_Class	Unsigned	O[2]
High_Limit	REAL	O[2]
Low_Limit	REAL	O[2]
Deadband	REAL	O[2]
Limit_Enable	BACnetLimitEnable	O[2]
Event_Enable	BACnetEventTransitionBits	O[2]
Acked_Transitions	BACnetEventTransitionBits	O[2]
Notify_Type	BACnetNotifyType	O[2]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[2]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[3]
Profile_Name	CharacterString	O

[1] This property is required if the object supports COV reporting.
[2] These properties are required if the object supports intrinsic reporting.
[3] This property, if present, is required to be read only.

12.3.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.3.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.3.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be ANALOG_OUTPUT.

12.3.4 Present_Value (Commandable)

This property, of type REAL, indicates the current value, in engineering units, of the output.

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12.3.5 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.3.6 Device_Type

This property, of type CharacterString, is a text description of the physical device connected to the analog output. It will typically be used to describe the type of device attached to the analog output**.**

12.3.7 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of an analog output. Three of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the physical output is no longer tracking changes to the Present_Value property and the Reliability property is no longer a reflection of the physical output. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0**).**

12.3.8 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT. Changes in the Event_State property to the value FAULT are considered to be "fault" events.

12.3.9 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the Present_Value or the operation of the physical output in question is "reliable" as far as the BACnet Device or operator can determine and, if not, why. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED ,OPEN_LOOP, SHORTED_LOOP, NO_OUTPUT, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.3.10 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the physical point that the object represents is not in service. This means that changes to the Present_Value property are decoupled from the physical output when the value of Out_Of_Service is TRUE. In addition, the Reliability property and the corresponding state of the FAULT flag of the Status_Flags property shall be decoupled from the physical output when Out_Of_Service is TRUE. While the Out_Of_Service property is TRUE, the Present_Value and Reliability properties may still be changed to any value as a means of simulating specific fixed conditions or for testing purposes. Other functions that depend on the state of the Present_Value or Reliability properties shall respond to changes made to these properties while Out_Of_Service is TRUE, as if those changes had occurred to the physical output. The Present_Value property shall still be controlled by the BACnet command prioritization mechanism if Out_Of_Service is TRUE. See Clause 19.

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12.3.11 Units

This property, of type BACnetEngineeringUnits, indicates the measurement units of this object. See the BACnetEngineeringUnits ASN.1 production in Clause 21 for a list of engineering units defined by this standard.

12.3.12 Min_Pres_Value

This property, of type REAL, indicates the lowest number that can be reliably used for the Present_Value property of this object.

12.3.13 Max_Pres_Value

This property, of type REAL, indicates the highest number that can be reliably used for the Present_Value property of this object.

12.3.14 Resolution

This property, of type REAL, indicates the smallest recognizable change in Present_Value in engineering units (read-only).

12.3.15 Priority_Array

This property is a read-only array of prioritized values. See Clause 19 for a description of the prioritization mechanism.

12.3.16 Relinquish_Default

This property is the default value to be used for the Present_Value property when all command priority values in the Priority_Array property have a NULL value. See Clause 19.

12.3.17 COV_Increment

This property, of type REAL, shall specify the minimum change in Present_Value that will cause a COVNotification to be issued to subscriber COV-clients. This property is required if COV reporting is supported by this object.

12.3.18 Time_Delay

This property, of type Unsigned, shall specify the minimum period of time in seconds the Present_Value must remain outside the band defined by the High_Limit and Low_Limit properties before a TO-OFFNORMAL event is generated or within the same band, including the Deadband property, before a TO-NORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.3.19 Notification_Class

This property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.3.20 High_Limit

This property, of type REAL, shall specify a limit that the Present_Value must exceed before an event is generated. This property is required if intrinsic reporting is supported by this object.

12.3.20.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must exceed the High_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the HighLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-OFFNORMAL flag must be set in the Event_Enable property, and
(d) the Event_State must not be equal to LOW_LIMIT.

The Analog Output object shall not generate a TO-OFFNORMAL transition from the LOW_LIMIT or HIGH_LIMIT state. When transitioning from LOW_LIMIT to HIGH_LIMIT, the object shall first transition to the NORMAL state.

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12.3.20.2 Conditions for Generating a TO-NORMAL Event

Once exceeded, the Present_Value must fall below the High_Limit minus the Deadband before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must fall below the High_Limit minus the Deadband for a minimum period of time, specified in the Time_Delay property, and
(b) the HighLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-NORMAL flag must be set in the Event_Enable property.

12.3.21 Low_Limit

This property, of type REAL, shall specify a limit below which the Present_Value must fall before an event is generated. . This property is required if intrinsic reporting is supported by this object .

12.3.21.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must fall below the Low_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the LowLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-OFFNORMAL flag must be set in the Event_Enable property, and
(d) the Event_State must not be equal to HIGH_LIMIT.

The Analog Output object shall not generate a TO-OFFNORMAL transition from the LOW_LIMIT or HIGH_LIMIT state. When transitioning from LOW_LIMIT to HIGH_LIMIT, the object shall first transition to the NORMAL state.

12.3.21.2 Conditions for Generating a TO-NORMAL Event

Once the Present_Value has fallen below the Low_Limit, the Present_Value must exceed the Low_Limit plus the Deadband before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must exceed the Low_Limit plus the Deadband for a minimum period of time, specified in the Time_Delay property, and
(b) the LowLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-NORMAL flag must be set in the Event_Enable property.

12.3.22 Deadband

This property, of type REAL, shall specify a range between the High_Limit and Low_Limit properties within which the Present_Value must remain for a TO-NORMAL event to be generated under these conditions:

(a) the Present_Value must fall below the High_Limit minus Deadband, and
(b) the Present_Value must exceed the Low_Limit plus the Deadband, and
(c) the Present_Value must remain within this range for a minimum period of time, specified in the Time_Delay property, and
(d) either the HighLimitEnable or LowLimitEnable flag must be set in the Limit_Enable property, and
(e) the TO-NORMAL flag must be set in the Event_Enable property.

This property is required if intrinsic reporting is supported by this object.

12.3.23 Limit_Enable

This property, of type BACnetLimitEnable, shall convey two flags that separately enable and disable reporting of high limit and low limit offnormal events and their return to normal. This property is required if intrinsic reporting is supported by this object.

12.3.24 Event_Enable

This property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. In the context of Analog Output objects, transitions to

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High_Limit and Low_Limit Event_States are considered to be "offnormal" events. This property is required if intrinsic reporting is supported by this object.

12.3.25 Acked_Transitions

This property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. In the context of Analog Output objects, transitions to High_Limit and Low_Limit Event_States are considered to be "offnormal" events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

12.3.26 Notify_Type

This property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.3.27 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.3.28 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.3.29 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.4 Analog Value Object Type

The Analog Value object type defines a standardized object whose properties represent the externally visible characteristics of an analog value. An "analog value" is a control system parameter residing in the memory of the BACnet Device. The object and its properties are summarized in Table 12-4 and described in detail in this subclause.

Table 12-4. Properties of the Analog Value Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Present_Value	REAL	R[4]
Description	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	R
Units	BACnetEngineeringUnits	R
Priority_Array	BACnetPriorityArray	O[1]
Relinquish_Default	REAL	O[1]
COV_Increment	REAL	O[2]
Time_Delay	Unsigned	O[3]
Notification_Class	Unsigned	O[3]
High_Limit	REAL	O[3]
Low_Limit	REAL	O[3]
Deadband	REAL	O[3]
Limit_Enable	BACnetLimitEnable	O[3]
Event_Enable	BACnetEventTransitionBits	O[3]
Acked_Transitions	BACnetEventTransitionBits	O[3]
Notify_Type	BACnetNotifyType	O[3]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[3]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[5]
Profile_Name	CharacterString	O

[1] If Present_Value is commandable, then both of these properties shall be present.
[2] This property is required if the object supports COV reporting.
[3] These properties are required if the object supports intrinsic reporting.
[4] If Present_Value is commandable, then it is required to be writable. This property is required to be writable when Out_Of_Service is TRUE.
[5] This property, if present, is required to be read only.

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12.4.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.4.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.4.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be ANALOG_VALUE.

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12.4.4 Present_Value

This property, of type REAL, indicates the current value, in engineering units, of the analog value. Present_Value shall be optionally commandable. If Present_Value is commandable for a given object instance, then the Priority_Array and Relinquish_Default properties shall also be present for that instance. The Present_Value property shall be writable when Out_Of_Service is TRUE.

12.4.5 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.4.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of an analog value. Three of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value property is not changeable through BACnet services. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0).

12.4.7 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT. Changes in the Event_State property to the value FAULT are considered to be "fault" events.

12.4.8 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the Present_Value is "reliable" as far as the BACnet Device can determine and, if not, why. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, OVER_RANGE, UNDER_RANGE, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.4.9 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the Present_Value of the Analog Value object is prevented from being modified by software local to the BACnet device in which the object resides. When Out_Of_Service is TRUE, the Present_Value property may be written to freely. If the Priority_Array and Relinquish_Default properties are present, then writing to the Present_Value property shall be controlled by the BACnet command prioritization mechanism. See Clause 19.

12.4.10 Units

This property, of type BACnetEngineeringUnits, indicates the measurement units of this object. See the BACnetEngineeringUnits ASN.1 production in Clause 21 for a list of engineering units defined by this standard.

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12.4.11 Priority_Array

This property is a read-only array that contains prioritized commands that are in effect for this object. See Clause 19 for a description of the prioritization mechanism. If either the Priority_Array property or the Relinquish_Default property are present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.4.12 Relinquish_Default

This property is the default value to be used for the Present_Value property when all command priority values in the Priority_Array property have a NULL value. See Clause 19. If either the Relinquish_Default property or the Priority_Array property are present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.4.13 COV_Increment

This property, of type REAL, shall specify the minimum change in Present_Value that will cause a COVNotification to be issued to subscriber COV-clients. This property is required if COV reporting is supported by this object.

12.4.14 Time_Delay

This property, of type Unsigned, shall specify the minimum period of time during which the Present_Value must remain outside the band defined by the High_Limit and Low_Limit properties before a TO-OFFNORMAL event is generated or within the same band, including the Deadband property, before a TO-NORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.4.15 Notification_Class

This property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.4.16 High_Limit

This property, of type REAL, shall specify a limit that the Present_Value must exceed before an event is generated. This property is required if intrinsic reporting is supported by this object.

12.4.16.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must exceed the High_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the HighLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-OFFNORMAL flag must be set in the Event_Enable property, and
(d) the Event_State must not be equal to LOW_LIMIT.

The Analog Value object shall not generate a TO-OFFNORMAL transition from the LOW_LIMIT or HIGH_LIMIT state. When transitioning from LOW_LIMIT to HIGH_LIMIT, the object shall first transition to the NORMAL state.

12.4.16.2 Conditions for Generating a TO-NORMAL Event

Once exceeded, the Present_Value must fall below the High_Limit minus the Deadband before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must fall below the High_Limit minus the Deadband for a minimum period of time, specified in the Time_Delay property, and
(b) the HighLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-NORMAL flag must be set in the Event_Enable property.

12.4.17 Low_Limit

This property, of type REAL, shall specify a limit below which the Present_Value must fall before an event is generated. This property is required if intrinsic reporting is supported by this object.

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12.4.17.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must fall below the Low_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the LowLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-OFFNORMAL flag must be set in the Event_Enable property, and
(d) the Event_State must not be equal to HIGH_LIMIT.

The Analog Value object shall not generate a TO-OFFNORMAL transition from the LOW_LIMIT or HIGH_LIMIT state. When transitioning from HIGH_LIMIT to LOW_LIMIT, the object shall first transition to the NORMAL state.

12.4.17.2 Conditions for Generating a TO-NORMAL Event

Once the Present_Value has fallen below the Low_Limit, the Present_Value must exceed the Low_Limit plus the Deadband before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must exceed the Low_Limit plus the Deadband for a minimum period of time, specified in the Time_Delay property, and
(b) the LowLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-NORMAL flag must be set in the Event_Enable property.

12.4.18 Deadband

This property, of type REAL, shall specify a range between the High_Limit and Low_Limit properties within which the Present_Value must remain for a TO-NORMAL event to be generated under these conditions:

(a) the Present_Value must fall below the High_Limit minus Deadband, and
(b) the Present_Value must exceed the Low_Limit plus the Deadband, and
(c) the Present_Value must remain within this range for a minimum period of time, specified in the Time_Delay property, and
(d) either the HighLimitEnable or LowLimitEnable flag must be set in the Limit_Enable property, and
(e) the TO-NORMAL flag must be set in the Event_Enable property.

This property is required if intrinsic reporting is supported by this object.

12.4.19 Limit_Enable

This property, of type BACnetLimitEnable, shall convey two flags that separately enable and disable reporting of high limit and low limit offnormal events and their return to normal. This property is required if intrinsic reporting is supported by this object.

12.4.20 Event_Enable

This property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. In the context of Analog Value objects, transitions to High_Limit and Low_Limit Event_States are considered to be "offnormal" events. This property is required if intrinsic reporting is supported by this object.

12.4.21 Acked_Transitions

This property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. In the context of Analog Value objects, transitions to High_Limit and Low_Limit Event_States are considered to be "offnormal" events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgment is expected);

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(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

12.4.22 Notify_Type

This property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.4.23 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.4.24 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.4.25 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.5 Averaging Object Type

The Averaging object type defines a standardized object whose properties represent the externally visible characteristics of a value that is sampled periodically over a specified time interval. The Averaging object records the minimum, maximum and average value over the interval, and makes these values visible as properties of the Averaging object. The sampled value may be the value of any BOOLEAN, INTEGER, Unsigned, Enumerated or REAL property value of any object within the BACnet Device in which the object resides. Optionally, the object property to be sampled may exist in a different BACnet Device. The Averaging object shall use a "sliding window" technique that maintains a buffer of *N* samples distributed over the specified interval. Every (time interval/N) seconds a new sample is recorded displacing the oldest sample from the buffer. At this time, the minimum, maximum and average are recalculated. The buffer shall maintain an indication for each sample that permits the average calculation and minimum/maximum algorithm to determine the number of valid samples in the buffer.

The Averaging object type and its properties are summarized in Table 12-5 and described in detail in this subclause.

Table 12-5. Properties of the Averaging Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Minimum_Value	REAL	R
Minimum_Value_Timestamp	BACnetDateTime	O
Average_Value	REAL	R
Variance_Value	REAL	O
Maximum_Value	REAL	R
Maximum_Value_Timestamp	BACnetDateTime	O
Description	CharacterString	O
Attempted_Samples	Unsigned	W[1]
Valid_Samples	Unsigned	R
Object_Property_Reference	BACnetDeviceObjectPropertyReference	R[1]
Window_Interval	Unsigned	W[1]
Window_Samples	Unsigned	W[1]
Profile_Name	CharacterString	O

[1] If any of these properties are written to using BACnet services, then all of the buffer samples shall become invalid, 'Attempted_Samples' shall become zero, 'Valid_Samples' shall become zero, 'Minimum_Value' shall become INF, 'Average_Value' shall become NaN and 'Maximum_Value' shall become -INF.

12.5.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.5.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.5.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be AVERAGING.

12.5.4 Minimum_Value

This property, of type REAL, shall reflect the lowest value contained within the buffer window for the most recent 'Window_Samples' samples, or the actual number of samples ('Valid_Samples') if less than 'Window_Samples' samples have

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been taken. After a device restart, or after 'Attempted_Samples', 'Object_Property_Reference', 'Window_Samples' or 'Window_Interval' are written to using BACnet services, until a sample is taken, 'Minimum_Value' shall have the value **INF**.

12.5.5 Minimum_Value_Timestamp

This optional property, of type BACnetDateTime, indicates the date and time at which the value stored in Minimum_Value was sampled.

12.5.6 Average_Value

This property, of type REAL, shall reflect the average value contained within the buffer window for the most recent 'Window_Samples' samples, or the actual number of samples ('Valid_Samples') if less than 'Window_Samples' samples have been taken. The average shall be calculated by taking the arithmetic sum of all non-missed buffer samples and dividing by the number of non-missed buffer samples. After a device restart, or after 'Attempted_Samples', 'Object_Property_Reference', 'Window_Samples' or 'Window_Interval' are written to using BACnet services, until a sample is taken, 'Average_Value' shall have the value **NaN**.

12.5.7 Variance_Value

This optional property, of type REAL, shall reflect the variance value contained within the buffer window for the most recent 'Window_Samples' samples, or the actual number of samples ('Valid_Samples') if less than 'Window_Samples' samples have been taken. After a device restart, or after 'Attempted_Samples', 'Object_Property_Reference', 'Window_Samples' or 'Window_Interval' are written to using BACnet services, until a sample is taken, 'Variance_Value' shall have the value **NaN**.

12.5.8 Maximum_Value

This property, of type REAL, shall reflect the highest value contained within the buffer window for the most recent 'Window_Samples' samples, or the actual number of samples ('Valid_Samples') if less than 'Window_Samples' samples have been taken. After a device restart, or after 'Attempted_Samples', 'Object_Property_Reference', 'Window_Samples' or 'Window_Interval' are written to using BACnet services, until a sample is taken, 'Maximum_Value' shall have the value **-INF**.

12.5.9 Maximum_Value_Timestamp

This optional property, of type BACnetDateTime, indicates the date and time at which the value stored in Maximum_Value was sampled.

12.5.10 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.5.11 Attempted_Samples

This property, of type Unsigned, indicates the number of samples that have been attempted to be collected for the current window. The only acceptable value that may be written to this property shall be zero. If 'Attempted_Samples' is less than 'Window_Samples' then a period of time less than 'Window_Interval' has elapsed since a device restart, or 'Attempted_Samples', 'Object_Property_Reference', 'Window_Samples' or 'Window_Interval' have been written to using BACnet services. The number of missed samples in the current window can be calculated by subtracting 'Valid_Samples' from 'Attempted_Samples.' After a device restart, or after 'Attempted_Samples', 'Object_Property_Reference', 'Window_Samples' or 'Window_Interval' are written to using BACnet services, until a sample is taken, 'Attempted_Samples' shall have the value zero.

12.5.12 Valid_Samples

This read-only property, of type Unsigned, indicates the number of samples that have been successfully collected for the current window. This value can be used to determine whether any of the samples in the current 'Window_Interval' are missing. The number of missed samples in the current window can be calculated by subtracting 'Valid_Samples' from 'Attempted_Samples.' A result greater than zero indicates the number of samples that encountered an error when the sample was being recorded. After a device restart, or after 'Attempted_Samples', 'Object_Property_Reference', 'Window_Samples' or 'Window_Interval' are written to using BACnet services until a sample is taken, 'Valid_Samples' shall have the value **zero**.

12.5.13 Object_Property_Reference

This property, of type BACnetDeviceObjectPropertyReference, shall identify the object and property whose value is to be sampled during the 'Window_Interval'. The object referenced may be located within the device containing the Averaging

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object, or optionally the Averaging object may support the referencing of object properties in other devices. External references may be restricted to a particular set of BACnet devices. The referenced object property must have any of the numeric datatypes BOOLEAN, INTEGER, Unsigned, Enumerated or REAL. All sampled data shall be converted to REAL for calculation purposes. BOOLEAN FALSE shall be considered to be zero and TRUE shall be considered to be one. Enumerated datatypes shall be treated as Unsigned values. If an implementation supports writing to 'Object_Property_Reference', then if 'Object_Property_Reference' is written to using BACnet services, then all of the buffer samples shall become invalid, 'Attempted_Samples' shall become zero, 'Valid_Samples' shall become zero, 'Minimum_Value' shall become INF, 'Average_Value' shall become NaN and 'Maximum_Value' shall become -INF.

12.5.14 Window_Interval

This property, of type Unsigned, shall indicate the period of time in seconds over which the minimum, maximum and average values are calculated. The minimum acceptable value for 'Window_Interval' shall be a local matter. Every 'Window_Interval' divided by 'Window_Samples' seconds a new sample shall be taken by reading the value of the property referenced by the 'Object_Property_Reference'. Whether the sample represents an instantaneous "snapshot" or a continuously calculated sample shall be a local matter. If 'Window_Interval' is written to using BACnet services, then all of the buffer samples shall become invalid, 'Attempted_Samples' shall become zero, 'Valid_Samples' shall become zero, 'Minimum_Value' shall become INF, 'Average_Value' shall become NaN and 'Maximum_Value' shall become -INF.

12.5.15 Window_Samples

This property, of type Unsigned, shall indicate the number of samples to be taken during the period of time specified by the 'Window_Interval' property. 'Window_Samples' must be greater than zero and all implementations shall support at least 15 samples. Every 'Window_Interval' divided by 'Window_Samples' seconds a new sample shall be taken by reading the value of the property referenced by the 'Object_Property_Reference'. Whether the sample represents an instantaneous "snapshot" or a continuously calculated sample shall be a local matter. If 'Window_Samples' is written to using BACnet services, then all of the buffer samples shall become invalid, 'Attempted_Samples' shall become zero, 'Valid_Samples' shall become zero, 'Minimum_Value' shall become INF, 'Average_Value' shall become NaN and 'Maximum_Value' shall become -INF.

12.5.16 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.6 Binary Input Object Type

The Binary Input object type defines a standardized object whose properties represent the externally visible characteristics of a binary input. A "binary input" is a physical device or hardware input that can be in only one of two distinct states. In this description, those states are referred to as ACTIVE and INACTIVE. A typical use of a binary input is to indicate whether a particular piece of mechanical equipment, such as a fan or pump, is running or idle. The state ACTIVE corresponds to the situation when the equipment is on or running, and INACTIVE corresponds to the situation when the equipment is off or idle.

In some applications, electronic circuits may reverse the relationship between the application-level logical states ACTIVE and INACTIVE and the physical state of the underlying hardware. For example, a normally open relay contact may result in an ACTIVE state when the relay is energized, while a normally closed relay contact may result in an INACTIVE state when the relay is energized. The Binary Input object provides for this possibility by including a Polarity property. See Clauses 12.6.4 and 12.6.11.

The object and its properties are summarized in Table 12-6 and described in detail in this subclause.

Table 12-6. Properties of the Binary Input Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Present_Value	BACnetBinaryPV	R[1]
Description	CharacterString	O
Device_Type	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	R
Polarity	BACnetPolarity	R
Inactive_Text	CharacterString	O[2]
Active_Text	CharacterString	O[2]
Change_Of_State_Time	BACnetDateTime	O[3]
Change_Of_State_Count	Unsigned	O[3]
Time_Of_State_Count_Reset	BACnetDateTime	O[3]
Elapsed_Active_Time	Unsigned32	O[4]
Time_Of_Active_Time_Reset	BACnetDateTime	O[4]
Time_Delay	Unsigned	O[5]
Notification_Class	Unsigned	O[5]
Alarm_Value	BACnetBinaryPV	O[5]
Event_Enable	BACnetEventTransitionBits	O[5]
Acked_Transitions	BACnetEventTransitionBits	O[5]
Notify_Type	BACnetNotifyType	O[5]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[5]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[6]
Profile_Name	CharacterString	O

[1] This property is required to be writable when Out_Of_Service is TRUE.
[2] If one of the optional properties Inactive_Text or Active_Text is present, then both of these properties shall be present.
[3] If one of the optional properties Change_Of_State_Time, Change_Of_State_Count, or Time_Of_State_Count_Reset is present, then all of these properties shall be present.
[4] If one of the optional properties Elapsed_Active_Time or Time_Of_Active_Time_Reset is present, then both of these properties shall be present.
[5] These properties are required if the object supports intrinsic reporting.
[6] This property, if present, is required to be read only.

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12.6.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.6.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.6.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object-type class. The value of this property shall be BINARY_INPUT.

12.6.4 Present_Value

This property, of type BACnetBinaryPV, reflects the logical state of the Binary Input. The logical state of the Input shall be either INACTIVE or ACTIVE. The relationship between the Present_Value and the physical state of the Input is determined by the Polarity property. The possible states are summarized in Table 12-7.

Table 12-7. BACnet Polarity Relationships

Present_Value	Polarity	Physical State of Input	Physical State of Device
INACTIVE	NORMAL	OFF or INACTIVE	not running
ACTIVE	NORMAL	ON or ACTIVE	Running
INACTIVE	REVERSE	ON or ACTIVE	not running
ACTIVE	REVERSE	OFF or INACTIVE	running

The Present_Value property shall be writable when Out_Of_Service is TRUE.

12.6.5 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.6.6 Device_Type

This property, of type CharacterString, is a text description of the physical device connected to the binary input. It will typically be used to describe the type of device attached to the binary input.

12.6.7 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of a binary input. Three of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM — Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT — Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN — Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value and Reliability properties are no longer tracking changes to the physical input. Otherwise, the value is logical FALSE (0).

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OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0).

12.6.8 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT. Changes in the Event_State property to the value FAULT are considered to be "fault" events.

12.6.9 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the Present_Value or the operation of the physical input in question is "reliable" as far as the BACnet Device or operator can determine and, if not, why. The Reliability property for this object may have any of the following values:

{NO_FAULT_DETECTED, NO_SENSOR, OPEN_LOOP, SHORTED_LOOP, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.6.10 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the physical input the object represents is not in service. This means that the Present_Value property is decoupled from the physical input and will not track changes to the physical input when the value of Out_Of_Service is TRUE. In addition, the Reliability property and the corresponding state of the FAULT flag of the Status_Flags property shall be decoupled from the physical input when Out_Of_Service is TRUE. While the Out_Of_Service property is TRUE, the Present_Value and Reliability properties may be changed to any value as a means of simulating specific fixed conditions or for testing purposes. Other functions that depend on the state of the Present_Value or Reliability properties shall respond to changes made to these properties while Out_Of_Service is TRUE, as if those changes had occurred in the physical input.

12.6.11 Polarity

This property, of type BACnetPolarity, indicates the relationship between the physical state of the Input and the logical state represented by the Present_Value property. If the Polarity property is NORMAL, then the ACTIVE state of the Present_Value property is also the ACTIVE or ON state of the physical Input as long as Out_Of_Service is FALSE. If the Polarity property is REVERSE, then the ACTIVE state of the Present_Value property is the INACTIVE or OFF state of the physical Input as long as Out_Of_Service is FALSE. See Table 12-7. Therefore, when Out_Of_Service is FALSE for a constant physical input state, a change in the Polarity property shall produce a change in the Present_Value property. If Out_Of_Service is TRUE, then the Polarity property shall have no effect on the Present_Value property.

12.6.12 Inactive_Text

This property, of type CharacterString, characterizes the intended effect of the INACTIVE state of the Present_Value property from the human operator's viewpoint. The content of this string is a local matter, but it is intended to represent a human-readable description of the INACTIVE state. For example, if the physical input is connected to a switch contact, then the Inactive_Text property might be assigned a value such as "Fan 1 Off". If either the Inactive_Text property or the Active_Text property are present, then both of them shall be present.

12.6.13 Active_Text

This property, of type CharacterString, characterizes the intended effect of the ACTIVE state of the Present_Value property from the human operator's viewpoint. The content of this string is a local matter, but it is intended to represent a human-readable description of the ACTIVE state. For example, if the physical input is a switch contact, then the Active_Text property might be assigned a value such as "Fan 1 On". If either the Active_Text property or the Inactive_Text property are present, then both of them shall be present.

12.6.14 Change_Of_State_Time

This property, of type BACnetDateTime, represents the date and time at which the most recent change of state occurred. A "change of state" shall be defined as any event that alters the Present_Value property. When Out_Of_Service is FALSE, a change to the Polarity property shall alter Present_Value and thus be considered a change of state. When Out_Of_Service is

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TRUE, changes to Polarity shall not cause changes of state. If one of the optional properties Change_Of_State_Time, Change_Of_State_Count, or Time_Of_State_Count_Reset is present, then all of these properties shall be present.

12.6.15 Change_Of_State_Count

This property, of type Unsigned, represents the number of times that the Present_Value property has changed state since the Change_Of_State_Count property was most recently set to a zero value. The Change_Of_State_Count property shall have a range of 0-65535 or greater. A "change of state" shall be defined as any event that alters the Present_Value property. When Out_Of_Service is FALSE, a change to the Polarity property shall alter Present_Value and thus be considered a change of state. When Out_Of_Service is TRUE, changes to Polarity shall not cause changes of state. If one of the optional properties Change_Of_State_Time, Change_Of_State_Count, or Time_Of_State_Count_Reset is present, then all of these properties shall be present.

12.6.16 Time_Of_State_Count_Reset

This property, of type BACnetDateTime, represents the date and time at which the Change_Of_State_Count property was most recently set to a zero value. If one of the optional properties Change_Of_State_Time, Change_Of_State_Count, or Time_Of_State_Count_Reset is present, then all of these properties shall be present.

12.6.17 Elapsed_Active_Time

This property, of type Unsigned32, represents the accumulated number of seconds that the Present_Value property has had the value ACTIVE since the Elapsed_Active_Time property was most recently set to a zero value. If one of the optional properties Elapsed_Active_Time or Time_Of_Active_Time_Reset are present, then both of these properties shall be present.

12.6.18 Time_Of_Active_Time_Reset

This property, of type BACnetDateTime, represents the date and time at which the Elapsed_Active_Time property was most recently set to a zero value. If one of the optional properties Elapsed_Active_Time or Time_Of_Active_Time_Reset are present, then both of these properties shall be present.

12.6.19 Time_Delay

This property, of type Unsigned, shall specify the minimum period of time in seconds during which the Present_Value must remain equal to the Alarm_Value property before a TO-OFFNORMAL event is generated, or remain not equal to the Alarm_Value property before a TO-NORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.6.20 Notification_Class

This property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.6.21 Alarm_Value

This property, of type BACnetBinaryPV, shall specify the value that the Present_Value must have before an event is generated. This property is required if intrinsic reporting is supported by this object.

12.6.21.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must maintain the value specified by Alarm_Value for a minimum period of time, specified in the Time_Delay property, and
(b) the TO-OFFNORMAL flag must be enabled in the Event_Enable property.

12.6.21.2 Conditions for Generating a TO-NORMAL Event

Once equal, the Present_Value must become not equal to this property before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must remain not equal to the Alarm_Value for a minimum period of time, specified by the Time_Delay property, and
(b) the TO-NORMAL flag must be enabled in the Event_Enable property.

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12.6.22 Event_Enable

This property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. This property is required if intrinsic reporting is supported by this object.

12.6.23 Acked_Transitions

This property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

12.6.24 Notify_Type

This property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.6.25 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.6.26 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.6.27 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.7 Binary Output Object Type

The Binary Output object type defines a standardized object whose properties represent the externally visible characteristics of a binary output. A "binary output" is a physical device or hardware output that can be in only one of two distinct states. In this description, those states are referred to as ACTIVE and INACTIVE. A typical use of a binary output is to switch a particular piece of mechanical equipment, such as a fan or pump, on or off. The state ACTIVE corresponds to the situation when the equipment is on or running, and INACTIVE corresponds to the situation when the equipment is off or idle.

In some applications, electronic circuits may reverse the relationship between the application-level logical states, ACTIVE and INACTIVE, and the physical state of the underlying hardware. For example, a normally open relay contact may result in an ACTIVE state (device energized) when the relay is energized, while a normally closed relay contact may result in an ACTIVE state (device energized) when the relay is not energized. The Binary Output object provides for this possibility by including a Polarity property. See 12.7.4 and 12.7.11.

The object and its properties are summarized in Table 12-8 and described in detail in this subclause.

Table 12-8. Properties of the Binary Output Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Present_Value	BACnetBinaryPV	W
Description	CharacterString	O
Device_Type	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	R
Polarity	BACnetPolarity	R
Inactive_Text	CharacterString	O[1]
Active_Text	CharacterString	O[1]
Change_Of_State_Time	BACnetDateTime	O[2]
Change_Of_State_Count	Unsigned	O[2]
Time_Of_State_Count_Reset	BACnetDateTime	O[2]
Elapsed_Active_Time	Unsigned32	O[3]
Time_Of_Active_Time_Reset	BACnetDateTime	O[3]
Minimum_Off_Time	Unsigned32	O
Minimum_On_Time	Unsigned32	O
Priority_Array	BACnetPriorityArray	R
Relinquish_Default	BACnetBinaryPV	R
Time_Delay	Unsigned	O[4]
Notification_Class	Unsigned	O[4]
Feedback_Value	BACnetBinaryPV	O[4]
Event_Enable	BACnetEventTransitionBits	O[4]
Acked_Transitions	BACnetEventTransitionBits	O[4]
Notify_Type	BACnetNotifyType	O[4]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[4]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[5]
Profile_Name	CharacterString	O

[1] If one of the optional properties Inactive_Text or Active_Text is present, then both of these properties shall be present.
[2] If one of the optional properties Change_Of_State_Time, Change_Of_State_Count, or Time_Of_State_Count_Reset is present, then all of these properties shall be present.
[3] If one of the optional properties Elapsed_Active_Time or Time_Of_Active_Time_Reset is present, then both of these properties shall be present.
[4] These properties are required if the object supports intrinsic reporting.
[5] This property, if present, is required to be read only.

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12.7.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.7.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.7.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be BINARY_OUTPUT.

12.7.4 Present_Value (Commandable)

This property, of type BACnetBinaryPV, reflects the logical state of the Binary Output. The logical state of the output shall be either INACTIVE or ACTIVE. The relationship between the Present_Value and the physical state of the output is determined by the Polarity property. The possible states are summarized in Table 12-9.

Table 12-9. BACnet Polarity Relationships

Present_Value	Polarity	Physical State of Output	Physical State of Device
INACTIVE	NORMAL	OFF or INACTIVE	not running
ACTIVE	NORMAL	ON or ACTIVE	running
INACTIVE	REVERSE	ON or ACTIVE	not running
ACTIVE	REVERSE	OFF or INACTIVE	running

12.7.5 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.7.6 Device_Type

This property, of type CharacterString, is a text description of the physical device connected to the binary output. It will typically be used to describe the type of device attached to the binary output.

12.7.7 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of a binary output. Three of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM — Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT — Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN — Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the physical output is no longer tracking changes to the

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Present_Value property and the Reliability property is no longer a reflection of the physical output. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE(0).

12.7.8 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT. Changes in the Event_State property to the value FAULT are considered to be "fault" events.

12.7.9 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the Present_Value or the operation of the physical output in question is "reliable" as far as the BACnet Device or operator can determine and, if not, why. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, NO_OUTPUT, OPEN_LOOP, SHORTED_LOOP, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.7.10 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the physical point the object represents is not in service. This means that changes to the Present_Value property are decoupled from the physical output when the value of Out_Of_Service is TRUE. In addition, the Reliability property and the corresponding state of the FAULT flag of the Status_Flags property shall be decoupled from the physical output when Out_Of_Service is TRUE. While the Out_Of_Service property is TRUE, the Present_Value and Reliability properties may still be changed to any value as a means of simulating specific fixed conditions or for testing purposes. Other functions that depend on the state of the Present_Value or Reliability properties shall respond to changes made to these properties while Out_Of_Service is TRUE, as if those changes had occurred to the physical output. The Present_Value property shall still be controlled by the BACnet command prioritization mechanism if Out_Of_Service is TRUE. See Clause 19.

12.7.11 Polarity

This property, of type BACnetPolarity, indicates the relationship between the physical state of the output and the logical state represented by the Present_Value property. If the Polarity property is NORMAL, then the ACTIVE state of the Present_Value property is also the ACTIVE or ON state of the physical output as long as Out_Of_Service is FALSE. If the Polarity property is REVERSE, then the ACTIVE state of the Present_Value property is the INACTIVE or OFF state of the physical output as long as Out_Of_Service is FALSE. See Table 12-9. If Out_Of_Service is TRUE, then the Polarity property shall have no effect on the physical output state**.**

12.7.12 Inactive_Text

This property, of type CharacterString, characterizes the intended effect, from the human operator's viewpoint, of the INACTIVE state of the Present_Value property on the final device that is ultimately controlled by the output. The content of this string is a local matter, but it is intended to represent a human-readable description of the INACTIVE state. For example, if the physical output is a relay contact that turns on a light, then the Inactive_Text property might be assigned a value such as "Light Off". If one of the optional properties Inactive_Text or Active_Text is present, then both of these properties shall be present.

12.7.13 Active_Text

This property, of type CharacterString, characterizes the intended effect, from the human operator's viewpoint, of the ACTIVE state of the Present_Value property on the final device that is ultimately controlled by the output. The content of this string is a local matter, but it is intended to represent a human-readable description of the ACTIVE state. For example, if the physical output is a relay contact that turns on a light, then the Active_Text property might be assigned a value such as "Light On". If one of the optional properties Inactive_Text or Active_Text is present, then both of these properties shall be present.

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12.7.14 Change_Of_State_Time

This property, of type BACnetDateTime, represents the date and time at which the most recent change of state occurred. A "change of state" shall be defined as any event that alters the Present_Value property. Changes to Polarity shall not cause changes of state. If one of the optional properties Change_Of_State_Time, Change_Of_State_Count, or Time_Of_State_Count_Reset is present, then all of these properties shall be present.

12.7.15 Change_Of_State_Count

This property, of type Unsigned, represents the number of times that the Present_Value property has changed state since the Change_Of_State_Count property was most recently set to a zero value. The Change_Of_State_Count property shall have a range of 0-65535 or greater. A "change of state" shall be defined as any event that alters the Present_Value property. Changes to Polarity shall not cause changes of state. If one of the optional properties Change_Of_State_Time, Change_Of_State_Count, or Time_Of_State_Count_Reset is present, then all of these properties shall be present.

12.7.16 Time_Of_State_Count_Reset

This property, of type BACnetDateTime, represents the date and time at which the Change_Of_State_Count property was most recently set to a zero value. If one of the optional properties Change_Of_State_Time, Change_Of_State_Count, or Time_Of_State_Count_Reset is present, then all of these properties shall be present.

12.7.17 Elapsed_Active_Time

This property, of type Unsigned32, represents the accumulated number of seconds that the Present_Value property has had the value ACTIVE since this property was most recently set to a zero value. If one of the optional properties Elapsed_Active_Time or Time_Of_Active_Time_Reset is present, then both of these properties shall be present.

12.7.18 Time_Of_Active_Time_Reset

This property, of type BACnetDateTime, represents the date and time at which the Elapsed_Active_Time property was most recently set to a zero value. If one of the optional properties Elapsed_Active_Time or Time_Of_Active_Time_Reset is present, then both of these properties shall be present.

12.7.19 Minimum_Off_Time

This property, of type Unsigned32, represents the minimum number of seconds that the Present_Value shall remain in the INACTIVE state after a write to the Present_Value property causes that property to assume the INACTIVE state.

The mechanism by which this is accomplished is described in 19.2.3.

12.7.20 Minimum_On_Time

This property, of type Unsigned32, represents the minimum number of seconds that the Present_Value shall remain in the ACTIVE state after a write to the Present_Value property causes that property to assume the ACTIVE state.

The mechanism by which this is accomplished is described in 19.2.3.

12.7.21 Priority_Array

This property is a read-only array that contains prioritized commands that are in effect for this object. See Clause 19 for a description of the prioritization mechanism.

12.7.22 Relinquish_Default

This property is the default value to be used for the Present_Value property when all command priority values in the Priority_Array property have a NULL value. See Clause 19.

12.7.23 Time_Delay

This property, of type Unsigned, shall specify the minimum period of time in seconds during which the Present_Value must be different from the Feedback_Value property before a TO-OFFNORMAL event is generated or must remain equal to the Feedback_Value property before a TO-NORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

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12.7.24 Notification_Class

This property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.7.25 Feedback_Value

This property, of type BACnetBinaryPV, shall indicate the status of a feedback value from which the Present_Value must differ before an event is generated. This property is required if intrinsic reporting is supported by this object. The manner by which the Feedback_Value is determined shall be a local matter.

12.7.25.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must be different from the Feedback_Value for a minimum period of time, specified by the Time_Delay property, and
(b) the TO-OFFNORMAL flag must be enabled in the Event_Enable property.

12.7.25.2 Conditions for Generating a TO-NORMAL Event

Once different, the Present_Value must become equal to this property before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must remain equal to the Feedback_Value for a minimum period of time, specified by the Time_Delay property, and
(b) the TO-NORMAL flag must be enabled in the Event_Enable property.

12.7.26 Event_Enable

This property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. This property is required if intrinsic reporting is supported by this object.

12.7.27 Acked_Transitions

This property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

12.7.28 Notify_Type

This property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.7.29 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

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12.7.30 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.7.31 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.8 Binary Value Object Type

The Binary Value object type defines a standardized object whose properties represent the externally visible characteristics of a binary value. A "binary value" is a control system parameter residing in the memory of the BACnet Device. This parameter may assume only one of two distinct states. In this description, those states are referred to as ACTIVE and INACTIVE. The Binary Value object and its properties are summarized in Table 12-10 and described in detail in this subclause.

Table 12-10. Properties of the Binary Value Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Present_Value	BACnetBinaryPV	R[1]
Description	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	R
Inactive_Text	CharacterString	O[2]
Active_Text	CharacterString	O[2]
Change_Of_State_Time	BACnetDateTime	O[3]
Change_Of_State_Count	Unsigned32	O[3]
Time_Of_State_Count_Reset	BACnetDateTime	O[3]
Elapsed_Active_Time	Unsigned32	O[4]
Time_Of_Active_Time_Reset	BACnetDateTime	O[4]
Minimum_Off_Time	Unsigned32	O
Minimum_On_Time	Unsigned32	O
Priority_Array	BACnetPriorityArray	O[5]
Relinquish_Default	BACnetBinaryPV	O[5]
Time_Delay	Unsigned	O[6]
Notification_Class	Unsigned	O[6]
Alarm_Value	BACnetBinaryPV	O[6]
Event_Enable	BACnetEventTransitionBits	O[6]
Acked_Transitions	BACnetEventTransitionBits	O[6]
Notify_Type	BACnetNotifyType	O[6]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[6]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[7]
Profile_Name	CharacterString	O

[1] If Present_Value is commandable, then it is required to be writable. This property is required to be writable when Out_Of_Service is TRUE.
[2] If one of the optional properties Inactive_Text or Active_Text is present, then both of these properties shall be present.
[3] If one of the optional properties Change_Of_State_Time, Change_Of_State_Count, or Time_Of_State_Count_Reset is present, then all of these properties shall be present.
[4] If one of the optional properties Elapsed_Active_Time or Time_Of_Active_Time_Reset is present, then both of these properties shall be present.
[5] If Present_Value is commandable, then both of these properties shall be present.
[6] These properties are required if the object supports intrinsic reporting.
[7] This property, if present, is required to be read only.

12.8.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

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12.8.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.8.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be BINARY_VALUE.

12.8.4 Present_Value

This property, of type BACnetBinaryPV, reflects the logical state of the Binary Value. The logical state shall be either INACTIVE or ACTIVE. Present_Value shall be optionally commandable. If Present_Value is commandable for a given instance, then the Priority_Array and Relinquish_Default properties shall also be present for that instance. The Present_Value property shall be writable when Out_Of_Service is TRUE.

12.8.5 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.8.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of a binary value object. Three of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value property is not changeable through BACnet services. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0).

12.8.7 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT. Changes in the Event_State property to the value FAULT are considered to be "fault" events.

12.8.8 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the Present_Value is "reliable" as far as the BACnet Device or operator can determine. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}.

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12.8.9 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the Present_Value of the Binary Value object is prevented from being modified by software local to the BACnet device in which the object resides. When Out_Of_Service is TRUE, the Present_Value property may be written to freely. If the Priority_Array and Relinquish_Default properties are present, then writing to the Present_Value property shall be controlled by the BACnet command prioritization mechanism. See Clause 19.

12.8.10 Inactive_Text

This property, of type CharacterString, characterizes the intended effect of the INACTIVE state of the Binary Value. The content of this string is a local matter, but it is intended to represent a human-readable description of the INACTIVE state. If one of the optional properties Inactive_Text or Active_Text is present, then both of these properties shall be present.

12.8.11 Active_Text

This property, of type CharacterString, characterizes the intended effect of the ACTIVE state of the Binary Value. The content of this string is a local matter, but it is intended to represent a human-readable description of the ACTIVE state. If one of the optional properties Inactive_Text or Active_Text is present, then both of these properties shall be present.

12.8.12 Change_Of_State_Time

This property, of type BACnetDateTime, represents the date and time at which the most recent change of state occurred. A "change of state" shall be defined as any event that alters the logical state of the Binary Value. If one of the optional properties Change_Of_State_Time, Change_Of_State_Count, or Time_Of_State_Count_Reset is present, then all of these properties shall be present.

12.8.13 Change_Of_State_Count

This property, of type Unsigned32, represents the number of times that the state of the Binary Value has changed since this property was most recently set to a zero value. The Change_Of_State_Count property shall have a range of 0-65535 or greater. If one of the optional properties Change_Of_State_Time, Change_Of_State_Count, or Time_Of_State_Count_Reset is present, then all of these properties shall be present.

12.8.14 Time_Of_State_Count_Reset

This property, of type BACnetDateTime, represents the date and time at which the Change_Of_State_Count property was most recently set to a zero value. If one of the optional properties Change_Of_State_Time, Change_Of_State_Count, or Time_Of_State_Count_Reset is present, then all of these properties shall be present.

12.8.15 Elapsed_Active_Time

This property, of type Unsigned32, represents the accumulated number of seconds that the Present_Value property has had the value ACTIVE since this property was most recently set to a zero value. If one of the optional properties Elapsed_Active_Time or Time_Of_Active_Time_Reset is present, then both of these properties shall be present.

12.8.16 Time_Of_Active_Time_Reset

This property, of type BACnetDateTime, represents the date and time at which the Elapsed_Active_Time property was most recently set to a zero value. If one of the optional properties Elapsed_Active_Time or Time_Of_Active_Time_Reset is present, then both of these properties shall be present.

12.8.17 Minimum_Off_Time

This property, of type Unsigned32, represents the minimum number of seconds that the Present_Value shall remain in the INACTIVE state after a write to the Present_Value property causes that property to assume the INACTIVE state.

If the Present_Value is commandable according to Clause 19, then the mechanism by which this is accomplished is described in 19.2.3. Otherwise, the mechanism is a local matter.

12.8.18 Minimum_On_Time

This property, of type Unsigned32, represents the minimum number of seconds that the Present_Value shall remain in the ACTIVE state after a write to the Present_Value property causes that property to assume the ACTIVE state.

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If the Present_Value is commandable according to Clause 19, then the mechanism by which this is accomplished is described in 19.2.3. Otherwise, the mechanism is a local matter.

12.8.19 Priority_Array

This property is a read-only array that contains prioritized commands that are in effect for this object. See Clause 19 for a description of the prioritization mechanism. If either the Relinquish_Default property or the Priority_Array property are present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present and Present_Value shall be writable.

12.8.20 Relinquish_Default

This property is the default value to be used for the Present_Value property when all command priority values in the Priority_Array property have a NULL value. See Clause 19. If either the Relinquish_Default property or the Priority_Array property are present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present and Present_Value shall be writable.

12.8.21 Time_Delay

This property, of type Unsigned, shall specify the minimum period of time in seconds during which the Present_Value must be different from the Alarm_Value property before a TO-OFFNORMAL event is generated or must remain equal to the Alarm_Value property before a TO-NORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.8.22 Notification_Class

This property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.8.23 Alarm_Value

This property, of type BACnetBinaryPV, shall specify the value that the Present_Value property must have before a TO-OFFNORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.8.23.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must maintain the value specified by Alarm_Value for a minimum period of time, specified by the Time_Delay property, and
(b) the TO-OFFNORMAL flag must be enabled in the Event_Enable property.

12.8.23.2 Conditions for Generating a TO-NORMAL Event

Once equal, the Present_Value must become not equal to this property before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must remain not equal to the Alarm_Value for a minimum period of time, specified by the Time_Delay property, and
(b) the TO-NORMAL flag must be enabled in the Event_Enable property.

12.8.24 Event_Enable

This property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. This property is required if intrinsic reporting is supported by this object.

12.8.25 Acked_Transitions

This property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;

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(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgment is expected);

(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

12.8.26 Notify_Type

This property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.8.27 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.8.28 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.8.29 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.9 Calendar Object Type

The Calendar object type defines a standardized object used to describe a list of calendar dates, which might be thought of as "holidays," "special events," or simply as a list of dates. The object and its properties are summarized in Table 12-11 and described in detail in this subclause.

Table 12-11. Properties of the Calendar Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Present_Value	BOOLEAN	R
Date_List	List of BACnetCalendarEntry	R
Profile_Name	CharacterString	O

12.9.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.9.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.9.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be CALENDAR.

12.9.4 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.9.5 Present_Value

This property, of type BOOLEAN, indicates the current value of the calendar: TRUE if the current date is in the Date_List and FALSE if it is not.

12.9.6 Date_List

This property is a List of BACnetCalendarEntry, each of which is either a specific date or date pattern (Date), range of dates (BACnetDateRange), or month/week-of-month/day-of-week specification (BACnetWeekNDay). If the current date matches the calendar entry criteria, the present value of the Calendar object is TRUE.

As an example, if the calendar entry is a BACnetWeekNDay with an unspecified octet in the month and week-of-month fields but with a specific day-of-week, it means that the Calendar object is TRUE on that day-of-week all year long.

If a BACnet Device permits writing to the Date_List property, all choices and all allowed forms of values in the BACnetCalendarEntry shall be supported.

12.9.7 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

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A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.10 Command Object Type

The Command object type defines a standardized object whose properties represent the externally visible characteristics of a multi-action command procedure. A Command object is used to write a set of values to a group of object properties, based on the "action code" that is written to the Present_Value of the Command object. Whenever the Present_Value property of the Command object is written to, it triggers the Command object to take a set of actions that change the values of a set of other objects' properties.

The Command object would typically be used to represent a complex context involving multiple variables. The Command object is particularly useful for representing contexts that have multiple states. For example, a particular zone of a building might have three states: UNOCCUPIED, WARMUP, and OCCUPIED. To establish the operating context for each state, numerous objects' properties may need to be changed to a collection of known values. For example, when unoccupied, the temperature setpoint might be 65°F and the lights might be off. When occupied, the setpoint might be 72°F and the lights turned on, etc.

The Command object defines the relationship between a given state and those values that shall be written to a collection of different objects' properties to realize that state. Normally, a Command object is passive. Its In_Process property is FALSE, indicating that the Command object is waiting for its Present_Value property to be written with a value. When Present_Value is written, the Command object shall begin a sequence of actions. The In_Process property shall be set to TRUE, indicating that the Command object has begun processing one of a set of action sequences that is selected based on the particular value written to the Present_Value property. If an attempt is made to write to the Present_Value property through WriteProperty services while In_Process is TRUE, then a Result(-) shall be returned with 'error class' = OBJECT and 'error code' = BUSY, rejecting the write.

The new value of the Present_Value property determines which sequence of actions the Command object shall take. These actions are specified in an array of action lists indexed by this value. The Action property contains these lists. A given list may be empty, in which case no action takes place, except that In_Process is returned to FALSE and All_Writes_Successful is set to TRUE. If the list is not empty, then for each action in the list the Command object shall write a particular value to a particular property of a particular object in a particular BACnet Device. Note, however, that the capability to write to remote devices is not required.

Note also that the Command object does not guarantee that every write will be successful, and no attempt is made by the Command object to "roll back" successfully written properties to their previous values in the event that one or more writes fail. If any of the writes fail, then the All_Writes_Successful property is set to FALSE and the Write_Successful flag for that BACnetActionCommand is set to FALSE. If the Quit_On_Failure flag is TRUE for the failed BACnetActionCommand, then all subsequent BACnetActionCommands in the list shall have their Write_Successful flag set to FALSE. If an individual write succeeds, then the Write_Successful flag for that BACnetActionCommand shall be set to TRUE. If all the writes are successful, then the All_Writes_Successful property is set to TRUE. Once all the writes have been processed to completion by the Command object, the In_Process property is set back to FALSE and the Command object becomes passive again, waiting for another command.

It is important to note that the particular value that is written to the Present_Value property is not what triggers the action, but the act of writing itself. Thus if the Present_Value property has the value 5 and it is again written with the value 5, then the 5th list of actions will be performed again. Writing zero to the Present_Value causes no action to be taken and is the same as invoking an empty list of actions.

The Command object is a powerful concept with many beneficial applications. However, there are unique aspects of the Command object that can cause confusing or destructive side effects if the Command object is improperly configured. Since the Command object can manipulate other objects' properties, it is possible that a Command object could be configured to command itself. In such a case, the In_Process property acts as an interlock and protects the Command object from self-oscillation. However, it is also possible for a Command object to command another Command object that commands the first Command object and so on. The possibility exists for Command objects that command GROUP objects. In these cases of "circular referencing," it is possible for confusing side effects to occur. When references occur to objects in other BACnet Devices, there is an increased possibility of time delays, which could cause oscillatory behavior between Command objects that are improperly configured in such a circular manner. Caution should be exercised when configuring Command objects that reference objects outside the BACnet device that contains them.

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The Command object and its properties are summarized in Table 12-12 and described in detail in this subclause.

Table 12-12. Properties of the Command Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Present_Value	Unsigned	W
In_Process	BOOLEAN	R
All_Writes_Successful	BOOLEAN	R
Action	BACnetARRAY[N] of BACnetActionList	R
Action_Text	BACnetARRAY[N] of CharacterString	O
Profile_Name	CharacterString	O

12.10.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.10.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.10.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be COMMAND.

12.10.4 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.10.5 Present_Value

This property, of type Unsigned, indicates which action the Command object is to take or has already taken. Whenever the Present_Value property is written to, it triggers the Command object to take a set of actions that change the values of a set of other objects' properties.

The Present_Value may be written to with any value from 0 to the maximum number of actions supported by the Action property. When the Present_Value is written to, the Command object begins a sequence of actions. The new value of the Present_Value property determines which list of actions the Command object shall take. These actions are specified in the Action property, which is an array of lists of actions to take. The array is indexed by the value being written. A given list may be empty, in which case no action takes place. If the list is not empty, then for each action in the list, the Command object shall write a particular value to a particular property of a particular object in a particular BACnet Device.

12.10.6 In_Process

This property, of type BOOLEAN, shall be set to TRUE when a value is written to the Present_Value property. This TRUE value indicates that the Command object has begun processing one of a set of action sequences. Once all of the writes have been attempted by the Command object, the In_Process property shall be set back to FALSE.

12.10.7 All_Writes_Successful

This property, of type BOOLEAN, indicates the success or failure of the sequence of actions that are triggered when the Present_Value property is written to. At that time, In_Process is set to TRUE and All_Writes_Successful is set to FALSE. If after the list has been executed, all of the writes have succeeded, then All_Writes_Successful is set to TRUE at the same time that In_Process is set to FALSE. Therefore, while In_Process is TRUE, the value of All_Writes_Successful is not a valid indication of the current or previous operation.

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12.10.8 Action

This property, of type BACnetARRAY of BACnetActionList, specifies an array of "action lists." These action lists are indexed by the value that is written to the Present_Value property. A given list may be empty, in which case no action takes place, except that In_Process is returned to FALSE and All_Writes_Successful is set to TRUE. If the list is not empty, then for each action in the list, the Command object shall write a particular value to a particular property of a particular object in a particular BACnet Device based on the specifications in each BACnetActionCommand. Each write shall occur in the order that BACnetActionCommand list elements would appear if the list was read using the ReadProperty service. The value zero is a special case that takes no action and behaves like an empty list. The number of defined action lists may be found by reading the Action property with an array index of zero. If the size of this array is changed, the size of the Action_Text array, if present, shall also be changed to the same size.

Each BACnetActionCommand is a specification of a single value to be written to a single property of a single object. BACnetActionCommands have nine parts: an optional BACnet device identifier, an object identifier, a property identifier, a conditional property array index, a value to be written, a conditional priority, an optional post-writing delay time, a premature quit flag, and a write success flag. The components and their datatypes are shown below.

Component	Datatype
Device_Identifier	BACnetObjectIdentifier (Optional)
Object_Identifier	BACnetObjectIdentifier
Property_Identifier	BACnetPropertyIdentifier
Property_Array_Index	Unsigned (Conditional)
Property_Value	Any
Priority	Unsigned (1..16) (Conditional)
Post_Delay	Unsigned (Optional)
Quit_On_Failure	BOOLEAN
Write_Successful	BOOLEAN

If the Device_Identifier is not present, then the write shall be performed on objects residing in the device that contains the Command object. A device that supports the Command object type is not required to support writing outside the device. If the Property_Identifier refers to an array property, then the Property_Array_Index shall also be present to specify the index within the array of the property to be written. If the property being written is a commandable property, then a priority value shall be supplied; otherwise it shall be omitted. If the Quit_On_Failure flag is TRUE, then if the write fails for any reason, the device shall terminate the execution of the action list prematurely. Otherwise, writing shall continue after each failure with the next element of the action list. In either case, All_Writes_Successful shall remain FALSE throughout the execution of the list. After each write, whether successful or not, if the Post_Delay is present, it shall represent a delay in seconds prior to the execution of the next write or the completion of all writing and the setting of In_Process to FALSE.

If the write fails for any reason, then the Write_Successful flag shall be set to FALSE. If the Quit_On_Failure flag is TRUE, then the first write that fails shall also terminate the execution list prematurely. In this case, the Write_Successful flag in subsequent entries in the same list shall be set to FALSE. If the write succeeds, then the Write_Successful flag shall be set to TRUE.

12.10.9 Action_Text

This property, of type BACnetARRAY of CharacterString, shall be used to indicate a text string description for each of the possible values of the Present_Value property. The content of these strings is not restricted. If the size of this array is changed, the size of the Action array shall also be changed to the same size.

12.10.10 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

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A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.11 Device Object Type

The Device object type defines a standardized object whose properties represent the externally visible characteristics of a BACnet Device. There shall be exactly one Device object in each BACnet Device. A Device object is referenced by its Object_Identifier property, which is not only unique to the BACnet Device that maintains this object but is also unique throughout the BACnet internetwork. The Device object type and its properties are summarized in Table 12-13 and described in detail in this subclause.

Table 12-13. Properties of the Device Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
System_Status	BACnetDeviceStatus	R
Vendor_Name	CharacterString	R
Vendor_Identifier	Unsigned16	R
Model_Name	CharacterString	R
Firmware_Revision	CharacterString	R
Application_Software_Version	CharacterString	R
Location	CharacterString	O
Description	CharacterString	O
Protocol_Version	Unsigned	R
Protocol_Revision	Unsigned	R
Protocol_Services_Supported	BACnetServicesSupported	R
Protocol_Object_Types_Supported	BACnetObjectTypesSupported	R
Object_List	BACnetARRAY[N]of BACnetObjectIdentifier	R
Structured_Object_List	BACnetARRAY[N]of BACnetObjectIdentifier	O
Max_APDU_Length_Accepted	Unsigned	R
Segmentation_Supported	BACnetSegmentation	R
Max_Segments_Accepted	Unsigned	O[1]
VT_Classes_Supported	List of BACnetVTClass	O[2]
Active_VT_Sessions	List of BACnetVTSession	O[2]
Local_Time	Time	O[3,4,15]
Local_Date	Date	O[3,4,15]
UTC_Offset	INTEGER	O[4]
Daylight_Savings_Status	BOOLEAN	O[4]
APDU_Segment_Timeout	Unsigned	O[1]
APDU_Timeout	Unsigned	R
Number_Of_APDU_Retries	Unsigned	R
Time_Synchronization_Recipients	List of BACnetRecipient	O[5]
Max_Master	Unsigned(1..127)	O[6]
Max_Info_Frames	Unsigned	O[6]
Device_Address_Binding	List of BACnetAddressBinding	R
Database_Revision	Unsigned	R
Configuration_Files	BACnetARRAY[N] of BACnetObjectIdentifier	O[7]
Last_Restore_Time	BACnetTimeStamp	O[7]
Backup_Failure_Timeout	Unsigned16	O[8]
Backup_Preparation_Time	Unsigned16	O
Restore_Preparation_Time	Unsigned16	O
Restore_Completion_Time	Unsigned16	O
Backup_And_Restore_State	BACnetBackupState	O
Active_COV_Subscriptions	List of BACnetCOVSubscription	O[9]
Slave_Proxy_Enable	BACnetARRAY[N] of BOOLEAN	O[10]
Manual_Slave_Address_Binding	List of BACnetAddressBinding	O[10]
Auto_Slave_Discovery	BACnetARRAY[N] of BOOLEAN	O[11]
Slave_Address_Binding	List of BACnetAddressBinding	O[12]

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Last_Restart_Reason	BACnetRestartReason	O[13]
Time_Of_Device_Restart	BACnetTimeStamp	O[13]
Restart_Notification_Recipients	List of BACnetRecipient	O[13]
UTC_Time_Synchronization_Recipients	List of BACnetRecipient	O[5]
Time_Synchronization_Interval	Unsigned	O[14]
Align_Intervals	BOOLEAN	O[14]
Interval_Offset	Unsigned	O[14]
Profile_Name	CharacterString	O

[1] Required if segmentation of any kind is supported.
[2] If one of the properties VT_Classes_Supported or Active_VT_Sessions is present, then both of these properties shall be present. Both properties are required if support for VT Services is indicated in the PICS.
[3] If the device supports the execution of the TimeSynchronization service, then these properties shall be present.
[4] If the device supports the execution of the UTCTimeSynchronization service, then these properties shall be present.
[5] If this property is present, then Time_Synchronization_Interval, Align_Intervals and Interval_Offset shall be present. If present, this property shall be writable.
[6] These properties are required if the device is an MS/TP master node.
[7] These properties are required if the device supports execution of the backup and restore procedures.
[8] This property shall be present and writable if the device supports the backup and restore procedures.
[9] This property is required if the device supports execution of either the SubscribeCOV or SubscribeCOVProperty service.
[10] This property shall be present and writable if the device is capable of being a Slave-Proxy device.
[11] This property shall be present if the device is capable of being a Slave-Proxy device that implements automatic discovery of slaves.
[12] This property shall be present if the device is capable of being a Slave-Proxy device.
[13] These properties are required if the device supports the restart procedure as described in Clause 19.3.
[14] If either Time_Synchronization_Recipients or UTC_Time_Synchronization_Recipients is present, then this property shall be present and writable.
[15] These properties shall be present if the device is capable of tracking date and time.

12.11.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. For the Device object, the object identifier shall be unique internetwork-wide.

12.11.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique internetwork-wide. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.11.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be DEVICE.

12.11.4 System_Status

This property, of type BACnetDeviceStatus, reflects the current physical and logical status of the BACnet Device. The values that may be taken on by this property are:

{OPERATIONAL, OPERATIONAL_READ_ONLY, DOWNLOAD_REQUIRED,
DOWNLOAD_IN_PROGRESS, NON_OPERATIONAL, BACKUP_IN_PROGRESS}

The exact meaning of these states, except for BACKUP_IN_PROGRESS, in a given device and their synchronization with other internal operations of the device or the execution of BACnet services by the device are local matters and are not defined by this standard.

12.11.5 Vendor_Name

This property, of type CharacterString, identifies the manufacturer of the BACnet Device.

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12.11.6 Vendor_Identifier

This property, of type Unsigned16, is a unique vendor identification code, assigned by ASHRAE, which is used to distinguish proprietary extensions to the protocol. See Clause 23.

12.11.7 Model_Name

This property, of type CharacterString, is assigned by the vendor to represent the model of the BACnet Device.

12.11.8 Firmware_Revision

This property, of type CharacterString, is assigned by the vendor to represent the level of firmware installed in the BACnet Device.

12.11.9 Application_Software_Version

This property, of type CharacterString, identifies the version of application software installed in the machine. The content of this string is a local matter, but it could be a date-and-time stamp, a programmer's name, a host file version number, etc.

12.11.10 Location

This property, of type CharacterString, indicates the physical location of the BACnet Device.

12.11.11 Description

This property, of type CharacterString, is a string of printable characters that may be used to describe the application being carried out by the BACnet Device or other locally desired descriptive information.

12.11.12 Protocol_Version

This property, of type Unsigned, represents the version of the BACnet protocol supported by this BACnet Device. Every major revision of BACnet shall increase this version number by one. The initial release of BACnet shall be version 1.

12.11.13 Protocol_Revision

This property, of type Unsigned, shall indicate the minor revision level of the BACnet standard. This value shall start at 1 and be incremented for any substantive change(s) to the BACnet standard that affect device communication or behavior. This value shall revert to zero upon each change to the Protocol_Version property. Changes to the values for Protocol_Version and Protocol_Revision are recorded in the History of Revisions at the end of this standard.

This property is required for all devices implementing BACnet Protocol_Version 1, Protocol_Revision 1 and above. Absence of this property shall indicate a device implemented to a version of the standard prior to the definition of the Protocol_Revision property.

12.11.14 Protocol_Services_Supported

This property, of type BACnetServicesSupported, indicates which standardized protocol services are executed by this device's protocol implementation.

12.11.15 Protocol_Object_Types_Supported

This property, of type BACnetObjectTypesSupported, indicates which standardized object types can be present in this device's protocol implementation. The list of properties present in a particular object may be acquired by use of the ReadPropertyMultiple service with a property reference of ALL (see 15.7.3.1.2).

12.11.16 Object_List

This read-only property is a BACnetARRAY of Object_Identifiers, one Object_Identifier for each object within the device that is accessible through BACnet services.

12.11.17 Structured_Object_List

This optional property is a BACnetARRAY of BACnetObjectIdentifier. Entries in the array reference objects chosen for use as starting points for the traversal of object hierarchies. The objects directly referenced by this property shall be restricted to Structured View and Life Safety Zone objects.

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12.11.18 Max_APDU_Length_Accepted

This property, of type Unsigned, is the maximum number of octets that may be contained in a single, indivisible application layer protocol data unit. The value of this property shall be greater than or equal to 50. The value of this property is also constrained by the underlying data link technology. See Clauses 6 through 11.

If the value of this property is not encodable in the 'Max APDU Length Accepted' parameter of a ConfirmedRequest-PDU, then the value encoded shall be the highest encodable value less than the value of this property. In such cases, a responding device may ignore the encoded value in favor of the value of this property, if it is known.

12.11.19 Segmentation_Supported

This property, of type BACnetSegmentation, indicates whether the BACnet Device supports segmentation of messages and, if so, whether it supports segmented transmission, reception, or both:

{SEGMENTED_BOTH, SEGMENTED_TRANSMIT, SEGMENTED_RECEIVE, NO_SEGMENTATION}

12.11.20 Max_Segments_Accepted

The Max_Segments_Accepted property, of type Unsigned, shall indicate the maximum number of segments of an APDU that this device will accept.

12.11.21 VT_Classes_Supported

The VT_Classes_Supported property is a List of BACnetVTClass each of which is an enumeration indicating a particular set of terminal characteristics. A given BACnet Device may support multiple types of behaviors for differing types of terminals or differing types of operator interface programs. At a minimum, such devices shall support the "Default-terminal" VT-class defined in 17.5.

If one of the properties VT_Classes_Supported or Active_VT_Sessions is present, then both of these properties shall be present. Both properties are required if support for VT Services is indicated in the PICS.

12.11.22 Active_VT_Sessions

The Active_VT_Sessions property is a List of BACnetVTSession each of which consists of a Local VT Session Identifier, a Remote VT Session Identifier, and Remote VT Address. This property provides a network-visible indication of those virtual terminal sessions (VT-Sessions) that are active at any given time. Whenever a virtual terminal session is created with the VT-Open service, a new entry is added to the Active_VT_Sessions list. Similarly, whenever a VT-session is terminated, the corresponding entry shall be removed from the Active_VT_Sessions list.

If one of the properties VT_Classes_Supported or Active_VT_Sessions is present, then both of these properties shall be present. Both properties are required if support for VT Services is indicated in the PICS.

12.11.23 Local_Time

The Local_Time property, of type Time, shall indicate the time of day to the best of the device's knowledge. If the BACnet Device does not have any knowledge of time or date, then the Local_Time property shall be omitted. This property shall be present if the BACnet Device is capable of tracking date and time. If the device restarts, and there is no local time available yet, then the clock shall be initialized to the time 00:00:00.00 and the device shall commence tracking the time.

12.11.24 Local_Date

The Local_Date property, of type Date, shall indicate the date to the best of the device's knowledge. If the BACnet Device does not have any knowledge of time or date, then the Local_Date property shall be omitted. This property shall be present if the BACnet Device is capable of tracking date and time. If the device restarts, and there is no local date available yet, then the clock shall be initialized to a date on or before January 1, 1990 and the device shall commence tracking the date.

12.11.25 UTC_Offset

The UTC_Offset property, of type INTEGER, shall indicate the number of minutes (-780 to +780) offset between local standard time and Universal Time Coordinated. The time zones to the west of the zero degree meridian shall be positive values, and those to the east shall be negative values. The value of the UTC_Offset property is subtracted from the UTC received in UTCTimeSynchronization service requests to calculate the correct local standard time.

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12.11.26 Daylight_Savings_Status

The Daylight_Savings_Status property, of type BOOLEAN, shall indicate whether daylight savings time is in effect (TRUE) or not (FALSE) at the BACnet Device's location.

12.11.27 APDU_Segment_Timeout

The APDU_Segment_Timeout property, of type Unsigned, shall indicate the amount of time in milliseconds between retransmission of an APDU segment. A suggested default value for this property is 5,000 milliseconds. This value shall be non-zero if the Device object property called Number_Of_APDU_Retries is non-zero. See 5.3. If segmentation of any kind is supported, then the APDU_Segment_Timeout property shall be present.

In order to achieve reliable communication, it is recommended that the values of the APDU_Segment_Timeout properties of the Device objects of all intercommunicating devices should contain the same value.

12.11.28 APDU_Timeout

The APDU_Timeout property, of type Unsigned, shall indicate the amount of time in milliseconds between retransmissions of an APDU requiring acknowledgment for which no acknowledgment has been received. A suggested default value for this property is 6,000 milliseconds for devices that permit modification of this parameter. Otherwise, the default value shall be 10,000 milliseconds. This value shall be non-zero if the Device object property called Number_Of_APDU_Retries is non-zero. See Clause 5.3.

In order to achieve reliable communication, it is recommended that the values of the APDU_Timeout properties of the Device objects of all intercommunicating devices should contain the same value.

12.11.29 Number_Of_APDU_Retries

The Number_Of_APDU_Retries property, of type Unsigned, shall indicate the maximum number of times that an APDU shall be retransmitted. A suggested default value for this property is 3. If this device does not perform retries, then this property shall be set to zero. If the value of this property is greater than zero, a non-zero value shall be placed in the Device object APDU_Timeout property. See Clause 5.3.

12.11.30 Deleted Clause

This clause has been removed.

12.11.31 Time_Synchronization_Recipients

This optional property, of type List of BACnetRecipient, is used to control the restrictions placed on a device's use of the TimeSynchronization service. The value of this property shall be a list of zero or more BACnetRecipients. If the list is of length zero, or the property is not present, the device is prohibited from automatically sending a TimeSynchronization request. If the list is of length one or more, the device may automatically send a TimeSynchronization request but only to the devices or addresses listed. If this property is present, it shall be writable.

12.11.32 Max_Master

The Max_Master property, of type Unsigned, shall be present if the device is a master node on an MS/TP network. The value of Max_Master specifies the highest possible address for master nodes and shall be less than or equal to 127. If the Max_Master property is not writable via BACnet services, its value shall be 127. See Clause 9.5.3

12.11.33 Max_Info_Frames

The Max_Info_Frames property, of type Unsigned, shall be present if the device is a node on an MS/TP network. The value of Max_Info_Frames specifies the maximum number of information frames the node may send before it must pass the token. If Max_Info_Frames is not writable or otherwise user configurable, its value shall be one. See Clause 9.5.3.

12.11.34 Device_Address_Binding

The Device_Address_Binding property is a List of BACnetAddressBinding each of which consists of a BACnet Object_Identifier of a BACnet Device object and a BACnet device address in the form of a BACnetAddress. Entries in the list identify the actual device addresses that will be used when the remote device must be accessed via a BACnet service request. A value of zero may be used for the network-number portion of BACnetAddress entries for other devices residing on

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the same network as this device. The list may be empty if no device identifier-device address bindings are currently known to the device.

12.11.35 Database_Revision

This property, of type Unsigned, is a logical revision number for the device's database. It is incremented when an object is created, an object is deleted, an object's name is changed, an object's Object_Identifier property is changed, or a restore is performed with the exception that the creation and deletion of temporary configuration files during a backup or restore procedure shall not affect this property.

12.11.36 Configuration_Files

This optional property is a BACnet Array of BACnetObjectIdentifier. Entries in the array identify the files within the device that define the device's image that can be backed up. The contents of this property is only required to be valid during the backup procedure. This property must be supported if the device supports the BACnet backup and restore procedure as described in Clause 19.1.

12.11.37 Last_Restore_Time

This optional property, of type BACnetTimeStamp, is the time at which the device's image was last restored as described in Clause 19.1. This property must be supported if the device supports the BACnet backup and restore procedures as described in Clause 19.1.

12.11.38 Backup_Failure_Timeout

This optional property, of type Unsigned16, is the time, in seconds, that the device being backed up or restored must wait before unilaterally ending the backup or restore procedure. This property must be writable with the intent that the device performing the backup, or the human operator, will configure this with an appropriate timeout.

12.11.39 Active_COV_Subscriptions

The Active_COV_Subscriptions property is a List of BACnetCOVSubscription, each of which consists of a Recipient, a Monitored Property Reference, an Issue Confirmed Notifications flag, a Time Remaining value and an optional COV Increment. This property provides a network-visible indication of those COV subscriptions that are active at any given time. Whenever a COV Subscription is created with the SubscribeCOV or SubscribeCOVProperty service, a new entry is added to the Active_COV_Subscriptions list. Similarly, whenever a COV Subscription is terminated, the corresponding entry shall be removed from the Active_COV_Subscriptions list.

This property is required if the device supports execution of either SubscribeCOV or SubscribeCOVProperty service.

12.11.40 Slave_Proxy_Enable

This property, of type BACnetArray of BOOLEAN, is an indication whether (TRUE) or not (FALSE) the device will perform Slave-Proxy functions for each of the MS/TP ports represented by each array element. This property shall be present if the device is capable of performing the functions of a Slave-Proxy device. The value of this property shall be retained over a device reset.

12.11.41 Manual_Slave_Address_Binding

This property, of type List of BACnetAddressBinding, describes the manually configured set of slave devices for which this device is acting as a Slave Proxy as described in 16.10.2. This property shall be present if the device is capable of performing the functions of a Slave-Proxy device. If present, and the device is directly attached to an MS/TP network, then this property shall be writable.

This property is used to manually configure a set of slave devices for which this device will be a proxy. This property allows a Slave Proxy that does not support automatic slave discovery be configured with a set of slaves for which this device will be a proxy. It also allows a Slave-Proxy device to be a proxy for Slave devices that do not support the special object instance of 4194303 as described in Clause 12. The value of this property shall be retained over a device reset. When enabled, the Slave-Proxy device shall periodically check each device that is in this list, and not in the Slave_Address_Binding list, by reading the device's Protocol_Services_Supported property from the device's Device object using the ReadProperty service. If the device responds and indicates that it does not execute the Who-Is service, it shall be added to the Slave_Address_Binding property. The period at which the devices are checked is a local matter.

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12.11.42 Auto_Slave_Discovery

This property, of type BACnetArray of BOOLEAN, is an indication whether (TRUE) or not (FALSE) the device will perform automatic slave detection functions for each of the MS/TP ports represented by each array element. This property shall be present if the device is capable of performing the functions of a Slave-Proxy device. The value of this property shall be retained over a device reset.

Slave detection shall be accomplished by the proxy device using ReadProperty services to read, at a minimum, the Device object's Protocol_Services_Supported property for each MAC address on each port where Auto_Slave_Discovery for that port is TRUE. The ReadProperty service shall use the special object instance of 4194303 as described in Clause 12. If the device is found to support execution of the Who-Is service, it is ignored; otherwise, the device shall be added to the Slave_Address_Binding property. The slave detection algorithm shall be repeated periodically. The period at which it is repeated is a local matter.

12.11.43 Slave_Address_Binding

This property, of type List of BACnetAddressBinding, describes the set of slave devices for which this device is acting as a Slave-Proxy as described in 16.10.2. This property shall be present if the device is capable of performing the functions of a Slave-Proxy device. The set of devices described by the Slave_Address_Binding property consists of those devices described in the Manual_Slave_Address_Binding and those devices that are automatically discovered. When enabled, the Slave-Proxy device shall periodically check each device in this list by reading the device's Protocol_Services_Supported property from the device's Device object using the ReadProperty service. If the device fails to respond, or indicates that it executes Who-Is, it shall be removed from the list. The period at which the devices are checked is a local matter.

12.11.44 Last_Restart_Reason

This property, of type BACnetRestartReason, indicates the reason for the last device restart. This property shall be present if the device supports the BACnet restart procedure as described in Clause 19.3. The possible values for this property are:

UNKNOWN	The device cannot determine the cause of the last reset.
COLDSTART	A ReinitializeDevice request was received with a 'Reinitialized State of Device' of COLDSTART or the device was made to COLDSTART by some other means.
WARMSTART	A ReinitializeDevice request was received with a 'Reinitialized State of Device' of WARMSTART or the device was made to WARMSTART by some other means.
DETECTED_POWER_LOST	The device detected that incoming power was lost.
DETECTED_POWERED_OFF	The device detected that its power switch was turned off.
HARDWARE_WATCHDOG	The hardware watchdog timer reset the device.
SOFTWARE_WATCHDOG	The software watchdog timer reset the device.
SUSPENDED	The device was suspended. How the device was suspended or what it means to be suspended is a local matter.

12.11.45 Time_Of_Device_Restart

This property, of type BACnetTimeStamp, is the time at which the device was last restarted. This property shall be present if the device supports the BACnet restart procedure as described in Clause 19.3.

12.11.46 Restart_Notification_Recipients

The Restart_Notification_Recipients property is used to control the restrictions on which devices, if any, are to be notified when a restart occurs. The value of this property shall be a list of zero or more BACnetRecipients. If the list is of length zero, a device is prohibited from sending a device restart notification. The default value of the property shall be a single entry representing a broadcast on the local network. If the property is not writable, then it shall contain the default value. If the list is of length one or more, a device shall send a restart notification, but only to the devices or addresses listed. This property shall be present if and only if the device supports the BACnet restart procedure as described in Clause 19.3.

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12.11.47 UTC_Time_Synchronization_Recipients

This optional property, of type List of BACnetRecipient, is used to control the restrictions placed on a device's use of the UTCTimeSynchronization service. The value of this property shall be a list of zero or more BACnetRecipients. If the list is of length zero, or the property is not present, the device is prohibited from automatically sending a UTCTimeSynchronization request. If the list is of length one or more, the device may automatically send a UTCTimeSynchronization request but only to the devices or addresses listed. If this property is present, it shall be writable.

12.11.48 Time_Synchronization_Interval

This optional property, of type Unsigned, specifies the periodic interval in minutes at which TimeSynchronization and UTCTimeSynchronization requests shall be sent. If this property has a value of zero, then periodic time synchronization is disabled. If this property is present, it shall be writable.

12.11.49 Align_Intervals

This optional property, of type BOOLEAN, specifies whether (TRUE) or not (FALSE) clock-aligned periodic time synchronization is enabled. If periodic time synchronization is enabled and the time synchronization interval is a factor of (divides without remainder) an hour or day, then the beginning of the period specified for time synchronization shall be aligned to the hour or day, respectively. If this property is present, it shall be writable.

12.11.50 Interval_Offset

This optional property, of type Unsigned, specifies the offset in minutes from the beginning of the period specified for time synchronization until the actual time synchronization requests are sent. The offset used shall be the value of Interval_Offset modulo the value of Time_Synchronization_Interval; e.g., if Interval_Offset has the value 31 and Time_Synchronization_Interval is 30, the offset used shall be 1. Interval_Offset shall have no effect if Align_Intervals is FALSE. If this property is present, it shall be writable.

12.11.51 Backup_Preparation_Time

This optional property, of type Unsigned16, indicates the amount of time in seconds that the device might remain unresponsive after the sending of a ReinitializeDevice-ACK at the start of a backup procedure. The device that initiated the backup shall either wait the period of time specified by this property or be prepared to encounter communication timeouts during this period. The use of this value is described in more detail in Clause 19.1.

This property is required if the device supports execution of the backup and restore procedures and cannot complete backup preparation within the minimum value it will accept in its APDU_Timeout property.

12.11.52 Restore_Preparation_Time

This optional property, of type Unsigned16, indicates the amount of time in seconds that the device is allowed to remain unresponsive after the sending of a ReinitializeDevice-ACK at the start of a restore procedure. The restoring device shall either wait or be prepared to encounter communication timeouts during this period. The use of this value is described in more detail in Clause 19.1.

This property is required if the device supports execution of the backup and restore procedures and cannot complete restore preparation within the minimum value it will accept in its APDU_Timeout property.

12.11.53 Restore_Completion_Time

This optional property, of type Unsigned16, indicates the amount of time in seconds that the device is allowed to remain unresponsive after the sending of a ReinitializeDevice-ACK at the end of a restore procedure. The restoring device shall either wait or be prepared to encounter communication timeouts during this period. The use of this value is described in more detail in Clause 19.1.

This property is required if the device supports execution of the backup and restore procedures and cannot respond to subsequent communications within the minimum value it will accept in its APDU_Timeout property.

12.11.54 Backup_And_Restore_State

This optional property, of type BACnetBackupState, indicates a server device's backup and restore state. The use of this value is described in more detail in Clause 19.1.

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12.11.55 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.12 Event Enrollment Object Type

The Event Enrollment object type defines a standardized object that represents and contains the information required for managing events within BACnet systems. "Events" are changes of value of any property of any object that meet certain predetermined criteria. The primary purpose for Event Enrollment objects is to define an event and to provide a connection between the occurrence of an event and the transmission of a notification message to one or more recipients.

The Event Enrollment object contains the event-type description, the parameters needed to determine if the event has occurred, and a device to be notified. Alternatively, a Notification Class object may serve to identify the recipients of event notifications. A device is considered to be "enrolled for event notification" if it is the recipient to be notified or one of the recipients in a Notification Class object referenced by the Event Enrollment object.

Clause 13 describes the interaction between Event Enrollment objects and the Alarm and Event application services. The Event Enrollment object and its properties are summarized in Table 12-14 and described in detail in this subclause.

Table 12-14. Properties of the Event Enrollment Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Event_Type	BACnetEventType	R
Notify_Type	BACnetNotifyType	R
Event_Parameters	BACnetEventParameter	R
Object_Property_Reference	BACnetDeviceObjectPropertyReference	R
Event_State	BACnetEventState	R
Event_Enable	BACnetEventTransitionBits	R
Acked_Transitions	BACnetEventTransitionBits	R
Notification_Class	Unsigned	R
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	R
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[1]
Profile_Name	CharacterString	O

[1] This property, if present, is required to be read only.

12.12.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the device that maintains it.

12.12.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.12.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be EVENT_ENROLLMENT.

12.12.4 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.12.5 Event_Type

This read-only property, of type BACnetEventType, indicates the type of event algorithm that is to be used to detect the occurrence of events and report to enrolled devices. This parameter is an enumerated type that may have any of the following values:

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{CHANGE_OF_BITSTRING, CHANGE_OF_STATE, CHANGE_OF_VALUE, COMMAND_FAILURE, FLOATING_LIMIT, OUT_OF_RANGE, BUFFER_READY, CHANGE_OF_LIFE_SAFETY, EXTENDED, UNSIGNED_RANGE, ACCESS_EVENT, CHANGE_OF_STATUS_FLAGS, DOUBLE_OUT_OF_RANGE, SIGNED_OUT_OF_RANGE, UNSIGNED_OUT_OF_RANGE, CHANGE_OF_CHARACTERSTRING}

There is a specific relationship between each event algorithm, the parameter list, and the event types that are valid for the event. The Event_Type reflects the algorithm that is used to determine the state of an event. The algorithm for each Event_Type is specified in Clause 13. The Event_Parameters property provides the parameters needed by the algorithm.

The valid combinations of Event_Type, Event_State, and Event_Parameters values are summarized in Table 12-15.

Table 12-15. Event_Types, Event_States, and their Parameters

Event_Type	Event_State	Event_Parameters
CHANGE_OF_BITSTRING	NORMAL OFFNORMAL	Time_Delay Bitmask List_Of_Bitstring_Values
CHANGE_OF_STATE	NORMAL OFFNORMAL	Time_Delay List_Of_Values
CHANGE_OF_VALUE	NORMAL	Time_Delay Bitmask Referenced_Property_Increment
COMMAND_FAILURE	NORMAL OFFNORMAL	Time_Delay Feedback_Property_Reference
FLOATING_LIMIT	NORMAL HIGH_LIMIT LOW_LIMIT	Time_Delay Setpoint_Reference Low_Diff_Limit High_Diff_Limit Deadband
OUT_OF_RANGE, DOUBLE_OUT_OF_RANGE UNSIGNED_OUT_OF_RANGE, SIGNED_OUT_OF_RANGE	NORMAL HIGH_LIMIT LOW_LIMIT	Time_Delay Low_Limit High_Limit Deadband
BUFFER_READY	NORMAL	Notification_Threshold Previous_Notification_Count
CHANGE_OF_LIFE_SAFETY	NORMAL OFFNORMAL LIFE_SAFETY_ALARM	Time_Delay List_Of_Alarm_Values List_Of_Life_Safety_Alarm_Values Mode_Property_Reference
CHANGE_OF_CHARACTERSTRING	NORMAL OFFNORMAL	Time_Delay List_of_Alarm_Values
EXTENDED	Any BACnetEventState	Vendor_Id Extended_Event_Type Parameters
UNSIGNED_RANGE	NORMAL HIGH_LIMIT LOW_LIMIT	Time_Delay Low_Limit High_Limit
CHANGE_OF_STATUS_FLAGS	NORMAL OFFNORMAL	Time_Delay Selected_Flags
ACCESS_EVENT	NORMAL	List_Of_Access_Events Access_Event_Time_Reference

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12.12.6 Notify_Type

This property, of type BACnetNotifyType, shall convey whether the notifications generated by the monitoring algorithm specified by the Event_Type property should be Events or Alarms.

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12.12.7 Event_Parameters

The Event_Parameters property, of type BACnetEventParameter, determines the algorithm used to monitor the referenced object and provides the parameter values needed for this algorithm. The meaning of each value in the Event_Parameters, depends on the algorithm as indicated by the Event_Type column in Table 12-15. Each of the possible parameters is described below.

Bitmask	This parameter, of type BIT STRING, applies to the CHANGE_OF_BITSTRING event algorithm and the CHANGE_OF_VALUE event algorithm in the special case where the referenced property is a BIT STRING datatype. It represents a bitmask that is used to indicate which bits in the referenced property are to be monitored by the algorithm. A value of one in a bit position indicates that the bit in this position in the referenced property is to be monitored by the algorithm. A value of zero in a bit position indicates that the bit in this position in the referenced property is not significant for the purpose of detecting this CHANGE_OF_BITSTRING or CHANGE_OF_VALUE.
List_Of_Bitstring_Values	This parameter is a list of bitstrings that apply to the CHANGE_OF_BITSTRING event algorithm. This list of bitstrings defines the set of states for which the referenced property is OFFNORMAL. Only the bits indicated by the Bitmask are significant. If the value of the referenced property changes to one of the values in the List_Of_Bitstring_Values, then the Event_State property of the Event Enrollment object makes a transition TO-OFFNORMAL and appropriate notifications are sent.
List_Of_Values	This parameter is a list of BACnetPropertyStates that apply to the CHANGE_OF_STATE event algorithm. This event algorithm applies to referenced properties that have discrete or enumerated values. The List_Of_Values is a subset of the possible values that the property may have. If the value of the referenced property changes to one of the values in the List_Of_Values, then the Event_State property of the Event Enrollment object makes a transition TO-OFFNORMAL and appropriate notifications are sent.
Referenced_Property_Increment	This parameter, of type REAL, applies to the CHANGE_OF_VALUE event algorithm. It represents the increment by which the referenced property must change in order for the event to occur.
Time_Delay	This parameter, of type Unsigned, applies to all event types and represents the time, in seconds, that the conditions monitored by the event algorithm must persist before an event notification is issued.
Feedback_Property_Reference	This parameter, of type BACnetDeviceObjectPropertyReference, applies to the COMMAND_FAILURE algorithm. It identifies the object and property that provides the feedback to ensure that the commanded property has changed value. This property may reference only object properties that have enumerated values or are of type BOOLEAN.
Setpoint_Reference	This parameter, of type BACnetDeviceObjectPropertyReference, applies to the FLOATING_LIMIT event algorithm. It indicates the setpoint reference for the reference property interval.

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Deadband, High_Diff_Limit, Low_Diff_Limit, High_Limit (REAL), Low_Limit (REAL)	These parameters, of type REAL, apply to the FLOATING_LIMIT and OUT_OF_RANGE event algorithms. Their use is described in the algorithms for these types in Clause 13.
Notification_Threshold	This parameter, of type Unsigned, applies to the BUFFER_READY algorithm. It specifies the value of Records_Since_Notification at which notification occurs.
Previous_Notification_Count	This parameter, of type Unsigned32, applies to the BUFFER_READY algorithm. It contains the value that Total_Record_Count had at the time the previous BUFFER_READY notification occurred.
List_Of_Life_Safety_Alarm_Values	This parameter is a list of BACnetLifeSafetyState that applies to the CHANGE_OF_LIFE_SAFETY algorithm. If the value of the referenced property changes to one of the values in the List_Of_Life_Safety_Alarm_Values, then the Event_State property of the Event Enrollment object makes a transition TO-OFFNORMAL and appropriate notifications are sent. The resulting event state is LIFE_SAFETY_ALARM
List_Of_Alarm_Values	This parameter is a list of BACnetLifeSafetyState that applies to the CHANGE_OF_LIFE_SAFETY algorithm. If the value of the referenced property changes to one of the values in the List_Of_Alarm_Values, then the Event_State property of the Event Enrollment object makes a transition TO-OFFNORMAL and appropriate notifications are sent. The resulting event state is OFFNORMAL.
Mode_Property_Reference	This parameter, of type BACnetDeviceObjectPropertyReference, applies to the CHANGE_OF_LIFE_SAFETY algorithm. It identifies the object and property that provides the operating mode of the referenced object providing life safety functionality(normally the Mode property). This parameter may reference only object properties that are of type BACnetLifeSafetyMode.
Vendor_Id	This parameter, of type Unsigned16, is a vendor identification code, assigned by ASHRAE, which is used to distinguish proprietary extensions to the protocol. See clause 23.
Extended_Event_Type	This parameter, of type Unsigned, is a value selected by the organization indicated by Vendor_Id, which specifies the interpretation of the Parameters parameter.
Parameters	This parameter consists of a set of data values whose interpretation is specified by the combination of Vendor_Id and Extended_Event_Type. The set of data values constitutes the set of input parameters for the proprietary algorithm.
High_Limit (Unsigned), Low_Limit (Unsigned)	These parameters, of type Unsigned, apply to the UNSIGNED_RANGE event algorithm. Their use is described in the algorithm for these types in Clause 13.
List_Of_Access_Events	This parameter is a list of BACnetAccessEvent values that applies to the ACCESS_EVENT algorithm. If the value of the referenced property is updated to one of the values in the List_Of_Access_Events, then the Event_State property of the Event Enrollment object makes a transition TO-NORMAL and appropriate notifications are sent.

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Access_Event_Time_Reference	This parameter, of type BACnetDeviceObjectPropertyReference, applies to the ACCESS_EVENT algorithm. It identifies the object and property (normally the Access_Event_Time property) that provides the last update time of the referenced property that is monitored for access events. This parameter may only reference object properties that are of type BACnetTimeStamp.
Selected_Flags	This parameter, of type BACnetStatusFlags, selects which flags should be monitored for the CHANGE_OF_STATUS_FLAGS algorithm.

12.12.8 Object_Property_Reference

This property, of type BACnetDeviceObjectPropertyReference, designates the particular object and property referenced by this Event Enrollment object. The algorithm specified by the Event_Type property is applied to the referenced property in order to determine the Event_State of the event.

If this property is writable, it may be restricted to only support references to objects inside of the device containing the Event Enrollment object. If the property is restricted to referencing objects within the containing device, an attempt to write a reference to an object outside the containing device into this property shall cause a Result(-) to be returned with an error class of PROPERTY and an error code of OPTIONAL_FUNCTIONALITY_NOT_SUPPORTED.

If this property is set to reference an object outside the device containing the Event Enrollment object, the method used for acquisition of the referenced property value for the purpose of monitoring is a local matter. The only restriction on the method of data acquisition is that the monitoring device be capable of using ReadProperty for this purpose so as to be interoperable with all BACnet devices.

12.12.9 Event_State

This property, of type BACnetEventState, contains the current state of the event. The permitted values for Event_State are specific to the Event_Type. See Table 12-15. The value of the Event_State property is independent of the Event_Enable flags. See 12.12.10.

12.12.10 Event_Enable

This property, of type BACnetEventTransitionBits, conveys three flags that determine whether notifications are enabled for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL transitions. When a flag is set, this means that the corresponding transition would cause notification to be sent to all enrolled devices. When a flag is cleared, this means that the corresponding transition would not be reported. The object's Event_State property shall be continuously updated regardless of the value of the Event_Enable property.

12.12.11 Acked_Transitions

This property, of type BACnetEventTransitionBits, shall convey three separate flags that each indicate whether the most recent TO-OFFNORMAL, TO-FAULT, or TO-NORMAL event transitions have been acknowledged, if acknowledgment is required for that transition.

12.12.12 Notification_Class

This property, of type Unsigned, implicitly references a Notification Class object in the device containing the Event Enrollment object. The class is used to specify the handling, reporting, and acknowledgment characteristics for one or more event-initiating objects.

12.12.13 Event_Time_Stamps

This property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively.

12.12.14 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

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12.12.15 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.13 File Object Type

The File object type defines a standardized object that is used to describe properties of data files that may be accessed using File Services (see Clause 14). The file object type and its properties are summarized in Table 12-16 and described in detail in this subclause.

Table 12-16. Properties of the File Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
File_Type	CharacterString	R
File_Size	Unsigned	R[1]
Modification_Date	BACnetDateTime	R
Archive	BOOLEAN	W
Read_Only	BOOLEAN	R
File_Access_Method	BACnetFileAccessMethod	R
Record_Count	Unsigned	O[2]
Profile_Name	CharacterString	O

[1] If the file size can be changed by writing to the file, and File_Access_Method is STREAM_ACCESS, then this property shall be writable.
[2] This property shall be present only if File_Access_Method is RECORD_ACCESS. If the number of records can be changed by writing to the file, then this property shall be writable.

12.13.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.13.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.13.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be FILE.

12.13.4 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.13.5 File_Type

This property, of type CharacterString, identifies the intended use of this file.

12.13.6 File_Size

This property, of type Unsigned, indicates the size of the file data in octets. If the size of the file can be changed by writing to the file, and File_Access_Method is STREAM_ACCESS, then this property shall be writable.

Writing to the File_Size property with a value less than the current size of the file shall truncate the file at the specified position. Writing a File_Size of 0 shall delete all of the file data but not the File object itself. Writing to the File_Size property with a value greater than the current size of the file shall expand the size of the file but the value of the new octets of the file shall be a local matter.

Devices may restrict the allowed values for writes to the File_Size. Specifically, devices may allow deletion of the file contents by writing a value of zero, but not necessarily allow arbitrary truncation or expansion.

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Any change to the File_Size property shall also update the Modification_Date property to reflect the date when the size was changed.

If the size of the file is unknown, an attempt to read this property shall result in an Error Class of 'PROPERTY' and an Error Code of 'UNKNOWN_FILE_SIZE'.

12.13.7 Modification_Date

This property, of type BACnetDateTime, indicates the last time this object's underlying file data or File_Size was modified. A File object shall be considered modified when any of these conditions occur:

(a) the File object is created;
(b) the underlying file data that it represents is written using AtomicWriteFile or ConfirmedPrivateTransfer or UnconfirmedPrivateTransfer services or is written by some internal process; or
(c) the File_Size property changes.

If the Local_Time and Local_Date properties are present, this property shall contain a specific datetime value; otherwise this property shall contain either a specific or an unspecified datetime value.

12.13.8 Archive

This property, of type BOOLEAN, shall be set to FALSE when the Modification_Date property changes for any reason. It is the responsibility of an archiving process to set the value of this property to TRUE when it completes. The mechanism by which archiving occurs shall be a local matter.

12.13.9 Read_Only

This property, of type BOOLEAN, indicates whether (FALSE) or not (TRUE) the file data may be changed through the use of a BACnet AtomicWriteFile service.

12.13.10 File_Access_Method

This property, of type BACnetFileAccessMethod, indicates the type(s) of file access supported for this object. The possible values for File_Access_Method are:

{RECORD_ACCESS, STREAM_ACCESS}

12.13.11 Record_Count

This property, of type Unsigned, indicates the size of the file data in records. The Record_Count property shall be present only if File_Access_Type is RECORD_ACCESS. If the number of records can be changed by writing to the file, then this property shall be writable.

Writing to the Record_Count property with a value less than the current size of the file shall truncate the file at the specified position. Writing a Record_Count of 0 shall delete all of the file data but not the File object itself. Writing to the Record_Count property with a value greater than the current size of the file shall expand the size of the file but the value of the new octets of the file shall be a local matter.

Devices may restrict the allowed values for writes to the Record_Count. Specifically, devices may allow deletion of the file contents by writing a value of zero, but not necessarily allow arbitrary truncation or expansion.

12.13.12 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

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A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.14 Group Object Type

The Group object type defines a standardized object whose properties represent a collection of other objects and one or more of their properties. A group object is used to simplify the exchange of information between BACnet Devices by providing a shorthand way to specify all members of the group at once. A group may be formed using any combination of object types. The group object and its properties are summarized in Table 12-17 and described in detail in this subclause.

Table 12-17. Properties of the Group Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
List_Of_Group_Members	List of ReadAccessSpecification	R
Present_Value	List of ReadAccessResult	R
Profile_Name	CharacterString	O

12.14.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.14.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.14.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be GROUP.

12.14.4 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.14.5 List_Of_Group_Members

This property is a list of one or more read access specifications, which defines the members of the group that shall be referenced when this object is specified in a protocol transaction. Each read access specification shall consist of two parts: 1) an Object_Identifier and 2) a List Of Property References. All members of the group shall be objects that reside in the same device that maintains the Group object. See the ASN.1 production for ReadAccessSpecification in Clause 21.

Nesting of group objects is not permitted; that is, the List_Of_Group_Members shall not refer to the Present_Value property of a Group object or a Global Group object.

12.14.6 Present_Value

This property is a list that contains the values of all the properties specified in the List_Of_Group_Members. This is a "read-only" property; it cannot be used to write a set of values to the members of the group. The Present_Value list shall be reconstructed each time the property is read by fetching the member properties. (NOTE: This requirement is to reduce concurrency problems that could result if the Present_Value were stored.)

12.14.7 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

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A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.15 Life Safety Point Object Type

The Life Safety Point object type defines a standardized object whose properties represent the externally visible characteristics associated with initiating and indicating devices in fire, life safety and security applications. The condition of a Life Safety Point object is represented by a *mode* and a *state*.

Mode changes determine the object's inner logic and, consequently, influence the evaluation of the state. Typically, the operating *mode* would be under operator control.

The *state* of the object represents the condition of the controller according to the logic internal to the device. The implementation of the logic applied to such controllers to determine the various possible states is a local matter.

Typical applications of the Life Safety Point object include automatic fire detectors, pull stations, sirens, supervised printers, etc. Similar objects can be identified in security control panels.

The Life Safety Point object type and its properties are summarized in Table 12-18 and described in detail in this subclause.

NOTE: Do not confuse the Present_Value state with the Event_State property, which reflects the offnormal state of the Life Safety Point object.

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Table 12-18. Properties of the Life Safety Point Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Present_Value	BACnetLifeSafetyState	R
Tracking_Value	BACnetLifeSafetyState	R[1]
Description	CharacterString	O
Device_Type	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	R[1]
Out_Of_Service	BOOLEAN	R
Mode	BACnetLifeSafetyMode	W
Accepted_Modes	List of BACnetLifeSafetyMode	R
Time_Delay	Unsigned	O[2]
Notification_Class	Unsigned	O[2]
Life_Safety_Alarm_Values	List of BACnetLifeSafetyState	O[2]
Alarm_Values	List of BACnetLifeSafetyState	O[2]
Fault_Values	List of BACnetLifeSafetyState	O[2]
Event_Enable	BACnetEventTransitionBits	O[2]
Acked_Transitions	BACnetEventTransitionBits	O[2]
Notify_Type	BACnetNotifyType	O[2]
Event_Time_Stamps	BACnetARRAY [3] of BACnetTimeStamp	O[2]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[4]
Silenced	BACnetSilencedState	R
Operation_Expected	BACnetLifeSafetyOperation	R
Maintenance_Required	BACnetMaintenance	O
Setting	Unsigned8	O
Direct_Reading	REAL	O[3]
Units	BACnetEngineeringUnits	O[3]
Member_Of	List of BACnetDeviceObjectReference	O
Profile_Name	CharacterString	O

[1] These properties are required to be writable when Out_Of_Service is TRUE.
[2] These properties are required if the object supports intrinsic alarming.
[3] If either of these properties is present, then both must be present.
[4] This property, if present, is required to be read only.

12.15.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.15.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.15.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be LIFE_SAFETY_POINT.

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12.15.4 Present_Value

This property, of type BACnetLifeSafetyState, reflects the state of the Life Safety Point object. The means of deriving the Present_Value shall be a local matter. Present_Value may latch non-NORMAL state values until reset.

12.15.5 Tracking_Value

This property, of type BACnetLifeSafetyState, reflects the non-latched state of the Life Safety Point object. The means of deriving the state shall be a local matter. Unlike Present_Value, which may latch non-NORMAL state values until reset, Tracking_Value shall continuously track changes in the state. The Tracking_Value property shall be writable when Out_Of_Service is TRUE.

12.15.6 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.15.7 Device_Type

This optional property, of type CharacterString, is a text description of the physical device that the Life Safety Point object represents.

12.15.8 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of the Life Safety Point object. Three of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT Logical TRUE (1) if the Reliability property does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the physical input(s) are no longer tracking changes to the Present_Value property and the Reliability property is no longer a reflection of the physical input(s). Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0).

12.15.9 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. The Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL.

12.15.10 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the Present_Value or the operation of the physical input(s) in question are "reliable" as far as the BACnet Device or operator can determine and, if not, why. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, OPEN_LOOP, SHORTED_LOOP, MULTI_STATE_FAULT, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.15.10.1 Conditions for Generating a TO-FAULT Event

A TO-FAULT event is generated under these conditions:

(a) the Reliability property becomes not equal to NO_FAULT_DETECTED, and

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(b) the TO-FAULT flag is enabled in the Event_Enable property.

12.15.11 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the input(s) or process the object represents is not in service. This means that changes to the Tracking_Value property are decoupled from the input(s) or process when the value of Out_Of_Service is TRUE. In addition, the Reliability property and the corresponding state of the FAULT flag of the Status_Flags property shall be decoupled when Out_Of_Service is TRUE. While the Out_Of_Service property is TRUE, the Tracking_Value and Reliability properties may be changed to any value as a means of simulating specific fixed conditions or for testing purposes. Other functions that depend on the state of the Tracking_Value or Reliability properties shall respond to changes made to these properties while Out_Of_Service is TRUE, as if those changes had occurred to the input(s) or process.

12.15.12 Mode

This writable property, of type BACnetLifeSafetyMode, shall convey the desired operating mode for the Life Safety Point object. The Life Safety Point object shall generate CHANGE_OF_LIFE_SAFETY event notifications for any mode transition if the respective flags TO-OFFNORMAL, TO-FAULT or TO-NORMAL are set in the Event_Enable property (see 12.15.16.1, 12.15.16.2, 12.15.17.1, 12.15.17.2, 12.15.18.1, and 12.15.18.2).

12.15.13 Accepted_Modes

This read-only property, of type List of BACnetLifeSafetyMode, shall specify all values the Mode property accepts when written to using BACnet services. Even though a mode is listed in this property, the write may be denied by the object due to the internal state of the object at that time. The value of the Accepted_Modes property does not depend on the internal state of the object and shall not change when the internal state changes. If a write is denied, a Result(-) specifying an 'Error Class' of PROPERTY and an 'Error Code' of VALUE_OUT_OF_RANGE shall be returned. Internal computation in the object may set the Mode property to a value other than one of those listed in the Accepted_Modes property.

12.15.14 Time_Delay

This optional property, of type Unsigned, shall specify the minimum period of time in seconds that the Present_Value must remain:

(a) equal to any of the values in the Life_Safety_Alarm_Values property before a TO-OFFNORMAL event is generated, or
(b) equal to any one of the values in the Alarm_Values property before a TO-OFFNORMAL event is generated, or
(c) not equal to any of the values in the Life_Safety_Alarm_Values property, Alarm_Values property, or Fault_Values property before a TO-NORMAL event is generated.

This property is required if intrinsic reporting is supported by this object.

12.15.15 Notification_Class

This optional property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.15.16 Life_Safety_Alarm_Values

This optional property, of type List of BACnetLifeSafetyState, shall specify any states the Present_Value must equal before a TO-OFFNORMAL event is generated and event state LIFE_SAFETY_ALARM is entered. This property is required if intrinsic reporting is supported by this object.

12.15.16.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the TO-OFFNORMAL flag must be enabled in the Event_Enable property, and
(b) the Present_Value must equal any of the values in the Life_Safety_Alarm_Values list, and
(c) the Present_Value must remain within the Life_Safety_Alarm_Values list for a minimum period of time, specified by the Time_Delay property.

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New events shall be generated upon a change of Mode if the TO-OFFNORMAL flag is set in the Event_Enable property.

12.15.16.2 Conditions for Generating a TO-NORMAL Event

Once equal, the Present_Value must become not equal to any of the states in the Life_Safety_Alarm_Values property, and not equal to any of the states in the Alarm_Values property, and not equal to any of the states in the Fault_Values property, before a TO-NORMAL event is generated under these conditions:

(a) the TO-NORMAL flag must be enabled in the Event_Enable property, and
(b) the Present_Value must remain not equal to any of the states in the Life_Safety_Alarm_Values property, and
(c) the Present_Value must remain not equal to any of the states in the Alarm_Values property, and
(d) the Present_Value must remain not equal to any of the states in the Fault_Values property, and
(e) the Present_Value must remain equal to the same value for a minimum period of time, specified by the Time_Delay property.

New events shall be generated upon a change of Mode if the TO-NORMAL flag is set in the Event_Enable property.

12.15.17 Alarm_Values

This optional property, of type List of BACnetLifeSafetyState, shall specify any states the Present_Value must equal before a TO-OFFNORMAL event is generated and event state OFFNORMAL is entered. This property is required if intrinsic reporting is supported by this object.

12.15.17.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the TO-OFFNORMAL flag must be enabled in the Event_Enable property, and
(b) the Present_Value must equal any of the values in the Alarm_Values list, and
(c) the Present_Value must remain within the Alarm_Values list for a minimum period of time specified by the Time_Delay property.

New events shall be generated upon a change of Mode if the TO-OFFNORMAL flag is set in the Event_Enable property.

12.15.17.2 Conditions for Generating a TO-NORMAL Event

Conditions for generating a TO-NORMAL event are defined in 12.15.16.2.

12.15.18 Fault_Values

This optional property, of type List of BACnetLifeSafetyState, shall specify any states the Present_Value must equal before a TO-FAULT event is generated. If Present_Value becomes equal to any of the states in the Fault_Values list, and no physical fault has been detected for any inputs that the Present_Value represents, then the Reliability property shall have the value MULTI_STATE_FAULT. The Fault_Values property is required if intrinsic reporting is supported by this object.

New events shall be generated upon a change of Mode if the TO-FAULT flag is set in the Event_Enable property.

12.15.18.1 Conditions for Generating a TO-FAULT Event

A TO-FAULT event is generated under these conditions:

(a) the TO-FAULT flag must be enabled in the Event_Enable property, and
(b) the Present_Value must equal at least one of the values in the Fault_Values list.

12.15.18.2 Conditions for Generating a TO-NORMAL Event

Conditions for generating a TO-NORMAL event are defined in 12.15.16.2.

12.15.19 Event_Enable

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events that are based on Present_Value and/or Mode changes. This property is required if intrinsic reporting is supported by this object.

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12.15.20 Acked_Transitions

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

12.15.21 Notify_Type

This optional property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.15.22 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.15.23 Silenced

This property, of type BACnetSilencedState, shall indicate whether the most recently occurring transition for this object that has produced an audible or visual indication has been silenced by the receipt of a LifeSafetyOperation service request or a local process.

12.15.24 Operation_Expected

The Operation_Expected property, of type BACnetLifeSafetyOperation, shall specify the next operation expected by this object to handle a specific life safety situation.

12.15.25 Maintenance_Required

This optional property, of type BACnetMaintenance, shall indicate the type of maintenance required for the life safety point. This may be periodic maintenance, or a "parameter-determined" maintenance, such as dirtiness value for an associated detector, and shall be determined locally.

12.15.26 Setting

This optional property, of type Unsigned8, shall be used to convey the desired setting of the input(s) or process used to determine the logical state of the Present_Value. The range of the Setting property shall be from 0 (least sensitive) to 100 (most sensitive). The interpretation of the setting and the actual number of useful settings for a given Life Safety Point object shall be a local matter.

12.15.27 Direct_Reading

This optional property, of type REAL, shall indicate an analog quantity that reflects the measured or calculated reading from an initiating device. The manner in which this reading is used to determine the logical state of the object shall be a local matter. If this property is present, then the Units property shall also be present.

12.15.28 Units

This optional property, of type BACnetEngineeringUnits, shall indicate the units of the quantity represented by the Direct_Reading property. If this property is present, then the Direct_Reading property shall also be present.

12.15.29 Member_Of

This optional property, of type List of BACnetDeviceObjectReference, shall indicate those Life Safety Zone objects of which this Life Safety Point object is considered to be a zone member. Each object in the Member_Of list shall be a Life Safety Zone object.

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This property may be restricted to only support references to objects inside of the device containing the Life Safety Point object. If the property is writable and is restricted to referencing objects within the containing device, an attempt to write a reference to an object outside the containing device into this property shall cause a Result(-) to be returned with an error class of PROPERTY and an error code of OPTIONAL_FUNCTIONALITY_NOT_SUPPORTED.

12.15.30 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.15.31 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.16 Life Safety Zone Object Type

The Life Safety Zone object type defines a standardized object whose properties represent the externally visible characteristics associated with an arbitrary group of BACnet Life Safety Point and Life Safety Zone objects in fire, life safety and security applications. The condition of a Life Safety Zone object is represented by a *mode* and a *state*.

Mode changes determine the object's inner logic and, consequently, influence the evaluation of the state. Typically, the operating *mode* would be under operator control.

The *state* of the object represents the condition of the controller according to the logic internal to the device. The implementation of the logic applied to such controllers to determine the various possible states is a local matter.

Typical applications of the Life Safety Zone object include fire zones, panel zones, detector lines, extinguishing controllers, remote transmission controllers, etc. Similar objects can be identified in security control panels.

The Life Safety Zone object type and its properties are summarized in Table 12-19 and described in detail in this subclause.

NOTE: Do not confuse the Present_Value state with the Event_State property, which reflects the offnormal state of the Life Safety Zone object.

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Table 12-19. Properties of the Life Safety Zone Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Present_Value	BACnetLifeSafetyState	R
Tracking_Value	BACnetLifeSafetyState	R[1]
Description	CharacterString	O
Device_Type	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	R[1]
Out_Of_Service	BOOLEAN	R
Mode	BACnetLifeSafetyMode	W
Accepted_Modes	List of BACnetLifeSafetyMode	R
Time_Delay	Unsigned	O[2]
Notification_Class	Unsigned	O[2]
Life_Safety_Alarm_Values	List of BACnetLifeSafetyState	O[2]
Alarm_Values	List of BACnetLifeSafetyState	O[2]
Fault_Values	List of BACnetLifeSafetyState	O[2]
Event_Enable	BACnetEventTransitionBits	O[2]
Acked_Transitions	BACnetEventTransitionBits	O[2]
Notify_Type	BACnetNotifyType	O[2]
Event_Time_Stamps	BACnetARRAY [3] of BACnetTimeStamp	O[2]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[3]
Silenced	BACnetSilencedState	R
Operation_Expected	BACnetLifeSafetyOperation	R
Maintenance_Required	BOOLEAN	O
Zone_Members	List of BACnetDeviceObjectReference	R
Member_Of	List of BACnetDeviceObjectReference	O
Profile_Name	CharacterString	O

[1] These properties are required to be writable when Out_Of_Service is TRUE.
[2] These properties are required if the object supports intrinsic alarming.
[3] This property, if present, is required to be read only.

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12.16.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.16.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.16.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be LIFE_SAFETY_ZONE.

12.16.4 Present_Value

This property, of type BACnetLifeSafetyState, reflects the state of the Life Safety Zone object. The means of deriving the Present_Value shall be a local matter. Present_Value may latch non-NORMAL state values until reset.

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12.16.5 Tracking_Value

This property, of type BACnetLifeSafetyState, reflects the non-latched state of the Life Safety Zone object. The means of deriving the state shall be a local matter. Unlike Present_Value, which may latch non-NORMAL state values until reset, Tracking_Value shall continuously track changes in the state. The Tracking_Value property shall be writable when Out_Of_Service is TRUE.

12.16.6 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.16.7 Device_Type

This optional property, of type CharacterString, is a text description of the physical zone or area that the Life Safety Zone object represents. It will typically be used to describe the locale of the Life Safety Point objects that are Zone_Members of the Life Safety Zone object.

12.16.8 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of the Life Safety Zone object. Three of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM — Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT — Logical TRUE (1) if the Reliability property does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN — Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the physical input(s) are no longer tracking changes to the Present_Value property and the Reliability property is no longer a reflection of the physical input(s). Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE — Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0).

12.16.9 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. The Event_State property shall indicate the event state of the object.

12.16.10 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the Present_Value or the operation of the physical input(s) in question are "reliable" as far as the BACnet Device or operator can determine and, if not, why. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, OPEN_LOOP, SHORTED_LOOP, MULTI_STATE_FAULT,
COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.16.10.1 Conditions for Generating a TO-FAULT Event

A TO-FAULT event is generated under these conditions:

(a) the Reliability property becomes not equal to NO_FAULT_DETECTED, and
(b) the TO-FAULT flag is enabled in the Event_Enable property.

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12.16.11 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the input(s) or process the object represents is not in service. This means that changes to the Tracking_Value property are decoupled from the input(s) or process when the value of Out_Of_Service is TRUE. In addition, the Reliability property and the corresponding state of the FAULT flag of the Status_Flags property shall be decoupled when Out_Of_Service is TRUE. While the Out_Of_Service property is TRUE, the Tracking_Value and Reliability properties may be changed to any value as a means of simulating specific fixed conditions or for testing purposes. Other functions that depend on the state of the Tracking_Value or Reliability properties shall respond to changes made to these properties while Out_Of_Service is TRUE, as if those changes had occurred to the input(s) or process.

12.16.12 Mode

This writable property, of type BACnetLifeSafetyMode, shall convey the desired operating mode for the Life Safety Point object. The Life Safety Point object shall generate CHANGE_OF_LIFE_SAFETY event notifications for any mode transition if the respective flags TO-OFFNORMAL, TO-FAULT or TO-NORMAL are set in the Event_Enable property (see 12.16.16.1, 12.16.16.2, 12.16.17.1, 12.16.17.2, 12.16.18.1, and 12.16.18.2).

12.16.13 Accepted_Modes

This read-only property, of type List of BACnetLifeSafetyMode, shall specify all values the Mode property accepts when written to using BACnet services. Even though a mode is listed in this property, the write may be denied by the object due to the internal state of the object at that time. The value of the Accepted_Modes property does not depend on the internal state of the object and shall not change when the internal state changes. If a write is denied, a Result(-) specifying an 'Error Class' of PROPERTY and an 'Error Code' of VALUE_OUT_OF_RANGE shall be returned. Internal computation in the object may set the Mode property to a value other than one of those listed in the Accepted_Modes property.

12.16.14 Time_Delay

This optional property, of type Unsigned, shall specify the minimum period of time in seconds that the Present_Value must remain:

(a) equal to any of the values in the Life_Safety_Alarm_Values property before a TO-OFFNORMAL event is generated, or
(b) equal to any one of the values in the Alarm_Values property before a TO-OFFNORMAL event is generated, or
(c) not equal to any of the values in the Life_Safety_Alarm_Values property, Alarm_Values property, or Fault_Values property before a TO-NORMAL event is generated.

This property is required if intrinsic reporting is supported by this object.

12.16.15 Notification_Class

This optional property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value.

12.16.16 Life_Safety_Alarm_Values

This optional property, of type List of BACnetLifeSafetyState, shall specify any states the Present_Value must equal before a TO-OFFNORMAL event is generated and event state LIFE_SAFETY_ALARM is entered. This property is required if intrinsic reporting is supported by this object.

12.16.16.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the TO-OFFNORMAL flag must be enabled in the Event_Enable property, and
(b) the Present_Value must equal any of the values in the Life_Safety_Alarm_Values list, and
(c) the Present_Value must remain within the Life_Safety_Alarm_Values list for a minimum period of time, specified by the Time_Delay property.

New events shall be generated upon a change of Mode if the TO-OFFNORMAL flag is set in the Event_Enable property.

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12.16.16.2 Conditions for Generating a TO-NORMAL Event

Once equal, the Present_Value must become not equal to any of the states in the Life_Safety_Alarm_Values property, and not equal to any of the states in the Alarm_Values property, and not equal to any of the states in the Fault_Values property, before a TO-NORMAL event is generated under these conditions:

(a) the TO-NORMAL flag must be enabled in the Event_Enable property, and
(b) the Present_Value must remain not equal to any of the states in the Life_Safety_Alarm_Values property, and
(c) the Present_Value must remain not equal to any of the states in the Alarm_Values property, and
(d) the Present_Value must remain not equal to any of the states in the Fault_Values property, and
(e) the Present_Value must remain equal to the same value for a minimum period of time, specified by the Time_Delay property.

New events shall be generated upon a change of Mode if the TO-NORMAL flag is set in the Event_Enable property.

12.16.17 Alarm_Values

This optional property, of type List of BACnetLifeSafetyState, shall specify any states the Present_Value must equal before a TO-OFFNORMAL event is generated and event state OFFNORMAL is entered. This property is required if intrinsic reporting is supported by this object.

12.16.17.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the TO-OFFNORMAL flag must be enabled in the Event_Enable property, and
(b) the Present_Value must equal at least one of the values in the Alarm_Values list, and
(c) the Present_Value must remain equal to the same value for a minimum period of time, specified by the Time_Delay property.

New events shall be generated upon a change of Mode if the TO-OFFNORMAL flag is set in the Event_Enable property.

12.16.17.2 Conditions for Generating a TO-NORMAL Event

Conditions for generating a TO-NORMAL event are defined in 12.16.16.2.

12.16.18 Fault_Values

This optional property, of type List of BACnetLifeSafetyState, shall specify any states the Present_Value must equal before a TO-FAULT event is generated. If Present_Value becomes equal to any of the states in the Fault_Values list, and no physical fault has been detected for any inputs that the Present_Value represents, then the Reliability property shall have the value MULTI_STATE_FAULT. The Fault_Values property is required if intrinsic reporting is supported by this object.

New events shall be generated upon a change of Mode if the TO-FAULT flag is set in the Event_Enable property.

12.16.18.1 Conditions for Generating a TO-FAULT Event

A TO-FAULT event is generated under these conditions:

(a) the TO-FAULT flag must be enabled in the Event_Enable property, and
(b) the Present_Value must equal at least one of the values in the Fault_Values list.

12.16.18.2 Conditions for Generating a TO-NORMAL Event

Conditions for generating a TO-NORMAL event are defined in 12.16.16.2.

12.16.19 Event_Enable

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events that are based on Present_Value or Mode changes.

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12.16.20 Acked_Transitions

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgment is expected).

12.16.21 Notify_Type

This optional property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms.

12.16.22 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.16.23 Silenced

This property, of type BACnetSilencedState, shall indicate whether the most recently occurring transition for this object that has produced an audible or visual indication has been silenced by the receipt of a LifeSafetyOperation service request or a local process.

12.16.24 Operation_Expected

The Operation_Expected property, of type BACnetLifeSafetyOperation, shall specify the next operation expected by this object to handle a specific life safety situation.

12.16.25 Maintenance_Required

This optional property, of type BOOLEAN, shall indicate that maintenance is required for one or more of the life safety points that are members of this zone.

12.16.26 Zone_Members

This property, of type List of BACnetDeviceObjectReference, shall indicate which Life Safety Point and Life Safety Zone objects are members of the zone represented by this object.

This property may be restricted to only support references to objects inside of the device containing the Life Safety Zone object. If the property is writable and is restricted to referencing objects within the containing device, an attempt to write a reference to an object outside the containing device into this property shall cause a Result(-) to be returned with an error class of PROPERTY and an error code of OPTIONAL_FUNCTIONALITY_NOT_SUPPORTED.

12.16.27 Member_Of

This optional property, of type List of BACnetDeviceObjectReference, shall indicate those Life Safety Zone objects of which this Life Safety Zone object is considered to be a zone member. Each object in the Member_Of list shall be a Life Safety Zone object.

This property may be restricted to only support references to objects inside of the device containing the Life Safety Zone object. If the property is writable and is restricted to referencing objects within the containing device, an attempt to write a reference to an object outside the containing device into this property shall cause a Result(-) to be returned with an error class of PROPERTY and an error code of OPTIONAL_FUNCTIONALITY_NOT_SUPPORTED.

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12.16.28 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.16.29 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.17 Loop Object Type

The Loop object type defines a standardized object whose properties represent the externally visible characteristics of any form of feedback control loop. Flexibility is achieved by providing three independent gain constants with no assumed values for units. The appropriate gain units are determined by the details of the control algorithm, which is a local matter. The Loop object type and its properties are summarized in Table 12-20 and described in detail in this subclause. Figure 12-2 illustrates the relationship between the Loop object properties and the other objects referenced by the loop.

Table 12-20. Properties of the Loop Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Present_Value	REAL	R
Description	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	R
Update_Interval	Unsigned	O
Output_Units	BACnetEngineeringUnits	R
Manipulated_Variable_Reference	BACnetObjectPropertyReference	R
Controlled_Variable_Reference	BACnetObjectPropertyReference	R
Controlled_Variable_Value	REAL	R
Controlled_Variable_Units	BACnetEngineeringUnits	R
Setpoint_Reference	BACnetSetpointReference	R
Setpoint	REAL	R
Action	BACnetAction	R
Proportional_Constant	REAL	O[1]
Proportional_Constant_Units	BACnetEngineeringUnits	O[1]
Integral_Constant	REAL	O[2]
Integral_Constant_Units	BACnetEngineeringUnits	O[2]
Derivative_Constant	REAL	O[3]
Derivative_Constant_Units	BACnetEngineeringUnits	O[3]
Bias	REAL	O
Maximum_Output	REAL	O
Minimum_Output	REAL	O
Priority_For_Writing	Unsigned	R
COV_Increment	REAL	O[4]
Time_Delay	Unsigned	O[5]
Notification_Class	Unsigned	O[5]
Error_Limit	REAL	O[5]
Deadband	REAL	O[5]
Event_Enable	BACnetEventTransitionBits	O[5]
Acked_Transitions	BACnetEventTransitionBits	O[5]
Notify_Type	BACnetNotifyType	O[5]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[5]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[6]
Profile_Name	CharacterString	O

[1] If one of these optional properties is present, then both of these properties shall be present.
[2] If one of these optional properties is present, then both of these properties shall be present.
[3] If one of these optional properties is present, then both of these properties shall be present.
[4] This property is required if the object supports COV reporting.
[5] These properties are required if the object supports intrinsic reporting.
[6] This property, if present, is required to be read only.

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12.17.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it**.**

12.17.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.17.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object-type class. The value of this property shall be LOOP.

12.17.4 Present_Value

This property indicates the current output value of the loop algorithm in units of the Output_Units property.

12.17.5 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.17.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of the loop. Three of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM	Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise Logical TRUE (1).
FAULT	Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).
OVERRIDDEN	Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value property is not changeable through BACnet services. Otherwise, the value is logical FALSE (0).
OUT_OF_SERVICE	Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE(0).

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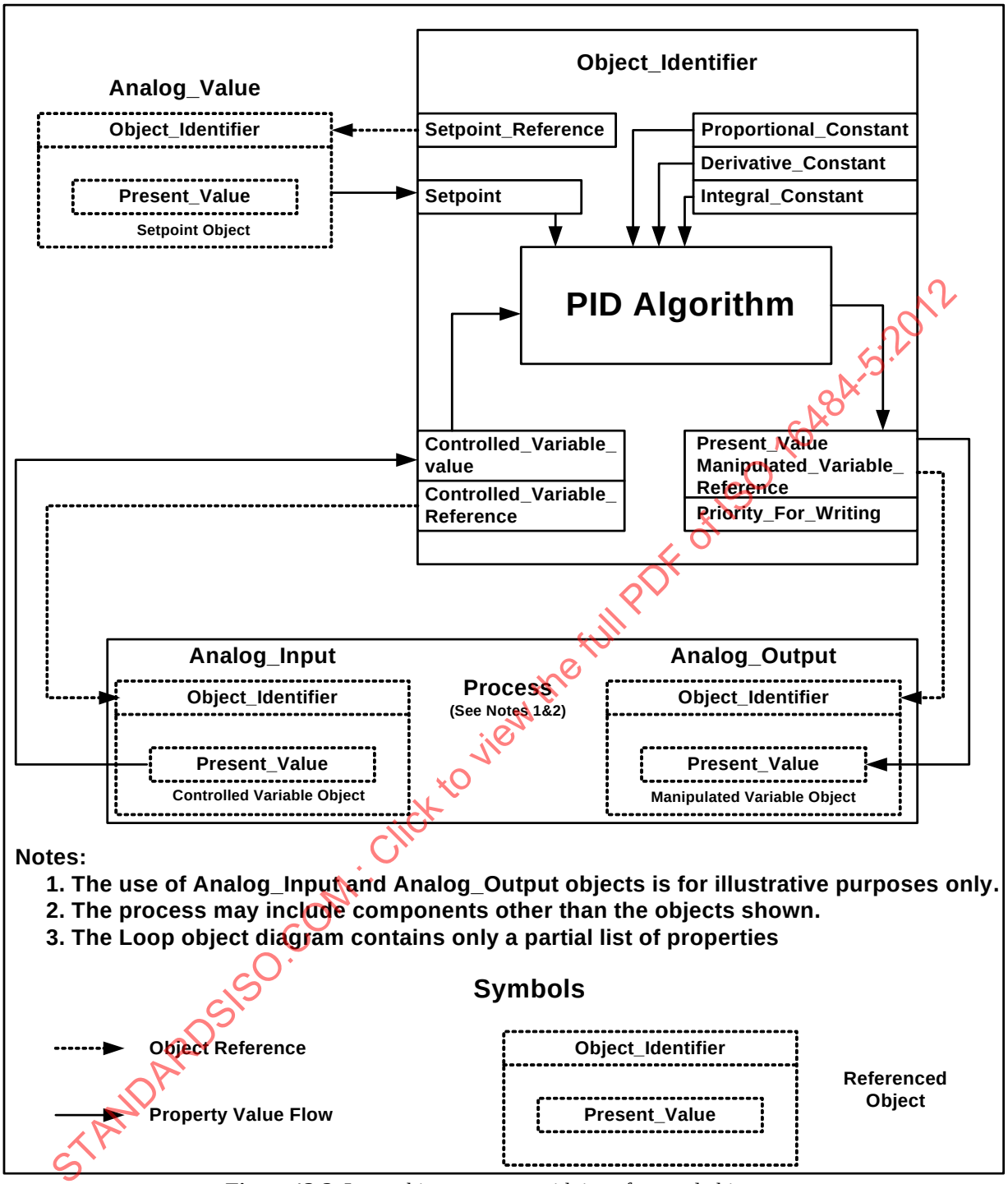

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Figure 12-2. Loop object structure with its referenced objects.

12.17.7 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT. Changes in the Event_State property to the value FAULT are considered to be "fault" events.

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12.17.8 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the Present_Value of the loop in question is reliable as far as the BACnet Device or operator can determine and, if not, why. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, OPEN_LOOP, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.17.9 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the algorithm this object represents is or is not in service.

12.17.10 Update_Interval

This property, of type Unsigned, indicates the interval in milliseconds at which the loop algorithm updates the output (Present_Value property).

NOTE: No property that represents the interval at which the process variable is sampled or the algorithm is executed is part of this object. The Update_Interval value may be the same as these other values but could also be different depending on the algorithm utilized. The sampling or execution interval is a local matter and need not be represented as part of this object.

12.17.11 Output Units

This property, of type BACnetEngineeringUnits, indicates the engineering units for the output (Present_Value property) of this control loop.

12.17.12 Manipulated_Variable_Reference

This property is of type BACnetObjectPropertyReference. The output (Present_Value) of the control loop is written to the object and property designated by the Manipulated_Variable_Reference. It is normally the Present_Value of an Analog Output object used to position a device, but it could also be another object or property, such as that used to stage multiple Binary Outputs.

12.17.13 Controlled_Variable_Reference

This property is of type BACnetObjectPropertyReference. The Controlled_Variable_Reference identifies the property used to set the Controlled_Variable_Value property of the Loop object. It is normally the Present_Value property of an Analog Input object used for measuring a process variable, temperature, for example, but it could also be another object, such as an Analog Value, which calculates a minimum or maximum of a group of Analog Inputs for use in discriminator control.

12.17.14 Controlled_Variable_Value

This property, of type REAL, is the value of the property of the object referenced by the Controlled_Variable_Reference property. This control loop compares the Controlled_Variable_Value with the Setpoint to calculate the error.

12.17.15 Controlled_Variable_Units

This property, of type BACnetEngineeringUnits, indicates the engineering units for the Controlled_Variable_Value property of this object.

12.17.16 Setpoint_Reference

This property, of type BACnetSetpointReference, contains zero or one references. The absence of a reference indicates that the setpoint for this control loop is fixed and is contained in the Setpoint property. The presence of a reference indicates that the property of another object contains the setpoint value used for this Loop object and the reference specifies that property.

12.17.17 Setpoint

This property, of type REAL, is the value of the loop setpoint or of the property of the object referenced by the Setpoint_Reference, expressed in units of the Controlled_Variable_Units property.

12.17.18 Action

This property, of type BACnetAction, defines whether the loop is DIRECT or REVERSE acting.

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12.17.19 Proportional_Constant

This property, of type REAL, is the value of the proportional gain parameter used by the loop algorithm. It may be used to represent any of the various forms of gain for the proportional control mode, such as overall gain, throttling range, or proportional band. If either the Proportional_Constant property or the Proportional_Constant_Units property are present, then both of these properties shall be present.

12.17.20 Proportional_Constant_Units

This property, of type BACnetEngineeringUnits, indicates the engineering units of the Proportional_Constant property of this object. If either the Proportional_Constant_Units property or the Proportional_Constant property are present, then both of these properties shall be present.

12.17.21 Integral_Constant

This property, of type REAL, is the value of the integral gain parameter used by the loop algorithm. It may be used to represent any of the various forms of gain for the integral control mode, such as reset time or rate. If either the Integral_Constant property or the Proportional_Constant_Units property are present, then both of these properties shall be present.

12.17.22 Integral_Constant_Units

This property, of type BACnetEngineeringUnits, indicates the engineering units of the Integral_Constant property of this object. If either the Integral_Constant_Units property or the Proportional_Constant property are present, then both of these properties shall be present.

12.17.23 Derivative_Constant

This property, of type REAL, is the value of the derivative gain parameter used by the loop algorithm. It may be used to represent any of the various forms of gain for the derivative control mode, such as derivative time or rate time. If either the Derivative_Constant property or the Derivative_Constant_Units property are present, then both of these properties shall be present.

12.17.24 Derivative_Constant_Units

This property, of type BACnetEngineeringUnits, indicates the engineering units of the Derivative_Constant property of this object. If either the Derivative_Constant_Units property or the Derivative_Constant property are present, then both of these properties shall be present.

12.17.25 Bias

This property, of type REAL, is the bias value used by the loop algorithm expressed in units of the Output_Units property.

12.17.26 Maximum_Output

This property, of type REAL, is the maximum value of the Present_Value property as limited by the PID loop algorithm. It is normally used to prevent the algorithm from controlling beyond the range of the controlled device and to prevent integral term "windup."

12.17.27 Minimum_Output

This property, of type REAL, is the minimum value of the Present_Value property as limited by the loop algorithm. It is normally used to prevent the algorithm from controlling beyond the range of the controlled device and to prevent integral term "windup."

12.17.28 Priority_For_Writing

Loop objects may be used to control the commandable property of an object. This property, of type Unsigned, provides a priority to be used by the command prioritization mechanism. It identifies the particular priority slot in the Priority_Array of the Manipulated_Variable_Reference that is controlled by this loop. It shall have a value in the range 1-16.

12.17.29 COV_Increment

This property, of type REAL, shall specify the minimum change in Present_Value that will cause a COVNotification to be issued to subscriber COV-clients. This property is required if COV reporting is supported by this object.

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12.17.30 Time_Delay

This property, of type Unsigned, shall specify the minimum period of time in seconds that the difference between the Setpoint and the Controlled_Variable_Value (the Error) must remain outside the band defined by the Error_Limit property before a TO-OFFNORMAL event is generated or within the same band before a TO-NORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.17.31 Notification_Class

This property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.17.32 Error_Limit

This property, of type REAL, shall convey the absolute magnitude that the difference between the Setpoint and Controlled_Variable_Value (the Error) must exceed before a TO-OFFNORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

The Loop object shall not generate a TO-OFFNORMAL transition from the LOW_LIMIT or HIGH_LIMIT state. When transitioning from LOW_LIMIT to HIGH_LIMIT, or HIGH_LIMIT to LOW_LIMIT, the object shall first transition to the NORMAL state.

12.17.32.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Error must exceed the Error_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the TO-OFFNORMAL flag must be set in the Event_Enable property,

where Error is defined as AbsoluteValue(Setpoint — Controlled_Variable_Value). From the perspective of the FLOATING_LIMIT algorithm, the limits are calculated as:

High_Diff_Limit = Error_Limit
Low_Diff_Limit = Error_Limit

12.17.32.2 Conditions for Generating a TO-NORMAL Event

Once the Error_Limit has been exceeded, a TO-NORMAL event is generated under these conditions:

(a) the Error must fall below the Error_Limit minus the Deadband for a minimum period of time, specified in the Time_Delay property, and
(b) the TO-NORMAL flag must be set in the Event_Enable property,

where Error is defined as AbsoluteValue(Setpoint — Controlled_Variable_Value).

12.17.33 Deadband

This property, of type REAL, shall specify a positive offset from the Error_Limit property, which defines a band around the SignedError (the difference between the Setpoint and the Controlled_Variable_Value properties) within the range of (Error_Limit — Deadband) and ((—Error_Limit)+Deadband).The SignedError must remain within this range for a TO-NORMAL event to be generated under these conditions :

(a) the SignedError must fall below the Error_Limit minus Deadband,
(b) the SignedError must exceed the —Error_Limit plus the Deadband,
(c) the SignedError must remain within this range for a minimum period of time, specified in the Time_Delay property, and
(d) the TO-NORMAL flag must be set in the Event_Enable property.

This property is required if intrinsic reporting is supported by this object.

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12.17.34 Event_Enable

This property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. This property is required if intrinsic reporting is supported by this object.

12.17.35 Acked_Transitions

This property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

12.17.36 Notify_Type

This property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.17.37 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.17.38 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.17.39 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.18 Multi-state Input Object Type

The Multi-state Input object type defines a standardized object whose Present_Value represents the result of an algorithmic process within the BACnet Device in which the object resides. The algorithmic process itself is a local matter and is not defined by the protocol. For example, the Present_Value or state of the Multi-state Input object may be the result of a logical combination of multiple binary inputs or the threshold of one or more analog inputs or the result of a mathematical computation. The Present_Value property is an integer number representing the state. The State_Text property associates a description with each state. The Multi-state Input object type and its properties are summarized in Table 12-21 and described in detail in this subclause.

NOTE: Do not confuse the Present_Value state with the Event_State property, which reflects the offnormal state of the Multi-state Input.

Table 12-21. Properties of the Multi-state Input Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Present_Value	Unsigned	R[1]
Description	CharacterString	O
Device_Type	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	O[2]
Out_Of_Service	BOOLEAN	R
Number_Of_States	Unsigned	R
State_Text	BACnetARRAY[N] of CharacterString	O
Time_Delay	Unsigned	O[3]
Notification_Class	Unsigned	O[3]
Alarm_Values	List of Unsigned	O[3]
Fault_Values	List of Unsigned	O[3]
Event_Enable	BACnetEventTransitionBits	O[3]
Acked_Transitions	BACnetEventTransitionBits	O[3]
Notify_Type	BACnetNotifyType	O[3]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[3]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[4]
Profile_Name	CharacterString	O

[1] This property is required to be writable when Out_Of_Service is TRUE.
[2] This property is required if Fault_Values is present.
[3] These properties are required if the object supports intrinsic reporting.
[4] This property, if present, is required to be read only.

12.18.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.18.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.18.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be MULTISTATE_INPUT.

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12.18.4 Present_Value

This property, of type Unsigned, reflects the logical state of the input. The logical state of the input shall be one of 'n' states, where 'n' is the number of states defined in the Number_Of_States property. The means used to determine the current state is a local matter. The Present_Value property shall always have a value greater than zero. The Present_Value property shall be writable when Out_Of_Service is TRUE. Any local modification to the value of the Present_Value when the Number_Of_States property is changed is a local matter.

12.18.5 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.18.6 Device_Type

This property, of type CharacterString, is a text description of the multi-state input. It will typically be used to describe the type of device attached to the multi-state input.

12.18.7 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of the multi-state input. Three of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM — Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT — Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN — Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value and Reliability properties are no longer tracking changes to the physical input. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE — Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0).

12.18.8 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then:

(a) if the Reliability property is not present, then the value of Event_State shall be NORMAL, or
(b) if the Reliability property is present and Reliability is NO_FAULT_DETECTED then Event_State shall be NORMAL, or
(c) If the Reliability property is present and Reliability is not NO_FAULT_DETECTED then Event_State shall be FAULT.

12.18.9 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the Present_Value or the operation of the physical inputs in question are "reliable" as far as the BACnet Device or operator can determine and, if not, why. The Reliability property is required to be present if the Fault_Values property is present. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, NO_SENSOR, OVER_RANGE, UNDER_RANGE, OPEN_LOOP, SHORTED_LOOP, MULTI_STATE_FAULT, , COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

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12.18.9.1 Conditions for Generating a TO-FAULT Event

A TO-FAULT event is generated under these conditions:

(a) the Reliability property becomes not equal to NO_FAULT_DETECTED, and
(b) the TO-FAULT flag must be enabled in the Event_Enable property.

12.18.10 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the inputs the object represents are not in service. This means that the Present_Value property is decoupled from the input and will not track changes to the input when the value of Out_Of_Service is TRUE. In addition, the Reliability property and the corresponding state of the FAULT flag of the Status_Flags property shall be decoupled from the input when Out_Of_Service is TRUE. While the Out_Of_Service property is TRUE, the Present_Value and Reliability properties may be changed to any value as a means of simulating specific fixed conditions or for testing purposes. Other functions that depend on the state of the Present_Value or Reliability properties shall respond to changes made to these properties while Out_Of_Service is TRUE, as if those changes had occurred in the input.

12.18.11 Number_Of_States

This property, of type Unsigned, defines the number of states that the Present_Value may have. The Number_Of_States property shall always have a value greater than zero. If the value of this property is changed, the size of the State_Text array, if present, shall also be changed to the same value.

12.18.12 State_Text

This property is a BACnetARRAY of character strings representing descriptions of all possible states of the Present_Value. The number of descriptions matches the number of states defined in the Number_Of_States property. The Present_Value, interpreted as an integer, serves as an index into the array. If the size of this array is changed, the Number_Of_States property shall also be changed to the same value.

12.18.13 Time_Delay

This optional property, of type Unsigned, shall specify the minimum period of time in seconds that the Present_Value must remain equal to any one of the values in the Alarm_Values property before a TO-OFFNORMAL event is generated or remain not equal to any of the values in the Alarm_Values property before a TO-NORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.18.14 Notification_Class

This property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.18.15 Alarm_Values

This property, of type List of Unsigned, shall specify any states the Present_Value must equal before a TO-OFFNORMAL event is generated. This property is required if intrinsic reporting is supported by this object. Any local modification to the values of Alarm_Values when the Number_Of_States property is changed is a local matter.

12.18.15.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value property must equal at least one of the values in the Alarm_Values list, and
(b) the Present_Value must remain equal to the same value for a minimum period of time, specified in the Time_Delay property, and
(c) the TO-OFFNORMAL flag must be enabled in the Event_Enable property.

12.18.15.2 Conditions for Generating a TO-NORMAL Event

Once equal, the Present_Value must become not equal to any of the states in this property and not equal to any of the states in the Fault_Values property before a TO-NORMAL event is generated under these conditions:

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(a) the Present_Value must remain not equal to any of the values in the Alarm_Values list for a minimum period of time, specified in the Time_Delay property, and
(b) the Present_Value must remain not equal to any of the states in the Fault_Values property, and
(c) the TO-NORMAL flag must be enabled in the Event_Enable property.

12.18.16 Fault_Values

This optional property, of type List of Unsigned, shall specify any states the Present_Value must equal before a TO-FAULT event is generated. If Present_Value becomes equal to any of the states in the Fault_Values list, and no physical fault has been detected for any inputs that the Present_Value represents, then the Reliability property shall have the value MULTI_STATE_FAULT. The Fault_Values property is required if intrinsic reporting is supported by this object. Any local modification to the values of Fault_Values when the Number_Of_States property is changed is a local matter.

12.18.17 Event_Enable

This property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. This property is required if intrinsic reporting is supported by this object.

12.18.18 Acked_Transitions

This property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

12.18.19 Notify_Type

This property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.18.20 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.18.21 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.18.22 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

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A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.19 Multi-state Output Object Type

The Multi-state Output object type defines a standardized object whose properties represent the desired state of one or more physical outputs or processes within the BACnet Device in which the object resides. The actual functions associated with a specific state are a local matter and not specified by the protocol. For example, a particular state may represent the active/inactive condition of several physical outputs or perhaps the value of an analog output. The Present_Value property is an unsigned integer number representing the state. The State_Text property associates a description with each state.

The Multi-state Output object type and its properties are summarized in Table 12-22 and described in detail in this subclause.

Table 12-22. Properties of the Multi-state Output Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Present_Value	Unsigned	W
Description	CharacterString	O
Device_Type	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	R
Number_Of_States	Unsigned	R
State_Text	BACnetARRAY[N]of CharacterString	O
Priority_Array	BACnetPriorityArray	R
Relinquish_Default	Unsigned	R
Time_Delay	Unsigned	O[1]
Notification_Class	Unsigned	O[1]
Feedback_Value	Unsigned	O[1]
Event_Enable	BACnetEventTransitionBits	O[1]
Acked_Transitions	BACnetEventTransitionBits	O[1]
Notify_Type	BACnetNotifyType	O[1]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[1]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[2]
Profile_Name	CharacterString	O

[1] These properties are required if the object supports intrinsic reporting.
[2] This property, if present, is required to be read only.

12.19.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.19.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.19.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be MULTISTATE_OUTPUT.

12.19.4 Present_Value (Commandable)

This property, of type Unsigned, reflects the logical state of an output. The logical state of the output shall be one of 'n' states, where 'n' is the number of states defined in the Number_Of_States property. How the Present_Value is used is a local matter. Any local modification to the value of the Present_Value when the Number_Of_States property is changed is a local matter. The Present_Value property shall always have a value greater than zero.

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12.19.5 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.19.6 Device_Type

This property, of type CharacterString, is a text description of the physical device connected to the multi-state output. It will typically be used to describe the type of device attached to the multi-state output.

12.19.7 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of the multi-state output. Three of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the physical output is no longer tracking changes to the Present_Value property and the Reliability property is no longer a reflection of the physical output. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0).

12.19.8 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL.

12.19.9 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the Present_Value or the operation of the physical outputs in question are "reliable" as far as the BACnet Device or operator can determine and, if not, why. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, OPEN_LOOP, SHORTED_LOOP, NO_OUTPUT, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.19.10 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the output or process the object represents is not in service. This means that changes to the Present_Value property are decoupled from the output when the value of Out_Of_Service is TRUE. In addition, the Reliability property and the corresponding state of the FAULT flag of the Status_Flags property shall be decoupled when Out_Of_Service is TRUE. While the Out_Of_Service property is TRUE, the Present_Value and Reliability properties may still be changed to any value as a means of simulating specific fixed conditions or for testing purposes. Other functions that depend on the state of the Present_Value or Reliability properties shall respond to changes made to these properties while Out_Of_Service is TRUE, as if those changes had occurred to the output. The Present_Value property shall still be controlled by the BACnet command prioritization mechanism if Out_Of_Service is TRUE. See Clause 19.

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12.19.11 Number_Of_States

This property, of type Unsigned, defines the number of states the Present_Value may have. The Number_Of_States property shall always have a value greater than zero**.** If the value of this property is changed, the size of the State_Text array, if present, shall also be changed to the same value.

12.19.12 State_Text

This property is a BACnetARRAY of character strings representing descriptions of all possible states of the Present_Value. The number of descriptions matches the number of states defined in the Number_Of_States property. The Present_Value, interpreted as an integer, serves as an index into the array. If the size of this array is changed, the Number_Of_States property shall also be changed to the same value.

12.19.13 Priority_Array

This property is a read-only array that contains prioritized commands that are in effect for this object. See Clause 19 for a description of the prioritization mechanism. Any local modification to the values in the Priority_Array when the Number_Of_States property is changed is a local matter.

12.19.14 Relinquish_Default

This property is the default value to be used for the Present_Value property when all command priority values in the Priority_Array have a NULL value. See Clause 19. Any local modification to the value of the Relinquish_Default when the Number_Of_States property is changed is a local matter.

12.19.15 Time_Delay

This property, of type Unsigned, shall specify the minimum period of time in seconds that the Present_Value must be different from the Feedback_Value property before a TO-OFFNORMAL event is generated or remain equal to the Feedback_Value property before a TO-NORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.19.16 Notification_Class

This property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.19.17 Feedback_Value

This property, of type Unsigned, shall indicate the status of a feedback value from which the Present_Value must differ before a TO-OFFNORMAL event is generated. This property is required if intrinsic reporting is supported by this object. The manner by which the Feedback_Value is determined shall be a local matter.

12.19.17.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must be different from the Feedback_Value for a minimum period of time, specified by the Time_Delay property, and
(b) the TO-OFFNORMAL flag must be enabled in the Event_Enable property.

12.19.17.2 Conditions for Generating a TO-NORMAL Event

Once different, the Present_Value must become equal to this property before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must remain equal to the Feedback_Value for a minimum period of time, specified by the Time_Delay property, and
(b) the TO-NORMAL flag must be enabled in the Event_Enable property.

12.19.18 Event_Enable

This property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. This property is required if intrinsic reporting is supported by this object.

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12.19.19 Acked_Transitions

This property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

12.19.20 Notify_Type

This property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.19.21 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.19.22 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.19.23 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.20 Multi-state Value Object Type

The Multi-state Value object type defines a standardized object whose properties represent the externally visible characteristics of a multi-state value. A "multi-state value" is a control system parameter residing in the memory of the BACnet Device. The actual functions associated with a specific state are a local matter and not specified by the protocol. For example, a particular state may represent the active/inactive condition of several physical inputs and outputs or perhaps the value of an analog input or output. The Present_Value property is an unsigned integer number representing the state. The State_Text property associates a description with each state.

The Multi-state Value object type and its properties are summarized in Table 12-23 and described in detail in this subclause.

NOTE: Do not confuse the Present_Value state with the Event_State property, which reflects the offnormal state of the Multi-state Value.

Table 12-23. Properties of the Multi-state Value Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Present_Value	Unsigned	R[1]
Description	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	O[2]
Out_Of_Service	BOOLEAN	R
Number_Of_States	Unsigned	R
State_Text	BACnetARRAY[N] of CharacterString	O
Priority_Array	BACnetPriorityArray	O[3]
Relinquish_Default	Unsigned	O[3]
Time_Delay	Unsigned	O[4]
Notification_Class	Unsigned	O[4]
Alarm_Values	List of Unsigned	O[4]
Fault_Values	List of Unsigned	O[4]
Event_Enable	BACnetEventTransitionBits	O[4]
Acked_Transitions	BACnetEventTransitionBits	O[4]
Notify_Type	BACnetNotifyType	O[4]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[4]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[5]
Profile_Name	CharacterString	O

[1] If Present_Value is commandable, then it is required to also be writable. This property is required to be writable when Out_Of_Service is TRUE.
[2] This property is required if Fault_Values is present.
[3] If Present_Value is commandable, then both of these properties shall be present.
[4] These properties are required if the object supports intrinsic reporting.
[5] This property, if present, is required to be read only.

12.20.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

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12.20.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.20.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be MULTISTATE_VALUE.

12.20.4 Present_Value

This property, of type Unsigned, reflects the logical state of the multi-state value. The logical state of the multi-state value shall be one of 'n' states, where 'n' is the number of states defined in the Number_Of_States property. How the Present_Value is used is a local matter. The Present_Value property shall always have a value greater than zero. Present_Value shall be optionally commandable. If Present_Value is commandable for a given object instance, then the Priority_Array and Relinquish_Default properties shall also be present for that instance. The Present_Value property shall be writable when Out_Of_Service is TRUE. Any local modification to the value of the Present_Value when the Number_Of_States property is changed is a local matter.

12.20.5 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.20.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of the multi-state value. Three of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM — Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT — Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN — Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the physical output is no longer tracking changes to the Present_Value property and the Reliability property is no longer a reflection of the physical output. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE — Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0).

12.20.7 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting then:

(a) if the Reliability property is not present, then the value of Event_State shall be NORMAL, or
(b) if the Reliability property is present and Reliability is NO_FAULT_DETECTED then Event_State shall be NORMAL, or
(c) if the Reliability property is present and Reliability is not NO_FAULT_DETECTED then Event_State shall be FAULT.

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12.20.8 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the Present_Value is "reliable" as far as the BACnet Device or operator can determine and, if not, why. The Reliability property is required to be present if the Fault_Values property is present. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, MULTI_STATE_FAULT, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.20.8.1 Conditions for Generating a TO-FAULT Event

A TO-FAULT event is generated under these conditions:

(a) the Reliability property becomes not equal to NO_FAULT_DETECTED, and
(b) the TO-FAULT flag must be enabled in the Event_Enable property.

12.20.9 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the Present_Value property of the Multi-state Value object is prevented from being modified by software local to the BACnet device in which the object resides. When Out_Of_Service is TRUE the Present_Value property may still be written to freely. In addition, the Reliability property and the corresponding state of the FAULT flag of the Status_Flags property shall be decoupled when Out_Of_Service is TRUE. While the Out_Of_Service property is TRUE, the Present_Value and Reliability properties may be changed to any value as a means of simulating specific fixed conditions or for testing purposes. Other functions that depend on the state of the Present_Value or Reliability properties shall respond to changes made to these properties while Out_Of_Service is TRUE. If the Priority_Array and Relinquish_Default properties are present, then writing to the Present_Value property shall be controlled by the BACnet command prioritization mechanism. See Clause 19.

12.20.10 Number_Of_States

This property, of type Unsigned, defines the number of states the Present_Value may have. The Number_Of_States property shall always have a value greater than zero. If the value of this property is changed, the size of the State_Text array, if present, shall also be changed to the same value.

12.20.11 State_Text

This property is a BACnetARRAY of character strings representing descriptions of all possible states of the Present_Value. The number of descriptions matches the number of states defined in the Number_Of_States property. The Present_Value, interpreted as an integer, serves as an index into the array. If the size of this array is changed, the Number_Of_States property shall also be changed to the same value.

12.20.12 Priority_Array

This property is a read-only array that contains prioritized commands that are in effect for this object. See Clause 19 for a description of the prioritization mechanism. If either the Priority_Array property or the Relinquish_Default property are present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present. Any local modification of the values in the Priority_Array when the Number_Of_States property is changed is a local matter.

12.20.13 Relinquish_Default

This property is the default value to be used for the Present_Value property when all command priority values in the Priority_Array property have a NULL value. See Clause 19. If either the Relinquish_Default property or the Priority_Array property are present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present. Any local modification to the value of the Relinquish_Default when the Number_Of_States property is changed is a local matter.

12.20.14 Time_Delay

This property, of type Unsigned, shall specify the minimum period of time in seconds that the Present_Value must remain:

(a) equal to any one of the values in the Alarm_Values property before a TO-OFFNORMAL event is generated, or
(b) not equal to any of the values in the Alarm_Values property before a TO-NORMAL event is generated.

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This property is required if intrinsic reporting is supported by this object.

12.20.15 Notification_Class

This property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.20.16 Alarm_Values

This property, of type List of Unsigned, shall specify any states the Present_Value must equal before a TO-OFFNORMAL event is generated. This property is required if intrinsic reporting is supported by this object. Any local modification to the values in Alarm_Values when the Number_Of_States property is changed is a local matter.

12.20.16.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must equal at least one of the values in the Alarm_Values list, and
(b) the Present_Value must remain equal to the same value for a minimum period of time, specified by the Time_Delay property, and
(c) the TO-OFFNORMAL flag must be enabled in the Event_Enable property.

12.20.16.2 Conditions for Generating a TO-NORMAL Event

Once equal, the Present_Value must become not equal to any of the states in this property and not equal to any of the states in the Fault_Values property before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must remain not equal to any of the states in the Alarm_Values property for a minimum period of time, specified by the Time_Delay property, and
(b) the Present_Value must remain not equal to any of the states in the Fault_Values property, and
(c) the TO-NORMAL flag must be enabled in the Event_Enable property.

12.20.17 Fault_Values

This property, of type List of Unsigned, shall specify any states the Present_Value must equal before a TO-FAULT event is generated. If Present_Value becomes equal to any of the states in the Fault_Values list, and no physical fault has been detected for any inputs or outputs that the Present_Value represents, then the Reliability property shall have the value MULTI_STATE_FAULT. The Fault_Values property is required if intrinsic reporting is supported by this object. Any local modification to the values in Fault_Values when the Number_Of_States property is changed is a local matter.

12.20.18 Event_Enable

This property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. This property is required if intrinsic reporting is supported by this object.

12.20.19 Acked_Transitions

This property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

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12.20.20 Notify_Type

This property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.20.21 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.20.22 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.20.23 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.21 Notification Class Object Type

The Notification Class object type defines a standardized object that represents and contains information required for the distribution of event notifications within BACnet systems. Notification Classes are useful for event-initiating objects that have identical needs in terms of how their notifications should be handled, what the destination(s) for their notifications should be, and how they should be acknowledged.

A notification class defines how event notifications shall be prioritized in their handling according to TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events; whether these categories of events require acknowledgment (nearly always by a human operator); and what destination devices or processes should receive notifications.

The purpose of prioritization is to provide a means to ensure that alarms or event notifications with critical time considerations are not unnecessarily delayed. The possible range of priorities is 0 - 255. A lower number indicates a higher priority. The priority and the Network Priority (Clause 6.2.2) are associated as defined in Table 13-5. Priorities may be assigned to TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events individually within a notification class.

The purpose of acknowledgment is to provide assurance that a notification has been acted upon by some other agent, rather than simply having been received correctly by another device. In most cases, acknowledgments come from human operators. TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events may, or may not, require individual acknowledgment within a notification class.

It is often necessary for event notifications to be sent to multiple destinations or to different destinations based on the time of day or day of week. Notification Classes may specify a list of destinations, each of which is qualified by time, day of week, and type of handling. A destination specifies a set of days of the week (Monday through Sunday) during which the destination is considered viable by the Notification Class object. In addition, each destination has a FromTime and ToTime, which specify a window using specific times, on those days of the week, during which the destination is viable. If an event that uses a Notification Class object occurs and the day is one of the days of the week that is valid for a given destination and the time is within the window specified in the destination, then the destination shall be sent a notification. Destinations may be further qualified, as applicable, by any combination of the three event transitions TO-OFFNORMAL, TO-FAULT, or TO-NORMAL.

The destination also defines the recipient device to receive the notification and a process within the device. Processes are identified by numeric handles that are only meaningful to the destination device. The administration of these handles is a local matter. The recipient device may be specified by either its unique Device Object_Identifier or its BACnetAddress. In the latter case, a specific node address, a multicast address, or a broadcast address may be used. The destination further specifies whether the notification shall be sent using a confirmed or unconfirmed event notification.

The Notification Class object and its properties are summarized in Table 12-24 and described in detail in this subclause.

Table 12-24. Properties of the Notification Class Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Notification_Class	Unsigned	R
Priority	BACnetARRAY[3] of Unsigned	R
Ack_Required	BACnetEventTransitionBits	R
Recipient_List	List of BACnetDestination	R
Profile_Name	CharacterString	O

12.21.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it**.**

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12.21.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.21.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be NOTIFICATION_CLASS.

12.21.4 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.21.5 Notification_Class

This property, of type Unsigned, shall indicate the numeric value of this notification class and shall be equal to the instance number of the Notification Class object. Event-initiating objects shall use this number to refer to this Notification Class object indirectly.

12.21.6 Priority

This property, of type BACnetARRAY[3] of Unsigned, shall convey the priority to be used for event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. Priorities shall range from 0 - 255 inclusive. A lower number indicates a higher priority. The priority and the Network Priority (see 6.2.2) are associated as defined in Table 13-5.

12.21.7 Ack_Required

This property, of type BACnetEventTransitionBits, shall convey three separate flags that represent whether acknowledgment shall be required in notifications generated for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL event transitions, respectively.

12.21.8 Recipient_List

This property, of type List of BACnetDestination, shall convey a list of one or more recipient destinations to which notifications shall be sent when event-initiating objects using this class detect the occurrence of an event. The destinations themselves define a structure of parameters that is summarized in Table 12-25.

Table 12-25. Components of a BACnetDestination

Parameter	Type	Description
Valid Days	BACnetDaysOfWeek	The set of days of the week on which this destination may be used between From Time and To Time
From Time, To Time	Time	The window of time (inclusive) during which the destination is viable on the days of the week specified by Valid Days. These values shall be specific times.
Recipient	BACnetRecipient	The destination device(s) to receive notifications
Process Identifier	Unsigned32	The handle of a process within the recipient device that is to receive the event notification
Issue Confirmed Notifications	Boolean	(TRUE) if confirmed notifications are to be sent and (FALSE) if unconfirmed notifications are to be sent
Transitions	BACnet Event Transition Bits	A set of three flags that indicate those transitions {TO-OFFNORMAL, TO-FAULT, TO-NORMAL} for which this recipient is suitable

12.21.9 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

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A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.22 Program Object Type

The Program object type defines a standardized object whose properties represent the externally visible characteristics of an application program. In this context, an application program is an abstract representation of a process within a BACnet Device, which is executing a particular body of instructions that act upon a particular collection of data structures. The logic that is embodied in these instructions and the form and content of these data structures are local matters.

The Program object provides a network-visible view of selected parameters of an application program in the form of properties of the Program object. Some of these properties are specified in the standard and exhibit a consistent behavior across different BACnet Devices. The operating state of the process that executes the application program may be viewed and controlled through these standardized properties, which are required for all Program objects. In addition to these standardized properties, a Program object may also provide vendor-specific properties. These vendor-specific properties may serve as inputs to the program, outputs from the program, or both. However, these vendor-specific properties may not be present at all. If any vendor-specific properties are present, the standard does not define what they are or how they work, as this is specific to the particular application program and vendor.

The Program object type and its standardized properties are summarized in Table 12-26 and described in detail in this subclause.

Table 12-26. Properties of the Program Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Program_State	BACnetProgramState	R
Program_Change	BACnetProgramRequest	W
Reason_For_Halt	BACnetProgramError	O[1]
Description_Of_Halt	CharacterString	O[1]
Program_Location	CharacterString	O
Description	CharacterString	O
Instance_Of	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	R
Profile_Name	CharacterString	O

[1] If one of the optional properties Reason_For_Halt or Description_Of_Halt is present, then both of these properties shall be present.

12.22.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.22.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.22.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object-type class. The value of this property shall be PROGRAM.

12.22.4 Program_State

This property, of type BACnetProgramState, reflects the current logical state of the process executing the application program this object represents. This property is Read-Only. The values that may be taken on by this property are:

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IDLE	process is not executing
LOADING	application program being loaded
RUNNING	process is currently executing
WAITING	process is waiting for some external event
HALTED	process is halted because of some error condition
UNLOADING	process has been requested to terminate

12.22.5 Program_Change

This property, of type BACnetProgramRequest, is used to request changes to the operating state of the process this object represents. The Program_Change property provides one means for changing the operating state of this process. The process may change its own state as a consequence of execution as well. The values that may be taken on by this property are:

READY	ready for change request (the normal state)
LOAD	request that the application program be loaded, if not already loaded
RUN	request that the process begin executing, if not already running
HALT	request that the process halt execution
RESTART	request that the process restart at its initialization point
UNLOAD	request that the process halt execution and unload

Normally the value of the Program_Change property will be READY, meaning that the program is ready to accept a new request to change its operating state. If the Program_Change property is not READY, then it may not be written to and any attempt to write to the property shall return a Result(-). If it has one of the other enumerated values, then a previous request to change state has not yet been honored, so new requests cannot be accepted. When the request to change state is finally honored, then the Program_Change property value shall become READY and the new state shall be reflected in the Program_State property. Depending on the current Program_State, certain requested values for Program_Change may be invalid and would also return a Result(-) if an attempt were made to write them. Figure 12-3 shows the valid state transitions and the resulting new Program_State.

It is important to note that program loading could be terminated either due to an error or a request to HALT that occurs during loading. In either case, it is possible to have Program_State=HALTED and yet not have a complete or operable program in place. In this case, a request to RESTART is taken to mean LOAD instead. If a complete program is loaded but HALTED for any reason, then RESTART simply reenters program execution at its initialization entry point.

There may be BACnet Devices that support Program objects but do not require "loading" of the application programs, as these applications may be built in. In these cases, loading is taken to mean "preparing for execution," the specifics of which are a local matter.

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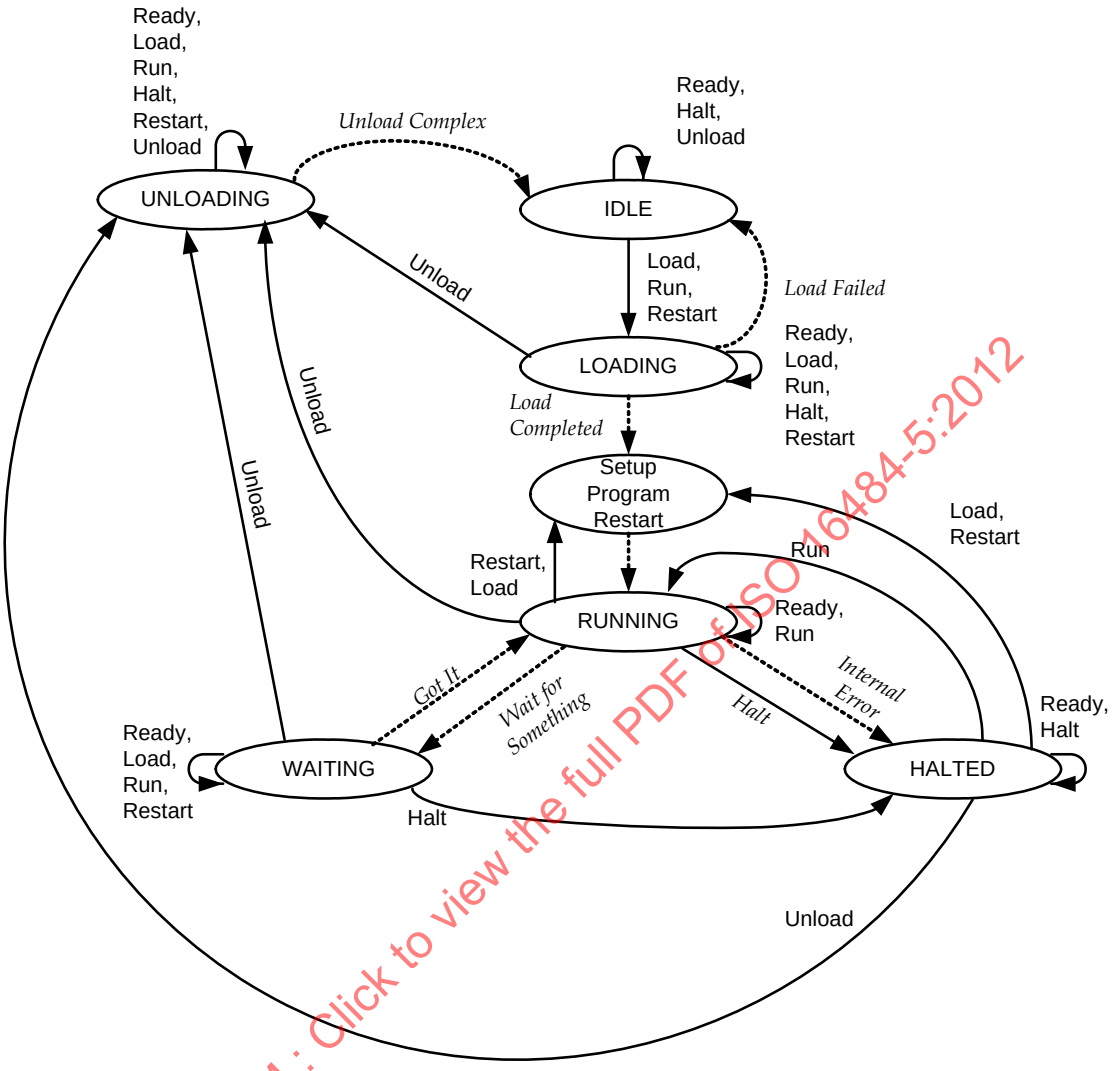

Figure 12-3. State Transitions for the program object.

12.22.6 Reason_For_Halt

If the process executing the application program this object represents encounters any type of error that causes process execution to be halted, then this property shall reflect the reason why the process was halted. The Reason_For_Halt property shall be an enumerated type called BACnetProgramError. The values that may be taken on by this property are:

NORMAL	process is not halted due to any error condition
LOAD_FAILED	the application program could not complete loading
INTERNAL	process is halted by some internal mechanism
PROGRAM	process is halted by Program_Change request
OTHER	process is halted for some other reason

If one of the optional properties Reason_For_Halt or Description_Of_Halt is present, then both of these properties shall be present.

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12.22.7 Description_Of_Halt

This property is a character string that may be used to describe the reason why a program has been halted. This property provides essentially the same information as the Reason_For_Halt property, except in a human-readable form. The content of this string is a local matter. If one of the optional properties Reason_For_Halt or Description_Of_Halt is present, then both of these properties shall be present.

12.22.8 Program_Location

This property is a character string that may be used by the application program to indicate its location within the program code, for example, a line number or program label or section name. The content of this string is a local matter.

12.22.9 Description

This property is a string of printable characters that may be used to describe the application being carried out by this process or other locally desired descriptive information.

12.22.10 Instance_Of

This property is a character string that is the local name of the application program being executed by this process. The content of this string is a local matter.

12.22.11 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of the program. Three of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM The value of this flag shall be logical FALSE (0).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the program has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that neither the Program_Change, Program_State nor any other program-specific property may be changed through BACnet services. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0).

12.22.12 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the application-specific properties of the program object or the process executing the application program are "reliable" as far as the BACnet Device can determine and, if not, why. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, PROCESS_ERROR, , COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.22.13 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the process this object represents is not in service. In this case, "in service" means that the application program is properly loaded and initialized, although the process may or may not be actually executing. If the Program_State property has the value IDLE, then Out_Of_Service shall be TRUE.

12.22.14 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a

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dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.23 Pulse Converter Object Type

The Pulse Converter object type defines a standardized object that represents a process whereby ongoing measurements made of some quantity, such as electric power or water or natural gas usage, and represented by pulses or counts, might be monitored over some time interval for applications such as peak load management, where it is necessary to make periodic measurements but where a precise accounting of every input pulse or count is not required.

The Pulse Converter object might represent a physical input. As an alternative, it might acquire the data from the Present_Value of an Accumulator object, representing an input in the same device as the Pulse Converter object. This linkage is illustrated by the dotted line in Figure 12-4. Every time the Present_Value property of the Accumulator object is incremented, the Count property of the Pulse Converter object is also incremented.

The Present_Value property of the Pulse Converter object can be adjusted at any time by writing to the Adjust_Value property, which causes the Count property to be adjusted, and the Present_Value recomputed from Count. In the illustration in Figure 12-4, the Count property of the Pulse Converter was adjusted down to 0 when the Total_Count of the Accumulator object had the value 0070.

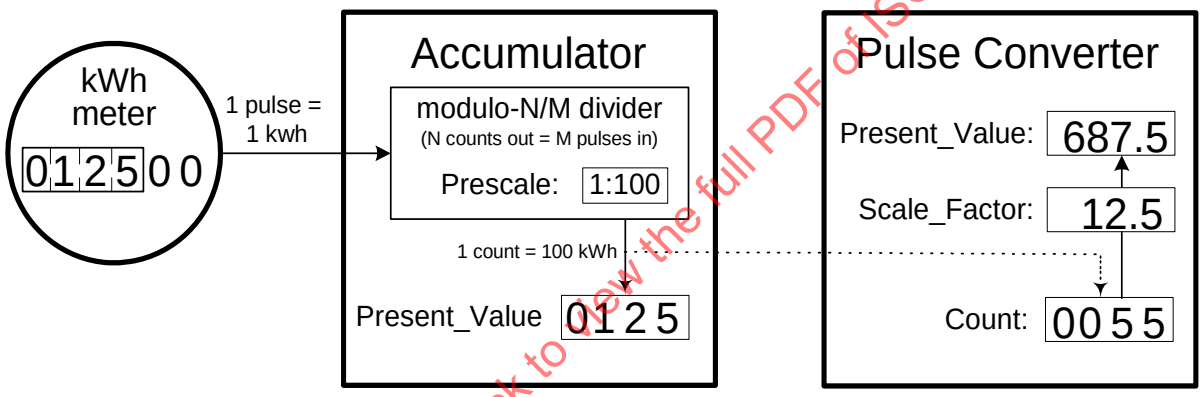

Figure 12-4. Relationship between the Pulse Converter and Accumulator objects.

The object and its properties are summarized in Table 12-27 and described in detail in this subclause.

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Table 12-27. Properties of the Pulse Converter Object

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Present_Value	REAL	R[1]
Input_Reference	BACnetObjectPropertyReference	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	R
Units	BACnetEngineeringUnits	R
Scale_Factor	REAL	R
Adjust_Value	REAL	W
Count	Unsigned	R
Update_Time	BACnetDateTime	R
Count_Change_Time	BACnetDateTime	R
Count_Before_Change	Unsigned	R
COV_Increment	REAL	O[2]
COV_Period	Unsigned	O[2]
Notification_Class	Unsigned	O[3]
Time_Delay	Unsigned	O[3]
High_Limit	REAL	O[3]
Low_Limit	REAL	O[3]
Deadband	REAL	O[3]
Limit_Enable	BACnetLimitEnable	O[3]
Event_Enable	BACnetEventTransitionBits	O[3]
Acked_Transitions	BACnetEventTransitionBits	O[3]
Notify_Type	BACnetNotifyType	O[3]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[3]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[4]
Profile_Name	CharacterString	O

[1] This property is required to be writable when Out_Of_Service is TRUE.
[2] These properties are required if the object supports COV reporting.
[3] These properties are required if the object supports intrinsic reporting.
[4] This property, if present, is required to be read only.

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12.23.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.23.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

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12.23.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be PULSE_CONVERTER.

12.23.4 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.23.5 Present_Value

This property, of type REAL, indicates the accumulated value of the input being measured. It is computed by multiplying the current value of the Count property by the value of the Scale_Factor property. The value of the Present_Value property may be adjusted by writing to the Adjust_Value property. The Present_Value property shall be writable when Out_Of_Service is TRUE.

12.23.6 Input_Reference

This optional property, of type BACnetObjectPropertyReference, indicates the object and property (typically an Accumulator object's Present_Value property) representing the actual physical input that is to be measured and presented by the Pulse Converter object. The referenced property should have a datatype of INTEGER or Unsigned.

If this property is not present, the Pulse Converter object directly represents the physical input.

12.23.7 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of a Pulse Converter. Three of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the program has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value, Count and Reliability properties are no longer tracking changes to the input. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0).

12.23.8 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting and if the Reliability property is not present, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT. Changes in the Event_State property to the value FAULT are considered to be "fault" events.

12.23.9 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the Present_Value and/or Count properties or the operation of the physical input in question is "reliable" as far as the BACnet Device or operator can determine and, if not, why. The Reliability property for this object type may have any of the following values:

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{NO_FAULT_DETECTED, NO_SENSOR, OVER_RANGE, UNDER_RANGE, OPEN_LOOP, SHORTED_LOOP, UNRELIABLE_OTHER, , COMMUNICATION_FAILURE, CONFIGURATION_ERROR}

If Input_Reference is configured to reference a property that is not of datatype Unsigned or INTEGER, or is otherwise not supported as an input source for this object, the Reliability property shall indicate CONFIGURATION_ERROR.

12.23.10 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the input that the object directly represents, if any, is not in service. ("Directly represents" means that the Input_Reference property is not present in this object.) The Present_Value property is decoupled from the Count property and will not track changes to the input when the value of Out_Of_Service is TRUE. In addition, the Reliability property and the corresponding state of the FAULT flag of the Status_Flags property shall be decoupled from the input when Out_Of_Service is TRUE. While the Out_Of_Service property is TRUE, the Present_Value and Reliability properties may be changed to any value as a means of simulating specific fixed conditions or for testing purposes. Other functions that depend on the state of the Present_Value or Reliability properties shall respond to changes made to these properties while Out_Of_Service is TRUE as if those changes had occurred in the input.

If the Input_Reference property is present, the state of the Out_Of_Service property of the object referenced by Input_Reference shall not be indicated by the Out_Of_Service property of the Pulse Converter object.

12.23.11 Units

This property, of type BACnetEngineeringUnits, indicates the measurement units of the Present_Value property. See the BACnetEngineeringUnits ASN.1 production in Clause 21 for a list of engineering units defined by this standard.

12.23.12 Scale_Factor

This property, of type REAL, provides the conversion factor for computing Present_Value. It represents the change in Present_Value resulting from changing the value of Count by one.

12.23.13 Adjust_Value

This property, of type REAL, is written to adjust the Present_Value property (and thus the Count property also) by the amount written to Adjust_Value.

The following series of operations shall be performed atomically when this property is written:

(1) The value written to Adjust_Value shall be stored in the Adjust_Value property.
(2) The value of Count shall be copied to the Count_Before_Change property.
(3) The value of Count shall be decremented by the value calculated by performing the integer division (Adjust_Value/Scale_Factor) and discarding the remainder.
(4) The current date and time shall be stored in the Count_Change_Time property.

A write to this property results in a change in the value of Present_Value. Whether the new value is computed as part of the atomic series of operations or when Present_Value is read is a local matter.

An attempt to write Adjust_Value with a value that would cause an overflow or underflow condition in Count shall result in a Result(-) to be returned with an error class of PROPERTY and an error code of VALUE_OUT_OF_RANGE.

If Adjust_Value has never been written, it shall have a value of zero.

12.23.14 Count

This read-only property, of type Unsigned, indicates the count of the input pulses as acquired from the physical input or the property referenced by the Input_Reference property.

If the property referenced by Input_Reference property is present, has datatype Unsigned or INTEGER, and is supported as an input source for this object, the value of the Count property is derived from the referenced property. An increment by one count in the referenced property is reflected by an increment of one count in the Count property. The means by which this is

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done shall be a local matter. Because the value of the Pulse Converter object Count property may be changed by a write to the Adjust_Value property, the value of the Count property can be different from the value of the referenced property.

12.23.15 Update_Time

This read-only property, of type BACnetDateTime, reflects the date and time of the most recent change to the Count property as a result of input pulse accumulation and is updated atomically with the Count property.

12.23.16 Count_Change_Time

This read-only property, of type BACnetDateTime, represents the date and time of the most recent occurrence of a write to the Adjust_Value property.

12.23.17 Count_Before_Change

This property, of type Unsigned, indicates the value of the Count property just prior to the most recent write to the Adjust_Value properties. If no such write has yet occurred, this property shall have the value zero.

12.23.18 COV_Increment

This property, of type REAL, shall specify the minimum change in Present_Value that will cause a COV notification to be issued to subscriber COV-clients. This property is required if COV reporting is supported by this object.

12.23.19 COV_Period

The COV_Period property, of type Unsigned, shall indicate the amount of time in seconds between the periodic COV notifications performed by this object. This property is required if COV reporting is supported by this object. See Clause 13.1.

12.23.20 Notification_Class

This property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.23.21 Time_Delay

This property, of type Unsigned, shall specify the minimum period of time in seconds that the Present_Value must remain outside the band defined by the High_Limit and Low_Limit properties before a TO-OFFNORMAL event is generated or remain within the same band, including the Deadband property, before a TO-NORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.23.22 High_Limit

This property, of type REAL, shall specify a limit that the Present_Value must exceed before an event is generated. This property is required if intrinsic reporting is supported by this object.

12.23.22.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must exceed the High_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the HighLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-OFFNORMAL flag must be set in the Event_Enable property, and
(d) the Event_State must not be equal to LOW_LIMIT.

The Pulse Converter object shall not generate a TO-OFFNORMAL transition from the LOW_LIMIT or HIGH_LIMIT state. When transitioning from LOW_LIMIT to HIGH_LIMIT, the object shall first transition to the NORMAL state.

12.23.22.2 Conditions for Generating a TO-NORMAL Event

Once exceeded, the Present_Value must fall below the High_Limit minus the Deadband before a TO-NORMAL event is generated under these conditions:

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(a) the Present_Value must fall below the High_Limit minus the Deadband for a minimum period of time, specified in the Time_Delay property, and
(b) the HighLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-NORMAL flag must be set in the Event_Enable property.

12.23.23 Low_Limit

This property, of type REAL, shall specify a limit below which the Present_Value must fall before an event is generated. This property is required if intrinsic reporting is supported by this object.

12.23.23.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:
(a) the Present_Value must fall below the Low_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the LowLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-OFFNORMAL flag must be set in the Event_Enable property, and
(d) the Event_State must not be equal to HIGH_LIMIT.

The Pulse Converter object shall not generate a TO-OFFNORMAL transition from the LOW_LIMIT or HIGH_LIMIT state. When transitioning from HIGH_LIMIT to LOW_LIMIT, the object shall first transition to the NORMAL state.

12.23.23.2 Conditions for Generating a TO-NORMAL Event

Once the Present_Value has fallen below the Low_Limit, the Present_Value must exceed the Low_Limit plus the Deadband before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must exceed the Low_Limit plus the Deadband for a minimum period of time, specified in the Time_Delay property, and
(b) the LowLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-NORMAL flag must be set in the Event_Enable property.

12.23.24 Deadband

This property, of type REAL, shall specify a range between the High_Limit and Low_Limit properties, which the Present_Value must remain within for a TO-NORMAL event to be generated under these conditions:

(a) the Present_Value must fall below the High_Limit minus Deadband, and
(b) the Present_Value must exceed the Low_Limit plus the Deadband, and
(c) the Present_Value must remain within this range for a minimum period of time, specified in the Time_Delay property, and
(d) either the HighLimitEnable or LowLimitEnable flag must be set in the Limit_Enable property, and
(e) the TO-NORMAL flag must be set in the Event_Enable property

This property is required if intrinsic reporting is supported by this object.

12.23.25 Limit_Enable

This property, of type BACnetLimitEnable, shall convey two flags that separately enable and disable reporting of high limit and low limit offnormal events and their return to normal. This property is required if intrinsic reporting is supported by this object.

12.23.26 Event_Enable

This property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. In the context of Pulse Converter objects, transitions to the High_Limit or Low_Limit Event_States are considered to be "offnormal" events. This property is required if intrinsic reporting is supported by this object.

12.23.27 Acked_Transitions

This property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgements for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. In the context of Pulse Converter

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objects, transitions to High_Limit and Low_Limit Event_State are considered to be "offnormal" events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgement;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgement is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgement is expected).

This property is required if intrinsic reporting is supported by this object.

12.23.28 Notify_Type

This property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.23.29 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.23.30 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.23.31 Profile_Name

This property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.24 Schedule Object Type

The Schedule object type defines a standardized object used to describe a periodic schedule that may recur during a range of dates, with optional exceptions at arbitrary times on arbitrary dates. The Schedule object also serves as a binding between these scheduled times and the writing of specified "values" to specific properties of specific objects at those times. The Schedule object type and its properties are summarized in Table 12-28 and described in detail in this subclause.

Schedules are divided into days, of which there are two types: normal days within a week and exception days. Both types of days can specify scheduling events for either the full day or portions of a day, and a priority mechanism defines which scheduled event is in control at any given time.

The current state of the Schedule object is represented by the value of its Present_Value property, which is normally calculated using the time/value pairs from the Weekly_Schedule and Exception_Schedule properties, with a default value for use when no schedules are in effect. Details of this calculation are provided in the description of the Present_Value property.

Versions of the Schedule object prior to Protocol_Revision 4 only support schedules that define an entire day, from midnight to midnight. For compatibility with these versions, this whole day behavior can be achieved by using a specific schedule format. Weekly_Schedule and Exception_Schedule values that begin at 00:00, and do not use any NULL values, will define schedules for the entire day. Property values in this format will produce the same results in all versions of the Schedule object.

Table 12-28. Properties of the Schedule Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Present_Value	Any	R
Description	CharacterString	O
Effective_Period	BACnetDateRange	R
Weekly_Schedule	BACnetARRAY[7]of BACnetDailySchedule	O[1]
Exception_Schedule	BACnetARRAY[N]of BACnetSpecialEvent	O[1]
Schedule_Default	Any	R
List_Of_Object_Property_References	List of BACnetDeviceObjectPropertyReference	R
Priority_For_Writing	Unsigned(1..16)	R
Status_Flags	BACnetStatusFlags	R
Reliability	BACnetReliability	R
Out_Of_Service	BOOLEAN	R
Profile_Name	CharacterString	O

[1] At least one of these properties is required.

12.24.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.24.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.24.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object-type class. The value of this property shall be SCHEDULE.

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12.24.4 Present_Value

This property indicates the current value of the schedule, which may be any primitive datatype. As a result, most analog, binary, and enumerated values may be scheduled. This property shall be writable when Out_Of_Service is TRUE (see 12.24.14).

Any change in the value of this property shall be written to all members of the List_Of_Object_Property_References property. An error writing to any member of the list shall not stop the Schedule object from writing to the remaining members.

The normal calculation of the value of the Present_Value property is illustrated as follows (the actual algorithm used is a local matter but must yield the same results as this one):

1. Find the highest relative priority (as defined by Clause 12.24.8) Exception_Schedule array element that is in effect for the current day and whose current value (see method below) is not NULL, and assign that value to the Present_Value property.
2. If the Present_Value was not assigned in the previous step, then evaluate the current value of the Weekly_Schedule array element for the current day and if that value is not NULL, assign it to the Present_Value property.
3. If the Present_Value was not assigned in the previous steps, then assign the value of the Schedule_Default property to the Present_Value property.

The method for evaluating the current value of a schedule (either exception or weekly) is to find the latest element in the list of BACnetTimeValues that occurs on or before the current time, and then use that element's value as the current value for the schedule. If no such element is found, then the current value for the schedule shall be NULL.

These calculations are such that they can be performed at any time and the correct value of Present_Value property will result. These calculations must be performed at 00:00 each day, whenever the device resets, whenever properties that can affect the results are changed, whenever the time in the device changes by an amount that may have an effect on the calculation result, and at other times, as required, to maintain the correct value of the Present_Value property through the normal passage of time.

Note that the Present_Value property will be assigned the value of the Schedule_Default property at 00:00 of any given day, unless there is an entry for 00:00 in effect for that day. If a scheduled event logically begins on one day and ends on another, an entry at 00:00 shall be placed in the schedule that is in effect for the second day, and for any subsequent days of the event's duration, to ensure the correct result whenever Present_Value is calculated

12.24.5 Description

This property is a string of printable characters whose content is not restricted.

12.24.6 Effective_Period

This property specifies the range of dates within which the Schedule object is active. Seasonal scheduling may be achieved by defining several SCHEDULE objects with non-overlapping Effective_Periods to control the same property references. Upon entering its effective period, the object shall calculate its Present_Value and write that value to all members of the List_Of_Object_Property_References property. An error writing to any member of the list shall not stop the Schedule object from writing to the remaining members.

12.24.7 Weekly_Schedule

This property is a BACnetARRAY containing exactly seven elements. Each of the elements 1-7 contains a BACnetDailySchedule. A BACnetDailySchedule consists of a list of BACnetTimeValues that are (time, value) pairs, which describe the sequence of schedule actions on one day of the week when no Exception_Schedule is in effect. The time portion of each BACnetTimeValue shall contain a specific time. The array elements 1-7 correspond to the days Monday - Sunday, respectively. The Weekly_Schedule is an optional property, but either the Weekly_Schedule or a non-empty Exception_Schedule shall be supported in every instance of a Schedule object.

If the Weekly_Schedule property is written with a schedule item containing a datatype not supported by this instance of the Schedule object (e.g., the List_Of_Object_Property_References property cannot be configured to reference a property of the

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unsupported datatype), the device may return a Result(-) response, specifying an 'Error Class' of PROPERTY and an 'Error Code' of DATATYPE_NOT_SUPPORTED.

12.24.8 Exception_Schedule

This property is a BACnetARRAY of BACnetSpecialEvents. Each BACnetSpecialEvent describes a sequence of schedule actions that takes precedence over the normal day's behavior on a specific day or days.

BACnetSpecialEvent ::= (Period, List of BACnetTimeValue, EventPriority)

Period ::= Choice of {BACnetCalendarEntry | CalendarReference}

EventPriority ::= Unsigned (1..16)

The Period may be a BACnetCalendarEntry or it may refer to a Calendar object. A BACnetCalendarEntry would be used if the BACnetSpecialEvent is specific to this Schedule object, while Calendar objects might be defined for common holidays to be referenced by multiple Schedule objects. Each BACnetCalendarEntry is either a specific date or date pattern (Date), range of dates (BACnetDateRange), or month/week-of-month/day-of-week specification (BACnetWeekNDay). If the current date matches any of the calendar entry criteria, the BACnetSpecialEvent would be activated and the list of BACnetTimeValue items would be enabled for use.

As an example, if the calendar entry is a BACnetWeekNDay with an unspecified octet for month and week-of-month fields but with a specific day-of-week, it means the BACnetSpecialEvent applies on that day-of-week all year long.

Each item in the List of BACnetTimeValue specifies a time and a value of primitive datatype that is used at the time specified by the time portion. The time portion shall contain a specific time.

Each BACnetSpecialEvent contains an EventPriority that determines its importance relative to other BACnetSpecialEvent elements within the same Exception_Schedule array. Since BACnetSpecialEvent elements within the same Exception_Schedule array may have overlapping periods, it is necessary to have a mechanism to determine the relative priorities for the BACnetSpecialEvent elements that apply on any given day. If more than one BACnetSpecialEvent applies to a given day, the relative priority of the BACnetSpecialEvent elements shall be determined by their EventPriority values. If multiple overlapping BACnetSpecialEvent elements have the same EventPriority value, then the BACnetSpecialEvent with the lowest index number in the array shall have higher relative priority. The highest EventPriority is 1 and the lowest is 16. The EventPriority is not related to the Priority_For_Writing property of the Schedule object.

If a BACnet Device supports writing to the Exception_Schedule property, all possible choices in the BACnetSpecialEvent elements shall be supported. If the size of this array is increased by writing to array index zero, each new array element shall contain an empty List of BACnetTimeValue.

If the Exception_Schedule property is written with a schedule item containing a datatype not supported by this instance of the Schedule object (e.g., the List_Of_Object_Property_References property cannot be configured to reference a property of the unsupported datatype), the device may return a Result(-) response, specifying an 'Error Class' of PROPERTY and an 'Error Code' of DATATYPE_NOT_SUPPORTED.

12.24.9 Schedule_Default

This property holds a default value to be used for the Present_Value property when no other scheduled value is in effect (see Clause 12.24.4). This may be any primitive datatype.

If the Schedule_Default property is written with a value containing a datatype not supported by this instance of the Schedule object (e.g., the List_Of_Object_Property_References property cannot be configured to reference a property of the unsupported datatype), the device may return a Result(-) response, specifying an 'Error Class' of PROPERTY and an 'Error Code' of DATATYPE_NOT_SUPPORTED.

12.24.10 List_Of_Object_Property_References

This property specifies the Device Identifiers, Object Identifiers and Property Identifiers of the properties to be written with specific values at specific times on specific days.

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If this property is writable, it may be restricted to only support references to objects inside of the device containing the Schedule object. If the property is restricted to referencing objects within the containing device, an attempt to write a reference to an object outside the containing device into this property shall cause a Result(-) to be returned with an error class of PROPERTY and an error code of OPTIONAL_FUNCTIONALITY_NOT_SUPPORTED.

If this property is set to reference an object outside the device containing the Schedule object, the method used for writing to the referenced property value for the purpose of controlling the property is a local matter. The only restriction on the method of writing to the referenced property is that the scheduling device be capable of using WriteProperty for this purpose so as to be interoperable with all BACnet devices.

12.24.11 Priority_For_Writing

This property defines the priority at which the referenced properties are commanded. It corresponds to the 'Priority' parameter of the WriteProperty service. It is an unsigned integer in the range 1-16, with 1 being considered the highest priority and 16 the lowest. See Clause 19.

12.24.12 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of the schedule object. Two of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM The value of this flag shall be logical FALSE (0).

FAULT Logical TRUE (1) if the Reliability property does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the schedule object has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value property is not changeable through BACnet services. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0).

12.24.13 Reliability

The Reliability property, of type BACnetReliability, provides an indication that the properties of the schedule object are in a consistent state. All non-NULL values used in the Weekly_Schedule, the Exception_Schedule, and the Schedule_Default properties shall be of the same datatype, and all members of the List_Of_Object_Property_References shall be writable with that datatype. If these conditions are not met, then this property shall have the value CONFIGURATION_ERROR. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, CONFIGURATION_ERROR,, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

If the List_Of_Object_Property_References contains a member that references a property in a remote device, the detection of a configuration error may be delayed until an attempt is made to write a scheduled value.

12.24.14 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the internal calculations of the schedule object are used to determine the value of the Present_Value property. This means that the Present_Value property is decoupled from the internal calculations and will not track changes to other properties when Out_Of_Service is TRUE. Other functions that depend on the state of the Present_Value, such as writing to the members of the

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List_Of_Object_Property_References, shall respond to changes made to that property while Out_Of_Service is TRUE, as if those changes had occurred by internal calculations.

12.24.15 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.25 Trend Log Object Type

A Trend Log object monitors a property of a referenced object and, when predefined conditions are met, saves ("logs") the value of the property and a timestamp in an internal buffer for subsequent retrieval. The data may be logged periodically, upon a change of value or when "triggered" by a write to the Trigger property. The Trigger property allows the acquisition of samples to be controlled by network write operations or internal processes. Errors that prevent the acquisition of the data, as well as changes in the status or operation of the logging process itself, are also recorded. Each timestamped buffer entry is called a trend log "record."

The referenced object may reside in the same device as the Trend Log object or in an external device. The referenced property's value may be recorded upon COV subscription or periodic poll. If the value of the monitored object's Status_Flags property is available, then it may optionally be recorded along with the value of the referenced property.

Each Trend Log object maintains an internal, optionally fixed-size buffer. This buffer fills or grows as log records are added. If the buffer becomes full, the least recent record is overwritten when a new record is added, or collection may be set to stop. Trend Log records are transferred as BACnetLogRecords using the ReadRange service. The buffer may be cleared by writing a zero to the Record_Count property. Each record in the buffer has an implied SequenceNumber which is equal to the value of the Total_Record_Count property immediately after the record is added.

Several datatypes are defined for storage in the log records. The ability to store ANY datatypes is optional. Data stored in the log buffer may be optionally restricted in size to 32 bits, as in the case of bit strings, to facilitate implementation in devices with strict storage requirements.

Logging may be enabled and disabled through the Enable property and at dates and times specified by the Start_Time and Stop_Time properties. Trend Log enabling and disabling is recorded in the log buffer.

Event reporting (notification) may be provided to facilitate automatic fetching of log records by processes on other devices such as fileservers. Support is provided for algorithmic reporting; optionally, intrinsic reporting may be provided.

In intrinsic reporting, when the number of records specified by the Notification_Threshold property have been collected since the previous notification (or startup), a new notification is sent to all subscribed devices.

In response to a notification, subscribers may fetch all of the new records. If a subscriber needs to fetch all of the new records, it should use the 'By Sequence Number' form of the ReadRange service request.

A missed notification may be detected by a subscriber if the 'Current Notification' parameter received in the previous BUFFER_READY notification is different than the 'Previous Notification' parameter of the current BUFFER_READY notification. If the ReadRange-ACK response to the ReadRange request issued under these conditions has the FIRST_ITEM bit of the 'Result Flags' parameter set to TRUE, Trend Log records have probably been missed by this subscriber.

The acquisition of log records by remote devices has no effect upon the state of the Trend Log object itself. This allows completely independent, but properly sequential, access to its log records by all remote devices. Any remote device can independently update its records at any time.

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Table 12-29. Properties of the Trend Log Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Enable	BOOLEAN	W
Start_Time	BACnetDateTime	O[1,2]
Stop_Time	BACnetDateTime	O[1,2]
Log_DeviceObjectProperty	BACnetDeviceObjectPropertyReference	O[1]
Log_Interval	Unsigned	O[1,3]
COV_Resubscription_Interval	Unsigned	O
Client_COV_Increment	BACnetClientCOV	O
Stop_When_Full	BOOLEAN	R
Buffer_Size	Unsigned32	R
Log_Buffer	List of BACnetLogRecord	R
Record_Count	Unsigned32	W
Total_Record_Count	Unsigned32	R
Notification_Threshold	Unsigned32	O[4]
Records_Since_Notification	Unsigned32	O[4]
Last_Notify_Record	Unsigned32	O[4]
Event_State	BACnetEventState	R
Notification_Class	Unsigned	O[4]
Event_Enable	BACnetEventTransitionBits	O[4]
Acked_Transitions	BACnetEventTransitionBits	O[4]
Notify_Type	BACnetNotifyType	O[4]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[4]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[6]
Profile_Name	CharacterString	O
Logging_Type	BACnetLoggingType	R
Align_Intervals	BOOLEAN	O[5]
Interval_Offset	Unsigned	O[5]
Trigger	BOOLEAN	O
Status_Flags	BACnetStatusFlags	R
Reliability	BACnetReliability	O

[1] These properties are required to be present if the monitored property is a BACnet property.
[2] If present, these properties are required to be writable.
[3] If present, this property is required to be writable when Logging_Type has the value POLLED or the value COV. Also, if present this property is required to be read-only if Logging_Type has the value TRIGGERED.
[4] These properties are required to be present if the object supports intrinsic reporting.
[5] These properties are required to be present if the object supports clock-aligned logging.
[6] This property, if present, is required to be read only.

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12.25.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.25.2 Object_Name

This property, of type CharacterString, shall represent a name for the Object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

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12.25.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be TREND_LOG.

12.25.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.25.5 Enable

This property, of type BOOLEAN, indicates and controls whether (TRUE) or not (FALSE) logging of events and collected data is enabled. Logging occurs if and only if Enable is TRUE, Local_Time is on or after Start_Time, and Local_Time is before Stop_Time. If Start_Time contains an unspecified datetime, then it shall be considered equal to 'the start of time'. If Stop_Time contains an unspecified datetime, then it shall be considered equal to 'the end of time'. Log_Buffer records of type log-status are recorded without regard to the value of the Enable property.

Attempts to write the value TRUE to the Enable property while Stop_When_Full is TRUE and Record_Count is equal to Buffer_Size shall cause a Result(-) response to be issued, specifying an 'Error Class' of OBJECT and an 'Error Code' of LOG_BUFFER_FULL.

12.25.6 Start_Time

This optional property, of type BACnetDateTime, specifies the date and time at or after which logging shall be enabled by this property. If this property contains an unspecified datetime, then the conditions for logging to be enabled by Start_Time shall be ignored. If Start_Time specifies a date and time after Stop_Time, then logging shall be disabled. This property shall be writable if present.

When Start_Time is reached, the value of the Enable property is not changed.

12.25.7 Stop_Time

This optional property, of type BACnetDateTime, specifies the date and time at or after which logging shall be disabled by this property. If this property contains an unspecified datetime, then the conditions for logging to be disabled by Stop_Time shall be ignored. If Stop_Time specifies a date and time earlier than Start_Time, then logging shall be disabled. This property shall be writable if present.

When Stop_Time is reached, the value of the Enable property is not changed.

12.25.8 Log_DeviceObjectProperty

This optional property, of type BACnetDeviceObjectPropertyReference, specifies the Device Identifier, Object Identifier and Property Identifier of the property to be trend logged.

If this property is writable, it may be restricted to reference only objects inside the device containing the Trend Log object. If the property is restricted to referencing objects within the containing device, an attempt to write a reference to an object outside the containing device into this property shall cause a Result(-) to be returned.

12.25.9 Log_Interval

This optional property, of type Unsigned, specifies the periodic interval in hundredths of seconds for which the referenced property is to be logged when Logging_Type has the value POLLED. If the Logging_Type property has either of the values COV or TRIGGERED, then the value of the Log_Interval property shall be zero and ignored.

To maintain compatibility with previous versions of the standard, devices supporting COV data collection shall support switching between COV and polled modes in response to writes to Log_Interval. If the Logging_Type property has the value POLLED, changing the Log_Interval property from a non-zero value to the value zero shall change the value of Logging_Type to COV, and shall cause the Trend Log object to issue COV subscriptions for the referenced property. If the Logging_Type property has the value COV, writing a non-zero value to the Log_Interval property shall change the value of Logging_Type to POLLED, and shall cause the Trend Log object to periodically poll the monitored property.

If present, this property shall be writable if Logging_Type has either the value POLLED or the value COV. This property shall be read-only if Logging_Type has the value TRIGGERED.

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12.25.10 COV_Resubscription_Interval

If the Trend Log is acquiring data from a remote device by COV subscription, this optional property, of type Unsigned, specifies the number of seconds between COV resubscriptions, provided that COV subscription is in effect. SubscribeCOV requests shall specify twice this lifetime for the subscription and shall specify the issuance of confirmed notifications. If COV subscriptions are in effect, the first COV subscription is issued when the Trend Log object begins operation or when Enable becomes TRUE. If present, the value of this property shall be non-zero. If this property is not present, then COV subscription shall not be attempted.

12.25.11 Client_COV_Increment

If the Trend Log is acquiring COV data, this optional property, of type BACnetClientCOV, specifies the increment to be used in determining that a change of value has occurred. If the referenced object and property supports COV reporting according to Clause 13.1, this property may have the value NULL; in this case change of value is determined by the criteria of Clause 13.1.

12.25.12 Stop_When_Full

This property, of type BOOLEAN, specifies whether (TRUE) or not (FALSE) logging should cease when the buffer is full. When logging ceases because the addition of one more record would cause the buffer to be full, Enable shall be set to FALSE and the event recorded.

If Stop_When_Full is writable, attempts to write the value TRUE to the Stop_When_Full property while Record_Count is equal to Buffer_Size shall result in the oldest Log_Buffer record being discarded, and shall cause the Enable property to be set to FALSE and the event to be recorded.

12.25.13 Buffer_Size

This property, of type Unsigned32, shall specify the maximum number of records the buffer may hold. If writable, it may not be written when Enable is TRUE. The disposition of existing records when Buffer_Size is written is a local matter.

12.25.14 Log_Buffer

This property is a list of up to Buffer_Size timestamped records of datatype BACnetLogRecord, each of which conveys a recorded data value, an error related to data-collection, or status changes in the Trend Log object. Each record has data fields as follows:

Timestamp The local date and time when the record was collected.

LogDatum The data value read from the monitored object and property, an error encountered in an attempt to read a value, or a change in status or operation of the Trend Log object itself.

StatusFlags If this field is present in the log record, then it shall contain the value of the Status_Flags property of the monitored object. If the monitored object is in a different device than the Trend Log object, then it is recommended that the Status_Flags and the data value in the monitored object property be acquired together with a single service request, such as COVNotification or ReadPropertyMultiple.

The choices available for the LogDatum are listed below:

log-status This choice represents a change in the status or operation of the Trend Log object. Whenever one of the events represented by the flags listed below occurs, a record shall be appended to the buffer.

LOG_DISABLED This flag is changed whenever collection of records by the Trend Log object is enabled or disabled. It shall be TRUE if Enable is FALSE, or the local time is outside the range defined by Start_Time and Stop_Time, or the addition of this record will cause the buffer to be full and Stop_When_Full is TRUE; otherwise it shall be FALSE.

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	BUFFER_PURGED	This flag shall be set to TRUE whenever the buffer is cleared by writing zero to the Record_Count property or by a change to the Log_DeviceObjectProperty property. After this value is recorded in the buffer, the subsequent immediate change to FALSE shall not be recorded. A record indicating the purging of the buffer shall be placed into the buffer even if the Trend Log is disabled or outside of the time range defined by the Start_Time and Stop_Time properties.
	LOG_INTERRUPTED	This flag indicates that the collection of records by the Trend Log object was interrupted by a power failure, device reset, object reconfiguration or other such disruption, such that samples prior to this record might have been missed.
boolean-value real-value enum-value unsigned-value signed-value bitstring-value null-value	These choices represent the data values and datatypes read from the monitored object and property.	
failure	This choice represents an error encountered in an attempt to read a data value from the monitored object. If the error is conveyed by an error response from a remote device the Error Class and Error Code in the response shall be recorded.	
time-change	This choice represents a change in the clock setting in the device, it records the number of seconds by which the clock changed. If the number is not known, such as when the clock is initialized for the first time, the value recorded shall be zero. This record shall be recorded after changing the local time of the device and the timestamp shall reflect the new local time of the device.	
any-value	This choice represents the data values and datatypes read from the monitored object and property.	

Also associated with each record is an implied record number, the value of which is equal to Total_Record_Count at the point where the record has been added into the Log Buffer and Total_Record_Count has been adjusted accordingly. All clients shall be able to correctly handle the case where the Trend Log is reset such that its Total_Record_Count is returned to zero and also the case where Total_Record_Count has wrapped back to one.

The buffer is not network accessible except through the use of the ReadRange service, in order to avoid problems with record sequencing when segmentation is required. Attempts to read this property with the ReadProperty-Request or ReadPropertyMultiple-Request shall cause a Result(-) response to be issued, specifying an 'Error Class' of PROPERTY and an 'Error Code' of READ_ACCESS_DENIED.

12.25.15 Record_Count

This property, of type Unsigned32, shall represent the number of records currently resident in the log buffer. A write of the value zero to this property shall cause all records in the log buffer to be deleted and Records_Since_Notification to be reset to zero. Upon completion, this event shall be reported in the log as the initial entry.

12.25.16 Total_Record_Count

This property, of type Unsigned32, shall represent the total number of records collected by the Trend Log object since creation. When the value of Total_Record_Count reaches its maximum possible value of 2^{32} - 1, the next value it takes shall be one. Once this value has wrapped to one, its semantic value (the total number of records collected) has been lost but its use in generating notifications remains.

12.25.17 Notification_Threshold

This property, of type Unsigned32, shall specify the value of Records_Since_Notification at which notification occurs. This property is required if intrinsic reporting is supported by this object.

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12.25.18 Records_Since_Notification

This property, of type Unsigned32, represents the number of records collected since the previous notification, or since the beginning of logging if no previous notification has occurred. This property is required if intrinsic reporting is supported by this object.

12.25.19 Last_Notify_Record

This property, of type Unsigned32, represents the SequenceNumber associated with the most recently collected record whose collection caused the value of the Records_Since_Notification property to become equal to or greater than the value of the Notification_Threshold property that triggered a notification. If no notification has occurred since logging began the value of this property shall be zero. This property is required if intrinsic reporting is supported by this object.

12.25.20 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL. The allowed states are NORMAL, and FAULT.

12.25.21 Notification_Class

This property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.25.22 Event_Enable

This optional property, of type BACnetEventTransitionBits, shall convey flags that separately enable and disable reporting of TO-FAULT and TO-NORMAL events. This property is required if intrinsic reporting is supported by this object.

12.25.22.1 Conditions for Generating a TO-NORMAL Event

A TO-NORMAL event is generated if the TO-NORMAL flag is enabled in the Event_Enable property, and either:

(a) the value of the Records_Since_Notification property changes from being less than the value of Notification_Threshold to being equal to or greater than the value of Notification_Threshold, or
(b) the value of the Notification_Threshold property changes from being greater than the value of Records_Since_Notification to being equal to or less than the value of Records_Since_Notification, or
(c) the Reliability property changes to the value NO_FAULT_DETECTED.

12.25.22.2 Conditions for Generating a TO-FAULT Event

A TO-FAULT event is generated if the TO-FAULT flag is enabled in the Event_Enable property and the Reliability property changes to a value other than NO_FAULT_DETECTED.

12.25.23 Acked_Transitions

This property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

12.25.24 Notify_Type

This property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

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12.25.25 Event_Time_Stamps

This optional property, of type BACnetARRAY [3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.25.26 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

12.25.27 Logging_Type

This property, of type BACnetLoggingType, specifies whether the Trend Log collects records using polling, COV or triggered acquisition.

If this property is writable, an attempt to write a value not supported by the object into this property shall cause a Result(-) response to be issued, specifying an 'Error Class' of PROPERTY and 'Error Code' of OPTIONAL_FUNCTIONALITY_NOT_SUPPORTED.

If this property has the value COV, then the Trend Log shall issue COV subscriptions for the referenced property, and shall log the COV notifications if they indicate a changed value.

If this property has the value POLLED, then the Trend Log shall periodically poll the monitored property on the interval defined by the Log_Interval, Align_Intervals, and Interval_Offset properties.

If the value POLLED is written to this property when the value of Log_Interval is zero, then the Log_Interval property shall be updated with an appropriate default polling interval. Determination of the appropriate default polling interval is a local matter.

If either of the values COV or TRIGGERED is written to this property when Log_Interval has a non-zero value, then the Log_Interval property shall be updated with the value zero.

12.25.28 Align_Intervals

This optional property, of type BOOLEAN, specifies whether (TRUE) or not (FALSE) clock-aligned periodic logging is enabled. If clock-aligned periodic logging is enabled and the value of Log_Interval is a factor of (that is, divides without remainder) a second, minute, hour or day, then the beginning of the period specified for logging shall be aligned to the second, minute, hour or day, respectively.

This property is required if the object supports clock-aligned logging. This property has no effect on the behavior of the Trend Log object if the Logging_Type property has a value other than POLLED.

12.25.29 Interval_Offset

This optional property, of type Unsigned, specifies the offset in hundredths of seconds from the beginning of the period specified for logging until the actual acquisition of a log record begins. The offset used shall be the value of Interval_Offset modulo the value of Log_Interval; i.e., if Interval_Offset has the value 31 and Log_Interval is 30, the offset used shall be 1. Interval_Offset shall have no effect if Align_Intervals is FALSE.

This property is required if the object supports clock-aligned logging.

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12.25.30 Trigger

This optional property, of type BOOLEAN, shall cause the Trend Log object to acquire a log record whenever the value of this property is changed from FALSE to TRUE. It shall remain TRUE while the Trend Log object is acquiring the data items for a record. When all data items have been collected or it has been determined that all outstanding data requests will not be fulfilled, the Trend Log object shall reset the value to FALSE.

If the value of the Logging_Type property is not TRIGGERED and an attempt is made to write the value TRUE to the Trigger property, it is left as a local matter whether to execute the logging operation or not. For devices that choose not to execute triggered logging when Logging_Type is not equal to TRIGGERED, attempts to write the value TRUE to this property when Logging_Type has a value other than TRIGGERED shall cause a Result(-) response to be issued, specifying an 'Error Class' of PROPERTY and an 'Error Code' of NOT_CONFIGURED_FOR_TRIGGERED_LOGGING.

Writing to the Trigger property is not restricted to network-visible write operations; internal processes may control the acquisition of samples by writing to this property.

12.25.31 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of a Trend Log object. The IN_ALARM and FAULT flags are associated with the values of other properties of this object. A more detailed status may be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN The value of this flag shall be Logical FALSE (0).

OUT_OF_SERVICE The value of this flag shall be Logical FALSE (0).

12.25.32 Reliability

This optional property, of type BACnetReliability, provides an indication of whether the application-specific properties of the object or the process executing the application program are "reliable" as far as the BACnet Device can determine. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, CONFIGURATION_ERROR, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.25.33 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

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12.26 Access Door Object Type

The Access Door object type is an abstract interface to a physical door whose properties represent the externally visible characteristics of an access control door. The Access Door is comprised of a collection of physical door hardware, such as a door lock, a door contact, and a Request-To-Exit device, which together comprise a door for access control. The individual hardware components of the door may or may not be exposed through this object. The object and its properties are summarized in Table 12-30 and described in detail in this subclause.

Table 12-30. Properties of the Access Door Object

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Present_Value	BACnetDoorValue	W
Description	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	R
Out_Of_Service	BOOLEAN	R
Priority_Array	BACnetPriorityArray	R
Relinquish_Default	BACnetDoorValue	R
Door_Status	BACnetDoorStatus	O[1,2]
Lock_Status	BACnetLockStatus	O[1]
Secured_Status	BACnetDoorSecuredStatus	O
Door_Members	BACnetARRAY[N] of BACnetDeviceObjectReference	O
Door_Pulse_Time	Unsigned	R
Door_Extended_Pulse_Time	Unsigned	R
Door_Unlock_Delay_Time	Unsigned	O
Door_Open_Too_Long_Time	Unsigned	R
Door_Alarm_State	BACnetDoorAlarmState	O[1, 3]
Masked_Alarm_Values	List of BACnetDoorAlarmState	O
Maintenance_Required	BACnetMaintenance	O
Time_Delay	Unsigned	O[3]
Notification_Class	Unsigned	O[3]
Alarm_Values	List of BACnetDoorAlarmState	O[3]
Fault_Values	List of BACnetDoorAlarmState	O[3]
Event_Enable	BACnetEventTransitionBits	O[3]
Acked_Transitions	BACnetEventTransitionBits	O[3]
Notify_Type	BACnetNotifyType	O[3]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[3]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[4]
Profile_Name	CharacterString	O

[1] These properties, when present, shall be writable when Out_Of_Service is TRUE.
[2] This property is required if the property Secured_Status is present.
[3] These properties are required if the object supports intrinsic reporting.
[4] This property, if present, is required to be read only.

12.26.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

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12.26.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.26.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object-type class. The value of this property shall be ACCESS_DOOR.

12.26.4 Present_Value (Commandable)

This property, of type BACnetDoorValue, reflects the current active command of the access door object. The Present_Value is commandable and has one of the following values:

LOCK — The door is commanded to the locked state.

UNLOCK — The door is commanded to the unlocked state.

PULSE_UNLOCK — The door will be commanded to the unlocked state for a maximum of the time specified by Door_Pulse_Time, after which the value will be automatically relinquished from the priority array at the commanded priority. It is permissible for the local controller to relinquish the value from the priority array before the time specified by Door_Pulse_Time has expired. The conditions when this may occur are considered a local matter.

If a value of PULSE_UNLOCK is written at a given priority and the Present_Value is currently being commanded, at any value, at a higher priority then the lower priority value will be relinquished immediately.

EXTENDED_PULSE_UNLOCK — The door will be commanded to the unlocked state for a maximum of the time specified by Door_Extended_Pulse_Time, after which the value will be automatically relinquished from the priority array at the commanded priority. It is permissible for the local controller to relinquish the value from the priority array before the time specified by Door_Extended_Pulse_Time has expired. The conditions when this may occur are considered a local matter.

If a value of EXTENDED_PULSE_UNLOCK is written at a given priority and the Present_Value is currently being commanded, at any value, at a higher priority then the lower priority value will be relinquished immediately.

Note that the present value represents the commanded state of the door, which does not necessarily correspond to the physical state of the door lock.

The present value of the Access Door is defined for a standard access controlled door, where the control operation is to lock or unlock. However, this does not exclude motorized devices such as sliding doors, parking gates, etc where the operation is to open or close. In these cases, locked shall be equivalent to closed and unlocked shall be equivalent to open.

12.26.5 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.26.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of the physical door. Three of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are:

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

Where:

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IN_ALARM	Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).
FAULT	Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).
OVERRIDDEN	Logical TRUE (1) if the object has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the physical door is no longer tracking changes to the Present_Value property and the Reliability property is no longer a reflection of the reliability of the physical inputs(s) and output(s). Otherwise, the value is logical FALSE (0).
OUT_OF_SERVICE	Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0).

12.26.7 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. The Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL.

12.26.8 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the Present_Value or the operation of the physical inputs or outputs which comprise this door are "reliable" as far as the BACnet Device or operator can determine and, if not, why. The Reliability property for this object may have any of the following values:

{NO_FAULT_DETECTED, MULTISTATE_FAULT, CONFIGURATION_ERROR,
COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.26.8.1 Conditions for Generating a TO-FAULT Event

A TO-FAULT event is generated under these conditions:

(a) the Reliability property becomes not equal to NO_FAULT_DETECTED, and
(b) the TO-FAULT flag must be enabled in the Event_Enable property.

12.26.9 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the logical door which this object represents is not in service. This means that the Present_Value property is decoupled from the physical door and will not track changes to the physical door when the value of Out_Of_Service is TRUE. In addition, the Reliability property and the corresponding state of the FAULT flag of the Status_Flags property shall be decoupled from the physical door when Out_Of_Service is TRUE. While the Out_Of_Service property is TRUE, the Present_Value and Reliability properties, and if present, the Door_Status, Lock_Status and Door_Alarm_State properties, may be changed to any value as a means of simulating specific fixed conditions or for testing purposes. Other functions that depend on the state of the Present_Value or Reliability properties, and if present the Door_Status, Lock_Status and Door_Alarm_State properties, shall respond to changes made to these properties while Out_Of_Service is TRUE, as if those changes had occurred to the physical door.

12.26.10 Priority_Array

This property is a read-only array that contains prioritized commands that are in effect for this object. See Clause 19 for a description of the prioritization mechanism.

12.26.11 Relinquish_Default

This property is the default value to be used for the Present_Value property when all command priority values in the Priority_Array property have a NULL value. See Clause 19. The acceptable values for this property are either LOCK or UNLOCK and the property shall not take on either of the values PULSE_UNLOCK or EXTENDED_PULSE_UNLOCK.

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12.26.12 Door_Status

This optional property, of type BACnetDoorStatus, represents the open or closed state of the physical door. The values that may be taken on by this property are:

CLOSED	The door is closed.
OPENED	The door is open or partially open.
UNKNOWN	It is unknown whether the door is opened or closed.

This property, if present, is required to be writable when Out_Of_Service is TRUE.

12.26.13 Lock_Status

This optional property, of type BACnetLockStatus, represents the monitored (as opposed to the commanded) status of the door lock. The values that may be taken on by this property are:

LOCKED	The door lock is locked.
UNLOCKED	The door lock is unlocked.
FAULT	The lock status input associated with the door lock is unreliable.
UNKNOWN	There is no lock status input associated with the door and therefore the status of the physical lockis unknown.

This property, if present, is required to be writable when Out_Of_Service is TRUE.

12.26.14 Secured_Status

This optional property, of type BACnetDoorSecuredStatus, represents whether or not the physical door is in a secured state. This property shall have a value of SECURED if, and only if, all of the following conditions are met:

(a) the IN_ALARM flag of the Status_Flags property is FALSE, and
(b) the Masked_Alarm_Values list, if it exists, is empty , and
(c) the Door_Status property has a value of CLOSED, and
(d) the Present_Value property has a value of LOCK,
(e) the Lock_Status property, if it exists, has a value of LOCKED or UNKNOWN.

If one or more of the previous conditions are not met, the property shall have a value of UNSECURED. If the device can not determine any of the previous conditions, then the property shall have a value of UNKNOWN.

12.26.15 Door_Members

This optional property of type BACnetARRAY[N] of BACnetDeviceObjectReference holds an array of references to BACnet objects which represent I/O devices, authentication devices, schedules, programs, or other objects that are associated with the physical door. It is a local matter as to how this array is used and which objects are referenced in this array. The array may be empty or not present if the vendor does not wish to expose the individual objects that make up this physical door.

12.26.16 Door_Pulse_Time

This property, of type Unsigned, is the maximum duration of time, in tenths of seconds, for which the door will be unlocked when the Present_Value has a value of PULSE_UNLOCK, after which time the Present_Value shall be automatically relinquished at the priority that established the PULSE_UNLOCK command.

12.26.17 Door_Extended_Pulse_Time

This property, of type Unsigned, is the maximum amount of time, in tenths of seconds, which the door will be unlocked when the Present_Value has a value of EXTENDED_PULSE_UNLOCK, after which time the Present_Value shall be automatically relinquished at the priority that established the EXTENDED_PULSE_UNLOCK command.

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12.26.18 Door_Unlock_Delay_Time

This optional property, of type Unsigned, is the duration of time, in tenths of seconds, which the physical door lock will delay unlocking when the Present_Value changes to a value of PULSE_UNLOCK or EXTENDED_PULSE_UNLOCK.

12.26.19 Door_Open_Too_Long_Time

This property, of type Unsigned, is the time, in tenths of seconds, to delay before setting the Door_Alarm_State to DOOR_OPEN_TOO_LONG after it is determined that a door-open-too-long condition exists. A door-open-too-long condition occurs when the Present_Value has a value of LOCK and one of the following conditions exist:

(a) The Present_Value had a previous value of PULSE_UNLOCK and the door has been in a continual open state for the time specified by Door_Open_Too_Long_Time after the Door_Pulse_Time has expired.
(b) The Present_Value had a previous value of EXTENDED_PULSE_UNLOCK and the door has been in a continual open state for the time specified by Door_Open_Too_Long_Time after the Door_Extended_Pulse_Time has expired.
(c) The Present_Value had a previous value of UNLOCK and the door has been in a continual open state for the time specified by Door_Open_Too_Long_Time.

12.26.20 Door_Alarm_State

This optional property, of type BACnetDoorAlarmState, is the alarm state for the physical door. The CHANGE_OF_STATE event algorithm will monitor this property. When no alarm or fault condition exists for this object, this property shall take on the value NORMAL. It is considered a local matter as to when this property is set to a non-normal value. It is up to the internal control logic to take Lock_Status, Door_Status, Present_Value and information from other objects into account when calculating the proper alarm state. However, this property cannot take on any value which is also in the Masked_Alarm_Values list. If the property is currently set to a specific state and that state is written to the Masked_Alarm_Values list, then the Door_Alarm_State will immediately return to the NORMAL state.

This property is required if intrinsic reporting is supported by this object, and if present, required to be writable when Out_Of_Service is TRUE.

12.26.21 Masked_Alarm_Values

This optional property, of type List of BACnetDoorAlarmState, shall specify any alarm and/or fault states which are masked. An alarm state which is currently masked will prevent the Door_Alarm_State property from being equal to that state.

12.26.22 Maintenance_Required

This optional property, of type BACnetMaintenance, shall indicate the type of maintenance required for the Access Door. This may be periodic maintenance, or a "parameter-determined" maintenance, such as maximum duty-cycle for a door lock, and shall be determined locally.

12.26.23 Time_Delay

This optional property, of type Unsigned, shall specify the minimum period of time in seconds that the Door_Alarm_State must remain equal to any one of the values in the Alarm_Values property before a TO-OFFNORMAL event is generated or remain not equal to any of the values in the Alarm_Values property before a TO-NORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.26.24 Notification_Class

This optional property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.26.25 Alarm_Values

This optional property, of type List of BACnetDoorAlarmState, shall specify any states the Door_Alarm_State must equal before a TO-OFFNORMAL event is generated and event state OFFNORMAL is entered. This property is required if intrinsic reporting is supported by this object.

12.26.25.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

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(a) the TO-OFFNORMAL flag must be enabled in the Event_Enable property, and
(b) the Door_Alarm_State must equal any of the values in the Alarm_Values list, and
(c) he Door_Alarm_State must remain equal to the same value within the Alarm_Values list for a minimum period of time specified by the Time_Delay property.

12.26.25.2 Conditions for Generating a TO-NORMAL Event

Once equal, the Door_Alarm_State must become not equal to any of the states in the Alarm_Values property, and not equal to any of the states in the Fault_Values property, before a TO-NORMAL event is generated under these conditions:

(a) the TO-NORMAL flag must be enabled in the Event_Enable property, and
(b) the Door_Alarm_State must remain not equal to any of the states in the Alarm_Values property, and
(c) the Door_Alarm_State must remain not equal to any of the states in the Fault_Values property, and
(d) the Door_Alarm_State must remain equal to the same value for a minimum period of time, specified by the Time_Delay property.

12.26.26 Fault_Values

This optional property, of type List of BACnetDoorAlarmState, shall specify any states the Door_Alarm_State must equal before a TO-FAULT event is generated. If Door_Alarm_State becomes equal to any of the states in the Fault_Values list and no physical fault has been detected, then the Reliability property shall have the value MULTI_STATE_FAULT. This property is required if intrinsic reporting is supported by this object.

12.26.27 Conditions for Generating a TO-FAULT Event

A TO-FAULT event is generated under these conditions:

(a) the TO-FAULT flag must be enabled in the Event_Enable property, and
(b) the Door_Alarm_State must equal any of the values in the Fault_Values property.

12.26.28 Conditions for Generating a TO-NORMAL Event

Conditions for generating a TO-NORMAL event are defined in Clause 12.26.25.2.

12.26.29 Event_Enable

This property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. This property is required if intrinsic reporting is supported by this object.

12.26.30 Acked_Transitions

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

12.26.31 Notify_Type

This optional property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

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12.26.32 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.26.33 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.26.34 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.27 Event Log Object Type

An Event Log object records event notifications with timestamps and other pertinent data in an internal buffer for subsequent retrieval. Each timestamped buffer entry is called an event log "record."

Each Event Log object maintains an internal, optionally fixed-size buffer. This buffer fills or grows as event log records are added. If the buffer becomes full, the least recent records are overwritten when new records are added, or collection may be set to stop. Event log records are transferred as BACnetEventLogRecords using the ReadRange service. The buffer may be cleared by writing a zero to the Record_Count property. The determination of which notifications are placed into the log is a local matter. Each record in the buffer has an implied SequenceNumber that is equal to the value of the Total_Record_Count property immediately after the record is added.

Logging may be enabled and disabled through the Enable property and at dates and times specified by the Start_Time and Stop_Time properties. Event Log enabling and disabling is recorded in the event log buffer.

Event reporting (notification) may be provided to facilitate automatic fetching of event log records by processes on other devices such as fileservers. Support is provided for algorithmic reporting; optionally, intrinsic reporting may be provided.

In intrinsic reporting, when the number of records specified by the Notification_Threshold property has been collected since the previous notification (or startup), a new notification is sent to all subscribed devices.

In response to a notification, subscribers may fetch all of the new records. If a subscriber needs to fetch all of the new records, it should use the 'By Sequence Number' form of the ReadRange service request.

A missed notification may be detected by a subscriber if the 'Current Notification' parameter received in the previous BUFFER_READY notification is different than the 'Previous Notification' parameter of the current BUFFER_READY notification. If the ReadRange-ACK response to the ReadRange request issued under these conditions has the FIRST_ITEM bit of the 'Result Flags' parameter set to TRUE, event log records have probably been missed by this subscriber.

The acquisition of log records by remote devices has no effect upon the state of the Event Log object itself. This allows completely independent, but properly sequential, access to its log records by all remote devices. Any remote device can independently update its records at any time.

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Table 12-31. Properties of the Event Log Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	O
Enable	BOOLEAN	W
Start_Time	BACnetDateTime	O[1, 2]
Stop_Time	BACnetDateTime	O[1, 2]
Stop_When_Full	BOOLEAN	R
Buffer_Size	Unsigned32	R
Log_Buffer	List of BACnetEventLogRecord	R
Record_Count	Unsigned32	W
Total_Record_Count	Unsigned32	R
Notification_Threshold	Unsigned32	O[3]
Records_Since_Notification	Unsigned32	O[3]
Last_Notify_Record	Unsigned32	O[3]
Notification_Class	Unsigned	O[3]
Event_Enable	BACnetEventTransitionBits	O[3]
Acked_Transitions	BACnetEventTransitionBits	O[3]
Notify_Type	BACnetNotifyType	O[3]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[3]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[4]
Profile_Name	CharacterString	O

[1] If present, these properties are required to be writable.
[2] If one of these properties is present, then all shall be present.
[3] These properties are required to be present if the object supports intrinsic reporting.
[4] This property, if present, is required to be read only.

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12.27.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.27.2 Object_Name

This property, of type CharacterString, shall represent a name for the Object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.27.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be EVENT_LOG.

12.27.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.27.5 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of an Event Log object. The IN_ALARM and FAULT flags are associated with the values of other properties of this object. A more detailed status may be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

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{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN The value of this flag shall be Logical FALSE (0).

OUT_OF_SERVICE The value of this flag shall be Logical FALSE (0).

12.27.6 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL. The Event_State property for this object may have either of the following values:

{NORMAL, FAULT}

12.27.7 Reliability

This optional property, of type BACnetReliability, provides an indication of whether the application-specific properties of the object or the process executing the application program are "reliable" as far as the BACnet Device can determine. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, CONFIGURATION_ERROR, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.27.8 Enable

This property, of type BOOLEAN, indicates and controls whether (TRUE) or not (FALSE) logging of events is enabled. Logging occurs if and only if Enable is TRUE, Local_Time is on or after Start_Time, and Local_Time is before Stop_Time. If Start_Time contains an unspecified datetime, then it shall be considered equal to 'the start of time'. If Stop_Time contains an unspecified datetime, then it shall be considered equal to 'the end of time'. Log_Buffer records of type log-status are recorded without regard to the value of the Enable property.

Attempts to write the value TRUE to the Enable property while Stop_When_Full is TRUE and Record_Count is equal to Buffer_Size shall cause a Result(-) response to be issued, specifying an 'Error Class' of OBJECT and an 'Error Code' of LOG_BUFFER_FULL.

12.27.9 Start_Time

This optional property, of type BACnetDateTime, specifies the date and time at or after which logging shall be enabled by this property. If this property contains an unspecified datetime, then the conditions for logging to be enabled by Start_Time shall be ignored. If Start_Time specifies a date and time after Stop_Time, then logging shall be disabled. If either of the optional properties Start_Time or Stop_Time is present, then both of these properties shall be present. This property shall be writable if present.

12.27.10 Stop_Time

This optional property, of type BACnetDateTime, specifies the date and time at or after which logging shall be disabled by this property. If this property contains an unspecified datetime, then the conditions for logging to be disabled by Stop_Time shall be ignored. If Stop_Time specifies a date and time earlier than Start_Time, then logging shall be disabled. If either of the optional properties Start_Time or Stop_Time is present, then both of these properties shall be present. This property shall be writable if present.

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12.27.11 Stop_When_Full

This property, of type BOOLEAN, specifies whether (TRUE) or not (FALSE) logging should cease when the buffer is full. When logging ceases because the addition of one more record would cause the buffer to be full, Enable shall be set to FALSE and the event recorded.

If Stop_When_Full is writable, attempts to write the value TRUE to the Stop_When_Full property while Record_Count is equal to Buffer_Size shall result in the oldest Log_Buffer record being discarded, and shall cause the Enable property to be set to FALSE and the event to be recorded.

12.27.12 Buffer_Size

This property, of type Unsigned32, shall specify the maximum number of records the buffer may hold. If writable, it may not be written when Enable is TRUE. The disposition of existing records when Buffer_Size is written is a local matter.

12.27.13 Log_Buffer

This property is a list of up to Buffer_Size timestamped records of datatype BACnetEventLogRecord, each of which conveys the event notification parameters or status changes in the Event Log object. Each record has data fields as follows:

Timestamp — The local date and time that the entry was placed into the event log.

LogDatum — The notification information, or a change in status or operation of the Event Log object itself.

The choices available for the LogDatum are listed below:

log-status — This choice represents a change in the status or operation of the Event Log object. Whenever one of the events represented by the flags listed below occurs, a record shall be appended to the buffer.

- LOG_DISABLED — This flag is changed whenever collection of records by the Event Log object is enabled or disabled. It shall be TRUE if Enable is FALSE, or the local time is outside the range defined by Start_Time and Stop_Time, or the addition of this record will cause the buffer to be full and Stop_When_Full is TRUE; otherwise it shall be FALSE.
- BUFFER_PURGED — This flag shall be set to TRUE whenever the buffer is deleted by a write of the value zero to the Record_Count property. After this value is recorded in the buffer, the subsequent immediate change to FALSE shall not be recorded.
- LOG_INTERRUPTED — This flag indicates that the collection of records by the Event Log object was interrupted by a power failure, device reset, object reconfiguration or other such disruption, such that samples prior to this record might have been missed.

notification — This choice represents an event notification that was received. It consists of the body of the ConfirmedEventNotification or UnconfirmedEventNotification. If the event was generated locally, this shall hold what would be received if the Event Log object existed on a remote device. In such a case the value of the Process Identifier parameter is a local matter.

time-change — This choice, which represents a change in the clock setting in the device, records the number of seconds by which the clock changed. If the number is not known, such as when the clock is initialized for the first time, the value recorded shall be zero.

Also associated with each record is an implied record number, the value of which is equal to Total_Record_Count at the point where the record has been added into the Log_Buffer and Total_Record_Count has been adjusted accordingly. All

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clients shall be able to correctly handle the case where the event log is reset such that its Total_Record_Count is returned to zero and also the case where Total_Record_Count has wrapped back to one.

The buffer is not network accessible except through the use of the ReadRange service in order to avoid problems with record sequencing when segmentation is required. Attempts to read this property with the ReadProperty-Request or ReadPropertyMultiple-Request shall result in an error specifying an error class of PROPERTY and an error code of READ_ACCESS_DENIED.

12.27.14 Record_Count

This property, of type Unsigned32, shall represent the number of records currently resident in the log buffer. A write of the value zero to this property shall cause all records in the log buffer to be deleted and Records_Since_Notification to be reset to zero. Upon completion, this event shall be reported in the log as the initial entry.

12.27.15 Total_Record_Count

This property, of type Unsigned32, shall represent the total number of records collected by the Event Log object since creation. When the value of Total_Record_Count reaches its maximum possible value of 2^{32} - 1, the next value it takes shall be one. Once this value has wrapped to one, its semantic value (the total number of records collected) has been lost but its use in generating notifications remains.

12.27.16 Notification_Threshold

This optional property, of type Unsigned32, shall specify the value of Records_Since_Notification at which notification occurs. This property is required if intrinsic reporting is supported by this object.

12.27.17 Records_Since_Notification

This optional property, of type Unsigned32, represents the number of records collected since the previous notification, or since the beginning of logging if no previous notification has occurred. This property is required if intrinsic reporting is supported by this object.

12.27.18 Last_Notify_Record

This property, of type Unsigned32, represents the SequenceNumber associated with the most recently collected record whose collection caused the value of the Records_Since_Notification property to become equal to or greater than the value of the Notification_Threshold property which triggered a notification. If no notification has occurred since logging began, the value of this property shall be zero. This property is required if intrinsic reporting is supported by this object.

12.27.19 Notification_Class

This optional property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.27.20 Event_Enable

This optional property, of type BACnetEventTransitionBits, shall convey flags that separately enable and disable reporting of TO-NORMAL and TO-FAULT events. This property is required if intrinsic reporting is supported by this object.

12.27.20.1 Conditions for Generating a TO-NORMAL Event

A TO-NORMAL event is generated if the TO-NORMAL flag is enabled in the Event_Enable property, and either:

(a) the value of the Records_Since_Notification property changes from being less than the value of Notification_Threshold to being equal to or greater than the value of Notification_Threshold, or
(b) the value of the Notification_Threshold property changes from being greater than the value of Records_Since_Notification to being equal to or less than the value of Records_Since_Notification, or
(c) the Reliability property changes to the value NO_FAULT_DETECTED.

12.27.20.2 Conditions for Generating a TO-FAULT Event

A TO-FAULT event is generated if the TO-FAULT flag is enabled in the Event_Enable property and the Reliability property changes to a value other than NO_FAULT_DETECTED.

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12.27.21 Acked_Transitions

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgements for TO-OFFNORMAL, TO-FAULT and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgement;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgement is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgement is expected).

12.27.22 Notify_Type

This optional property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.27.23 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.27.24 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.27.25 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.28 Load Control Object Type

The Load Control object type defines a standardized object whose properties represent the externally visible characteristics of a mechanism for controlling load requirements. A BACnet device can use a Load Control object to allow external control over the shedding of a load that it controls. The mechanisms by which the loads are shed are not visible to the BACnet client. One or more objects may be used in the device to allow independent control over different sub-loads. The Load Control object may also be used in a hierarchical fashion to control other Load Control objects in other BACnet devices.

A BACnet client (controller) can request that the Load Control object shed a portion of its load for a specified time by writing to the four properties: Requested_Shed_Level, Start_Time, Shed_Duration, and Duty_Window. For any given shed request, which may arrive while a previous request is pending or active, each of these parameters is optional except for Start_Time, which must be written if no shed request is pending or active. If no shed request is pending or active, only the writing of Start_Time will cause the Load Control object to become active. Modification of these shed request parameters serves to configure the load shed command. Initial values of these properties, and the values taken at the completion of a shed command execution, are as specified in the individual property descriptions.

The Load Control object shed mechanism follows a state machine whose operation is displayed in Figure 12-5. This state machine only describes the behavior of the Load Control object when the Enable property has the value TRUE. See Clause 12.27.14 for a description of the effect of this property. The state machine captures the transitions that occur within the Load Control object.

If the device is unable to comply fully with the shed request by shedding the entire amount of load requested, it is a local matter whether the device sheds as much load as it can or whether it does not shed any of its loads. Determination of compliance with a client's load shed request may also be affected by other factors, such as the definition of the baseline usage, synchronization of time between the client and the device containing the Load Control object, and any intrinsic limits on shed amounts that the device may have. If these factors are not in agreement, the client's determination of compliance may not match the object's determination.

The activity of a Load Control object in the SHED_REQUEST_PENDING state will vary. For a Load Control object controlling only one or more direct loads that it can shed instantly, the activity will be simply waiting for the first duty window to arrive, at which point it will monitor the clock and cycle on/off or begin modulation of loads or reduce loads by some other means. The object may need to begin shedding some of the loads before Start_Time in order to meet the shed target by Start_Time, in which case it will enter the SHED_NON_COMPLIANT state. For a Load Control object controlling other Load Control objects subordinate to it, the shedding activity will begin prior to Start_Time by communicating the shed request (possibly modified) to these other Load Control objects. There may be some Load Control objects that indicate an inability to comply with the request, which may lead to requests for increased load reduction from these or other Load Control objects.

While the Load Control object is designed to allow independent operation, it is possible that there will exist within a building (or even within a device) a hierarchy of Load Control objects, where one Load Control object receives a load shed command, possibly from a non-BACnet client (e.g., a utility), and the controller which hosts that object (the master) in turn will be responsible for managing and issuing requests to other Load Control objects. There may be a negotiation between the master and its subordinate Load Control objects. The master uses WriteProperty or WritePropertyMultiple to set shed request parameters in the subordinate Load Control objects. A subordinate Load Control object would then set its Expected_Shed_Level property to the value that it expects to be able to achieve after Start_Time. Before Start_Time, the master object can read the Expected_Shed_Level properties of its subordinates to determine expected compliance with the request. After Start_Time plus Duty_Window, the Actual_Shed_Level properties of the subordinate objects will reflect the actual amount shed in the past Duty_Window. If by reading these properties the master Load Control object determines that one or more subordinate objects cannot completely comply with the request, the master may choose to modify the shed requests to subordinates, such that the overall shed target is achieved. For instance, it may request that another object shed a greater amount of its load or it may choose to request that the noncompliant device shed a greater amount. This negotiation could be repeated at each successive level in the hierarchy. If the subordinate Load Control objects also support intrinsic reporting, expected or actual instances of non-compliance can be reported to the master object using event notifications.

Where large loads are concerned, it is expected that the master Load Control object will employ sequencing to distribute the startup and shutdown of managed loads. When the load control master is used in a gateway to a non-BACnet load control

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client, such as a utility company, the gateway shall accept and process any start randomization commands and accordingly distribute the initiation of load control requests to its subordinate Load Control objects.

The Load Control object shall exhibit restorative behavior across a restart or time change of the BACnet device in which it resides. The shed request property values shall be maintained across a device restart. Upon device restart or a time change, the object shall behave as if Start_Time were written and shall re-evaluate the state machine's state.

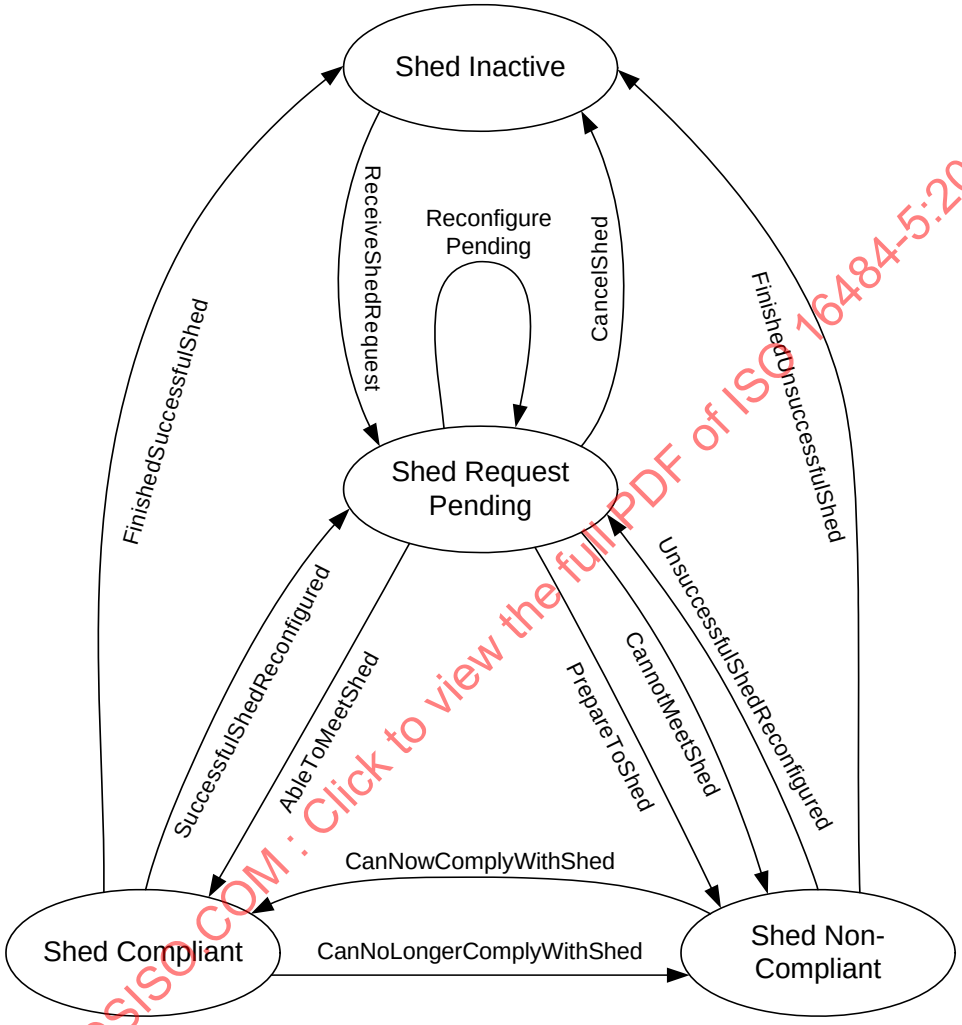

Figure 12-5. State Diagram for Load Control Object.

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SHED_INACTIVE

In the SHED_INACTIVE state, the Load Control object waits for a shed request.

ReceiveShedRequest
If Start_Time is written, the object shall calculate Expected_Shed_Level and Actual_Shed_Level and enter the SHED_REQUEST_PENDING state.

SHED_REQUEST_PENDING

In the SHED_REQUEST_PENDING state, the object makes a determination from the newly written shed parameters whether the shed request needs to be executed immediately or at some time in the future.

CancelShed
If the current time is after Start_Time plus Shed_Duration, this request is for an invalid time and is ignored. The object shall stop shedding and enter the SHED_INACTIVE state.

If Requested_Shed_Level is equal to the default value for the choice, or Start_Time contains an unspecified datetime, then this is a cancellation of shedding. The object shall stop shedding and enter the SHED_INACTIVE state.

ReconfigurePending
If the current time is prior to Start_Time, and a new write is received for Requested_Shed_Level, Shed_Duration, Duty_Window, or Start_Time, this is a reconfiguration of the shed request. The object shall calculate Expected_Shed_Level and Actual_Shed_Level and enter the SHED_REQUEST_PENDING state.

PrepareToShed
If the current time is prior to Start_Time, but the loads to be shed require time to decrease usage to the requested shed level, the object may choose to initiate shedding of its subordinates prior to Start_Time in order to be in compliance by Start_Time. If this approach is followed, the object shall calculate Expected_Shed_Level and Actual_Shed_Level and enter the SHED_NON_COMPLIANT state.

CannotMeetShed
If the current time is after Start_Time, and the object is unable to meet the shed request immediately, it shall begin shedding its loads, calculate Expected_Shed_Level and Actual_Shed_Level, and enter the SHED_NON_COMPLIANT state.

AbleToMeetShed
If the current time is after Start_Time and the object is able to achieve the shed request immediately, it shall shed its loads, calculate Expected_Shed_Level and Actual_Shed_Level, and enter the SHED_COMPLIANT state.

If the current time is before Start_Time, and the object has initiated shedding prior to Start_Time in order to be in compliance by Start_Time, and the object has achieved the requested shed level, it shall calculate Expected_Shed_Level and Actual_Shed_Level and enter the SHED_COMPLIANT state.

SHED_NON_COMPLIANT

In the SHED_NON_COMPLIANT state, the object attempts to meet the shed request until the shed is achieved, the object is reconfigured, or the request has completed unsuccessfully.

FinishedUnsuccessfulShed
If the current time is after Start_Time plus Shed_Duration, the shed request has completed unsuccessfully. The object shall stop shedding and enter the SHED_INACTIVE state.

UnsuccessfulShedReconfigured
If the object receives a write to any of the properties Requested_Shed_Level, Shed_Duration, Duty_Window, or Start_Time, the object shall enter the SHED_REQUEST_PENDING state.

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CanNowComplyWithShed

If the object has achieved the Requested_Shed_Level, it shall calculate Expected_Shed_Level and Actual_Shed_Level and enter the SHED_COMPLIANT state.

SHED_COMPLIANT

In the SHED_COMPLIANT state, the object continues meeting the shed request until the shed is either reconfigured or completes, or conditions change and the object is no longer able to maintain the requested shed level.

FinishedSuccessfulShed

If the current time is after Start_Time plus Shed_Duration, the shed request has completed successfully. The object shall stop shedding, set Start_Time to an unspecified datetime, and enter the SHED_INACTIVE state.

SuccessfulShedReconfigured

If the object receives a write to any of the properties Requested_Shed_Level, Shed_Duration, Duty_Window, or Start_Time, the object shall enter the SHED_REQUEST_PENDING state.

CanNoLongerComplyWithShed

If the object is no longer able to maintain the Requested_Shed_Level, it shall calculate Expected_Shed_Level and Actual_Shed_Level and enter the SHED_NON_COMPLIANT state.

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Table 12-32. Properties of the Load Control Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Present_Value	BACnetShedState	R
State_Description	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	O
Requested_Shed_Level	BACnetShedLevel	W
Start_Time	BACnetDateTime	W
Shed_Duration	Unsigned	W
Duty_Window	Unsigned	W
Enable	BOOLEAN	W
Full_Duty_Baseline	REAL	O
Expected_Shed_Level	BACnetShedLevel	R
Actual_Shed_Level	BACnetShedLevel	R
Shed_Levels	BACnetARRAY[N] of Unsigned	W[1]
Shed_Level_Descriptions	BACnetARRAY[N] of CharacterString	R
Notification_Class	Unsigned	O[2]
Time_Delay	Unsigned	O[2]
Event_Enable	BACnetEventTransitionBits	O[2]
Acked_Transitions	BACnetEventTransitionBits	O[2]
Notify_Type	BACnetNotifyType	O[2]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[2]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[3]
Profile_Name	CharacterString	O

[1] The elements of this array are required to be writable, although the array is not required to be resizable.
[2] These properties are required if the object supports intrinsic reporting.
[3] This property, if present, is required to be read only.

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12.28.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.28.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.28.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be LOAD_CONTROL.

12.28.4 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

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12.28.5 Present_Value

This property, of type BACnetShedState, indicates the current load shedding state of the object. See Figure 12-5 for a diagram of the state machine governing the value of Present_Value.

12.28.6 State_Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted. The State_Description provides additional information for human operators about the shed state of the Load Control object.

12.28.7 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of a Load Control object. Three of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device, otherwise logical FALSE (0).

OUT_OF_SERVICE This bit shall always be Logical FALSE (0).

12.28.8 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting and if the Reliability property is not present, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT. Changes in the Event_State property to the value FAULT are considered to be "fault" events.

12.28.9 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the Load Control object is reliably reporting its compliance with any load shed requests. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.28.10 Requested_Shed_Level

This property, of type BACnetShedLevel, indicates the desired load shedding. Table 12-33 describes the default values and power targets for the different choices of Requested_Shed_Level.

If the choice for Requested_Shed_Level is PERCENT, the value of Requested_Shed_Level is interpreted as a requested percentage of Full Duty to which the device is to attempt to reduce its load. The determination of the Full Duty rating (or some alternative baseline power usage) is a local matter. It may be determined from the Full_Duty_Baseline property, if present.

If the choice for Requested_Shed_Level is LEVEL, the value of Requested_Shed_Level is used to set a preconfigured level of load shedding.

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The Load Control object's available shed actions are described by the Shed_Level_Descriptions array and are mapped to the BACnet visible values of Requested_Shed_Level by the Shed_Levels array. The SHED_INACTIVE state shall always be represented by the value 0, which is not represented in the Shed_Levels or Shed_Level_Descriptions arrays. If Requested_Shed_Level choice is AMOUNT, the value of Requested_Shed_Level shall be interpreted as an amount, in kilowatts, by which to reduce power usage. Load Control objects are required to support the LEVEL choice. Support for the PERCENT and AMOUNT choices is optional. This allows a master to be guaranteed the ability to write to the Load Control object by using the LEVEL choice.

If a load control command has been issued, and execution of the command has completed, Requested_Shed_Level shall be reset to the default value appropriate to the choice of Requested_Shed_Level used for the last command.

Table 12-33. Requested_Shed_Level Default Values and Power Targets

Choice	Default Requested_Shed_Level value	Power load target in kW
PERCENT	100	(current baseline) * Requested_Shed_Level / 100
LEVEL	0	locally pre-specified shed target for the given level
AMOUNT	0.0	(current baseline) - Requested_Shed_Level

12.28.11 Start_Time

This property, of type BACnetDateTime, indicates the start of the duty window in which the load controlled by the Load Control object must be compliant with the requested shed. Load shedding (or determination of loads to shed) may need to begin before Start_Time in order to be compliant with the shed request by Start_Time. If no shed request is pending or active, Start_Time shall contain an unspecified datetime value. If a load control command has been issued, and execution of the command has completed, Start_Time shall be reset by the device to contain an unspecified datetime value. If a client wishes to initiate an immediate shed, it can set Start_Time to a value prior to the device's current time.

12.28.12 Shed_Duration

This property, of type Unsigned, indicates the duration of the load shed action, starting at Start_Time. The units for Shed_Duration are minutes. If no shed request is pending or active, Shed_Duration shall be zero. If a load control command has been issued, and execution of the command has completed, Shed_Duration shall be reset by the device to zero.

12.28.13 Duty_Window

This property, of type Unsigned, indicates the time window used for load shed accounting. The units for Duty_Window are minutes. Duty_Window is used for performance measurement or compliance purposes. The average power consumption across a duty window must be less than or equal to the requested reduced consumption. It is a local matter whether this window is fixed or sliding. The first Duty_Window begins at Start_Time. If a shed request is received with no value written to this property, Duty_Window shall be set to some pre-agreed upon value. If a load control command has been issued, and execution of the command has completed, Duty_Window shall be reset by the device to this pre-agreed value.

12.28.14 Enable

This property, of type BOOLEAN, indicates and controls whether the Load Control object is currently enabled to respond to load shed requests. If Enable is TRUE, the object will respond to load shed requests normally and follow the state machine described in Figure 12-5. If Enable is FALSE, the object will transition to the SHED_INACTIVE state if necessary and remain in that state. It shall not respond to any load shed request while Enable is FALSE.

12.28.15 Full_Duty_Baseline

This property, of type REAL, indicates the baseline power consumption value for the sheddable load controlled by this object, if a fixed baseline is used. Shed requests may be made with respect to this baseline, that is , to "percent of baseline" and "amount off baseline". The units of Full_Duty_Baseline are kilowatts.

12.28.16 Expected_Shed_Level

This property, of type BACnetShedLevel, indicates the amount of power that the object expects to be able to shed in response to a load shed request. When the object is in the SHED_INACTIVE state, this value shall be equal to the default value of Requested_Shed_Level. When a shed request is pending or active, Expected_Shed_Level shall be equal to the shed level the object expects to be able to achieve at Start_Time. Expected_Shed_Level allows a client (e.g., a master-level Load Control object) to determine if a pending shed request needs to be modified in order to achieve the requested shed level, in the event

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that Expected_Shed_Level is less than the Requested_Shed_Level. The units for Expected_Shed_Level are the same as the units for Requested_Shed_Level.

12.28.17 Actual_Shed_Level

This property, of type BACnetShedLevel, indicates the actual amount of power being shed in response to a load shed request. When the object is in the SHED_INACTIVE state, this value shall be equal to the default value of Requested_Shed_Level. After Start_Time plus Duty_Window has elapsed, this value shall be the actual shed amount as calculated based on the average value over the previous duty window. The units for Actual_Shed_Level are the same as the units for Requested_Shed_Level.

12.28.18 Shed_Levels

This property is a BACnetARRAY of unsigned integers representing the shed levels for the LEVEL choice of BACnetShedLevel that have meaning for this particular Load Control object. The array shall be ordered by increasing shed amount. When commanded with the LEVEL choice, the Load Control object shall take a shedding action described by the corresponding element in the Shed_Level_Descriptions array. If the Load Control object is commanded to go to a level that is not in the Shed_Levels array, it shall go to the Shed_Level whose entry in the Shed_Levels array has the nearest numerically lower value. The elements of the array are required to be writable, allowing local configuration of how this Load Control object will participate in load shedding for the facility. This array is not required to be resizable through BACnet write services. The size of this array shall be equal to the size of the Shed_Level_Descriptions array. The behavior of this object when the Shed_Levels array contains duplicate entries is a local matter.

12.28.19 Shed_Level_Descriptions

This property is a BACnetARRAY of character strings representing a description of the shed levels that the Load Control object can take on. This allows a local configuration tool to provide to a user an understanding of what each shed level in this Load Control object's load shedding algorithm will do. The level at which each shed action will occur can then be configured by writing to the Shed_Levels property.

12.28.20 Notification_Class

This property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.28.21 Time_Delay

This property, of type Unsigned, shall specify the minimum period of time in seconds that the Present_Value property shall remain equal to SHED_NON_COMPLIANT when the current time is after Start_Time and before a TO-OFFNORMAL event is generated, or not equal to SHED_NON_COMPLIANT before a TO-NORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.28.22 Event_Enable

This property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. This property is required if intrinsic reporting is supported by this object.

12.28.22.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must remain in the SHED_NON_COMPLIANT state for a minimum period of time, specified in the Time_Delay property,
(b) the TO-OFFNORMAL flag must be set in the Event_Enable property, and
(c) the current time is after Start_Time.

12.28.22.2 Conditions for Generating a TO-NORMAL Event

Once the Present_Value transitions to the SHED_NON_COMPLIANT state, a TO-NORMAL event is generated under these conditions:

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(a) the Present_Value leaves the SHED_NON_COMPLIANT state and remains out of this state for a minimum period of time, specified in the Time_Delay property, and
(b) the TO-NORMAL flag must be set in the Event_Enable property.

12.28.23 Acked_Transitions

This property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgements for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgement;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgement is expected); or
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgement is expected).

This property is required if intrinsic reporting is supported by this object.

12.28.24 Notify_Type

This property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.28.25 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.28.26 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.28.27 Profile_Name

This property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.29 Structured View Object Type

The Structured View object type defines a standardized object that provides a container to hold references to subordinate objects, which may include other Structured View objects, thereby allowing multilevel hierarchies to be created. The hierarchies are intended to convey a structure or organization such as a geographical distribution or application organization. Subordinate objects may reside in the same device as the Structured View object or in other devices on the network.

The Structured View object and its properties are summarized in Table 12-34 and described in detail in this subclause.

Table 12-34. Properties of the Structured View Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Node_Type	BACnetNodeType	R
Node_Subtype	CharacterString	O
Subordinate_List	BACnetARRAY[N] of BACnetDeviceObjectReference	R
Subordinate_Annotations	BACnetARRAY[N] of CharacterString	O
Profile_Name	CharacterString	O

12.29.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.29.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.29.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be STRUCTURED_VIEW.

12.29.4 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.29.5 Node_Type

This property, of type BACnetNodeType, provides a general classification of the object in the hierarchy of objects.

It is intended as a general suggestion to a client application about the contents of a Structured View object, and is not intended to convey an exact definition. Further refinement of classification is provided by the Node_Subtype property. The allowable values for this property are:

{UNKNOWN, SYSTEM, NETWORK, DEVICE, ORGANIZATIONAL, AREA, EQUIPMENT, POINT, COLLECTION, PROPERTY, FUNCTIONAL, OTHER}

Where the following are suggested interpretations:

UNKNOWN	Indicates that a value for Node_Type is not available or has not been configured at this time
SYSTEM	An entire mechanical system

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NETWORK	A communications network
DEVICE	Contains a set of elements which collectively represents a BACnet device, a logical device, or a physical device
ORGANIZATIONAL	Business concepts such as departments or people
AREA	Geographical concept such as a campus, building, floor, etc.
EQUIPMENT	Single piece of equipment that may be a collection of "Points"
POINT	Contains a set of elements which collectively defines a single point of data, either a physical input or output of a control or monitoring device, or a software calculation or configuration setting
COLLECTION	A generic container used to group things together, such as a collection of references to all space temperatures in a building
PROPERTY	Defines a characteristic or parameter of the parent node
FUNCTIONAL	Single system component such as a control module or a logical component such as a function block
OTHER	Everything that does not fit into one of these broad categories

12.29.6 Node_Subtype

This property, of type CharacterString, is a string of printable characters whose content is not restricted. It provides a more specific classification of the object in the hierarchy of objects, providing a short description of the item represented by the node.

12.29.7 Subordinate_List

This property is a BACnetARRAY of BACnetDeviceObjectReference that defines the members of the current Structured View.

By including references to 'child' Structured View objects, multilevel hierarchies may be created.

If the optional device identifier is not present for a particular Subordinate_List member, then that object must reside in the same device that maintains the Structured View object. If Subordinate_List is writable using WriteProperty services, the Subordinate_List may optionally be restricted to reference-only objects in the local device. To avoid recursion, it is suggested that a single Structured View object should be referenced only once in the hierarchy.

If the size of the Subordinate_List array is changed, the size of the Subordinate_Annotations array, if present, shall also be changed to the same size. Uninitialized Subordinate_List array elements shall be given the instance number 4194303.

A Subordinate_List array element whose instance number is equal to 4194303 shall be considered uninitialized and shall be ignored.

12.29.8 Subordinate_Annotations

This optional property, a BACnetARRAY of CharacterString, shall be used to define a text string description for each member of the Subordinate_List. The content of these strings is not restricted.

If the size of this array is changed, the size of the Subordinate_List array shall also be changed to the same size.

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12.29.9 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.30 Trend Log Multiple Object Type

A Trend Log Multiple object monitors one or more properties of one or more referenced objects, either in the same device as the Trend Log Multiple object or in an external device. When predefined conditions are met, the object saves ("logs") the value of the properties and a timestamp into an internal buffer for subsequent retrieval. The data may be logged periodically or when "triggered" by a write to the Trigger property. Errors that prevent the acquisition of the data, as well as changes in the status or operation of the logging process itself, are also recorded. Each timestamped buffer entry is called a "log record".

The Log_DeviceObjectProperty array holds the list of properties to be monitored and logged. If an element of the Log_DeviceObjectProperty array has an object or device instance number equal to 4194303, this indicates that the element is 'empty' or 'uninitialized'. For empty or uninitialized elements, an indication that no property was specified shall be written to the corresponding entry in each log record.

Each Trend Log Multiple object maintains an internal, optionally fixed-size, buffer in its Log_Buffer property. This buffer fills or grows as log records are added. If the buffer becomes full, the least recent log record is overwritten when a new log record is added, or collection may be set to stop. Trend Log Multiple buffers are transferred as a list of BACnetLogMultipleRecord using the ReadRange service. The buffer may be cleared by writing a zero to the Record_Count property. Each log record in the buffer has an implied SequenceNumber that is equal to the value of the Total_Record_Count property immediately after the log record is added.

Logging may be enabled and disabled through the Enable property and at dates and times specified by the Start_Time and Stop_Time properties. The enabling and disabling of record collection is recorded in the Log_Buffer.

Event reporting (notification) may be provided to facilitate automatic fetching of log records by processes on other devices such as fileservers. Mechanisms for both algorithmic and intrinsic reporting are provided.

In intrinsic reporting, when the number of records specified by the Notification_Threshold property has been collected since the previous notification (or startup), a new notification is sent to all subscribed devices.

In response to a notification, subscribers may fetch all of the new log records. If a subscriber needs to fetch all of the new log records, it should use the 'By Sequence Number' form of the ReadRange service request.

A missed notification may be detected by a subscriber if the 'Current Notification' parameter received in the previous BUFFER_READY notification is different than the 'Previous Notification' parameter of the current BUFFER_READY notification. If the ReadRange-ACK response to the ReadRange request issued under these conditions has the FIRST_ITEM bit of the 'Result Flags' parameter set to TRUE, Trend Log Multiple log records have probably been missed by this subscriber.

The acquisition of log records by remote devices has no effect upon the state of the Trend Log Multiple object itself. This allows completely independent, but properly sequential, access to its log records by all remote devices. Any remote device can independently update its records at any time.

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Table 12-35. Properties of the Trend Log Multiple Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	O
Enable	BOOLEAN	W
Start_Time	BACnetDateTime	O[1]
Stop_Time	BACnetDateTime	O[1]
Log_DeviceObjectProperty	BACnetARRAY[N] of BACnetDeviceObjectPropertyReference	R
Logging_Type	BACnetLoggingType	R
Log_Interval	Unsigned	R[2]
Align_Intervals	BOOLEAN	O[3]
Interval_Offset	Unsigned	O[3]
Trigger	BOOLEAN	O
Stop_When_Full	BOOLEAN	R
Buffer_Size	Unsigned32	R
Log_Buffer	List of BACnetLogMultipleRecord	R
Record_Count	Unsigned32	W
Total_Record_Count	Unsigned32	R
Notification_Threshold	Unsigned32	O[4]
Records_Since_Notification	Unsigned32	O[4]
Last_Notify_Record	Unsigned32	O[4]
Notification_Class	Unsigned	O[4]
Event_Enable	BACnetEventTransitionBits	O[4]
Acked_Transitions	BACnetEventTransitionBits	O[4]
Notify_Type	BACnetNotifyType	O[4]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[4]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[5]
Profile_Name	CharacterString	O

[1] If present, these properties are required to be writable.
[2] This property is required to be writable when Logging_Type has the value POLLED and is required to be read-only when Logging_Type has the value TRIGGERED.
[3] These properties are required to be present if the object supports clock-aligned logging.
[4] These properties are required to be present if the object supports intrinsic reporting.
[5] This property, if present, is required to be read only.

12.30.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.30.2 Object_Name

This property, of type CharacterString, shall represent a name for the Object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.30.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be TREND LOG MULTIPLE.

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12.30.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.30.5 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of a Trend Log Multiple object. The IN_ALARM and FAULT flags are associated with the values of other properties of this object. A more detailed status may be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN The value of this flag shall be Logical FALSE (0).

OUT_OF_SERVICE The value of this flag shall be Logical FALSE (0).

12.30.6 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL. The Event_State property of this object may have either of the following values:

{NORMAL, FAULT}

12.30.7 Reliability

This optional property, of type BACnetReliability, provides an indication of whether the application-specific properties of the object or the process executing the application program are "reliable" as far as the BACnet Device can determine. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, CONFIGURATION_ERROR, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.30.8 Enable

This property, of type BOOLEAN, indicates and controls whether (TRUE) or not (FALSE) logging of events and collected data is enabled. Logging occurs if and only if Enable is TRUE, Local_Time is on or after Start_Time, and Local_Time is before Stop_Time. If Start_Time contains an unspecified datetime, then it shall be considered equal to 'the start of time'. If Stop_Time contains an unspecified datetime, then it shall be considered equal to 'the end of time'. Log records of type log-status or no-data are recorded without regard to the value of the Enable property.

Attempts to write the value TRUE to the Enable property while Stop_When_Full is TRUE and Record_Count is equal to Buffer_Size shall cause a Result(-) response to be issued, specifying an 'Error Class' of OBJECT and an 'Error Code' of LOG_BUFFER_FULL.

12.30.9 Start_Time

This optional property, of type BACnetDateTime, specifies the date and time at or after which logging shall be enabled by this property. If this property contains an unspecified datetime, then the conditions for logging to be enabled by Start_Time shall be ignored. If Start_Time specifies a date and time after Stop_Time, then logging shall be disabled. This property shall be writable if present.

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When Start_Time is reached, the value of the Enable property is not changed.

12.30.10 Stop_Time

This optional property, of type BACnetDateTime, specifies the date and time at or after which logging shall be disabled by this property. If this property contains an unspecified datetime, then the conditions for logging to be disabled by Stop_Time shall be ignored. If Stop_Time specifies a date and time earlier than Start_Time, then logging shall be disabled. This property shall be writable if present.

When Stop_Time is reached, the value of the Enable property is not changed.

12.30.11 Log_DeviceObjectProperty

This property, of type BACnetARRAY of BACnetDeviceObjectPropertyReference, specifies the properties to be logged.

If this property is writable, it may be restricted to reference-only objects inside the device containing the Trend Log Multiple object. If the property is restricted to referencing objects within the containing device, an attempt to write a reference to an object outside the containing device into this property shall cause a Result(-) response to be issued, specifying an 'Error Class' of PROPERTY and an 'Error Code' of OPTIONAL_FUNCTIONALITY_NOT_SUPPORTED.

Elements of the Log_DeviceObjectProperty array containing object or device instance numbers equal to 4194303 are considered to be 'empty' or 'uninitialized'. An error shall be written to log record entries corresponding to these empty or uninitialized array elements, specifying an 'Error Class' of PROPERTY and an 'Error Code' of NO_PROPERTY_SPECIFIED.

If this property is changed, one of the following actions shall be taken:

Either the Log_Buffer shall be purged and a BUFFER_PURGED log-status record shall be recorded, or

Log data values corresponding to changed elements of the Log_DeviceObjectProperty array shall be purged by replacing the relevant log data values in each log record with errors, specifying an 'Error Class' of PROPERTY and an 'Error Code' of LOGGED VALUE PURGED.

The selection of which action to take is a local matter.

12.30.12 Logging_Type

This property, of type BACnetLoggingType, specifies whether the Trend Log Multiple collects records using polling or triggered acquisition.

COV Logging is not allowed for a Trend Log Multiple object. If this property is writable, an attempt to write the value COV into this property shall cause a Result(-) response to be issued, specifying an 'Error Class' of PROPERTY and an 'Error Code' of VALUE_OUT_OF_RANGE.

If the value POLLED is written to this property when the value of Log_Interval is zero, the Log_Interval property shall be updated with an appropriate default polling interval. Determination of the appropriate default polling interval is a local matter.

If the value TRIGGERED is written to this property when Log_Interval has a non-zero value, the Log_Interval property shall be updated with the value zero.

12.30.13 Log_Interval

This property, of type Unsigned, specifies the periodic interval in hundredths of seconds for which the referenced properties are to be logged when Logging_Type has the value POLLED. If Logging_Type has the value TRIGGERED, then the value of this property shall be zero and ignored.

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This property shall be writable if Logging_Type has the value POLLED, and shall be read-only if Logging_Type has the value TRIGGERED.

12.30.14 Align_Intervals

This optional property, of type BOOLEAN, specifies whether (TRUE) or not (FALSE) clock-aligned periodic logging is enabled. If periodic logging is enabled and the value of Log_Interval is a factor of (that is, it divides without remainder) a second, minute, hour or day, then the beginning of the period specified for logging shall be aligned to the second, minute, hour or day, respectively.

This property is required if the object supports clock-aligned logging. This property has no effect on the behavior of the Trend Log Multiple object if the Logging_Type property has a value other than POLLED.

12.30.15 Interval_Offset

This optional property, of type Unsigned, specifies the offset in hundredths of seconds from the beginning of the period specified for logging until the actual acquisition of a log record begins. The offset used shall be the value of Interval_Offset modulo the value of Log_Interval; i.e., if Interval_Offset has the value 31 and Log_Interval is 30, the offset used shall be 1. Interval_Offset shall have no effect if Align_Intervals = FALSE.

This property is required if the object supports clock-aligned logging.

12.30.16 Trigger

This optional property, of type BOOLEAN, shall cause the Trend Log Multiple object to acquire a log record whenever the value of this property is changed from FALSE to TRUE. It shall remain TRUE while the Trend Log Multiple object is acquiring the data items for a log record. When all log data items have been collected or it has been determined that all outstanding data requests will not be fulfilled, the Trend Log Multiple object shall reset the value to FALSE.

If the value of the Logging_Type property is not TRIGGERED and an attempt is made to write the value TRUE to the Trigger property, it is left as a local matter whether to execute the logging operation or not. For devices that choose not to execute triggered logging when Logging_Type is not equal to TRIGGERED, attempts to write the value TRUE to this property when Logging_Type has a value other than TRIGGERED shall cause a Result(-) response to be issued, specifying an 'Error Class' of PROPERTY and an 'Error Code' of NOT_CONFIGURED_FOR_TRIGGERED_LOGGING.

Writing to the Trigger property is not restricted to network visible write operations; internal processes may control the acquisition of samples by writing to this property.

12.30.17 Stop_When_Full

This property, of type BOOLEAN, specifies whether (TRUE) or not (FALSE) logging should cease when the Log_Buffer is full. When logging ceases because the addition of one more log record would cause the buffer to be full, Enable shall be set to FALSE and the event recorded.

If Stop_When_Full is writable, attempts to write the value TRUE to the Stop_When_Full property while Record_Count is equal to Buffer_Size shall result in the oldest log record in the Log_Buffer being discarded, and shall cause the Enable property to be set to FALSE and the event to be recorded.

12.30.18 Buffer_Size

This property, of type Unsigned32, shall specify the maximum number of records the Log_Buffer can hold. If writable, it may not be written when Enable is TRUE. The disposition of existing log records when Buffer_Size is written is a local matter.

12.30.19 Log_Buffer

This property is a list of BACnetLogMultipleRecord records. Each log record conveys either a set of recorded data values or errors related to data-collection, a status change in the Trend Log Multiple object, or an indication that the time and/or date was changed in the device hosting the Trend Log Multiple object.

Each log record has data fields as follows:

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Timestamp The local date and time when the record was stored.

LogData A set of recorded data values or errors related to data-collection, a status change in the Trend Log Multiple object itself, or an indication that the time and/or date was changed in the device hosting the Trend Log Multiple object.

The choices available for LogData are listed below:

log- status This choice represents a change in the status or operation of the Trend Log Multiple object. Whenever one of the events represented by the flags listed below occurs, a log record shall be appended to the Log_Buffer.

LOG_DISABLED This flag is changed whenever collection of log records by the Trend Log Multiple object is enabled or disabled. It shall be TRUE if Enable is FALSE, or the local time is outside the range defined by Start_Time and Stop_Time, or the addition of this log record will cause the Log_Buffer to be full and Stop_When_Full is TRUE; otherwise it shall be FALSE.

BUFFER_PURGED This flag shall be set to TRUE whenever the Log_Buffer is cleared by writing zero to the Record_Count property, or due to a change to the Log_DeviceObjectProperty property. After this value is recorded in the Log_Buffer, the subsequent immediate change to FALSE shall not be recorded. A log record indicating the purging of the Log_Buffer shall be placed into the buffer even if logging is disabled or outside of the time range defined by the Start_Time and Stop_Time properties.

LOG_INTERRUPTED This flag indicates that the collection of log records by the Trend Log Multiple object was interrupted by a power failure, device reset, object reconfiguration or other such disruption, such that samples prior to this record might have been missed.

log-data The set of logged values. The order of logged values shall correspond to the order of the Log_DeviceObjectProperty array.

boolean-value
real-value
enum-value
unsigned-value
signed-value
bitstring-value
null-value
These choices represent the data values and datatypes read from the monitored object and property.

any-value This choice represents the data values and datatypes read from the monitored object and property.

failure This choice indicates either that an entry in the Log_DeviceObjectProperty array contains an object or device instance equal to 4194303, that a previously logged value was purged, or that an error was encountered in an attempt to read a data value from the monitored object. If the error is conveyed by an error response from a remote device, the Error Class and Error Code in the response shall be recorded.

time-change This choice represents a change in the clock setting in the device; it records the number of

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seconds by which the clock changed. If the number is not known, such as when the clock is initialized for the first time, the value recorded shall be zero.

Also associated with each log record is an implied record number, the value of which is equal to Total_Record_Count at the point where the log record has been added into the Log_Buffer and Total_Record_Count has been adjusted accordingly. All clients must be able to correctly handle the case where the Log_Buffer is reset such that its Total_Record_Count is returned to zero and also the case where Total_Record_Count has wrapped back to zero.

The Log_Buffer is not network accessible except through the use of the ReadRange service, in order to avoid problems with record sequencing when segmentation is required. Attempts to read this property with the ReadProperty-Request or ReadPropertyMultiple-Request shall cause a Result(-) response to be issued, specifying an 'Error Class' of PROPERTY and an 'Error Code' of READ_ACCESS_DENIED.

12.30.20 Record_Count

This property, of type Unsigned32, shall represent the number of log records currently resident in the Log_Buffer. A write of the value zero to this property shall cause all log records in the Log_Buffer to be deleted and Records_Since_Notification to be reset to zero. Upon completion, this event shall be reported in the log as the initial entry.

12.30.21 Total_Record_Count

This property, of type Unsigned32, shall represent the total number of log records collected by the Trend Log Multiple object since creation. When the value of Total_Record_Count reaches its maximum possible value of 2^{32} - 1, the next value it takes shall be one. Once this value has wrapped to one, its semantic value (the total number of log records collected) has been lost but its use in generating notifications remains.

12.30.22 Notification_Threshold

This optional property, of type Unsigned32, shall specify the value of Records_Since_Notification at which notification occurs. This property is required if intrinsic reporting is supported by this object.

12.30.23 Records_Since_Notification

This optional property, of type Unsigned32, represents the number of log records collected since the previous notification, or since the beginning of logging if no previous notification has occurred. This property is required if intrinsic reporting is supported by this object.

12.30.24 Last_Notify_Record

This property, of type Unsigned32, represents the SequenceNumber associated with the most recently collected log record whose collection caused the value of the Records_Since_Notification property to become equal to or greater than the value of the Notification_Threshold property which triggered a notification. If no notification has occurred since logging began the value of this property shall be zero. This property is required if intrinsic reporting is supported by this object.

12.30.25 Notification_Class

This optional property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.30.26 Event_Enable

This optional property, of type BACnetEventTransitionBits, shall convey flags that separately enable and disable reporting of TO-FAULT and TO-NORMAL events.. This property is required if intrinsic reporting is supported by this object.

12.30.26.1 Conditions for Generating a TO-NORMAL Event

A TO-NORMAL event is generated if the TO-NORMAL flag is enabled in the Event_Enable property, and either:

(a) the value of the Records_Since_Notification property changes from being less than the value of Notification_Threshold to being equal to or greater than the value of Notification_Threshold, or
(b) the value of the Notification_Threshold property changes from being greater than the value of Records_Since_Notification to being equal to or less than the value of Records_Since_Notification, or
(c) the Reliability property changes to the value NO_FAULT_DETECTED.

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12.30.26.2 Conditions for Generating a TO-FAULT Event

A TO-FAULT event is generated if the TO-FAULT flag is enabled in the Event_Enable property, and the Reliability property changes to a value other than NO_FAULT_DETECTED.

12.30.27 Acked_Transitions

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

12.30.28 Notify_Type

This optional property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.30.29 Event_Time_Stamps

This optional property, of type BACnetARRAY [3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.30.30 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.30.31 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.31 Access Point Object Type

The Access Point object type defines a standardized object whose properties represent the externally visible characteristics associated with the authentication and authorization process of an access controlled point. (e.g., door, gate, turnstile). Access through this point is directional in that it represents access in one direction only. A door, in which access is controlled in both directions, is represented by two separate Access Point objects.

Authentication is the process of verifying the identity of an access user requesting access through an access-controlled door. This can be an authentication policy as simple as a single-factor authentication, in which one authentication factor (i.e., magnetic-stripe card, proximity-card, smart card) is used to identify a known user. In a multi-factor authentication policy, a combination of two or more authentication factors (e.g., card + PIN, card + biometric) are used to verify the identity of the access user. The Access Point object supports the definition of single-factor and multi-factor authentication policies, including the functionality to switch the policy in effect. On false attempts to authenticate, the Access Point may lock-down, for an infinite or specific amount of time.

Authorization is the process of determining whether the access user is permitted to access the zone that he or she has requested to enter. Once the access user has been authenticated successfully, a list of criteria is checked to determine whether access can be granted. If one or more of the authorization criteria fail, then the access user is denied access. Once the access user is granted access, the door will be commanded unlocked at the specified command priority and the access user can access the zone. The door which is controlled is specified in the Access Point. Authorization criteria supported by the Access Point are authorization modes, occupancy enforcement, external verification and threat level.

Authentication and authorization begins when an access user presents an authentication factor at the access controlled point. The process this object represents consumes the authentication factors from the corresponding Credential Data Input objects and performs the authentication and authorization functions. The result is to grant or deny access and to generate corresponding access events. If the object is out of service or not reliable, then these functions are not performed.

The Access Point object generates access events. Access events are stateless (i.e., NORMAL to NORMAL transitions only). A single access transaction, such as a request to enter or an operator action, can result in one or more access events. All access events that belong to the same access transaction have the same access event tag.

For intrinsic reporting, the ACCESS_EVENT algorithm is applied for both Access Alarm Events and Access Transaction Events:

Access Alarm Events: These are events requiring operator attention and handling, and the Access Point object may request human operator acknowledgement of these events.

Access Transaction Events: These are events that are to be logged, not requiring immediate operator attention. The Access Point object does not request human operator acknowledgement of these events.

Access Points which authorize entrance to an access controlled zone are entry points of that zone. Access Points which authorize exit from an access controlled zone are exit points of that zone. In the typical case a specific Access Point is an exit point from one zone and an entry point to an adjacent zone. If the Access Point leads from an Access Zone to no zone (i.e., outside), then the Access Point is an exit point only. If the Access Point leads from no zone (i.e., outside) to an Access Zone, then the Access Point is an entry point only. If the Access Point does not lead from or to an Access Zone (e.g., internal check point or muster point), then the Access Point is neither an entry nor an exit point.

Table 12-36. Properties of the Access Point Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Status_Flags	BACnetStatusFlags	R

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Event_State	BACnetEventState	R
Reliability	BACnetReliability	R
Out_Of_Service	BOOLEAN	R
Authentication_Status	BACnetAuthenticationStatus	R
Active_Authentication_Policy	Unsigned	R
Number_Of_Authentication_Policies	Unsigned	R
Authentication_Policy_List	BACnetARRAY[N] of BACnetAuthenticationPolicy	O[1]
Authentication_Policy_Names	BACnetARRAY[N] of CharacterString	O[1]
Authorization_Mode	BACnetAuthorizationMode	R
Verification_Time	Unsigned	O
Lockout	BOOLEAN	O[2]
Lockout_Relinquish_Time	Unsigned	O
Failed_Attempts	Unsigned	O
Failed_Attempt_Events	List of BACnetAccessEvent	O
Max_Failed_Attempts	Unsigned	O[3]
Failed_Attempts_Time	Unsigned	O[3]
Threat_Level	BACnetAccessThreatLevel	O
Occupancy_Upper_Limit_Enforced	BOOLEAN	O
Occupancy_Lower_Limit_Enforced	BOOLEAN	O
Occupancy_Count_Adjust	BOOLEAN	O
Accompaniment_Time	Unsigned	O
Access_Event	BACnetAccessEvent	R
Access_Event_Tag	Unsigned	R
Access_Event_Time	BACnetTimeStamp	R
Access_Event_Credential	BACnetDeviceObjectReference	R
Access_Event_Authentication_Factor	BACnetAuthenticationFactor	O
Access_Doors	BACnetARRAY[N] of BACnetDeviceObjectReference	R
Priority_For_Writing	Unsigned (1…16)	R
Muster_Point	BOOLEAN	O
Zone_To	BACnetDeviceObjectReference	O
Zone_From	BACnetDeviceObjectReference	O
Notification_Class	Unsigned	O[4]
Transaction_Notification_Class	Unsigned	O
Access_Alarm_Events	List of BACnetAccessEvent	O[4]
Access_Transaction_Events	List of BACnetAccessEvent	O[4]
Event_Enable	BACnetEventTransitionBits	O[4]
Acked_Transitions	BACnetEventTransitionBits	O[4]
Notify_Type	BACnetNotifyType	O[4]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[4]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[5]
Profile_Name	CharacterString	O

[1] The size of this array shall equal the value of the Number_Of_Authentication_Policies property.
[2] This property is required to be present if Lockout_Relinquish_Time is present.
[3] If this property is present, then the Failed_Attempts property shall be present.
[4] These properties are required to be present if the object supports intrinsic reporting.
[5] This property, if present, is required to be read only.

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12.31.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.31.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.31.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be ACCESS_POINT.

12.31.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.31.5 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of the Access Point. A more detailed status may be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT Logical TRUE (1) if the Reliability is not NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the Access Point has been overridden by some mechanism local to the BACnet Device. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0).

12.31.6 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. The allowed event states are NORMAL and FAULT. If the object does not support intrinsic reporting, then:

(a) if the Reliability is NO_FAULT_DETECTED, then Event_State shall be NORMAL, or
(b) if the Reliability is not NO_FAULT_DETECTED, then Event_State shall be FAULT.

12.31.7 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the authentication and authorization process this object represents is "reliable" as far as the BACnet Device can determine and, if not, why. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, PROCESS_ERROR, CONFIGURATION_ERROR,
COMMUNICATION_FAILURE, UNRELIABLE_OTHER}.

If Reliability has a value other than NO_FAULT_DETECTED, the process that this object represents shall not perform any authentication or authorization. No access events are generated in this case.

12.31.7.1 Conditions for Generating a TO-FAULT Event

A TO-FAULT event is generated under these conditions:

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(a) the Reliability property becomes not equal to NO_FAULT_DETECTED, and
(b) the TO-FAULT flag is set in the Event_Enable property.

12.31.7.2 Conditions for Generating a TO-NORMAL Event

A TO-NORMAL event is generated under these conditions:

(a) the Reliability property becomes equal to NO_FAULT_DETECTED, and
(b) the TO-NORMAL flag is set in the Event_Enable property.

12.31.8 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the authentication and authorization process this object represents is out of service. If out of service, then the process that this object represents shall not perform any authentication or authorization.

When this property changes from FALSE to TRUE, then the Access_Event property shall be set to OUT_OF_SERVICE. When this property changes from TRUE to FALSE, then the Access_Event property shall be set to OUT_OF_SERVICE_RELINQUISHED.

12.31.9 Authentication_Status

This property, of type BACnetAuthenticationStatus, shall indicate the current status of the authentication process. This is an enumeration with the following status values:

NOT_READY	The authentication process is not ready to perform a new authentication. This indicates a temporary condition due to processing of the current authentication factor, initialization during startup or other internal processing.
READY	The authentication process is ready to start a new authentication
DISABLED	The authentication process has been disabled. The property shall take on this status when the Out_Of_Service property is TRUE.
WAITING_FOR_AUTHENTICATION_FACTOR	The authentication process is waiting for an additional authentication factor for a multi-factor authentication.
WAITING_FOR_ACCOMPANIMENT	The authentication process is waiting for the authentication of the accompanying credential.
WAITING_FOR_VERIFICATION	The authentication process is waiting for the verification of the credential by an external process.
IN_PROGRESS	The authentication process is currently performing an authentication.

12.31.10 Active_Authentication_Policy

This property, of type Unsigned, shall specify the active authentication policy. The active authentication policy of this object shall be one of 'n' authentication policies, where 'n' is the number of authentication policies defined in the Number_Of_Authentication_Policies property.

The value of the Number_Of_Authentication_Policies property specifies the maximum value that can be written to Active_Authentication_Policy. If a value is written greater than the maximum value or specifies an index of an invalid entry in the Authentication_Policy_List property, if present, then the write attempt is denied and a Result(-) specifying an 'Error Class' of PROPERTY and an 'Error Code' of VALUE_OUT_OF_RANGE shall be returned.

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If the Authentication_Policy_List property is present, then the value of Active_Authentication_Policy property is an array index that corresponds to the authentication policy as specified in the Authentication_Policy_List property. If no valid authentication policy exists or the current active authentication policy is not valid (i.e., the Authentication_Policy_List entry is empty or not well formed), then this property shall take a value of zero. If the value of the Number_Of_Authentication_Policies property becomes less than the value of this property, then this property shall take a value of zero.

If this property has the value of zero, then the Reliability property shall have the value CONFIGURATION_ERROR.

12.31.11 Number_Of_Authentication_Policies

This property, of type Unsigned, shall specify the number of specified authentication policies. This property shall always have a value greater than zero. If the value of this property is changed, the size of the Authentication_Policy_List array and the size of the Authentication_Policy_Names array, if present, shall also be changed to the same value.

12.31.12 Authentication_Policy_List

This optional property, of type BACnetARRAY[N] of BACnetAuthenticationPolicy, specifies the authentication policies defined for this Access Point.

Each element in the array defines an authentication policy for this access point. The BACnetAuthenticationPolicy structure contains the following fields:

Policy — This field is a list of sequence elements that specifies the Credential Data Input objects which are used for this authentication policy. Each element of the list has the following fields:

- Credential-Data-Input — This field, of type BACnetDeviceObjectReference, contains a reference to an object of type Credential Data Input where the authentication factor value is read from the physical device.
- Index — This field, of type Unsigned, indicates the order in which the authentication process expects to receive authentication factors from Credential Data Input objects. The value shall start with the value 1 and continue in increasing sequence. If two or more entries of the Policy list have the same index value this indicates that there is a choice between any of the authentication factors supported by the Credential Data Input objects referenced by these entries. In this case the user may present any one of these authentication factors.

Order-Enforced — If TRUE, then the ordering sequence, as specified by the Index fields of this Policy list, is enforced. If FALSE, then the order is not enforced.

Timeout — This field, of type Unsigned, specifies the maximum time in seconds for which all authentication factors, as defined by this policy, must be presented. A value of zero indicates an unlimited time to present all authentication factors. If not all authentication factors are presented in the allotted time, then a timeout occurs and authentication fails.

An Authentication_Policy_List array element shall be considered invalid if the Policy field is empty or if it is not well formed. In this case the Reliability property shall have the value CONFIGURATION_ERROR. If a write to the Authentication_Policy_List property would cause an array element to be invalid, then a Result (-) shall be returned with an error class of PROPERTY and an error code of VALUE_OUT_OF_RANGE.

If this property is not present, then the authentication policies are a local matter.

The size of this array shall equal the value of the Number_Of_Authentication_Policies property.

12.31.12.1 Reading Authentication Factors

The authentication factors to be read are determined by the current authentication policy in effect. If the Authentication_Policy_List property is present, the authentication policy is explicitly defined and specifies which Credential Data Input objects the authentication factors are read from. When any authentication factor is read, then the Access_Event property shall be set to AUTHENTICATION_FACTOR_READ.

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If the authentication factor read does not match any known authentication factor or the authentication factor read has an error (i.e., has a format type of ERROR), then authentication shall fail and access shall not be granted. In the case where the authentication factor is unknown the Access Event property shall be set to DENIED_UNKNOWN_CREDENTIAL. In the case where the authentication factor has an error, then the Access_Event property shall be set to DENIED_AUTHENTICATION_FACTOR_ERROR.

It may be possible with certain credential readers to signal a duress code when reading an authentication factor. Determining when a duress code has been read is a local matter. In this case the Access_Event property shall be set to DURESS.

12.31.12.1.1 Single-Factor Authentication

In single-factor authentication, only one authentication factor is required to identify and authenticate the access credential. Depending on the current authentication policy, the access user may have a choice of multiple credentials to use.

12.31.12.1.2 Multi-Factor Authentication

In multi-factor authentication, two or more authentication factors are used for authentication. Typically when multiple factors are used, the first authentication factor is used to identify the credential while the subsequent authentication factors are used to validate the identity. All authentication factors of a multi-factor authentication are expected to be configured in the same Access Credential object.

If a timeout is specified for the current authentication policy and not all authentication factors are read within that time, then authentication shall fail and access shall not be granted. In this case the Access_Event property is set to DENIED_AUTHENTICATION_FACTOR_TIMEOUT.

If one of the authentication factors presented is not the value expected or is presented in an incorrect order, then it is a local matter as to whether authentication fails immediately or whether the access user is given subsequent chances to present the correct authentication factor. If authentication fails immediately, then the Access_Event property shall be set to DENIED_INCORRECT_AUTHENTICATION_FACTOR. If the access user is allowed subsequent chances but fails to present the correct authentication factor within a certain number of attempts, then the Access_Event property shall be set to DENIED_MAX_ATTEMPTS. The maximum number of attempts the access user is allowed is a local matter.

12.31.12.1.3 External Authentication

If the authentication decision is made by an external process, such as a remote server, it may be possible that the authentication process becomes unavailable. When this occurs and when there is no secondary authentication process available, then the authentication shall fail and the Access_Event property shall be set to DENIED_AUTHENTICATION_UNAVAILABLE.

12.31.12.2 Initializing New Array Elements When the Array Size is Increased

If the size of the Authentication_Policy_List array is increased without initial values being provided, then the new array elements for which no initial value is provided shall be initialized with an empty Policy list, Order-Enforced shall be FALSE, and Timeout shall have the value zero.

12.31.13 Authentication_Policy_Names

This optional property, of type BACnetARRAY [N] of CharacterString, specifies the names of the defined authentication policies.

The size of this array shall equal the value of the Number_Of_Authentication_Policies property

12.31.14 Authorization_Mode

This property, of type BACnetAuthorizationMode, determines how authorization is performed at the Access Point. An Access Point object is not required to support all of these authorization modes but is required to support at least AUTHORIZE.

AUTHORIZE	The access rights of an active credential are evaluated, in addition to other possible authorization checks.

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GRANT_ACTIVE	An active credential is granted access without evaluating the access rights assigned to the credential. Other authorization checks can still lead to denying access.
DENY_ALL	All credentials are denied access and the Access_Event property is set to DENIED_DENY_ALL. When a credential has a master exemption it is granted access unless other authorization checks fail.
VERIFICATION_REQUIRED	The access rights of an active credential are evaluated, in addition to other possible authorization checks. Granting access requires external verification. In this case the Access_Event property is set to VERIFICATION_REQUIRED and the access point waits for the external verification. The external verification process and the mechanism by which the verification result is provided to the access point is a local matter. If the external verification process denies access, then the Access_Event property shall be set to DENIED_VERIFICATION_FAILED. If there is no external verification result within the time specified by the Verification_Time property, then the Access_Event property shall be set to DENIED_VERIFICATION_TIMEOUT.
AUTHORIZATION_DELAYED	The access rights of an active credential are evaluated, in addition to other possible authorization checks. Granting access is delayed by the time specified by the Verification_Time property. This provides an external verification process the opportunity to deny access. In this case the Access_Event property is set to AUTHORIZATION_DELAYED and the access point waits for the external verification. The external verification process and the mechanism by which the verification result is provided to the access point is a local matter. If the external verification process denies access within the time specified in the Verification_Time property, then the Access_Event property shall be set to DENIED_VERIFICATION_FAILED. If there is no external verification result within the time specified by the Verification_Time property, then this authorization check succeeded.
NONE	No authorization functionality takes place at this access point and no authorization events (e.g., grant or any deny events) are generated. This may be used to implement special access point functionality, such as a guard tour or muster point, where authorization checks are not required.
<Proprietary Enum Values>	A vendor may use other proprietary enumeration values to allow proprietary authorization modes other than those defined by the standard. For proprietary extensions of this enumeration, see Clause 23.1 of this standard.

12.31.14.1 Authorization Decision

Authorization is the process of determining whether or not the credential that has been used to request access at an access point will be permitted access. The authorization process completes when the access decision to grant or deny has been reached. Typically there are multiple authorization criteria used to determine if access will be granted. Examples of authorization criteria are checking access rights, checking passback violations, checking threat level, checking occupancy limits, etc. It is a local matter as to what order the authorization criteria are checked. The authorization criteria used to determine whether access is allowed may change according to the time of day, the location and the credential used.

If all authorization criteria are successful, then the credential is granted access at the access point. In this case, the Access_Event property shall be set to GRANTED.

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If even one authorization check fails, then access is denied and the Access_Event property is set to the appropriate deny event. If there is no access event, either defined or proprietary, which is specific to the actual reason why access was denied, then the Access_Event property shall be set to DENIED_OTHER.

Access may be denied if the authorization process detects an inconsistency with the access request, such as when an access user requests access to a zone but there is no record of that access user being in the building. How the inconsistency is determined is a local matter. In this case access is denied and the Access_Event property shall be set to DENIED_UNEXPECTED_LOCATION_USAGE.

12.31.15 Verification_Time

This optional property, of type Unsigned, shall specify the time, in seconds, to wait for external verification when the Authorization_Mode property has a value of AUTHORIZATION_DELAYED or VERIFICATION_REQUIRED.

12.31.16 Lockout

This optional property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the access controlled point this object represents is in a lockout state. When the access point is in a lockout state, any access request shall always be denied, except for an active credential that has a master exemption. For each denied access request, the Access_Event property shall be set to DENIED_LOCKOUT. An Access Point object may be set to a lockout state due to too many failed access attempts, as defined in the Max_Failed_Attempts property, or by writing TRUE to this property.

When the property Lockout becomes TRUE due to too many failed access attempts, then the Access_Event property shall be set to LOCKOUT_MAX_ATTEMPTS. If TRUE is written to this property for any other reason, the Access_Event property shall be set to LOCKOUT_OTHER. When the Lockout property becomes FALSE, the Access_Event property shall be set to LOCKOUT_RELINQUISHED.

If the Lockout property is present, then the Lockout_Relinquish_Time property shall also be present.

12.31.17 Lockout_Relinquish_Time

This optional property, of type Unsigned, shall specify the time, in seconds, to delay after the Lockout property has taken on the value TRUE, before automatically relinquishing the lockout state. The lockout state is relinquished by setting the Lockout property to FALSE. A value of zero indicates that the lockout state will not automatically be relinquished.

If the Lockout_Relinquish_Time is present, then the Lockout property shall also be present.

12.31.18 Failed_Attempts

This optional property, of type Unsigned, shall indicate the current count of successive failed access attempts. Any successive failed access attempt shall increment the value of this property.

This property shall be set to zero when a successful access attempt occurs or when the property Lockout becomes FALSE.

12.31.19 Failed_Attempt_Events

This optional property, of type List of BACnetAccessEvent, specifies those access events that are counted as a failed access attempt.

If this property is not present, it is a local matter as to which access events are considered a failed attempt.

12.31.20 Max_Failed_Attempts

This optional property, of type Unsigned, shall specify the maximum number of successive failed access attempts before the Lockout property is set to TRUE. If the Failed_Attempts property becomes greater than or equal to the value of this property and this property is not zero, the Lockout property is set to TRUE. Zero indicates that the Lockout property is not set to TRUE as the result of failed access attempts.

If the Max_Failed_Attempts property is present, then the Failed_Attempts property shall also be present.

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12.31.21 Failed_Attempts_Time

This optional property, of type Unsigned, shall specify the time, in seconds, to delay before setting the Failed_Attempts property to zero, after the last failed access attempt.

If the Failed_Attempts_Time is present, then the Failed_Attempts property shall also be present.

12.31.22 Threat_Level

This optional property, of type BACnetAccessThreatLevel, shall specify the current threat level for this Access Point. Zero is the lowest threat level, effectively disabling the threat level check, while 100 is the maximum threat level. If the threat authority of the authenticated credential is lower than the value of this property, then the authorization fails. In this case the Access_Event property shall be set to DENIED_THREAT_LEVEL.

12.31.23 Occupancy_Upper_Limit_Enforced

This optional property, of type BOOLEAN, indicates whether the upper occupancy limit of the access controlled zone, for which this object is an entry point, is enforced (TRUE) or not (FALSE). If enforced, authorization shall fail if the access controlled zone's occupancy is greater than or equal to its upper occupancy limit, unless the credential is exempted from this authorization check. When this authorization check fails, the Access_Event property shall be set to DENIED_UPPER_OCCUPANCY_LIMIT.

12.31.24 Occupancy_Lower_Limit_Enforced

This optional property, of type BOOLEAN, indicates whether the lower occupancy limit of the access controlled zone, for which this object is an exit point, is enforced (TRUE) or not (FALSE). If enforced, authorization shall fail if the access controlled zone's occupancy is lower than or equal to its lower occupancy limit, unless the credential is exempted from this authorization check. When this authorization check fails, the Access_Event property shall be set to DENIED_LOWER_OCCUPANCY_LIMIT.

12.31.25 Occupancy_Count_Adjust

This optional property, of type BOOLEAN, indicates whether (TRUE) this object will adjust the occupancy count of the zones for which it controls access, or not (FALSE). The occupancy count is decremented for the zone for which this Access Point is an exit point and incremented for the zone for which this Access Point is an entry point.

Occupancy count shall be adjusted if the credential holder passes through the access point. How this is determined is a local matter. The occupancy count of the zones is adjusted by writing a negative amount to the Adjust_Value property of the exit access zone and the corresponding positive amount to the Adjust_Value property of the entry access zone.

If this property is not supported, then the Access Point object behaves as if the value is FALSE.

12.31.26 Accompaniment_Time

This optional property, of type Unsigned, shall specify the time, in seconds, to wait for a second credential to be presented at this access point when the original credential requires accompaniment. If an accompanying credential is not presented within this time the authorization of the original credential shall fail and the Access_Event property shall be set to DENIED_NO_ACCOMPANIMENT.

12.31.27 Access_Event

This property, of type BACnetAccessEvent, indicates the last access event which occurred at this Access Point.

BACnetAccessEvent is an enumeration of authentication and authorization decisions, subsequent actions, and results of these actions. An Access Point is not required to support all values of this enumeration.

NONE	The access point did not yet determine any access event or the object is not generating access events. This is not a reported event. It is required to enable algorithmic ACCESS_EVENT reporting.
GRANTED	Access granted to the presented credential.

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MUSTER	If the access point is a muster point, a muster event is generated when a credential is presented.
PASSBACK_DETECTED	A passback violation for the presented credential has been detected.
DURESS	A duress incident was detected at this access point.
TRACE	A traced credential has been presented.
LOCKOUT_MAX_ATTEMPTS	The access point is in a lockout state due to maximum failed access attempts.
LOCKOUT_OTHER	The access point is in a lockout state due to any reason other than maximum failed access attempts.
LOCKOUT_RELINQUISHED	The access point has relinquished the lockout state.
LOCKED_BY_HIGHER_PRIORITY	The controlled Access Door object is commanded at a higher priority.
OUT_OF_SERVICE	The Out_Of_Service flag of the Access Point object has been set to TRUE.
OUT_OF_SERVICE_RELINQUISHED	The Out_Of_Service flag of the Access Point object has been set to FALSE.
ACCOMPANIMENT_BY	The credential presented accompanies the previous credential.
AUTHENTICATION_FACTOR_READ	An authentication factor has been read. This event indicates a successful read of an authentication factor in single-factor or multi-factor authentication.
AUTHORIZATION_DELAYED	Authorization of a credential is delayed to allow time for an external process to deny access.
VERIFICATION_REQUIRED	Authorization of a credential requires verification from an external process.
NO_ENTRY_AFTER_GRANTED	Access was granted to the presented credential but the physical door was not opened.
DENIED_DENY_ALL	Access denied because the Authorization_Mode property of the Access Point object is set to DENY_ALL.
DENIED_UNKNOWN_CREDENTIAL	Access denied due to an unknown credential. The authentication factor presented did not match any known authentication factor.
DENIED_AUTHENTICATION_UNAVAILABLE	Access denied because the authentication and authorization decision is unavailable.
DENIED_AUTHENTICATION_FACTOR_TIMEOUT	Access denied due to required authentication factor for multi-factor authentication not being presented within time.
DENIED_INCORRECT_AUTHENTICATION_FACTOR	Access denied due to the authentication factor presented for a multi-factor-authentication not being the one expected.
DENIED_POINT_NO_ACCESS_RIGHTS	Access denied due to evaluation of TRUE of a negative access rule for the access point.

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DENIED_ZONE_NO_ACCESS_RIGHTS	Access denied due to evaluation of TRUE of a negative access rule for the access zone.
DENIED_NO_ACCESS_RIGHTS	Access denied due to no positive access rule being found for the access zone or access point.
DENIED_OUT_OF_TIME_RANGE	Access denied due to the presented credential not being valid at this access point or access zone at this time.
DENIED_THREAT_LEVEL	Access denied due to insufficient threat authority for the presented credential.
DENIED_PASSBACK	Access denied due to a passback violation for the presented credential.
DENIED_UNEXPECTED_LOCATION_USAGE	Access denied due to the credential being used at a location which violates local consistency rules.
DENIED_MAX_ATTEMPTS	Access denied due to too many failed multi-factor access attempts at the access point.
DENIED_LOWER_OCCUPANCY_LIMIT	Exit from a zone for which this access point is an exit access point is denied due to zone occupancy being below or at the minimum limit.
DENIED_UPPER_OCCUPANCY_LIMIT	Access to a zone for which this access point is an entry access point is denied due to zone occupancy being at or above the maximum limit.
DENIED_AUTHENTICATION_FACTOR_LOST	Access denied due to the authentication factor used being reported as lost.
DENIED_AUTHENTICATION_FACTOR_STOLEN	Access denied due to the authentication factor used being reported as stolen.
DENIED_AUTHENTICATION_FACTOR_DAMAGED	Access denied due to the authentication factor used being reported as damaged.
DENIED_AUTHENTICATION_FACTOR_DESTROYED	Access denied due to the authentication factor used being reported as destroyed.
DENIED_AUTHENTICATION_FACTOR_DISABLED	Access denied due to the authentication factor used being disabled for unspecified or unknown reasons.
DENIED_AUTHENTICATION_FACTOR_ERROR	Access denied due to the authentication factor used having a read error.
DENIED_CREDENTIAL_UNASSIGNED	Access denied due to the credential used not having yet been assigned to an access user.
DENIED_CREDENTIAL_NOT_PROVISONED	Access denied due to the credential used not yet having been provisioned.
DENIED_CREDENTIAL_NOT_YET_ACTIVE	Access denied due to the credential used not yet being active.
DENIED_CREDENTIAL_EXPIRED	Access denied due to the credential used having expired.
DENIED_CREDENTIAL_MANUAL_DISABLE	Access denied due to the credential used having been manually disabled.
DENIED_CREDENTIAL_LOCKOUT	Access denied due to the credential used being locked out.

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DENIED_CREDENTIAL_MAX_DAYS	Access denied due to the number of days the credential may be used having been exceeded.
DENIED_CREDENTIAL_MAX_USES	Access denied due to the number of allowed uses of the credential used has been exceeded.
DENIED_CREDENTIAL_INACTIVITY	Access denied due to the credential used being disabled after a period of inactivity.
DENIED_CREDENTIAL_DISABLED	Access denied due to the credential used being disabled for unspecified or unknown reasons.
DENIED_NO_ACCOMPANIMENT	Access denied due to the expected accompanying credential not being presented.
DENIED_INCORRECT_ACCOMPANIMENT	Access denied due to the accompanying credential presented being incorrect
DENIED_LOCKOUT	Access denied due to the access point being in lockout state.
DENIED_VERIFICATION_FAILED	Access denied due to an external process denying access when verification was required.
DENIED_VERIFICATION_TIMEOUT	Access denied due to an external process having failed to send a response, in the allotted time, when verification was required.
DENIED_OTHER	Access is denied for unspecified reasons.
<Proprietary Enum Values>	A vendor may use other proprietary enumeration values to indicate Access Events other than those defined by this standard. For proprietary extensions of this enumeration, see Clause 23.1 of this standard.

12.31.27.1 Operations for setting the Access_Event property

When a new event occurs at the access point, the following series of operations shall be performed atomically:

The value written to Access_Event shall be stored in the Access_Event property,

(1) If this event is the start of a new access transaction, the value of the Access_Event_Tag property shall be incremented.
(2) The current date and time shall be stored in the Access_Event_Time property.
(3) The reference to the Access Credential object that is associated with this event shall be stored in the Access_Event_Credential property. See Clause 12.31.30 for other conditions.
(4) The value of the authentication factor that is associated with this event shall be stored in the Access_Event_Authentication_Factor property. See Clause 12.31.31 for other conditions.

12.31.28 Access_Event_Tag

This property, of type Unsigned, is a numeric value which identifies the access transaction to which the current access event belongs. Multiple access events may be generated by a single access transaction.

The value of this property shall increase monotonically for each new access transaction. It may be implemented using modulo arithmetic. The initial value of this property before any access transaction has occurred shall be a local matter.

12.31.29 Access_Event_Time

This property, of type BACnetTimeStamp, indicates the most recent update time of the Access_Event property. This property shall update its value on each update of Access_Event. Update times of type Time or Date shall have X'FF' in each octet, and Sequence number update times shall have the value 0 if no update has yet occurred.

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12.31.30 Access_Event_Credential

This property, of type BACnetDeviceObjectReference, shall specify the Access Credential object that corresponds to the access event specified in the Access_Event property, if applicable.
This property shall contain 4194303 in the instance part of the object identifier and in the device instance part of the device identifier, if present, under the following conditions:

(a) there is no credential recognized up to now, or
(b) there is no credential that is associated to the current access event, or
(c) the credential of the authentication factor that is associated to the current event is unknown, or
(d) the device chooses not to expose the credential.

12.31.31 Access_Event_Authentication_Factor

This optional property, of type BACnetAuthenticationFactor, shall specify the authentication factor that corresponds to the access event specified in the Access_Event property, if applicable. Otherwise it shall contain a value of format type UNDEFINED.

This property shall contain a value of format type UNDEFINED under the following conditions:

(a) there was no authentication factor read up to now, or
(b) there is no authentication factor that is associated to the current access event, or
(c) the device chooses not to expose the authentication factor.

12.31.32 Access_Doors

This property, of type BACnetARRAY[N] of BACnetDeviceObjectReference, shall specify the references to those Access Door objects whose Present_Value properties are commanded after successful authorization. If this Access Point object does not command Access Door objects (e.g., muster point), or is used to control access to other resources or functions, or commands other objects, then this array shall be empty.

12.31.32.1 Commanding Access Doors

After successful authorization the following actions occur:

(1) The Access_Event property shall be set to GRANTED, and
(2) The physical doors, as specified in the Access_Doors property, are commanded with either a PULSE_UNLOCK or EXTENDED_PULSE_UNLOCK door command, at the priority specified by the Priority_For_Writing property.

Commanding the doors may fail due to a higher priority command in effect in the Access Door object. In this case the Access_Event property shall be set to LOCKED_BY_HIGHER_PRIORITY.

The respective Access Doors may be monitored to verify that they are opened and access takes place. If no access takes place, the Access_Event property shall be set to NO_ENTRY_AFTER_GRANTED.

12.31.33 Priority_For_Writing

This property, of type Unsigned (1..16), defines the priority at which the referenced Access Door object's Present_Value properties are commanded. It corresponds to the 'Priority' parameter of the WriteProperty service. The value 1 is considered the highest priority and 16 the lowest. See Clause 19.2.

12.31.34 Muster_Point

This optional property, of type BOOLEAN, indicates whether this Access Point generates muster access events (TRUE) or not (FALSE).

A muster event is generated by setting the Access_Event property to MUSTER after an access credential has been presented at the access point. It is a local matter as to whether a muster event is generated for unknown credentials.

12.31.35 Zone_To

This optional property, of type BACnetDeviceObjectReference, shall specify the Access Zone object for which this Access Point object is an entry access controlled point, allowing entrance to the zone. This property shall not reference the same

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Access Zone object as the Zone_From property. If the Access Point is not an entry point to an access controlled zone, then this property shall contain 4194303 in the instance part of the object identifier and in the device instance part of the device identifier, if present.

12.31.36 Zone_From

This optional property, of type BACnetDeviceObjectReference, shall specify the Access Zone object for which this Access Point object is an exit access controlled point, allowing exit from the zone. This property shall not reference the same Access Zone object as the Zone_To property. If the Access Point is not an exit point from an access controlled zone, then this property shall contain 4194303 in the instance part of the object identifier and in the device instance part of the device identifier, if present.

12.31.37 Notification_Class

This optional property, of type Unsigned, shall specify the notification class to be used when generating Access Alarm Event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.31.38 Transaction_Notification_Class

This optional property, of type Unsigned, shall specify the notification class of Access Transaction Events. The Transaction_Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. If this property is not present, then the Notification Class specified by the property Notification_Class shall be used for Access Transaction Events.

12.31.39 Access_Alarm_Events

This optional property, of type List of BACnetAccessEvent, shall specify any access events which are reported as Access Alarm Events. This property is required if intrinsic reporting is supported by this object.

An Access Alarm Event is reported when the following conditions are true:

(a) The Access_Event is updated and the updated value is equal to one of the values in Access_Alarm_Events, and
(b) the TO-NORMAL flag is enabled in the Event_Enable property.

The notification is sent with Notify Type as specified by the property Notify_Type.

The Notification Class object referenced by the Notification_Class property is used to report Access Alarm Events.

12.31.40 Access_Transaction_Events

This optional property, of type List of BACnetAccessEvent, shall specify any access events that are reported as Access Transaction Events. This property is required if intrinsic reporting is supported by this object.

An Access Transaction Event is reported when the following conditions are true:

(a) the Access_Event is updated and the updated value is equal to one of the values in Access_Transaction_Events, and
(b) the TO-NORMAL flag is set in the Event_Enable property.

The value of Notify_Type is ignored and the notification is sent with a Notify Type of EVENT. The Event_Time_Stamps TO-NORMAL element is not affected. The Acked_Transitions TO_NORMAL bit is not affected.

The Notification Class object referenced by the Transaction_Notification_Class property is used to report Access Transaction Events. If Transaction_Notification_Class is not present, the Notification Class object referenced by Notification_Class is used. The Ack_Required property of the respective Notification Class object is ignored and the value FALSE is conveyed in the AckRequired parameter of the event notification message.

12.31.41 Event_Enable

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT and TO-NORMAL events.

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This property is required if intrinsic reporting is supported by this object.

12.31.42 Acked_Transitions

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

12.31.43 Notify_Type

This optional property, of type BACnetNotifyType, shall convey whether the Access Alarm Event notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

Access Transaction Events generated by the object are always of type EVENT, regardless of the value of this property.

12.31.44 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.31.45 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.31.46 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name shall begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.32 Access Zone Object Type

The Access Zone object type defines a standardized object whose properties represent the externally visible characteristics associated with a secured geographical zone for which authentication and authorization of a credential takes place to obtain physical access. Entrance to the zone takes place through entry access controlled points while the zone is exited through exit access controlled points. These access controlled points are represented by Access Point objects.

The Access Zone object may optionally support occupancy counting and the specification of occupancy limits. Access may be denied if limits are violated. The enforcement rules are specified at the corresponding entry and/or exit Access Point objects. The Access Zone object's Occupancy_State is the state of occupancy. This state is derived from the actual occupancy count and occupancy limits.

Intrinsic reporting of this object is based on the Occupancy_State property and uses the CHANGE_OF_STATE algorithm.

"Who's in" reporting is supported through a list of the credentials which are currently in the zone. Credentials are added on successful entrance through an access controlled entry point and removed on successful exit through an access controlled exit point. This list may also be maintained based on time conditions or other local methods.

The Access Zone object supports passback detection and allows the selection of hard, soft or no-passback enforcement. A passback violation occurs when entrance to this zone is requested at an access controlled point while the credential is assumed to be in this zone. The list of credentials in this zone may be used to detect a passback violation.

A specific access controlled zone may be represented by a single Access Zone object in a single device, or in multiple devices by one Access Zone object per device. When an access controlled zone is represented in multiple devices, the representing Access Zone objects may not have the same Object_Identifier in each device; however, they may be identified using the Global_Identifier property. It is a local matter as to how these objects are synchronized.

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Table 12-37. Properties of the Access Zone Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Global_Identifier	Unsigned32	W
Occupancy_State	BACnetAccessZoneOccupancyState	R
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Reliability	BACnetReliability	R[1]
Out_Of_Service	BOOLEAN	R
Occupancy_Count	Unsigned	O[1,3,4]
Occupancy_Count_Enable	BOOLEAN	O[3,4]
Adjust_Value	INTEGER	O[3,4,5]
Occupancy_Upper_Limit	Unsigned	O
Occupancy_Lower_Limit	Unsigned	O
Credentials_In_Zone	List of BACnetDeviceObjectReference	O
Last_Credential_Added	BACnetDeviceObjectReference	O
Last_Credential_Added_Time	BACnetDateTime	O
Last_Credential_Removed	BACnetDeviceObjectReference	O
Last_Credential_Removed_Time	BACnetDateTime	O
Passback_Mode	BACnetAccessPassbackMode	O
Passback_Timeout	Unsigned	O[2]
Entry_Points	List of BACnetDeviceObjectReference	R
Exit_Points	List of BACnetDeviceObjectReference	R
Time_Delay	Unsigned	O[3]
Notification_Class	Unsigned	O[3]
Alarm_Values	List of BACnetAccessZoneOccupancyState	O[3]
Event_Enable	BACnetEventTransitionBits	O[3]
Acked_Transitions	BACnetEventTransitionBits	O[3]
Notify_Type	BACnetNotifyType	O[3]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[3]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[6]
Profile_Name	CharacterString	O

[1] These properties, if present, shall be writeable when Out_Of_Service is TRUE.
[2] If this property is present, then Passback_Mode shall be present.
[3] These properties are required if the object supports intrinsic reporting.
[4] These properties are required if the object supports occupancy counting.
[5] The Adjust_Value property shall be writeable if present.
[6] This property, if present, is required to be read only.

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12.32.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.32.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

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12.32.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be ACCESS_ZONE.

12.32.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.32.5 Global_Identifier

This property, of type Unsigned32, is a unique identifier which is used to globally identify the access controlled zone this object represents. This value may be used to identify Access Zone objects in multiple devices that represent the same access controlled zone.

If this value is assigned, it shall be unique internetwork-wide and all Access Zone objects in all devices that represent this access controlled zone shall have this value. A value of zero indicates that no global identifier is assigned.

12.32.6 Occupancy_State

This property, of type BACnetAccessZoneOccupancyState, reflects the occupancy state of the zone.

BACnetAccessZoneOccupancyState is an enumeration of possible occupancy states.

NORMAL	This is the occupancy state when occupancy counting is enabled and no other standard or proprietary states are applicable.
BELOW_LOWER_LIMIT	If Occupancy_Lower_Limit property is present and the Occupancy_Count property is lower than this value.
AT_LOWER_LIMIT	If Occupancy_Lower_Limit property is present and the Occupancy_Count property is equal to this value.
AT_UPPER_LIMIT	If Occupancy_Upper_Limit property is present and the Occupancy_Count property is equal to this value.
ABOVE_UPPER_LIMIT	If Occupancy_Upper_Limit property is present and the Occupancy_Count property is greater than this value.
DISABLED	This is the occupancy state when occupancy counting is disabled for this object. Occupancy counting is disabled when the Occupancy_Count_Enable property is FALSE.
NOT_SUPPORTED	This is the occupancy state when occupancy counting is not supported by this object.
<Proprietary Enum Values>	A vendor may use other proprietary enumeration values to indicate other states based on the Occupancy_Count property other than those defined by this standard. For proprietary extensions of this enumeration, see Clause 23.1 of this standard.

12.32.7 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of the Access Zone object. A more detailed status may be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

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FAULT Logical TRUE (1) if the Reliability is not NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN The value of this flag shall be logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0).

12.32.8 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then:

(a) if the Reliability is NO_FAULT_DETECTED, then Event_State shall be NORMAL, or
(b) if the Reliability is not NO_FAULT_DETECTED, then Event_State shall be FAULT.

12.32.9 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the Occupancy_State, Occupancy_Count and/or Credentials_In_Zone properties of this object are "reliable" as far as the BACnet Device can determine and, if not, why. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, CONFIGURATION_ERROR, UNRELIABLE_OTHER}.

The Reliability property shall be writable when Out_Of_Service is TRUE.

12.32.9.1 Conditions for Generating a TO-FAULT Event

A TO-FAULT event is generated under these conditions:

(a) the Reliability property becomes not equal to NO_FAULT_DETECTED, and
(b) the TO-FAULT flag is enabled in the Event_Enable property.

12.32.9.2 Conditions for Generating a TO-NORMAL Event

A TO-NORMAL event is generated under these conditions:

(a) the Reliability property becomes equal to NO_FAULT_DETECTED, and
(b) the TO-NORMAL flag is set in the Event_Enable property.

12.32.10 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the object is out of service.

When the object is out of service, the Reliability property and the corresponding state of the FAULT flag of the Status_Flags property shall be decoupled and the Reliability property may be changed to any value as a means of simulating specific fixed conditions or for testing purposes. Other functions that depend on the state of the Reliability property shall respond to changes made to this property while Out_Of_Service is TRUE.

If occupancy counting is supported and the object is out of service, then the Occupancy_Count property is decoupled from the processing of occupancy counting. In addition, writing to the Adjust_Value property shall not modify the Occupancy_Count. The Occupancy_Count property may be changed to any value as a means of simulating specific fixed conditions or for testing purposes. Other functions that depend on the state of the Occupancy_State property shall respond to changes made to this property while Out_Of_Service is TRUE.

12.32.11 Occupancy_Count

This optional property, of type Unsigned, is used to indicate the actual occupancy count of a zone. If the value of the Occupancy_Count_Enable property is FALSE, then this property shall have a value of zero. The value of the Occupancy_Count property may be adjusted by writing to the Adjust_Value property. The Occupancy_Count property shall

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be writable when Out_Of_Service is TRUE. When Out_Of_Service becomes FALSE, it is a local matter as to what value this property is set to.

If occupancy counting is supported by this object, then this property shall be present.

This property is required if intrinsic reporting is supported by this object.

12.32.12 Occupancy_Count_Enable

This optional property, of type BOOLEAN, indicates whether occupancy counting is enabled (TRUE) or not (FALSE).

If this property has a value of FALSE, then the Occupancy_State property shall have a value of DISABLED.

When this property changes from FALSE to TRUE it is a local matter as to what value the Occupancy_Count property is set to.

If occupancy counting is supported by this object, then this property shall be present.

This property is required if intrinsic reporting is supported by this object.

12.32.13 Adjust_Value

This optional property, of type INTEGER, shall adjust the Occupancy_Count property when written.

The following series of operations shall be performed atomically when this property is written and the value of the Occupancy_Count_Enable property is TRUE:

(1) The value written to Adjust_Value shall be stored in the Adjust_Value property.
(2) If the value written is non-zero, then this value shall be added to the value of the Occupancy_Count property. If the value written is negative and the resulting value of the Occupancy_Count property would be less than zero, then the Occupancy_Count property shall be set to zero. If the value written is zero, then the value of the Occupancy_Count property shall be set to zero.

When this property is written and the value of the Occupancy_Count_Enable property is FALSE, then the Adjust_Value property shall be set to zero.

If Adjust_Value has never been written or the Occupancy_Count_Enable property is FALSE, then this property shall have a value of zero.

If occupancy counting is supported by this object, then this property shall be present and writable.

This property is required if intrinsic reporting is supported by this object.

12.32.14 Occupancy_Upper_Limit

This optional property, of type Unsigned, specifies the occupancy upper limit of the zone. If this property has a value of zero, then there is no upper limit. If this value is not zero, it shall be greater than the value of the Occupancy_Lower_Limit, if present.

12.32.15 Occupancy_Lower_Limit

This optional property, of type Unsigned, specifies the occupancy lower limit of the zone. If this property has a value of zero, then there is no lower limit.

12.32.16 Credentials_In_Zone

This optional property, of type List of BACnetDeviceObjectReference, is used to list references to those Access Credential objects that represent credentials assumed to be in this zone. This information may be used to verify whether a specific credential is already in the zone for passback detection purposes. If the zone does not support listing credentials, then this list, if present, shall be empty. It is a local matter as to how this list is updated.

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12.32.17 Last_Credential_Added

This optional property, of type BACnetDeviceObjectReference, indicates the reference to the Access Credential object which has last been added to the Credentials_In_Zone property. If no credential has been added yet, then this reference shall contain 4194303 in the instance part of the object identifier and in the device instance part of the device identifier, if present. If COV property subscriptions for this property are present, then any update, even one with the same value, is reported by a COV notification.

12.32.18 Last_Credential_Added_Time

This optional property, of type BACnetDateTime, indicates the date and time when a reference to an Access Credential object has last been added to the Credentials_In_Zone property. If this property is present, but no credential has yet been added, then this property shall not convey an actual time and shall contain a value of X'FF' in all octets.

12.32.19 Last_Credential_Removed

This optional property, of type BACnetDeviceObjectReference, indicates the reference to the Access Credential object which has last been removed from the Credentials_In_Zone property. If no credential has been removed yet, then this reference shall contain 4194303 in the instance part of the object identifier and in the device instance part of the device identifier, if present. If COV property subscriptions for this property are present, then any update, even one with the same value, is reported by a COV notification.

12.32.20 Last_Credential_Removed_Time

This optional property, of type BACnetDateTime, indicates the date and time when a reference to an Access Credential object has last been removed from the Credentials_In_Zone property. If this property is present, but no credential has yet been removed, then this property shall not convey an actual time and shall contain a value of X'FF' in all octets.

12.32.21 Passback_Mode

This optional property, of type BACnetAccessPassbackMode, specifies how all Access Point objects that represent entry points to the access controlled zone this object represents shall handle passback violations. Passback modes are:

PASSBACK_OFF	Passback violations are not checked.
HARD_PASSBACK	Passback violations are checked, enforced and reported. When a passback violation is detected, the Access_Event Property of the corresponding Access Point object shall be set to DENIED_PASSBACK and the authorization for the credential shall fail.
SOFT_PASSBACK	Passback violations are checked and reported but not enforced. When a passback violation is detected, the Access_Event Property of the corresponding Access Point object shall be set to PASSBACK_DETECTED.

12.32.22 Passback_Timeout

This optional property, of type Unsigned, specifies the passback timeout in minutes. The timeout is evaluated individually for every credential used to enter the zone. The timeout period for a particular credential begins at the time of successful access to the zone. After the timeout has expired for a particular credential, a passback violation of this credential will no longer be detected. A value of zero or absence of this property indicates passback violations will never time out.

If Passback_Timeout is present, Passback_Mode shall be present.

12.32.23 Entry_Points

This property, of type List of BACnetDeviceObjectReference, references all Access Point objects that lead into the zone.

12.32.24 Exit_Points

This property, of type List of BACnetDeviceObjectReference, references all Access Point objects that lead out of the zone.

12.32.25 Time_Delay

This optional property, of type Unsigned, shall specify the minimum period of time in seconds that the Occupancy_State remains:

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(a) equal to any one of the values in the Alarm_Values property before a TO-OFFNORMAL event is generated, or
(b) not equal to any of the values in the Alarm_Values property before a TO-NORMAL event is generated.

This property is required if intrinsic reporting is supported by this object.

12.32.26 Notification_Class

This optional property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.32.27 Alarm_Values

This optional property, of type List of BACnetAccessZoneOccupancyState, shall specify any states the Occupancy_State shall equal before a TO-OFFNORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.32.27.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Occupancy_State equals at least one of the values in the Alarm_Values list, and
(b) the Occupancy_State remains equal to any value within the Alarm_Values list for a minimum period of time specified by the Time_Delay property, and
(c) the TO-OFFNORMAL flag is enabled in the Event_Enable property.

12.32.27.2 Conditions for Generating a TO-NORMAL Event

Once equal, if the Occupancy_State becomes not equal to any of the states in this property, then a TO-NORMAL event is generated under these conditions:

(a) the Occupancy_State remains not equal to any of the states in the Alarm_Values property for a minimum period of time specified by the Time_Delay property, and
(b) the TO-NORMAL flag is enabled in the Event_Enable property.

12.32.28 Event_Enable

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. This property is required if intrinsic reporting is supported by this object.

12.32.29 Acked_Transitions

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

12.32.30 Notify_Type

This optional property, of type BACnetNotifyType, shall convey whether the notifications generated by the object are Events or Alarms. This property is required if intrinsic reporting is supported by this object.

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12.32.31 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.32.32 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.32.33 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name begins with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.33 Access User Object Type

The Access User object type defines a standardized object whose properties represent the externally visible characteristics associated with a user of a physical access control system.

The Access User object is used to represent an individual person, a group of users, or an asset. Relationships among access users are supported for representation of hierarchical organizations (e.g., companies, departments, or groups of any kind) or for representing ownership of assets.

The Access User object is not directly involved in authentication and authorization. It is used for informational purposes. It can hold a name, a reference number and a reference to an external system providing details of the access user.

The Access User object can have Access Credential objects assigned. This information can be used for administrative purposes (e.g., disabling all credentials of a person).

When a user is represented in multiple devices, the representing Access User objects may not have the same Object_Identifier in each device; however, they may be identified using the Global_Identifier property. It is a local matter as to how these objects are synchronized.

Table 12-38. Properties of the Access User Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Global_Identifier	Unsigned32	W
Status_Flags	BACnetStatusFlags	R
Reliability	BACnetReliability	R
User_Type	BACnetAccessUserType	R
User_Name	CharacterString	O
User_External_Identifier	CharacterString	O
User_Information_Reference	CharacterString	O
Members	List of BACnetDeviceObjectReference	O
Member_Of	List of BACnetDeviceObjectReference	O
Credentials	List of BACnetDeviceObjectReference	R
Profile_Name	CharacterString	O

12.33.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.33.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.33.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be ACCESS_USER.

12.33.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

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12.33.5 Global_Identifier

This property, of type Unsigned32, is a unique identifier which is used to globally identify the access user this object represents. This value may be used to identify Access User objects in multiple devices which represent the same access user.

If this value is assigned, it shall be unique internetwork-wide and all Access User objects in all devices which represent this access user shall have this value. A value of zero indicates that no global identifier is assigned.

12.33.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of this object. A more detailed status may be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM The value of this flag shall be logical FALSE (0).

FAULT Logical TRUE (1) if the Reliability is not NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN The value of this flag shall be logical FALSE (0).

OUT_OF_SERVICE The value of this flag shall be logical FALSE (0).

12.33.7 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether this object is "reliable" as far as the BACnet Device can determine and, if not, why. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, CONFIGURATION_ERROR, UNRELIABLE_OTHER}.

12.33.8 User_Type

This property, of type BACnetAccessUserType, specifies the access user type this object represents. The following user types are defined:

ASSET	The Access User object represents a physical item.
GROUP	The Access User object represents a group of access users.
PERSON	The Access User object represents an individual person.
<Proprietary Enum Values>	A vendor may use other proprietary enumeration values to allow proprietary access user types other than those defined by this standard. For proprietary extensions of this enumeration, see Clause 23.1 of this standard.

12.33.9 User_Name

This optional property, of type CharacterString, is a string of printable characters which specifies the name of the access user. The content is not restricted and can contain multiple lines.

12.33.10 User_External_Identifier

This optional property, of type CharacterString, specifies an external identifier associated with the access user. While the content is typically unique, its interpretation is a local matter.

12.33.11 User_Information_Reference

This optional property, of type CharacterString, specifies a reference to an external system where additional information of the user can be found. The interpretation of the content is a local matter.

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12.33.12 Members

This optional property, of type List of BACnetDeviceObjectReference, references the Access User objects that represent the associated access users. Each object referenced shall be an Access User object.

12.33.13 Member_Of

This optional property, of type List of BACnetDeviceObjectReference, references the Access User objects that represent the access users to which this access user is associated. Each object referenced shall be an Access User object.

12.33.14 Credentials

This property, of type List of BACnetDeviceObjectReference, references all Access Credential objects that represent those credentials which are owned by this access user. Each object referenced shall be an Access Credential object.

12.33.15 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name begins with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.34 Access Rights Object Type

The Access Rights object type defines a standardized object whose properties represent the externally visible characteristics associated with access rights for physical access control.

The Access Rights object is a collection of individual access rule specifications which define privileges for entering and leaving access controlled zones or for accessing other resources or functions. One or many credentials can share this collection of access rules. This object type supports role-based access control models.

The Access Rights object contains a collection of negative and positive access rules. A negative access rule specifies where and when access shall be denied. A positive access rule specifies where and when access may be granted. Negative access rules take precedence over positive access rules. All negative access rules of all Access Rights objects assigned to a credential are evaluated before any positive access rule.

Each access rule, whether positive or negative, specifies the location of access, which is an access controlled point or a zone, a condition which determines whether the rule applies at this time, and a flag which indicates whether the rule is enabled. In the most typical case the condition is determined by evaluating the Present_Value of a Schedule object that specifies time ranges. In addition, each of these access rules can be enabled or disabled individually.

The Access Rights object can specify an accompaniment requirement that defines the access user that owns the accompanying credential, the credential required to accompany, or the access rights required to be assigned to the accompanying credential.

When a specific access rights collection is represented in multiple devices, the representing Access Rights objects may not have the same Object_Identifier in each device; however, they may be identified using the Global_Identifier property. It is a local matter as to how these objects are synchronized.

Table 12-39. Properties of the Access Rights Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Global_Identifier	Unsigned32	W
Status_Flags	BACnetStatusFlags	R
Reliability	BACnetReliability	R
Enable	BOOLEAN	R
Negative_Access_Rules	BACnetARRAY[N] of BACnetAccessRule	R
Positive_Access_Rules	BACnetARRAY[N] of BACnetAccessRule	R
Accompaniment	BACnetDeviceObjectReference	O
Profile_Name	CharacterString	O

12.34.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.34.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

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12.34.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be ACCESS_ RIGHTS.

12.34.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.34.5 Global_Identifier

This property, of type Unsigned32, is a unique identifier which is used to globally identify the collection of access rights this object represents. This value may be used to identify Access Rights objects in multiple devices which represent the same collection of access rights.

If this value is assigned, it shall be unique internetwork-wide and all Access Rights objects in all devices which represent this collection of access rights shall have this value. A value of zero indicates that no global identifier is assigned.

12.34.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of this object. A more detailed status may be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM The value of this flag shall be logical FALSE (0).

FAULT Logical TRUE (1) if the Reliability is not NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN The value of this flag shall be logical FALSE (0).

OUT_OF_SERVICE The value of this flag shall be logical FALSE (0).

12.34.7 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether this object is "reliable" as far as the BACnet Device can determine and, if not, why. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, CONFIGURATION_ERROR, UNRELIABLE_OTHER}.

12.34.8 Enable

This property, of type BOOLEAN, indicates whether this object is enabled (TRUE) or disabled (FALSE). When this object is disabled all the access rules specified in the Positive_Access_Rules and Negative_Access_Rules properties are disabled.

12.34.9 Negative_Access_Rules

This property, of type BACnetARRAY[N] of BACnetAccessRule, specifies the negative access rules. Each element of the array is evaluated as described in Clause 12.34.9.1.

To determine how access rules are evaluated, see Clause 12.34.9.2.

12.34.9.1 Access Rule Specification

An access rule specification is of type BACnetAccessRule. This is a structure with the following fields:

Time-Range-Specifier This field is an enumeration that specifies the evaluation of the Time-Range field:

SPECIFIED Time-Range references a property that will be evaluated to TRUE or FALSE as defined for the Time-Range field.

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ALWAYS — The value of the Time-Range field is ignored and always evaluates to TRUE.

Time-Range

This optional field, of type BACnetDeviceObjectPropertyReference, references a property that can be evaluated to TRUE or FALSE, which defines whether the rule is valid (TRUE) or not (FALSE).

The Time-Range reference shall be considered *unspecified* if it contains 4194303 in the instance part of the object identifier and in the device instance part of the device identifier, if present.

This field shall be present if Time-Range-Specifier is SPECIFIED. If Time-Range-Specifier is ALWAYS and this field is present, then this reference shall be unspecified.

If Time-Range-Specifier is SPECIFIED and this field references a property of type other than BOOLEAN, then the following evaluations apply:

If the value of the referenced property is of type Unsigned, a value of zero shall evaluate to FALSE, while any other value shall evaluate to TRUE.

If the value of the referenced property is of type INTEGER, a value of less than or equal to zero shall evaluate to FALSE, while any value greater than zero shall evaluate to TRUE.

If the value of the referenced property is of type BACnetBinaryPV, then INACTIVE shall evaluate to FALSE, while ACTIVE evaluates to TRUE.

If the referenced property does not exist or is unspecified, or if its value cannot be retrieved or is of type NULL, the Time-Range evaluates to FALSE.

If the reference property is of any other type, then the evaluation is a local matter.

Note: This field can reference a Schedule object Present_Value property for the specification of time ranges.

Location-Specifier

This field is an enumeration that specifies how the Location field is evaluated:

SPECIFIED — Location references a specific Access Point or Access Zone object and is evaluated as specified for the Location field.

ALL — The value of the Location field is ignored and matches any access controlled point.

Location

This optional field, of type BACnetDeviceObjectReference, refers to the Access Point or Access Zone that this access rule is valid for.

The Location reference shall be considered *unspecified* if it contains 4194303 in the instance part of the object identifier and in the device instance part of the device identifier, if present.

This field shall be present if Location-Specifier is SPECIFIED. If Location-Specifier is ALL and this field is present, then this reference shall be unspecified.

If Location-Specifier is SPECIFIED, then the following evaluations apply:

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When Location refers to an Access Point object, this access controlled point is required to be the location where the credential used to request access has been authenticated.

When Location refers to an Access Zone object, the access controlled point where the credential used to request access has been authenticated is required to be an entry point to this zone.

If the referenced object does not exist, is unspecified, or cannot be retrieved, then the Location evaluates to FALSE.

Enable — This field, of type BOOLEAN, specifies whether this rule is enabled (TRUE) or not (FALSE).

An access rule evaluates to true when all of the following conditions are met:

(a) Time_Range field evaluates to TRUE, and
(b) the Location field matches the location of authentication, and
(c) the Enable field is TRUE.

12.34.9.2 Access Rules Authorization Check

The access rules authorization check is performed on the access rules assigned to a credential.

All the negative access rules of all the Access Rights objects referenced by the respective Access Credential object shall be evaluated before the positive access rules. If any enabled negative rule evaluates to true, then this authorization check fails and access shall be denied. In this case, the Access_Event property of the Access Point object shall be set to DENIED_POINT_NO_ACCESS_RIGHTS if the negative rule prohibits access through the access point, or to DENIED_ZONE_NO_ACCESS_RIGHTS if the negative rule prohibits access to the zone.

If no negative access rule evaluates to true, then the positive access rules of all the Access Rights objects referenced by the respective Access Credential object shall be evaluated. When the first enabled positive access rule is found that evaluates to true, then this authorization check succeeds. Access may subsequently be denied or granted based on other authorization checks.

If all positive access rules of all the Access Rights objects referenced by this credential evaluate to false, then this authorization check shall fail. In this case, if the credential has access through this access point or to the access zone at a different time, then the Access_Event property of the Access Point object shall be set to DENIED_OUT_OF_TIME_RANGE. Otherwise, the Access_Event property shall be set to DENIED_NO_ACCESS_RIGHTS.

If the respective Access Credential object has a master exemption, then this authorization check is not performed and always considered successful.

12.34.9.3 Initializing New Array Elements When the Array Size is Increased

If the size of the Negative_Access_Rules array is increased without initial values being provided, then the new array elements, for which no initial value is provided, shall be initialized to contain SPECIFIED for the Time-Range-Specifier field, an unspecified reference in the Time-Range field, SPECIFIED for the Location-Specifier field, an unspecified reference in the Location field, and TRUE for the Enable field.

12.34.10 Positive_Access_Rules

This property, of type BACnetARRAY[N] of BACnetAccessRule, specifies the positive access rules. Each element of the array is evaluated as described in Clause 12.34.9.1.

To determine how access rules are evaluated, see Clause 12.34.9.2

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12.34.10.1 Initializing New Array Elements When the Array Size is Increased

If the size of the Positive_Access_Rules array is increased without initial values being provided, then the new array elements, for which no initial value is provided, shall be initialized to contain SPECIFIED for the Time-Range-Specifier field, an unspecified reference in the Time-Range field, SPECIFIED for the Location-Specifier field, an unspecified reference in the Location field, and TRUE for the Enable field.

12.34.11 Accompaniment

This optional property, of type BACnetDeviceObjectReference, specifies that the access rights, which this object represents, may be evaluated successfully only if the original credential, which has this Access Rights object assigned, is accompanied by a second credential that meets the accompaniment criteria and is presented at the same access point. The accompanying credential must also have valid access rights to the Access Point where both credentials are presented. It is a local matter as to whether the accompanying credential is required to be presented by the access user before or after the original credential.

If the accompanying credential is not presented within the amount of time, specified by the Accompaniment_Time property of the Access Point object, then the authorization of the original credential will fail. If this time is not specified then the amount of time to wait for the accompanying credential is a local matter. When the expected accompaniment is not received, the Access_Event property of the Access Point object shall be set to DENIED_NO_ACCOMPANIMENT.

When an accompaniment is presented, whether valid or not, the Access_Event property of the Access Point object shall be set to ACCOMPANIMENT_BY.

The accompaniment criteria are specified as:

(a) If this property refers to an Access Rights object, then the accompanying credential is required to have that Access Rights object assigned.
(b) If this property refers to an Access Credential object, then this object is required to represent the accompanying credential.
(c) If this property refers to an Access User object, then this object is required to represent the access user which owns the accompanying credential.

If an invalid accompaniment is provided, then the Access_Event property of the Access Point object shall be set to DENIED_INCORRECT_ACCOMPANIMENT.

If no accompaniment requirement is specified then this reference shall contain 4194303 in the instance part of the object identifier and in the device instance part of the device identifier, if present.

12.34.12 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name begins with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.35 Access Credential Object Type

The Access Credential object type defines a standardized object whose properties represent the externally visible characteristics of a credential that is used for authentication and authorization when requesting access.

The credential can be owned by an access user of any type. Access user ownership is represented by a reference to an Access User object.

The Access Credential object is a container of related authentication factors. Each authentication factor in the credential can be individually enabled or disabled. An Access Credential object can represent a single authentication factor, a group of authentication factors each having identical access rights, or multiple authentication factors required for multi-factor-authentications.

The access rights assigned to the credential are specified by referencing Access Rights objects. Each reference can be individually enabled or disabled.

The Credential_Status indicates the validity of this credential for authentication. The status is derived from other properties of this object or can be set from an external process.

The credential can be restricted in its use for authentication. It can be restricted based on activation and expiry dates, the number of days it can be used or the number of uses. It can be disabled if it is not used for a specified number of days. The credential can be exempted from authorization checks such as passback violation enforcement and occupancy enforcements. It can indicate whether an extended time is required to pass through a door.

A threat authority can be specified for the credential. If this value is lower than the threat level at the access controlled point, then access is denied.

The credential can be flagged to be traced. Any access controlled point recognizing this credential shall generate a corresponding TRACE access event.

When a credential is represented in multiple devices, the representing Access Credential objects may not have the same Object_Identifier in each device; however, they may be identified using the Global_Identifier property. It is a local matter as to how these objects are synchronized.

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Table 12-40. Properties of the Access Credential Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Global_Identifier	Unsigned32	W
Status_Flags	BACnetStatusFlags	R
Reliability	BACnetReliability	R
Credential_Status	BACnetBinaryPV	R
Reason_For_Disable	List of BACnetAccessCredentialDisableReason	R
Authentication_Factors	BACnetARRAY[N] of BACnetCredentialAuthenticationFactor	R
Activation_Time	BACnetDateTime	R
Expiry_Time	BACnetDateTime	R
Credential_Disable	BACnetAccessCredentialDisable	R
Days_Remaining	INTEGER	O[1]
Uses_Remaining	INTEGER	O
Absentee_Limit	Unsigned	O[1]
Belongs_To	BACnetDeviceObjectReference	O
Assigned_Access_Rights	BACnetARRAY[N] of BACnetAssignedAccessRights	R
Last_Access_Point	BACnetDeviceObjectReference	O
Last_Access_Event	BACnetAccessEvent	O
Last_Use_Time	BACnetDateTime	O
Trace_Flag	BOOLEAN	O
Threat_Authority	BACnetAccessThreatLevel	O
Extended_Time_Enable	BOOLEAN	O
Master_Exemption	BOOLEAN	O
Passback_Exemption	BOOLEAN	O
Occupancy_Exemption	BOOLEAN	O
Profile_Name	CharacterString	O

[1] If this property is present, then the property Last_Use_Time shall also be present.

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12.35.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.35.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.35.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be ACCESS_CREDENTIAL.

12.35.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

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12.35.5 Global_Identifier

This property, of type Unsigned32, is a unique identifier which is used to globally identify the credential this object represents. This value may be used to identify Access Credential objects in multiple devices which represent the same credential.

If this value is assigned, it shall be unique internetwork-wide and all Access Credential objects in all devices which represent this credential shall have this value. A value of zero indicates that no global identifier is assigned.

12.35.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of this object. A more detailed status may be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM The value of this flag shall be logical FALSE (0).

FAULT Logical TRUE (1) if the Reliability is not NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN The value of this flag shall be logical FALSE (0).

OUT_OF_SERVICE The value of this flag shall be logical FALSE (0).

12.35.7 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether this object is "reliable" as far as the BACnet Device can determine and, if not, why. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, CONFIGURATION_ERROR, UNRELIABLE_OTHER}.

12.35.8 Credential_Status

This property, of type BACnetBinaryPV, specifies whether the credential is active or inactive. Only the value ACTIVE enables the credential to be used for authentication. While the list in property Reason_For_Disable is nonempty, the status of the credential shall be INACTIVE, otherwise it shall be ACTIVE.

When an inactive credential is used, the authentication of this credential shall fail and access to the access point shall be denied. In this case, the Access_Event property of the Access Point object where the credential has attempted access shall be set to the value which corresponds to the reason this credential is disabled, as specified in the Reason_For_Disable property. See Clause 12.36.9.1.

12.35.9 Reason_For_Disable

This property, of type List of BACnetAccessCredentialDisableReason, contains a list of disable-reasons why the credential has been disabled. The credential can be disabled for multiple reasons at the same time. While the Credential_Status property has a value INACTIVE, this list shall not be empty. When an entry is removed from this list that results in the list becoming empty, the Credential_Status shall be set to ACTIVE.

The disable-reasons for which the credential can be disabled are as follows:

DISABLED The credential is disabled for unspecified reasons.

DISABLED_NEEDS_PROVISIONING The credential needs further provisioning, which may include vendor proprietary data.

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DISABLED_UNASSIGNED	The credential is not currently assigned to any access user. This status is assigned only if the property Belongs_To is present and contains instance 4194303 in the object identifier.
DISABLED_NOT_YET_ACTIVE	The credential is not yet valid at this time. The current time is before the Activation_Time.
DISABLED_EXPIRED	The credential is no longer valid. The current time is after the Expiry_Time.
DISABLED_LOCKOUT	Too many retries in multi-factor authentications have been performed.
DISABLED_MAX_DAYS	The maximum number of days for which this credential is valid for has been exceeded.
DISABLED_MAX_USES	The maximum number of uses for which this credential is valid for has been exceeded.
DISABLED_INACTIVITY	The credential has exceeded the allowed period of inactivity.
DISABLED_MANUAL	The credential is commanded to be disabled by a human operator.
<Proprietary Enum Values>	A vendor may use other proprietary enumeration values to indicate disable reasons other than those defined by this standard. For proprietary extensions of this enumeration, see Clause 23.1 of this standard.

12.35.9.1 Conditions for setting the Access_Event property of the Access Point object

When access is requested using a credential that is inactive, access shall not be granted. In this case the Access Point object representing the access point where access was requested shall set its Access_Event property as defined in the following table:

Table 12-41. Credential Disable Reasons and Applicable Access Events

Credential Disable Reason	Applicable Access Event
DISABLED_NEEDS_PROVISIONING	DENIED_CREDENTIAL_NOT_PROVISONED
DISABLED_UNASSIGNED	DENIED_CREDENTIAL_UNASSIGNED
DISABLED_NOT_YET_ACTIVE	DENIED_CREDENTIAL_NOT_YET_ACTIVE
DISABLED_LOCKOUT	DENIED_CREDENTIAL_LOCKOUT
DISABLED_MAX_DAYS	DENIED_CREDENTIAL_MAX_DAYS
DISABLED_MAX_USES	DENIED_CREDENTIAL_MAX_USES
DISABLED_INACTIVITY	DENIED_CREDENTIAL_INACTIVITY
DISABLED_MANUAL	DENIED_CREDENTIAL_MANUAL_DISABLE
DISABLED	DENIED_CREDENTIAL_DISABLED

If Reason_For_Disable contains multiple values, it is a local matter as to which corresponding access event the Access_Event property is set to.

12.35.10 Authentication_Factors

This property, of type BACnetARRAY[N] of BACnetCredentialAuthenticationFactor, specifies the authentication factors that belong to this credential. Each element of the array has two fields:

Disable	This field, of type BACnetAccessAuthenticationFactorDisable, specifies whether the corresponding authentication factor is disabled or not. Any value other than NONE indicates that the authentication factor is not valid for authentication. The following authentication factor disable values are defined:

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	DISABLED	The physical authentication factor is disabled for unspecified reasons.
	DISABLED_LOST	The physical authentication factor is reported to be lost.
	DISABLED_STOLEN	The physical authentication factor is reported to be stolen.
	DISABLED_DAMAGED	The physical authentication factor is reported to be damaged.
	DISABLED_DESTROYED	The physical authentication factor is reported to be destroyed.
	<Proprietary Enum Values>	A vendor may use other proprietary enumeration values to specify disable values other than those defined by this standard. For proprietary extensions of this enumeration, see Clause 23.1 of this standard.
Authentication-Factor	This field, of type BACnetAuthenticationFactor, specifies the authentication factor that belongs to this credential.	

Any access attempt using an authentication factor which is disabled shall fail. In this case, the Access_Event property of the Access Point object where this authentication factor was used shall be set to the value corresponding to the reason why it was disabled. See the following table.

Table 12-42. Authentication Factor Disable and Applicable Access Events

Authentication Factor Disable	Applicable Access Event
DISABLED	DENIED_AUTHENTICATION_FACTOR_DISABLED
DISABLED_LOST	DENIED_AUTHENTICATION_FACTOR_LOST
DISABLED_STOLEN	DENIED_AUTHENTICATION_FACTOR_STOLEN
DISABLED_DAMAGED	DENIED_AUTHENTICATION_FACTOR_DAMAGED
DISABLED_DESTROYED	DENIED_AUTHENTICATION_FACTOR_DESTROYED

12.35.10.1 Initializing New Array Elements When the Array Size is Increased

If the size of the Authentication _Factors array is increased without initial values being provided, then the new array elements for which no initial value is provided shall be initialized to contain DISABLE for the Disable field and an authentication factor with format type UNDEFINED for the Authentication-Factor field.

12.35.11 Activation_Time

This property, of type BACnetDateTime, specifies the date and time at or after which the credential becomes active. If the current time is before the activation time, the credential shall be disabled and the value DISABLED_NOT_YET_ACTIVE shall be added to the Reason_For_Disable list. The value DISABLED_NOT_YET_ACTIVE shall be removed from the list when this condition no longer applies. If all of the octets of the BACnetDateTime value contain a value of X'FF', then the credential has an activation time of 'start of time'.

12.35.12 Expiry_Time

This property, of type BACnetDateTime, specifies the date and time after which the credential will expire. This defines the end of the validity period of the credential. If the current time is after the expiry time, the credential shall be disabled and the value DISABLED_EXPIRED shall be added to the Reason_For_Disable list. The value DISABLED_EXPIRED shall be

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removed from the list when this condition no longer applies. If all of the fields of the BACnetDateTime value contain a value of X'FF', then the credential has an expiry time of 'end-of-time'.

12.35.13 Credential_Disable

This property, of type BACnetAccessCredentialDisable, contains a value that disables a credential for reasons external to this object. If this property is writable, then it is the mechanism by which an operator or external process may disable the credential.

When this property is changed, any disable reason added to the Reason_For_Disable list as a result of a previous change of this property shall be removed from that list. When this property takes on any value other than NONE, the corresponding disable-reason value shall be added to the Reason_For_Disable list.

The following credential disable values are defined:

NONE	The credential has not been disabled by an operator or external process.
DISABLE	The credential has been disabled for unspecified reasons. The disable-reason value DISABLED shall be added to the Reason_For_Disable property.
DISABLE_MANUAL	The credential has been disabled by a human operator. The disable-reason value DISABLED_MANUAL shall be added to the Reason_For_Disable property.
DISABLE_LOCKOUT	The credential is disabled because it has been locked out by an external process. The disable-reason value DISABLED_LOCKOUT shall be added to the Reason_For_Disable property.
<Proprietary Enum Values>	A vendor may use other proprietary enumeration values for disabling a credential other than those defined by this standard. A disable-reason value shall be added to the Reason_For_Disable property. It is a local matter which disable reason is added. For proprietary extensions of this enumeration, see Clause 23.1 of this standard.

12.35.14 Days_Remaining

This optional property, of type INTEGER, specifies the number of remaining days for which the credential can be used. If this property has a value greater than zero, its value shall be decremented by one when the credential this object represents is granted access at an access controlled point, and the current date is more recent than the date indicated in the property Last_Use_Time. If this property becomes zero, the Access Credential shall be disabled and the value DISABLED_MAX_DAYS shall be added to the Reason_For_Disable property. The value DISABLED_MAX_DAYS shall be removed from the Reason_For_Disable property when this property is set to a value greater than zero.

If this property is present and the credential this object represents is not limited in the days it can be used, then the value of this property shall be -1 and DISABLED_MAX_USES shall never be added to the Reason_For_Disable property.

If Days_Remaining is present, then Last_Use_Time shall also be present.

12.35.15 Uses_Remaining

This optional property, of type INTEGER, specifies the number of remaining uses that the credential can be used for authentication. If this property has a value greater than zero and access is granted at an access controlled point, then the value of this property shall be decremented by one. If this property becomes zero, then the Access Credential shall be disabled and the value DISABLED_MAX_USES shall be added to the Reason_For_Disable property. The value

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DISABLED_MAX_USES shall be removed from the Reason_For_Disable property when this property is set to a value greater than zero.

If this property is present and the credential this object represents is not limited in the number of uses, then the value of this property shall be -1 and DISABLED_MAX_USES shall never be added to the Reason_For_Disable property.

12.35.16 Absentee_Limit

This optional property, of type Unsigned, specifies the maximum number of consecutive days for which the credential can remain inactive (i.e. unused) before it becomes disabled. The calculation of inactivity duration is based on the time of last use as indicated by the property Last_Use_Time. If Last_Use_Time does not have a valid time and date, then the absentee limit shall be considered to not be exceeded. When the absentee limit is exceeded, the Access Credential shall be disabled and the value DISABLED_INACTIVITY shall be added to the Reason_For_Disable list. The value DISABLED_INACTIVITY shall be removed from the list when this condition no longer applies.

If Absentee_Limit is present, Last_Use_Time shall also be present.

12.35.17 Belongs_To

This optional property, of type BACnetDeviceObjectReference, references an Access User object that represents the owning access user (i.e., person, group, or asset). If this property is present and the credential is not assigned to an access user, this property shall contain an instance number of 4194303 in the instance part of the object identifier and in the device instance part of the device identifier, if present. The determination of whether the credential is valid for authentication, based on the value of this property, is a local matter. If the credential has not been assigned to an access user and the policy of the site requires that it be assigned, then the credential shall be disabled and the value DISABLED_UNASSIGNED shall be added to the Reason_For_Disable list. The value DISABLED_UNASSIGNED shall be removed from the list when this condition no longer applies.

12.35.18 Assigned_Access_Rights

This property, of type BACnetARRAY [N] of BACnetAssignedAccessRights, specifies the access rights assigned to this credential. The structure has two fields:

Assigned-Access-Rights	This field, of type BACnetDeviceObjectReference, refers to an Access Rights object that defines access rights assigned to this credential. Each object referenced in this field shall be an Access Rights object. Any entry which references a non-existent Access Rights object shall be ignored. If no access rights are specified, then this reference shall contain 4194303 in the instance part of the object identifier and in the device instance part of the device identifier, if present.
Enable	This field, of type BOOLEAN, specifies whether the access rights specified in the assigned-access-rights field is enabled (TRUE) or not (FALSE) for the credential this object represents.

12.35.18.1 Initializing New Array Elements When the Array Size is Increased

If the size of the Assigned_Access_Rights array is increased without initial values being provided, then the new array elements for which no initial value is provided shall be initialized to contain 4194303 in the instance part of the object identifier and in the device instance part of the device identifier, if present, for the Assigned-Access-Rights field, and the value FALSE for the Enable field.

12.35.19 Last_Access_Point

This optional property, of type BACnetDeviceObjectReference, refers to the last Access Point object where one of the authentication factors of the credential has been used. If property level COV is in effect for this property, any update of this property shall cause a COV notification to be issued, regardless of whether the value of this property changes. If the credential this object represents has never been used, then this property shall contain 4194303 in the instance part of the object identifier and in the device instance part of the device identifier, if present.

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12.35.20 Last_Access_Event

This optional property, of type BACnetAccessEvent, shall specify the last access event generated at an access controlled point on use of this credential. If the credential this object represents has never been used, then this property shall have a value of NONE.

12.35.21 Last_Use_Time

This optional property, of type BACnetDateTime, specifies the date and time of the last use of the credential at an access controlled point, independent of whether access was granted or denied. If the credential this object represents has never been used, then this property shall have the value X'FF' for all date and time octets.

12.35.22 Trace_Flag

This optional property, of type BOOLEAN, specifies whether the credential is being traced. When a traced credential is used at an access point, the Access_Event property of the corresponding Access Point object shall be set to TRACE.

12.35.23 Threat_Authority

This optional property, of type BACnetAccessThreatLevel, specifies the maximum threat level for which this credential is valid. If this value is less than the Threat_Level property of the Access Point object where the access credential is used, access is denied. If this property is not present, the threat authority of this credential is assumed to be zero.

12.35.24 Extended_Time_Enable

This optional property, of type BOOLEAN, specifies which command of type BACnetDoorValue shall be used to command the access door when access is granted. If extended time is enabled (TRUE), EXTENDED_PULSE_UNLOCK is used, otherwise (FALSE) PULSE_UNLOCK is used.

12.35.25 Master_Exemption

This optional property, of type BOOLEAN, specifies a master exemption from authorization checks. Once authenticated, the credential, if active, is exempted from all standard authorization checks if master exemption is enabled (TRUE). It is a local matter as to whether the credential is exempted from proprietary authorization checks.

12.35.26 Passback_Exemption

This optional property, of type BOOLEAN, specifies an exemption from passback enforcement. If passback exemption is enabled (TRUE), then the credential is not denied access due to passback violations.

12.35.27 Occupancy_Exemption

This optional property, of type BOOLEAN, specifies an exemption from occupancy enforcement. If occupancy exemption is enabled (TRUE), then the occupancy count in the Access Zone object shall be updated as normal; however, the access credential shall not be denied access due to occupancy limit enforcement.

12.35.28 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name begins with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.36 Credential Data Input Object Type

The Credential Data Input object type defines a standardized object whose properties represent the externally visible characteristics of a process that provides authentication factors read by a physical device. An authentication factor is a data element of a credential that is a unique digital identifier used to verify the identity of a credential. A credential may have multiple authentication factors.

Examples of physical devices that may be represented by this object type are card readers, keypads, biometric readers, etc.

A single physical credential reader which supports multiple authentication factor formats may be represented by multiple Credential Data Input objects when the authentication factor formats are not functionally equivalent or cannot be used interchangeably. An example of a device of this type is a credential reader that contains both a card and biometric reader. In this case two specific Credential Data Input objects are used; one for the card reader function and one for the biometric reader function respectively.

Alternatively, a single physical credential reader that supports multiple authentication factor formats may be represented by a single Credential Data Input object when the authentication factor formats are functionally equivalent and may be used interchangeably. An example of a device of this type is a credential reader that can read multiple Wiegand formats. It is recommended that a single Credential Data Input object that supports multiple authentication factor formats be associated with a single physical device.

The Credential Data Input object type and its properties are summarized in Table 12-43 and described in detail in this subclause.

Table 12-43. Properties of the Credential Data Input Object

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Present_Value	BACnetAuthenticationFactor	R[1]
Description	CharacterString	O
Status_Flags	BACnetStatusFlags	R
Reliability	BACnetReliability	R[1]
Out_Of_Service	BOOLEAN	R
Supported_Formats	BACnetARRAY[N] of BACnetAuthenticationFactorFormat	R
Supported_Format_Classes	BACnetARRAY[N] of Unsigned	O[2]
Update_Time	BACnetTimeStamp	R
Profile_Name	CharacterString	O

[1] This property is required to be writable when Out_Of_Service is TRUE.
[2] The size of this array shall be the same as the size of the Supported_Formats array.

12.36.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.36.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.36.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be CREDENTIAL_DATA_INPUT.

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12.36.4 Present_Value

This property, of type BACnetAuthenticationFactor, is a structure that encapsulates the authentication factor value. The structure has three fields, which are defined as follows:

Format-Type — This field, of type BACnetAuthenticationFactorType, specifies the format of the authentication factor value in the Value field. The value of this field shall be one of the format types specified in the Supported_Formats property. If there is no current authentication factor value read by this object, then this field shall take on the value UNDEFINED. In addition, if this field contains a value that is not specified in the Supported_Formats property, such as after a modification to the Supported_Formats property or after the Out_Of_Service property changes from TRUE to FALSE, then this field shall take on the value UNDEFINED. If an authentication factor is read that contains errors or that cannot be interpreted as one of the specified format types, then this field shall take on the value ERROR.

Format-Class — This field, of type Unsigned, shall contain the value specified in the Supported_Format_Classes array field that corresponds to the authentication format type in the Format-Type field. If the Supported_Format_Classes property is not present, this field shall always have a value of zero. If Format-Type has a value of UNDEFINED, then this field shall have a value of zero.

Value — This field, of type OCTET STRING, holds the authentication factor value data. The encoding of this value is specified in the Format-Type field and defined in Table P-1 of ANNEX P.

The Present_Value property shall be writable when Out_Of_Service is TRUE.

12.36.5 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.36.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of the Credential Data Input object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM — The value of this flag shall be logical FALSE (0).

FAULT — Logical TRUE (1) if the Reliability is not NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN — The value of this flag shall be logical FALSE (0).

OUT_OF_SERVICE — Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0).

12.36.7 Reliability

The Reliability property, of type BACnetReliability, provides an indication of whether the Present_Value is "reliable" as far as the BACnet Device or operator can determine. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, CONFIGURATION_ERROR, OPEN_LOOP, SHORTED_LOOP, PROCESS_ERROR, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}.

The Reliability property shall be writable when Out_Of_Service is TRUE.

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12.36.8 Out_Of_Service

The Out_Of_Service property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the Present_Value of the Credential Data Input object is prevented from being modified by some process local to the BACnet device in which the object resides.

While the Out_Of_Service property is TRUE, the Present_Value and Reliability properties may be changed to any value as a means of simulating specific fixed conditions or for testing purposes. Other functions that depend on the state of the Present_Value or Reliability properties shall respond to changes made to these properties while Out_Of_Service is TRUE, as if those changes had occurred in the input.

12.36.9 Supported_Formats

This property, of type BACnetARRAY of BACnetAuthenticationFactorFormat, is used to specify which authentication factor formats are supported by this object. The structure of an element of this array has three fields that are defined as follows:

Format-Type — This field, of type BACnetAuthenticationFactorType, specifies a supported authentication factor format type.

Vendor-ID — This optional field, of type Unsigned16, is required when Format-Type field has a value of CUSTOM. It shall contain the BACnet vendor identifier of the vendor which defined the custom format. This value may differ from the Vendor_Identifier property value in the Device object, which identifies the device manufacturer. If the Format-Type field does not have a value of CUSTOM and this field is present it shall have a value of zero.

Vendor-Format — This optional field of type Unsigned16 is required when Format-Type field has a value of CUSTOM. It shall contain a unique identifier that identifies a specific custom authentication factor format as defined by the BACnet vendor in the Vendor-ID field. If the Format-Type field does not have a value of CUSTOM and this field is present, then it shall have a value of zero.

12.36.9.1 Resizing Supported_Formats Array and Supported_Format_Classes Array, by Writing Any of these Properties

The size of the Supported Formats array and Supported_Format_Classes arrays shall be maintained so that both have the same size. If either of these arrays is present and writable and the number of elements of one is reduced, then each of the arrays shall be truncated to the new reduced size. If either of these arrays is present and writable and the number of elements of one array is increased, then the other array shall be increased to the new expanded size and the new array elements initialized according to the requirements of each property. See Clauses 12.36.9.2 and 12.36.10.2.

12.36.9.2 Initializing New Array Elements When the Array Size is Increased

If the size of the Supported_Formats array is increased without entry values being provided, then the new array entries shall be initialized with the Format-Type having a value of UNDEFINED. If Vendor-ID and Vendor-Format are present, they shall be initialized with a value of zero.

12.36.10 Supported_Format_Classes

This optional property, of type BACnetARRAY of Unsigned, specifies the values that the Format-Class field of the Present_Value may take on. The value of the ith element of this array shall be used when an authentication factor is read that is of the format defined in the ith element of the Supported_Formats array.

This property is used to distinguish between multiple different supported authentication factor formats, used on a site, of which two or more use the same authentication factor format type and may have colliding value ranges. A value of zero is used as the default where no differentiation is required. Otherwise, the value is site specific and can be any non-zero value.

12.36.10.1 Resizing Supported_Formats Array and Supported_Format_Classes Array by Writing Any of these Properties

See Clause 12.36.9.1

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12.36.10.2 Initializing New Array Elements When the Array Size is Increased

If the size of the Supported_Format_Classes array is increased without entry values being provided, then the new array entries shall be initialized with a value of zero.

12.36.11 Update_Time

This property, of type BACnetTimeStamp, indicates the most recent update time when the Present_Value was updated. This property shall update its value on each update of the Present_Value. If no update has yet occurred, update times of type Time or Date shall have X'FF' in each octet, and Sequence number update times shall have the value 0.

12.36.12 Profile_Name

This property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name shall begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.37 CharacterString Value Object Type

The CharacterString Value object type defines a standardized object whose properties represent the externally visible characteristics of a named data value in a BACnet device. A BACnet device can use a CharacterString Value object to make any kind of character string data value accessible to other BACnet devices. The mechanisms by which the value is derived are not visible to the BACnet client.

If a set of strings is known and fixed, then a MultiState Value object is an alternative that may provide some benefit to automated processes consuming the numeric Present_Value.

Table 12-44. Properties of the CharacterString Value Object

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Present_Value	CharacterString	R[1]
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	O[3]
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	O
Priority_Array	BACnetPriorityArray	O[2]
Relinquish_Default	CharacterString	O[2]
Time_Delay	Unsigned	O[3]
Notification_Class	Unsigned	O[3]
Alarm_Values	BACnetARRAY[N] of BACnetOptionalCharacterString	O[3]
Fault_Values	BACnetARRAY[N] of BACnetOptionalCharacterString	O[3]
Event_Enable	BACnetEventTransitionBits	O[3]
Acked_Transitions	BACnetEventTransitionBits	O[3]
Notify_Type	BACnetNotifyType	O[3]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[3]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[4]
Profile_Name	CharacterString	O

[1] If Present_Value is commandable, then it is required to be writable. This property is required to be writable when Out_Of_Service is TRUE.
[2] If Present_Value is commandable, then both of these properties shall be present.
[3] These properties are required if the object supports intrinsic reporting.
[4] This property, if present, is required to be read only.

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12.37.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.37.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

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12.37.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be CHARACTERSTRING_VALUE.

12.37.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.37.5 Present_Value

This property, of type CharacterString, indicates the current value of the object. The Present_Value property shall be writable when Out_Of_Service is TRUE (see Clause 12.37.9).

12.37.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of a CharacterString Value object. Three of the flags are associated with the values of another property of this object. A more detailed status could be determined by reading the property that is linked to this flag. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical TRUE (1) if the Event_State property is present and does not have a value of NORMAL, otherwise logical FALSE (0).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value property is not changeable through BACnet services. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property is present and has a value of TRUE, otherwise logical FALSE (0).

12.37.7 Event_State

This optional property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT. Changes in the Event_State property to the value FAULT are considered to be "fault" events. This property is required if intrinsic reporting is supported by this object.

12.37.8 Reliability

This optional property, of type BACnetReliability, provides an indication of whether the CharacterString Value object is reliably reporting its value. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, COMMUNICATION_FAILURE, MULTI_STATE_FAULT, UNRELIABLE_OTHER}

12.37.8.1 Conditions for Generating a TO-FAULT Event

A TO-FAULT event is generated under these conditions:

(a) the Reliability property becomes not equal to NO_FAULT_DETECTED, and
(b) the TO-FAULT flag must be enabled in the Event_Enable property.

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12.37.9 Out_Of_Service

This optional property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the Present_Value of the CharacterString Value object is decoupled from software local to the BACnet device in which the object resides that normally produces the Present_Value as an output or consumes it as an input. When Out_Of_Service is TRUE, the Present_Value property may be written to freely.

12.37.10 Priority_Array

This optional property, of type BACnetPriorityArray, is a read-only array containing prioritized commands that are in effect for this object. See Clause 19 for a description of the prioritization mechanism. If either the Priority_Array property or the Relinquish_Default property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.37.11 Relinquish_Default

This optional property is the default value to be used for the Present_Value property when all command priority values in the Priority_Array property have a NULL value. See Clause 19. If either the Relinquish_Default property or the Priority_Array property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.37.12 Time_Delay

This optional property, of type Unsigned, shall specify the minimum period of time in seconds during which the Present_Value must contain one of the character strings specified by the Alarm_Values property before a TO-OFFNORMAL event is generated, or not contain any of the non-empty character strings specified by the Alarm_Values property before a TO-NORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.37.13 Notification_Class

This optional property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.37.14 Alarm_Values

This optional property, of type BACnetARRAY of BACnetOptionalCharacterString, shall specify one or more string values, at least one of which must match Present_Value before an event is generated. A "match" with Present_Value is defined as follows:

(a) If the alarm string is NULL, it is not considered a match.
(b) If the alarm string is empty (of zero length), then it is considered a match if and only if the Present_Value is also an empty string.
(c) If the alarm string is not empty, then it is considered a match if the alarm string appears in any position within the Present_Value string. For character-matching purposes, character case shall be significant, and so a match must be an exact match character by character.

This property is required if intrinsic reporting is supported by this object.

12.37.14.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must match at least one of the string values in the Alarm_Values list, for a minimum period of time, specified in the Time_Delay property, and
(b) the TO-OFFNORMAL flag must be enabled in the Event_Enable property.

After a TO-OFFNORMAL event has been generated and before a TO-NORMAL event has been generated, if the Present_Value changes such that it matches a different string from the Alarm_Values list for Time_Delay seconds, the algorithm shall generate another TO-OFFNORMAL event.

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12.37.14.2 Conditions for Generating a TO-NORMAL Event

Once matching a value in this property, the Present_Value must not match any of the values in this property before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must remain not matching any of the non-empty string values in Alarm_Values for a minimum period of time, specified by the Time_Delay property, and
(b) the TO-NORMAL flag must be enabled in the Event_Enable property.

12.37.15 Fault_Values

This optional property, of type BACnetARRAY of BACnetOptionalString, shall specify any value the Present_Value must match before a TO-FAULT event is generated. If Present_Value matches any of the states in the Fault_Values list, then the Reliability property shall have the value MULTI_STATE_FAULT. The Fault_Values property is required if intrinsic reporting is supported by this object.

The method for "matching" fault values is the same as for Alarm_Values. See 12.38.14

12.37.16 Event_Enable

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. This property is required if intrinsic reporting is supported by this object.

12.37.17 Acked_Transitions

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning that event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning that no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

12.37.18 Notify_Type

This optional property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.37.19 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.37.20 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.37.21 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document

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named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.38 DateTime Value Object Type

The DateTime Value object type defines a standardized object whose properties represent the externally visible characteristics of a named data value in a BACnet device. A BACnet device can use a DateTime Value object to make any kind of datetime data value accessible to other BACnet devices. The mechanisms by which the value is derived are not visible to the BACnet client.

A DateTime Value object is used to represent a single moment in time. In contrast, the DateTime Pattern Value object can be used to represent multiple recurring dates and times.

Table 12-45. Properties of the DateTime Value Object

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Present_Value	BACnetDateTime	R[1]
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	O
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	O
Priority_Array	BACnetPriorityArray	O[2]
Relinquish_Default	BACnetDateTime	O[2]
Is_UTC	BOOLEAN	O
Profile_Name	CharacterString	O

[1] If Present_Value is commandable, then it is required to be writable. This property is required to be writable when Out_Of_Service is TRUE.

[2] If Present_Value is commandable, then both of these properties shall be present.

12.38.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.38.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.38.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be DATETIME_VALUE.

12.38.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.38.5 Present_Value

This property, of type BACnetDateTime, indicates the current value of the object. The value of this property shall contain either a fully specified date and time or it shall indicate a fully unspecified date and time by setting all octets to X'FF'. A fully specified date and time does not contain any octets that are equal to X'FF' or the special values for the 'month' or 'day of month' fields, the Present_Value property shall be writable when Out_Of_Service is TRUE (see Clause 12.38.9).

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12.38.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of a DateTime Value object. Three of the flags are associated with the values of another property of this object. A more detailed status could be determined by reading the property that is linked to this flag. The relationship between individual flags is not defined by the protocol. The four flags are:

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical TRUE (1) if the Event_State property is present and does not have a value of NORMAL, otherwise logical FALSE (0).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value property is not changeable through BACnet services. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property is present and has a value of TRUE, otherwise logical FALSE (0).

12.38.7 Event_State

This optional property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the Reliability property is not present, or if the Reliability property is present and has a value of NO_FAULT_DETECTED, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT.

12.38.8 Reliability

This optional property, of type BACnetReliability, provides an indication of whether the DateTime Value object is reliably reporting its value. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.38.9 Out_Of_Service

This optional property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the Present_Value of the DateTime Value object is decoupled from software local to the BACnet device in which the object resides that normally produces the Present_Value as an output or consumes it as an input. When Out_Of_Service is TRUE, the Present_Value property may be written to freely.

12.38.10 Priority_Array

This optional property is a read-only array containing prioritized commands that are in effect for this object. See Clause 19 for a description of the prioritization mechanism. If either the Priority_Array property or the Relinquish_Default property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.38.11 Relinquish_Default

This optional property, of type BACnetDateTime, is the default value to be used for the Present_Value property when all command priority values in the Priority_Array property have a NULL value. See Clause 19. If either the Relinquish_Default property or the Priority_Array property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.38.12 Is_UTC

This optional property, of type BOOLEAN, indicates whether the Present_Value property indicates a UTC date and time (when TRUE) or a local date and time (when FALSE). If this property is absent, the Present_Value shall be a local date and time.

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12.38.13 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.39 Large Analog Value Object Type

The Large Analog Value object type defines a standardized object whose properties represent the externally visible characteristics of a named data value in a BACnet device. A BACnet device can use a Large Analog Value object to make any kind of double-precision data value accessible to other BACnet devices. The mechanisms by which the value is derived are not visible to the BACnet client.

Table 12-46. Properties of the Large Analog Value Object

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Present_Value	Double	R[1]
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	O[4]
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	O
Units	BACnetEngineeringUnits	R
Priority_Array	BACnetPriorityArray	O[2]
Relinquish_Default	Double	O[2]
COV_Increment	Double	O[3]
Time_Delay	Unsigned	O[4]
Notification_Class	Unsigned	O[4]
High_Limit	Double	O[4]
Low_Limit	Double	O[4]
Deadband	Double	O[4]
Limit_Enable	BACnetLimitEnable	O[4]
Event_Enable	BACnetEventTransitionBits	O[4]
Acked_Transitions	BACnetEventTransitionBits	O[4]
Notify_Type	BACnetNotifyType	O[4]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[4]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[5]
Profile_Name	CharacterString	O

[1] If Present_Value is commandable, then it is required to be writable. This property is required to be writable when Out_Of_Service is TRUE.
[2] If Present_Value is commandable, then both of these properties shall be present.
[3] This property is required if the object supports COV reporting.
[4] These properties are required if the object supports intrinsic reporting.
[5] This property, if present, is required to be read only.

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12.39.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.39.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

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12.39.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be LARGE_ANALOG_VALUE.

12.39.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.39.5 Present_Value

This property, of type Double, indicates the current value of the object. The Present_Value property shall be writable when Out_Of_Service is TRUE (see Clause 12.39.9).

12.39.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of a Large Analog Value object. Three of the flags are associated with the values of another property of this object. A more detailed status could be determined by reading the property that is linked to this flag. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical TRUE (1) if the Event_State property is present and does not have a value of NORMAL, otherwise logical FALSE (0).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value property is not changeable through BACnet services. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property is present and has a value of TRUE, otherwise logical FALSE (0).

12.39.7 Event_State

This optional property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT. Changes in the Event_State property to the value FAULT are considered to be "fault" events. This property is required if intrinsic reporting is supported by this object.

12.39.8 Reliability

This optional property, of type BACnetReliability, provides an indication of whether the Large Analog Value object is reliably reporting its value. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.39.9 Out_Of_Service

This optional property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the Present_Value of the Large Analog Value object is decoupled from software local to the BACnet device in which the object resides that normally produces the Present_Value as an output or consumes it as an input. When Out_Of_Service is TRUE, the Present_Value property may be written to freely.

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12.39.10 Units

This property, of type BACnetEngineeringUnits, indicates the measurement units of this object. See the BACnetEngineeringUnits ASN.1 production in Clause 21 for a list of engineering units defined by this standard.

12.39.11 Priority_Array

This optional property, of type BACnetPriorityArray, is a read-only array containing prioritized commands that are in effect for this object. See Clause 19 for a description of the prioritization mechanism. If either the Priority_Array property or the Relinquish_Default property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.39.12 Relinquish_Default

This optional property, of type Double, is the default value to be used for the Present_Value property when all command priority values in the Priority_Array property have a NULL value. See Clause 19. If either the Relinquish_Default property or the Priority_Array property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.39.13 COV_Increment

This optional property, of type Double, shall specify the minimum change in Present_Value that will cause a COVNotification to be issued to subscriber COV-clients. This property is required if COV reporting is supported by this object.

12.39.14 Time_Delay

This optional property, of type Unsigned, shall specify the minimum period of time in seconds during which the Present_Value must remain outside the band defined by the High_Limit and Low_Limit properties before a TO-OFFNORMAL event is generated, or within the same band, including the Deadband property, before a TO-NORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.39.15 Notification_Class

This optional property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.39.16 High_Limit

This optional property, of type Double, shall specify a limit that the Present_Value must exceed before an event is generated. This property is required if intrinsic reporting is supported by this object.

12.39.16.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must exceed the High_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the HighLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-OFFNORMAL flag must be set in the Event_Enable property.

12.39.16.2 Conditions for Generating a TO-NORMAL Event

Once exceeded, the Present_Value must fall below the High_Limit minus the Deadband before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must fall below the High_Limit minus the Deadband for a minimum period of time, specified in the Time_Delay property, and
(b) the HighLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-NORMAL flag must be set in the Event_Enable property.

12.39.17 Low_Limit

This optional property, of type Double, shall specify a limit below which the Present_Value must fall before an event is generated. This property is required if intrinsic reporting is supported by this object.

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12.39.17.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must fall below the Low_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the LowLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-OFFNORMAL flag must be set in the Event_Enable property.

12.39.17.2 Conditions for Generating a TO-NORMAL Event

Once the Present_Value has fallen below the LowLimit, the Present_Value must exceed the Low_Limit plus the Deadband before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must exceed the Low_Limit plus the Deadband for a minimum period of time, specified in the Time_Delay property, and
(b) the LowLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-NORMAL flag must be set in the Event_Enable property.

12.39.18 Deadband

This optional property, of type Double, shall specify a range between the High_Limit and Low_Limit properties within which the Present_Value must remain for a TO-NORMAL event to be generated under these conditions:

(a) the Present_Value must fall below the High_Limit minus Deadband, and
(b) the Present_Value must exceed the Low_Limit plus the Deadband, and
(c) the Present_Value must remain within this range for a minimum period of time, specified in the Time_Delay property, and
(d) either the HighLimitEnable or LowLimitEnable flag must be set in the Limit_Enable property, and
(e) the TO-NORMAL flag must be set in the Event_Enable property.

This property is required if intrinsic reporting is supported by this object.

12.39.19 Limit_Enable

This optional property, of type BACnetLimitEnable, shall convey two flags that separately enable and disable reporting of HighLimit and LowLimit offnormal events and their return to normal. This property is required if intrinsic reporting is supported by this object.

12.39.20 Event_Enable

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. This property is required if intrinsic reporting is supported by this object.

12.39.21 Acked_Transitions

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning that event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning that no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

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12.39.22 Notify_Type

This optional property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.39.23 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.39.24 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.39.25 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.40 BitString Value Object Type

The BitString Value object type defines a standardized object whose properties represent the externally visible characteristics of a named data value in a BACnet device. A BACnet device can use a BitString Value object to make any kind of bitstring data value accessible to other BACnet devices. The mechanisms by which the value is derived are not visible to the BACnet client.

Table 12-47. Properties of the BitString Value Object

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Present_Value	BIT STRING	R[1]
Bit_Text	BACnetARRAY[N] of CharacterString	O
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	O[3]
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	O
Priority_Array	BACnetPriorityArray	O[2]
Relinquish_Default	BIT STRING	O[2]
Time_Delay	Unsigned	O[3]
Notification_Class	Unsigned	O[3]
Alarm_Values	BACnetARRAY[N] of BIT STRING	O[3]
Bit_Mask	BIT STRING	O[3]
Event_Enable	BACnetEventTransitionBits	O[3]
Acked_Transitions	BACnetEventTransitionBits	O[3]
Notify_Type	BACnetNotifyType	O[3]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[3]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[4]
Profile_Name	CharacterString	O

[1] This property is required to be writable when Out_Of_Service is TRUE.
[2] If Present_Value is commandable, then both of these properties shall be present.
[3] These properties are required if the object supports intrinsic reporting.
[4] This property, if present, is required to be read only.

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12.40.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.40.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.40.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be BITSTRING_VALUE.

12.40.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

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12.40.5 Present_Value

This property, of type BIT STRING, indicates the current value of the object. The Present_Value property shall be writable when Out_Of_Service is TRUE (see Clause 12.40.10).

12.40.6 Bit_Text

This optional property is a BACnetARRAY of Character Strings representing descriptions of all possible bits of the Present_Value. The number of descriptions matches the number of bits in the Present_Value property. The bits in Present_Value have a one-to-one correspondence with one-based indices in the array, where bit (0) corresponds to array index one.

12.40.7 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of a BitString Value object. Three of the flags are associated with the values of another property of this object. A more detailed status could be determined by reading the property that is linked to this flag. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Always Logical FALSE (0).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value property is not changeable through BACnet services. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property is present and has a value of TRUE, otherwise logical FALSE (0).

12.40.8 Event_State

This optional property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT. Changes in the Event_State property to the value FAULT are considered to be "fault" events. This property is required if intrinsic reporting is supported by this object.

12.40.9 Reliability

This optional property, of type BACnetReliability, provides an indication of whether the BitString Value object is reliably reporting its value. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.40.10 Out_Of_Service

This optional property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the Present_Value of the BitString Value object is decoupled from software local to the BACnet device in which the object resides that normally produces the Present_Value as an output or consumes it as an input. When Out_Of_Service is TRUE, the Present_Value property may be written to freely.

12.40.11 Priority_Array

This optional property is a read-only array containing prioritized commands that are in effect for this object. See Clause 19 for a description of the prioritization mechanism. If either the Priority_Array property or the Relinquish_Default property is

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present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.40.12 Relinquish_Default

This optional property, of type BIT STRING, is the default value to be used for the Present_Value property when all command priority values in the Priority_Array property have a NULL value. See Clause 19. If either the Relinquish_Default property or the Priority_Array property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.40.13 Time_Delay

This optional property, of type Unsigned, shall specify the minimum period of time in seconds during which the Present_Value must either equal, after applying the Bit_Mask, at least one of the values in the Alarm_Values property before a TO-OFFNORMAL event is generated, or be not equal to, after applying the Bit_Mask, any of the values in the Alarm_Values property before a TO-NORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.40.14 Notification_Class

This optional property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.40.15 Alarm_Values

This optional property, of type BACnetARRAY of BIT STRING, shall specify any values that the Present_Value must equal, after applying the Bit_Mask, before a TO-OFFNORMAL event is generated. Only the bits indicated by the Bit_Mask are significant. This property is required if intrinsic reporting is supported by this object.

12.40.15.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must remain equal to at least one of the values in the Alarm_Values list, after applying the Bit_Mask, for a minimum period of time, specified in the Time_Delay property, and
(b) the TO-OFFNORMAL flag must be enabled in the Event_Enable property.

12.40.15.2 Conditions for Generating a TO-NORMAL Event

Once equal, the Present_Value must become not equal to any of the values of this property, after applying Bit_Mask before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must remain not equal to any of the values in the Alarms_Values list, after applying the Bit_Mask, for a minimum period of time, specified by the Time_Delay property, and
(b) the TO-NORMAL flag must be enabled in the Event_Enable property.

12.40.16 Bit_Mask

This optional property, of type BIT STRING, shall specify a bitmask that is used to indicate which bits in the Present_Value are to be monitored by the intrinsic alarm algorithm. A value of one in a bit position indicates that the bit in this position in the Present_Value is to be monitored by the algorithm. A value of zero in a bit position indicates that the bit in this position in the Present_Value is not significant for the purpose of the algorithm.

12.40.17 Event_Enable

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. This property is required if intrinsic reporting is supported by this object.

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12.40.18 Acked_Transitions

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning that event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning that no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

12.40.19 Notify_Type

This optional property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.40.20 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.40.21 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.40.22 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.41 OctetString Value Object Type

The OctetString Value object type defines a standardized object whose properties represent the externally visible characteristics of a named data value in a BACnet device. A BACnet device can use an OctetString Value object to make any kind of OCTET STRING data value accessible to other BACnet devices. The mechanisms by which the value is derived are not visible to the BACnet client.

Table 12-48. Properties of the OctetString Value Object

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Present_Value	OCTET STRING	R[1]
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	O
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	O
Priority_Array	BACnetPriorityArray	O[2]
Relinquish_Default	OCTET STRING	O[2]
Profile_Name	CharacterString	O

[1] This property is required to be writable when Out_Of_Service is TRUE.
[2] If Present_Value is commandable, then both of these properties shall be present.

12.41.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.41.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.41.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be OCTETSTRING_VALUE.

12.41.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.41.5 Present_Value

This property, of type OCTET STRING, indicates the current value of the object. The Present_Value property shall be writable when Out_Of_Service is TRUE (see Clause 12.41.9).

12.41.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of an OctetString Value object. Three of the flags are associated with the values of another property of this object. A more detailed status could be determined by reading the property that is linked to this flag. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

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where:

IN_ALARM — Logical TRUE (1) if the Event_State property is present and does not have a value of NORMAL, otherwise logical FALSE (0).

FAULT — Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN — Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value property is not changeable through BACnet services. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE — Logical TRUE (1) if the Out_Of_Service property is present and has a value of TRUE, otherwise logical FALSE (0).

12.41.7 Event_State

This optional property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the Reliability property is not present, or if the Reliability property is present and has a value of NO_FAULT_DETECTED, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT.

12.41.8 Reliability

This optional property, of type BACnetReliability, provides an indication of whether the OctetString Value object is reliably reporting its value. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.41.9 Out_Of_Service

This optional property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the Present_Value of the OctetString Value object is decoupled from software local to the BACnet device in which the object resides that normally produces the Present_Value as an output or consumes it as an input. When Out_Of_Service is TRUE, the Present_Value property may be written to freely.

12.41.10 Priority_Array

This optional property, of type BACnetPriorityArray, is a read-only array containing prioritized commands that are in effect for this object. See Clause 19 for a description of the prioritization mechanism. If either the Priority_Array property or the Relinquish_Default property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.41.11 Relinquish_Default

This optional property, of type OCTET STRING, is the default value to be used for the Present_Value property when all command priority values in the Priority_Array property have a NULL value. See Clause 19. If either the Relinquish_Default property or the Priority_Array property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.41.12 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.42 Time Value Object Type

The Time Value object type defines a standardized object whose properties represent the externally visible characteristics of a named data value in a BACnet device. A BACnet device can use a Time Value object to make any kind of time data value accessible to other BACnet devices. The mechanisms by which the value is derived are not visible to the BACnet client.

A Time Value object is used to represent a single moment in time. In contrast, the Time Pattern Value object can be used to represent multiple recurring times.

Table 12-49. Properties of the Time Value Object

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Present_Value	Time	R[1]
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	O
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	O
Priority_Array	BACnetPriorityArray	O[2]
Relinquish_Default	Time	O[2]
Profile_Name	CharacterString	O

[1] If Present_Value is commandable, then it is required to be writable. This property is required to be writable when Out_Of_Service is TRUE.

[2] If Present_Value is commandable, then both of these properties shall be present.

12.42.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.42.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.42.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be TIME_VALUE.

12.42.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.42.5 Present_Value

This property, of type Time, indicates the current value of the object. The value of this property shall contain either a fully specified time of day or it shall indicate a fully unspecified time by setting all octets to X'FF'. A fully specified time shall contain no octets that are equal to X'FF'. This property shall always be used to indicate a time of day, not a duration or relative time value. The Present_Value property shall be writable when Out_Of_Service is TRUE (see Clause 12.42.9).

12.42.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of a Time Value object. Three of the flags are associated with the values of another property of this object. A more detailed status could be

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determined by reading the property that is linked to this flag. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical TRUE (1) if the Event_State property is present and does not have a value of NORMAL, otherwise logical FALSE (0).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value property is not changeable through BACnet services. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property is present and has a value of TRUE, otherwise logical FALSE (0).

12.42.7 Event_State

This optional property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the Reliability property is not present, or if the Reliability property is present and has a value of NO_FAULT_DETECTED, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT.

12.42.8 Reliability

This optional property, of type BACnetReliability, provides an indication of whether the Time Value object is reliably reporting its value. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.42.9 Out_Of_Service

This optional property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the Present_Value of the Time Value object is decoupled from software local to the BACnet device in which the object resides that normally produces the Present_Value as an output or consumes it as an input. When Out_Of_Service is TRUE, the Present_Value property may be written to freely.

12.42.10 Priority_Array

This optional property, of type BACnetPriorityArray, is a read-only array containing prioritized commands that are in effect for this object. See Clause 19 for a description of the prioritization mechanism. If either the Priority_Array property or the Relinquish_Default property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.42.11 Relinquish_Default

This optional property, of type Time, is the default value to be used for the Present_Value property when all command priority values in the Priority_Array property have a NULL value. See Clause 19. If either the Relinquish_Default property or the Priority_Array property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.42.12 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document

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named by the remainder of the profile name. This vendor identifier is not required to have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.43 Integer Value Object Type

The Integer Value object type defines a standardized object whose properties represent the externally visible characteristics of a named data value in a BACnet device. A BACnet device can use an Integer Value object to make any kind of signed integer data value accessible to other BACnet devices. The mechanisms by which the value is derived are not visible to the BACnet client.

Table 12-50. Properties of the Integer Value Object

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Present_Value	INTEGER	R[1]
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	O[4]
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	O
Units	BACnetEngineeringUnits	R
Priority_Array	BACnetPriorityArray	O[2]
Relinquish_Default	INTEGER	O[2]
COV_Increment	Unsigned	O[3]
Time_Delay	Unsigned	O[4]
Notification_Class	Unsigned	O[4]
High_Limit	INTEGER	O[4]
Low_Limit	INTEGER	O[4]
Deadband	Unsigned	O[4]
Limit_Enable	BACnetLimitEnable	O[4]
Event_Enable	BACnetEventTransitionBits	O[4]
Acked_Transitions	BACnetEventTransitionBits	O[4]
Notify_Type	BACnetNotifyType	O[4]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[4]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[5]
Profile_Name	CharacterString	O

[1] If Present_Value is commandable, then it is required to be writable. This property is required to be writable when Out_Of_Service is TRUE.
[2] If Present_Value is commandable, then both of these properties shall be present.
[3] This property is required if the object supports COV reporting.
[4] These properties are required if the object supports intrinsic reporting.
[5] This property, if present, is required to be read only.

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12.43.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.43.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

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12.43.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be INTEGER_VALUE.

12.43.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.43.5 Present_Value

This property, of type INTEGER, indicates the current value of the object. The Present_Value property shall be writable when Out_Of_Service is TRUE (see Clause 12.43.9).

12.43.6 Status_Flags

This required property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of an Integer Value object. Three of the flags are associated with the values of another property of this object. A more detailed status could be determined by reading the property that is linked to this flag. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical TRUE (1) if the Event_State property is present and does not have a value of NORMAL, otherwise logical FALSE (0).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value property is not changeable through BACnet services. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property is present and has a value of TRUE, otherwise logical FALSE (0).

12.43.7 Event_State

This optional property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT. Changes in the Event_State property to the value FAULT are considered to be "fault" events. This property is required if intrinsic reporting is supported by this object.

12.43.8 Reliability

This optional property, of type BACnetReliability, provides an indication of whether the Integer Value object is reliably reporting its value. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.43.9 Out_Of_Service

This optional property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the Present_Value of the Integer Value object is decoupled from software local to the BACnet device in which the object resides that normally produces the Present_Value as an output or consumes it as an input. When Out_Of_Service is TRUE, the Present_Value property may be written to freely.

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12.43.10 Units

This property, of type BACnetEngineeringUnits, indicates the measurement units of this object. See the BACnetEngineeringUnits ASN.1 production in Clause 21 for a list of engineering units defined by this standard.

12.43.11 Priority_Array

This optional property, of type BACnetPriorityArray, is a read-only array containing prioritized commands that are in effect for this object. See Clause 19 for a description of the prioritization mechanism. If either the Priority_Array property or the Relinquish_Default property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.43.12 Relinquish_Default

This optional property, of type INTEGER, is the default value to be used for the Present_Value property when all command priority values in the Priority_Array property have a NULL value. See Clause 19. If either the Relinquish_Default property or the Priority_Array property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.43.13 COV_Increment

This optional property, of type Unsigned, shall specify the minimum change in Present_Value that will cause a COVNotification to be issued to subscriber COV-clients. This property is required if COV reporting is supported by this object.

12.43.14 Time_Delay

This optional property, of type Unsigned, shall specify the minimum period of time in seconds during which the Present_Value must remain outside the band defined by the High_Limit and Low_Limit properties before a TO-OFFNORMAL event is generated, or within the same band, including the Deadband property, before a TO-NORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.43.15 Notification_Class

This optional property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.43.16 High_Limit

This optional property, of type INTEGER, shall specify a limit that the Present_Value must exceed before an event is generated. This property is required if intrinsic reporting is supported by this object.

12.43.16.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must exceed the High_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the HighLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-OFFNORMAL flag must be set in the Event_Enable property.

12.43.16.2 Conditions for Generating a TO-NORMAL Event

Once exceeded, the Present_Value must fall below the High_Limit minus the Deadband before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must fall below the High_Limit minus the Deadband for a minimum period of time, specified in the Time_Delay property, and
(b) the HighLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-NORMAL flag must be set in the Event_Enable property.

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12.43.17 Low_Limit

This optional property, of type INTEGER, shall specify a limit below which the Present_Value must fall before an event is generated. This property is required if intrinsic reporting is supported by this object.

12.43.17.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must fall below the Low_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the LowLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-OFFNORMAL flag must be set in the Event_Enable property.

12.43.17.2 Conditions for Generating a TO-NORMAL Event

Once the Present_Value has fallen below the LowLimit, the Present_Value must exceed the Low_Limit plus the Deadband before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must exceed the Low_Limit plus the Deadband for a minimum period of time, specified in the Time_Delay property, and
(b) the LowLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-NORMAL flag must be set in the Event_Enable property.

12.43.18 Deadband

This optional property, of type Unsigned, shall specify a range between the High_Limit and Low_Limit properties within which the Present_Value must remain for a TO-NORMAL event to be generated under these conditions:

(a) the Present_Value must fall below the High_Limit minus Deadband, and
(b) the Present_Value must exceed the Low_Limit plus the Deadband, and
(c) the Present_Value must remain within this range for a minimum period of time, specified in the Time_Delay property, and
(d) either the HighLimitEnable or LowLimitEnable flag must be set in the Limit_Enable property, and
(e) the TO-NORMAL flag must be set in the Event_Enable property.

This property is required if intrinsic reporting is supported by this object.

12.43.19 Limit_Enable

This optional property, of type BACnetLimitEnable, shall convey two flags that separately enable and disable reporting of HighLimit and LowLimit offnormal events and their return to normal. This property is required if intrinsic reporting is supported by this object.

12.43.20 Event_Enable

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. This property is required if intrinsic reporting is supported by this object.

12.43.21 Acked_Transitions

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning that event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning that no acknowledgment is expected).

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This property is required if intrinsic reporting is supported by this object.

12.43.22 Notify_Type

This optional property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.43.23 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.43.24 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.43.25 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.44 Positive Integer Value Object Type

The Positive Integer Value object type defines a standardized object whose properties represent the externally visible characteristics of a named data value in a BACnet device. A BACnet device can use a Positive Integer Value object to make any kind of unsigned data value accessible to other BACnet devices. The mechanisms by which the value is derived are not visible to the BACnet client.

Table 12-51. Properties of the Positive Integer Value Object

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Present_Value	Unsigned	R[1]
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	O[4]
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	O
Units	BACnetEngineeringUnits	R
Priority_Array	BACnetPriorityArray	O[2]
Relinquish_Default	Unsigned	O[2]
COV_Increment	Unsigned	O[3]
Time_Delay	Unsigned	O[4]
Notification_Class	Unsigned	O[4]
High_Limit	Unsigned	O[4]
Low_Limit	Unsigned	O[4]
Deadband	Unsigned	O[4]
Limit_Enable	BACnetLimitEnable	O[4]
Event_Enable	BACnetEventTransitionBits	O[4]
Acked_Transitions	BACnetEventTransitionBits	O[4]
Notify_Type	BACnetNotifyType	O[4]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[4]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[5]
Profile_Name	CharacterString	O

[1] If Present_Value is commandable, then it is required to be writable. This property is required to be writable when Out_Of_Service is TRUE.
[2] If Present_Value is commandable, then both of these properties shall be present.
[3] This property is required if the object supports COV reporting.
[4] These properties are required if the object supports intrinsic reporting.
[5] This property, if present, is required to be read only.

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12.44.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.44.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

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12.44.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be POSITIVE_INTEGER_VALUE.

12.44.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.44.5 Present_Value

This property, of type Unsigned, indicates the current value of the object. The Present_Value property shall be writable when Out_Of_Service is TRUE (see Clause 12.44.9).

12.44.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of a Positive Integer Value object. Three of the flags are associated with the values of another property of this object. A more detailed status could be determined by reading the property that is linked to this flag. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical TRUE (1) if the Event_State property is present and does not have a value of NORMAL, otherwise logical FALSE (0).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value property is not changeable through BACnet services. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property is present and has a value of TRUE, otherwise logical FALSE (0).

12.44.7 Event_State

This optional property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT. Changes in the Event_State property to the value FAULT are considered to be "fault" events. This property is required if intrinsic reporting is supported by this object.

12.44.8 Reliability

This optional property, of type BACnetReliability, provides an indication of whether the Positive Integer Value object is reliably reporting its value. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.44.9 Out_Of_Service

This optional property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the Present_Value of the Positive Integer Value object is decoupled from software local to the BACnet device in which the object resides that normally produces the Present_Value as an output or consumes it as an input. When Out_Of_Service is TRUE, the Present_Value property may be written to freely.

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12.44.10 Units

This property, of type BACnetEngineeringUnits, indicates the measurement units of this object. See the BACnetEngineeringUnits ASN.1 production in Clause 21 for a list of engineering units defined by this standard.

12.44.11 Priority_Array

This optional property, of type BACnetPriorityArray, is a read-only array containing prioritized commands that are in effect for this object. See Clause 19 for a description of the prioritization mechanism. If either the Priority_Array property or the Relinquish_Default property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.44.12 Relinquish_Default

This optional property, of type Unsigned, is the default value to be used for the Present_Value property when all command priority values in the Priority_Array property have a NULL value. See Clause 19. If either the Relinquish_Default property or the Priority_Array property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.44.13 COV_Increment

This optional property, of type Unsigned, shall specify the minimum change in Present_Value that will cause a COVNotification to be issued to subscriber COV-clients. This property is required if COV reporting is supported by this object.

12.44.14 Time_Delay

This optional property, of type Unsigned, shall specify the minimum period of time in seconds during which the Present_Value must remain outside the band defined by the High_Limit and Low_Limit properties before a TO-OFFNORMAL event is generated, or within the same band, including the Deadband property, before a TO-NORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.44.15 Notification_Class

This optional property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.44.16 High_Limit

This optional property, of type Unsigned, shall specify a limit that the Present_Value must exceed before an event is generated. This property is required if intrinsic reporting is supported by this object.

12.44.16.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must exceed the High_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the HighLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-OFFNORMAL flag must be set in the Event_Enable property.

12.44.16.2 Conditions for Generating a TO-NORMAL Event

Once exceeded, the Present_Value must fall below the High_Limit minus the Deadband before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must fall below the High_Limit minus the Deadband for a minimum period of time, specified in the Time_Delay property, and
(b) the HighLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-NORMAL flag must be set in the Event_Enable property.

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12.44.17 Low_Limit

This optional property, of type Unsigned, shall specify a limit below which the Present_Value must fall before an event is generated. This property is required if intrinsic reporting is supported by this object.

12.44.17.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the Present_Value must fall below the Low_Limit for a minimum period of time, specified in the Time_Delay property, and
(b) the LowLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-OFFNORMAL flag must be set in the Event_Enable property.

12.44.17.2 Conditions for Generating a TO-NORMAL Event

Once the Present_Value has fallen below the LowLimit, the Present_Value must exceed the Low_Limit plus the Deadband before a TO-NORMAL event is generated under these conditions:

(a) the Present_Value must exceed the Low_Limit plus the Deadband for a minimum period of time, specified in the Time_Delay property, and
(b) the LowLimitEnable flag must be set in the Limit_Enable property, and
(c) the TO-NORMAL flag must be set in the Event_Enable property.

12.44.18 Deadband

This optional property, of type Unsigned, shall specify a range between the High_Limit and Low_Limit properties within which the Present_Value must remain for a TO-NORMAL event to be generated under these conditions:

(a) the Present_Value must fall below the High_Limit minus Deadband, and
(b) the Present_Value must exceed the Low_Limit plus the Deadband, and
(c) the Present_Value must remain within this range for a minimum period of time, specified in the Time_Delay property, and
(d) either the HighLimitEnable or LowLimitEnable flag must be set in the Limit_Enable property, and
(e) the TO-NORMAL flag must be set in the Event_Enable property.

This property is required if intrinsic reporting is supported by this object.

12.44.19 Limit_Enable

This optional property, of type BACnetLimitEnable, shall convey two flags that separately enable and disable reporting of HighLimit and LowLimit offnormal events and their return to normal. This property is required if intrinsic reporting is supported by this object.

12.44.20 Event_Enable

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. This property is required if intrinsic reporting is supported by this object.

12.44.21 Acked_Transitions

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning that event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning that no acknowledgment is expected).

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This property is required if intrinsic reporting is supported by this object.

12.44.22 Notify_Type

This optional property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.44.23 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

12.44.24 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.44.25 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.45 Date Value Object Type

The Date Value object type defines a standardized object whose properties represent the externally visible characteristics of a named data value in a BACnet device. A BACnet device can use a Date Value object to make any kind of date data value accessible to other BACnet devices. The mechanisms by which the value is derived are not visible to the BACnet client.

A Date Value object is used to represent a single day. In contrast, the Date Pattern Value object can be used to represent multiple recurring dates.

Table 12-52. Properties of the Date Value Object

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Present_Value	Date	R[1]
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	O
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	O
Priority_Array	BACnetPriorityArray	O[2]
Relinquish_Default	Date	O[2]
Profile_Name	CharacterString	O

[1] If Present_Value is commandable, then it is required to be writable. This property is required to be writable when Out_Of_Service is TRUE.
[2] If Present_Value is commandable, then both of these properties shall be present.

12.45.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.45.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.45.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be DATE_VALUE.

12.45.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.45.5 Present_Value

This property, of type Date, indicates the current value of the object. The value of this property shall contain either a fully specified date or it shall indicate a fully unspecified date by setting all octets to X'FF'. A fully specified date shall not contain octets that are equal to X'FF' or contain special values for the 'month' or 'day of month' fields. The Present_Value property shall be writable when Out_Of_Service is TRUE (see Clause 12.45.9).

12.45.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of a Date Value object. Three of the flags are associated with the values of another property of this object. A more detailed status could be

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determined by reading the property that is linked to this flag. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical TRUE (1) if the Event_State property is present and does not have a value of NORMAL, otherwise logical FALSE (0).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value property is not changeable through BACnet services. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property is present and has a value of TRUE, otherwise logical FALSE (0).

12.45.7 Event_State

This optional property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the Reliability property is not present, or if the Reliability property is present and has a value of NO_FAULT_DETECTED, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT.

12.45.8 Reliability

This optional property, of type BACnetReliability, provides an indication of whether the Date Value object is reliably reporting its value. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.45.9 Out_Of_Service

This optional property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the Present_Value of the Date Value object is decoupled from software local to the BACnet device in which the object resides that normally produces the Present_Value as an output or consumes it as an input. When Out_Of_Service is TRUE, the Present_Value property may be written to freely.

12.45.10 Priority_Array

This optional property, of type BACnetPriorityArray, is a read-only array containing prioritized commands that are in effect for this object. See Clause 19 for a description of the prioritization mechanism. If either the Priority_Array property or the Relinquish_Default property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.45.11 Relinquish_Default

This optional property, of type Date, is the default value to be used for the Present_Value property when all command priority values in the Priority_Array property have a NULL value. See Clause 19. If either the Relinquish_Default property or the Priority_Array property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.45.12 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document

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named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.46 DateTime Pattern Value Object Type

The DateTime Pattern Value object type defines a standardized object whose properties represent the externally visible characteristics of a named data value in a BACnet device. A BACnet device can use a DateTime Pattern Value object to make any kind of datetime data value accessible to other BACnet devices. The mechanisms by which the value is derived are not visible to the BACnet client.

DateTime Pattern objects can be used to represent multiple recurring dates and times based on rules defined by the pattern of individual fields of the date and time, some of which can be special values like "even months", or "don't care", which matches any value in that field. Examples of possibilities would be: "11:00 every Thursday in any June", or "every day in May 2009".

Table 12-53. Properties of the DateTime Pattern Value Object

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Present_Value	BACnetDateTime	R[1]
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	O
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	O
Is_UTC	BOOLEAN	O
Priority_Array	BACnetPriorityArray	O[2]
Relinquish_Default	BACnetDateTime	O[2]
Profile_Name	CharacterString	O

[1] If Present_Value is commandable, then it is required to be writable. This property is required to be writable when Out_Of_Service is TRUE.

[2] If Present_Value is commandable, then both of these properties shall be present.

12.46.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.46.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.46.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be DATETIME_PATTERN_VALUE.

12.46.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.46.5 Present_Value

This property, of type BACnetDateTime, indicates the current value of the object. The value of this property may indicate a fully specified date and time or a partially specified datetime pattern by containing one or more unspecified octets that are equal to X'FF' or the special values for the 'month' or 'day of month' fields. The Present_Value property shall be writable when Out_Of_Service is TRUE (see Clause 12.46.9).

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12.46.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of a DateTime Pattern Value object. Three of the flags are associated with the values of another property of this object. A more detailed status could be determined by reading the property that is linked to this flag. The relationship between individual flags is not defined by the protocol. The four flags are:

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical TRUE (1) if the Event_State property is present and does not have a value of NORMAL, otherwise logical FALSE (0).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value property is not changeable through BACnet services. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property is present and has a value of TRUE, otherwise logical FALSE (0).

12.46.7 Event_State

This optional property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the Reliability property is not present, or if the Reliability property is present and has a value of NO_FAULT_DETECTED, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT.

12.46.8 Reliability

This optional property, of type BACnetReliability, provides an indication of whether the DateTime Pattern Value object is reliably reporting its value. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.46.9 Out_Of_Service

This optional property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the Present_Value of the DateTime Value object is decoupled from software local to the BACnet device in which the object resides that normally produces the Present_Value as an output or consumes it as an input. When Out_Of_Service is TRUE, the Present_Value property may be written to freely.

12.46.10 Priority_Array

This optional property, of type BACnetPriorityArray, is a read-only array containing prioritized commands that are in effect for this object. See Clause 19 for a description of the prioritization mechanism. If either the Priority_Array property or the Relinquish_Default property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.46.11 Relinquish_Default

This optional property, of type BACnetDateTime, is the default value to be used for the Present_Value property when all command priority values in the Priority_Array property have a NULL value. See Clause 19. If either the Relinquish_Default property or the Priority_Array property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.46.12 Is_UTC

This optional property indicates whether the Present_Value property indicates a UTC date and time (when TRUE) or a local date and time (when FALSE). If this property is absent, the Present_Value shall be a local date and time.

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12.46.13 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.47 Time Pattern Value Object Type

The Time Pattern Value object type defines a standardized object whose properties represent the externally visible characteristics of a named data value in a BACnet device. A BACnet device can use a Time Pattern Value object to make any kind of time data value accessible to other BACnet devices. The mechanisms by which the value is derived are not visible to the BACnet client.

Time Pattern objects can be used to represent multiple recurring times based on rules defintед by the pattern of individual fields of the time, some of which may be "don't care", which matches any value in that field. Examples of possibilities would be: "every minute of the 11 o'clock hour of the day", or "the thirteenth minute of any hour".

Table 12-54. Properties of the Time Pattern Value Object

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Present_Value	Time	R[1]
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	O
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	O
Priority_Array	BACnetPriorityArray	O[2]
Relinquish_Default	Time	O[2]
Profile_Name	CharacterString	O

[1] If Present_Value is commandable, then it is required to be writable. This property is required to be writable when Out_Of_Service is TRUE.
[2] If Present_Value is commandable, then both of these properties shall be present.

12.47.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.47.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.47.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be TIME_PATTERN_VALUE.

12.47.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.47.5 Present_Value

This property, of type Time, indicates the current value of the object. The value of this property may indicate a fully specified time or a partially specified time pattern by containing one or more "unspecified" octets that are equal to X'FF'. The Present_Value property shall be writable when Out_Of_Service is TRUE (see Clause 12.47.9).

12.47.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of a Time Pattern Value object. Three of the flags are associated with the values of another property of this object. A more detailed status could

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be determined by reading the property that is linked to this flag. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical TRUE (1) if the Event_State property is present and does not have a value of NORMAL, otherwise logical FALSE (0).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value property is not changeable through BACnet services. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property is present and has a value of TRUE, otherwise logical FALSE (0).

12.47.7 Event_State

This optional property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the Reliability property is not present, or if the Reliability property is present and has a value of NO_FAULT_DETECTED, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT.

12.47.8 Reliability

This optional property, of type BACnetReliability, provides an indication of whether the Time Pattern Value object is reliably reporting its value. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.47.9 Out_Of_Service

This optional property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the Present_Value of the Time Value object is decoupled from software local to the BACnet device in which the object resides that normally produces the Present_Value as an output or consumes it as an input. When Out_Of_Service is TRUE, the Present_Value property may be written to freely.

12.47.10 Priority_Array

This optional property, of BACnetPriorityArray, is a read-only array containing prioritized commands that are in effect for this object. See Clause 19 for a description of the prioritization mechanism. If either the Priority_Array property or the Relinquish_Default property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.47.11 Relinquish_Default

This optional property, of type Time, is the default value to be used for the Present_Value property when all command priority values in the Priority_Array property have a NULL value. See Clause 19. If either the Relinquish_Default property or the Priority_Array property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.47.12 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document

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named by the remainder of the profile name. This vendor identifier is not required to have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.48 Date Pattern Value Object Type

The Date Pattern Value object type defines a standardized object whose properties represent the externally visible characteristics of a named data value in a BACnet device. A BACnet device can use a Date Pattern Value object to make any kind of date data value accessible to other BACnet devices. The mechanisms by which the value is derived are not visible to the BACnet client.

Date Pattern objects can be used to represent multiple recurring dates and times based on rules definted by the pattern of individual fields of the date and time, some of which can be special values like "even months", or "don't care", which matches any value in that field. Examples of possibilities would be: "every Thursday in May of any year", or "every day in May 2009".

Table 12-55. Properties of the Date Pattern Value Object

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Present_Value	Date	R[1]
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	O
Reliability	BACnetReliability	O
Out_Of_Service	BOOLEAN	O
Priority_Array	BACnetPriorityArray	O[2]
Relinquish_Default	Date	O[2]
Profile_Name	CharacterString	O

[1] If Present_Value is commandable, then it is required to be writable. This property is required to be writable when Out_Of_Service is TRUE.

[2] If Present_Value is commandable, then both of these properties shall be present.

12.48.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.48.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.48.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be DATE_PATTERN_VALUE.

12.48.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.48.5 Present_Value

This property, of type Date, indicates the current value of the object. The value of this property may indicate a fully specified date or a partially specified date pattern by containing one or more "unspecified" octets that are equal to X'FF' or the special values for the 'month' or 'day of month' fields. The Present_Value property shall be writable when Out_Of_Service is TRUE (see Clause 12.48.9).

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12.48.6 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of a Date Value object. Three of the flags are associated with the values of another property of this object. A more detailed status could be determined by reading the property that is linked to this flag. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical TRUE (1) if the Event_State property is present and does not have a value of NORMAL, otherwise logical FALSE (0).

FAULT Logical TRUE (1) if the Reliability property is present and does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the point has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value property is not changeable through BACnet services. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property is present and has a value of TRUE, otherwise logical FALSE (0).

12.48.7 Event_State

This optional property, of type BACnetEventState, is included in order to provide a way to determine if this object has an active event state associated with it. If the Reliability property is not present, or if the Reliability property is present and has a value of NO_FAULT_DETECTED, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of the Event_State property shall be FAULT.

12.48.8 Reliability

This optional property, of type BACnetReliability, provides an indication of whether the Date Value object is reliably reporting its value. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}

12.48.9 Out_Of_Service

This optional property, of type BOOLEAN, is an indication whether (TRUE) or not (FALSE) the Present_Value of the Date Value object is decoupled from software local to the BACnet device in which the object resides that normally produces the Present_Value as an output or consumes it as an input. When Out_Of_Service is TRUE, the Present_Value property may be written to freely.

12.48.10 Priority_Array

This optional property, of type BACnetPriorityArray, is a read-only array containing prioritized commands that are in effect for this object. See Clause 19 for a description of the prioritization mechanism. If either the Priority_Array property or the Relinquish_Default property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.48.11 Relinquish_Default

This optional property, of type Date, is the default value to be used for the Present_Value property when all command priority values in the Priority_Array property have a NULL value. See Clause 19. If either the Relinquish_Default property or the Priority_Array property is present, then both of them shall be present. If Present_Value is commandable, then Priority_Array and Relinquish_Default shall both be present.

12.48.12 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a

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dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.49 Network Security Object Type

The Network Security object type defines a standardized object whose properties represent the externally visible network security settings and status of a BACnet Device. Secure BACnet devices shall contain exactly one Network Security object and they shall have an instance of 1. A detailed description of BACnet security and secure BACnet devices can be found in Clause 24.

Operations on the Network Security object shall always be deemed to have sufficient authorization if the request is secured with an Installation key.

Table 12-56. Properties of the Network Security Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Base_Device_Security_Policy	BACnetSecurityLevel	W
Network_Access_Security_Policies	BACnetARRAY[N] of BACnetNetworkSecurityPolicy	W
Security_Time_Window	Unsigned	W
Packet_Reorder_Time	Unsigned	W
Distribution_Key_Revision	Unsigned8	R
Key_Sets	BACnetARRAY[2] of BACnetSecurityKeySet	R
Last_Key_Server	BACnetAddressBinding	W
Security_PDU_Timeout	Unsigned16	W
Update_Key_Set_Timeout	Unsigned16	R
Supported_Security_Algorithms	List of Unsigned8	R
Do_Not_Hide	BOOLEAN	W
Profile_Name	CharacterString	O

12.49.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.49.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

12.49.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be NETWORK_SECURITY.

12.49.4 Description

This property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.49.5 Base_Device_Security_Policy

This writable property, of type BACnetSecurityLevel, specifies the minimum level of security that the device requires allowing client devices to know the level of security to use when communicating with the device.

While devices may require higher security levels for some operations, this property shall be readable using the security level defined by this property.

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12.49.6 Network_Access_Security_Policies

This writable property, of type BACnetArray of BACnetNetworkSecurityPolicy, specifies the security policy for each network directly connected to the device. It specifies the level of security that the device should use for network infrastructure services, such as Who-Is, I-Am, Who-Is-Router, etc. This array shall have 1 entry for each network port.

The Port ID field shall correspond to the Port ID of the associated network as described in Clause 6. For non-routing nodes, this value shall be 0.

This property shall be readable via the base security level for the device.

12.49.7 Security_Time_Window

This writable property, of type Unsigned, specifies the security time window for the device in seconds. The recommended default value for this property is 180 (3 minutes). The property shall be restricted to the range 1 through 600.

12.49.8 Packet_Reorder_Time

This writable property, of type Unsigned, specifies the packet reorder time, in milliseconds, used by the device for validating Message Ids. The recommended default value for this property is 500 (0.5 seconds). The property shall be restricted to the range 1 through 3000.

12.49.9 Distribution_Key_Revision

This read-only property, of type Unsigned8, identifies the device's Distribution key revision. This property shall be 0 if the device does not have a Distribution key.

12.49.10 Key_Sets

This read only property, of type BACnetArray of BACnetSecurityKeySet, describes the contents of the device's 2 key sets. The actual key values are not included in the contents of this property. When a key set has not been provided, the key-revision field shall be set to 0, the key-ids field shall be empty, and the activation-time and expiration-time fields shall contain all wildcard values.

12.49.11 Last_Key_Server

This writable property, of type BACnetAddressBinding, specifies the device identifier and address of the last Key Server that successfully updated a security key in the device. If no Key Server has updated the keys sets in the device, the deviceObjectIdentifier field shall contain 4194303 in the instance part, the network-number field shall be 0, and the mac-address field shall be empty.

This property is writable in order to allow a Key Server address to be provided to the secure device before it has received a Device-Master key. This allows the secure device to be directed to the Key Server in a legacy environment where globally broadcast Request-Key-Update messages will not be routed. A device may make this property read-only once a Device-Master key has been received.

12.49.12 Security_PDU_Timeout

This writable property, of type Unsigned16, specifies the length of time, in milliseconds, the device waits for a security response. For the application TSM to work correctly, this value should be configured to be less than the APDU_Segment_Timeout value in the Device object.

12.49.13 Update_Key_Set_Timeout

This property, of type Unsigned16, indicates the maximum amount of time, in milliseconds, that the device will take to respond to an Update-Key-Set message. This value added to the device Max_APDU_Timeout results in the amount of time that a Key Server shall wait for a Security-Response for an Update-Key-Set message. The use of Max_APDU_Timeout is to allow for network delay; whereas the Update_Key_Set_Timeout provides for the actual time the device will need to apply the keys to its key set.

12.49.14 Supported_Security_Algorithms

This read-only property, of type list of Unsigned8, identifies the encryption and signature algorithm pairs that the device supports. See Clause 24.21.1 for a list of defined values.

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12.49.15 Do_Not_Hide

This writable property, of type BOOLEAN, indicates whether or not the device is allowed to ignore certain network security error conditions. When True, the device is required to return errors in all of the conditions described in Clause 24.3.

It is recommended that this property default to True.

12.49.16 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier need not have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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12.50 Global Group Object Type

The Global Group object type defines a standardized object whose properties represent a collection of other objects and one or more of their properties. A Global Group object is used to simplify the exchange of information between BACnet devices by providing a shorthand way to specify all members of the group at once.

A Global Group object differs from a Group object in that its members can be from anywhere in the BACnet internetwork, it supports intrinsic event reporting, and it exposes a method for sending periodic COV notifications. The Global Group object is able to monitor all referenced Status_Flags properties to detect changes to non-normal states and can initiate an event notification message conveying the values of all of the members of the group. This provides a mechanism to define a large set of property values that are made available when an event occurs.

Table 12-57. Properties of the Global Group Object Type

Property Identifier	Property Datatype	Conformance Code
Object_Identifier	BACnetObjectIdentifier	R
Object_Name	CharacterString	R
Object_Type	BACnetObjectType	R
Description	CharacterString	O
Group_Members	BACnetARRAY[N] of BACnetDeviceObjectPropertyReference	R
Group_Member_Names	BACnetARRAY[N] of CharacterString	O
Present_Value	BACnetARRAY[N] of BACnetPropertyAccessResult	R
Status_Flags	BACnetStatusFlags	R
Event_State	BACnetEventState	R
Member_Status_Flags	BACnetStatusFlags	R
Reliability	BACnetReliability	O
Out_of_Service	BOOLEAN	R
Update_Interval	Unsigned	O
Requested_Update_Interval	Unsigned	O
COV_Resubscription_Interval	Unsigned	O
Client_COV_Increment	BACnetClientCOV	O
Time_Delay	Unsigned	O[1]
Notification_Class	Unsigned	O[1]
Event_Enable	BACnetEventTransitionBits	O[1]
Acked_Transitions	BACnetEventTransitionBits	O[1]
Notify_Type	BACnetNotifyType	O[1]
Event_Time_Stamps	BACnetARRAY[3] of BACnetTimeStamp	O[1]
Event_Message_Texts	BACnetARRAY[3] of CharacterString	O[3]
COVU_Period	Unsigned	O[2]
COVU_Recipients	List of BACnetRecipient	O[2]
Profile_Name	CharacterString	O

[1] These properties are required if the object supports intrinsic reporting.
[2] These properties are required if the object sends periodic unsubscribed COV notifications for Present_Value. These properties are required to be writable if present.
[3] This property, if present, is required to be read only.

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12.50.1 Object_Identifier

This property, of type BACnetObjectIdentifier, is a numeric code that is used to identify the object. It shall be unique within the BACnet Device that maintains it.

12.50.2 Object_Name

This property, of type CharacterString, shall represent a name for the object that is unique within the BACnet Device that maintains it. The minimum length of the string shall be one character. The set of characters used in the Object_Name shall be restricted to printable characters.

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12.50.3 Object_Type

This property, of type BACnetObjectType, indicates membership in a particular object type class. The value of this property shall be GLOBAL_GROUP.

12.50.4 Description

This optional property, of type CharacterString, is a string of printable characters whose content is not restricted.

12.50.5 Group_Members

This property, of type BACnetARRAY of BACnetDeviceObjectPropertyReference, defines the members of the group. If the optional device identifier is not present for a particular group member, then that object shall reside in the same device that maintains the Global Group object. If the Group_Members property is writable using WriteProperty services, then the object shall support group members that are outside the device that maintains the Global Group object.

Nesting of group objects is not permitted; that is, Group_Members shall not refer to the Present_Value property of a Group object or a Global Group object.

12.50.5.1 Resizing Group_Members and Group_Member_Names by Writing Either Property

The size of the Group_Members and Group_Member_Names properties shall be maintained so that both have the same size. If either of these arrays is writable and the size of one array is reduced, the size of the other array and the Present_Value array shall also be truncated to the new reduced size. If the size of either array is increased, the other array and the Present_Value array shall all be increased to the new expanded size and the new array elements initialized according to the requirements of each property. See Clauses 12.50.5.2, 12.50.6.2, and 12.50.7.1.

12.50.5.2 Initializing New Array Elements When the Array Size is Increased

If the size of the Group_Members array is increased by writing to the size of either the Group_Members or Group_Member_Names property, the new array entries shall be initialized by setting the object or device instance numbers of the BACnetDeviceObjectPropertyReference equal to 4194303, indicating that the value is not initialized. The initial value of the other parameters is a local matter except that they must be of the correct datatype.

12.50.6 Group_Member_Names

This optional property, of type BACnetARRAY of CharacterString, represents a descriptive name for the members of the Global Group. The number of names matches the number of members defined in Group_Members. The array index of the name shall match the array index of the corresponding group member.

12.50.6.1 Resizing Group_Members and Group_Member_Names by Writing Either Property

See Clause 12.50.5.1.

12.50.6.2 Initializing New Array Elements When the Array Size is Increased

If the size of the Group_Member_Names array is increased by writing to the size of either the Group_Members or Group_Member_Names property, the new array entries shall be initialized with empty strings.

12.50.7 Present_Value

This read-only property, of type BACnetARRAY of BACnetPropertyAccessResult, contains the values of all the properties specified in the Group_Members property. The array index of the Present_Value shall match the corresponding array index in Group_Members. This is a "read-only" property; it cannot be used to write a set of values to the members of the group.

The Present_Value data shall be stored locally. The Present_Value may be updated based on COV notifications, polling, or a combination of the two. The method of acquisition used for any particular member is a local matter. If the Present_Value, or a portion of the Present_Value, is acquired periodically and the Requested_Update_Interval property is present, then an attempt shall be made to update the Present_Value within this time interval. If the Present_Value, or a portion of the Present_Value, is acquired periodically and the Requested_Update_Interval is not present, then the update interval is a local matter. When updating the Present_Value, if a group member's property value cannot be acquired, a property access error shall be stored in the access result for that member of the group. If a property access error was returned when attempting to update the group member's property value, then that access error shall be the one stored in the access result. Otherwise, the choice of property access error to store shall be a local matter.

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The Present_Value array shall be maintained at the same size as the Group_Members array. If the Group_Members property is writable and the size of the array is reduced, the Present_Value array shall be truncated to match. If the Group_Members property is writable and the size of the array is increased, the Present_Value array shall be increased in size to match with the value of the new array elements being determined through the same mechanism that is used to update the values. If a specific element in the Group_Members property changes, then the corresponding element in the Present_Value array shall be updated through the same mechanism that is used to update the values. Note that the size of the Group_Members property can also be affected by changing the size of the Group_Member_Names property.

The value of the Present_Value property shall continue to be updated regardless of the value of the Reliability property.

12.50.7.1 Initializing New Array Elements When the Array Size is Increased

If the size of the Present_Value array is increased by writing to the size of either the Group_Members or Group_Member_Names property, the new array entries shall be initialized with the Access Result parameter having a value of type PropertyAccessError, with an Error Class of PROPERTY and an Error Code of VALUE_NOT_INITIALIZED. The other parameters shall have values consistent with the corresponding entry in the Group_Members array.

12.50.8 Status_Flags

This property, of type BACnetStatusFlags, represents four Boolean flags that indicate the general "health" of the Global Group object. Three of the flags are associated with the values of other properties of this object. A more detailed status could be determined by reading the properties that are linked to these flags. The relationship between individual flags is not defined by the protocol. The four flags are

{IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE}

where:

IN_ALARM Logical FALSE (0) if the Event_State property has a value of NORMAL, otherwise logical TRUE (1).

FAULT Logical TRUE (1) if the Reliability property does not have a value of NO_FAULT_DETECTED, otherwise logical FALSE (0).

OVERRIDDEN Logical TRUE (1) if the global group has been overridden by some mechanism local to the BACnet Device. In this context "overridden" is taken to mean that the Present_Value is no longer tracking the group members' values, the Event_State property is no longer tracking changes to the Event_State of group member objects, and the Reliability property is no longer a reflection of the result of any internal algorithm for determining the reliability of the Global Group object. Otherwise, the value is logical FALSE (0).

OUT_OF_SERVICE Logical TRUE (1) if the Out_Of_Service property has a value of TRUE, otherwise logical FALSE (0).

12.50.9 Event_State

The Event_State property, of type BACnetEventState, is included in order to provide a way to determine whether this object has an active event state associated with it. If the object supports intrinsic reporting, then the Event_State property shall indicate the event state of the object. If the object does not support intrinsic reporting, then the value of this property shall be NORMAL. If the Reliability property is present and does not have a value of NO_FAULT_DETECTED, then the value of this property shall be FAULT. Changes in the Event_State property to the value FAULT are considered to be "fault" events.

12.50.10 Member_Status_Flags

The Member_Status_Flags property is a logical combination of all the Status_Flags properties contained in the Present_Value. The logical combination means that each of the flags in this property (IN_ALARM, FAULT, OVERRIDDEN, OUT_OF_SERVICE) is TRUE if and only if the corresponding flag is set in any of the Status_Flags property values in the Present_Value property. This property shall be updated whenever new Status_Flags property values are updated in the Present_Value.

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12.50.10.1 Conditions for Generating a TO-OFFNORMAL Event

A TO-OFFNORMAL event is generated under these conditions:

(a) the IN_ALARM flag of the Member_Status_Flags property must remain equal to TRUE for a minimum period of time, specified by the Time_Delay property, and
(b) the TO-OFFNORMAL flag must be enabled in the Event_Enable property.

When a TO-OFFNORMAL event is generated, the Global Group object shall return the most recently stored Present_Value as a parameter in the event notification message.

12.50.10.2 Conditions for Generating a TO-NORMAL Event

A TO-NORMAL event is generated if the TO-NORMAL flag is enabled in the Event_Enable property, and either:

(a) the IN_ALARM flag of the Member_Status_Flags property remains equal to FALSE for a minimum period of time, specified by the Time_Delay property, or
(b) the Reliability property changes to the value NO_FAULT_DETECTED.

When a TO-NORMAL event is generated, the Global Group object shall return the most recently stored Present_Value as a parameter in the event notification message.

12.50.10.3 Conditions for Generating a TO-FAULT Event

A TO-FAULT event is generated if the TO-FAULT flag is enabled in the Event_Enable property and the Reliability property changes to a value other than NO_FAULT_DETECTED.

When a TO-FAULT event is generated, the Global Group object shall return the most recently stored Present_Value as a parameter in the event notification message.

12.50.11 Reliability

This optional property, of type BACnetReliability, provides an indication of whether the Present_Value is "reliable" as far as the BACnet Device or operator can determine. If the FAULT flag of the Member_Status_Flags has a value of TRUE, then the value of this property shall be MEMBER_FAULT. If one or more group member values cannot be updated because of a communication failure, the value of this property shall be COMMUNICATION_FAILURE. If the conditions for a MEMBER_FAULT and a COMMUNICATION_FAILURE are both present, the selection of which value to use is a local matter. The Reliability property for this object type may have any of the following values:

{NO_FAULT_DETECTED, MEMBER_FAULT, COMMUNICATION_FAILURE, UNRELIABLE_OTHER}.

12.50.12 Out_of_Service

This property, of type BOOLEAN, indicates and controls whether (TRUE) or not (FALSE) the Present_Value property is updated to track the values of the group members. In addition, the Reliability property and the corresponding state of the FAULT flag of the Status_Flags property shall be decoupled from their normal calculations when Out_Of_Service is TRUE. While the Out_Of_Service property is TRUE, the Reliability property may be changed to any value as a means of simulating specific fixed conditions or for testing purposes. Other functions that depend on the state of the Reliability property shall respond to changes made to these properties while Out_Of_Service is TRUE as if those changes had occurred by normal operation.

12.50.13 Update_Interval

This optional property, of type Unsigned, provides an indication of the actual period of time–between updates to Present_Value, measured in hundredths of a second. The method used to calculate Update_Interval is a local matter.

12.50.14 Requested_Update_Interval

This optional property, of type Unsigned, indicates the requested period of time between updates to Present_Value, measured in hundredths of a second when the object is not out-of-service.

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12.50.15 COV_Resubscription_Interval

If the Global Group is acquiring data from a remote device by COV subscription, this optional property, of type Unsigned, specifies the number of seconds between COV resubscriptions, provided that COV subscription is in effect. SubscribeCOV requests shall specify twice this lifetime for the subscription and shall specify the issuance of confirmed notifications. If COV subscriptions are in effect, the first COV subscription is issued when the Global Group object begins operation. If present, the value of this property shall be non-zero. If this property is not present, then COV subscription shall not be attempted.

12.50.16 Client_COV_Increment

If the Global Group is acquiring COV data, this optional property, of type BACnetClientCOV, specifies the increment to be used in determining that a change of value has occurred. If all the referenced objects and properties support COV reporting according to Clause 13.1, this property may have the value NULL; in this case change of value is determined by the criteria of Clause 13.1.

12.50.17 Time_Delay

This optional property, of type Unsigned, shall specify the minimum period of time in seconds during which the IN_ALARM flag of Member_Status_Flags must be TRUE before a TO-OFFNORMAL event is generated. It is also the minimum period of time in seconds during which the IN_ALARM flag of Member_Status_Flags must remain FALSE before a TO-NORMAL event is generated. This property is required if intrinsic reporting is supported by this object.

12.50.18 Notification_Class

This optional property, of type Unsigned, shall specify the notification class to be used when handling and generating event notifications for this object. The Notification_Class property implicitly refers to a Notification Class object that has a Notification_Class property with the same value. This property is required if intrinsic reporting is supported by this object.

12.50.19 Event_Enable

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately enable and disable reporting of TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. This property is required if intrinsic reporting is supported by this object.

12.50.20 Acked_Transitions

This optional property, of type BACnetEventTransitionBits, shall convey three flags that separately indicate the receipt of acknowledgments for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events. These flags shall be cleared upon the occurrence of the corresponding event and set under any of these conditions:

(a) upon receipt of the corresponding acknowledgment;
(b) upon the occurrence of the event if the corresponding flag is not set in the Event_Enable property (meaning event notifications will not be generated for this condition and thus no acknowledgment is expected);
(c) upon the occurrence of the event if the corresponding flag is set in the Event_Enable property and the corresponding flag in the Ack_Required property of the Notification Class object implicitly referenced by the Notification_Class property of this object is not set (meaning no acknowledgment is expected).

This property is required if intrinsic reporting is supported by this object.

12.50.21 Notify_Type

This optional property, of type BACnetNotifyType, shall convey whether the notifications generated by the object should be Events or Alarms. This property is required if intrinsic reporting is supported by this object.

12.50.22 Event_Time_Stamps

This optional property, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the times of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property is required if intrinsic reporting is supported by this object.

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12.50.23 Event_Message_Texts

This optional property, of type BACnetARRAY[3]of CharacterString, shall convey the Message Text of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events, respectively. This property shall be read only. If no notification of a transition has occurred yet, an empty string shall be stored in the respective array element.

12.50.24 COVU_Period

The optional COVU_Period property, of type Unsigned, shall indicate the amount of time in seconds between the periodic unsubscribed COV notifications performed by this object. These COV notifications convey the value of the Present_Value and Member_Status_Flags properties. If the value of COVU_Period is zero, then periodic unsubscribed COV notification messages shall not be transmitted.

12.50.25 COVU_Recipients

This optional property, of type List of BACnetRecipient, is used to control the restrictions on which devices, if any, are to receive periodic unsubscribed COV notifications for the Present_Value. This property is required if the object sends such notifications. The value of this property shall be a list of zero or more BACnetRecipients. If the list is of length zero, a device is prohibited from sending such notifications. If the list is of length one or more, the device shall send the notifications, but only to the devices or addresses listed.

12.50.26 Profile_Name

This optional property, of type CharacterString, is the name of an object profile to which this object conforms. To ensure uniqueness, a profile name must begin with a vendor identifier code (see Clause 23) in base-10 integer format, followed by a dash. All subsequent characters are administered by the organization registered with that vendor identifier code. The vendor identifier code that prefixes the profile name shall indicate the organization that publishes and maintains the profile document named by the remainder of the profile name. This vendor identifier is not required to have any relationship to the vendor identifier of the device within which the object resides.

A profile defines a set of additional properties, behavior, and/or requirements for this object beyond those specified here. This standard defines only the format of the names of profiles. The definition of the profiles themselves is outside the scope of this standard.

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13 ALARM AND EVENT SERVICES

This clause describes the conceptual approach and application services used in BACnet to manage communication related to events. Object types relating to event management are defined in Clause 12. In general, "events" are changes of value of certain properties of certain objects, or internal status changes, that meet predetermined criteria. There are three mechanisms provided in BACnet for managing events: change of value reporting, intrinsic reporting, and algorithmic change reporting.

Change of value (COV) reporting allows a COV-client to subscribe with a COV-server, on a permanent or temporary basis, to receive reports of some changes of value of some referenced property based on fixed criteria. Certain BACnet standard objects may optionally support COV reporting. If a standard object provides COV reporting, then changes of value of specific properties of the object, in some cases based on programmable increments, trigger COV notifications to be sent to one or more subscriber clients. Typically, COV notifications are sent to supervisory programs in COV-client devices or to operators or logging devices. Proprietary objects may support COV reporting at the implementor's option.

Intrinsic reporting allows a BACnet device to provide one or more event sources, intrinsic to the device, that generate event notifications that may be directed to one or more destinations. Certain BACnet standard objects may optionally support intrinsic reporting by supporting optional properties that define the type of event to be generated and options for handling and routing of the notifications. Internal status changes and alarms may also use intrinsic reporting to generate diagnostic notifications. Proprietary objects may support intrinsic reporting at the implementor's option.

Algorithmic change reporting allows a notification-client to subscribe with a notification-server to receive reports of changes of value of any property of any object on the basis of predetermined, and network-visible, criteria. Any of the standardized algorithms described in Clause 13.3 may be used to establish criteria for change reporting. Once established, occurrences of change may be reported to one or more destinations based on further criteria. Algorithmic change reporting differs from intrinsic reporting in that Event Enrollment objects are used to determine the event condition(s).

Intrinsic and algorithmic change reporting rely on the concept of event classification for selective reporting of individual occurrences of events. Particular intrinsic or algorithmic change events may specify a notification class number that is directly related to a Notification Class object within the initiating device. The Notification Class object is used to specify the handling and routing of events to one or more destinations. The Notification Class object defines the priorities to be used in event-notification messages, whether acknowledgment by an application process or human operator is required, and at what time periods during the week given destinations are to be used.

BACnet devices that support event notification are free to define any number of unique conditions that trigger alarm or event notifications. Alarms and events are broadly classified into one of three possible groups: fault, offnormal, and normal. A "fault" condition is a malfunction, nearly always representing a failure within the automation system itself. An "offnormal" condition is a condition within the system that is not normally expected or is outside the bounds of ideal operation. A "normal" condition is anything else.

Event-initiating objects may identify their "state" from moment to moment as one of any number of possibly unique event states. Notifications are triggered by the "transition" of conditions for an object, usually from one unique event state to another. A transition to a particular event state may be used to identify specific unique handling for the notification(s) generated by an object, for example, controlling the destination for a notification or whether the particular transition event should require acknowledgment. In these contexts, all transitions that result in a state that is not normal, and not a fault, are considered to be TO-OFFNORMAL transitions. Transitions to any fault state are considered to be TO-FAULT transitions. All other transitions are, by definition, TO-NORMAL transitions.

Events may be selectively identified as belonging to the category of "alarms" or "events." Event-initiating objects indicate this distinction through the Notify_Type property. In BACnet, the singular distinction between alarms and all other events is whether the event will be reported by the GetAlarmSummary service or not. Alarms will be reported by the GetAlarmSummary service, while all other events will not be reported by GetAlarmSummary. In every other respect, BACnet makes no distinction between an alarm and an event.

None of the reporting mechanisms is preferred, as each addresses particular needs generally found in building automation and control systems. A given BACnet device may use any or all of these mechanisms to provide alarm and event management

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functions. However, each mechanism dictates a standardized complement of services and/or objects that are used to realize their functions.

13.1 Change of Value Reporting

Change of value (COV) reporting allows a COV-client to subscribe with a COV-server, on a permanent or temporary basis, to receive reports of some changes of value of some referenced property based on fixed criteria. If an object provides COV reporting, then changes of value of any subscribed-to properties of the object, in some cases based on programmable increments, trigger COV notifications to be sent to subscribing clients. Typically, COV notifications are sent to supervisory programs in COV-client devices or to operators or logging devices. Any object, proprietary or standard, may support COV reporting at the implementor's option.

COV subscriptions are established using the SubscribeCOV service or the SubscribeCOVProperty service. The subscription establishes a connection between the change of value detection and reporting mechanism within the COV-server device and a "process" within the COV-client device. Notifications of changes are issued by the COV-server when changes occur after the subscription has been established. The ConfirmedCOVNotification and UnconfirmedCOVNotification services are used by the COV-server to convey change notifications. The choice of confirmed or unconfirmed service is specified in the subscription.

When a BACnet standard object, of a type listed in Table 13-1, supports COV reporting it shall support COV reporting for the property as listed in Table 13-1. At the implementor's discretion, COV reporting may also be supported for any other property of the object. For properties listed in Table 13-1 that have a numeric datatype, the COV increment used to determine when to generate notifications will be the COV_Increment property of the object unless a COV_Increment parameter is supplied in the SubscribeCOVProperty service. For other properties that have a numeric datatype, the COV increment to use when not supplied with the SubscribeCOVProperty service shall be a local matter. This is to allow multiple subscribers that do not require a specific increment to use a common increment to allow for the reduction of the processing burden on the COV-server. The criteria for COV reporting for properties other than those listed in Table 13-1 is based on the datatype of the property subscribed to and is described in Table 13-1a.

If an object supports the COV_Period property and COV_Period is non-zero, it shall issue COV notifications to all subscribed recipients at the regular interval specified by COV_Period, in addition to the notifications initiated by the change of value of the monitored property. The value of the monitored property conveyed by the periodic COV notification shall be the basis for determining whether a subsequent COV notification is required by the change in value of the monitored property. If COV_Period is zero, the periodic notifications shall not be issued.

It is the responsibility of the COV-server to maintain the list of active subscriptions for each object that supports COV notification. This list of subscriptions shall be capable of holding at least a single subscription for each object that supports COV notification, although multiple subscriptions may be supported at the implementor's option. The list of subscriptions is network-visible through the device object's Active_COV_Subscriptions property. Subscriptions may be created with finite lifetimes, meaning that the subscription may lapse and be automatically canceled after a period of time. Optionally, the lifetime may be specified as infinite, meaning that no automatic cancellation occurs. However, the COV-server is not required to guarantee preservation of subscriptions across power failures or "restarts." Periodic resubscription is allowed and expected and shall simply succeed as if the subscription were new, extending the lifetime of the subscription.

The different standard objects that support standardized COV reporting use different criteria for determining that a "change of value" has occurred, which are summarized in Table 13-1. Proprietary object types, or other standard object types not listed in Table 13-1, that support COV reporting of the Present_Value property, should follow these criteria whenever possible. Any objects that may optionally provide COV support and the change of value algorithms they shall employ are summarized in Tables 13-1 and 13-1a.

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Table 13-1. Standardized Objects That May Support COV Reporting

Object Type	Criteria	Properties Reported
Access Door	If Present_Value changes at all or Status_Flags changes at all or Door_Alarm_State changes at all (if the object has a Door_Alarm_State property)	Present_Value, Status_Flags, Door_Alarm_State (if the object has a Door_Alarm_State property)
Access Point [1]	If Access_Event_Time changes at all or Status_Flags changes at all	Access_Event, Status_Flags, Access_Event_Tag, Access_Event_Time, Access_Event_Credential, Access_Event_Authentication_Factor (if present)
Analog Input, Analog Output, Analog Value, Large Analog Value, Integer Value, Positive Integer Value	If Present_Value changes by COV_Increment or Status_Flags changes at all	Present_Value, Status_Flags
Binary Input, Binary Output, Binary Value, Life Safety Point, Life Safety Zone, Multi-state Input, Multi-state Output, Multi-state Value, OctetString Value, CharacterString Value, Time Value, DateTime Value, Date Value, Time Pattern Value, Date Pattern Value, DateTime Pattern Value	If Present_Value changes at all or Status_Flags changes at all	Present_Value, Status_Flags
Credential Data Input	If Update_Time changes at all or Status_Flags changes at all	Present_Value, Status_Flags, Update_Time
Load Control	If Present_Value, Status_Flags, Requested_Shed_Level, Start_Time, Shed_Duration, or Duty_Window changes at all	Present_Value, Status_Flags, Requested_Shed_Level, Start_Time, Shed_Duration, Duty_Window
Loop	If Present_Value changes by COV_Increment or Status_Flags changes at all	Present_Value, Status_Flags, Setpoint, Controlled_Variable_Value
Pulse Converter	If Present_Value changes by COV_Increment or Status_Flags changes at all or If COV_Period expires	Present_Value, Status_Flags, Update_Time

[1] For COV contexts for this object type in Active_COV_Subscriptions in the Device object, the Monitored Property Reference shall contain the Access_Event property identifier.

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Table 13-1a. Criteria Used for COV Reporting of Properties Other Than Those Listed in Table 13-1.

Datatype	Criteria	Properties Reported
REAL	If the property changes by the increment (from the service if provided; otherwise, as determined by the device) or Status_Flags changes at all (if the object has a Status_Flags property)	The subscribed-to property, Status_Flags (if the object has a Status_Flags property)
All other datatypes	If the property changes at all or Status_Flags changes at all (if the object has a Status_Flags property)	The subscribed-to property, Status_Flags (if the object has a Status_Flags property)

13.1.1 Unsubscribed COV Notifications

Some objects may share information by generating UnconfirmedCOVNotification messages without using COV subscriptions. As described in Clause 13.7, such notifications set the Subscriber Process Identifier parameter to zero to identify them as unsubscribed.

The use of UnconfirmedCOVNotification messages in this manner is not restricted, and any object can use this mechanism to distribute its properties' values to one or more recipients. The selection of which properties to send and the criteria for when to send them are sent are a local matter. A single object is not restricted to sending a single set of properties and thus may use this mechanism for different purposes with different collections of properties to different recipients.

Some standardized objects have standardized usages of this mechanism, and those are listed in Table 13-1b. Inclusion in the table does not restrict other collections of properties from being sent for other purposes.

Table 13-1b. Standardized Objects That May Support Standardized Unsubscribed COV Reporting

Object Type	Distribution Controlled By	Criteria	Properties Reported
Device	Restart_Notification_Recipients	Device has completed the restart process. See Clause 19.3	System_Status, Time_Of_Device_Reset, Last_Restart_Reason
Global Group	COVU_Recipients	Periodic, as determined by COVU_Period	Member_Status_Flags[1], Elements of Present_Value[1]

[1] For Global Group, the elements of Present_Value shall be encoded individually each in its own BACnetPropertyValue production and shall include its array index. The elements shall be sent in index order and the first element shall be the Unsigned value at array index 0 (to inform recipients of the total array size). If the total Present_Value array is too large to fit within a single message, then multiple notifications shall be sent in order to convey all the elements. If a single element is too large to fit in a single message, it shall be encoded as an Error production with an error class of PROPERTY and an error code of VALUE_TOO_LONG. When multiple notifications are required, the index 0 element of Present_Value and the Member_Status_Flags shall be present only in the first notification.

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13.2 Intrinsic Reporting

Intrinsic reporting allows a BACnet device to provide one or more alarm or event sources, intrinsic to the device, which generate alarm or event notifications that may be directed to one or more destinations. Certain BACnet standard objects may optionally support intrinsic reporting by providing optional properties for defining the type of alarm or event to be generated and options for handling and routing of the notifications. Internal status changes and alarms may also use intrinsic reporting to generate diagnostic notifications. Proprietary objects may support intrinsic reporting at the implementor's option. If a standard object provides intrinsic reporting, then changes of value of specific properties of the object, in some cases based on programmable criteria, or changes of status internal to the object trigger event notifications to be sent to one or more destinations based on notification class. Typically, event notifications are sent to operators or logging devices represented by "processes" within a notification-client device. The ConfirmedEventNotification and UnconfirmedEventNotification services are used by the notification-server to convey notifications.

The connection between the event detection and reporting mechanism within the device, which initiates the event notification, and the "processes" within one or more notification-client devices is made indirectly through a Notification Class object in the initiating device. The Notification Class object may be configured statically or dynamically in those devices that support the dynamic modification or creation of Notification Class objects. Multiple alarm or event-initiating objects may reference the same Notification Class object in a device. The notification class provides information to control the handling of the notification in the following ways:

(a) by providing the priority to be used in the event notification, based on whether the event transition is TO-OFFNORMAL, TO-FAULT, or TO-NORMAL;
(b) by specifying whether the event requires acknowledgment, based on whether the event transition is TO-OFFNORMAL, TO-FAULT, or TO-NORMAL;
(c) by providing a specific destination for the event notification that is a (process, recipient) tuple, based on time of day, day of week, and type of event transition (TO-OFFNORMAL, TO-FAULT, or TO-NORMAL);
(d) by providing an indication of whether confirmed or unconfirmed notification is to be used for a given destination.

Different object types use different standardized criteria for determining that an event has occurred. Proprietary object types that support intrinsic notification shall follow these criteria for determining when an event has occurred. Proprietary intrinsic reporting shall use the services described in 13.8 and 13.9. The standardized objects that may optionally provide intrinsic event notification support and the event types they shall employ are summarized in Table 13-2. The object properties are described in Clause 12.

The standard object types shown in Table 13-2 use standard event types for reporting the values of parameters relevant to the event. These values are returned in the 'Event Values' parameter of the ConfirmedEventNotification and UnconfirmedEventNotification services. The event type determines which set of values to return for each of the standard event types. These return values are summarized in Table 13-3. Proprietary object types that do not use one of the standard event types may return a list of property values instead.

In the case of Binary Input and Binary Value objects, the Alarm_Value property specifies which of the two Present_Value states shall be interpreted as OFFNORMAL. The opposing state shall be interpreted as NORMAL. Transitions to either or both states may generate notifications if the corresponding flags are set in Event_Enable.

In the case of Multi-state Input, Multi-state Value, Life Safety Point, and Life Safety Zone objects the Alarm_Values property lists each of the possible Present_Value states that shall be interpreted as OFFNORMAL. The Fault_Values property lists each of the possible Present_Value states that shall be interpreted as FAULT. All other Present_Value states shall be interpreted as NORMAL. Transitions to any of the states may generate notifications if the corresponding flags are set in Event_Enable.

In the case of Life Safety Zone and Life Safety Point, the Life_Safety_Alarm_Values property lists each of the possible Present_Value states that shall be interpreted as LIFE_SAFETY_ALARM. The Alarm_Values property lists each of the possible Present_Value states that shall be interpreted as OFFNORMAL. The Fault_Values property lists each of the possible Present_Value states that shall be interpreted as FAULT. All other Present_Value states shall be interpreted as NORMAL. Transitions to any of the states may generate notifications if the corresponding flags are set in Event_Enable.

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In the case of the Access Zone object, the Alarm_Values property lists each of the possible Occupancy_State states that shall be interpreted as OFFNORMAL. All other Occupancy_State states shall be interpreted as NORMAL. Transitions to any of the states may generate notifications if the corresponding flags are set in Event_Enable.

In the case of Access Point, the ACCESS_EVENT algorithm is applied for both Access Alarm Events and Access Transaction Events:

(1) Access Alarm Events

The Access_Alarm_Events property of the Access Point lists each of the Access_Event values that shall be reported, when Access_Event_Time changes, as EVENT or ALARM notifications according to the Notify_Type, if the TO-NORMAL bit of Event_Enable is TRUE. The Event_State remains NORMAL.

The Notification Class object referenced by Notification_Class is used to distribute Access Alarm Events.

(2) Access Transaction Events

The Access_Transaction_Events property of the Access Point lists each of the Access_Event values that shall be reported when Access_Event_Time changes, if the TO-NORMAL bit of Event_Enable is TRUE, as EVENT notifications ignoring Notify_Type. The Event_State remains NORMAL. The Event_Time_Stamps TO-NORMAL element is not affected. Acked_Transitions is not affected.

The Notification Class object referenced by Transaction_Notification_Class is used to distribute Access Transaction Events. If Transaction_Notification_Class is not present in the Access Point object, then the Notification Class object referenced by Notification_Class is used. Ack_Required of the respective Notification Class object is ignored and the value FALSE is conveyed in the AckRequired parameter of the event notification message.

Table 13-2. Standard Objects That May Support Intrinsic Reporting

Object Type	Criteria	Event Type
Access Door	If Door_Alarm_State changes to a new state for longer than Time_Delay AND the new transition is enabled in Event_Enable	CHANGE_OF_STATE
Access Point	(Access Alarm Events) If Access_Event_Time changes and Access_Event is equal to one of the values in the Access_Alarm_Events list	ACCESS_EVENT
Access Zone	If Occupancy_State becomes equal to one of the values contained in Alarm_Values AND remains equal to any value within the Alarm_Values list for longer than Time_Delay AND the new transition is enabled in Event_Enable	CHANGE_OF_STATE
Accumulator	If Pulse_Rate exceeds range from Low_Limit through High_Limit for longer than Time_Delay AND the new transition is enabled in Event_Enable and Limit_Enable, OR Pulse_Rate returns to range from Low_Limit through High_Limit for longer than Time_Delay AND the new transition is enabled in Event_Enable and Limit_Enable	UNSIGNED_RANGE

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Analog Input, Analog Output, Analog Value, Pulse Converter	If Present_Value is above High_Limit for longer than Time_Delay AND the HighLimitEnable flag is set in Limit_Enable AND the TO-OFFNORMAL flag is set in Event_Enable AND Event_State is NORMAL, OR If Present_Value is below Low_Limit for longer than Time_Delay AND the LowLimitEnable flag is set in Limit_Enable AND the TO-OFFNORMAL flag is set in Event_Enable AND Event_State is NORMAL, OR If Present_Value is below High_Limit - Deadband for longer than Time_Delay AND the TO-NORMAL flag is set in Event_Enable AND the HighLimitEnable flag is set in Limit_Enable AND Event_State is HIGH_LIMIT, OR If Present_Value is above Low_Limit + Deadband for longer than Time_Delay AND the TO-NORMAL flag is set in Event_Enable AND the LowLimitEnable flag is set in Limit_Enable AND Event_State is LOW_LIMIT	OUT_OF_RANGE
Binary Input, Binary Value, Multi-state Input, Multi-state Value	If Present_Value changes to a new state for longer than Time_Delay AND the new transition is enabled in Event_Enable	CHANGE_OF_STATE
Binary Output, Multi-state Output	If Present_Value differs from Feedback_Value for longer than Time_Delay AND the new transition is enabled in Event_Enable	COMMAND_FAILURE
BitString Value	If Present_Value, after application of Bit_Mask, equals at least one of the values of the Alarm_Values set for longer than Time_Delay AND the new transition is enabled in Event_Enable	CHANGE_OF_BITSTRING
CharacterString Value	If any one of the strings in Alarm_Values appears in any position within the Present_Value (per match criteria 12.A.12) for longer than Time_Delay AND the new transition is enabled in Event_Enable	CHANGE_OF_CHARACTERSTRING
Event Log, Trend Log, Trend Log Multiple	If Event_State is NORMAL and Records_Since_Notification is greater than or equal to Notification_Threshold	BUFFER_READY
Global Group	If the IN_ALARM flag of the Member_Status_Flags property changes to a new value and remains equal to the new value for a minimum period of time specified by the Time_Delay property, and the flag for the new transition is enabled in the Event_Enable property	CHANGE_OF_STATUS_FLAGS
Integer Value	If Present_Value exceeds range between High_Limit and Low_Limit for longer than Time_Delay AND the new transition is enabled in Event_Enable and Limit_Enable, OR Present_Value returns within the High_Limit - Deadband to Low_Limit + Deadband range for longer than Time_Delay AND the new transition is enabled in Event_Enable and Limit_Enable	SIGNED_OUT_OF_RANGE

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Large Analog Value	If Present_Value exceeds the range between High_Limit and Low_Limit for longer than Time_Delay AND the new transition is enabled in Event_Enable and Limit_Enable, OR Present_Value returns within the High_Limit - Deadband to Low_Limit + Deadband range for longer than Time_Delay AND the new transition is enabled in Event_Enable and Limit_Enable	DOUBLE_OUT_OF_RANGE
Life Safety Point, Life Safety Zone	If Present_Value changes to become equal to one of the values in the Life_Safety_Alarm_Values list AND remains equal to a value within the Life_Safety_Alarm_Values list for longer than Time_Delay AND the new transition is enabled in Event-Enable OR If Present_Value changes to become equal to one of the values in the Alarm_Values list AND remains equal to a value within the Alarm_Values list for longer than Time_Delay AND the new transition is enabled in Event-Enable OR Mode changes	CHANGE_OF_LIFE_SAFETY
Load Control	If Present_Value equals SHED_NON_COMPLIANT for longer than Time_Delay AND the new transition is enabled in Event_Enable	COMMAND_FAILURE
Loop	If Controlled_Variable_Value is above (Setpoint + Error_Limit) for longer than Time_Delay AND the TO-OFFNORMAL flag is set in Event_Enable AND Event_State is NORMAL, OR If Controlled_Variable_Value is below (Setpoint - Error_Limit) for longer than Time_Delay AND the TO-OFFNORMAL flag is set in Event_Enable AND Event_State is NORMAL, OR If Controlled_Variable_Value is below ((Setpoint + Error_Limit) - Deadband) for longer than Time_Delay AND the TO-NORMAL flag is set in Event_Enable AND Event_State is HIGH_LIMIT, OR If Controlled_Variable_Value is above ((Setpoint - Error_Limit) + Deadband) for longer than Time_Delay AND the TO-NORMAL flag is set in Event_Enable AND Event_State is LOW_LIMIT	FLOATING_LIMIT

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Positive Integer Value	If Present_Value exceeds range between High_Limit and Low_Limit for longer than Time_Delay AND the new transition is enabled in Event_Enable and Limit_Enable, OR Present_Value returns within the High_Limit - Deadband to Low_Limit + Deadband range for longer than Time_Delay AND the new transition is enabled in Event_Enable and Limit_Enable	UNSIGNED_OUT_OF_RANGE

Table 13-3. Standard Object Property Values Returned in Notifications

Object	Event Type	Notification Parameters	Referenced Object's Properties
Access Door	CHANGE_OF_STATE	New_State Status_Flags	Door_Alarm_State Status_Flags
Access Point	ACCESS_EVENT	Access_Event Status_Flags Access_Event_Tag Access_Event_Time Access_Credential Authentication_Factor (if present)	Access_Event Status_Flags Access_Event_Tag Access_Event_Time Access_Event_Credential Access_Event_Authentication_Factor (if present)
Access Zone	CHANGE_OF_STATE	New_State Status_Flags	Occupancy_State Status_Flags
Accumulator	UNSIGNED_RANGE	Exceeding_Value Status_Flags Exceeded_Limit	Pulse_Rate Status_Flags Low_Limit or High_Limit
Analog Input, Analog Output, Analog Value, Pulse Converter	OUT_OF_RANGE	Exceeding_Value Status_Flags Deadband Exceeded_Limit	Present_Value Status_Flags Deadband Low_Limit or High_Limit
Binary Input, Binary Value, Multi-state Input, Multi-state Value	CHANGE_OF_STATE	New_State Status_Flags	Present_Value Status_Flags
Binary Output, Multi-state Output	COMMAND_FAILURE	Command_Value Status_Flags Feedback_Value	Present_Value Status_Flags Feedback_Value
BitString Value	CHANGE_OF_BITSTRING	Referenced_Bitstring Status_Flags	Present_Value Status_Flags
CharacterString Value	CHANGE_OF_CHARACTER STRING	Changed_Value Status_Flags Alarm_Value	Present_Value Status_Flags Alarm_Values[N]
Event Log, Trend Log, Trend Log Multiple	BUFFER_READY	Buffer_Property Previous_Notification Current_Notification	BACnetDeviceObjectPropertyReference[1] Last_Notify_Record Total_Record_Count
Global Group	CHANGE_OF_STATUS_FLA GS	Present_Value[2] Referenced_Flags	Present_Value Member_Status_Flags
Integer Value	SIGNED_OUT_OF_RANGE	Exceeding_Value Status_Flags Deadband Exceeded_Limit	Present_Value Status_Flags Deadband High_Limit or Low_Limit

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Large Analog Value	DOUBLE_OUT_OF_RANGE	Exceeding_Value Status_Flags Deadband Exceeded_Limit	Present_Value Status_Flags Deadband High_Limit or Low_Limit
Life Safety Point, Life Safety Zone	CHANGE_OF_LIFE_SAFETY	New_State New_Mode Status_Flags Operation_Expected	Present_Value Mode Status_Flags Operation_Expected
Load Control	COMMAND_FAILURE	Command_Value Status_Flags Feedback_Value	Requested_Shed_Level Status_Flags Actual_Shed_Level
Loop	FLOATING_LIMIT	Referenced_Value Status_Flags Setpoint_Value Error_Limit	Controlled_Variable_Value Status_Flags Setpoint Error_Limit

[1] This parameter conveys a reference to the Log_Buffer property of the object.
[2] This parameter is optional and may be omitted if it is determined to be too large. The method of such determination is a local matter.

Table 13-4. Notification Parameters for Standard Event Types

Event Type	Notification Parameters	Description
CHANGE_OF_BITSTRING	Referenced_Bitstring Status_Flags	The new value of the referenced bitstring property. The Status_Flags of the referenced object.
CHANGE_OF_STATE	New_State Status_Flags	The new value of the referenced property. The Status_Flags of the referenced object.
CHANGE_OF_VALUE	New_Value Status_Flags	The new value of the referenced property. The Status_Flags of the referenced object.
COMMAND_FAILURE	Command_Value Status_Flags Feedback_Value	The value of the property that was commanded. The Status_Flags of the referenced object. The value that differs from the Command_Value.
FLOATING_LIMIT	Referenced_Value Status_Flags Setpoint_Value Error_Limit	The new value of the referenced property. The Status_Flags of the referenced object. The value of the setpoint reference. The difference limit that was exceeded.
OUT_OF_RANGE	Exceeding_Value Status_Flags Deadband Exceeded_Limit	The value that exceeded a limit. The Status_Flags of the referenced object. The deadband used for limit checking. The limit that was exceeded.
BUFFER_READY	Buffer_Property Previous_Notification Current_Notification	Reference to the buffer property. Current_Notification parameter of the previous notification sent or 0 if no previouis notification has been sent. SequenceNumber of the record that triggered this notification.
CHANGE_OF_LIFE_SAFETY	New_State New_Mode Status_Flags Operation_Expected	The new value of the referenced property The new mode of the referenced object The Status_Flags of the referenced object The next operation requested by the referenced object.
UNSIGNED_RANGE	Exceeding_Value Status_Flags Exceeded_Limit	The value that exceeded a limit The Status_Flags of the referenced object The limit that was exceeded
CHANGE_OF_STATUS_FLAGS	Present_Value[1] Referenced_Flags	The value of the Present_Value property of the referenced object. The referenced property.

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ACCESS_EVENT	Access_Event Status_Flags Access_Event_Tag Access_Event_Time Access_Credential Authentication_Factor (if present)	The new value of the referenced property The Status_Flags of the referenced object The Access_Event_Tag of the referenced object The new value of the referenced Access_Event_Time property The Access_Event_Credential of the referenced object The Access_Event_Authentication_Factor of the referenced object (if present)
CHANGE_OF_CHARACTER STRING	Changed_Value Status_Flags Alarm_Value	The new value that contained the alarm. The Status_Flags of the referenced object. The Alarm_Values string that triggered the alarm.
DOUBLE_OUT_OF_RANGE	Exceeding_Value Status_Flags Deadband Exceeded_Limit	The value that exceeded a limit. The Status_Flags of the referenced object. The deadband used for limit checking. The limit that was exceeded.
SIGNED_OUT_OF_RANGE	Exceeding_Value Status_Flags Deadband Exceeded_Limit	The value that exceeded a limit. The Status_Flags of the referenced object. The deadband used for limit checking. The limit that was exceeded.
UNSIGNED_OUT_OF_RANGE	Exceeding_Value Status_Flags Deadband Exceeded_Limit	The value that exceeded a limit. The Status_Flags of the referenced object. The deadband used for limit checking. The limit that was exceeded.

[1] This parameter is optional and may be omitted if it is determined to be too large. The method of such determination is a local matter.

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13.3 Algorithmic Change Reporting

Algorithmic change reporting enables a BACnet device to provide one or more alarm or event sources, defined by Event Enrollment objects, to generate alarm or event notifications that may be directed to one or more destinations. Any of the standardized algorithms may be used to establish criteria for change reporting. Once established, occurrences of change may be reported to one or more destinations based on further criteria. Changes of value of specific properties of an object may be programmed to trigger event notifications to be sent to one or more destinations based on notification class. Typically, event notifications are sent to application programs represented by processes within a notification-client device. The ConfirmedEventNotification and UnconfirmedEventNotification services are used by the notification-server to convey notifications.

The object(s) whose properties are referred to is known as the Reference Object(s). The criteria used to ascertain that an event has occurred are determined by the Event Type.

The following event type algorithms are specified in this standard because of their widespread occurrence in building automation and control systems. They are:

(a) CHANGE_OF_BITSTRING
(b) CHANGE_OF_STATE
(c) CHANGE_OF_VALUE
(d) COMMAND_FAILURE
(e) FLOATING_LIMIT
(f) OUT_OF_RANGE
(g) BUFFER_READY
(h) CHANGE_OF_LIFE_SAFETY
(i) UNSIGNED_RANGE
(j) ACCESS_EVENT
(k) DOUBLE_OUT_OF_RANGE
(l) SIGNED_OUT_OF_RANGE
(m) UNSIGNED_OUT_OF_RANGE
(n) CHANGE_OF_CHARACTERSTRING
(o) CHANGE_OF_STATUS_FLAGS

Events are based on algorithms applied to the properties of specific objects called "reference objects." Such a property is called a "referenced property." These properties are referenced by the Object_Property_Reference of an Event Enrollment object. The parameters required to compute the current state of the event are contained in the Event_Parameters property of the same Event Enrollment object. The relationship between the Event_Type, Event_State, and the Event_Parameters are summarized in Table 12-14. Each parameter in the Event_Parameters property is described in detail in 12.11.7. The algorithms that are used to determine the Event_State of each event type are specified in this subclause. Figure 13-11 shows an example of the relationships between Event Enrollment objects, referenced objects, and Notification Class objects.

Event enrollment objects shall use standard event types for reporting the values of parameters relevant to the event. These values are returned in the 'Event Values' parameter of the ConfirmedEventNotification and UnconfirmedEventNotification services. The event type determines which set of values to return for each of the standard event types. These return values are summarized in Table 13-4. Event Enrollment objects must report proprietary event algorithms using the extended-event notification type.

If the referenced object and property is any of those appearing in Table 13-3, then the value of the Status_Flags property of the referenced object shall be conveyed by the 'status-flags' parameter of the ConfirmedEventNotification or UnconfirmedEventNotification service request issued by the Event Enrollment object. A change in the FAULT flag (independent of any Time_Delay notification parameter) of the referenced object's Status_Flags property shall be treated as if the referenced object's Event_State property had made the associated transition to or from the FAULT state and a notification issued if notification for the resultant transition is enabled.

When an Event Enrollment object is created, its Event_State property shall be initialized to NORMAL.

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If any of the parameters required to process the event algorithm are missing or inconsistent with the Event_Type, the Event Enrollment object shall become disabled and all the bit flags in the Event_Enable property shall be cleared.

13.3.1 CHANGE_OF_BITSTRING Algorithm

A CHANGE_OF_BITSTRING occurs when the value of the referenced property becomes equal to one of the values contained in the List_Of_Bitstring_Values after applying the Bitmask, and that value remains equal for Time_Delay seconds. For the purpose of event notification, CHANGE_OF_BITSTRING generates a TO-OFFNORMAL transition.
A CHANGE_OF_BITSTRING clears when the value of the referenced property is no longer equal to one of the values contained in the List_Of_Bitstring_Values after applying the Bitmask, and that value remains not equal for Time_Delay seconds. The clearing of a CHANGE_OF_BITSTRING generates a TO-NORMAL transition. See Figure 13-1.

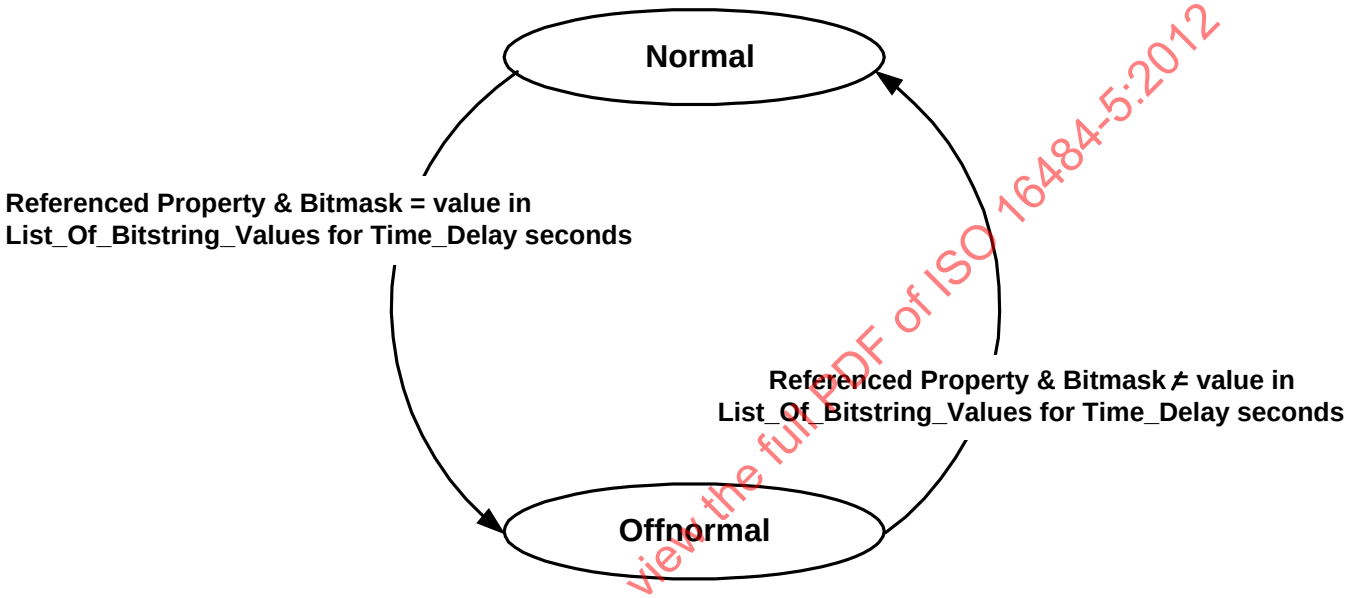

Figure 13-1. CHANGE_OF_BITSTRING algorithm.

13.3.2 CHANGE_OF_STATE Algorithm

A CHANGE_OF_STATE occurs when the value of the referenced property becomes equal to one of the values contained in the List_Of_Values, and this value remains equal for Time_Delay seconds. This type of event may only be applied to properties that have discrete or enumerated values, including Boolean. For the purposes of event notification, CHANGE_OF_STATE events generate a TO-OFFNORMAL transition.

A CHANGE_OF_STATE event clears when the value of the referenced property is no longer equal to one of the values contained in the List_Of_Values, and that value remains not equal for Time_Delay seconds. The clearing of a CHANGE_OF_STATE generates a TO-NORMAL transition. See Figure 13-2.

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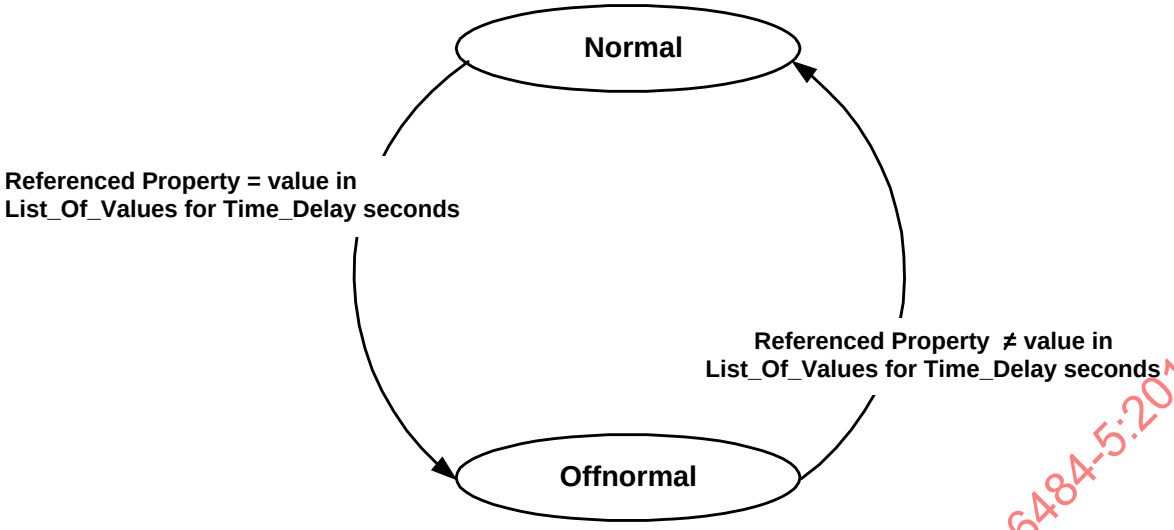

Figure 13-2. CHANGE_OF_STATE algorithm.

13.3.3 CHANGE_OF_VALUE Algorithm

A CHANGE_OF_VALUE occurs when the absolute value of a referenced property changes by an amount equal to or greater than the Referenced_Property_Increment, and this condition remains for Time_Delay seconds. The initialization of the referenced property value used in the algorithm shall be a local matter, but the value of the referenced property at the time a CHANGE_OF_VALUE occurs shall be used in carrying out the algorithm until the next CHANGE_OF_VALUE. For the purposes of event notification, CHANGE_OF_VALUE generates TO-NORMAL transitions. See Figure 13-3.

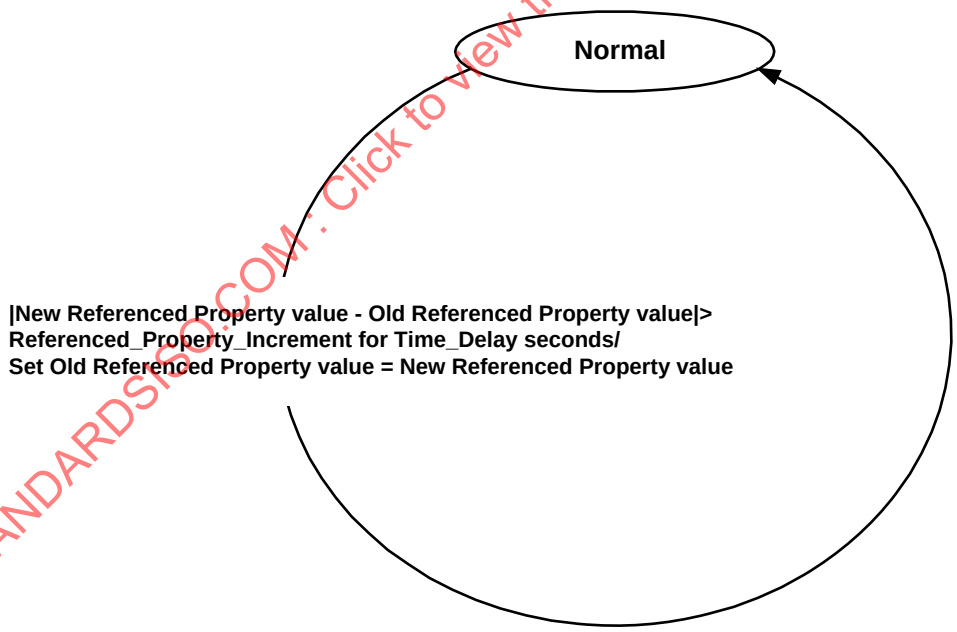

Figure 13-3. CHANGE_OF_VALUE algorithm.

If the referenced property is a bitstring datatype, then the CHANGE_OF_VALUE occurs when any of the bits defined in the Bitmask parameter change state and remain changed for Time_Delay seconds. See Figure 13-4.

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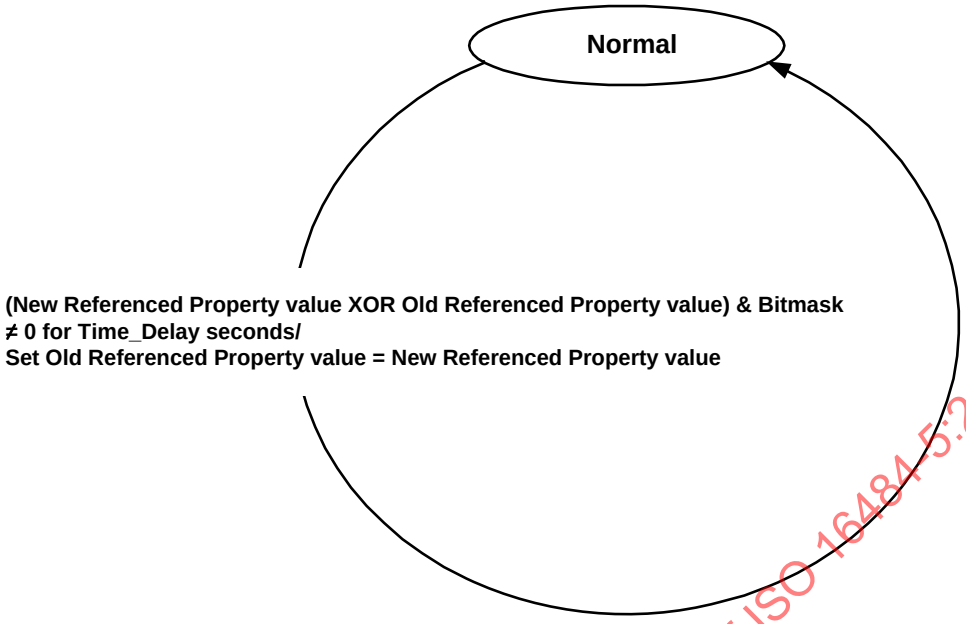

Figure 13-4. CHANGE_OF_VALUE algorithm (Bitstring).

13.3.4 COMMAND_FAILURE Algorithm

A COMMAND_FAILURE occurs if the values of the referenced property and the Feedback_Property_Reference disagree for a time period greater than the Time_Delay parameter. It may be used, for example, to verify that a process change has occurred after writing to a property. This type of event shall only be applied to properties that take on discrete values. For the purpose of event notification, COMMAND_FAILURE generates a TO-OFFNORMAL transition.

A COMMAND_FAILURE clears if, at any time subsequent to its occurrence, the value of the referenced property and the Feedback_Property_Reference become equal for a time period greater than the Time_Delay parameter. The clearing of a COMMAND_FAILURE generates a TO-NORMAL transition. See Figure 13-5.

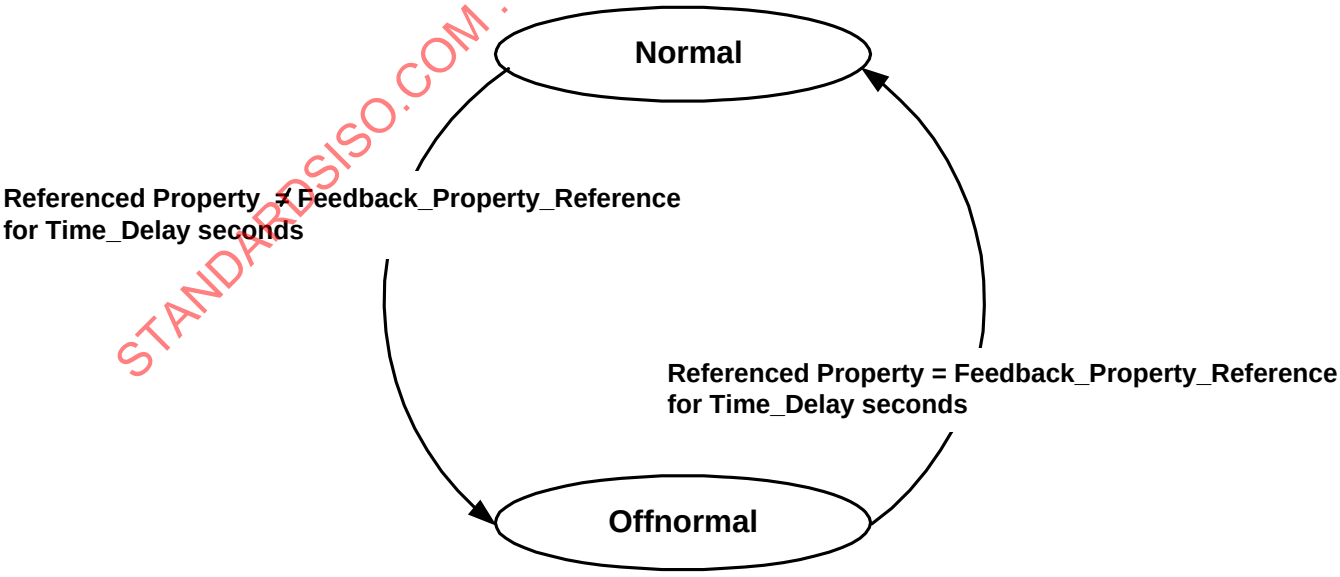

Figure 13-5. COMMAND_FAILURE algorithm.

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13.3.5 FLOATING_LIMIT Algorithm

A FLOATING_LIMIT occurs if the referenced property leaves a range of values determined by the current value of the Setpoint_Reference, High_Diff_Limit, Low_Diff_Limit, and Deadband.

Starting in the NORMAL state, if the value of the referenced property becomes greater than Setpoint_Reference + High_Diff_Limit for a period of time greater than the Time_Delay parameter, the Event Enrollment object sets the Event_State property to the HIGH_LIMIT state and generates a TO-OFFNORMAL transition. The Event Enrollment object generates a TO-NORMAL transition and sets the Event_State property to NORMAL when the referenced property returns to a value less than Setpoint_Reference + High_Diff_Limit - Deadband for a period of time greater than the Time_Delay parameter. In each case, the event notification shall show an 'Event Type' of FLOATING_LIMIT.

Starting in the NORMAL state, if the value of the referenced property becomes less than Setpoint_Reference - Low_Diff_Limit for a period greater than the Time_Delay parameter, the Event Enrollment object sets the Event_State property to the LOW_LIMIT state and generates a TO-OFFNORMAL transition. The Event Enrollment object generates a TO-NORMAL transition and sets the Event_State property to NORMAL when the referenced property returns to a value greater that Setpoint_Reference - Low_Diff_Limit + Deadband for a period of time greater than the Time_Delay parameter. In each case, the event notification shall show an EventType of FLOATING_LIMIT. See Figure 13-6.

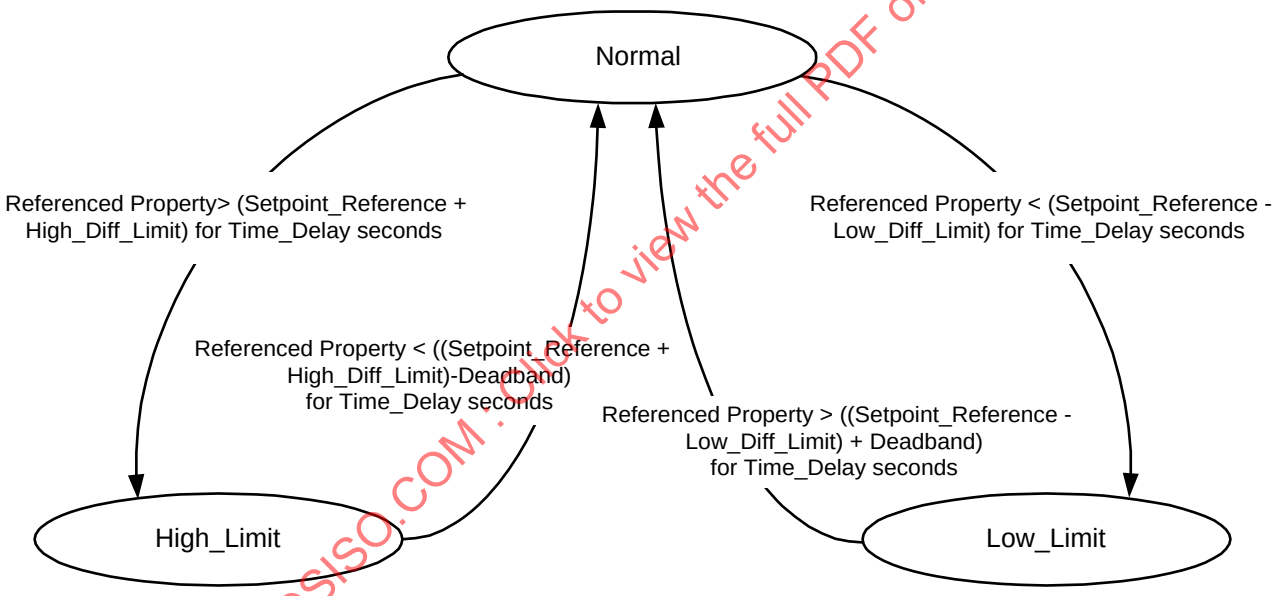

Figure 13-6. FLOATING_LIMIT algorithm.

Figure 13-7 shows the relationship of the various parameters used in the FLOATING_LIMIT algorithm.

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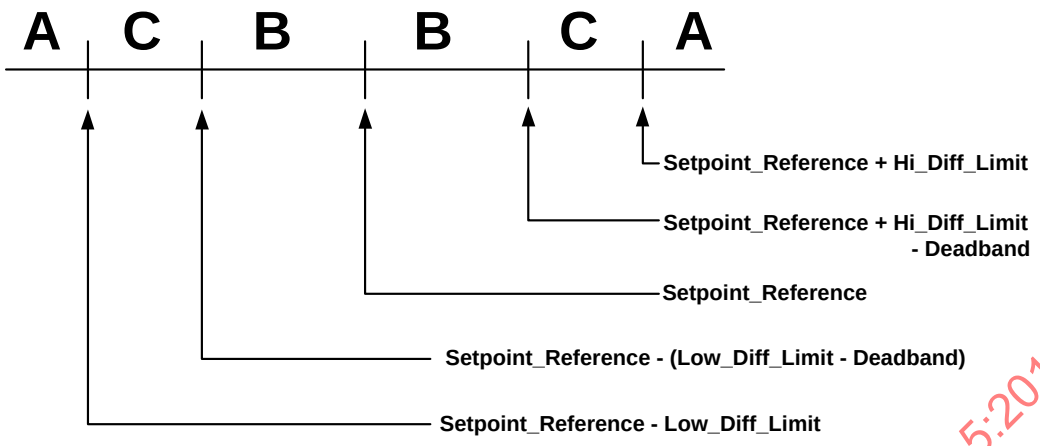

Range A: Referenced property entering this range constitutes a TO-OFFNORMAL transition.
Range B: Referenced property entering this range after being in A constitutes a TO-NORMAL transition.
Range C: Deadband range. Referenced property must transition to range B before a TO-NORMAL transition occurs.

Figure 13-7. FLOATING_LIMIT algorithm.

13.3.6 OUT_OF_RANGE Algorithm

An OUT_OF_RANGE occurs if the referenced property leaves a range of values defined by the High_Limit and Low_Limit parameters and remains there for Time_Delay seconds. If the transition is to a value above the High_Limit or below the Low_Limit, the Event Enrollment object generates a TO-OFFNORMAL transition. The event notification shall show an 'Event Type' of OUT_OF_RANGE.

The Event Enrollment object shall not generate a TO-OFFNORMAL transition from the LOW_LIMIT or HIGH_LIMIT state. When transitioning from LOW_LIMIT to HIGH_LIMIT, or HIGH_LIMIT to LOW_LIMIT, the object shall first transition to the NORMAL state.

An OUT_OF_RANGE clears when the referenced property attains a value greater than the (Low_Limit + Deadband) or a value less than the (High_Limit - Deadband) and remains there for Time_Delay seconds. The Event Enrollment object generates a TO-NORMAL transition. The event notification shall show an 'Event Type' of OUT_OF_RANGE. See Figure 13-8.

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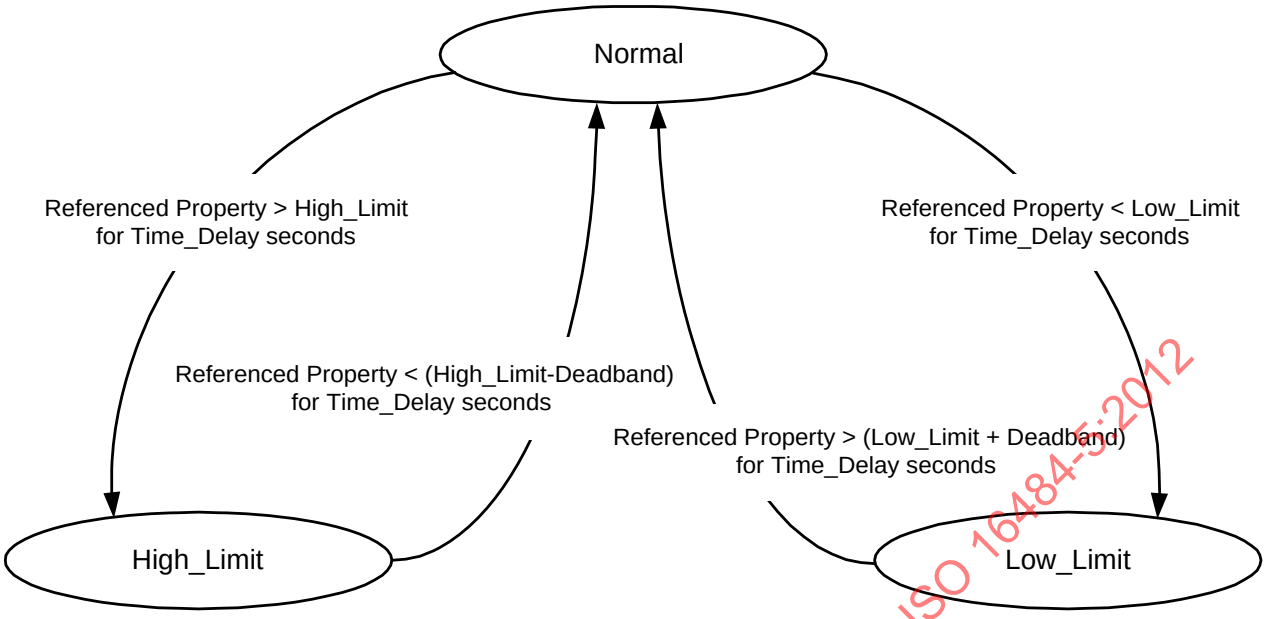

Figure 13-8. OUT_OF_RANGE, DOUBLE_OUT_OF_RANGE, SIGNED_OUT_OF_RANGE, and UNSIGNED_OUT_OF_RANGE algorithm.

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13.3.7 BUFFER_READY Algorithm

A BUFFER_READY occurs when the number of records specified by Notification_Threshold have been entered into the log since the start of operation or the previous notification, whichever is most recent. The number of records collected is determined by the formula Total_Record_Count - Previous_Notification_Count, if Total_Record_Count is greater than or equal to Previous_Notification_Count, otherwise it is determined by the formula Total_Record_Count - Previous_Notification_Count + 2^{32} - 1. Upon completion of the notification, Previous_Record_Count is set to the value of Total_Record_Count that caused the notifications to occur.

Previous_Notification_Count is an internal variable, of type Unsigned32, which maintains the value of Total_Record_Count at which the most recent notification took place. Upon initialization it shall be set to the value of the Total_Record_Count property in the object referenced by Object_Property_Reference.

For the purposes of event notification, the BUFFER_READY event generates TO-NORMAL transitions.

13.3.8 CHANGE_OF_LIFE_SAFETY Algorithm

A CHANGE_OF_LIFE_SAFETY occurs when the value of the referenced property becomes equal to any of the values in the List_Of_Life_Safety_Alarm_Values, and remains within the set of values in this list for Time_Delay seconds. The resulting event state is LIFE_SAFETY_ALARM.

A CHANGE_OF_LIFE_SAFETY also occurs when the value of the referenced property becomes equal to any of the values in the List_Of_Alarm_Values, and remains within the set of values in this list for Time_Delay seconds. The resulting event state is OFFNORMAL.

A CHANGE_OF_LIFE_SAFETY also occurs for any change of the property referred to by the Mode_Property_Reference.

For the purpose of event notification, CHANGE_OF_LIFE_SAFETY events generate a TO-OFFNORMAL transition.

The CHANGE_OF_LIFE_SAFETY algorithm is depicted in Figure 13-9

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13.3.9 UNSIGNED_RANGE Algorithm

An UNSIGNED_RANGE occurs if the referenced property leaves the range of values from Low_Limit through High_Limit parameters and remains there for Time_Delay seconds. If the transition is to a value above High_Limit or below Low_Limit, the Event Enrollment object generates a TO-OFFNORMAL transition. The event notification shall show an 'Event Type' of UNSIGNED_RANGE.

An UNSIGNED_RANGE clears when the referenced property attains a value from Low_Limit through High_Limit and remains there for Time_Delay seconds. The Event Enrollment object generates a TO-NORMAL transition. The event notification shall show an 'Event Type' of UNSIGNED_RANGE. See Figure 13-10.

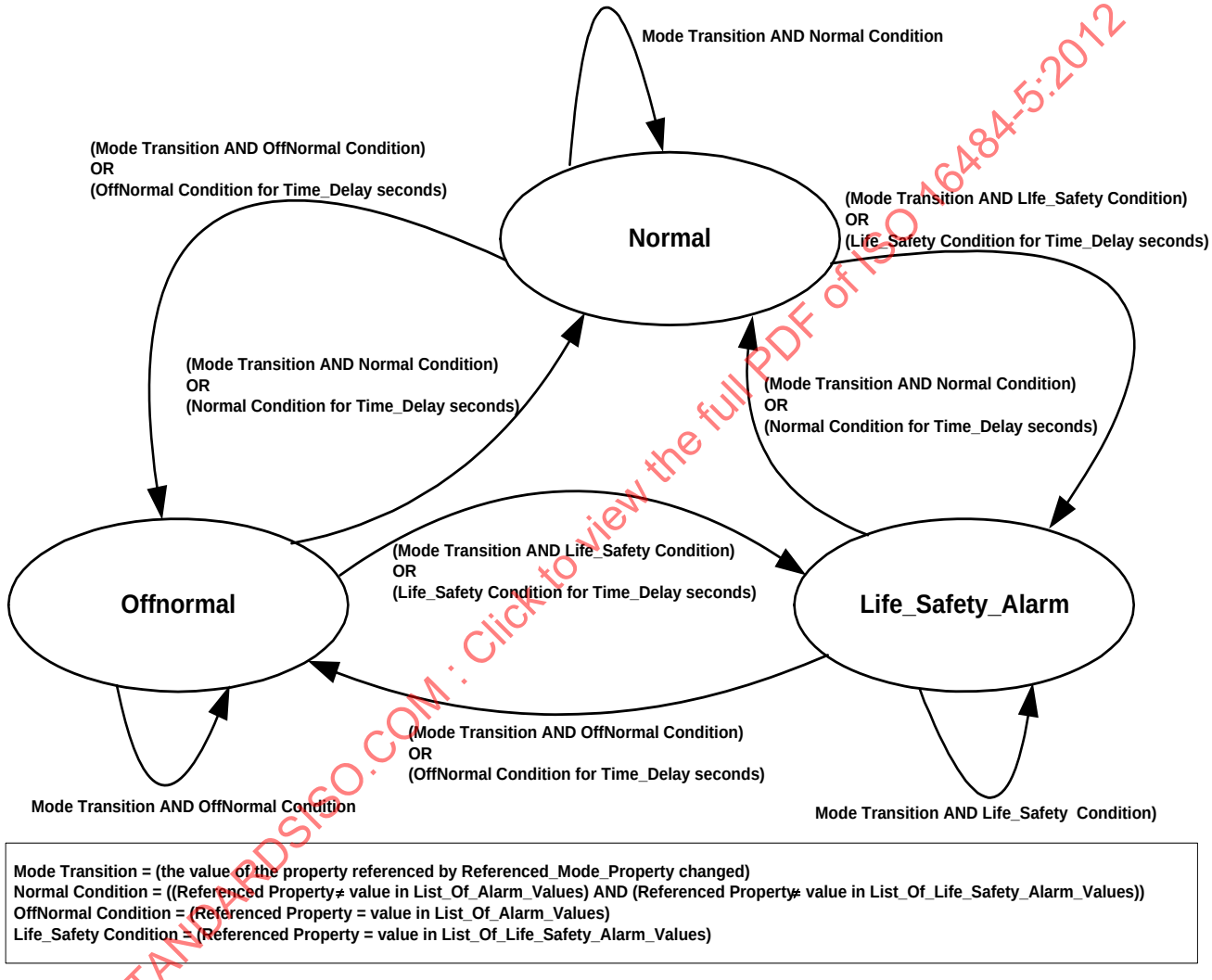

Figure 13-9. CHANGE_OF_LIFE_SAFETY algorithm.

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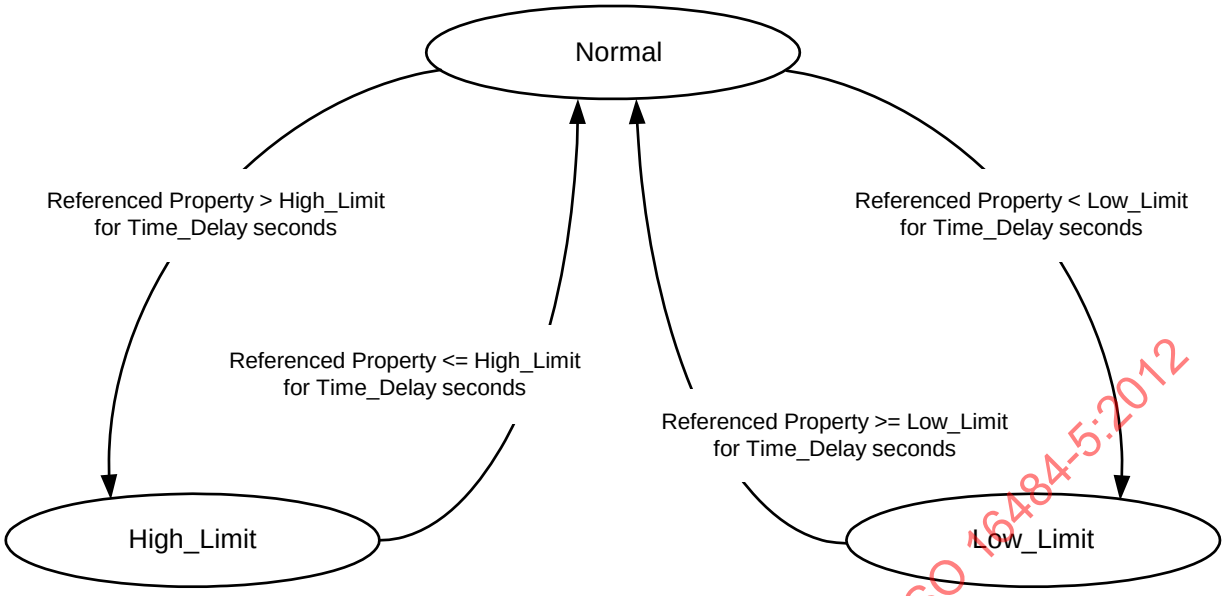

Figure 13-10. UNSIGNED_RANGE algorithm.

13.3.10 ACCESS_EVENT Algorithm

An ACCESS_EVENT event occurs when the value of the property referred to by Access_Event_Time_Reference changes and the referenced property is equal to one of the values contained in the List_Of_Access_Events. This type of event may be applied only to properties that are of type BACnetAccessEvent. For the purposes of event notification, ACCESS_EVENT events generate a TO-NORMAL transition.

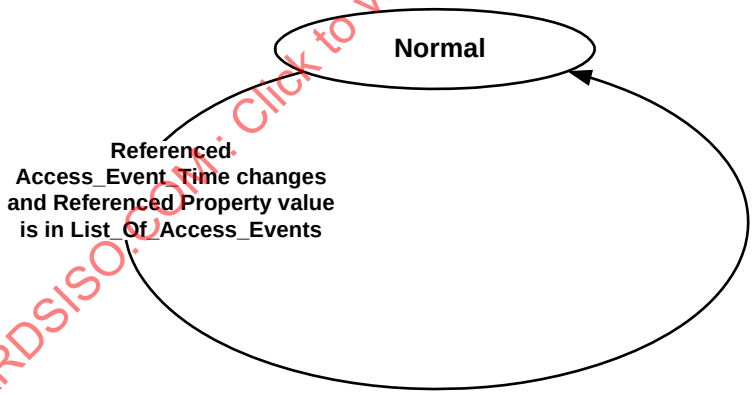

Figure 13-11. ACCESS_EVENT Algorithm

13.3.11 CHANGE_OF_CHARACTERSTRING Algorithm

A CHANGE_OF_CHARACTERSTRING occurs when the value of the referenced property contains one of the non-empty values in the List_Of_Values, and continues to contain a non-empty value from the list for Time_Delay seconds. For the purposes of event notification, CHANGE_OF_CHARACTERSTRING events generate a TO-OFFNORMAL transition.

Once in the OFF_NORMAL state, if the referenced value changes to contain a different non-empty value from the List_Of_Values for Time_Delay seconds, the algorithm will generate another TO-OFFNORMAL transition.

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A CHANGE_OF_CHARACTERSTRING event clears when the value of the referenced property no longer contains any of the non-empty values in the List_Of_Values, and that condition remains for Time_Delay seconds. The clearing of a CHANGE_OF_CHARACTERSTRING generates a TO-NORMAL transition. See Figure 13-12.

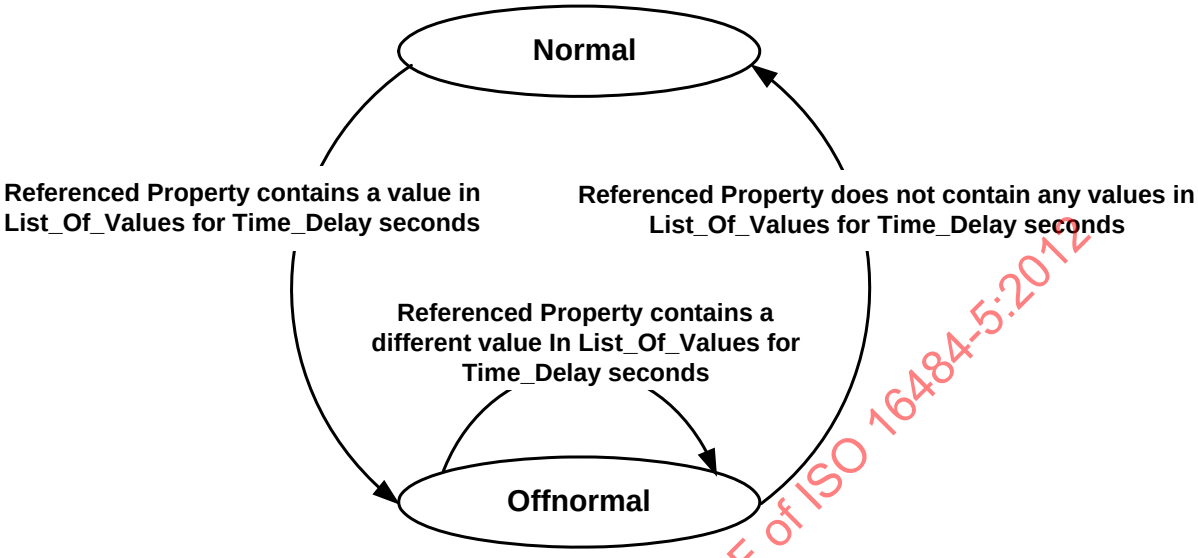

Figure 13-12. CHANGE_OF_CHARACTERSTRING algorithm.

13.3.12 DOUBLE_OUT_OF_RANGE Algorithm

A DOUBLE_OUT_OF_RANGE occurs if the referenced property leaves a range of values defined by the High_Limit and Low_Limit parameters and remains there for Time_Delay seconds. If the transition is to a value above the High_Limit or below the Low_Limit, the Event Enrollment object generates a TO-OFFNORMAL transition. The event notification shall show an 'Event Type' of DOUBLE_OUT_OF_RANGE.

A DOUBLE_OUT_OF_RANGE clears when the referenced property attains a value greater than the (Low_Limit + Deadband) or a value less than the (High_Limit - Deadband) and remains there for Time_Delay seconds. The Event Enrollment object generates a TO-NORMAL transition. The event notification shall show an 'Event Type' of DOUBLE_OUT_OF_RANGE. See Figure 13-8.

13.3.13 SIGNED_OUT_OF_RANGE Algorithm

A SIGNED_OUT_OF_RANGE occurs if the referenced property leaves a range of values defined by the High_Limit and Low_Limit parameters and remains there for Time_Delay seconds. If the transition is to a value above the High_Limit or below the Low_Limit, the Event Enrollment object generates a TO-OFFNORMAL transition. The event notification shall show an 'Event Type' of SIGNED_OUT_OF_RANGE.

A SIGNED_OUT_OF_RANGE clears when the referenced property attains a value greater than the (Low_Limit + Deadband) or a value less than the (High_Limit - Deadband) and remains there for Time_Delay seconds. The Event Enrollment object generates a TO-NORMAL transition. The event notification shall show an 'Event Type' of SIGNED_OUT_OF_RANGE. See Figure 13-8.

13.3.14 UNSIGNED_OUT_OF_RANGE Algorithm

An UNSIGNED_OUT_OF_RANGE occurs if the referenced property leaves a range of values defined by the High_Limit and Low_Limit parameters and remains there for Time_Delay seconds. If the transition is to a value above the High_Limit or below the Low_Limit, the Event Enrollment object generates a TO-OFFNORMAL transition. The event notification shall show an 'Event Type' of UNSIGNED_OUT_OF_RANGE.

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An UNSIGNED_OUT_OF_RANGE clears when the referenced property attains a value greater than the (Low_Limit + Deadband) or a value less than the (High_Limit - Deadband) and remains there for Time_Delay seconds. The Event Enrollment object generates a TO-NORMAL transition. The event notification shall show an 'Event Type' of UNSIGNED_OUT_OF_RANGE. See Figure 13-8.

13.3.15 CHANGE_OF_STATUS_FLAGS Algorithm

A CHANGE_OF_STATUS_FLAGS occurs when the referenced property, which must be of type BACnetStatusFlags, has a value of TRUE for any of its flags that also has a value of TRUE in the corresponding flag in the Selected_Flags event parameter for longer than Time_Delay seconds. For the purposes of event notification, CHANGE_OF_STATUS_FLAGS events generate a TO-OFFNORMAL transition.

After the algorithm is in the OFFNORMAL state, if the set of selected flags in the referenced property that have a value of TRUE changes without becoming empty, then this algorithm shall generate another TO-OFFNORMAL transition.

A CHANGE_OF_STATUS_FLAGS event clears when the set of selected flags in the referenced property that have a value of TRUE is empty for longer than Time_Delay seconds. The clearing of a CHANGE_OF_STATUS_FLAGS generates a TO-NORMAL transition. See Figure 13-13.

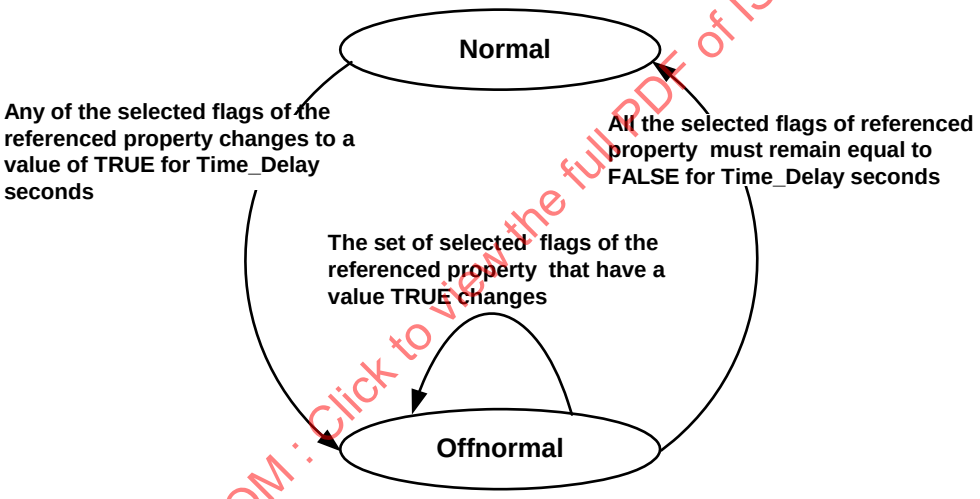

Figure 13-13. CHANGE_OF_STATUS_FLAGS algorithm.

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13.4 Alarm and Event Occurrence and Notification

The connection between the occurrence of an event and the transmission of a notification message to one or more recipients is established in one of several ways, depending on the type of reporting desired. COV events are connected to one or more subscribers through the use of the SubscribeCOV service. Intrinsic events are connected to one or more recipients indirectly through association with a Notification Class object. Algorithmic change events are connected to one or more recipients by the creation of an Event Enrollment object.

The criteria for event occurrence detection are specified through properties of those objects that may generate event notifications and using parameters of the SubscribeCOV service. These properties are described under the particular objects that may generate events, as summarized in Table 13-2, and in the Event Enrollment object. All objects that generate events have a property that indicates the state of the object with respect to alarm and event handling, and each such object may be explicitly enabled or disabled for reporting of specific events.

Intrinsic object-generated events, and events generated by Event Enrollment objects, may be controlled by a Notification Class object that defines their handling options.

COV and event notifications may be specified to use either confirmed or unconfirmed services for notification messages. By providing two kinds of notification mechanisms, BACnet allows the application designer to decide the relative importance of each event and whether or not notification of its occurrence is essential or merely desirable. In the former case, notification can be carried out with a confirmed service and repeated for as many recipients as required. In the latter case, an unconfirmed service using a broadcast or multicast address may be used.

Notification Class objects specify the destination devices for notification messages using BACnetRecipients. The recipients may be individual devices, groups of devices with a common multicast address, or all devices reachable by a broadcast address. If a broadcast is used, the scope may be limited to all devices on a single network or it may be extended to encompass all devices on a BACnet internetwork. See Clause 6.

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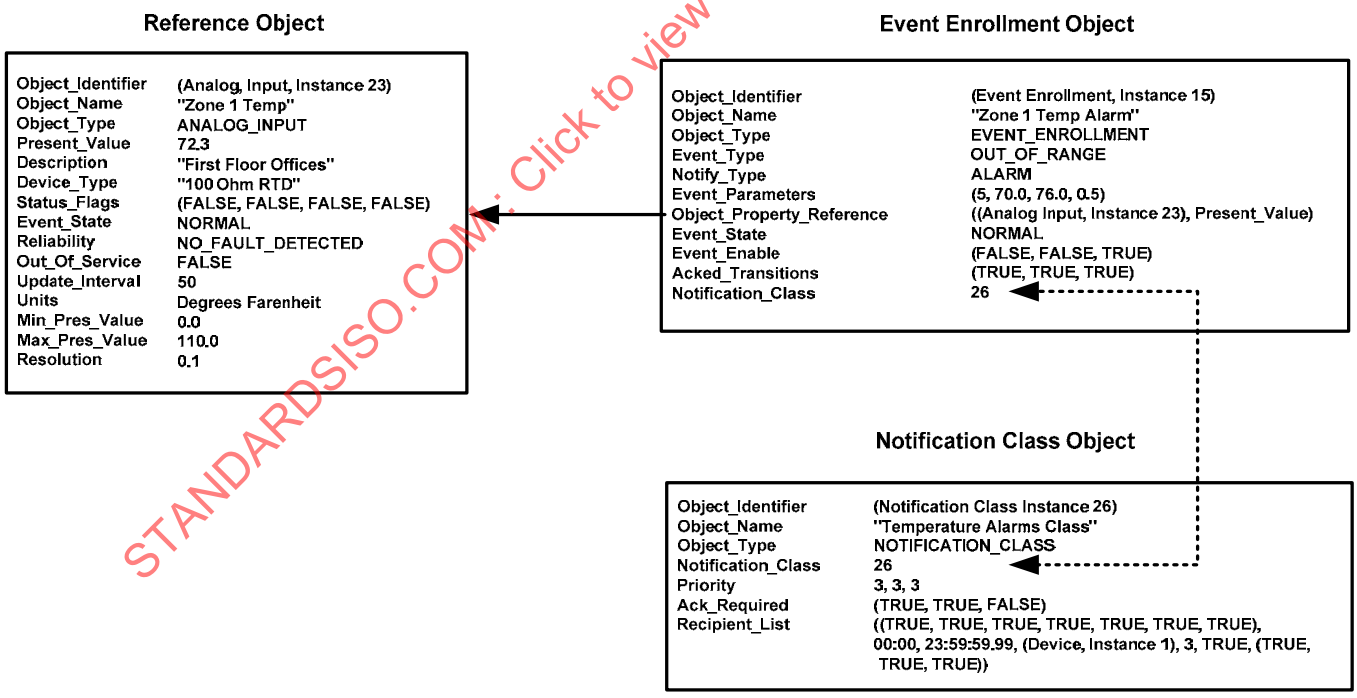

Figure 13-11. Example of an Event Enrollment.

The event notification services contain a 'Time Stamp' parameter that indicates the chronological order of events. This 'Time Stamp' may be the actual time as determined by the local device clock or, if the device has no clock, a sequence number.

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Sequence numbers are required to increase monotonically up to their maximum value, at which point the number "wraps around" to zero. A device may have a single sequence number for all event-initiating objects, or it may have a separate sequence number for each object.

Eleven services are defined specifically for event management:

(a) AcknowledgeAlarm
(b) ConfirmedCOVNotification
(c) UnconfirmedCOVNotification
(d) ConfirmedEventNotification
(e) UnconfirmedEventNotification
(f) GetAlarmSummary
(g) GetEnrollmentSummary
(h) GetEventInformation
(i) LifeSafetyOperation
(j) SubscribeCOV
(k) SubscribeCOVProperty

13.4.1 Alarm and Event Priority Classification

Alarms and events traversing the BACnet network need prioritization to assure that important information reaches its destination and is acted upon quickly. To assure alarm prioritization at the network level, the Network Priority as defined in 6.2.2 shall be set as a function of the alarm and event priority as defined in Table 13-5. Annex M provides additional clarity and examples of specific messages and priorities.

Table 13-5. Alarm and Event Priority - Network Priority Association

Alarm and Event Priority	Network Priority
00 - 63	Life Safety message
64 - 127	Critical Equipment message
128 - 191	Urgent message
192 - 255	Normal message

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13.5 AcknowledgeAlarm Service

In some systems a device may need to know that an operator has seen the alarm notification. The AcknowledgeAlarm service is used by a notification-client to acknowledge that a human operator has seen and responded to an event notification with 'AckRequired' = TRUE. Ensuring that the acknowledgment actually comes from a person with appropriate authority is a local matter. This service may be used in conjunction with either the ConfirmedEventNotification service or the UnconfirmedEventNotification service.

13.5.1 Structure

The structure of the AcknowledgeAlarm service primitives is shown in Table 13-6. The terminology and symbology used in this table are explained in Clause 5.6.

Table 13-6. Structure of AcknowledgeAlarm Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Acknowledging Process Identifier	M	M(=)		
Event Object Identifier	M	M(=)		
Event State Acknowledged	M	M(=)		
Time Stamp	M	M(=)		
Acknowledgment Source	M	M(=)		
Time Of Acknowledgment	M	M(=)		
Result(+)			S	S(=)
Result(-)			S	S(=)
Error Type			M	M(=)

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13.5.1.1 Argument

This parameter shall convey the parameters for the AcknowledgeAlarm confirmed service request.

13.5.1.2 Acknowledging Process Identifier

This parameter, of type Unsigned32, shall specify the 'Process Identifier' parameter that identifies the acknowledging process. The assignment of acknowledging process identifiers is a local matter.

13.5.1.3 Event Object Identifier

This parameter, of type BACnetObjectIdentifier, shall specify the 'Event Object Identifier' parameter of the event notification to which this acknowledgment is a response. This is the same object that initiated the event notification that is being acknowledged.

13.5.1.4 Event State Acknowledged

This parameter, of type BACnetEventState, shall match the value of the 'To State' from the event notification that is being acknowledged. The 'Event State Acknowledged' matches the 'To State' if they are equal, or if 'Event State Acknowledged' is OFFNORMAL and 'To State' is any "offnormal" state (such as HIGH_LIMIT). This parameter is included so that the remote device that initiated the event notification can ensure that the state being acknowledged is recorded in the Acked_Transitions property of the initiating object.

An 'Event State Acknowledged' of OFFNORMAL shall match any off-normal event state.

13.5.1.5 Time Stamp

This parameter, of type BACnetTimeStamp, shall convey the same 'Time Stamp' that was received in the event notification that is being acknowledged by this service. The 'Time Stamp' is used by the recipient of this service request to identify the event notification that is being acknowledged in the case when more than one has been issued with the same 'To State'.

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13.5.1.6 Acknowledgment Source

This parameter, of type CharacterString, shall specify the identity of the operator or process that is acknowledging the event notification.

13.5.1.7 Time Of Acknowledgment

This parameter, of type BACnetTimeStamp, shall specify the time that the operator or process acknowledged the event notification.

13.5.1.8 Result(+)

The 'Result(+)' parameter shall indicate that the service request succeeded and the alarm is marked as acknowledged.

13.5.1.9 Result(-)

The 'Result(-)' parameter shall indicate that the service request failed. The reason for failure is specified by the 'Error Type' parameter.

13.5.1.10 Error Type

This parameter consists of two components: (1) 'Error Class' and (2) 'Error Code'. See Clause 18.

The 'Error Class' and 'Error Code' to be returned for specific situations are as follows:

Situation	Error Class	Error Code
The object does not exist.	OBJECT	UNKNOWN_OBJECT
The object exists but does not support or is not configured for event generation.	OBJECT	NO_ALARM_CONFIGURED
The requesting BACnet device does not have appropriate authorization to Acknowledge this alarm.	SERVICES	SERVICE_REQUEST_DENIED
The timestamp provided in the AcknowledgeAlarm message does not match with the latest timestamp for the transition being acknowledged.	SERVICES	INVALID_TIMESTAMP
The 'Event State Acknowledged' does not match the 'To State' parameter of the original Event Notification message. An 'Event State Acknowledged' of OFFNORMAL shall match any off-normal event state.	SERVICES	INVALID_EVENT_STATE

13.5.2 Service Procedure

After verifying the validity of the request, the responding BACnet-user shall attempt to locate the specified object. If the object exists and if the 'Time Stamp' parameter matches the most recent time for the event being acknowledged, then the bit in the Acked_Transitions property of the object that corresponds to the value of the 'Event State Acknowledged' parameter shall be set to 1, a 'Result(+)' primitive shall be issued, and an event notification with a 'Notify Type' parameter equal to ACK_NOTIFICATION shall be issued. Otherwise, a 'Result(-)' primitive shall be issued. An acknowledgment notification shall use the same type of service (confirmed or unconfirmed) directed to the same recipients to which the original confirmed or unconfirmed event notification was sent.The Time Stamp conveyed in the acknowledgement notification shall not be derived from the Time Stamp of the original event notification, but rather the time at which the acknowledgement notification is generated.

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13.6 ConfirmedCOVNotification Service

The ConfirmedCOVNotification service is used to notify subscribers about changes that may have occurred to the properties of a particular object. Subscriptions for COV notifications are made using the SubscribeCOV service or the SubscribeCOVProperty service.

13.6.1 Structure

The structure of the ConfirmedCOVNotification service primitives is shown in Table 13-7. The terminology and symbology used in this table are explained in Clause 5.6.

Table 13-7. Structure of ConfirmedCOVNotification Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Subscriber Process Identifier	M	M(=)		
Initiating Device Identifier	M	M(=)		
Monitored Object Identifier	M	M(=)		
Time Remaining	M	M(=)		
List of Values	M	M(=)		
Result(+)			S	S(=)
Result(-)			S	S(=)
Error Type			M	M(=)

13.6.1.1 Argument

This parameter shall convey the parameters for the ConfirmedCOVNotification service request.

13.6.1.2 Subscriber Process Identifier

This parameter, of type Unsigned32, shall convey a numeric "handle" meaningful to the subscriber. This handle shall be used to identify the process within the COV client that should receive the notification.

13.6.1.3 Initiating Device Identifier

This parameter, of type BACnetObjectIdentifier, shall convey the Device Object_Identifier of the device that initiated the ConfirmedCOVNotification service request.

13.6.1.4 Monitored Object Identifier

This parameter, of type BACnetObjectIdentifier, shall convey the Object_Identifier of the object that has changed.

13.6.1.5 Time Remaining

This parameter, of type Unsigned, shall convey the remaining lifetime of the subscription in seconds. A value of zero shall indicate an indefinite lifetime without automatic cancellation.

13.6.1.6 List of Values

This parameter shall convey a list of one or more property values whose contents depends on the type of object being monitored. Table 13-1 summarizes the BACnet standard objects and those property values that shall be returned in the 'List of Values' parameter when those objects are enabled for COV reporting. The property values are returned in the order shown in Table 13-1.

13.6.1.7 Result(+)

The 'Result(+)' parameter shall indicate that the requested service has succeeded.

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13.6.1.8 Result(-)

The 'Result(-)' parameter shall indicate that the service request has failed. The reason for failure shall be specified by the 'Error Type' parameter.

13.6.1.8.1 Error Type

This parameter shall consist of two component parameters: (1) the 'Error Class' and (2) the 'Error Code'. See Clause 18.

13.6.2 Service Procedure

After verifying the validity of the request, the responding BACnet-user shall take whatever local actions have been assigned to the indicated COV and issue a 'Result(+)' service primitive. If the service request cannot be executed, a 'Result(-)' service primitive shall be issued indicating the error encountered.

The 'Error Class' and 'Error Code' to be returned for specific situations are as follows:

Situation	Error Class	Error Code
No subscription exists for the specified object, property, and process identifier. Devices may ignore this condition and return a BACnet-SimpleACK-PDU.	SERVICES	UNKNOWN_SUBSCRIPTION

13.7 UnconfirmedCOVNotification Service

The UnconfirmedCOVNotification Service is used to notify subscribers about changes that may have occurred to the properties of a particular object, or to distribute object properties of wide interest (such as outside air conditions) to many devices simultaneously without a subscription. Subscriptions for COV notifications are made using the SubscribeCOV service. For unsubscribed notifications, the algorithm for determining when to issue this service is a local matter and may be based on a change of value, periodic updating, or some other criteria.

13.7.1 Structure

The structure of the UnconfirmedCOVNotification service primitive is shown in Table 13-8. The terminology and symbology used in this table are explained in Clause 5.6.

Table 13-8. Structure of UnconfirmedCOVNotification Service Primitive

Parameter Name	Req	Ind
Argument	M	M(=)
Subscriber Process Identifier	M	M(=)
Initiating Device Identifier	M	M(=)
Monitored Object Identifier	M	M(=)
Time Remaining	M	M(=)
List of Values	M	M(=)

13.7.1.1 Argument

This parameter shall convey the parameters for the UnconfirmedCOVNotification service request.

13.7.1.2 Subscriber Process Identifier

This parameter, of type Unsigned32, shall convey a numeric "handle" meaningful to the subscriber. This handle shall be used to identify the process within the COVclient that should receive the notification. The value of zero is reserved for unsubscribed COV.

13.7.1.3 Initiating Device Identifier

This parameter, of type BACnetObjectIdentifier, shall convey the Device Object_Identifier of the device that initiated the UnconfirmedCOVNotification service request.

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13.7.1.4 Monitored Object Identifier

This parameter, of type BACnetObjectIdentifier, shall convey the Object_Identifier of the object that has changed.

13.7.1.5 Time Remaining

This parameter, of type Unsigned, shall convey the remaining lifetime of the subscription in seconds. A value of zero shall indicate an indefinite lifetime, without automatic cancellation, or an unsubscribed notification.

13.7.1.6 List of Values

This parameter shall convey a list of one or more property values whose contents depend on the type of object being monitored. Table 13-1 summarizes the BACnet standard objects and those property values that shall be returned in the 'List of Values' parameter when those objects are enabled for COV reporting.

13.7.2 Service Procedure

Since this is an unconfirmed service, no response primitives are expected. Actions taken in response to this notification are a local matter.

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13.8 ConfirmedEventNotification Service

The ConfirmedEventNotification service is used by a notification-server to notify a remote device that an event has occurred and that the notification-server needs a confirmation that the notification has been received. This confirmation means only that the device received the message. It does not imply that a human operator has been notified. A separate AcknowledgeAlarm service is used to indicate that an operator has acknowledged the receipt of the notification if the notification specifies that acknowledgment is required. If multiple recipients must be notified, a separate invocation of this service shall be used to notify each intended recipient. If a confirmation that a notification was received is not needed, then the UnconfirmedEventNotification may be used.

13.8.1 Structure

The structure of the ConfirmedEventNotification service primitives is shown in Table 13-9. The terminology and symbology used in this table are explained in Clause 5.6.

Table 13-9. Structure of ConfirmedEventNotification Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Process Identifier	M	M(=)		
Initiating Device Identifier	M	M(=)		
Event Object Identifier	M	M(=)		
Time Stamp	M	M(=)		
Notification Class	M	M(=)		
Priority	M	M(=)		
Event Type	M	M(=)		
Message Text	U	U(=)		
Notify Type	M	M(=)		
AckRequired	C	C(=)		
From State	C	C(=)		
To State	M	M(=)		
Event Values	C	C(=)		
Result(+)			S	S(=)
Result(-)			S	S(=)
Error Type			M	M

13.8.1.1 Argument

This parameter shall convey the parameters for the ConfirmedEventNotification service request.

13.8.1.2 Process Identifier

This parameter, of type Unsigned32, shall convey the identification of the process in the receiving device for which the notification is intended.

13.8.1.3 Initiating Device Identifier

This parameter, of type BACnetObjectIdentifier, shall convey the Device Object_Identifier of the device that initiated the ConfirmedEventNotification service request.

13.8.1.4 Event Object Identifier

This parameter, of type BACnetObjectIdentifier, shall specify the Object_Identifier of the object that is initiating the notification. This parameter is used by the AcknowledgeAlarm service to identify the object whose notification is being acknowledged.

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13.8.1.5 Time Stamp

This parameter, of type BACnetTimeStamp, shall convey the current time as determined by the clock in the device issuing the service request. If this device has no clock, then this parameter shall convey a sequence number, of type Unsigned, which indicates the relative ordering of this event notification to all other event notifications issued by this device without regard to their intended recipient. The sequence numbers shall increase monotonically (they may be implemented using modulo arithmetic). A device may have a single sequence number for all event-initiating objects or a separate sequence number for each object.

13.8.1.6 Notification Class

This parameter, of type Unsigned, designates the notification class of the event. Definition of the various notification classes is a local matter (see 13.2, 13.4, and 12.21 for discussion of Notification Class objects).

13.8.1.7 Priority

This parameter, of type Unsigned8, shall specify the priority of the event that has occurred. The priority is specified by the Priority property of the Notification Class or Event Enrollment objects associated with this event. The possible range of priorities is 0-255. A lower number indicates a higher priority. The priority and the Network Priority (see 6.2.2) are associated as defined in Table 13-5.

13.8.1.8 Event Type

This parameter, of type BACnetEventType, shall specify the type of event that has occurred. Event types that are defined in this standard may be found in Table 12-15.

13.8.1.9 Message Text

This optional parameter, of type CharacterString, shall convey a string of printable characters. This parameter may be used to convey a message to be logged or displayed, which pertains to the occurrence of the event. The content of the message is a local matter. If the optional property Event_Message_Texts is present in the event generating object, the text conveyed in this Message_Text parameter shall be stored in the respective field of the Event_Message_Texts array.

13.8.1.10 Notify Type

This parameter, of type BACnetNotifyType, shall convey whether this notification is an event or an alarm or a notification that someone has acknowledged a previous event notification:

{ALARM, EVENT, ACK_NOTIFICATION}.

13.8.1.11 AckRequired

This parameter, of type BOOLEAN, shall convey whether this notification requires acknowledgment (TRUE) or not (FALSE). This parameter shall only be present if the 'Notify Type' parameter is EVENT or ALARM.

13.8.1.12 From State

This parameter, of type BACnetEventState, shall indicate the Event_State of the object prior to the occurrence of the event that initiated this notification. This parameter shall only be present if the 'Notify Type' parameter is EVENT or ALARM.

13.8.1.13 To State

This parameter, of type BACnetEventState, shall indicate the Event_State of the object after the occurrence of the event that initiated this notification.

13.8.1.14 Event Values

This parameter, of type BACnetNotificationParameters, shall convey a set of values relevant to the particular event and whose content depends on the type of object that initiated the notification (see Tables 13-2, 13-3, and 13-4). This parameter shall only be present if the 'Notify Type' parameter is EVENT or ALARM. The returned set of values may be either a list of property values representing properties of the object specified by the 'Event Object Identifier' or one of the standard event type notification parameter sets defined in Table 13-4.

13.8.1.15 Result(+)

The 'Result(+)' parameter shall indicate that the requested service has succeeded.

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13.8.1.16 Result(-)

The 'Result(-)' parameter shall indicate that the service request has failed. The reason for failure shall be specified by the 'Error Type' parameter.

13.8.1.16.1 Error Type

This parameter shall consist of two component parameters: (1) the 'Error Class' and (2) the 'Error Code'. See Clause 18.

13.8.2 Service Procedure

After verifying the validity of the request, the responding BACnet-user shall take whatever local actions have been assigned to the indicated event occurrence and issue a 'Result(+)' service primitive. If the service request cannot be executed, a 'Result(-)' service primitive shall be issued indicating the encountered error.

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13.9 UnconfirmedEventNotification Service

The UnconfirmedEventNotification service is used by a notification-server to notify a remote device that an event has occurred. Its purpose is to notify recipients that an event has occurred, but confirmation that the notification was received is not required. Applications that require confirmation that the notification was received by the remote device should use the ConfirmedEventNotification service. The fact that this is an unconfirmed service does not mean it is inappropriate for notification of alarms. Events of type Alarm may require a human acknowledgment that is conveyed using the AcknowledgeAlarm service. Thus, using an unconfirmed service to announce the alarm has no effect on the ability to confirm that an operator has been notified. Any device that executes this service shall support programmable process identifiers to allow broadcast and multicast 'Process Identifier' parameters to be assigned on a per installation basis.

13.9.1 Structure

The structure of the UnconfirmedEventNotification service primitives is shown in Table 13-10. The terminology and symbology used in this table are explained in Clause 5.6.

Table 13-10. Structure of UnconfirmedEventNotification Service Primitive

Parameter Name	Req	Ind
Argument	M	M(=)
Process Identifier	M	M(=)
Initiating Device Identifier	M	M(=)
Event Object Identifier	M	M(=)
Time Stamp	M	M(=)
Notification Class	M	M(=)
Priority	M	M(=)
Event Type	M	M(=)
Message Text	U	U(=)
Notify Type	M	M(=)
AckRequired	C	C(=)
From State	C	C(=)
To State	M	M(=)
Event Values	C	C(=)

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13.9.1.1 Argument

The 'Argument' parameter shall convey the parameters for the UnconfirmedEventNotification service request.

13.9.1.2 Process Identifier

This parameter, of type Unsigned32, shall convey the identification of the process in the receiving device for which the notification is intended.

13.9.1.3 Initiating Device Identifier

This parameter, of type BACnetObjectIdentifier, shall convey the Device Object_Identifier of the device that initiated the UnconfirmedEventNotification service request.

13.9.1.4 Event Object Identifier

This parameter, of type BACnetObjectIdentifier, shall specify the identifier of the object that is initiating the notification. This parameter is used by the AcknowledgeAlarm service to identify the object whose notification is being acknowledged.

13.9.1.5 Time Stamp

This parameter, of type BACnetTimeStamp, shall convey the current time as determined by the clock in the device issuing the service request. If this device has no clock, then this parameter shall convey a sequence number that indicates the relative ordering of this event notification to all other event notifications issued by this device without regard to their intended recipient. The sequence numbers shall increase monotonically (they may be implemented using modulo arithmetic). A device may have a single sequence number for all event-initiating objects or a separate sequence number for each object.

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13.9.1.6 Notification Class

This parameter, of type Unsigned, designates the notification class of the event. Definition of the various notification classes is a local matter (see 13.2, 13.4, and 12.21 for discussion of Notification Class objects).

13.9.1.7 Priority

This parameter, of type Unsigned8, shall specify the priority of the event that has occurred. The priority is specified by the Priority property of the Notification Class object associated with the event. The possible range of priorities is 0-255. A lower number indicates a higher priority. The priority and the Network Priority (see 6.2.2) are associated as defined in Table 13-5.

13.9.1.8 Event Type

This parameter, of type BACnetEventType, shall specify the type of event that has occurred. Event types that are defined in this standard may be found in Table 12-15.

13.9.1.9 Message Text

This optional parameter, of type CharacterString, shall convey a string of printable characters. This parameter may be used to convey a message to be logged or displayed, which pertains to the occurrence of the event. The content of the message is a local matter. If the optional property Event_Message_Texts is present in the event generating object, the text conveyed in this Message_Text parameter shall be stored in the respective field of the Event_Message_Texts array.

13.9.1.10 Notify Type

This parameter, of type BACnetNotifyType, shall convey whether this notification is an event or an alarm or a notification that someone has acknowledged a previous event notification:

{EVENT, ALARM, ACK_NOTIFICATION}.

13.9.1.11 AckRequired

This parameter, of type BOOLEAN, shall convey whether this notification requires acknowledgment (TRUE) or not (FALSE). This parameter shall only be present if the 'Notify Type' parameter is EVENT or ALARM.

13.9.1.12 From State

This parameter, of type BACnetEventState, shall indicate the state of the object prior to the occurrence of the event that initiated this notification. This parameter shall only be present if the 'Notify Type' parameter is EVENT or ALARM.

13.9.1.13 To State

This parameter, of type BACnetEventState, shall indicate the state of the object after the occurrence of the event that initiated this notification.

13.9.1.14 Event Values

This parameter, of type BACnetNotificationParameters, shall convey a set of values relevant to the particular event and whose content depends on the type of object that initiated the notification (see Tables 13-2, 13-3, and 13-4). This parameter shall only be present if the 'Notify Type' parameter is EVENT or ALARM. The returned set of values may be either a list of property values representing properties of the object specified by the 'Event Object Identifier' or one of the standard event-type notification parameter sets defined in Table 13-4.

13.9.2 Service Procedure

Since this is an unconfirmed service, no response primitives are expected. Actions taken in response to this notification are a local matter.

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13.10 GetAlarmSummary Service

The GetAlarmSummary service is used by a client BACnet-user to obtain a summary of "active alarms." The term "active alarm" refers to BACnet standard objects that have an Event_State property whose value is not equal to NORMAL and a Notify_Type property whose value is ALARM. The GetEnrollmentSummary service provides a more sophisticated approach with various kinds of filters.

13.10.1 Structure

The structure of the GetAlarmSummary service primitives is shown in Table 13-11. The terminology and symbology used in this table are explained in Clause 5.6.

Table 13-11. Structure of GetAlarmSummary Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Result(+)			S	S(=)
List of Alarm Summaries			M	M(=)
Object Identifier			M	M(=)
Alarm State			M	M(=)
Acknowledged Transitions			M	M(=)
Result(-)			S	S(=)
Error Type			M	M(=)

13.10.1.1 Argument

This parameter indicates the GetAlarmSummary confirmed service request.

13.10.1.2 Result(+)

The 'Result(+)' parameter shall indicate that the requested service has succeeded. A successful result includes the following parameters.

13.10.1.2.1 List of Alarm Summaries

The 'List of Alarm Summaries' shall contain zero or more Alarm Summaries. Each Alarm Summary shall consist of three parameters: 'Object Identifier', 'Alarm State', and 'Acknowledged States'. If the list is of length zero, then this shall be interpreted to mean that there are no active alarms for this device.

13.10.1.2.1.1 Object Identifier

This parameter, of type BACnetObjectIdentifier, shall identify the event-initiating object whose Event_State property is not equal to NORMAL and that has a Notify_Type property whose value is ALARM.

13.10.1.2.1.2 Alarm State

This parameter, of type BACnetEventState, indicates the value of the Event_State property of the object.

13.10.1.2.1.3 Acknowledged Transitions

This parameter, of type BACnetEventTransitionBits, indicates the value of the Acked_Transitions property of the object.

13.10.1.3 Result(-)

The 'Result(-)' parameter shall indicate that the service request has failed. The reason for failure shall be specified by the 'Error Type' parameter.

13.10.1.3.1 Error Type

This parameter shall consist of two component parameters: (1) the 'Error Class' and (2) the 'Error Code'. See Clause 18.

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13.10.2 Service Procedure

After verifying the validity of the request, the responding BACnet-user shall search all event-initiating objects that have an Event_State property not equal to NORMAL and a Notify_Type property whose value is ALARM. A positive response containing the alarm summaries for objects found in this search shall be constructed. If no objects are found that meet these criteria, then a list of length zero shall be returned.

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13.11 GetEnrollmentSummary Service

The GetEnrollmentSummary service is used by a client BACnet-user to obtain a summary of event-initiating objects. Several different filters may be applied to define the search criteria. This service may be used to obtain summaries of objects with any EventType and is thus a superset of the functionality provided by the GetAlarmSummary Service.

13.11.1 Structure

The structure of the GetEnrollmentSummary service primitives is shown in Table 13-12. The terminology and symbology used in this table are explained in Clause 5.6.

Table 13-12. Structure of GetEnrollmentSummary Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Acknowledgment Filter	M	M(=)		
Enrollment Filter	U	U(=)		
Event State Filter	U	U(=)		
Event Type Filter	U	U(=)		
Priority Filter	U	U(=)		
Notification Class Filter	U	U(=)		
Result(+)			S	S(=)
List of Enrollment Summaries			M	M(=)
Object Identifier			M	M(=)
Event Type			M	M(=)
Event State			M	M(=)
Priority			M	M(=)
Notification Class			U	U(=)
Result(-)			S	S(=)
Error type			M	M(=)

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13.11.1.1 Argument

This parameter shall convey the parameters for the GetEnrollmentSummary confirmed service request.

13.11.1.1.1 Acknowledgment Filter

This parameter, of type ENUMERATED, shall provide a means of restricting the event-initiating objects that are to be summarized. The 'Acknowledgment Filter' may take any of three values:

ALL - Shall request that the returned summary contain all event-initiating objects without regard to whether the objects have acknowledgments or not.

ACKED - Shall request that the returned summary contain only those objects for which the Acked_Transitions property has a value of one in every bit position.

NOT-ACKED - Shall request that the returned summary contain only reports for those objects for which the Acked_Transitions property has a value of zero in one or more bit positions.

13.11.1.1.2 Enrollment Filter

This parameter, of type BACnetRecipientProcess, shall provide a means of restricting the set of objects that are to be summarized. Only those objects for which the specified BACnetRecipient and Process Identifier are enrolled to receive notifications, either confirmed or unconfirmed, shall be summarized. In this case, "enrolled" shall mean that an event-initiating object references a Notification Class object containing one or more BACnetDestinations containing the indicated Process Identifier and BACnetRecipient.

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If this parameter is omitted, it shall mean that event-initiating objects shall be summarized without regard to enrollment status.

13.11.1.1.3 Event State Filter

This parameter shall provide a means of restricting the set of event-initiating objects that are to be summarized. It may have any of the following values:

{OFFNORMAL, FAULT, NORMAL, ALL, ACTIVE}.

Only those event-initiating objects whose Event_State property matches the value specified in this parameter shall be included. If the value ALL is specified, then all of the event-initiating objects shall be summarized without regard to the value of the Event_State property. If the value ACTIVE is specified, then only those event-initiating objects whose Event_State property has a value other than NORMAL shall be summarized. If this parameter is omitted, a default value of ALL shall be assumed.

13.11.1.1.4 Event Type Filter

This parameter is provided as a means of restricting the summary to only those event-initiating objects that can generate event notifications with an Event_Type equal to the value of this parameter. This parameter may have any legal value of Event_Type as defined in the Event Enrollment object specification. If this parameter is omitted, all event-initiating objects shall be included in the summary without regard to which EventTypes they generate.

13.11.1.1.5 Priority Filter

This parameter consists of two parts, MinPriority and MaxPriority, each of datatype Unsigned8. It provides a means of restricting the summary to only those event-initiating objects that can generate event notifications with a Priority as specified by this parameter. The 'Priority Filter' parameter consists of two parts, MinPriority and MaxPriority. All event-initiating objects, such that MinPriority ≤ Priority ≤ MaxPriority, shall be included in the summary. For the purpose of this filter, the Priority checked by the filter is the Priority associated with the most recent transition. If 'Priority Filter' is omitted, all event-initiating objects shall be summarized without regard to their Priority.

13.11.1.1.6 Notification Class Filter

This parameter, of type Unsigned, provides a means of restricting the summary to only those event-initiating objects that can generate event notifications with a Notification Class equal to the value of this parameter. If 'Notification Class Filter' is omitted, it shall mean that all event-initiating objects objects shall be summarized without regard to their Notification Class.

13.11.1.2 Result(+)

The 'Result(+)' parameter shall indicate that the requested service has succeeded. A successful result includes the following parameters.

13.11.1.2.1 List of Enrollment Summaries

The 'List of Enrollment Summaries' shall contain zero or more Enrollment Summaries. Each Enrollment Summary shall consist of up to five parameters: 'Object Identifier', 'Event Type', 'Event State', 'Priority', and, optionally, 'Notification Class'. If the list is of length zero, then this shall be interpreted to mean that there are no event-initiating objects that meet the search criteria specified in the request primitive.

13.11.1.2.1.1 Object Identifier

This parameter, of type BACnetObjectIdentifier, shall identify an object meeting the search criteria.

13.11.1.2.1.2 Event Type

This parameter, of type BACnetEventType, indicates the Event_Type that the object can generate.

13.11.1.2.1.3 Event State

This parameter, of type BACnetEventState, indicates the value of the Event_State property of the object.

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13.11.1.2.1.4 Priority

This parameter, of type Unsigned8, indicates the priority of notifications generated by the object.

13.11.1.2.1.5 Notification Class

This optional parameter, of type Unsigned, indicates the class of notifications generated by the object and implicitly refers to a Notification Class object that has a Notification_Class property of the same value.

13.11.1.3 Result(-)

The 'Result(-)' parameter shall indicate that the service request has failed. The reason for failure shall be specified by the 'Error Type' parameter.

13.11.1.3.1 Error Type

This parameter shall consist of two component parameters: (1) the 'Error Class' and (2) the 'Error Code'. See Clause 18.

13.11.2 Service Procedure

After verifying the validity of the request, the responding BACnet-user shall search for all event-initiating objects that meet the search criteria specified in the request primitive. The search criteria are the logical conjunctions of all of the explicitly stated filters and the default values for any filters that were omitted in the request primitive. A positive response containing the enrollment summaries for objects found in this search shall be constructed. If no objects are found that meet these criteria, then a list of length zero shall be returned.

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13.12 GetEventInformation Service

The GetEventInformation service is used by a client BACnet-user to obtain a summary of all "active event states". The term "active event states" refers to all event-initiating objects that

(a) have an Event_State property whose value is not equal to NORMAL, or
(b) have an Acked_Transitions property, which has at least one of the bits (TO-OFFNORMAL, TO-FAULT, TO-NORMAL) set to FALSE.

This service is intended to be implemented in all devices that generate event notifications.

13.12.1 Structure

The structure of the GetEventInformation service primitives is shown in Table 13-13. The terminology and symbology used in this table are explained in Clause 5.6.

Table 13-13. Structure of GetEventInformation Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Last Received Object Identifier	U	U(=)		
Result(+)				
List of Event Summaries			M	M(=)
Object Identifier			M	M(=)
Event State			M	M(=)
Acknowledged Transitions			M	M(=)
Event Time Stamps			M	M(=)
Notify Type			M	M(=)
Event Enable			M	M(=)
Event Priorities			M	M(=)
More Events			M	M(=)
Result(-)			S	S(=)
Error Type			M	M(=)

13.12.1.1 Argument

This parameter indicates the GetEventInformation confirmed service request.

13.12.1.1.1 Last Received Object Identifier

This optional parameter, of type BACnetObjectIdentifier, shall specify the last Object Identifier received in a preceding GetEventInformation-ACK, if its 'More Events' parameter was TRUE. If this parameter is omitted, the returned summary shall start with the first object meeting the "active event states" criteria. A fixed object processing order is assumed, however the particular order is a local matter. If the Last Received Object Identifier has become invalid in the responding device (i.e., the object is no longer present), the service shall resume if it is possible to determine the object that would have been the successor of the object that is no longer present. Otherwise a Result(-) shall be returned with an error class of OBJECT and an error code of UNKNOWN_OBJECT.

13.12.1.2 Result(+)

The 'Result(+)' parameter shall indicate that the requested service has succeeded. A successful result includes the following parameters.

13.12.1.2.1 List of Event Summaries

The 'List of Event Summaries' shall contain zero or more Event Summaries. Each Event Summary shall consist of seven parameters: 'Object Identifier', 'Event State', 'Acknowledged Transitions', 'Event Time Stamps', 'Notify Type', 'Event Enable' and 'Event Priorities'. If the list is of length zero, then this shall be interpreted to mean that there are no event-initiating objects that have active event states in this device.

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13.12.1.2.1.1 Object Identifier

This parameter, of type BACnetObjectIdentifier, shall identify the event-initiating object that has an Event_State property whose value is not equal to NORMAL or has an Acked_Transitions property that has at least one of the following bits (TO-OFFNORMAL, TO-FAULT, TO-NORMAL) set to FALSE.

13.12.1.2.1.2 Event State

This parameter, of type BACnetEventState, indicates the value of the Event_State property of the object.

13.12.1.2.1.3 Acknowledged Transitions

This parameter, of type BACnetEventTransitionBits, indicates the value of the Acked_Transitions property of the object.

13.12.1.2.1.4 Event Time Stamps

This parameter, of type BACnetARRAY[3] of BACnetTimeStamp, shall convey the timestamps of the last event notifications for TO-OFFNORMAL, TO-FAULT, and TO-NORMAL events.

13.12.1.2.1.5 Notify Type

This parameter, of type BACnetNotifyType, shall convey the value of the Notify_Type property of this object.

13.12.1.2.1.6 Event Enable

This parameter, of type BACnetEventTransitionBits, shall convey the value of the Event_Enable property of the object.

13.12.1.2.1.7 Event Priorities

This parameter, of type BACnetARRAY[3] of Unsigned, shall convey the priorities specified in the Priority property of the associated Notification Class object.

13.12.1.2.2 More Events

This parameter, of type BOOLEAN, shall indicate whether (TRUE) or not (FALSE) more objects exist that meet the active event state criteria of the service request, but that could not be returned in the reply.

13.12.1.3 Result(-)

The 'Result(-)' parameter shall indicate that the service request has failed. The reason for failure shall be specified by the 'Error Type' parameter.

13.12.1.3.1 Error Type

This parameter shall consist of two component parameters: (1) the 'Error Class' and (2) the 'Error Code'. See Clause 18.

13.12.2 Service Procedure

After verifying the validity of the request, the responding BACnet-user shall search for all event-initiating objects that meet the following conditions, beginning with the object following (in whatever internal ordering of objects is used by the responding device) the object specified by the 'Last Received Object Identifier' parameter, if present:

(a) have an Event_State property whose value is not equal to NORMAL, or
(b) have an Acked_Transitions property that has at least one of the following bits (TO-OFFNORMAL, TO-FAULT, TO-NORMAL) set to FALSE.

A positive response containing the event summaries for objects found in this search shall be constructed. If no objects are found that meet these criteria, then a list of length zero shall be returned. As many of the included objects as can be returned within the APDU shall be returned. If more objects exist that meet the criteria but cannot be returned in the APDU, the 'More Events' parameter shall be set to TRUE, otherwise it shall be set to FALSE.

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13.13 LifeSafetyOperation Service

The LifeSafetyOperation service is intended for use in fire, life safety and security systems to provide a mechanism for conveying specific instructions from a human operator to accomplish any of the following objectives:

(a) silence audible or visual notification appliances,
(b) reset latched notification appliances, or
(c) unsilence previously silenced audible or visual notification appliances.

Ensuring that the LifeSafetyOperation request actually comes from a person with appropriate authority is a local matter.

13.13.1 Structure

The structure of the LifeSafetyOperation primitive is shown in Table 13-14. The terminology and symbology used in this table are explained in Clause 5.6.

Table 13-14. Structure of LifeSafetyOperation Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Requesting Process Identifier	M	M(=)		
Requesting Source	M	M(=)		
Request	M	M(=)		
Object Identifier	U	U(=)		
Result(+)			S	S(=)
Result(-)			S	S(=)
Error Type			M	M(=)

13.13.1.1 Argument

This parameter shall convey the parameters for the LifeSafetyOperation confirmed service request.

13.13.1.1.1 Requesting Process Identifier

This parameter, of type Unsigned32, specifies an identifying number of significance to the sending device that uniquely identifies the process which initiated the service request. The assignment and meaning of process identifiers shall be a local matter.

13.13.1.1.2 Requesting Source

This parameter, of type CharacterString, specifies the identity of the human operator that initiated the LifeSafetyOperation service request.

13.13.1.1.3 Request

This parameter, of type BACnetLifeSafetyOperation, shall convey the requested operation:

{SILENCE, SILENCE_AUDIBLE, SILENCE_VISUAL, RESET, RESET_ALARM, RESET_FAULT, UNSILENCE, UNSILENCE_AUDIBLE, UNSILENCE_VISUAL}

13.13.1.1.4 Object Identifier

This parameter, of type BACnetObjectIdentifier, shall convey the specific BACnet object to which the life safety request is directed. If this parameter is not present, then all applicable objects within the receiving BACnet device shall be silenced or reset accordingly based on the 'Request' provided.

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13.13.1.2 Result(+)

The 'Result(+)' parameter shall indicate that the service request succeeded.

13.13.1.3 Result(-)

The 'Result(-)' parameter shall indicate that the service request has failed. The reason for the failure shall be specified by the 'Error Type' parameter.

13.13.1.3.1 Error Type

This parameter consists of two component parameters: (1) the 'Error Class' and (2) the 'Error Code'. See Clause 18.

13.13.2 Service Procedure

The responding BACnet-user shall first verify the validity of the 'Object Identifier' parameter and return a 'Result(-)' response with the appropriate error class and code if the 'Request' is invalid or if the 'Object Identifier' parameter is present and specifies an object that is either unknown or does not represent an appropriate request for this object type.

If the 'Object Identifier' parameter is not present, then the responding BACnet-user shall attempt to operate all applicable objects in the device based on the 'Request' parameter. If the 'Object Identifier' parameter is present, the responding BACnet-user shall attempt to silence or reset the object specified in the 'Object Identifier' parameter based on the 'Request' parameter. In either case, the responding BACnet-user shall issue a Result(+) primitive.

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13.14 SubscribeCOV Service

The SubscribeCOV service is used by a COV-client to subscribe for the receipt of notifications of changes that may occur to the properties of a particular object. Certain BACnet standard objects may optionally support COV reporting. If a standard object provides COV reporting, then changes of value of specific properties of the object, in some cases based on programmable increments, trigger COV notifications to be sent to one or more subscriber clients. Typically, COV notifications are sent to supervisory programs in BACnet client devices or to operators or logging devices. Proprietary objects may support COV reporting at the implementor's option. The standardized objects that may optionally provide COV support and the change of value algorithms they shall employ are summarized in Table 13-1.

The subscription establishes a connection between the change of value detection and reporting mechanism within the COV-server device and a "process" within the COV-client device. Notifications of changes are issued by the COV-server device when changes occur after the subscription has been established. The ConfirmedCOVNotification and UnconfirmedCOVNotification services are used by the COV-server device to convey change notifications. The choice of confirmed or unconfirmed service is made at the time the subscription is established.

13.14.1 Structure

The structure of the SubscribeCOV service primitives is shown in Table 13-15. The terminology and symbology used in this table are explained in Clause 5.6.

Table 13-15. Structure of SubscribeCOV Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Subscriber Process Identifier	M	M(=)		
Monitored Object Identifier	M	M(=)		
Issue Confirmed Notifications	U	U(=)		
Lifetime	U	U(=)		
Result(+)			S	S(=)
Result(-)			S	S(=)
Error Type			M	M(=)

13.14.1.1 Argument

This parameter shall convey the parameters for the SubscribeCOV confirmed service request.

13.14.1.2 Subscriber Process Identifier

This parameter, of type Unsigned32, shall convey a numeric "handle" meaningful to the subscriber. This handle shall be used to match future re-subscriptions and cancellations from the subscriber with the COV context that exists within the COV-server device and with confirmed or unconfirmed COV notifications to identify the process within the COV-client that should receive them. The value zero is reserved for unsubscribed COV notifications as described in 13.7.

13.14.1.3 Monitored Object Identifier

This parameter, of type BACnetObjectIdentifier, shall convey the identifier of the object within the receiving device for which a subscription is desired.

13.14.1.4 Issue Confirmed Notifications

This parameter, of type BOOLEAN, shall convey whether the COV-server device shall issue ConfirmedCOVNotifications (TRUE) or UnconfirmedCOVNotifications (FALSE) when changes occur. This parameter, if present, shall indicate a subscription or re-subscription is to occur and that the lifetime shall be refreshed to its initial state. If both the 'Issue Confirmed Notifications' and 'Lifetime' parameters are absent, then this shall indicate a cancellation request. If the 'Lifetime' parameter is present then the 'Issue Confirmed Notifications' parameter shall be present.

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13.14.1.5 Lifetime

This parameter, of type Unsigned, shall convey the desired lifetime of the subscription in seconds. A value of zero shall indicate an indefinite lifetime, without automatic cancellation. A non-zero value shall indicate the number of seconds that may elapse before the subscription shall be automatically cancelled. If both the 'Issue Confirmed Notifications' and 'Lifetime' parameters are absent, then this shall indicate a cancellation request. If the 'Lifetime' parameter is present then the 'Issue Confirmed Notifications' parameter shall be present.

Devices that execute this service shall accept, at a minimum, lifetime values up to and including 28800 seconds (8 hours). Devices may optionally support lifetime values larger than 28800. Devices that initiate this service shall be capable of providing Lifetime values less than or equal to 28800.

13.14.1.6 Result(+)

The 'Result(+)' parameter shall indicate that the requested service has succeeded.

13.14.1.7 Result(-)

The 'Result(-)' parameter shall indicate that the service request has failed. The reason for failure shall be specified by the 'Error Type' parameter.

13.14.1.7.1 Error Type

This parameter shall consist of two component parameters: (1) the 'Error Class' and (2) the 'Error Code'. See Clause 18.

13.14.2 Service Procedure

If neither 'Lifetime' nor 'Issue Confirmed Notifications' are present, then the request shall be considered to be a cancellation. Any COV context that already exists for the same BACnet address contained in the PDU that carries the SubscribeCOV request and has the same 'Subscriber Process Identifier' and 'Monitored Object Identifier' shall be disabled and a 'Result(+)' returned. Cancellations that are issued for which no matching COV context can be found shall succeed as if a context had existed, returning 'Result(+)'.

If the 'Lifetime' parameter is not present but the 'Issue Confirmed Notifications' parameter is present, then a value of zero (indefinite lifetime) shall be assumed for the lifetime. If the 'Issue Confirmed Notifications' parameter is present but the object to be monitored does not support COV reporting, then a 'Result(-)' shall be returned. If the object to be monitored does support COV reporting, then a check shall be made to locate an existing COV context for the same BACnet address contained in the PDU that carries the SubscribeCOV request and has the same 'Subscriber Process Identifier' and 'Monitored Object Identifier'. If an existing COV context is found, then the request shall be considered a re-subscription and shall succeed as if the subscription had been newly created.

If no COV context can be found that matches the request, then a new COV context shall be established that contains the BACnet address from the PDU that carries the SubscribeCOV request and the same 'Subscriber Process Identifier' and 'Monitored Object Identifier'. If no context can be created, then a 'Result(-)' shall be returned.

If a new context is created or a re-subscription is received, then the COV context shall be initialized and given a lifetime as specified by the 'Lifetime' parameter, if present, or zero if the 'Lifetime' parameter is not present. The subscription shall be automatically cancelled after that many seconds have elapsed unless a re-subscription is received. A lifetime of zero shall indicate that the subscription is indefinite and no automatic cancellation shall occur. In either case, a 'Result(+)' shall be returned. A ConfirmedCOVNotification or UnconfirmedCOVNotification shall be issued as soon as possible after the successful completion of a subscription or re-subscription request, as specified by the 'Issue Confirmed Notifications' parameter.

The 'Error Class' and 'Error Code' to be returned for specific situations are as follows:

Situation:	Error Class:	Error Code:
Specified object does not exist	OBJECT	UNKNOWN_OBJECT
Specified object does not support COV notifications	OBJECT	OPTIONAL_FUNCTIONALITY_NOT_SUPPORTED
No context can be created due to resource limitations	RESOURCES	NO_SPACE_TO_ADD_LIST_ELEMENT

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The Lifetime parameter is out of the range supported by the device	SERVICES	VALUE_OUT_OF_RANGE

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13.15 SubscribeCOVProperty Service

The SubscribeCOVProperty service is used by a COV-client to subscribe for the receipt of notifications of changes that may occur to the properties of a particular object. Any object may optionally support COV reporting. If a standard object provides COV reporting, then changes of value of subscribed-to properties of the object, in some cases based on programmable increments, trigger COV notifications to be sent to one or more subscriber clients. Typically, COV notifications are sent to supervisory programs in BACnet client devices or to operators or logging devices.

The subscription establishes a connection between the change of value detection and reporting mechanism within the COV-server device and a "process" within the COV-client device. Notifications of changes are issued by the COV-server device when changes occur after the subscription has been established. The ConfirmedCOVNotification and UnconfirmedCOVNotification services are used by the COV-server device to convey change notifications. The choice of confirmed or unconfirmed service is made at the time the subscription is established. Any object, proprietary or standard, may support COV reporting for any property at the implementor's option.

The SubscribeCOVProperty service differs from the SubscribeCOV service in that it allows monitoring of properties other than those listed in Table 13-1.

13.15.1 Structure

The structure of the SubscribeCOVProperty service primitives is shown in Table 13-16. The terminology and symbology used in this table are explained in Clause 5.6.

Table 13-16. Structure of SubscribeCOVProperty Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Subscriber Process Identifier	M	M(=)		
Monitored Object Identifier	M	M(=)		
Issue Confirmed Notifications	U	U(=)		
Lifetime	U	U(=)		
Monitored Property Identifier	M	M(=)		
COV Increment	U	U(=)		
Result(+)			S	S(=)
Result(-)			S	S(=)
Error Type			M	M(=)

13.15.1.1 Argument

This parameter shall convey the parameters for the SubscribeCOVProperty confirmed service request.

13.15.1.2 Subscriber Process Identifier

This parameter, of type Unsigned32, shall convey a numeric "handle" meaningful to the subscriber. This handle shall be used to match future re-subscriptions and cancellations from the subscriber with the COV context that exists within the COV-server device and with confirmed or unconfirmed COV notifications to identify the process within the COV-client that should receive them.

13.15.1.3 Monitored Object Identifier

This parameter, of type BACnetObjectIdentifier, shall convey the identifier of the object within the receiving device that contains the property for which a subscription is desired.

13.15.1.4 Issue Confirmed Notifications

This parameter, of type BOOLEAN, shall convey whether the COV-server device shall issue ConfirmedCOVNotifications (TRUE) or UnconfirmedCOVNotifications (FALSE) when changes occur. This parameter, if present, shall indicate that a subscription or re-subscription is to occur and that the lifetime shall be refreshed to its initial state. If both the 'Issue

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Confirmed Notifications' and 'Lifetime' parameters are absent, then this shall indicate a cancellation request. If the 'Lifetime' parameter is present then the 'Issue Confirmed Notifications' parameter shall be present.

13.15.1.5 Lifetime

This parameter, of type Unsigned, shall convey the desired lifetime of the subscription in seconds. A value of zero shall not be allowed. A non-zero value shall indicate the number of seconds that may elapse before the subscription shall be automatically cancelled. If both the 'Issue Confirmed Notifications' and 'Lifetime' parameters are absent, then this shall indicate a cancellation request. If the 'Issue Confirmed Notifications' parameter is present then the 'Lifetime' parameter shall be present.

Devices that execute this service shall accept, at a minimum, lifetime values up to and including 28800 seconds (8 hours). Devices may optionally support lifetime values larger than 28800. Devices that initiate this service shall be capable of providing Lifetime values less than or equal to 28800.

13.15.1.6 Monitored Property Identifier

This parameter, of type BACnetPropertyReference, shall convey the property identifier and optional array index for which a subscription is desired. If COV reporting is supported for a property that has an array datatype, it is a local matter to determine whether to support COV subscriptions for all elements of the array or only for particular elements in the array.

13.15.1.7 COV Increment

This parameter, of type REAL, shall specify the minimum change in the monitored property that will cause a COVNotification to be issued to subscriber COV-clients. This parameter is ignored if the datatype of the monitored property is not numeric. If the monitored property is Present_Value, its datatype is numeric, this parameter is not present, and the monitored object has a COV_Increment property, then the COV increment to use is taken from the COV_Increment property of the monitored object. Otherwise, the COV increment is a local matter. The intent is to allow the subscriber to use a previously established COV increment from another subscription or to allow use of the COV_Increment property in the monitored object.

13.15.1.8 Result(+)

The 'Result(+)' parameter shall indicate that the requested service has succeeded.

13.15.1.9 Result(-)

The 'Result(-)' parameter shall indicate that the service request has failed. The reason for failure shall be specified by the 'Error Type' parameter.

13.15.1.9.1 Error Type

This parameter shall consist of two component parameters: (1) the 'Error Class' and (2) the 'Error Code'. See Clause 18.

13.15.2 Service Procedure

If neither 'Lifetime' nor 'Issue Confirmed Notifications' are present, then the request shall be considered to be a cancellation. Any COV context that already exists for the same BACnet address contained in the PDU that carries the SubscribeCOVProperty request and has the same 'Subscriber Process Identifier', 'Monitored Object Identifier' and 'Monitored Property Identifier' shall be disabled and a 'Result(+)' returned. Cancellations that are issued for which no matching COV context can be found shall succeed as if a context had existed, returning 'Result(+)'. If an existing COV context is found, it shall be removed from the Active_COV_Subscriptions property in the Device object.

If the 'Issue Confirmed Notifications' parameter is present but the property to be monitored does not support COV reporting, then a 'Result(-)' shall be returned. If the property to be monitored does support COV reporting, then a check shall be made to locate an existing COV context for the same BACnet address contained in the PDU that carries the SubscribeCOVProperty request and has the same 'Subscriber Process Identifier', 'Monitored Object Identifier' and 'Monitored Property Identifier'. If an existing COV context is found, then the request shall be considered a re-subscription and shall succeed as if the subscription had been newly created.

If no COV context can be found that matches the request, then a new COV context shall be established that contains the BACnet address from the PDU that carries the SubscribeCOVProperty request and the same 'Subscriber Process Identifier',

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'Monitored Object Identifier' and 'Monitored Property Identifier'. The new context shall be included in the Active_COV_Subscriptions property of the Device object. If no context can be created, then a 'Result(-)' shall be returned.

If a new context is created, or a re-subscription is received, then the COV context shall be initialized and given a lifetime as specified by the 'Lifetime' parameter. The subscription shall be automatically cancelled after that many seconds have elapsed unless a re-subscription is received. A 'Result(+)' shall be returned and a ConfirmedCOVNotification or UnconfirmedCOVNotification shall be issued as soon as possible after the successful completion of a subscription or re-subscription request, as specified by the 'Issue Confirmed Notifications' parameter.

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14 FILE ACCESS SERVICES

This clause defines the set of services used to access and manipulate files contained in BACnet devices. The concept of files is used here as a network-visible representation for a collection of octets of arbitrary length and meaning. This is an abstract concept only and does not imply the use of disk, tape or other mass storage devices in the server devices. These services may be used to access vendor-defined files as well as specific files defined in the BACnet protocol standard.

Every file that is accessible by File Access Services shall have a corresponding File object in the BACnet device. This File object is used to identify the particular file by name. In addition, the File object provides access to "header information," such as the file's total size, creation date, and type. File Access Services may model files in two ways: as a continuous stream of octets or as a contiguous sequence of numbered records.

The File Access Services provide atomic read and write operations. In this context "atomic" means that during the execution of a read or write operation, no other AtomicReadFile or AtomicWriteFile operations are allowed for the same file. Synchronization of these services with internal operations of the BACnet device is a local matter and is not defined by this standard.

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14.1 AtomicReadFile Service

The AtomicReadFile Service is used by a client BACnet-user to perform an open-read-close operation on the contents of the specified file. The file may be accessed as records or as a stream of octets.

14.1.1 Structure

The structure of the AtomicReadFile service primitives is shown in Table 14-1. The terminology and symbology used in this table are explained in Clause 5.6.

Table 14-1. Structure of AtomicReadFile Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
File Identifier	M	M(=)		
Stream Access	S	S(=)		
File Start Position	M	M(=)		
Requested Octet Count	M	M(=)		
Record Access	S	S(=)		
File Start Record	M	M(=)		
Requested Record Count	M	M(=)		
Result(+)			S	S(=)
End Of File			M	M(=)
Stream Access			S	S(=)
File Start Position			M	M(=)
File Data			C	C(=)
Record Access			S	S(=)
File Start Record			M	M(=)
Returned Record Count			M	M(=)
File Record Data			C	C(=)
Result(-)			S	S(=)
Error Type			M	M(=)

14.1.2 Argument

This parameter shall convey the parameters for the AtomicReadFile confirmed service request.

14.1.2.1 File Identifier

This parameter is the Object_Identifier of the File object that identifies the file to be read.

14.1.2.2 Stream Access

The 'Stream Access' parameter shall indicate that stream-oriented file access is required. Stream access includes the parameters 'File Start Position' and 'Requested Octet Count'.

14.1.2.2.1 File Start Position

This parameter, of type INTEGER, represents the number of octets from the beginning of the file at which reading shall commence. A 'File Start Position' of 0 is the first octet of the file.

14.1.2.2.2 Requested Octet Count

This parameter, of type Unsigned, represents the number of octets that shall be read from the file starting at the 'File Start Position'.

14.1.2.3 Record Access

The 'Record Access' parameter shall indicate that record-oriented file access is required. Record access includes the parameters 'File Start Record' and 'Requested Record Count'.

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14.1.2.3.1 File Start Record

This parameter, of type INTEGER, represents the number of records from the beginning of the file at which reading shall commence. A 'File Start Record' of 0 is the first record of the file.

14.1.2.3.2 Requested Record Count

This parameter, of type Unsigned, represents the number of records that shall be read from the file starting at the 'File Start Record'.

14.1.3 Result(+)

The 'Result(+)' parameter shall indicate that the service request succeeded. A successful result includes the following parameters.

14.1.3.1 End Of File

The 'End Of File' parameter, of type BOOLEAN, shall be equal to TRUE if this response includes the last octet of the file and FALSE otherwise. This parameter shall be used to check for the end of file since the number of octets returned could be less than the 'Requested Octet Count' or the 'Returned Record Count' could be less than the 'Requested Record Count' due to the amount of data remaining in the file. This parameter also provides a data-independent way for the client user of this service to detect an end of file.

14.1.3.2 Stream Access

The 'Stream Access' parameter shall indicate that stream-oriented file access was requested. Stream access includes the parameters 'File Start Position' and 'File Data'.

14.1.3.2.1 File Start Position

This parameter, of type INTEGER, represents the number of octets from the beginning of the file from which the start of the data was read. A 'File Start Position' of 0 is the first octet of the file.

14.1.3.2.2 File Data

This parameter consists of an OCTET STRING that contains the requested file data.

14.1.3.3 Record Access

The 'Record Access' parameter shall indicate that record-oriented file access was requested. Record access includes the parameters 'File Start Record', 'Returned Record Count', and 'File Record Data'.

14.1.3.3.1 File Start Record

This parameter, of type INTEGER, represents the number of records from the beginning of the file from which the start of the data was read. A 'File Start Record' of 0 is the first record of the file.

14.1.3.3.2 Returned Record Count

This parameter, of type Unsigned, represents the number of records that were actually read from the file, which may be less than the 'Requested Record Count'.

14.1.3.3.3 File Record Data

This parameter consists of a List of OCTET STRINGs that contain the requested file data.

14.1.4 Result(-)

The 'Result(-)' parameter shall indicate that the service request has failed in its entirety. The reason for the failure shall be specified by the 'Error Type' parameter.

14.1.4.1 Error Type

This parameter consists of two component parameters: (1) the 'Error Class' and (2) the 'Error Code'. See Clause 18. The 'Error Class' and 'Error Code' to be returned for specific situations are as follows:

Situation:	Error Class:	Error Code:
The File object does not exist.	OBJECT	UNKNOWN_OBJECT

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'File Start Record' is out of range.	SERVICES	INVALID_FILE_START_POSITION
Incorrect File access method.	SERVICES	INVALID_FILE_ACCESS_METHOD
A non-File Object Identifier was provided.	SERVICES	INCONSISTENT_OBJECT_TYPE

14.1.5 Service Procedure

The responding BACnet-user shall first verify the validity of the 'File Identifier' parameter and return a 'Result(-)' response with the appropriate error class and code if the File object is unknown, if there is currently another AtomicReadFile or AtomicWriteFile service in progress, or if the File object is currently inaccessible for another reason. If the 'File Start Position' parameter or the 'File Start Record' parameter is either less than 0 or exceeds the actual file size, then the appropriate error is returned in a 'Result(-)' response. If not, then the responding BACnet-user shall read the number of octets specified by 'Requested Octet Count' or the number of records specified by 'Requested Record Count'. If the number of remaining octets or records is less than the requested amount, then the length of the 'File Data' returned or 'Returned Record Count' shall indicate the actual number read. If the returned response contains the last octet or record of the file, then the 'End Of File' parameter shall be TRUE, otherwise FALSE.

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14.2 AtomicWriteFile Service

The AtomicWriteFile Service is used by a client BACnet-user to perform an open-write-close operation of an OCTET STRING into a specified position or a List of OCTET STRINGs into a specified group of records in a file. The file may be accessed as records or as a stream of octets.

14.2.1 Structure

The structure of the AtomicWriteFile service primitives is shown in Table 14-2. The terminology and symbology used in this table are explained in Clause 5.6.

Table 14-2. Structure of AtomicWriteFile Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
File Identifier	M	M(=)		
Stream Access	S	S(=)		
File Start Position	M	M(=)		
File Data	M	M(=)		
Record Access	S	S(=)		
File Start Record	M	M(=)		
Record Count	M	M(=)		
File Record Data	M	M(=)		
Result(+)			S	S(=)
Stream Access			S	S(=)
File Start Position			M	M(=)
Record Access			S	S(=)
File Start Record			M	M(=)
Result(-)			S	S(=)
Error Type			M	M(=)

14.2.2 Argument

This parameter shall convey the parameters for the AtomicWriteFile confirmed service request.

14.2.2.1 File Identifier

This parameter is the Object_Identifier of the File object that identifies the file to be written.

14.2.2.2 Stream Access

The 'Stream Access' parameter shall indicate that stream-oriented file access is required. Stream access includes the parameters 'File Start Position' and 'File Data'.

14.2.2.2.1 File Start Position

This parameter, of type INTEGER, represents the number of octets from the beginning of the file at which the data shall start being written. A 'File Start Position' of 0 is the first octet of the file. A 'File Start Position' of -1 shall indicate the end of the current file, i.e., an append to file operation.

14.2.2.2.2 File Data

This parameter consists of an OCTET STRING that is to be written to the file.

14.2.2.3 Record Access

The 'Record Access' parameter shall indicate that record-oriented file access is required. Record access includes the parameters 'File Start Record', 'Record Count', and 'File Record Data'.

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14.2.2.3.1 File Start Record

This parameter, of type INTEGER, represents the number of records from the beginning of the file at which the data shall start being written. A 'File Start Record' of 0 is the first record of the file. A 'File Start Record' of -1 shall indicate the end of the current file, i.e. an append to file operation.

14.2.2.3.2 Record Count

This parameter, of type Unsigned, represents the number of records that shall be written to the file starting at the 'File Start Record'.

14.2.2.3.3 File Record Data

This parameter consists of a List of OCTET STRINGs that is to be written to the file.

14.2.3 Result(+)

The 'Result(+)' parameter shall indicate that the service request succeeded. A successful result shall include the following parameters.

14.2.3.1 Stream Access

The 'Stream Access' parameter shall indicate that stream-oriented file access was requested. Stream access includes the 'File Start Position' parameter. The 'File Start Position' parameter, of type INTEGER, represents the number of octets from the beginning of the file where the data were actually written. A 'File Start Position' of 0 is the first octet of the file.

14.2.3.2 Record Access

The 'Record Access' parameter shall indicate that record-oriented file access was requested. Record access includes the 'File Start Record' parameter. The 'File Start Record' parameter, of type INTEGER, represents the number of records from the beginning of the file where the data were actually written. A 'File Start Record' of 0 is the first record of the file.

14.2.4 Result(-)

The 'Result(-)' parameter shall indicate that the service request has failed in its entirety. The reason for the failure shall be specified by the 'Error Type' parameter.

14.2.4.1 Error Type

This parameter consists of two component parameters: (1) the 'Error Class' and (2) the 'Error Code'. See Clause 18. The 'Error Class' and 'Error Code' to be returned for specific situations are as follows:

Situation:	Error Class:	Error Code:
The File object does not exist.	OBJECT	UNKNOWN_OBJECT
'File Start Record' is out of range.	SERVICES	INVALID_FILE_START_POSITION
Incorrect File access method.	SERVICES	INVALID_FILE_ACCESS_METHOD
Write to a read-only File.	SERVICES	FILE_ACCESS_DENIED
A syntax error is encountered in the message after the file has been partially modified during the execution of this service.	SERVICES	INVALID_TAG
The File object is full	OBJECT	FILE_FULL
A non-File Object Identifier was provided	SERVICES	INCONSISTENT_OBJECT_TYPE

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14.2.5 Service Procedure

The responding BACnet-user shall first verify the validity of the 'File Identifier' parameter and return a 'Result(-)' response with the appropriate error class and code if the File object is unknown, if there is currently another AtomicReadFile or AtomicWriteFile service in progress, or if the File object is currently inaccessible for another reason. If the 'File Start Position' parameter or the 'File Start Record' parameter exceeds the actual file size, then the file shall be extended to the size indicated, but the contents of any intervening octets or records shall be a local matter. If either of these parameters has the special value -1, then the write operation shall be treated as an append to the current end of file. Then the responding BACnet-user shall write the number of octets specified by 'Octet Count' or the number of records specified by 'Record Count' to the file. If the write fails for any reason, then a 'Result(-)' response with the appropriate error class and code shall be returned. If the write succeeds in its entirety, then a 'Result(+)' response shall be returned. The 'File Start Position' or 'File Start Record' shall indicate the actual position or record at which data were written.

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15 OBJECT ACCESS SERVICES

This clause defines nine application services that collectively provide the means to access and manipulate the properties of BACnet objects. A BACnet object is any object whose properties are accessible through this protocol regardless of its particular function within the device in which it resides. These services may be used to access the properties of vendor-defined objects as well as those of objects specified in this standard.

15.1 AddListElement Service

The AddListElement service is used by a client BACnet-user to add one or more list elements to an object property that is a list.

15.1.1 Structure

The structure of the AddListElement service primitives is shown in Table 15-1. The terminology and symbology used in this table are explained in Clause 5.6.

Table 15-1. Structure of AddListElement Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Object Identifier	M	M(=)		
Property Identifier	M	M(=)		
Property Array Index	C	C(=)		
List of Elements	M	M(=)		
Result(+)			S	S(=)
Result(-)			S	S(=)
Error Type			M	M(=)
First Failed Element Number			M	M(=)

15.1.1.1 Argument

This parameter shall convey the parameters for the AddListElement confirmed service request.

15.1.1.1.1 Object Identifier

This parameter, of type BACnetObjectIdentifier, shall provide the means of identifying the object whose specified list property is to be modified by this service.

15.1.1.1.2 Property Identifier

This parameter, of type BACnetPropertyIdentifier, shall provide the means of uniquely identifying the property to be modified by this service.

15.1.1.1.3 Property Array Index

If the property identified above is of datatype array, this conditional parameter of type Unsigned shall be present and shall indicate the array index of the element of the referenced property to be modified by this service. Otherwise, it shall be omitted.

15.1.1.1.4 List of Elements

This parameter specifies one or more elements that shall be added to the property specified by the 'Property Identifier' parameter. The datatype of the elements of this parameter is determined by the definition of the object type for the object specified by the 'Object Identifier' parameter.

15.1.1.2 Result(+)

The 'Result(+)' parameter shall indicate that the service request succeeded and all of the specified elements were added to the list.

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15.1.1.3 Result(-)

The 'Result(-)' parameter shall indicate that the service request failed and none of the specified elements were added to the list. The reason for failure is specified by the 'Error Type' parameter.

15.1.1.3.1 Error Type

This parameter consists of two component parameters: (1) an 'Error Class' and (2) an 'Error Code'. See Clause 18. The 'Error Class' and 'Error Code' to be returned for specific situations are as follows:

Situation:	Error Class:	Error Code:
Specified object does not exist.	OBJECT	UNKNOWN_OBJECT
Specified property does not exist.	PROPERTY	UNKNOWN_PROPERTY
The element datatype does not match the property.	PROPERTY	INVALID_DATATYPE
The data being written has a datatype not supported by the property.	PROPERTY	DATATYPE_NOT_SUPPORTED
The element value is out of range for the property.	PROPERTY	VALUE_OUT_OF_RANGE
The specified property is currently not modifiable by the requester.	PROPERTY	WRITE_ACCESS_DENIED
There is not enough free memory for the element.	RESOURCES	NO_SPACE_TO_ADD_LIST_ELEMENT
The property or specified array element is not a list.	SERVICES	PROPERTY_IS_NOT_A_LIST
An array index is provided but the property is not an array.	PROPERTY	PROPERTY_IS_NOT_AN_ARRAY
An array index is provided that is outside the range existing in the property.	PROPERTY	INVALID_ARRAY_INDEX

15.1.1.3.2 First Failed Element Number

This parameter, of type Unsigned, shall convey the numerical position, starting at 1, of the offending element in the 'List of Elements' parameter received in the request. If the request is considered invalid for reasons other than the 'List of Elements' parameter, the 'First Failed Element Number' shall be equal to zero.

15.1.2 Service Procedure

After verifying the validity of the request, the responding BACnet-user shall attempt to modify the object identified in the 'Object Identifier' parameter. If the identified object exists and has the property specified in the 'Property Identifier' parameter, an attempt shall be made to add all of the elements specified in the 'List of Elements' parameter to the specified property. If this attempt is successful, a 'Result(+)' primitive shall be issued. If one or more of the elements is already present in the list, it shall be ignored, that is, shall not be added to the list. Ignoring an element that already exists shall not cause the service to fail.

If the specified object does not exist, the specified property does not exist, or the specified property is not a list, then the service shall fail and a 'Result(-)' response primitive shall be issued. If one or more elements cannot be added to the list and they are not already members, a 'Result(-)' response primitive shall be issued and no elements shall be added to the list.

The effect of this service shall be to add to the list all of the specified elements that are not already present or to add no elements to the list at all.

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15.2 RemoveListElement Service

The RemoveListElement service is used by a client BACnet-user to remove one or more elements from the property of an object that is a list. If an element is itself a list, the entire element shall be removed. This service does not operate on nested lists.

15.2.1 Structure

The structure of the RemoveListElement service primitives is shown in Table 15-2. The terminology and symbology used in this table are explained in Clause 5.6.

Table 15-2. Structure of RemoveListElement Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Object Identifier	M	M(=)		
Property Identifier	M	M(=)		
Property Array Index	C	C(=)		
List of Elements	M	M(=)		
Result (+)			S	S(=)
Result (-)			S	S(=)
Error Type			M	M(=)
First Failed Element Number			M	M(=)

15.2.1.1 Argument

This parameter shall convey the parameters for the RemoveListElement confirmed service request.

15.2.1.1.1 Object Identifier

This parameter, of type BACnetObjectIdentifier, shall provide the means of identifying the object whose specified list property is to be modified by this service.

15.2.1.1.2 Property Identifier

This parameter, of type BACnetPropertyIdentifier, shall provide the means of uniquely identifying the property to be modified by this service.

15.2.1.1.3 Property Array Index

If the property identified above is of datatype array, this conditional parameter of type Unsigned shall be present and shall indicate the array index of the element of the referenced property to be modified by this service. Otherwise, it shall be omitted.

15.2.1.1.4 List of Elements

This parameter specifies one or more elements that shall be removed from the property specified in the 'Property Identifier' parameter. The datatype of the elements of this parameter is determined by the definition of the object type for the object specified by the 'Object Identifier' parameter.

15.2.1.2 Result(+)

The 'Result(+)' parameter shall indicate that the service request succeeded and all of the specified elements have been removed.

15.2.1.3 Result(-)

The 'Result(-)' parameter shall indicate that the service request failed. The reason for failure is specified by the 'Error Type' parameter. None of the elements of the specified object shall be removed.

15.2.1.3.1 Error Type

This parameter consists of two component parameters: (1) an 'Error Class' and (2) an 'Error Code'. See Clause 18. The 'Error Class' and 'Error Code' to be returned for specific situations are as follows:

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Situation:	Error Class:	Error Code:
Specified object does not exist.	OBJECT	UNKNOWN_OBJECT
Specified property does not exist.	PROPERTY	UNKNOWN_PROPERTY
The element datatype does not match the property.	PROPERTY	INVALID_DATATYPE
The specified property is currently not modifiable by the requestor.	PROPERTY	WRITE_ACCESS_DENIED
A list element to be removed is not present.	SERVICES	LIST_ELEMENT_NOT_FOUND
The property or specified array element is not a list.	SERVICES	PROPERTY_IS_NOT_A_LIST
An array index is provided but the property is not an array.	PROPERTY	PROPERTY_IS_NOT_AN_ARRAY
An array index is provided that is outside the range existing in the property.	PROPERTY	INVALID_ARRAY_INDEX

15.2.1.3.2 First Failed Element Number

This parameter, of type Unsigned, shall convey the numerical position, starting at 1, of the offending element in the 'List of Elements' parameter received in the request. If the request is considered invalid for reasons other than the 'List of Elements' parameter, the 'First Failed Element Number' shall be equal to zero.

15.2.2 Service Procedure

After verifying the validity of the request, the responding BACnet-user shall attempt to modify the object identified in the 'Object Identifier' parameter. If the identified object exists and it has the property specified in the 'Property Identifier' parameter, an attempt shall be made to remove the elements in the 'List of Elements' from the property of the object. If one or more of the elements does not exist or cannot be removed because of insufficient authority, none of the elements shall be removed and a 'Result(-)' response primitive shall be issued.

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15.3 CreateObject Service

The CreateObject service is used by a client BACnet-user to create a new instance of an object. This service may be used to create instances of both standard and vendor specific objects. The standard object types supported by this service shall be specified in the PICS. The properties of standard objects created with this service may be initialized in two ways: initial values may be provided as part of the CreateObject service request or values may be written to the newly created object using the BACnet WriteProperty services. The initialization of non-standard objects is a local matter. The behavior of objects created by this service that are not supplied, or only partially supplied, with initial property values is dependent upon the device and is a local matter.

15.3.1 Structure

The structure of the CreateObject service primitives is shown in Table 15-3. The terminology and symbology used in this table are explained in Clause 5.6.

Table 15-3. Structure of CreateObject Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Object Specifier	M	M(=)		
List of Initial Values	U	U(=)		
Result(+)			S	S(=)
Object Identifier			M	M(=)
Result(-)			S	S(=)
Error Type			M	M(=)
First Failed Element Number			M	M(=)

15.3.1.1 Argument

This parameter shall convey the parameters for the CreateObject confirmed service request.

15.3.1.1.1 Object Specifier

This parameter shall convey information about the type of object that is to be created. The datatype is a choice between an object type and an object identifier. If the object type choice is used, the specified object type shall become the value of the Object_Type property of the newly created object and the responding BACnet-user shall select an object identifier. If the object identifier choice is used, an object with this particular object identifier shall be created.

15.3.1.1.2 List of Initial Values

This parameter shall convey a list of BACnetPropertyValues that shall be used to initialize the values of the specified properties of the newly created object.

15.3.1.2 Result(+)

The 'Result(+)' parameter shall indicate that the service request succeeded. A success includes successfully initializing all the properties specified in the 'List of Initial Values' parameter. The 'Result(+)' shall convey as a parameter an 'Object Identifier', which is the value of the Object_Identifier property of the newly created object. This identifier shall be unique within the server device.

15.3.1.3 Result(-)

The 'Result(-)' parameter shall indicate that the service request failed. The reason for failure is specified by the 'Error Type' parameter.

15.3.1.3.1 Error Type

This parameter consists of two component parameters: (1) an 'Error Class' and (2) an 'Error Code'. See Clause 18. The 'Error Class' and 'Error Code' to be returned for specific situations are as follows:

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Situation	Error Class	Error Code
The device cannot allocate the space needed for the new object.	RESOURCES	NO_SPACE_FOR_OBJECT
The device supports the object type and may have sufficient space, but does not support the creation of the object for some other reason.	OBJECT	DYNAMIC_CREATION_NOT_SUPPORTED
The device does not support the specified object type.	OBJECT	UNSUPPORTED_OBJECT_TYPE
The object being created already exists.	OBJECT	OBJECT_IDENTIFIER_ALREADY_EXISTS
A datatype of a property value specified in the List of Initial Values does not match the datatype of the property specified by the Property_Identifier.	PROPERTY	INVALID_DATATYPE
A value used in the List of Initial Values is outside the range of values defined for the property specified by the Property_Identifier.	PROPERTY	VALUE_OUT_OF_RANGE
A Property_Identifier has been specified in the List of Initial Values that is unknown for objects of the type being created.	PROPERTY	UNKNOWN_PROPERTY
A character string value was encountered in the List of Initial Values that is not a supported character set.	PROPERTY	CHARACTER_SET_NOT_SUPPORTED
A property specified by the Property_Identifier in the List of Initial Values does not support initialization during the CreateObject service.	PROPERTY	WRITE_ACCESS_DENIED
The data being written has a datatype not supported by the property.	PROPERTY	DATATYPE_NOT_SUPPORTED

15.3.1.3.2 First Failed Element Number

This parameter, of type Unsigned, shall convey the numerical position, starting at 1, of the offending 'Initial Value' in the 'List of Initial Values' parameter received in the request. If the request is considered invalid for reasons other than the 'List of Initial Values' parameter, the 'First Failed Element Number' shall be equal to zero.

15.3.2 Service Procedure

After verifying the validity of the request, the responding BACnet-user shall attempt to create a new object of the type specified in the 'Object Specifier' parameter.

If the 'Object Specifier' parameter contains an object type, the Object_Identifier property of the newly created object shall be initialized to a value that is unique within the responding BACnet-user device. The method used to generate the object identifier is a local matter. The Object_Type property shall be initialized to the value of the 'Object Specifier' parameter. If a new object of the specified type cannot be created, a 'Result(-)' primitive shall be returned and the 'First Failed Element Number' parameter shall have a value of zero.

If the 'Object Specifier' parameter contains an object identifier, the responding BACnet-user shall determine if an object with this identifier already exists. If such an object exists, then a new object shall not be created, and a 'Result(-)' primitive shall be returned and the 'First Failed Element Number' parameter shall have a value of zero. If such an object does not exist and it cannot be created, a 'Result(-)' primitive shall be returned and the 'First Failed Element Number' parameter shall have a value of zero. If such an object does not exist but it can be created, the new object shall be created. The Object_Identifier property of the new object shall have the value specified in the 'Object Specifier' parameter, and the Object_Type property shall have a value consistent with the object type field of the Object_Identifier. See Clause 20.2.14.

If the optional 'List of Initial Values' parameters is included, then all properties in the list shall be initialized as indicated. The initial values of all other properties are a local matter. If this initialization cannot be done, then a 'Result(-)' primitive shall be returned. The 'First Failed Element Number' parameter shall indicate the first property in the 'List of Initial Values' that

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cannot be initialized, and the object shall not be created. If the attempt to create the object is successful, a 'Result(+)' response primitive shall be issued that conveys the value of the Object_Identifier property of the newly created object.

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15.4 DeleteObject Service

The DeleteObject service is used by a client BACnet-user to delete an existing object. Although this service is general in the sense that it can be applied to any object type, it is expected that most objects in a control system cannot be deleted by this service because they are protected as a security feature. There are some objects, however, that may be created and deleted dynamically. Group objects and Event Enrollment objects are examples. This service is primarily used to delete objects of these types but may also be used to remove vendor-specific deletable objects.

15.4.1 Structure

The structure of the DeleteObject service primitives is shown in Table 15-4. The terminology and symbology used in this table are explained in Clause 5.6.

Table 15-4. Structure of DeleteObject Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Object Identifier	M	M(=)		
Result(+)			S	S(=)
Result(-)			S	S(=)
Error Type			M	M(=)

15.4.1.1 Argument

This parameter shall convey the parameters for the DeleteObject confirmed service request.

15.4.1.1.1 Object Identifier

This parameter, of type BACnetObjectIdentifier, shall specify the object that is to be deleted by this service.

15.4.1.2 Result(+)

The 'Result(+)' parameter shall indicate that the service request succeeded and the specified object was deleted.

15.4.1.3 Result(-)

The 'Result(-)' parameter shall indicate that the service request failed and the specified object was not deleted. The reason for failure is specified in the 'Error type' parameter.

15.4.1.3.1 Error Type

This parameter consists of two component parameters: (1) an 'Error Class' and (2) an 'Error Code'. See Clause 18. The 'Error Class' and 'Error Code' to be returned for specific situations are as follows:

Situation	Error Class	Error Code
The object to be deleted does not exist.	OBJECT	UNKNOWN_OBJECT
The object exists but cannot be deleted.	OBJECT	OBJECT_DELETION_NOT_PERMITTED

15.4.2 Service Procedure

After verifying the validity of the request, the responding BACnet-user shall attempt to delete the object specified by the 'Object Identifier' parameter of the request/indication primitive. If the specified object exists and can be deleted, it shall be deleted and the 'Result(+)' primitive shall be issued. If the specified object does not exist or cannot be deleted, then the 'Result(-)' primitive shall be issued.

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15.5 ReadProperty Service

The ReadProperty service is used by a client BACnet-user to request the value of one property of one BACnet Object. This service allows read access to any property of any object, whether a BACnet-defined object or not.

15.5.1 Structure

The structure of the ReadProperty service primitives is shown in Table 15-5. The terminology and symbology used in this table are explained in Clause 5.6.

Table 15-5. Structure of ReadProperty Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Object Identifier	M	M(=)		
Property Identifier	M	M(=)		
Property Array Index	U	U(=)		
Result (+)			S	S(=)
Object Identifier			M	M(=)
Property Identifier			M	M(=)
Property Array Index			U	U(=)
Property Value			M	M(=)
Result (-)			S	S(=)
Error Type			M	M(=)

15.5.1.1 Argument

This parameter shall convey the parameters for the ReadProperty confirmed service request.

15.5.1.1.1 Object Identifier

This parameter, of type BACnetObjectIdentifier, shall provide the means of identifying the object whose property is to be read and returned to the client BACnet-user.

15.5.1.1.2 Property Identifier

This parameter, of type BACnetPropertyIdentifier, shall provide the means of uniquely identifying the property to be read and returned by this service. Because this service is intended to read a single property of a single object, the value of this parameter shall not be one of the special property identifiers ALL, REQUIRED, or OPTIONAL.

15.5.1.1.3 Property Array Index

If the property identified above is of datatype array, this optional parameter of type Unsigned shall indicate the array index of the element of the property referenced by this service. If the 'Property Array Index' is omitted, this shall mean that the entire array shall be referenced.

If the property identified above is not of datatype array, this parameter shall be omitted.

15.5.1.2 Result(+)

The 'Result(+)' parameter shall indicate that the service request succeeded. A successful result includes the following parameters:

15.5.1.2.1 Object Identifier

This parameter, of type BACnetObjectIdentifier, shall identify the object whose property has been read and is being returned to the client BACnet-user.

15.5.1.2.2 Property Identifier

This parameter, of type BACnetPropertyIdentifier, shall identify the property that was read and is being returned by this service. Because this service is intended to read a single property of a single object, the value of this parameter shall not be one of the special property identifiers ALL, REQUIRED, or OPTIONAL.

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15.5.1.2.3 Property Array Index

If the property identified above is of datatype array and a 'Property Array Index' was specified in the request, this parameter of type Unsigned shall be present and shall indicate the array index of the element of the property referenced by this service. Otherwise it shall be omitted.

15.5.1.2.4 Property Value

If access to the specified property of the specified object was successful, this parameter shall be returned. It shall be of the datatype appropriate to the specified property and shall contain the value of the requested property.

15.5.1.3 Result(-)

The 'Result(-)' parameter shall indicate that the service request has failed in its entirety. The reason for the failure shall be specified by the 'Error Type' parameter.

15.5.1.3.1 Error Type

This parameter consists of two component parameters: (1) an 'Error Class' and (2) an 'Error Code'. See Clause 18. The 'Error Class' and 'Error Code' to be returned for specific situations are as follows:

Situation	Error Class	Error Code
Specified object does not exist.	OBJECT	UNKNOWN_OBJECT
Specified property does not exist.	PROPERTY	UNKNOWN_PROPERTY
An array index is provided but the property is not an array.	PROPERTY	PROPERTY_IS_NOT_AN_ARRAY
An array index is provided that is outside the range existing in the property.	PROPERTY	INVALID_ARRAY_INDEX

15.5.2 Service Procedure

After verifying the validity of the request, the responding BACnet-user shall attempt to access the specified property of the specified object. If the access is successful, a 'Result(+)' primitive, which returns the accessed value, shall be generated. If the access fails, a 'Result(-)' primitive shall be generated, indicating the reason for the failure.

When the object-type in the Object Identifier parameter contains the value 'Device Object' and the instance in the 'Object Identifier' parameter contains the value 4194303, the responding BACnet-user shall treat the Object Identifier as if it correctly matched the local Device object. This allows the device instance of a device that does not generate I-Am messages to be determined.

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15.6 Deleted Clause

This clause has been removed.

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15.7 ReadPropertyMultiple Service

The ReadPropertyMultiple service is used by a client BACnet-user to request the values of one or more specified properties of one or more BACnet Objects. This service allows read access to any property of any object, whether a BACnet-defined object or not. The user may read a single property of a single object, a list of properties of a single object, or any number of properties of any number of objects. A 'Read Access Specification' with the property identifier ALL can be used to learn the implemented properties of an object along with their values.

15.7.1 Structure

The structure of the ReadPropertyMultiple service primitives is shown in Table 15-10. The terminology and symbology used in this table are explained in Clause 5.6.

Table 15-10. Structure of ReadPropertyMultiple Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
List of Read Access Specifications	M	M(=)		
Result (+)			S	S(=)
List of Read Access Results			M	M(=)
Result (-)			S	S(=)
Error Type			M	M(=)

15.7.1.1 Argument

This parameter shall convey the parameters for the ReadPropertyMultiple confirmed service request.

15.7.1.1.1 List of Read Access Specifications

This parameter shall consist of a list of one or more 'Read Access Specifications'. Each specification shall consist of two parameters: (1) an 'Object Identifier' and (2) a 'List of Property References'. See 15.7.3.1.

15.7.1.2 Result(+)

The 'Result(+)' parameter shall indicate that the service request succeeded. A successful result includes the following parameter.

15.7.1.2.1 List of Read Access Results

The 'List of Read Access Results' parameter shall indicate the success or failure of the access to each specified property. The contents of each Read Access Result are described in 15.7.3.2.

15.7.1.3 Result(-)

The 'Result(-)' parameter shall indicate that the service request has failed in its entirety. The reason for the failure shall be specified by the 'Error Type' parameter.

15.7.1.3.1 Error Type

This parameter consists of two component parameters: (1) an 'Error Class' and (2) an 'Error Code'. See Clause 18. The 'Error Class' and 'Error Code' to be returned for specific situations are as follows:

Situation	Error Class	Error Code
Specified object does not exist.	OBJECT	UNKNOWN_OBJECT
Specified property does not exist.	PROPERTY	UNKNOWN_PROPERTY
An array index is provided but the property is not an array.	PROPERTY	PROPERTY_IS_NOT_AN_ARRAY
An array index is provided that is outside the range existing in the property.	PROPERTY	INVALID_ARRAY_INDEX

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15.7.2 Service Procedure

After verifying the validity of the request, the responding BACnet-user shall attempt to access the specified properties of the specified objects and shall construct a 'List of Read Access Results' in the order specified in the request. If the 'List of Property References' portion of the 'List of Read Access Specifications' parameter contains the property identifier ALL, REQUIRED, or OPTIONAL, then the 'List of Read Access Results' shall be constructed as if each property being returned had been explicitly referenced (see 15.7.3.1.2). While there is no requirement that the request be carried out "atomically," nonetheless the responding BACnet-user shall ensure that all readings are taken in the shortest possible time subject only to higher priority processing. The request shall continue to be executed until an attempt has been made to access all specified properties. If none of the specified objects is found or if none of the specified properties of the specified objects can be accessed, either a 'Result(-)' primitive or a Result(+) primitive that returns error codes for all properties shall be issued. If any of the specified properties of the specified objects can be accessed, then a 'Result(+)' primitive shall be issued, which returns all accessed values and error codes for all properties that could not be accessed.

When the object-type in the Object Identifier portion of the Read Access Specification parameter contains the value 'Device Object' and the instance of that 'Object Identifier' parameter contains the value 4194303, the responding BACnet-user shall treat the Object Identifier as if it correctly matched the local Device object. This allows the device instance of a device that does not generate I-Am messages to be determined.

15.7.3 Parameters Referenced by the ReadPropertyMultiple Service

The following parameters appear in the ReadPropertyMultiple service primitives.

15.7.3.1 Read Access Specification Parameter

The 'Read Access Specification' parameter is shown in Table 15-11. The terminology and symbology used in this table are explained in Clause 5.6.

Table 15-11. Structure of 'Read Access Specification' Parameter

Parameter Name	Req Ind	Rsp Cnf	Datatype
Object Identifier	M	M(=)	BACnetObjectIdentifier
List of Property References	M	M(=)	List of BACnetPropertyReference

15.7.3.1.1 Object Identifier

This parameter, of type BACnetObjectIdentifier, shall provide the means of identifying the object whose properties are to be read and returned to the service requester.

15.7.3.1.2 List of Property References

This parameter shall be a list of one or more BACnetPropertyReferences, each of which corresponds directly to a specific property of the object identified above. The property identifier ALL means that all defined properties of the object are to be accessed, including any proprietary properties.

The property identifier REQUIRED means that only those standard properties having a conformance code of "R" or "W" shall be returned. The property identifier OPTIONAL means that only those standard properties present in the object that have a conformance code "O" shall be returned. See the specification for the particular object type in Clause 12. If the property identifier ALL, REQUIRED, or OPTIONAL is specified and any of the selected properties is not readable by this service, then a Property Access Error for that property shall be returned in the List of Read Access Results as specified by Clause 15.7.3.2.

15.7.3.2 Read Access Result

The 'Read Access Result' parameter is shown in Table 15-12. The terminology and symbology used in this table are explained in Clause 5.6.

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Table 15-12. Structure of 'Read Access Result' Parameter

Parameter Name	Rsp	Cnf	Datatype
Object Identifier	M	M(=)	BACnetObjectIdentifier
List of Results	M	M(=)	
Property Identifier	M	M(=)	BACnetPropertyIdentifier
Property Array Index	U	U(=)	Unsigned
Property Value	S	S(=)	ANY
Property Access Error	S	S(=)	Error

15.7.3.2.1 Object Identifier

This parameter, of type BACnetObjectIdentifier, shall identify the object whose properties are being returned to the service requester.

15.7.3.2.2 List of Results

The result of reading a given property is either the present value of the property or an error code indicating why the access attempt failed. Each element in the 'List of Results' contains a 'Property Identifier' and conditionally a 'Property Array Index', followed by either a 'Property Value' or a 'Property Access Error'.

15.7.3.2.2.1 Property Identifier

This parameter, of type BACnetPropertyIdentifier, shall identify the property whose value has been read.

15.7.3.2.2.2 Property Array Index

If the property identified above is of datatype array and a 'Property Array Index' was specified in the request, this parameter of type Unsigned shall be present and shall indicate the array index of the element of the property referenced by this service. Otherwise it shall be omitted.

15.7.3.2.2.3 Property Value

If access to the specified property of the specified object is successful, this parameter shall be returned. It shall be of a datatype consistent with the requested property and shall contain the value of the requested property.

15.7.3.2.2.4 Property Access Error

If the responding BACnet-user is unable to access the specified property of the specified object, then this parameter shall be returned. It shall contain a value that indicates the reason for the access failure. This parameter consists of two component parameters: (1) an 'Error Class' and (2) an 'Error Code'. See Clause 18. Note that this parameter refers only to a failure of the access to a specific property of a specific object, whereas the 'Error Type' parameter returned in the 'Result(-)' primitive refers to a failure of the entire ReadPropertyMultiple service request.

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15.8 ReadRange Service

The ReadRange service is used by a client BACnet-user to read a specific range of data items representing a subset of data available within a specified object property. The service may be used with any list or array of lists property.

15.8.1 Structure

The structure of the ReadRange primitive is shown in Table 15-13. The terminology and symbology used in this table are explained in Clause 5.6.

Table 15-13. Structure of ReadRange Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Object Identifier	M	M(=)		
Property Identifier	M	M(=)		
Property Array Index	C	C(=)		
Range	U	U(=)		
Result(+)			S	S(=)
Object Identifier			M	M(=)
Property Identifier			M	M(=)
Property Array Index			C	C(=)
Result Flags			M	M(=)
Item Count			M	M(=)
Item Data			M	M(=)
First Sequence Number			C	C(=)
Result(-)			S	S(=)
Error Type			M	M(=)

15.8.1.1 Argument

This parameter shall convey the parameters for the ReadRange confirmed service request.

15.8.1.1.1 Object Identifier

This parameter, of type BACnetObjectIdentifier, specifies the object and property is to be read.

15.8.1.1.2 Property Identifier

This parameter, of type BACnetPropertyIdentifier, specifies the property to be read by this service. Because this service is intended to read a single property of a single object, the value of this parameter shall not be one of the special property identifiers ALL, REQUIRED, or OPTIONAL.

15.8.1.1.3 Property Array Index

If the property identified above is of datatype array of lists, this optional parameter of type Unsigned shall indicate the array index of the element of the property referenced by this service. If the property identified above is not of datatype array of lists, this parameter shall be omitted. The index value shall not be zero.

15.8.1.1.4 Range

This optional parameter shall convey criteria for the consecutive range items within the referenced property that are to be returned, as described in 15.8.2. The 'Range' parameter is shown in Table 15-14. The terminology and symbology used in this table are explained in Clause 5.6.

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Table 15-14. Structure of the 'Range' Parameter

Parameter Name	Req	Ind	Datatype
By Position	S	S(=)	
Reference Index	M	M(=)	Unsigned
Count	M	M(=)	INTEGER
By Sequence Number	S	S(=)	
Reference Sequence Number	M	M(=)	Unsigned32
Count	M	M(=)	INTEGER
By Time	S	S(=)	
Reference Time	M	M(=)	BACnetDateTime
Count	M	M(=)	INTEGER

15.8.1.1.4.1 By Position

The 'By Position' parameter shall indicate that the particular items to be read are referenced by an index.

15.8.1.1.4.1.1 Reference Index

The 'Reference Index' parameter specifies the index of the first (if 'Count' is positive) or last (if 'Count' is negative) item to be read.

15.8.1.1.4.1.2 Count

The absolute value of the 'Count' parameter specifies the number of records to be read. If 'Count' is positive, the record specified by 'Reference Index' shall be the first record read and returned; if 'Count' is negative the record specified by 'Reference Index' shall be the last record. 'Count' may not be zero.

15.8.1.1.4.2 By Sequence Number

The 'By Sequence Number' parameter shall indicate that the particular items to be read are referenced by a sequence number and that the response shall include the sequence number of the first returned item. This differs semantically from the 'By Position' parameter choice. The Reference Number provided in the 'By Position' choice references an item by its position in the list. In contrast, the Reference Number provided in the 'By Sequence Number' choice references an item by its sequence number, which it is given when the item is added to the list. Not all lists implement the concept of a sequence number. An example of a list that does implement the concept of a sequence number is the Log_Buffer property of the Trend Log object.

15.8.1.1.4.2.1 Reference Sequence Number

The 'Reference Sequence Number' parameter specifies the sequence number of the first (if 'Count' is positive) or last (if 'Count' is negative) item to be read.

15.8.1.1.4.2.2 Count

The absolute value of the 'Count' parameter specifies the number of records to be read. If 'Count' is positive, the record specified by 'Reference Sequence Number' shall be the first and oldest record read and returned. If 'Count' is negative the record specified by 'Reference Sequence Number' shall be the last and newest record read and returned. 'Count' shall not be zero.

15.8.1.1.4.3 By Time

The 'By Time' parameter shall indicate that the particular item to be read is referenced by timestamp and that the Sequence Number of the item shall be returned in the response. This form of the service is expected to be used when searching lists that are loosely indexed by time.

15.8.1.1.4.3.1 Reference Time

If 'Count' is positive, the first record to be read shall be the first record with a timestamp newer than the time specified by the 'Reference Time' parameter. If 'Count' is negative, the last record to be read shall be the newest record with a timestamp older than the time specified by the 'Reference Time' parameter. This parameter shall contain a specific datetime value.

15.8.1.1.4.3.2 Count

The absolute value of the 'Count' parameter specifies the number of records to be read. If 'Count' is positive, the first record with a timestamp newer than the time specified by 'Reference Time' shall be the first and oldest record read and returned; if

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'Count' is negative, the newest record with a timestamp older than the time specified by 'Reference Time' shall be the last and newest record. 'Count' shall not be zero.

15.8.1.2 Result(+)

The 'Result(+)' parameter shall indicate that the service request succeeded. A successful result includes the following parameters.

15.8.1.2.1 Object Identifier

This parameter, of type BACnetObjectIdentifier, specifies the object that was read.

15.8.1.2.2 Property Identifier

This parameter, of type BACnetPropertyIdentifier, shall identify that property that was read.

15.8.1.2.3 Property Array Index

If the property identified above is of datatype array of lists, this parameter of type Unsigned shall indicate the array index of the element of the property referenced by this service. If the property identified above is not of datatype array of lists, this parameter shall be omitted.

15.8.1.2.4 Result Flags

This parameter, of type BACnetResultFlags, shall convey several flags that describe characteristics of the response data:

{FIRST_ITEM, LAST_ITEM, MORE_ITEMS}

The FIRST_ITEM flag indicates whether this response includes the first list or array element (in the case of positional indexing), or the oldest timestamped item (in the case of time indexing).

The LAST_ITEM flag indicates whether this response includes the last list or array element (in the case of positional indexing), or the newest timestamped item (in the case of time indexing)

The MORE_ITEMS flag indicates whether more items matched the request but were not transmittable within the PDU.

15.8.1.2.5 Item Count

This parameter, of type Unsigned, represents the number of items that were returned.

15.8.1.2.6 Item Data

This parameter consists of a list of the requested data.

15.8.1.2.7 First Sequence Number

This parameter, of type Unsigned32, specifies the sequence number of the first item returned. This parameter is only included if the 'Range' parameter of the request was of the type 'By Sequence Number' or 'By Time' and 'Item Count' is greater than 0.

15.8.1.3 Result(-)

The 'Result(-)' parameter shall indicate that the service request has failed. The reason for the failure shall be specified by the 'Error Type' parameter.

15.8.1.3.1 Error Type

This parameter consists of two component parameters: (1) the 'Error Class' and (2) the 'Error Code'. See Clause 18. The 'Error Class' and 'Error Code' to be returned for specific situations are as follows:

Situation	Error Class	Error Code
Specified property does not exist.	PROPERTY	UNKNOWN_PROPERTY
The specified property is currently not readable by the requester.	PROPERTY	READ_ACCESS_DENIED

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Property is not a list or array of lists	SERVICES	PROPERTY_IS_NOT_A_LIST
An array index is provided but the property is not an array.	PROPERTY	PROPERTY_IS_NOT_AN_ARRAY
An array index is provided that is outside the range existing in the property.	PROPERTY	INVALID_ARRAY_INDEX

15.8.2 Service Procedure

The responding BACnet-user shall first verify the validity of the 'Object Identifier', 'Property Identifier' and 'Property Array Index' parameters and return a 'Result(-)' response with the appropriate error class and code if the object or property is unknown, if the referenced data is not a list or array, or if it is currently inaccessible for another reason.

If the 'Range' parameter is not present, then the responding BACnet-user shall read and attempt to return all of the available items in the list or array.

If the 'Range' parameter is present and specifies the 'By Position' parameters, then the responding BACnet-user shall read and attempt to return all of the items specified. The items specified include the item at the index specified by 'Reference Index' plus up to 'Count' - 1 items following if 'Count' is positive, or up to -1 - 'Count' items preceding if 'Count' is negative. The first element of a list shall be associated with index 1.

If the 'Range' parameter is present and specifies the 'By Time' parameter, then the responding BACnet-user shall read and attempt to return all of the items specified. If 'By Time' parameters are specified and the property values are not timestamped an error shall be returned. If 'Count' is positive, the records specified include the first record with a timestamp newer than 'Reference Time' plus up to 'Count'-1 items following. If 'Count' is negative, the records specified include the newest record with a timestamp older than 'Reference Time' and up to -1-'Count' records preceding. The sequence number of the first item returned shall be included in the response. The items shall be returned in chronological order.

If the 'Range' parameter is present and specifies the 'By Sequence Number' parameters, then the responding BACnet-user shall read and attempt to return all of the items specified. The items specified are all items with a sequence number in the range 'Reference Sequence Number' to 'Reference Sequence Number' plus 'Count'-1 if 'Count' is positive, or in the range 'Reference Sequence Number' plus 'Count'+1 to 'Reference Sequence' if 'Count' is negative.

To avoid missing items when using chained time-based reads, the first item in the desired set should be found using the 'By Time' form of the 'Range' parameter. Subsequent requests to retrieve the remaining items in the desired set should use the 'By Sequence Number' form of the 'Range' parameter. The reason for this is that lists that include a timestamp but are ordered by time of arrival may have entries with out-of-order timestamps due to negative time changes in the local device's clock. If items are read that match the request parameters but cannot be returned in the response, the 'Result Flags' parameter shall contain the MORE_ITEMS flag set to TRUE, otherwise it shall be FALSE. Remaining items may be obtained with subsequent requests specifying appropriately chosen parameters.

The returned response shall convey the number of items read and returned using the 'Item Count' parameter. The actual items shall be returned in the 'Item Data' parameter. If the returned response includes the first positional index and a 'By Position' request had been made, or the oldest sequence number and a 'By Sequence Number' or 'By Time' request had been made, then the 'Result Flags' parameter shall contain the FIRST_ITEM flag set to TRUE; otherwise it shall be FALSE.

If the returned response includes the last positional index and a 'By Position' request had been made, or the newest sequence number and a 'By Sequence Number' or 'By Time' request had been made, then the 'Result Flags' shall contain the LAST_ITEM flag set to TRUE; otherwise it shall be FALSE.

If there are no items in the list that match the 'Range' parameter criteria, then a Result(+) shall be returned with an 'Item Count' of 0 and no 'First Sequence Number' parameter.

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15.9 WriteProperty Service

The WriteProperty service is used by a client BACnet-user to modify the value of a single specified property of a BACnet object. This service potentially allows write access to any property of any object, whether a BACnet-defined object or not. Some implementors may wish to restrict write access to certain properties of certain objects. In such cases, an attempt to modify a restricted property shall result in the return of an error of 'Error Class' PROPERTY and 'Error Code' WRITE_ACCESS_DENIED. Note that these restricted properties may be accessible through the use of Virtual Terminal services or other means at the discretion of the implementor.

15.9.1 Structure

The structure of the WriteProperty service primitives is shown in Table 15-15. The terminology and symbology used in this table are explained in Clause 5.6.

Table 15-15. Structure of WriteProperty Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Object Identifier	M	M(=)		
Property Identifier	M	M(=)		
Property Array Index	U	U(=)		
Property Value	M	M(=)		
Priority	C	C(=)		
Result (+)			S	S(=)
Result (-)			S	S(=)
Error Type			M	M(=)

15.9.1.1 Argument

This parameter shall convey the parameters for the WriteProperty confirmed service request.

15.9.1.1.1 Object Identifier

This parameter, of type BACnetObjectIdentifier, shall provide the means of identifying the object whose property is to be modified.

15.9.1.1.2 Property Identifier

This parameter, of type BACnetPropertyIdentifier, shall provide the means of uniquely identifying the property to be written by this service. Because this service is intended to write a single property of a single object, the value of this parameter shall not be one of the special property identifiers ALL, REQUIRED, or, OPTIONAL.

15.9.1.1.3 Property Array Index

If the property identified above is of datatype array, this optional parameter of type Unsigned shall indicate the array index of the element of the property referenced by this service. If the 'Property Array Index' is omitted for an array, this shall mean that the entire array shall be referenced.

If the property identified above is not of datatype array, this parameter shall be omitted.

15.9.1.1.4 Property Value

If access to the specified property of the specified object is successful, this parameter shall be used to replace the value of the property at the time of access. It shall be of any datatype that is valid for the property being modified.

15.9.1.1.5 Priority

This parameter shall be an integer in the range 1-16, which indicates the priority assigned to this write operation. If an attempt is made to write to a commandable property without specifying the priority, a default priority of 16 (the lowest priority) shall be assumed. If an attempt is made to write to a property that is not commandable with a specified priority, the priority shall be ignored. See Clause 19.

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15.9.1.2 Result(+)

The 'Result(+)' parameter shall indicate that the service request succeeded in its entirety.

15.9.1.3 Result(-)

The 'Result(-)' parameter shall indicate that the service request has failed in its entirety. The reason for the failure shall be specified by the 'Error Type' parameter.

15.9.1.3.1 Error Type

This parameter consists of two component parameters: (1) an 'Error Class' and (2) an 'Error Code'. See Clause 18. The 'Error Class' and 'Error Code' to be returned for specific situations are as follows:

Situation	Error Class	Error Code
Specified object does not exist.	OBJECT	UNKNOWN_OBJECT
Specified property does not exist.	PROPERTY	UNKNOWN_PROPERTY
An array index is provided but the property is not an array.	PROPERTY	PROPERTY_IS_NOT_AN_ARRAY
An array index is provided that is outside the range existing in the property.	PROPERTY	INVALID_ARRAY_INDEX
The specified property is currently not writable by the requestor.	PROPERTY	WRITE_ACCESS_DENIED
The datatype of the value provided is incorrect for the specified property.	PROPERTY	INVALID_DATATYPE
The property is Object_Name and the name is already in use in the device.	PROPERTY	DUPLICATE_NAME
The property is Object Identifier and the identifier is already in use in the device.	PROPERTY	DUPLICATE_OBJECT_ID
The value provided is outside the range of values that the property can take on.	PROPERTY	VALUE_OUT_OF_RANGE
There is not enough space to store the new value.	RESOURCES	NO_SPACE_TO_WRITE_PROPERTY
The data being written has a datatype not supported by the property.	PROPERTY	DATATYPE_NOT_SUPPORTED
The Priority parameter is not within the defined range of 1..16. This condition may be ignored if the property is not commandable.	SERVICES	PARAMETER_OUT_OF_RANGE

15.9.2 Service Procedure

After verifying the validity of the request, the responding BACnet-user shall attempt to modify the specified property of the specified object using the value provided in the 'Property Value' parameter. If the modification attempt is successful, a 'Result(+)' primitive shall be issued. If the modification attempt fails, a 'Result(-)' primitive shall be issued indicating the reason for the failure. Interpretation of the conditional Priority parameter shall be as defined in Clause 19.

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15.10 WritePropertyMultiple Service

The WritePropertyMultiple service is used by a client BACnet-user to modify the value of one or more specified properties of a BACnet object. This service potentially allows write access to any property of any object, whether a BACnet-defined object or not.

Properties shall be modified by the WritePropertyMultiple service in the order specified in the 'List of Write Access Specifications' parameter, and execution of the service shall continue until all of the specified properties have been written to or a property is encountered that for some reason cannot be modified as requested.

Some implementors may wish to restrict write access to certain properties of certain objects. In such cases, an attempt to modify a restricted property shall result in the return of an error of 'Error Class' PROPERTY and 'Error Code' WRITE_ACCESS_DENIED. Note that these restricted properties may be accessible through the use of Virtual Terminal services or other means at the discretion of the implementor.

15.10.1 Structure

The structure of the WritePropertyMultiple service primitives is shown in Table 15-16. The terminology and symbology used in this table are explained in Clause 5.6.

Table 15-16. Structure of WritePropertyMultiple Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
List of Write Access Specifications	M	M(=)		
Result (+)			S	S(=)
Result (-)			S	S(=)
Error Type			M	M(=)
First Failed Write Attempt			M	M(=)

15.10.1.1 Argument

This parameter shall convey the parameters for the WritePropertyMultiple confirmed service request.

15.10.1.1.1 List of Write Access Specifications

Each 'Write Access Specification' conveys the information required to carry out the modification of a property or properties of a BACnet object. The specification consists of up to five parameters: (1) an 'Object Identifier'; a List of Properties each of which consists of (2) a 'Property Identifier'; (3) an optional 'Property Array Index'; (4) a 'Property Value'; and (5) an optional 'Priority'.

15.10.1.2 Result(+)

The 'Result(+)' parameter shall indicate that the service request succeeded in its entirety and that all specified properties were correctly modified.

15.10.1.3 Result(-)

The 'Result(-)' parameter shall indicate that at least one of the specified properties could not be modified as requested. The reason for the failure shall be conveyed by the 'Error Type' parameter along with the 'Object Identifier', 'Property Identifier', and 'Property Array Index' of the first encountered property that, for the reason specified by the 'Error Type' parameter, could not be properly written.

15.10.1.3.1 Error Type

This parameter consists of two component parameters: (1) an 'Error Class' and (2) an 'Error Code'. See Clause 18. The 'Error Class' and 'Error Code' to be returned in a 'Result(-)' for specific situations are as follows:

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Situation	Error Class	Error Code
Specified object does not exist.	OBJECT	UNKNOWN_OBJECT
Specified property does not exist.	PROPERTY	UNKNOWN_PROPERTY
An array index is provided but the property is not an array.	PROPERTY	PROPERTY_IS_NOT_AN_ARRAY
An array index is provided that is outside the range existing in the property.	PROPERTY	INVALID_ARRAY_INDEX
The specified property is currently read-only.	PROPERTY	WRITE_ACCESS_DENIED
The datatype of the value provided is incorrect for the specified property.	PROPERTY	INVALID_DATATYPE
The property is Object_Name and the name is already in use in the device.	PROPERTY	DUPLICATE_NAME
The property is Object Identifier and the identifier is already in use in the device.	PROPERTY	DUPLICATE_OBJECT_ID
The value provided is outside the range of values that the property can take on.	PROPERTY	VALUE_OUT_OF_RANGE
There is not enough space to store the new value.	RESOURCES	NO_SPACE_TO_WRITE_PROPERTY
The data being written has a datatype not supported by the property.	PROPERTY	DATATYPE_NOT_SUPPORTED
The Priority parameter is not within the defined range of 1..16. This condition may be ignored if the property is not commandable.	SERVICES	PARAMETER_OUT_OF_RANGE
A syntax error is encountered in the message after one or more properties have been successfully written.	SERVICES	INVALID_TAG

15.10.1.3.2 First Failed Write Attempt

This parameter, of type BACnetObjectPropertyReference, shall convey the 'Object Identifier', 'Property Identifier', and 'Property Array Index' of the first failed element in the 'List of Write Access Specification' for which the write attempt failed.

15.10.2 Service Procedure

For each 'Write Access Specification' contained in the 'List of Write Access Specifications', the value of each specified property shall be replaced by the property value provided in the 'Write Access Specification' and a 'Result(+)' primitive shall be issued, indicating that the service request was carried out in its entirety. Interpretation of the conditional Priority parameter shall be as specified in Clause 19.

If, in the process of carrying out the modification of the indicated properties in the order specified in the 'List of Write Access Specifications', a property is encountered that cannot be modified, the responding BACnet-user shall issue a 'Result(-)' response primitive indicating the reason for the failure. The result of this service shall be either that all of the specified properties or only the properties up to, but not including, the property specified in the 'First Failed Write Attempt' parameter were successfully modified.

A BACnet-Reject-PDU shall be issued only if no write operations have been successfully executed, indicating that the service request was rejected in its entirety. If any of the write operations contained in the 'List of Write Access Specifications' have been successfully executed, a Result(-) response indicating the reason for the failure shall be issued as described above.

15.10.3 Parameters Referenced by the WritePropertyMultiple Service

The 'Write Access Specification' parameter is shown in Table 15-17. The terminology and symbology used in this table are explained in Clause 5.6.

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Table 15-17. Structure of 'Write Access Specification' Parameter

Parameter Name	Req Ind	Rsp Cnf	Datatype
Object Identifier	M	M(=)	BACnetObjectIdentifier
List of Properties	M	M(=)	
Property Identifier	M	M(=)	BACnetPropertyIdentifier
Property Array Index	U	U(=)	Unsigned
Property Value	M	M(=)	ANY
Priority	C	C(=)	Unsigned(1..16)

15.10.3.1 Object Identifier

This parameter, of type BACnetObjectIdentifier, shall provide the means of identifying the object whose property or properties are to be modified.

15.10.3.2 List of Properties

This parameter shall specify a list of one or more properties of the object identified above, the value to be written to each property, and the priority assigned to the write operation. Each element of the list shall specify the following parameters.

15.10.3.2.1 Property Identifier

This parameter, of type BACnetPropertyIdentifier, shall provide the means of uniquely identifying the property to be written by this service. The value of this parameter shall not be one of the special property identifiers ALL, REQUIRED, or, OPTIONAL.

15.10.3.2.2 Property Array Index

If the property identified above is of datatype array, this optional parameter of type Unsigned shall indicate the array index of the element of the property referenced by this service. If the 'Property Array Index' is omitted for an array, this shall mean that the entire array shall be referenced.

If the property identified above is not of datatype array, this parameter shall be omitted.

15.10.3.2.3 Property Value

If access to the specified property of the specified object is successful, this parameter shall be used to replace the value of the property at the time of access. It shall be of any datatype that is valid for the property being modified.

15.10.3.2.4 Priority

This parameter shall be an integer in the range 1-16, which indicates the priority assigned to this write operation. If an attempt is made to write to a commandable property without specifying the priority, a default priority of 16 (the lowest priority) shall be assumed. If an attempt is made to write to a property that is not commandable with a specified priority, the priority shall be ignored. See Clause 19.

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16 REMOTE DEVICE MANAGEMENT SERVICES

16.1 DeviceCommunicationControl Service

The DeviceCommunicationControl service is used by a client BACnet-user to instruct a remote device to stop initiating and optionally stop responding to all APDUs (except DeviceCommunicationControl or, if supported, ReinitializeDevice) on the communication network or internetwork for a specified duration of time. This service is primarily used by a human operator for diagnostic purposes. A password may be required from the client BACnet-user prior to executing the service. The time duration may be set to "indefinite," meaning communication must be re-enabled by a DeviceCommunicationControl or, if supported, ReinitializeDevice service, not by time.

16.1.1 Structure

The structure of the DeviceCommunicationControl service primitives is shown in Table 16-1. The terminology and symbology used in this table are explained in Clause 5.6.

Table 16-1. Structure of DeviceCommunicationControl Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Time Duration	U	U(=)		
Enable/Disable	M	M(=)		
Password	U	U(=)		
Result (+)			S	S(=)
Result (-)			S	S(=)
Error Type			M	M(=)

16.1.1.1 Argument

This parameter shall convey the parameters for the DeviceCommunicationControl confirmed service request.

16.1.1.1.1 Time Duration

This optional parameter, of type Unsigned16, indicates the number of minutes that the remote device shall ignore all APDUs except DeviceCommunicationControl and, if supported, ReinitializeDevice APDUs. If the 'Time Duration' parameter is not present, then the time duration shall be considered indefinite, meaning that only an explicit DeviceCommunicationControl or ReinitializeDevice APDU shall enable communications. The 'Time Duration' parameter shall be ignored and the time period considered to be indefinite if the 'Enable/Disable' parameter has a value of ENABLE.

If the responding BACnet-user does not have a clock and the time duration is not indefinite, then the request shall be considered invalid and the responding BACnet-user shall issue a Result(-) response.

16.1.1.1.2 Enable/Disable

This parameter is an enumeration that may take on the values ENABLE, DISABLE, or DISABLE_INITIATION. It is used to indicate whether the responding BACnet-user is to enable all, disable initiation, or disable all communications on the network interface. When this parameter has a value of ENABLE, communications shall be enabled. When this parameter has a value of DISABLE, network communications shall be disabled as described in the DeviceCommunicationControl service procedure. When this parameter has a value of DISABLE_INITIATION, the initiation of communications shall be disabled as described in the DeviceCommunicationControl service procedure.

16.1.1.1.3 Password

This optional parameter shall be a CharacterString of up to 20 characters. For those devices that require password protection, the service shall be denied if the parameter is absent or if the password is incorrect. For those devices that do not require a password, this parameter shall be ignored.

16.1.1.2 Result(+)

This parameter shall indicate that the service request succeeded.

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16.1.1.3 Result(-)

This parameter shall indicate that the service request has failed. The reason for failure shall be specified by the 'Error Type' parameter.

16.1.1.3.1 Error Type

This parameter consists of two components parameters: (1) the 'Error Class' and (2) the 'Error Code'. See Clause 18. The 'Error Class' and 'Error Code' to be returned for specific situations are as follows:

Situation	Error Class	Error Code
The password is invalid or absent when one is required.	SECURITY	PASSWORD_FAILURE
The device does not have a clock and the 'Time Duration' parameter is not set to "indefinite".	SERVICES	OPTIONAL_FUNCTIONALITY_NOT_SUPPORTED

16.1.2 Service Procedure

After verifying the validity of the request, including the 'Time Duration' and 'Password' parameters, the responding BACnet-user shall respond with a 'Result(+)' service primitive. If the request is valid and the 'Enable/Disable' parameter is DISABLE, the responding BACnet-user shall discontinue responding to any subsequent messages except DeviceCommunicationControl and, if supported, ReinitializeDevice messages, and shall discontinue initiating messages. If the request is valid and the 'Enable/Disable' parameter is DISABLE_INITIATION, the responding BACnet-user shall discontinue the initiation of messages except for I-Am requests issued in accordance with the Who-Is service procedure. Communication shall be disabled in this manner until either the 'Time Duration' has expired or a valid DeviceCommunicationControl (with 'Enable/Disable' = ENABLE) or, if supported, a valid ReinitializeDevice (with 'Reinitialized State of Device' = WARMSTART or COLDSTART) message is received.

If the responding BACnet-user does not have a clock and the 'Time Duration' parameter is not set to "indefinite," the APDU shall be ignored and a 'Result(-)' service primitive shall be issued. If the 'Password' parameter is invalid or absent when a password is required, the APDU shall be ignored and an Error-PDU with 'error class' = SECURITY and 'error code' = PASSWORD_FAILURE shall be issued.

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16.2 ConfirmedPrivateTransfer Service

The ConfirmedPrivateTransfer is used by a client BACnet-user to invoke proprietary or non-standard services in a remote device. The specific proprietary services that may be provided by a given device are not defined by this standard. The PrivateTransfer services provide a mechanism for specifying a particular proprietary service in a standardized manner. The only required parameters for these services are a vendor identification code and a service number. Additional parameters may be supplied for each service if required. The form and content of these additional parameters, if any, are not defined by this standard. The vendor identification code and service number together serve to unambiguously identify the intended purpose of the information conveyed by the remainder of the APDU or the service to be performed by the remote device based on parameters in the remainder of the APDU.

The vendor identification code is a unique code assigned to the vendor by ASHRAE. The mechanism for administering these codes is not defined in this standard. See Clause 23.

16.2.1 ConfirmedPrivateTransfer Service Structure

The structure of the ConfirmedPrivateTransfer service primitives is shown in Table 16-2. The terminology and symbology used in this table are explained in Clause 5.6.

Table 16-2. Structure of ConfirmedPrivateTransfer Service Primitives

Parameter Name	Req	Ind	Rsp	Conf
Argument	M	M(=)		
Vendor ID	M	M(=)		
Service Number	M	M(=)		
Service Parameters	U	U(=)		
Result(+)			S	S(=)
Vendor ID			M	M(=)
Service Number			M	M(=)
Result Block			C	C(=)
Result(-)			S	S(=)
Error Type			M	M(=)
Vendor ID			M	M(=)
Service Number			M	M(=)
Error Parameters			U	U(=)

16.2.1.1 Argument

This parameter shall convey the parameters for the ConfirmedPrivateTransfer confirmed service request.

16.2.1.1.1 Vendor ID

This parameter, of type Unsigned, shall specify the unique vendor identification code for the type of vendor-proprietary service to be performed.

16.2.1.1.2 Service Number

This parameter, of type Unsigned, shall specify the desired service to be performed.

16.2.1.1.3 Service Parameters

This optional parameter shall convey additional parameters for the service specified by 'Vendor ID' and 'Service Number'. The datatype and interpretation of these parameters is a local matter.

16.2.1.2 Result(+)

The 'Result(+)' parameter shall indicate that the service request succeeded. A successful result indicates that the request APDU was received and the recipient was able to perform the indicated proprietary service.

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16.2.1.2.1 Vendor ID

This parameter, of type Unsigned, shall specify the unique vendor identification code for the vendor-proprietary service for which this is the result.

16.2.1.2.2 Service Number

This parameter, of type Unsigned, shall indicate the proprietary service for which this is the result.

16.2.1.2.3 Result Block

This conditional parameter, of type List of ANY, shall convey any additional results from the execution of the requested service. Interpretation of these results is a local matter.

16.2.1.3 Result(-)

The 'Result(-)' parameter shall indicate that the service request has failed. The reason for failure shall be specified by the 'Error Type' parameter.

16.2.1.3.1 Error Type

This parameter consists of two component parameters: (1) the 'Error Class' and (2) the 'Error Code'. See Clause 18.

16.2.1.3.2 Vendor ID

This parameter, of type Unsigned, shall specify the unique vendor identification code for the vendor-proprietary service for which this error is the result.

16.2.1.3.3 Service Number

This parameter, of type Unsigned, shall indicate the proprietary service for which this error is the result.

16.2.1.3.4 Error Parameters

This optional parameter shall convey any additional error results from the execution of the requested service. Interpretation of these results is a local matter.

16.2.2 Service Procedure

After verifying the validity of the request, the responding BACnet-user shall attempt to perform the specified proprietary service request. If successful, a 'Result(+)' response primitive shall be issued. If the request fails, a 'Result(-)' response primitive shall be issued.

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16.3 UnconfirmedPrivateTransfer Service

The UnconfirmedPrivateTransfer is used by a client BACnet-user to invoke proprietary or non-standard services in a remote device. The specific proprietary services that may be provided by a given device are not defined by this standard. The PrivateTransfer services provide a mechanism for specifying a particular proprietary service in a standardized manner. The only required parameters for these services are a vendor identification code and a service number. Additional parameters may be supplied for each service if required. The form and content of these additional parameters, if any, are not defined by this standard. The vendor identification code and service number together serve to unambiguously identify the intended purpose of the information conveyed by the remainder of the APDU or the service to be performed by the remote device based on parameters in the remainder of the APDU.

The vendor identification code is a unique code assigned to the vendor by ASHRAE. The mechanism for administering these codes is not defined in this standard. See Clause 23.

16.3.1 UnconfirmedPrivateTransfer Service Structure

The structure of the UnconfirmedPrivateTransfer service primitive is shown in Table 16-3. The terminology and symbology used in this table are explained in Clause 5.6.

Table 16-3. Structure of UnconfirmedPrivateTransfer Service Primitive

Parameter Name	Req	Ind
Argument	M	M(=)
Vendor ID	M	M(=)
Service Number	M	M(=)
Service Parameters	U	U(=)

16.3.1.1 Argument

This parameter shall convey the parameters for the UnconfirmedPrivateTransfer confirmed service request.

16.3.1.1.1 Vendor ID

This parameter, of type Unsigned, shall specify the unique vendor identification code for the type of vendor-proprietary service to be performed.

16.3.1.1.2 Service Number

This parameter, of type Unsigned, shall specify the desired service to be performed.

16.3.1.1.3 Service Parameters

This optional parameter shall convey additional parameters for the service specified by 'Vendor ID' and 'ServiceNumber'. The datatype and interpretation of these parameters is a local matter.

16.3.2 Service Procedure

Since this is an unconfirmed service, no response primitives are expected. Actions taken in response to this service request are a local matter.

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16.4 ReinitializeDevice Service

The ReinitializeDevice service is used by a client BACnet-user to instruct a remote device to reboot itself (cold start), reset itself to some predefined initial state (warm start), or to control the backup or restore procedure. Resetting or rebooting a device is primarily initiated by a human operator for diagnostic purposes. Use of this service during the backup or restore procedure is usually initiated on behalf of the user by the device controlling the backup or restore. Due to the sensitive nature of this service, a password may be required from the responding BACnet-user prior to executing the service.

A BACnet device may support the ReinitializeDevice service by supporting only the restart choices COLDSTART and WARMSTART. Support for the backup and restore features of this service is claimed separately.

16.4.1 Structure

The structure of the ReinitializeDevice service primitives is shown in Table 16-4. The terminology and symbology used in this table are explained in Clause 5.6.

Table 16-4. Structure of ReinitializeDevice Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Reinitialized State of Device	M	M(=)		
Password	U	U(=)		
Result (+)			S	S(=)
Result (-)			S	S(=)
Error Type			M	M(=)

16.4.1.1 Argument

This parameter shall convey the parameters for the ReinitializeDevice confirmed service request.

16.4.1.1.1 Reinitialized State of Device

This parameter allows the client user to specify the desired state of the device after its reinitialization. The value of the parameter may be one of COLDSTART, WARMSTART, STARTBACKUP, ENDBACKUP, STARTRESTORE, ENDRESTORE, or ABORTRESTORE.. WARMSTART shall mean to reboot the device and start over, retaining all data and programs that would normally be retained during a brief power outage. The precise interpretation of COLDSTART shall be defined by the vendor.

If the value of the parameter is WARMSTART and the device is not ready due to a configuration procedure in progress, the request shall be considered invalid and the responding BACnet user shall issue a Result(-) response.

If the value of the parameter is one of STARTBACKUP, ENDBACKUP, STARTRESTORE, ENDRESTORE, or ABORTRESTORE and communication has been disabled due to receipt of a DeviceCommunicationControl request with 'Enable/Disable' equal to DISABLE, the request shall be considered invalid and the responding BACnet user shall issue a Result(-) response.

The use of the backup and restore commands are defined in Clause 19.1.

16.4.1.1.2 Password

This optional parameter shall be a CharacterString of up to 20 characters. For those devices that require the password as a protection, the service request shall be denied if the parameter is absent or if the password is incorrect. For those devices that do not require a password, this parameter shall be ignored.

16.4.1.2 Result(+)

This parameter shall indicate that the service request succeeded.

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16.4.1.3 Result(-)

This parameter shall indicate that the service request has failed. The reason for the failure shall be specified by the 'Error Type' parameter.

16.4.1.3.1 Error Type

This parameter consists of two component parameters: (1) the 'Error Class' and (2) the 'Error Code'. See Clause 18. The 'Error Class' and 'Error Code' to be returned for specific situations are as follows:

Situation	Error Class	Error Code
The password is invalid or absent when one is required.	SECURITY	PASSWORD_FAILURE
The device is in the process of being configured.	DEVICE	CONFIGURATION_IN_PROGRESS
Communication has been disabled due to receipt of a DeviceCommunicationControl request.	SERVICES	COMMUNICATION_DISABLED

16.4.2 Service Procedure

After verifying the validity of the request, including the 'Reinitialized State of Device' and 'Password' parameters, the responding BACnet-user shall pre-empt all other outstanding requests and respond with a 'Result(+)' primitive. If the request is valid and 'Reinitialized State of Device' is WARMSTART or COLDSTART, then the responding BACnet-user shall immediately proceed to perform any applicable shut-down procedures prior to reinitializing the device as specified by the requesting BACnet-user in the request.

If 'Reinitialized State of Device' is WARMSTART and the device is not ready due to its initial characterization being in progress, a 'Result (-)' response primitive shall be issued.

If 'Reinitialized State of Device' is one of STARTBACKUP, ENDBACKUP, STARTRESTORE, ENDRESTORE, or ABORTRESTORE and communication has been disabled due to receipt of a DeviceCommunicationControl request with 'Enable/Disable' equal to DISABLE, the responding BACnet user shall respond with a Result(-) primitive. Otherwise, the responding BACnet user shall behave as described in Clause 19.1.

If the password is invalid or is absent when one is required, an Error-PDU with 'error class' of SECURITY and 'error code' of PASSWORD_FAILURE shall be issued.

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16.5 ConfirmedTextMessage Service

The ConfirmedTextMessage service is used by a client BACnet-user to send a text message to another BACnet device. This service is not a broadcast or multicast service. This service may be used in cases when confirmation that the text message was received is required. The confirmation does not guarantee that a human operator has seen the message. Messages may be prioritized into normal or urgent categories. In addition, a given text message may be optionally classified by a numeric class code or class identification string. This classification may be used by the receiving BACnet device to determine how to handle the text message. For example, the message class might indicate a particular output device on which to print text or a set of actions to take when the text is received. In any case, the interpretation of the class is a local matter.

16.5.1 ConfirmedTextMessage Service Structure

The structure of the ConfirmedTextMessage service primitives is shown in Table 16-5. The terminology and symbology used in this table are explained in Clause 5.6.

Table 16-5. Structure of ConfirmedTextMessage Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
Text Message Source Device	M	M(=)		
Message Class	U	U(=)		
Message Priority	M	M(=)		
Message	M	M(=)		
Result(+)			S	S(=)
Result(-)			S	S(=)
Error Type			M	M(=)

16.5.1.1 Argument

This parameter shall convey the parameters for the ConfirmedTextMessage service request.

16.5.1.1.1 Text Message Source Device

This parameter, of type BACnetObjectIdentifier, shall convey the value of the Object_Identifier property of the Device object of the device that initiated this text message.

16.5.1.1.2 Message Class

This parameter, if present, shall indicate the class of the received message. The datatype of this parameter shall be a choice of Unsigned or CharacterString. The interpretation of the meaning of any particular value for this parameter shall be a local matter.

16.5.1.1.3 Message Priority

This parameter, of type ENUMERATED, shall indicate the priority for message handling:

{NORMAL, URGENT}

16.5.1.1.4 Message

This parameter, of type CharacterString, shall be used to convey the text message.

16.5.1.2 Result(+)

The 'Result(+)' parameter shall indicate that the requested service has succeeded.

16.5.1.3 Result(-)

The 'Result(-)' parameter shall indicate that the requested service has failed. The reason for the failure shall be specified by the 'Error Type' parameter.

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16.5.1.3.1 Error Type

This parameter shall consist of two component parameters: (1) the 'Error Class' and (2) the 'Error Code'. See Clause 18.

16.5.2 ConfirmedTextMessage Service Procedure

After verifying the validity of the request, the responding BACnet-user shall take whatever local actions have been assigned to the indicated 'Message Class' and issue a 'Result(+)' service primitive. If the service request cannot be executed, a 'Result(-)'service primitive shall be issued indicating the encountered error.

Other than the requirement to return a success or failure response, actions taken in response to this notification are a local matter. However, typically the receiving device would take the text specified by the 'Message' parameter and display, print, or file it according to the classification specified by the 'Message Class' parameter. If the 'Message Class' parameter is omitted, then some general class might be assumed. If 'Message Priority' is URGENT, then clearly the messages should be considered as more important than existing NORMAL messages, which may be awaiting printing or some other action.

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16.6 UnconfirmedTextMessage Service

The UnconfirmedTextMessage service is used by a client BACnet-user to send a text message to one or more BACnet devices. This service may be broadcast, multicast, or addressed to a single recipient. This service may be used in cases where confirmation that the text message was received is not required. Messages may be prioritized into normal or urgent categories. In addition, a given text message may optionally be classified by a numeric class code or class identification string. This classification may be used by receiving BACnet devices to determine how to handle the text message. For example, the message class might indicate a particular output device on which to print text or a set of actions to take when the text message is received. In any case, the interpretation of the class is a local matter.

16.6.1 UnconfirmedTextMessage Service Structure

The structure of the UnconfirmedTextMessage service primitive is shown in Table 16-6. The terminology and symbology used in this table are explained in Clause 5.6.

Table 16-6. Structure of UnconfirmedTextMessage Service Primitive

Parameter Name	Req	Ind
Argument	M	M(=)
Text Message Source Device	M	M(=)
Message Class	U	U(=)
Message Priority	M	M(=)
Message	M	M(=)

The 'Argument' parameter shall convey the parameters for the UnconfirmedTextMessage service request.

16.6.1.1 Text Message Source Device

This parameter, of type BACnetObjectIdentifier, shall convey the value of the Object_Identifier property of the Device object of the device that initiated this text message.

16.6.1.2 Message Class

This parameter, if present, shall indicate the classification of the received message. The datatype of this parameter shall be a choice of Unsigned or CharacterString. The interpretation of the meaning of any particular value for this parameter shall be a local matter.

16.6.1.3 Message Priority

This parameter, of type ENUMERATED, shall indicate the priority for message handling:

{NORMAL, URGENT}

16.6.1.4 Message

This parameter, of type CharacterString, shall be used to convey the text message.

16.6.2 UnconfirmedTextMessage Service Procedure

Since this is an unconfirmed service, no response primitives are expected. Actions taken in response to this service request are a local matter. However, typically the receiving device(s) would take the text block specified by the 'Message' parameter and display or print or file them according to the classification specified by the 'Message Class' parameter. If the 'Message Class' parameter is omitted, then some general class might be assumed. If 'Message Priority' is URGENT, then clearly the messages should be considered as more important than existing NORMAL messages, which may be awaiting printing or some other action.

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16.7 TimeSynchronization Service

The TimeSynchronization service is used by a requesting BACnet-user to notify a remote device of the correct current time. This service may be broadcast, multicast, or addressed to a single recipient. Its purpose is to notify recipients of the correct current time so that devices may synchronize their internal clocks with one another.

16.7.1 Structure

The structure of the TimeSynchronization service primitive is shown in Table 16-7. The terminology and symbology used in this table are explained in Clause 5.6.

Table 16-7. Structure of TimeSynchronization Service Primitive

Parameter Name	Req	Ind
Argument	M	M(=)
Time	M	M(=)

16.7.1.1 Argument

The 'Argument' parameter shall convey the parameters for the TimeSynchronization service request.

16.7.1.1.1 Time

This parameter, of type BACnetDateTime, shall convey the current date and time as determined by the clock in the device issuing the service request. This parameter shall contain a specific datetime value.

16.7.2 Service Procedure

Since this is an unconfirmed service, no response primitives are expected. A device receiving a TimeSynchronization service indication shall update its local representation of time. This change shall be reflected in the Local_Time and Local_Date properties of the Device object.

No restrictions on the use of this service exist when it is invoked at the request of an operator. Otherwise, the use of this service is controlled by the value of the Time_Synchronization_Recipients property in the Device object. When the Time_Synchronization_Recipients list is of length zero, a device may not automatically send a TimeSynchronization request. When Time_Synchronization_Recipients list is of length one or more, a device may automatically send a TimeSynchronization request but only to the devices or addresses contained in the Time_Synchronization_Recipients list.

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16.8 UTCTimeSynchronization Service

The UTCTimeSynchronization service is used by a requesting BACnet-user to notify one or more remote devices of the correct Universal Time Coordinated (UTC). This service may be broadcast, multicast, or addressed to a single recipient. Its purpose is to notify recipients of the correct UTC so that devices may synchronize their internal clocks with one another.

16.8.1 Structure

The structure of the UTCTimeSynchronization service primitive is shown in Table 16-8. The terminology and symbology used in this table are explained in Clause 5.6.

Table 16-8. Structure of UTCTimeSynchronization Service Primitive

Parameter Name	Req	Ind
Argument	M	M(=)
Time	M	M(=)

16.8.1.1 Argument

The 'Argument' parameter shall convey the parameters for the UTCTimeSynchronization service request.

16.8.1.1.1 Time

This parameter, of type BACnetDateTime, shall convey the UTC date and time. This parameter shall contain a specific datetime value.

16.8.2 Service Procedure

Since this is an unconfirmed service, no response primitives are expected. A device receiving a UTCTimeSynchronization service indication shall update its local representation of time and date by subtracting the value of the 'UTC_Offset' property of the Device object from the 'Time' parameter and taking the 'Daylight_Savings_Status' property of the Device object into account as appropriate to the locality. This change shall be reflected in the Local_Time and Local_Date properties of the Device object.

No restrictions on the use of this service exist when it is invoked at the request of an operator. Otherwise, the initiation of this service by a device is controlled by the value of the UTC_Time_Synchronization_Recipients property in the Device object. When the UTC_Time_Synchronization_Recipients list is of length zero, a device may not automatically send a UTC_TimeSynchronization request. When UTC_Time_Synchronization_Recipients list is of length one or more, a device may automatically send a UTCTimeSynchronization request but only to the devices or addresses contained in the UTC_Time_Synchronization_Recipients list.

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16.9 Who-Has and I-Have Services

The Who-Has service is used by a sending BACnet-user to identify the device object identifiers and network addresses of other BACnet devices whose local databases contain an object with a given Object_Name or a given Object_Identifier. The I-Have service is used to respond to Who-Has service requests or to advertise the existence of an object with a given Object_Name or Object_Identifier. The I-Have service request may be issued at any time and does not need to be preceded by the receipt of a Who-Has service request. The Who-Has and I-Have services are unconfirmed services.

16.9.1 Who-Has Service Structure

The structure of the Who-Has service primitive is shown in Table 16-9. The terminology and symbology used in this table are explained in Clause 5.6.

Table 16-9. Structure of Who-Has Service Primitive

Parameter Name	Req	Ind
Argument	M	M(=)
Device Instance Range Low Limit	U	U(=)
Device Instance Range High Limit	U	U(=)
Object Identifier	S	S(=)
Object Name	S	S(=)

16.9.1.1 Argument

The 'Argument' parameter shall convey the parameters for the Who-Has unconfirmed service request.

16.9.1.1.1 Device Instance Range Low Limit

This parameter is an unsigned integer in the range 0 - 4,194,303. In conjunction with the 'Device Instance Range High Limit' parameter, it defines the devices that are qualified to respond with an I-Have service request if the 'Object Identifier' or 'Object Name' criteria are satisfied as described in Clauses 16.9.1.1.3 and 16.9.1.1.4. If the 'Device Instance Range Low Limit' parameter is present, then the 'Device Instance Range High Limit' parameter shall also be present, and only those devices whose Device Object_Identifier instance number falls within the range 'Device Instance Range Low Limit'≤ Object_Identifier Instance Number ≤ 'Device Instance Range High Limit' shall be qualified to respond. The value of the 'Device Instance Range Low Limit' shall be less than or equal to the value of the 'Device Instance Range High Limit'. If the 'Device Instance Range Low Limit' and 'Device Instance Range High Limit' parameters are omitted, then all devices that receive this message are qualified to respond with an I-Have service request.

16.9.1.1.2 Device Instance Range High Limit

This parameter is an unsigned integer in the range 0 - 4,194,303. In conjunction with the 'Device Instance Range Low Limit' parameter, it defines the devices that are qualified to respond with an I-Have service request if the 'Object Identifier' or 'Object Name' criteria are satisfied as described in Clauses 16.9.1.1.3 and 16.9.1.1.4. If the 'Device Instance Range High Limit' parameter is present, then the 'Device Instance Range Low Limit' parameter shall also be present, and only those devices whose Device Object_Identifier instance number falls within the range 'Device Instance Range Low Limit'≤ Object_Identifier Instance Number ≤ 'Device Instance Range High Limit' shall be qualified to respond. The value of the 'Device Instance Range High Limit' shall be greater than or equal to the value of the 'Device Instance Range Low Limit'. If the 'Device Instance Range Low Limit' and 'Device Instance Range High Limit' parameters are omitted, then all devices that receive this message are qualified to respond with an I-Have service request.

16.9.1.1.3 Object Identifier

The 'Object Identifier' parameter, of type BACnetObjectIdentifier, shall convey the Object_Identifier of the object that is to be located. If the 'Object Identifier' parameter is omitted, then the 'Object Name' parameter shall be present. If the 'Object Identifier' parameter is present, then only those devices that contain an object with an Object_Identifier property value matching the 'Object Identifier' parameter, which are qualified to respond as described in Clauses 16.9.1.1.1 and 16.9.1.1.2, shall respond with an I-Have service request.

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16.9.1.1.4 Object Name

The 'Object Name' parameter, of type CharacterString, shall convey the value of the Object_Name property of the object that is to be located. If the 'Object Name' parameter is omitted, then the 'Object Identifier' parameter shall be present. If the 'Object Name' parameter is present, then only those devices that contain an object with an Object_Name property value matching the 'Object Name' parameter, which are qualified to respond as described in Clauses 16.9.1.1.1 and 16.9.1.1.2, shall respond with an I-Have service request.

16.9.2 Who-Has Service Procedure

The sending BACnet-user shall transmit the Who-Has unconfirmed request, normally using a broadcast address. If the 'Device Instance Range Low Limit' and 'Device Instance Range High Limit' parameters are present, then only those receiving BACnet-users whose Device Object_Identifier instance number falls in the range 'Device Instance Range Low Limit ≤ Object_Identifier Instance Number ≤ 'Device Instance Range High Limit' shall be qualified to respond. If the 'Object Name' parameter is present, then only those qualified receiving BACnet-users that contain an object with an Object_Name property value matching the 'Object Name' parameter shall respond with an I-Have service request. If the 'Object Identifier' parameter is present, then only those qualified receiving BACnet-users that contain an object with an Object_Identifier property value matching the 'Object Identifier' parameter shall respond with an I-Have service request.

16.9.3 I-Have Service Structure

The structure of the I-Have service primitive is shown in Table 16-10. The terminology and symbology used in this table are explained in Clause 5.6.

Table 16-10. Structure of I-Have Service Primitive

Parameter Name	Req	Ind
Argument	M	M(=)
Device Identifier	M	M(=)
Object Identifier	M	M(=)
Object Name	M	M(=)

16.9.3.1 Argument

The 'Argument' parameter shall convey the parameters for the I-Have unconfirmed service request.

16.9.3.1.1 Device Identifier

The 'Device Identifier' parameter, of type BACnetObjectIdentifier, is the Device Object_Identifier of the device initiating the I-Have service request.

16.9.3.1.2 Object Identifier

The 'Object Identifier' parameter, of type BACnetObjectIdentifier, shall convey the Object_Identifier of the object that is being advertised as located in the initiating device. This identifier shall correspond to the value of the Object_Identifier property of the object being advertised.

16.9.3.1.3 Object Name

The 'Object Name' parameter, of type CharacterString, shall convey the name of the object that is being advertised as located in the initiating device. This name shall correspond to the value of the Object_Name property of the object being advertised.

16.9.4 I-Have Service Procedure

The sending BACnet-user shall broadcast the I-Have unconfirmed request. Such broadcasts may be on the local network only, a remote network only, or globally on all networks at the discretion of the application. If the I-Have is being transmitted in response to a previously received Who-Has, then the I-Have shall be transmitted in such a manner that the BACnet-user that sent the Who-Has will receive the resulting I-Have. Since the request is unconfirmed, no further action is required. A BACnet-user may issue an I-Have service request at any time.

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16.10 Who-Is and I-Am Services

The Who-Is service is used by a sending BACnet-user to determine the device object identifier, the network address, or both, of other BACnet devices that share the same internetwork. The Who-Is service is an unconfirmed service. The Who-Is service may be used to determine the device object identifier and network addresses of all devices on the network, or to determine the network address of a specific device whose device object identifier is known, but whose address is not. The I-Am service is also an unconfirmed service. The I-Am service is used to respond to Who-Is service requests. However, the I-Am service request may be issued at any time. It does not need to be preceded by the receipt of a Who-Is service request. In particular, a device may wish to broadcast an I-Am service request when it powers up. The network address is derived either from the MAC address associated with the I-Am service request, if the device issuing the request is on the local network, or from the NPCI if the device is on a remote network.

16.10.1 Who-Is Service Structure

The structure of the Who-Is service primitive is shown in Table 16-11. The terminology and symbology used in this table are explained in Clause 5.6.

Table 16-11. Structure of Who-Is Service Primitive

Parameter Name	Req	Ind
Argument	M	M(=)
Device Instance Range Low Limit	U	U(=)
Device Instance Range High Limit	U	U(=)

16.10.1.1 Argument

The 'Argument' parameter shall convey the parameters for the Who-Is unconfirmed service request.

16.10.1.1.1 Device Instance Range Low Limit

This parameter is an unsigned integer in the range 0 - 4,194,303. In conjunction with the 'Device Instance Range High Limit' parameter, it defines the devices that are qualified to respond with an I-Am service request. If the 'Device Instance Range Low Limit' parameter is present, then the 'Device Instance Range High Limit' parameter shall also be present, and only those devices whose Device Object_Identifier instance number falls within the range 'Device Instance Range Low Limit' ≤ Device Object_Identifier Instance Number ≤ 'Device Instance Range High Limit' shall be qualified to respond. The value of the 'Device Instance Range Low Limit' shall be less than or equal to the value of the 'Device Instance Range High Limit'. If the 'Device Instance Range Low Limit' and 'Device Instance Range High Limit' parameters are omitted, then all devices that receive this message are qualified to respond with an I-Am service request.

16.10.1.1.2 Device Instance Range High Limit

This parameter is an unsigned integer in the range 0 - 4,194,303. In conjunction with the 'Device Instance Range Low Limit' parameter, it defines the devices that are qualified to respond with an I-Am service request. If the 'Device Instance Range High Limit' parameter is present, then the 'Device Instance Range Low Limit' parameter shall also be present, and only those devices whose Device Object_Identifier instance number falls within the range 'Device Instance Range Low Limit' ≤ Device Object_Identifier Instance Number ≤ 'Device Instance Range High Limit' shall be qualified to respond. The value of the 'Device Instance Range High Limit' shall be greater than or equal to the value of the 'Device Instance Range Low Limit'. If the 'Device Instance Range Low Limit' and 'Device Instance Range High Limit' parameters are omitted, then all devices that receive this message are qualified to respond with an I-Am service request.

16.10.2 Who-Is Service Procedure

The sending BACnet-user shall transmit the Who-Is unconfirmed request, normally using a broadcast address. If the 'Device Instance Range Low Limit' and 'Device Instance Range High Limit' parameters are omitted, then all receiving BACnet-users shall return their Device Object_Identifier in individual responses using the I-Am service. If the 'Device Instance Range Low Limit' and 'Device Instance Range High Limit' parameters are present, then only those receiving BACnet-users whose Device Object_Identifier instance number falls within the range 'Device Instance Range Low Limit ≤ Device Object_Identifier Instance Number ≤ 'Device Instance Range High Limit' shall return their Device Object_Identifier using the I-Am service.
If the receiving BACnet-user has a Slave_Proxy_Enable property and the Slave_Proxy_Enable for the receiving port is TRUE, then the BACnet-user shall respond with an I-Am unconfirmed request for each of the slave devices on the MS/TP network that are present in the Slave_Address_Binding property and that match the device range parameters. The I-Am

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unconfirmed requests that are generated shall be generated as if the slave device originated the service. If the I-Am unconfirmed request is to be placed onto the MS/TP network on which the slave resides, then the MAC address included in the packet shall be that of the slave device. In the case where the I-Am unconfirmed request is to be placed onto a network other than that on which the slave resides, then the network layer shall contain SLEN and SNET filled in with the slave's MAC address as if it were routing a packet originally generated by the slave device.

16.10.3 I-Am Service Structure

The structure of the I-Am service primitive is shown in Table 16-12. The terminology and symbology used in this table are explained in Clause 5.6.

Table 16-12. Structure of I-Am Service Primitive

Parameter Name	Req	Ind
Argument	M	M(=)
I-Am Device Identifier	M	M(=)
Max APDU Length Accepted	M	M(=)
Segmentation Supported	M	M(=)
Vendor Identifier	M	M(=)

16.10.3.1 Argument

The 'Argument' parameter shall convey the parameters for the I-Am unconfirmed service request.

16.10.3.1.1 I-Am Device Identifier

The 'I-Am Device Identifier' parameter, of type BACnetObjectIdentifier, is the Device Object_Identifier of the device initiating the I-Am service request.

16.10.3.1.2 Max APDU Length Accepted

This parameter, of type Unsigned, shall convey the maximum number of octets that may be contained in a single, indivisible APDU. The value of this parameter shall be the same as the value of the Max_APDU_Length_Accepted property of the Device object. See 12.11.17.

16.10.3.1.3 Segmentation Supported

This parameter, of type BACnetSegmentation, conveys the capabilities of the device initiating the I-Am service request with respect to processing segmented messages. The value of this parameter shall be the same as the value of the Segmentation_Supported property of the Device object. See 12.11.18.

16.10.3.1.4 Vendor Identifier

This parameter, of type Unsigned16, shall convey the identity of the vendor who manufactured the device initiating the I-Am service request. The value of this parameter shall be the same as the value of the Vendor_Identifier property of the Device object. See 12.11.6 and Clause 23.

16.10.4 I-Am Service Procedure

The sending BACnet-user shall broadcast or unicast the I-Am unconfirmed request. If the I-Am is broadcast, this broadcast may be on the local network only, a remote network only, or globally on all networks at the discretion of the application. If the I-Am is being sent in response to a previously received Who-Is, then the I-Am shall be sent in such a manner that the BACnet-user that sent the Who-Is will receive the resulting I-Am. Since the request is unconfirmed, no further action is required. A BACnet-user may issue an I-Am service request at any time.

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17 VIRTUAL TERMINAL SERVICES

Virtual Terminal (VT) services are used by a client BACnet-user to establish a connection to an application program server in another BACnet device. The purpose of this connection is to facilitate the bi-directional exchange of character-oriented data. Normally, these services would be used to permit an application program in one BACnet device to act as a "terminal emulator" that interacts with an "operator interface" application program in another BACnet device.

These connections will be referred to here as VT-sessions. Once a VT-session is established, both the client application program and server application program will be referred to as VT-users.

The VT services provide the following features and services to the VT-user:

(a) the means to establish a VT-session between two peer VT-users for the purpose of enabling virtual terminal information exchange;
(b) the means to select between different VT-class types, including character repertoire and encoding;
(c) the means to control the integrity of the communication;
(d) the means to terminate the VT-session unilaterally;
(e) the means to exchange virtual terminal data.

17.1 Virtual Terminal Model

Each VT-session is a bi-directional connection between two peer application processes. Once a session is established between these peers, data are exchanged through the use of Virtual Terminal Queues (VTQ). The VTQs are first-in, first-out (FIFO) queues. The purpose of modeling the data flow between peer processes as FIFO queues is to isolate the implementation of the peer application process that is on each side of the VT-session from the other. Normally a human operator using a BACnet device will request the operator interface application program to establish a VT-session with an operator interface application program in another BACnet device. The VTQ model uses two FIFO queues to allow those operator interfaces, or other application programs that can provide simultaneous bi-directional interaction, to do so through the BACnet protocol.

Figure 17-1 shows a typical relationship between an operator interface application program and a physical device, such as a CRT terminal.

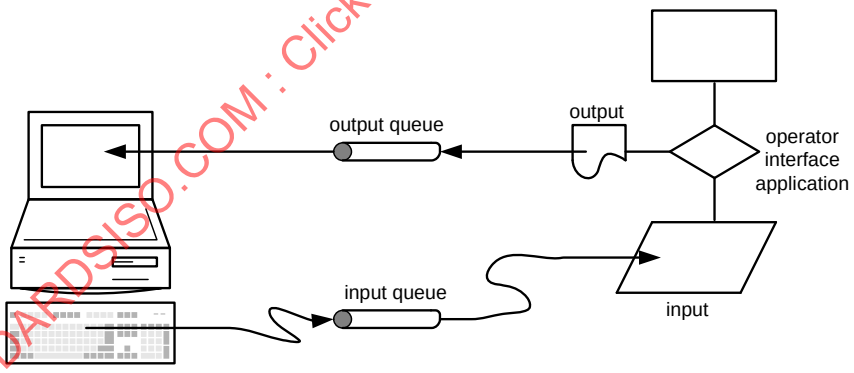

Figure 17-1. Relationship between an operator interface program and a physical device.

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Figure 17-2 shows how this model is extended using the VTQ concept.

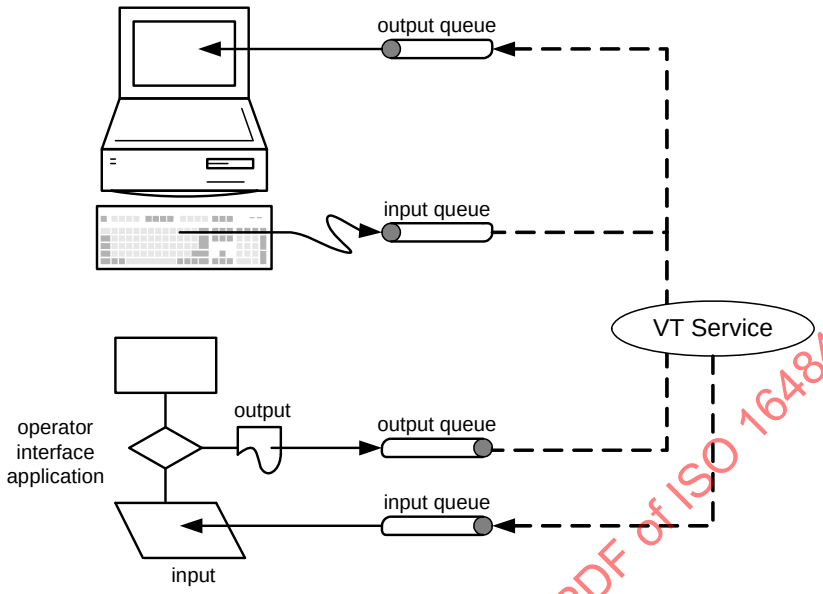

Figure 17-2. Extending the VT model to accommodate queues.

The peer processes at each end of a VT-session may not actually be agents for a physical device such as a CRT terminal. The VTQ model permits flexibility in the implementation of each BACnet device. There may, in fact, be several different processes that coordinate their use of VT Services within each BACnet device. For example, in a multi-window operator interface program, there may be several windows, each with its own interactive virtual terminal session to some other BACnet device. For this reason, each VT-session exists between two unique processes rather than between two BACnet devices. Each session, therefore, consists of two processes that act as agents for their respective application programs and their respective VTQs. These agent processes and their VTQs are called VT-Users. The model of this data flow is shown in Figure 17-3.

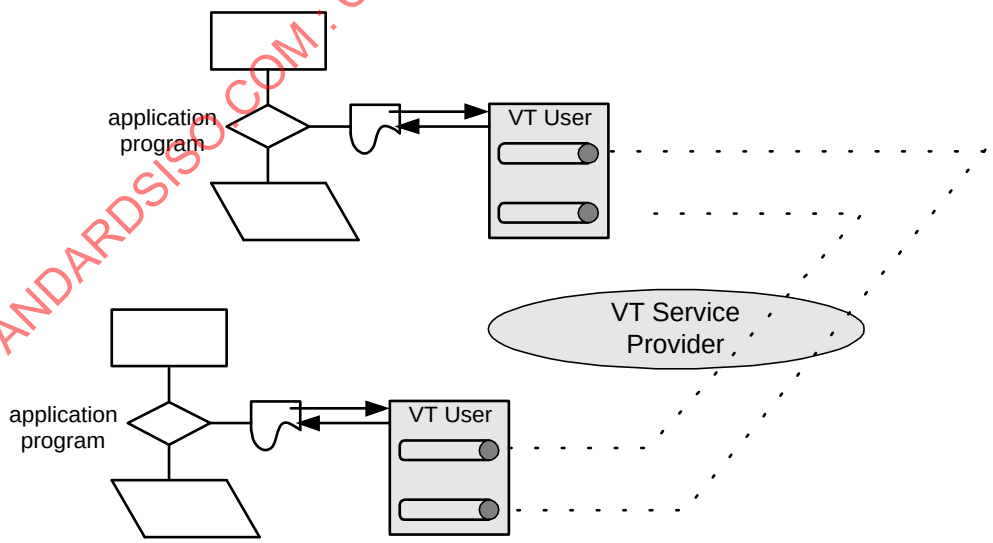

Figure 17-3. Virtual terminal data flow.

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Once the virtual terminal session is established, character data are exchanged by the two peers through their respective VTQs. Normally, characters typed by a human operator would be passed directly to an input queue for forwarding to the peer's input queue, without any echoing by the local device to which the operator is connected. The peer application program, upon receiving these characters from its input queue, would respond with characters placed in its output queue for forwarding back to the output queue of the operator device and so on. In particular, it shall be the responsibility of the operator interface application to generate all "screen" output, including carriage control and character echoing when appropriate.

Although the VT services model does provide a true peer-to-peer connection, as shown in Figure 17-3, a human operator typically uses one BACnet device to establish a virtual terminal connection to a second BACnet device. This second BACnet device contains an "operator interface" application program to which the operator's keystrokes are sent without filtering. The operator interface application program's output is conveyed through the VT services and ultimately displayed for the human operator. Normally, the BACnet device to which the operator is actually connected would recognize some local signal meaning "end virtual terminal session" but otherwise would not filter the operator's keystrokes.

17.1.1 Basic Services

There are three basic services provided: VT-Open, VT-Close, and VT-Data. The VT-Open service is used to establish a VT-session between peer processes. The VT-Close service is used to terminate a previously established session. The VT-Data service is used to exchange data between peer processes.

17.1.2 VT-classes

The classes of virtual terminal that are available in a peer VT service may be determined by examining the BACnet Device object in the peer device. The BACnet Device object has a property called VT_Classes_Supported, which may be read with the ReadProperty or ReadPropertyMultiple service to determine which VT-classes are available in that device.

17.1.3 Active VT-sessions

The active VT-sessions within a peer VT service may be determined by examining the BACnet Device object in the peer device. The BACnet Device object has a property called Active_VT_Sessions, which may be read with the ReadProperty or ReadPropertyMultiple service to determine which VT-session IDs are in use within that device.

17.1.4 State Diagram for VT-Open, VT-Data, and VT-Close

There are three phases of operation within a VT session context: IDLE, DATA EXCHANGE, and HOLD. In the IDLE phase, no VT-session exists. Once a VT-session is created through the use of the VT-Open service, the VT context enters the DATA EXCHANGE phase. The VT context remains in the DATA EXCHANGE phase until one of two events occurs:

(a) a successful VT-Close is performed, terminating the VT-session context, or
(b) a VT-Data request returns 'Result (-)'.

The HOLD phase occurs when a VT-Data request cannot be confirmed. Figure 17-4 shows the relationship between phases.

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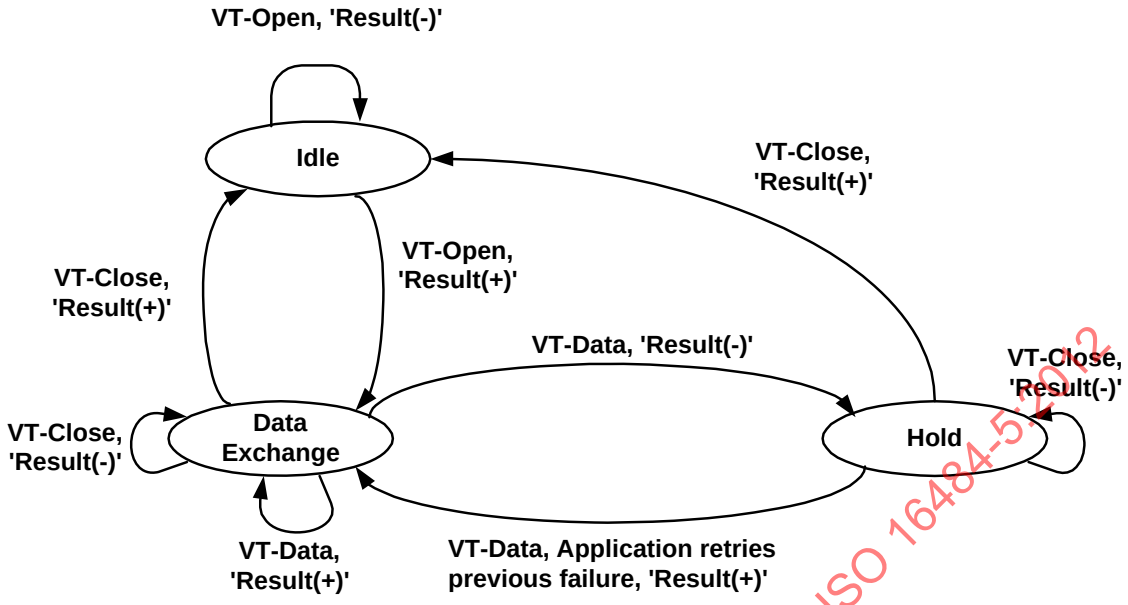

Figure 17-4. Virtual terminal services state diagram.

17.1.5 VT Session Synchronization

Each of the peers participating in a VT-session shall maintain two VT-data flags that are used to synchronize the VT-session. One flag represents the device's role as a sending BACnet-user and is the sequence number, which that alternates between zero and one, of the next VT-data that is to be sent. This sequence number is incremented modulo 2 upon receipt of a 'Result(+)' response to a VT-Data request. This flag is initialized to 0 (the first VT-Data request uses a sequence number of 0) when the VT-session is established.

The other flag represents the device's role as a receiving BACnet-user and is the sequence number of the last VT-Data request that was correctly received. This sequence number is initialized to 1 (the next VT-Data indication is expected to have a sequence number of 0) when the VT session is established. The sequence number is incremented modulo 2 when a VT-Data indication with the expected sequence number is received and successfully processed.

The receiving VT-session context shall also store the last received 'All New Data Accepted' and 'Accepted Octet Count'. This is required in the event that a 'Result(+)' response to a VT-Data indication is lost, which would be detected by the receipt of a VT-Data indication with the same 'VT-Data Flag' as the previously received 'VT-Data Flag' saved in the VT session context.

17.1.6 VT Session Identifiers

Associated with each VT-session are two session identifiers, a 'Local VT Session Identifier' and a 'Remote VT Session Identifier'. These session identifiers provide a way to associate the data from a particular VT-Data request with the correct process. The value of the session identifiers is established as part of the VT-Open service. Each device selects its own 'Local VT Session Identifier', which shall be unique to all active VT-sessions in the device, without regard to whether the device's role in the session is a client or a server. The appropriate 'Remote VT Session Identifier' is obtained from the VT-Open service parameters.

When VT data are conveyed to a remote device, the 'Remote VT Session Identifier' is conveyed with the data. This session identifier is used by the remote device to identify the correct VT-session.

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17.2 VT-Open Service

The VT-Open service is used to establish a VT-session with a peer VT-user. The service request includes a VT-class type that identifies a particular set of assumptions about the character repertoire and encoding to be used with this session.

17.2.1 Structure

The structure of the VT-Open service primitives is shown in Table 17-1. The terminology and symbology used in this table are explained in Clause 5.6.

Table 17-1. Structure of VT-Open Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
VT-class	M	M(=)		
Local VT Session Identifier	M	M(=)		
Result (+)			S	S(=)
Remote VT Session Identifier			M	M(=)
Result (-)			S	S(=)
Error Type			M	M(=)

17.2.1.1 Argument

This parameter shall convey the parameters for the VT-Open confirmed service request.

17.2.1.1.1 VT-class

This parameter, of type BACnetVTClass, shall identify the name of the desired class of session to be established. The standard enumeration is:

DEFAULT_TERMINAL
ANSI_X3.64
DEC_VT52
DEC_VT100
DEC_VT220
HP_700/94
IBM_3130

The enumeration DEFAULT_TERMINAL shall refer to a terminal with the characteristics defined in 17.5. All VT-users are required to support at least one VT-class, namely DEFAULT_TERMINAL. Other VT-class types may also be supported by a given VT-user. It is possible to discover which VT-class types are supported by reading the VT_Classes_Supported property of the Device object.

17.2.1.1.2 Local VT Session Identifier

The 'Local VT Session Identifier' parameter shall be an unsigned integer in the range 0-255 indicating the unique VT-session in the requesting VT-user, which shall be used to receive VT-Data output from the opened virtual terminal. This identifier becomes the 'Remote VT Session Identifier' to the responding VT-user.

17.2.1.2 Result (+)

The 'Result (+)' parameter shall indicate that the service request succeeded. A successful result includes the following parameter.

17.2.1.2.1 Remote VT Session Identifier

The 'Remote VT Session Identifier' parameter shall be an unsigned integer in the range 0-255 indicating a unique VT-session that exists within the responding VT-user's context. From the perspective of the responding VT-user, this parameter is the 'Local VT Session Identifier'.

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17.2.1.3 Result (-)

The 'Result (-)' parameter shall indicate that the service request has failed in its entirety. The reason for the failure shall be specified by the 'Error Type' parameter.

17.2.1.3.1 Error Type

This parameter consists of two component parameters: (1) the 'Error Class' and (2) the 'Error Code'. See Clause 18.

17.2.2 Service Procedure

After verifying the validity of the request, the responding BACnet-user shall attempt to allocate the resources necessary to establish a VT-session. If there is no VT-user that can provide the desired VT-class, then the 'Result (-)' response shall be returned. If there is a VT-user that can provide the desired VT-class, then the responding BACnet-user shall attempt to establish a new VT-session. If the VT-user does not have the resources to establish another session, then the 'Result (-)' response shall be returned. If the VT-user has the resources, a new VT-session shall be created, the local VT-data Flags shall be initialized as specified in 17.1.5, and a new VT-session Identifier shall be returned in the 'Result (+)' response.

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17.3 VT-Close Service

The VT-Close service is used to terminate a previously established VT-session with a peer VT-user. The service request may specify a particular VT-session to be terminated or a list of VT-sessions to be terminated.

17.3.1 Structure

The structure of the VT-Close service primitives is shown in Table 17-2. The terminology and symbology used in this table are explained in Clause 5.6.

Table 17-2. Structure of VT-Close Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
List of Remote VT Session Identifiers	M	M(=)		
Result (+)			S	S(=)
Result (-)			S	S(=)
Error Type			M	M(=)
List of VT Session Identifiers			C	C(=)

17.3.1.1 Argument

This parameter shall convey the parameters for the VT-Close confirmed service request.

17.3.1.1.1 List of Remote VT Session Identifiers

The 'List of Remote VT Session Identifiers' parameter shall consist of a list of one or more 'Remote VT Session Identifiers'. Each 'Remote VT Session Identifier' shall indicate the particular VT-session that is to be terminated.

17.3.1.2 Result (+)

The 'Result (+)' parameter shall indicate that the service request succeeded.

17.3.1.3 Result (-)

The 'Result (-)' parameter shall indicate that the service request has failed in its entirety. The reason for the failure shall be specified by the 'Error Type' parameter.

17.3.1.3.1 Error Type

This parameter consists of two component parameters: (1) the 'Error Class' and (2) the 'Error Code'. See Clause 18.

17.3.1.3.2 List of VT Session Identifiers

If the 'Error Type' parameter returns an 'Error Code' of VT_SESSION_TERMINATION_FAILURE, then this parameter shall be included. If the 'Error Type' parameter indicates some other error, then this parameter shall be omitted. The 'List of VT Session Identifiers' parameter shall consist of a list of one or more 'VT Session Identifiers'. Each 'VT Session Identifier' shall indicate the particular VT-session that could not be terminated. The Session Identifiers returned are the ones that are local with respect to the device receiving the 'Result(-)' primitive, the requesting VT-user.

17.3.2 Service Procedure

After verifying the validity of the request, the responding BACnet-user shall attempt to terminate each VT-session specified by the 'List of Remote VT Session Identifiers' parameter. From the viewpoint of the responding BACnet-user, these are 'Local VT Session Identifiers'. If one or more of the specified VT-sessions cannot be terminated for some reason, then all of the specified sessions that can be terminated shall be terminated and a 'Result (-)' response shall be returned. If all of the specified VT-sessions are successfully terminated, then the 'Result (+)' response shall be returned.

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17.4 VT-Data Service

The VT-Data service is used to exchange data with a peer VT-user through a previously established VT-session. The sending BACnet-user provides new input for the peer VT-user, which may accept or reject the new data. If the new data are rejected, then it is up to the sending BACnet-user to retry the request at a later time.

17.4.1 Structure

The structure of the VT-Data service primitives is shown in Table 17-3. The terminology and symbology used in this table are explained in Clause 5.6.

Table 17-3. Structure of VT-Data Service Primitives

Parameter Name	Req	Ind	Rsp	Cnf
Argument	M	M(=)		
VT-session Identifier	M	M(=)		
VT-new Data	M	M(=)		
VT-data Flag	M	M(=)		
Result (+)			S	S(=)
All new Data Accepted			M	M(=)
Accepted Octet Count			C	C(=)
Result (-)			S	S(=)
Error Type			M	M(=)

17.4.1.1 Argument

This parameter shall convey the parameters for the VT-Data confirmed service request.

17.4.1.1.1 VT-session Identifier

The 'VT-session Identifier' parameter shall indicate the particular VT-session to which data will be sent. It is the 'Remote VT Session Identifier' from the perspective of the requesting BACnet-user and the 'Local VT Session Identifier' from the perspective of the responding BACnet-user.

17.4.1.1.2 VT-new Data

The 'VT-new Data' parameter shall specify the octets of new data that are to be sent to the peer VT-user.

17.4.1.1.3 VT-data Flag

The 'VT-data Flag' parameter, of type Unsigned, shall indicate the expected sequence of VT-Data requests. It shall have values of 0 or 1, which alternate with each new VT-Data request for the same VT session.

17.4.1.2 Result (+)

The 'Result (+)' parameter shall indicate that the service request succeeded. A successful result includes the following parameters.

17.4.1.2.1 All New Data Accepted

The 'All New Data Accepted' parameter, of type BOOLEAN, shall be equal to TRUE if all of the 'VT-new Data' octets were accepted by the peer VT-user. In this case, the service shall be considered completed. If the 'All New Data Accepted' parameter is FALSE, then some of the 'VT-new Data' octets were unable to be accepted by the peer VT-user. Typically this could occur because of resource limitations in the peer VT-user. In this case, it is up to the sending BACnet user to re-issue the VT-Data request at a later time, including only those octets that could not be accepted.

17.4.1.2.2 Accepted Octet Count

The 'Accepted Octet Count' parameter shall only be present if the 'All New Data Accepted' parameter is FALSE. In this case, the 'Accepted Octet Count' parameter shall indicate the number of octets that were actually accepted from those presented in the

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'VT-new Data' parameter of the service request. If the 'All New Data Accepted' parameter is TRUE, then the 'Accepted Octet Count' parameter shall be omitted.

17.4.1.3 Result (-)

The 'Result (-)' parameter shall indicate that the service request has failed in its entirety. The reason for the failure shall be specified by the 'Error Type' parameter.

17.4.1.3.1 Error Type

This parameter consists of two component parameters: (1) the 'Error Class' and (2) the 'Error Code'. See Clause 18.

17.4.2 Service Procedure

The sending BACnet user shall send the initial VT-Data request using a 'VT-data Flag' value of 0. Subsequent VT-Data requests for the same session, except retries, shall alternate sequence numbers 0 and 1. New VT-Data requests with the alternate sequence number shall not be transmitted until a 'Result(+)' has been received for the previous VT-Data request.

After verifying the validity of the request, the receiving BACnet-user shall attempt to locate the session specified by the 'VT-session Identifier' parameter. If the VT-session cannot be located, then the 'Result (-)' response shall be returned.

If the specified VT-session is found and the received 'VT-Data Flag' is the same as the last received 'VT-Data Flag' for this session, then this is a duplicate VT-Data request. The data shall be discarded, and a 'Result(+)' shall be returned containing the 'All New Data Accepted' and 'Accepted Octet Count' values that have been saved in the VT-session context from the previous VT-Data response.

If the specified VT-session is found and the received 'VT-Data Flag' is different from the last received 'VT-Data Flag' for this session, then this is a new VT-Data request. If all of the data can be added to the session's input queue, then the data shall be queued and a 'Result(+)' shall be returned with 'All New Data Accepted' = TRUE and the 'Accepted Octet Count' absent. If all of the data in the VT-Data request cannot be added to the session's input queue, then as many data as possible shall be queued and the remainder discarded. A 'Result(+)' shall be returned with 'All New Data Accepted' = FALSE and 'Accepted octet Count' equal to the number of octets that were able to be queued. In either case, the returned 'All New Data Accepted' and 'Accepted Octet Count' values shall be saved in the VT-session context.

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17.5 Default-terminal Characteristics

Every VT-user shall implement at least one VT-class, DEFAULT_TERMINAL. The default terminal is based on a limited set of functions that are commonly found in all types of interactive terminal devices. The characteristics of the default terminal include a character repertoire, control functions, and page size assumptions. No other assumptions may be made about the behavior of the VT-user.

17.5.1 Default-terminal Character Repertoire

The default terminal character repertoire shall be defined as a particular mapping between single octet values and their associated meanings. The default terminal character repertoire shall include three types of meanings for a given octet value:

(a) a particular symbol (SYMBOL), e.g., "A";
(b) a particular implied control function (CONTROL), e.g., Carriage Return;
(c) a null meaning (NUL), e.g., Unused, shall be ignored.

Those octets specified as NUL within the default terminal character repertoire have no assumed meanings and shall be ignored if they are received by either VT-user. The default terminal character repertoire is a subset of ASCII. Table 17.4 summarizes the octet encodings for each character in the default terminal character repertoire. The "Octet Value" field indicates octet encodings as decimal (base 10) values from 0 to 255. A range of octet values is indicated by two decimal numbers, e.g., 000-006.

Table 17-4. Default Terminal Character Repertoire

Octet Value	Type	Meaning
000-006	NUL	none
007	CONTROL	audible indication (BEL)
008	CONTROL	non-destructive backspace (BS)
009	CONTROL	horizontal tab (TAB)
010	CONTROL	line feed (LF)
011-012	NUL	none
013	CONTROL	carriage return (CR)
014-031	NUL	none
032	SYMBOL	space
033	SYMBOL	! exclamation
034	SYMBOL	" double quote
035	SYMBOL	# pound sign
036	SYMBOL	$ dollar sign
037	SYMBOL	% percent
038	SYMBOL	& ampersand
039	SYMBOL	' apostrophe
040	SYMBOL	(left parenthesis
041	SYMBOL	) right parenthesis
042	SYMBOL	* asterisk
043	SYMBOL	+ plus sign
044	SYMBOL	, comma
045	SYMBOL	- minus sign
046	SYMBOL	. period
047	SYMBOL	/ forward slash

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Table 17-4. Default Terminal Character Repertoire *(continued)*

Octet Value	Type	Meaning
048	SYMBOL	0 zero
049	SYMBOL	1 one
050	SYMBOL	2 two
051	SYMBOL	3 three
052	SYMBOL	4 four
053	SYMBOL	5 five
054	SYMBOL	6 six
055	SYMBOL	7 seven
056	SYMBOL	8 eight
057	SYMBOL	9 nine
058	SYMBOL	: colon
059	SYMBOL	; semicolon
060	SYMBOL	< left angle bracket (or less than)
061	SYMBOL	= equal sign
062	SYMBOL	> right angle bracket (or greater than)
063	SYMBOL	? question mark
064	SYMBOL	@ commercial at sign
065	SYMBOL	A
066	SYMBOL	B
067	SYMBOL	C
068	SYMBOL	D
069	SYMBOL	E
070	SYMBOL	F
071	SYMBOL	G
072	SYMBOL	H
073	SYMBOL	I
074	SYMBOL	J
075	SYMBOL	K
076	SYMBOL	L
077	SYMBOL	M
078	SYMBOL	N
079	SYMBOL	O
080	SYMBOL	P
081	SYMBOL	Q
082	SYMBOL	R
083	SYMBOL	S
084	SYMBOL	T
085	SYMBOL	U
086	SYMBOL	V
087	SYMBOL	W
088	SYMBOL	X
089	SYMBOL	Y
090	SYMBOL	Z

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Table 17-4. Default Terminal Character Repertoire *(concluded)*

Octet Value	Type	Meaning
091	SYMBOL	[left square bracket
092	SYMBOL	\ back slash
093	SYMBOL	] right square bracket
094	SYMBOL	^ caret
095	SYMBOL	_ underscore
096	SYMBOL	` accent grave
097	SYMBOL	a
098	SYMBOL	b
099	SYMBOL	c
100	SYMBOL	d
101	SYMBOL	e
102	SYMBOL	f
103	SYMBOL	g
104	SYMBOL	h
105	SYMBOL	i
106	SYMBOL	j
107	SYMBOL	k
108	SYMBOL	l
109	SYMBOL	m
110	SYMBOL	n
111	SYMBOL	o
112	SYMBOL	p
113	SYMBOL	q
114	SYMBOL	r
115	SYMBOL	s
116	SYMBOL	t
117	SYMBOL	u
118	SYMBOL	v
119	SYMBOL	w
120	SYMBOL	x
121	SYMBOL	y
122	SYMBOL	z
123	SYMBOL	{ left curly bracket
124	SYMBOL	| vertical bar
125	SYMBOL	} right curly bracket
126	SYMBOL	~ tilde
127	CONTROL	non-destructive backspace (DEL)
128-255	NUL	none

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17.5.2 Control Functions

There are six octet codes within the default terminal character repertoire that perform control functions. In this context, control function means some action that is implied by the receipt of one of these control codes.

17.5.2.1 Octet Code 007

The octet code 007 shall represent an audible indication (BEL). Normally this would be used to sound a tone or bell signal.

17.5.2.2 Octet Codes 008 and 127

The octet code 008 shall represent a non-destructive backspace (BS). This shall cause the cursor of the virtual "output device" to be moved one character position to the left. If the cursor is at the extreme left or beginning of a line, then BS shall have no effect.

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This function shall only change the current position, without overwriting or altering any characters that have been previously displayed on the same "line." The octet code 127 shall be considered to be equivalent to 008 and shall have the same effects.

17.5.2.3 Octet Code 013

The octet code 013 shall represent a carriage return (CR). This shall cause the cursor to be reset to the beginning of the current "line." Subsequently received characters would then overwrite existing characters on the current "line."

17.5.2.4 Octet Code 010

The octet code 010 shall represent a line feed (LF). This shall cause the cursor to be advanced to the next line but shall not change cursor position within the line. Typically this code is used in conjunction with CR.

17.5.2.5 Octet Code 009

The octet code 009 shall represent a horizontal advance to the next tab stop (TAB). This shall cause the cursor to be advanced to the next tab position on the current line. This function shall only change the cursor position, without overwriting or altering any characters that have previously been displayed on the same line. Tab stops shall exist at every eight character positions, as shown in Figure 17-5.

17.5.3 Page Size Assumptions

There shall be only two assumptions about page size within the Default-terminal context. First, pages are assumed to have 80 columns.

```
        1         2         3         4         5
12345678901234567890123456789012345678901234567890 ...
       T         T         T         T         T         T ...
```

Figure 17-5. VT tab positions.

Each SYMBOL character received is assumed to occupy one column. NUL characters have no effect on column position. CONTROL characters have different effects, as described under 17.5.2. Second, each page is assumed to be unconstrained in length. This is equivalent to a printer with continuous form paper.

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18 ERROR, REJECT, and ABORT CODES

All errors associated with the BACnet protocol are enumerated according to a category called "Error Class." Within each Error Class, the errors are further enumerated individually by "Error Code." It is thus possible for an application to take remedial action based upon two levels of granularity.

18.1 Error Class - DEVICE

This Error Class pertains to circumstances that affect the functioning of an entire BACnet device. The presence of one of these errors generally indicates that the entire service request has failed.

DEVICE_BUSY - A service request has been temporarily declined because the addressed BACnet device expects to be involved in higher priority processing for a time in excess of the usual request/confirm timeout period.

CONFIGURATION_IN_PROGRESS - A service request has been temporarily declined because the addressed BACnet device is in the process of being configured, either by means local to the device or by means of other protocol services.

INCONSISTENT_CONFIGURATION - This error code is used when a device is misconfigured and hence cannot process a request.

INTERNAL_ERROR - There are cases where some internal error is encountered. These are cases that are never expected to occur, but if they do the manufacturer should be contacted.

NOT_CONFIGURED - A device may require configuration, possibly vendor-specific, before it becomes functional. If it is not configured, it can receive BACnet requests but cannot reasonably process them.

OPERATIONAL_PROBLEM - A service request has been declined because the addressed BACnet device has detected an operational problem that prevents it from carrying out the requested service.

OTHER - This error code is returned for a reason other than any of those previously enumerated for this Error Class.

18.2 Error Class - OBJECT

This Error Class pertains to problems related to identifying, accessing, and manipulating BACnet objects, whether BACnet-defined or not. Since these errors generally apply to individual object characteristics, they do not necessarily signal that an entire service request has failed.

DYNAMIC_CREATION_NOT_SUPPORTED - An attempt has been made to create an object using an object type that cannot be created dynamically.

FILE_FULL - This applies to the case when a File Object becomes filled to a designed limit, as opposed to a No Space Available / Out of Memory situation.

NO_ALARM_CONFIGURED - The BACnet object referenced by the service does not support, or is not configured for, event generation.

NO_OBJECTS_OF_SPECIFIED_TYPE - A search of the addressed BACnet device's object database has failed to find any objects of the object type specified in the service request.

OBJECT_DELETION_NOT_PERMITTED - An attempt has been made to delete an object that cannot be deleted or is currently protected from deletion.

OBJECT_IDENTIFIER_ALREADY_EXISTS - An attempt has been made to create a new object using an object identifier already in use.

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READ_ACCESS_DENIED - An attempt has been made to read the properties of an object defined as inaccessible through the BACnet protocol read services.

UNKNOWN_OBJECT - An Object_Identifier has been specified for an object that does not exist in the object database of the addressed BACnet device.

UNSUPPORTED_OBJECT_TYPE - An object type has been specified in a service parameter that is unknown or unsupported in the addressed BACnet device.

LOG_BUFFER_FULL - The attempted operation would result in the addition of a log record to an object whose log buffer is full.

OPTIONAL_FUNCTIONALITY_NOT_SUPPORTED - The requested action cannot be executed because the specified object does not support the optional functionality required.

BUSY - A service request has been temporarily declined because the addressed object is involved in a process that precludes execution of the service.

OTHER - This error code is returned for a reason other than any of those previously enumerated for this Error Class.

18.3 Error Class - PROPERTY

This Error Class pertains to problems related to identifying, accessing, and manipulating the properties of BACnet objects, whether BACnet-defined or not. Since these errors generally apply to individual property characteristics, they do not necessarily signal that an entire service request has failed.

CHARACTER_SET_NOT_SUPPORTED - A character string value was encountered that is not a supported character set.

DATATYPE_NOT_SUPPORTED - The data is of, or contains, a datatype not supported by this instance of this property.

INCONSISTENT_SELECTION_CRITERION - A property has been referenced with a datatype inconsistent with the 'Comparison Value' specified in a 'Object Selection Criteria' service parameter. This error would arise, for example, if an analog property were compared against a Boolean constant, or vice-versa.

INVALID_ARRAY_INDEX - An attempt was made to access an array property using an array index that is outside the range permitted for this array.

INVALID_DATATYPE - The datatype of a property value specified in a service parameter does not match the datatype of the property referenced by the specified Property_Identifier.

LOGGED_VALUE_PURGED - A previously logged value was purged due to a change to the list of logged properties.

NO_PROPERTY_SPECIFIED - No data was logged due to a device or object instance equal to 4194303 in the list of logged properties.

NOT_CONFIGURED_FOR_TRIGGERED_LOGGING - The attempted logging operation is only allowed when the Logging_Type property has the value TRIGGERED.

NOT_COV_PROPERTY - The property is not conveyed by COV notification.

OPTIONAL_FUNCTIONALITY_NOT_SUPPORTED - An attempt has been made to write a value to a property that would require the device to exhibit non-supported optional functionality.

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PROPERTY_IS_NOT_AN_ARRAY - An attempt has been made to access a property as an array and that property does not have an array datatype.

READ_ACCESS_DENIED - An attempt has been made to read a property defined as inaccessible through the BACnet protocol read services.

UNKNOWN_PROPERTY - A Property_Identifier has been specified in a service parameter that is unknown or unsupported in the addressed BACnet device for objects of the referenced object type.

UNKNOWN_FILE_SIZE - This error code is returned when the File_Size property is read and the size of the file is unknown.

VALUE_NOT_INITIALIZED - An attempt was made to read a property whose value has not been initialized.

VALUE_OUT_OF_RANGE - An attempt has been made to write to a property with a value that is outside the range of values defined for the property.

VALUE_TOO_LONG - A property value is too long to send in the current message context and an Abort is not an option, such as when sending an UnconfirmedCOVNotification.

WRITE_ACCESS_DENIED - An attempt has been made to write to a property defined as inaccessible through the BACnet protocol write services.

DUPLICATE_NAME - An attempt has been made to write to an Object_Name property with a value that is already in use in a different Object_Name property within the device.

DUPLICATE_OBJECT_ID - An attempt has been made to write to an Object_Identifier property with a value that is already in use in a different Object_Identifier within the same device.

OTHER - This error code is returned for a reason other than any of those previously enumerated for this Error Class.

18.4 Error Class - RESOURCES

This Error Class pertains to problems related to the resources of a BACnet device that affect its capacity to carry out protocol service requests.

NO_SPACE_FOR_OBJECT - An attempt to create an object has failed because not enough dynamic memory space exists in the addressed BACnet device.

NO_SPACE_TO_ADD_LIST_ELEMENT - An attempt to add an element to a list has failed because not enough dynamic memory space exists in the addressed BACnet device.

NO_SPACE_TO_WRITE_PROPERTY - An attempt to write a property has failed because not enough dynamic memory space exists in the addressed BACnet device.

OUT_OF_MEMORY - There are many internal operations during the processing of typical messages that may rely on acquiring dynamically allocated space. This indicates the failure of such an allocation.

OTHER - This error code is returned for a reason other than any of those previously enumerated for this Error Class.

18.5 Error Class - SECURITY

This Error Class pertains to problems related to security services. Without exception, these errors signal the inability of the responding BACnet-user to carry out the desired service in its entirety and are thus "fatal".

PASSWORD_FAILURE - The 'Operator Name' and 'Operator Password' did not associate correctly.

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READ_ACCESS_DENIED - The requesting device did not provide security credentials of sufficient authorization to allow the request.

WRITE_ACCESS_DENIED - The requesting device did not provide security credentials of sufficient authorization to allow the request.

SUCCESS - The security operation was successful.

ACCESS_DENIED - The requesting device did not provide security credentials of sufficient authorization to allow the request. This error is used when READ_ACCESS_DENIED and WRITE_ACCESS_DENIED are not appropriate.

BAD_DESTINATION_ADDRESS - The destination address in the request does not match that of the receiver.

BAD_DESTINATION_DEVICE_ID - The Destination Device Instance in the security wrapper does not match the local device instance.

BAD_SIGNATURE - The signature in a secure packet was incorrect.

BAD_SOURCE_ADDRESS - The source address in a secure packet was incorrect or missing.

BAD_TIMESTAMP - The timestamp in a secure packet was not within the allowable timestamp window of the receiver.

CANNOT_USE_KEY - A key was provided to the device via an Update-Key-Set or Update-Distribution-Key service that is based on an algorithm that the device does not support.

CANNOT_VERIFY_MESSAGE_ID - A device could not accurately ascertain whether it sent a challenged message or not.

CORRECT_KEY_REVISION - The device's key sets are current.

DESTINATION_DEVICE_ID_REQUIRED - The Destination Device Instance in the security header of a unicast message had the value 4194303 and the destination device requires this value to be set correctly for the operation requested.

DUPLICATE_MESSAGE - A message with the provided Message Id has already been received from the source device within the security time window.

ENCRYPTION_NOT_CONFIGURED - The device is not configured to accept encrypted messages.

ENCRYPTION_REQUIRED - The device requires encryption for the requested operation.

INCORRECT_KEY - The key provided to secure the message does not indicate sufficient authority to perform the requested operation.

INVALID_KEY_DATA - A key was received that contained invalid data.

KEY_UPDATE_IN_PROGRESS - A key update is already in progress.

MALFORMED_MESSAGE - The message size is invalid, or security parameters are missing or malformed.

NOT_KEY_SERVER - A device received a request that only a Key Server configured to service the message source could fulfill.

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SECURITY_NOT_CONFIGURED - The device is not configured for security on the receiving port.

SOURCE_SECURITY_REQUIRED - The operation requested requires that the source secure or encrypt the request.

TOO_MANY_KEYS - The device cannot be configured with the number of keys provided for the key set.

UNKNOWN_AUTHENTICATION_TYPE - The authentication method in a secure message is unknown to the receiving device.

UNKNOWN_KEY - The key used to secure message is unknown to the receiving device.

UNKNOWN_KEY_REVISION - The key revision used to secure message is unknown to the receiving device.

UNKNOWN_SOURCE_MESSAGE - The device did not send the challenged message.

OTHER - This error code is returned for a reason other than any of those previously enumerated for this Error Class.

18.6 Error Class - SERVICES

This Error Class pertains to problems related to the execution of protocol service requests, whether BACnet-defined or not.

CHARACTER_SET_NOT_SUPPORTED - A character string value was encountered that is not a supported character set.

COMMUNICATION_DISABLED - Communication has been disabled due to receipt of a DeviceCommunicationControl request.

COV_SUBSCRIPTION_FAILED - COV Subscription failed for some reason.

FILE_ACCESS_DENIED - Generated in response to an AtomicReadFile or AtomicWriteFile service request for access to a file that is currently locked or otherwise not accessible.

INCONSISTENT_OBJECT_TYPE - A device receives a service request for an object whose type is inconsistent with the service requested, or for an object that doesn't support the service. An example is an AtomicReadFile request received for an object that is not a File object.

INCONSISTENT_PARAMETERS - A conflict exists because two or more of the parameters specified in the service request are mutually exclusive.

INVALID_CONFIGURATION_DATA - The configuration data provided was invalid or corrupt.

INVALID_EVENT_STATE - The 'Event State Acknowledged' parameter conveyed by an AcknowledgeAlarm service request does not match the 'To State' parameter of the most recent occurrence of the same transition type of the event being acknowledged.

INVALID_FILE_ACCESS_METHOD - Generated in response to an AtomicReadFile or AtomicWriteFile request that specifies a 'File Access Method' that is not valid for the specified file.

INVALID_FILE_START_POSITION - Generated in response to an AtomicReadFile or AtomicWriteFile request that specifies an invalid 'File Start Position' or invalid 'File Start Record' parameter.

INVALID_PARAMETER_DATATYPE - The datatype of a value specified for a service parameter is not appropriate to the parameter.

INVALID TAG - This error indicates that a syntax error was encountered in the request.

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INVALID_TIME_STAMP - The 'Time Stamp' parameter conveyed by an AcknowledgeAlarm service request does not match the time of the most recent occurrence of the event being acknowledged.

MISSING_REQUIRED_PARAMETER - A parameter required for the execution of a service request has not been supplied.

OPTIONAL_FUNCTIONALITY_NOT_SUPPORTED - The parameters of a service are such that the device would be required to exhibit non-supported optional functionality.

PARAMETER_OUT_OF_RANGE - Generated in response to a confirmed request APDU that conveys a parameter whose value is outside the range defined for this service.

PROPERTY_IS_NOT_A_LIST - An attempt has been made to access a property via either the AddListElement service or the RemoveListElement service and that property does not have a list datatype.

PROPERTY_IS_NOT_AN_ARRAY - An attempt has been made to access a property as an array and that property does not have an array datatype.

SERVICE_REQUEST_DENIED - A request has been made to execute a service for which the requesting BACnet device does not have the appropriate authorization.

LIST_ELEMENT_NOT_FOUND - A list data item required for carrying out the service request was not found.

UNKNOWN_SUBSCRIPTION - No subscription can be found that matches the specified object, property, and process identifier for the received notification.

VALUE_OUT_OF_RANGE - The requested action cannot be executed because one of the parameters provided is outside of the range supported by the device.

OTHER - This error code is returned for a reason other than any of those previously enumerated for this Error Class.

18.7 Error Class - COMMUNICATION

This Error Class pertains to problems related to network communications. These codes indicate problems reported by a remote device in abort and reject PDUs, or they indicate problems detected internally. These error codes are stored in properties of objects whose operation involves the network communications, such as the Trend Log object's Log_Buffer property. This Error Class shall not be conveyed in error PDUs.

ABORT_APDU_TOO_LONG - An APDU was received from the local application program whose overall size exceeds the maximum transmittable length or exceeds the maximum number of segments accepted by the server.

ABORT_APPLICATION_EXCEEDED_REPLY_TIME - A device receives a confirmed request but its application layer has not responded within the published APDU Timeout period.

ABORT_BUFFER_OVERFLOW - An input buffer capacity has been exceeded in this device or was reported by the remote device.

ABORT_INVALID_APDU_IN_THIS_STATE - An APDU was received, by this device or the remote device, that was not expected in the present state of the Transaction State Machine.

ABORT_OUT_OF_RESOURCES - A device receives a request but cannot start processing because it has run out of some internal resource.

ABORT_PREEMPTED_BY_HIGHER_PRIORITY_TASK - The transaction was aborted to permit higher priority processing by this device or the remote device.

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ABORT_SEGMENTATION_NOT_SUPPORTED - An Abort PDU specifying an abort code of SEGMENTATION_NOT_SUPPORTED was sent or received by this device.

ABORT_TSM_TIMEOUT - A transaction state machine timer exceeded the timeout applicable for the current state, causing the transaction machine to abort the transaction.

ABORT_PROPRIETARY - An abort PDU with a proprietary reason was sent or received by this device.

ABORT_WINDOW_SIZE_OUT_OF_RANGE - A device receives a request that is segmented, or receives any segment of a segmented request, where the Proposed Window Size field of the PDU header is either zero or greater than 127.

ABORT_OTHER - This device sent or received an abort PDU with a reason of OTHER.

REJECT_BUFFER_OVERFLOW - An input buffer capacity has been exceeded in this device or has been reported by the remote device.

REJECT_INCONSISTENT_PARAMETERS - The remote device sent a reject PDU with a reason of INCONSISTENT_PARAMETERS.

REJECT_INVALID_PARAMETER_DATA_TYPE - The remote device sent a reject PDU with a reason of INVALID_PARAMETER_DATATYPE.

REJECT_INVALID_TAG - This device or the remote device encountered an invalid tag while parsing a message.

REJECT_MISSING_REQUIRED_PARAMETER - The remote device sent a reject PDU with a reason of MISSING_REQUIRED_PARAMETER.

REJECT_PARAMETER_OUT_OF_RANGE - The remote device sent a reject PDU with a reason of PARAMETER_OUT_OF_RANGE.

REJECT_TOO_MANY_ARGUMENTS - The remote device sent a reject PDU with a reason of TOO_MANY_ARGUMENTS.

REJECT_UNDEFINED_ENUMERATION - The remote device sent a reject PDU with a reason of UNDEFINED_ENUMERATION.

REJECT_UNRECOGNIZED_SERVICE - The remote device sent a reject PDU with a reason of UNRECOGNIZED_SERVICE.

REJECT_PROPRIETARY - This reject reason indicates that a proprietary reject reason was sent or received by this device.

REJECT_OTHER - The remote device sent a reject PDU with a reason of OTHER.

INVALID_TAG - This error indicates that an improper tag was found when parsing the response to a confirmed service request or an unconfirmed service request.

NETWORK_DOWN - This error indicates that the local network connection was not established when the request was initiated.

TIMEOUT - This error indicates that a request timed out before a response was received from the remote device.

UNKNOWN_DEVICE - This error indicates that a request was not initiated because the remote device could not be found.

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UNKNOWN_ROUTE - This error indicates that a request was not initiated because a route to the network where the remote device resides could not be found.

NOT_ROUTER_TO_DNET - A Reject-Message-To-Network with reason 1 was returned in response to a network request.

ROUTER_BUSY - A network request failed due to a router en-route being busy.

UNKNOWN_NETWORK_MESSAGE - A network request failed that relied on a network message unknown to the receiver.

MESSAGE_TOO_LONG - A network request failed due a message that was too long to make it to its destination.

SECURITY_ERROR - A network request failed due a security error en-route.

ADDRESSING_ERROR - A network request failed due to an addressing error.

WRITE_BDT_FAILED - A Write-Broadcast-Distribution-Table request failed.

READ_BDT_FAILED - A Read-Broadcast-Distribution-Table request failed.

REGISTER_FOREIGN_DEVICE_FAILED - A Register-Foreign-Device request failed.

READ_FDT_FAILED - A Read-Foreign-Device-Table request failed.

DELETE_FDT_ENTRY_FAILED - A Delete-Foreign-Device-Table-Entry request failed.

DISTRIBUTE_BROADCAST_FAILED - A broadcast network request failed due to a failure of a Distribute-Broadcast-To-Network.

ABORT_SECURITY_ERROR - The Transaction is aborted due to receipt of a security error.

ABORT_INSUFFICIENT_SECURITY - The transaction is aborted due to receipt of a PDU secured differently than the original PDU of the transaction.

OTHER - This error indicates that a communication error occurred other than those previously enumerated for this Error Class.

18.8 Error Class - VT

This Error Class pertains to problems related to the execution of Virtual Terminal services.

UNKNOWN_VT_CLASS - This error indicates that the 'VT-Class' specified in a VT-Open request was not recognized by the target device.

UNKNOWN_VT_SESSION - This error indicates that the 'VT-Session ID' specified in a VT-Data or VT-Close request was not recognized by the target device.

NO_VT_SESSIONS_AVAILABLE - This error indicates that the target device could not fulfill a VT-Open request because of resource limitations.

VT_SESSION_ALREADY_CLOSED - This error indicates that an attempt has been made to close a VT-session that has been previously terminated.

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VT_SESSION_TERMINATION_FAILURE - This error indicates that one of the 'VT-Sessions' specified in a VT-Close request could not be released for some implementation-dependent reason.

OTHER - This error code is returned for a reason other than any of those previously enumerated for this Error Class

18.9 Reject Reason

Only confirmed request PDUs can be rejected. The possible reasons for rejecting the PDU are enumerated in this subclause.

BUFFER_OVERFLOW - A buffer capacity has been exceeded.

INCONSISTENT_PARAMETERS - Generated in response to a confirmed request APDU that omits a conditional service argument that should be present or contains a conditional service argument that should not be present. This condition could also elicit a Reject PDU with a Reject Reason of INVALID_TAG.

INVALID_PARAMETER_DATA_TYPE - Generated in response to a confirmed request APDU in which the encoding of one or more of the service parameters does not follow the correct type specification. This condition could also elicit a Reject PDU with a Reject Reason of INVALID_TAG.

INVALID_TAG - While parsing a message, an invalid tag was encountered. Since an invalid tag could confuse the parsing logic, any of the following Reject Reasons may also be generated in response to a confirmed request containing an invalid tag: INCONSISTENT_PARAMETERS, INVALID_PARAMETER_DATA_TYPE, MISSING_REQUIRED_PARAMETER, and TOO_MANY_ARGUMENTS.

MISSING_REQUIRED_PARAMETER - Generated in response to a confirmed request APDU that is missing at least one mandatory service argument. This condition could also elicit a Reject PDU with a Reject Reason of INVALID_TAG.

PARAMETER_OUT_OF_RANGE - Generated in response to a confirmed request APDU that conveys a parameter whose value is outside the range defined for this service.

TOO_MANY_ARGUMENTS - Generated in response to a confirmed request APDU in which the total number of service arguments is greater than specified for the service. This condition could also elicit a Reject PDU with a Reject Reason of INVALID_TAG.

UNDEFINED_ENUMERATION - Generated in response to a confirmed request APDU in which one or more of the service parameters is decoded as an enumeration that is not defined by the type specification of this parameter.

UNRECOGNIZED_SERVICE - Generated in response to a confirmed request APDU in which the Service Choice field specifies an unknown or unsupported service.

OTHER - Generated in response to a confirmed request APDU that contains a syntax error for which an error code has not been explicitly defined.

18.10 Abort Reason

APDU_TOO_LONG - An APDU was received from the local application program whose overall size exceeds the maximum transmittable length or exceeds the maximum number of segments accepted by the server.

APPLICATION_EXCEEDED_REPLY_TIME - A device receives a confirmed request but its application layer has not responded within the published APDU Timeout period.

BUFFER_OVERFLOW - A buffer capacity has been exceeded.

INVALID_APDU_IN_THIS_STATE - Generated in response to an APDU that is not expected in the present state of the Transaction State Machine.

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OUT_OF_RESOURCES - A device receives a request but cannot start processing because it has run out of some internal resource.

PREEMPTED_BY_HIGHER_PRIORITY_TASK - The transaction shall be aborted to permit higher priority processing.

SEGMENTATION_NOT_SUPPORTED - Generated in response to an APDU that has its segmentation bit set to TRUE when the receiving device does not support segmentation. It is also generated when a BACnet-ComplexACK-PDU is large enough to require segmentation but it cannot be transmitted because either the transmitting device or the receiving device does not support segmentation.

SECURITY_ERROR - The Transaction is aborted due to receipt of a security error.

TSM_TIMEOUT - A transaction state machine timer exceeded the timeout applicable for the current state, causing the transaction machine to abort the transaction.

INSUFFICIENT_SECURITY - The transaction is aborted due to receipt of a PDU secured differently than the original PDU of the transaction.

WINDOW_SIZE_OUT_OF_RANGE - A device receives a request that is segmented, or receives any segment of a segmented request, where the Proposed Window Size field of the PDU header is either zero or greater than 127.

OTHER - This abort reason is returned for a reason other than any of those previously enumerated.

18.11 Confirmed Service Common Errors

Some errors are generic and can occur when any confirmed service is requested. The 'Error Class' and 'Error Code' to be returned for specific situations are as follows:

Situation	Error Class	Error Code
During the processing of the request, dynamically allocated memory was not available at an intermediate step so the request cannot be completed.	RESOURCES	OUT_OF_MEMORY
An unexpected internal error occurred that cannot be recovered from.	DEVICE	INTERNAL_ERROR
The device is not completely configured and therefore can't fulfill the request.	DEVICE	NOT_CONFIGURED
Some misconfiguration is preventing the request from being fulfilled.	DEVICE	INCONSISTENT_CONFIGURATION

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19 BACnet PROCEDURES

This clause defines several procedures that are commonly required in building automation and control systems. Each procedure makes use of BACnet capabilities defined elsewhere in this standard.

19.1 Backup and Restore

This clause describes the procedures to be used to backup and restore the configuration of BACnet devices.

19.1.1 The Backup and Restore Procedures

In BACnet building control systems, many devices will have configuration data that is set up by a vendor's proprietary configuration tool. This setup may consist of network visible BACnet objects and/or non-network visible settings. This section outlines the standard method that BACnet devices will employ if an interoperable device backup and restore feature is to be provided.

The backup and restore procedures use File objects to hold and transfer the configuration data. The content and format of the configuration files is a local matter. The choice of whether to use stream-based files or record-based files is a local matter. The services required to support the backup and restore procedures are ReinitializeDevice, ReadProperty, WriteProperty, AtomicWriteFile, AtomicReadFile, and optionally CreateObject, ReadPropertyMultiple, or WritePropertyMultiple.

19.1.2 Backup

For the purposes of this discussion, the device performing the backup procedure will be referred to as device A, and the device being backed up will be device B.

19.1.2.1 Initiation of the Backup Procedure

Device A sends a ReinitializeDevice(STARTBACKUP, <password>) message to device B. Device A will await a response from device B before continuing with the backup procedure.

19.1.2.2 Preparation for Backup

Before starting a backup procedure, device A shall read the Backup_Preparation_Time property, if present, from device B's Device object. If the property is not present in device B, the value shall be assumed to be 0.

Upon receipt of the ReinitializeDevice(STARTBACKUP, <password>) message, if device B is able to perform a backup procedure, device B shall respond with a 'Result(+)' to the ReinitializeDevice service request. Device B shall set its Backup_And_Restore_State to PREPARING_FOR_BACKUP. Upon receipt of a Result(+), device A shall monitor the Backup_And_Restore_State property and not continue with the backup until the property contains the value PERFORMING_A_BACKUP. During the time period immediately following the Result(+) defined by the Backup_Preparation_Time, device B is allowed to ignore requests from device A and as such device A shall not consider a lack of response during this period to be an error condition. It is a local matter whether device A initiates the monitoring of the Backup_And_Restore_State property during or after this time period. Once device B changes its Backup_And_Restore_State to PERFORMING_A_BACKUP, it shall not ignore requests from device A regardless of whether the Backup_Preparation_Time time period has expired.

If device B is unable to perform a backup procedure or is already performing a backup procedure, then it will respond to the ReinitializeDevice service request with a 'Result(-)' response. Assuming device B supports the backup procedure and the request was properly formulated, the valid Error Class:Error Codes that can be returned are :

DEVICE:CONFIGURATION_IN_PROGRESS - if device B is already processing a backup or a restore request.

SECURITY:PASSWORD_FAILURE - if the password that was provided was incorrect or if a password is required and one was not provided.

After device B responds to the ReinitializeDevice request with a 'Result(+)', device B has Backup_Preparation_Time seconds to prepare for the backup procedure. During this period of time, device B is not required to respond to any BACnet service requests. Once this period of time elapses, device B is required to respond to read requests for properties of the Device object. When device B has successfully completed its backup preparations in their entirety, the configuration File objects shall exist

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in the device and the Backup_And_Restore_State property shall be set to PERFORMING_A_BACKUP. The creation of configuration File objects during this time shall not have an effect on the Database_Revision property.

If device B is unable to successfully complete its backup preparations, it shall set its Backup_And_Restore_State to BACKUP_FAILURE. Device A shall end the backup procedure when it detects device B's state is set to BACKUP_FAILURE.

It is a local matter as to whether device B will respond to other requests while performing a backup procedure. The exception to this is that device B is required to accept and fulfill read requests by device A that consist of accesses to device B's Device object and/or its configuration File objects. Note that Device B is allowed to return an UNKNOWN_FILE_SIZE error in response to requests for the File_Size property of any of its configuration files if the file size is unknown. Any services that are rejected due to an in-progress backup procedure will be rejected with an error class of DEVICE and error code of DEVICE_BUSY.

It is a local matter as to whether device B will continue to perform control actions while it is in backup mode. If device B changes its operational behavior during a backup procedure, then the System_Status property of the Device object shall be set to BACKUP_IN_PROGRESS.

19.1.2.3 Loading the Backup Parameters

Upon receipt of a 'Result(+)' response from device B to the ReinitializeDevice(STARTBACKUP, <password>) message, device A will read the Configuration_Files property of the Device object. This property will be used to determine the files to read and in what order the files will be read. The value of the Configuration_Files property is not guaranteed to contain a complete or correct set of configuration File object references before the backup request is accepted by device B.

19.1.2.4 Backing Up the Configuration Files

Once device A has determined the files that make up the device configuration image, device A will determine the type of each file and will use the AtomicReadFile service to read each configuration file from device B. Each file will be read as a stream of bytes, or as a sequence of records depending on the File_Access_Method property of the File object. Stream access files will be read in byte order and record access files will be read in record order. The files will be read in the same order as they appear in the Configuration_Files property.

It is a local matter as to what device A does with the configuration files, although the intent of the service is to allow an operator to archive the setup of device B such that device B may be restored at a later date should its configuration become corrupt.

It is left up to the implementer of device A as to whether the files read from device B will be made available for examination by tools developed by the implementer of device B. It is recommended that record access files be stored on device A as a sequence of BACnet OCTET STRINGS.

19.1.2.5 Ending the Backup Procedure

When all of the configuration files have been read, device A sends a ReinitializeDevice(ENDBACKUP, <password>) message to device B. Device B will perform whatever actions are required to complete the backup in order to place the device back into the state it was in before the backup procedure or into any other state as defined by the vendor. Device B must not remain in the BACKUP_IN_PROGRESS mode after the backup procedure has ended.

If device A needs to abort the backup for any reason (i.e., the user aborts the procedure, device B fails to allow reads from a configuration file, or device A detects any other condition that inhibits the backup procedure), device A shall attempt to send ReinitializeDevice(ENDBACKUP, <password>) to device B. Upon receipt of this message, device B shall end the backup procedure. If the backup procedure is aborted, device A should not assume that the configuration files are still valid and continue to read them.

The receipt of the ReinitializeDevice(ENDBACKUP, <password>) message shall cause device B to exit backup mode.

If device B does not receive any messages related to the backup procedure from device A for the number of seconds specified in the Backup_Failure_Timeout property of its Device object, device B should assume that the backup procedure has been aborted, and device B should exit backup mode. A message related to the backup procedure is defined to be any

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ReadProperty, ReadPropertyMultiple, WriteProperty, WritePropertyMultiple, CreateObject, or AtomicReadFile request that directly accesses a configuration File object.

When the backup procedure ends, device B shall set its Backup_and_Restore_State to IDLE. The deletion of configuration File objects during the backup procedure shall not have an effect on the Database_Revision property.

19.1.3 Restore

For the purposes of this discussion, the device performing the restore procedure will be referred to as device A, and the device being restored will be device B.

19.1.3.1 Initiation of the Restore Procedure

Device A sends a ReinitializeDevice(STARTRESTORE, <password>) message to device B. Device A will await a response from device B before continuing the restore procedure.

19.1.3.2 Preparation for Restore

Before starting a restore procedure, device A shall read the Restore_Preparation_Time property from device B's Device object. If the property is not present in device B, the value shall be assumed to be 0.

Upon receipt of a restore request, if device B is able to perform a restore procedure, device B shall respond with a 'Result(+)' to the ReinitializeDevice service request. Device B shall set its Backup_And_Restore_State to PREPARING_FOR_RESTORE.

If device B is unable to perform a restore procedure, then it will respond to the ReinitializeDevice service request with a 'Result(-)' response. Assuming device B supports the restore procedure and the request was properly formulated, the valid Error Class:Error Codes that can be returned are:

DEVICE:CONFIGURATION_IN_PROGRESS - if device B is already processing a backup or a restore request.

SECURITY:PASSWORD_FAILURE - if the password that was provided was incorrect or if a password is required and one was not provided.

After device B responds to the ReinitializeDevice request with a 'Result(+)', device B has Restore_Preparation_Time seconds to prepare for the restore procedure. During this period of time, device B is not required to respond to any BACnet service requests. Once this period of time elapses, device B is required to respond to read requests for properties of the Device object. When device B has completed its restore preparations in their entirety, the configuration File objects shall exist in the device, or device B shall be able to accept CreateObject requests from device A to create the configuration File objects, and the Backup_And_Restore_State property shall be set to PERFORMING_A_RESTORE. Once device B changes its Backup_And_Restore_State to PERFORMING_A_RESTORE, it shall not ignore requests from device A regardless of whether the Restore_Preparation_Time time period has expired. The creation of configuration File objects during the Restore procedure, whether automatically created by the device or by the execution of the CreateObject service, shall not impact the value of the Database_Revision property.

If device B is unable to successfully complete its restore preparations, it shall set its Backup_And_Restore_State to RESTORE_FAILURE. Device A shall abort the restore procedure when it detects device B's state is set to RESTORE_FAILURE.

Upon receipt of a Result(+), device A shall monitor the Backup_And_Restore_State property and not continue with the restore until the property contains the value PERFORMING_A_RESTORE. During the time period immediately following the Result(+) defined by the Restore_Preparation_Time, device B is allowed to ignore requests from device A and as such device A shall not consider a lack of response during this period to be an error condition. It is a local matter whether device A initiates the monitoring of the Backup_And_Restore_State property during or after this time period.

It is a local matter as to whether device B will respond to other requests while it is in restore mode. The exception to this is that device B must accept and fulfill read and write requests by device A that consist of accesses to device B's Device object and/or its configuration File objects. Any services that are rejected due to an in-progress backup procedure will be rejected with an error class of DEVICE and error code of CONFIGURATION_IN_PROGRESS.

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Device B must be prepared to answer device A's requests for information from device B's Device object. If device B cannot service requests from devices other than device A, then device B shall reject those services with an error class of DEVICE and an error code of CONFIGURATION_IN_PROGRESS.

It is a local matter as to whether device B will continue to perform control actions while it is in restore mode. If device B changes its operational behavior during a restore procedure, then the System_Status property of the Device object shall be set to DOWNLOAD_IN_PROGRESS.

19.1.3.3 Restoring the Configuration Files

Device A will use the AtomicWriteFile service to write each configuration file to device B. If any of the files do not exist in device B, then device A will attempt to create the files using the CreateObject service. Any files that already exist in the device, and differ in size from the image being written to them, will be truncated by writing 0 to the File_Size property of the File object before the contents are written to the file.

The configuration files will be written as a stream of bytes, or as a sequence of records, depending on the value of the File_Access_Method property of the File object. Note that there is no standard file format for record-based files, whereas any file can be written as a stream of bytes.

Each configuration file written to the device should be a valid configuration file obtained from the vendor, from a vendor's configuration tool, or from a previous backup procedure. The files will be written to the device in the same order as they were retrieved during the backup procedure, or as specified by the vendor if the files were obtained from another source.

Device B is allowed to reject any write operation to the configuration file if it has determined that the content of the write is invalid (internal CRC error, Invalid type code, etc). If this is the case, device B will respond with an error class of SERVICES and an error code of INVALID_CONFIGURATION_DATA. It is a local matter as to whether device A will retry the request and how many times device A will retry, but device A should abort the restore procedure if device B continues to return an error.

19.1.3.4 Ending the Restore Procedure

When device A has completely written all of the configuration files to device B, device A shall send ReinitializeDevice(ENDRESTORE, <password>). Device B will perform whatever actions are required to complete the restore procedure within Restore_Completion_Time seconds after responding with a Result(+), which should include a validation of the restored configuration. If the validation fails, it is a local matter as to what device B will do beyond changing its System_State property to something other than DOWNLOAD_IN_PROGRESS.

If device A needs to abort the restore for any reason (i.e., the user aborts the procedure, device B fails to allow writes to a configuration file, or device A detects any other condition that inhibits the restore procedure), device A shall attempt to send ReinitializeDevice(ABORTRESTORE, <password>) to device B. Upon receipt of this message, device B shall abort the restore procedure within Restore_Completion_Time seconds after responding with a Result(+).

If device B does not receive any messages related to the restore procedure from device A for the number of seconds specified in the Backup_Failure_Timeout property of its Device object, device B should assume that the restore procedure has been aborted, and device B should exit restore mode. A message related to the restore procedure is defined to be any ReadProperty, ReadPropertyMultiple, WriteProperty, WritePropertyMultiple, CreateObject, or AtomicWriteFile request that directly accesses a configuration File object.

When the restore procedure ends successfully, device B shall set its Backup_and_Restore_State to IDLE and shall set the value of the Database_Revision property to the value it had before the restore, and then increment it.

Once the restore procedure has ended, whether it was successful or not, device B must change its System_Status property to something other than DOWNLOAD_IN_PROGRESS.

If the restore is successful, no other actions by device A shall be required, and device B will update the Last_Restore_Time property in its Device object.

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If the restore failed or was aborted and device B is unable to recover its old configuration, or cannot establish a default configuration, device B shall set its System_State to DOWNLOAD_REQUIRED. Every attempt shall be made to leave device B in a state that will accept additional restore procedures.

19.2 Command Prioritization

In building control systems, an object may be manipulated by a number of entities. For example, the present value of a Binary Output object may be set by several applications, such as demand metering, optimum start/stop, etc. Each such application program has a well-defined function it needs to perform. When the actions of two or more application programs conflict with regard to the value of a property, there is a need to arbitrate between them. The objective of the arbitration process is to ensure the desired behavior of an object that is manipulated by several program (or non-program) entities. For example, a start/stop program may specify that a particular Binary Output should be ON, while demand metering may specify that the same Binary Output should be OFF. In this case, the OFF should take precedence. An operator may be able to override the demand metering program and force the Binary Output ON, in which case the ON should take precedence.

In BACnet, this arbitration is provided by a prioritization scheme that assigns varying levels of priorities to commanding entities on a system-wide basis. Each object that contains a commandable property is responsible for acting upon prioritized commands in the order of their priorities. While there is a trade-off between the complexity and the robustness of any such mechanism, the scheme described here is intended to be effective but applicable to even simple BACnet devices.

The following property types are involved in the prioritization mechanism:

(a) Commandable Property: Each object that supports command prioritization has one or more distinguished properties that are referred to as "Commandable Properties." The value of these properties is controlled by the command prioritization mechanism.

(b) Priority_Array: This property is a read-only array that contains prioritized commands or NULLs in the order of decreasing priority. The highest priority (lowest array index) with a non-NULL value is the active command.

(c) Relinquish_Default: This property shall be of the same datatype (and engineering units) as the Commandable Property. When all entries in the Priority_Array are NULL, the value of the Commandable Property shall have the value specified by the Relinquish_Default property.

Although the Command object is used to write a set of values to a group of object properties, command prioritization is not involved unless the properties are commandable.

19.2.1 Prioritization Mechanism

For BACnet objects, commands are prioritized based upon a fixed number of priorities that are assigned to command-issuing entities. A prioritized command (one that is directed at a commandable property of an object) is performed via a WriteProperty service request or a WritePropertyMultiple service request. The request primitive includes a conditional 'Priority' parameter that ranges from 1 to 16. Each commandable property of an object has an associated priority table that is represented by the Priority_Array property. The Priority_Array consists of an array of commanded values in order of decreasing priority. The first value in the array corresponds to priority 1 (highest), the second value corresponds to priority 2, and so on, to the sixteenth value that corresponds to priority 16 (lowest).

An entry in the Priority_Array may have a commanded value or a NULL. A NULL value indicates that there is no existing command at that priority. An object continuously monitors all entries within the priority table in order to locate the entry with the highest priority non-NULL value and sets the commandable property to this value.

A commanding entity (application program, operator, etc.) may issue a command to write to the commandable property of an object, or it may relinquish a command issued earlier. Relinquishing of a command is performed by a write operation similar to the command itself, except that the commandable property value is NULL. Relinquishing a command places a NULL value in the Priority_Array corresponding to the appropriate priority. This prioritization approach shall be applied to local actions that change the value of commandable properties as well as to write operations via BACnet services.

If an attempt is made to write to a commandable property without explicitly specifying the priority, a default priority of 16 (the lowest priority) shall be assumed. If an attempt is made to write to a property that is not commandable with a specified priority,

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the priority shall be ignored. The Priority_Array property is read-only. Its values are changed indirectly by writing to the commandable property itself.

19.2.1.1 Commandable Properties

The prioritization scheme is applied to certain properties of objects. The standard commandable properties and objects are as follows:

OBJECT	COMMANDABLE PROPERTY
Analog Output	Present_Value
Binary Output	Present_Value
Multi-state Output	Present_Value
Multi-state Value	Present_Value
Analog Value	Present_Value
Binary Value	Present_Value
Access Door	Present_Value
BitString Value	Present_Value
CharacterString Value	Present_Value
Date Value	Present_Value
Date Pattern Value	Present_Value
DateTime Value	Presetn_Value
DateTime Pattern Value	Present_Value
Large Analog Value	Present_Value
OctetString Value	Present_Value
Integer Value	Present_Value
Time Value	Present_Value
Time Pattern Value	Present_Value
Positive Integer Value	Present_Value

The designated properties of the Analog Output, Binary Output, Multi-state Output and Access Door objects are commandable (prioritized) by definition. The designated properties of the Analog Value, Binary Value, Multi-state Value, BitString Value, CharacterString Value, Date Value, Date Pattern Value, DateTime Value, DateTime Pattern Value, Large Analog Value, OctetString Value, Integer Value, Time Value, Time Pattern Value, and Positive Integer Value objects may optionally be commandable. Individual vendors, however, may decide to apply prioritization to any of the vendor-specified properties. These additional commandable properties shall have associated Priority_Array and Relinquish_Default properties with appropriate names. See 23.3.

19.2.1.2 Prioritized Commands

Prioritized commands, i.e., commands directed at commandable properties, are either WriteProperty service requests or WritePropertyMultiple service requests. In either case, the request primitive shall contain (among others) the following parameters:

Property Identifier:	Commandable_Property
Property Value:	Desired Value
Priority:	Priority

The end result of a successful write operation is to place a desired value in the priority table at the appropriate priority. If another value was already present at that priority, it shall be overwritten with the new value, without any regard to the identity of the previous commanding entity.

19.2.1.3 Relinquish Commands

When a commanding entity no longer desires to control a commandable property, it issues a relinquish command. A relinquish command is also either a WriteProperty service request or a WritePropertyMultiple service request. In either case, the request primitive shall contain (among others) the following parameters:

Property Identifier:	Commandable_Property
Property Value:	NULL

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Priority: Priority

The placement of NULL in the value parameter indicates the absence of any command at that priority. When all elements of the priority table array contain NULL, the commandable property shall assume the value defined in the Relinquish_Default property of the object.

It is possible for an application entity to relinquish at a priority other than its own, resulting in unpredictable behavior. If more than one application is assigned the same priority, it is possible for one application entity to write-over (or relinquish) the commands from the other application entity, resulting in unpredictable operation. To minimize this possibility, it is very important not to allow more than one commanding entity to assume the same priority level within the system.

19.2.1.4 Command Source ID

There is no provision for maintaining command source identification as part of the priority table. Any implementation of command source identification is vendor-specific in nature.

19.2.1.5 Command Overwrite

Whenever a command is issued to a commandable property, the value is placed in the Priority_Array at the appropriate priority position, without any regard to the current value residing there. The new command overwrites the existing command. No notification of such overwrite is made to the original commanding entity.

19.2.2 Application Priority Assignments

Commanding entities are assigned one of the 16 possible priority levels. The assignment of most priorities is site dependent and represents the objectives of the site management. Table 19-1 contains the standard priorities. Other applications that need prioritization include Temperature Override, Demand Limiting, Optimum Start/Stop, Duty Cycling, and Scheduling. The relative priorities of these applications may vary from site to site and are not standardized. For interoperability at any particular site, the only requirement is that all devices implement the same priority scheme. The positions marked Available are open for assignment to DDC programs, EMS programs, etc. The interpretation of what conditions constitute Manual-Life Safety or Automatic-Life Safety decisions is a local matter.

Table 19-1. Standard Command Priorities

Priority Level	Application	Priority Level	Application
1	Manual-Life Safety	9	Available
2	Automatic-Life Safety	10	Available
3	Available	11	Available
4	Available	12	Available
5	Critical Equipment Control	13	Available
6	Minimum On/Off	14	Available
7	Available	15	Available
8	Manual Operator	16	Available

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19.2.3 Minimum_On_Time and Minimum_Off_Time

If the commandable property is the Present_Value property of a Binary Output object or a Binary Value object and that object possesses the optional Minimum_On_Time and Minimum_Off_Time properties, then minimum on and minimum off times shall behave according to the algorithm described in this subclause.

Command priority 6 is reserved for use by this algorithm and may not be used for other purposes in any object.

(a) the Present_Value is ACTIVE and the time since the last change of state of the Present_Value is less than the Minimum_On_Time, then element 6 of the Priority_Array shall contain a value of ACTIVE.

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(b) If the Present_Value is INACTIVE and the time since the last change of state of the Present_Value is less than the Minimum_Off_Time, then element 6 of the Priority_Array shall contain a value of INACTIVE.
(c) If neither (a) nor (b) is true, then element 6 of the Priority_Array shall contain a value of NULL.

These rules imply actions to be taken when the Present_Value is written and actions to be taken based on elapsed time. The means by which these actions are implemented is a local matter, so long as the behavior described in this subclause is achieved.

When a write to a commandable property occurs at any priority, the specified value or relinquish (NULL) is always written to the appropriate slot in the priority table, regardless of any minimum on or off times.

The Priority_Array is then examined by the local priority maintenance entity to determine the highest priority that contains a non-NULL value. If this value differs from the Present_Value immediately before the write, then a change of state has occured. If such a change of state occurs, the new value is also written to priority 6 in the Priority_Array and the time of the change is noted. The means by which the timing is performed is a local matter.

When the minimum on or off time signified by a non-NULL value in priority 6 has elapsed, the local minimum time maintenance entity shall write a NULL to priority 6 and re-examine the Priority_Array to determine the new Present_Value. If this value indicates a change of state, then the appropriate actions shall be taken as described above.

The effect of a non-NULL value in priority 6 is that writes at any lower priority (larger priority number) cannot cause a change of state. Thus, minimum on or off time protection may be achieved relative to these priorities.

Writes to any priority higher than 6 (smaller priority number) may cause changes of state regardless of Minimum_On_Time or Minimum_Off_Time. Thus, these priorities should be used only for critical or emergency use. Note, however, that changes of state caused by a write to these high priorities will also cause writes to priority 6 as described above. Thus, if a NULL is subsequently written to the high priority while minimum time is in effect, that time shall be observed before any change of state is made as a result of a value at a lower priority.

For additional discussion of minimum on and off time processing see Annex I.

19.2.4 Prioritization for Command Objects

A Command object is capable of issuing commands just as any other command-issuing entity. A Command object may be related to an application with any priority. The Action property of the Command object contains all of the parameters necessary for writing to commandable properties. See Clause 12.10.8.

19.2.5 Prioritization for Loop Objects

Loop objects may need to interact with objects that have a commandable property, even though, in general, they will not use BACnet services to do so. Each Loop object has a Priority_For_Writing property that designates the appropriate priority of this control loop with respect to the commandable property. See Clause 12.17.28.

19.2.6 Prioritization for Schedule Objects

Schedule objects may need to interact with objects that have a commandable property, even though, in general, they will not use BACnet services to do so. Each Schedule object has a Priority_For_Writing property that designates the appropriate priority of this schedule with respect to the commandable property. See Clause 12.24.11.

19.2.7 Prioritization for Access Point Objects

Access Point objects interact with the Present_Value property of Access Door objects; however, if the Access Door objects are local to the device, they will not use BACnet services to do so. Each Access Point object has a Priority_For_Writing property that designates the priority to be used to command the Access Door objects.

19.3 Device Restart Procedure

When a BACnet device restarts, there are a number of different configuration items that can be lost. For example, a device need not remember which devices have subscribed to receive change-of-value notifications or to which values they have subscribed. For this reason, other devices may be interested in determining when a device has restarted. This section outlines how a device may interoperably indicate that it has restarted.

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When a device is powered on, when it restarts due to a ReinitializeDevice service (COLDSTART or WARMSTART), or when it restarts for some other reason, the device shall transmit an UnconfirmedCOVNotification request. The 'Subscriber Process Identifier' parameter shall be 0, the 'Monitored Object Identifier' parameter shall reference the Device object, the 'Time Remaining' parameter shall be 0, and the 'List of Values' parameter shall contain three values, the System_Status, the Time_Of_Device_Restart, and the Last_Restart_Reason properties of the Device object. The device shall transmit this message after the complete power-up or restart sequence has been completed so that the system-status value is accurate.

The device shall send the restart notification to each recipient in the Restart_Notification_Recipients property of the Device object.

MS/TP slave devices are not able to support this procedure, although they may support the Time_Of_Device_Restart and Last_Restart_Reason properties.

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20 ENCODING BACnet PROTOCOL DATA UNITS

Application Layer Protocol Data Units (APDUs) are used in BACnet to convey the information contained in the application service primitives and associated parameters.

ISO Standard 8824, Specification of Abstract Syntax Notation One (ASN.(1), has been selected as the method for representing the data content of BACnet services. Clause 21 contains an ASN.1 definition for each service defined by this standard. ASN.1 provides an abstract syntax. However, the exact bit-by-bit layout of an APDU may have several forms, depending on the encoding rules that are selected.

Within the Open Systems Interconnection model, the encoding rules to be used are chosen by the presentation layer through a process of negotiation. This negotiation is used by cooperating systems to determine not only the basic encoding rules, of which ISO 8825, Specification of Basic Encoding Rules for ASN.1, is an example, but also whether or not the APDUs to be subjected to other manipulations such as data compression, encryption, or character code conversion.

Because BACnet's collapsed OSI architecture does not incorporate any presentation layer functionality, APDU encoding must be defined and agreed to by communicating devices in advance. BACnet's encoding rules have been designed to take into account the requirements of building automation and control systems for simplicity and compactness. As a result, they differ, in some respects, from ISO 8825 while still permitting the encoding of BACnet APDUs that have been represented using ASN.1. This means that BACnet services and procedures could be used in their entirety in a future OSI-compliant network by adding the presentation layer capability to negotiate either the encoding rules contained in this standard or any other encoding rules that might later be available.

The encoding of ASN.1 specified in ISO 8825 is intended to apply uniformly to all data elements in a PDU. Each data element is represented by three components: (1) identifier octets, (2) length octets, and (3) contents octets. The explicit identification of each data element allows parsers to be developed that can decode any PDU without prior knowledge of its format or semantic content. The alternative is to implicitly identify each data element, generally by mutual agreement as to its data format and location within the PDU. The former approach tends to result in greater generality at the expense of greater overhead; the latter approach tends to reduce overhead while limiting future extensibility.

The approach taken in BACnet is a compromise. The fixed portion of each APDU containing protocol control information is encoded implicitly and is described in 20.1. The variable portion of each APDU containing service-specific information is encoded explicitly and is described in 20.2. The resulting scheme significantly reduces overhead while preserving the possibility of easily adding new services in the future.

20.1 Encoding the Fixed Part of BACnet APDUs

BACnet APDUs consist of protocol control information and, possibly, user data.

"Protocol control information" (PCI) comprises data required for the operation of the application layer protocol, including the type of APDU, information to match service requests and service responses, and information to carry out the reassembly of segmented messages. This information is contained in the "header," or fixed part, of the APDU.

"User data" comprises information specific to individual service requests or responses. This portion of the APDU will be referred to as the 'variable part' of the APDU.

Because every APDU contains PCI fields, BACnet encodes the PCI without the use of tags or length information even though the ASN.1 might indicate the presence of tags in the syntactical descriptions of the APDUs. Tags are used to encode the variable-content user data as specified in 20.2. This selective use of tags results in a considerable reduction in overhead.

The remainder of this subclause lays out the format of each APDU type.

20.1.1 Encoding the BACnetPDU CHOICE Tag

All BACnet messages are defined by an ASN.1 production called the BACnetPDU. See Clause 21. BACnetPDU is a choice of one of eight BACnet APDU types. For all BACnet APDUs, this choice shall be encoded as a four-bit binary number in the bits 4 through 7 of the first octet of the APDU header, with bit 7 being the most significant bit. These bits indicate the value

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of the tag (0 - 7), which represents the APDU type choice. This encoding is illustrated in the examples below for each APDU type.

20.1.2 BACnet-Confirmed-Request-PDU

The BACnet-Confirmed-Request-PDU is used to convey the information contained in confirmed service request primitives.

```
BACnet-Confirmed-Request-PDU ::= SEQUENCE {
        pdu-type                        [0] Unsigned (0..15), -- 0 for this PDU type
        segmented-message               [1] BOOLEAN,
        more-follows                    [2] BOOLEAN,
        segmented-response-accepted     [3] BOOLEAN,
        reserved                        [4] Unsigned (0..3), -- must be set to zero
        max-segments-accepted           [5] Unsigned (0..7),  -- as per 20.1.2.4
        max-APDU-length-accepted        [6] Unsigned (0..15), -- as per 20.1.2.5
        invokeID                        [7] Unsigned (0..255),
        sequence-number                 [8] Unsigned (0..255) OPTIONAL, -- only if segmented msg
        proposed-window-size            [9] Unsigned (1..127) OPTIONAL, -- only if segmented msg
        service-choice                  [10] BACnetConfirmedServiceChoice,
        service-request                 [11] BACnet-Confirmed-Service-Request
-- Context specific tags 0..11 are NOT used in header encoding
        }
```

The parameters of the BACnet-Confirmed-Request-PDU have the following meanings.

20.1.2.1 segmented-message

This parameter indicates whether or not the confirmed service request is entirely, or only partially, contained in the present PDU. If the request is present in its entirety, the value of the 'segmented-message' parameter shall be FALSE. If the present PDU contains only a segment of the request, this parameter shall be TRUE.

20.1.2.2 more-follows

This parameter is only meaningful if the 'segmented-message' parameter is TRUE. If 'segmented-message' is TRUE, then the 'more-follows' parameter shall be TRUE for all segments comprising the confirmed service request except for the last and shall be FALSE for the final segment. If 'segmented-message' is FALSE, then 'more-follows' shall be set FALSE by the encoder and shall be ignored by the decoder.

20.1.2.3 segmented-response-accepted

This parameter shall be TRUE if the device issuing the confirmed request will accept a segmented complex acknowledgment as a response. It shall be FALSE otherwise. This parameter is included in the confirmed request so that the responding device may determine how to convey its response.

20.1.2.4 max-segments-accepted

This optional parameter specifies the maximum number of segments that the device will accept. This parameter is included in the confirmed request so that the responding device may determine how to convey its response. The parameter shall be encoded as follows:

B'000'	Unspecified number of segments accepted.
B'001'	2 segments accepted.
B'010'	4 segments accepted.
B'011'	8 segments accepted.
B'100'	16 segments accepted.
B'101'	32 segments accepted.
B'110'	64 segments accepted.
B'111'	Greater than 64 segments accepted.

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20.1.2.5 max-APDU-length-accepted

This parameter specifies the maximum size of a single APDU that the issuing device will accept. This parameter is included in the confirmed request so that the responding device may determine how to convey its response. The parameter shall be encoded as follows:

B'0000' Up to MinimumMessageSize (50 octets)
B'0001' Up to 128 octets
B'0010' Up to 206 octets (fits in a LonTalk frame)
B'0011' Up to 480 octets (fits in an ARCNET frame)
B'0100' Up to 1024 octets
B'0101' Up to 1476 octets (fits in an ISO 8802-3 frame)
B'0110' reserved by ASHRAE
B'0111' reserved by ASHRAE
B'1000' reserved by ASHRAE
B'1001' reserved by ASHRAE
B'1010' reserved by ASHRAE
B'1011' reserved by ASHRAE
B'1100' reserved by ASHRAE
B'1101' reserved by ASHRAE
B'1110' reserved by ASHRAE
B'1111' reserved by ASHRAE

20.1.2.6 invokeID

This parameter shall be an integer in the range 0 - 255 assigned by the service requester. It shall be used to associate the response to a confirmed service request with the original request. In the absence of any error, the 'invokeID' shall be returned by the service provider in a BACnet-SimpleACK-PDU or a BACnet-ComplexACK-PDU. In the event of an error condition, the 'invokeID' shall be returned by the service provider in a BACnet-Error-PDU, BACnet-Reject-PDU, or BACnet-Abort-PDU as appropriate.

The 'invokeID' shall be generated by the device issuing the service request. It shall be unique for all outstanding confirmed request APDUs generated by the device. The same 'invokeID' shall be used for all segments of a segmented service request. Once an 'invokeID' has been assigned to an APDU, it shall be maintained within the device until either a response APDU is received with the same 'invokeID' or a no response timer expires (see 5.3). In either case, the 'invokeID' value shall then be released for reassignment. The algorithm used to pick a value out of the set of unused values is a local matter. The storage mechanism for maintaining the used 'invokeID' values within the requesting and responding devices is also a local matter. The requesting device may use a single 'invokeID' space for all its confirmed APDUs or multiple 'invokeID' spaces (one per destination device address) as desired. Since the 'invokeID' values are only source-device-unique, the responding device shall maintain the 'invokeID' as well as the requesting device address until a response has been sent. The responding device may discard the 'invokeID' information after a response has been sent.

20.1.2.7 sequence-number

This optional parameter is only present if the 'segmented-message' parameter is TRUE. In this case, the 'sequence-number' shall be a sequentially incremented unsigned integer, modulo 256, which identifies each segment of a segmented request. The value of the received 'sequence-number' is used by the responder to acknowledge the receipt of one or more segments of a segmented request. The 'sequence-number' of the first segment of a segmented request shall be zero.

20.1.2.8 proposed-window-size

This optional parameter is only present if the 'segmented-message' parameter is TRUE. In this case, the 'proposed-window-size' parameter shall specify as an unsigned binary integer the maximum number of message segments containing 'invokeID' the sender is able or willing to send before waiting for a segment acknowledgment PDU (see 5.2 and 5.3). The value of the 'proposed-window-size' shall be in the range 1 - 127.

20.1.2.9 service-choice

This parameter shall contain the value of the BACnetConfirmedServiceChoice. See Clause 21.

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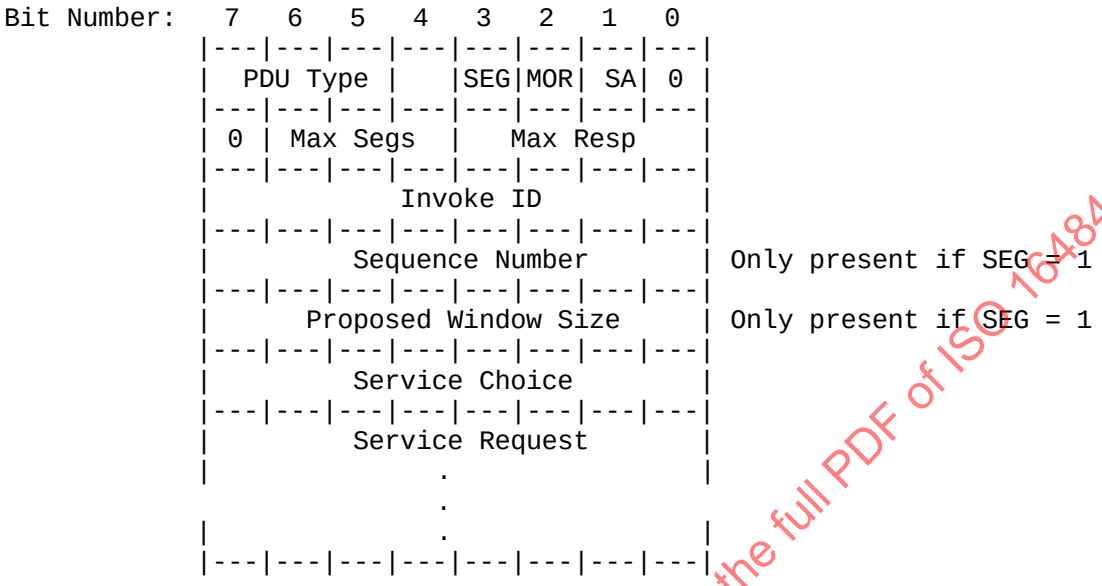
20.1.2.10 service-request

This parameter shall contain the parameters of the specific service that is being requested, encoded according to the rules of 20.2. These parameters are defined in the individual service descriptions in this standard and are represented in Clause 21 in accordance with the rules of ASN.1.

20.1.2.11 Format of the BACnet-Confirmed-Request-PDU

The format of the BACnet-Confirmed-Request-PDU is:



The PDU fields have the following values:

PDU Type =	0 (BACnet-Confirmed-Service-Request-PDU)
SEG =	0 (Unsegmented Request) 1 (Segmented Request)
MOR =	0 (No More Segments Follow) 1 (More Segments Follow)
SA =	0 (Segmented Response not accepted) 1 (Segmented Response accepted)
Max Segs =	(0..7) (Number of response segments accepted per 20.1.2.4)
Max Resp =	(0..15) (Size of Maximum APDU accepted per 20.1.2.5)
Invoke ID =	(0..255)
Sequence Number =	(0..255) Only present if SEG = 1
Proposed Window Size =	(1..127) Only present if SEG = 1
Service Choice =	BACnetConfirmedServiceChoice
Service Request =	Variable Encoding per 20.2.

Bits shown in the diagram as '0' shall be set to zero. These bits are currently unused and are reserved by ASHRAE.

20.1.3 BACnet-Unconfirmed-Request-PDU

The BACnet-Unconfirmed-Request-PDU is used to convey the information contained in unconfirmed service request primitives.

```
BACnet-Unconfirmed-Request-PDU ::= SEQUENCE {
        pdu-type            [0] Unsigned (0..15), -- 1 for this PDU type
        reserved            [1] Unsigned (0..15), -- must be set to zero
        service-choice      [2] BACnetUnconfirmedServiceChoice,
        service-request     [3] BACnet-Unconfirmed-Service-Request
```

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```
-- Context specific tags 0..3 are NOT used in header encoding
        }
```

The parameters of the BACnet-Unconfirmed-Request-PDU have the following meanings.

20.1.3.1 service-choice

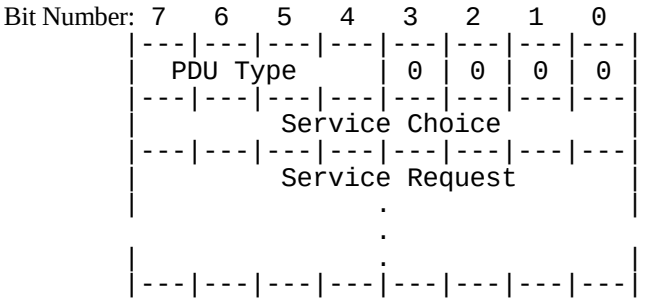
This parameter shall contain the value of the BACnetUnconfirmedServiceChoice. See Clause 21.

20.1.3.2 service-request

This parameter shall contain the parameters of the specific service that is being requested, encoded according to the rules of 20.2. These parameters are defined in the individual service descriptions in this standard and are represented in Clause 21 in accordance with the rules of ASN.1.

20.1.3.3 Format of the BACnet-Unconfirmed-Request-PDU

The format of the BACnet-Unconfirmed-Request-PDU is:



The PDU fields have the following values:

PDU Type = 1 (BACnet-Unconfirmed-Service-Request-PDU)
Service Choice = BACnetUnconfirmedServiceChoice
Service Request = Variable Encoding per 20.2.

Bits shown in the diagram as '0' shall be set to zero. These bits are currently unused and are reserved by ASHRAE.

20.1.4 BACnet-SimpleACK-PDU

The BACnet-SimpleACK-PDU is used to convey the information contained in a service response primitive ('Result(+)') that contains no other information except that the service request was successfully carried out.

```
BACnet-SimpleACK-PDU ::= SEQUENCE {
        pdu-type            [0] Unsigned (0..15), -- 2 for this PDU type
        reserved            [1] Unsigned (0..15), -- must be set to zero
        original-invokeID   [2] Unsigned (0..255),
        service-ACK-choice  [3] BACnetConfirmedServiceChoice
-- Context specific tags 0..3 are NOT used in header encoding
        }
```

The parameters of the BACnet-SimpleACK-PDU have the following meanings.

20.1.4.1 original-invokeID

This parameter shall be the 'invokeID' contained in the confirmed service request being acknowledged.

20.1.4.2 service-ACK-choice

This parameter shall contain the value of the BACnetConfirmedServiceChoice corresponding to the service contained in the previous BACnet-Confirmed-Service-Request that has resulted in this acknowledgment. See Clause 21.

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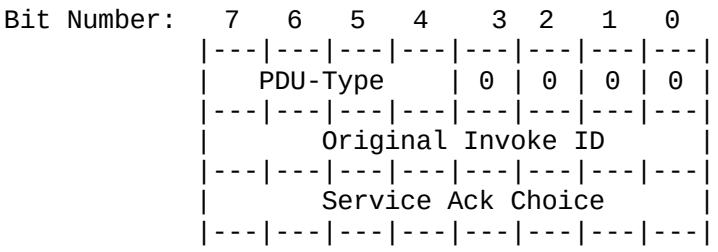
20.1.4.3 Format of the BACnet-SimpleACK-PDU

The format of the BACnet-SimpleACK-PDU is:



Note that this APDU is always three octets long.

The PDU fields have the following values:

PDU Type = 2 (BACnet-SimpleACK-PDU)
Original Invoke ID = (0..255)
Service ACK Choice = BACnetConfirmedServiceChoice

Bits shown in the diagram as '0' shall be set to zero. These bits are currently unused and are reserved by ASHRAE.

20.1.5 BACnet-ComplexACK-PDU

The BACnet-ComplexACK-PDU is used to convey the information contained in a service response primitive ('Result(+)') that contains information in addition to the fact that the service request was successfully carried out.

```
BACnet-ComplexACK-PDU ::= SEQUENCE {
        pdu-type                [0] Unsigned (0..15), -- 3 for this PDU type
        segmented-message       [1] BOOLEAN,
        more-follows            [2] BOOLEAN,
        reserved                [3] Unsigned (0..3), -- must be set to zero
        original-invokeID       [4] Unsigned (0..255),
        sequence-number         [5] Unsigned (0..255) OPTIONAL, --only if segment
        proposed-window-size    [6] Unsigned (1..127) OPTIONAL, -- only if segment
        service-ACK-choice      [7] BACnetConfirmedServiceChoice,
        service-ACK             [8] BACnet-Confirmed-Service-ACK
-- Context specific tags 0..8 are NOT used in header encoding
        }
```

The parameters of the BACnet-ComplexACK-PDU have the following meanings.

20.1.5.1 segmented-message

This parameter indicates whether or not the confirmed service response is entirely, or only partially, contained in the present PDU. If the response is present in its entirety, the 'segmented-message' parameter shall be FALSE. If the present PDU contains only a segment of the response, this parameter shall be TRUE.

20.1.5.2 more-follows

This parameter is only meaningful if the 'segmented-message' parameter is TRUE. If 'segmented-message' is TRUE, then the 'more-follows' parameter shall be TRUE for all segments comprising the confirmed service response except for the last and shall be FALSE for the final segment. If 'segmented-message' is FALSE, then 'more-follows' shall be set FALSE by the encoder and shall be ignored by the decoder.

20.1.5.3 original-invokeID

This parameter shall be the 'invokeID' contained in the confirmed service request being acknowledged. The same 'original-invokeID' shall be used for all segments of a segmented acknowledgment.

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20.1.5.4 sequence-number

This optional parameter is only present if the 'segmented-message' parameter is TRUE. In this case, the 'sequence-number' shall be a sequentially incremented unsigned integer, modulo 256, which identifies each segment of a segmented response. The value of the received 'sequence-number' is used by the original requester to acknowledge the receipt of one or more segments of a segmented response. The sequence-number of the first segment of a segmented response shall be zero.

20.1.5.5 proposed-window-size

This optional parameter is only present if the 'segmented-message' parameter is TRUE. In this case, the 'proposed-window-size' parameter shall specify as an unsigned binary integer the maximum number of message segments containing 'original-invokeID' the sender is able or willing to send before waiting for a segment acknowledgment PDU (see 5.2 and 5.3). The value of the 'proposed-window-size' shall be in the range 1 - 127.

20.1.5.6 service-ACK-choice

This parameter shall contain the value of the BACnetConfirmedServiceChoice corresponding to the service contained in the previous BACnet-Confirmed-Service-Request that has resulted in this acknowledgment. See Clause 21.

20.1.5.7 service-ACK

This parameter shall contain the parameters of the specific service acknowledgment that is being encoded according to the rules of 20.2. These parameters are defined in the individual service descriptions in this standard and are represented in Clause 21 in accordance with the rules of ASN.1.

20.1.5.8 Format of the BACnet-ComplexACK-PDU

The format of the BACnet-ComplexACK-PDU is:

```
Bit Number:   7   6   5   4   3   2   1   0
            |---|---|---|---|---|---|---|---|
            |  PDU Type     |SEG|MOR| 0 | 0 |
            |---|---|---|---|---|---|---|---|
            |       Original Invoke ID      |
            |---|---|---|---|---|---|---|---|
            |         Sequence Number       | Only present if SEG = 1
            |---|---|---|---|---|---|---|---|
            |       Proposed Window Size    | Only present if SEG = 1
            |---|---|---|---|---|---|---|---|
            |        Service ACK Choice     |
            |---|---|---|---|---|---|---|---|
            |           Service ACK         |
            |               .               |
            |               .               |
            |               .               |
            |---|---|---|---|---|---|---|---|
```

The PDU fields have the following values:

PDU Type =	3 (BACnet-ComplexACK-PDU)
SEG =	0 (Unsegmented Response)
	1 (Segmented Response)
MOR =	0 (No More Segments Follow)
	1 (More Segments Follow)
Original Invoke ID =	(0..255)
Sequence Number =	(0..255) Only present if SEG = 1
Proposed Window Size =	(1..127) Only present if SEG = 1
Service ACK Choice =	BACnetConfirmedServiceChoice
Service ACK =	Variable Encoding per 20.2.

Bits shown in the diagram as '0' shall be set to zero. These bits are currently unused and are reserved by ASHRAE.

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20.1.6 BACnet-SegmentACK-PDU

The BACnet-SegmentACK-PDU is used to acknowledge the receipt of one or more PDUs containing portions of a segmented message. It may also request the next segment or segments of the segmented message.

```
BACnet-SegmentACK-PDU ::= SEQUENCE {
        pdu-type            [0] Unsigned (0..15), -- 4 for this PDU type
        reserved            [1] Unsigned (0..3), -- must be set to zero
        negative-ACK        [2] BOOLEAN,
        server              [3] BOOLEAN,
        original-invokeID   [4] Unsigned (0..255),
        sequence-number     [5] Unsigned (0..255),
        actual-window-size  [6] Unsigned (1..127)
-- Context specific tags 0..6 are NOT used in header encoding
        }
```

The parameters of the BACnet-SegmentACK-PDU have the following meanings.

20.1.6.1 negative-ACK

This parameter shall be TRUE if the Segment-ACK PDU is being sent to indicate a segment received out of order. Otherwise, it shall be FALSE.

20.1.6.2 server

This parameter shall be TRUE when the SegmentACK PDU is sent by a server, that is, when the SegmentACK PDU is in acknowledgment of a segment or segments of a Confirmed-Request PDU.

This parameter shall be FALSE when the SegmentACK PDU is sent by a client, that is, when the SegmentACK PDU is in acknowledgment of a segment or segments of a ComplexACK PDU.

20.1.6.3 original-invokeID

This parameter shall be the 'invokeID' contained in the segment being acknowledged.

20.1.6.4 sequence-number

This parameter shall contain the 'sequence-number' of a previously received message segment. It is used to acknowledge the receipt of that message segment and all earlier segments of the message.

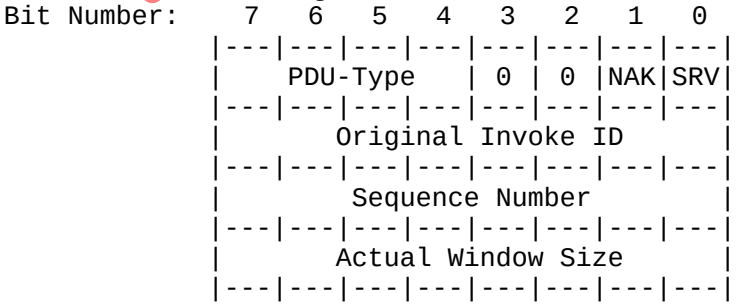
If the 'more-follows' parameter of the received message segment is TRUE, then the 'sequence-number' also requests continuation of the segmented message beginning with the segment whose 'sequence-number' is one plus the value of this parameter, modulo 256.

20.1.6.5 actual-window-size

This parameter shall specify as an unsigned binary integer the number of message segments containing 'original-invokeID' the sender will accept before sending another SegmentACK. See 5.3 for additional details. The value of the 'actual-window-size' shall be in the range 1 - 127.

20.1.6.6 Format of the BACnet-SegmentACK-PDU

The format of the BACnet-SegmentACK-PDU is:



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Note that this PDU is always four octets long.

The PDU fields have the following values:

PDU Type =	4 (BACnet-SegmentACK-PDU)
NAK =	0 (Normal Acknowledgment)
	1 (Negative Acknowledgment, Segment Out of Order)
SRV =	0 (Sent by Client)
	1 (Sent by Server)
Original Invoke ID =	(0..255)
Sequence Number =	(0..255)
Actual Window Size =	(1..127)

Bits shown in the diagram as '0' shall be set to zero. These bits are currently unused and are reserved by ASHRAE.

20.1.7 BACnet-Error-PDU

The BACnet-Error-PDU is used to convey the information contained in a service response primitive ('Result(-)') that indicates the reason why a previous confirmed service request failed either in its entirety or only partially.

```
BACnet-Error-PDU ::= SEQUENCE {
        pdu-type            [0] Unsigned (0..15), -- 5 for this PDU type
        reserved            [1] Unsigned (0..15), -- must be set to zero
        original-invokeID   [2] Unsigned (0..255),
        error-choice        [3] BACnetConfirmedServiceChoice,
        error               [4] BACnet-Error
-- Context specific tags 0..4 are NOT used in header encoding
        }
```

The parameters of the BACnet-Error-PDU have the following meanings.

20.1.7.1 original-invokeID

This parameter shall be the 'invokeID' contained in the confirmed service request to which the error is a response.

20.1.7.2 error-choice

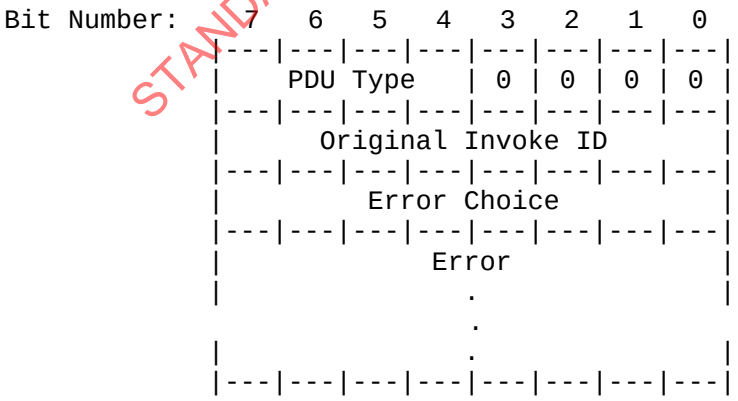
This parameter, of type BACnetConfirmedServiceChoice, shall contain the tag value of the BACnet-Error choice. See Clause 21.

20.1.7.3 error

This parameter, of type BACnet-Error, indicates the reason the indicated service request could not be carried out. This parameter shall be encoded according to the rules of 20.2.

20.1.7.4 Format of the BACnet-Error-PDU

The format of the BACnet-Error-PDU is:



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The PDU fields have the following values:

PDU Type = 5 (BACnet-Error-PDU)
Original Invoke ID = (0..255)
Error Choice = BACnetConfirmedServiceChoice
Error = Variable Encoding per 20.2.

Bits shown in the diagram as '0' shall be set to zero. These bits are currently unused and are reserved by ASHRAE.

20.1.8 BACnet-Reject-PDU

The BACnet-Reject-PDU is used to reject a received confirmed request PDU based on syntactical flaws or other protocol errors that prevent the PDU from being interpreted or the requested service from being provided. Only confirmed request PDUs may be rejected (see 18.8). A BACnet-Reject-PDU shall be sent only before the execution of the service, such as during the interval after a syntax check is performed on the request but before the service procedure is executed. Such a syntax check may occur as segments are received and thus may result in a BACnet-Reject-PDU being returned before the complete request has been received.

There are error conditions where a valid reject-reason and an equally valid error code exist that can be used to describe the condition. In such cases it is a local matter whether or not a BACnet-Reject-PDU is used to convey the error, with the exception that a BACnet-Reject-PDU shall not be returned if service execution has commenced and the execution has resulted in a standard network visible change in the device's state. For example, a WritePropertyMultiple-Request shall not be rejected if at least one of the write operations has already been applied. In such cases an error code shall be used.

```
BACnet-Reject-PDU ::= SEQUENCE {
        pdu-type            [0] Unsigned (0..15), -- 6 for this PDU type
        reserved            [1] Unsigned (0..15), -- must be set to zero
        original-invokeID   [2] Unsigned (0..255),
        reject reason       [3] BACnetRejectReason
-- Context specific tags 0..3 are NOT used in header encoding
        }
```

The parameters of the BACnet-Reject-PDU have the following meanings.

20.1.8.1 original-invokeID

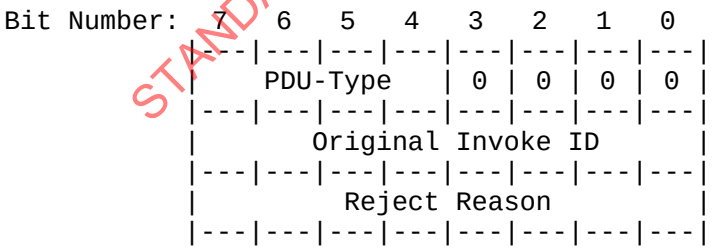
This parameter shall be the 'invokeID' of the PDU being rejected.

20.1.8.2 reject-reason

This parameter, of type BACnetRejectReason, contains the reason the PDU with the indicated 'invokeID' is being rejected.

20.1.8.3 Format of the BACnet-Reject-PDU

The format of the BACnet-Reject-PDU is:



Note that this PDU is always three octets long.

The PDU fields have the following values:

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PDU Type = 6 (BACnet-Reject-PDU)
Original Invoke ID = (0..255)
Reject Reason = One octet containing the reject reason enumeration

Bits shown in the diagram as '0' shall be set to zero. These bits are currently unused and are reserved by ASHRAE.

20.1.9 BACnet-Abort-PDU

The BACnet-Abort-PDU is used to terminate a transaction between two peers.

```
BACnet-Abort-PDU ::= SEQUENCE {
        pdu-type            [0] Unsigned (0..15), -- 7 for this PDU type
        reserved            [1] Unsigned (0..7), -- must be set to zero
        server              [2] BOOLEAN,
        original-invokeID   [3] Unsigned (0..255),
        abort-reason        [4] BACnetAbortReason
-- Context specific tags 0..4 are NOT used in header encoding
        }
```

The parameters of the BACnet-Abort-PDU have the following meanings.

20.1.9.1 server

This parameter shall be TRUE when the Abort PDU is sent by a server. This parameter shall be FALSE when the Abort PDU is sent by a client.

20.1.9.2 original-invokeID

This parameter shall be the 'invokeID' of the transaction being aborted.

20.1.9.3 abort-reason

This parameter, of type BACnetAbortReason, contains the reason the transaction with the indicated invoke ID is being aborted.

20.1.9.4 Format of the BACnet-Abort-PDU

The format of the BACnet-Abort-PDU is:

```
Bit Number:   7   6   5   4   3   2   1   0
            |---|---|---|---|---|---|---|---|
            |    PDU Type   | 0 | 0 | 0 |SRV|
            |---|---|---|---|---|---|---|---|
            |      Original Invoke ID       |
            |---|---|---|---|---|---|---|---|
            |          Abort Reason         |
            |---|---|---|---|---|---|---|---|
```

Note that this PDU is always three octets long.

The PDU fields have the following values:

PDU Type = 7 (BACnet-Abort-PDU)
SRV = 0 (Sent by Client)
1 (Sent by Server)
Original Invoke ID = (0..255)

Bits shown in the diagram as '0' shall be set to zero. These bits are currently unused and are reserved by ASHRAE.

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20.2 Encoding the Variable Part of BACnet APDUs

The encoding of the header portions of BACnet APDUs has been specified in 20.1. This subclause describes the encoding procedures for the variable portion of BACnet APDUs referred to hereafter as "service parameters." These parameters are of types BACnet-Confirmed-Service-Request, BACnet-Unconfirmed-Service-Request, BACnet-Confirmed-Service-ACK, and BACnet-Error. Each parameter is unambiguously defined by means of ASN.1 productions in Clause 21.

All data elements in service parameters are identified by constructs known as "tags." Each tag refers to a unique parameter or subparameter.

BACnet encoding uses two classes of tag. The first identifies fundamental datatypes used or defined in this standard, such as BOOLEANs, Unsigneds, CharacterStrings, Date, Time, or BACnetObjectIdentifiers. Where a datatype appears in upper case, its semantics are identical to the corresponding ASN.1 universal datatype of the same name, as indicated in Clause 21.

Such tags are called "application" tags, and the values of the tags are specified in 20.2.1.4.

The second class of tag is used to identify data elements whose datatype may be inferred from the context in which they appear. These tags are called "context specific" tags.

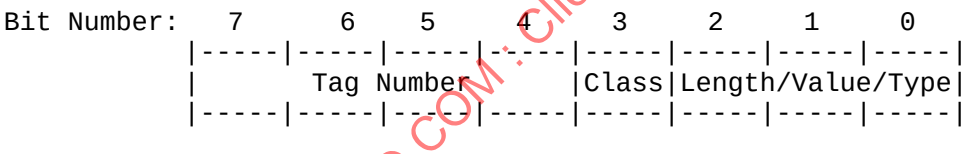
ASN.1 defines two other classes of tags, "universal" and "private." The encoding scheme used by BACnet does not allow, nor do any BACnet ASN.1 productions require, the use of these classes of tags.

In some instances, the datatype of a parameter cannot be deduced from the context in which it appears. In such cases, both a context specific and one or more application tags are required. These cases are indicated in the ASN.1 productions by service parameters whose datatypes are indicated by the keywords ABSTRACT-SYNTAX.&TYPE (ANY), CHOICE, SEQUENCE, or SEQUENCE OF.

The subclauses that follow show how each tagged element is identified, its length specified, and its value encoded.

20.2.1 General Rules For Encoding BACnet Tags

BACnet tags are encoded in an initial octet and zero or more conditional subsequent octets. The initial octet is defined as follows:



where Tag Number = the tag number within the class
Class = the class of tag (application or context specific)
Length/Value/Type = whether the data following the tag is primitive or constructed and specifies the length or value of primitive data.

20.2.1.1 Class

The Class bit shall be zero for application tags. The Class bit shall be one for context specific tags.

20.2.1.2 Tag Number

Tag numbers ranging from zero to 14 (inclusive) shall be encoded in the Tag Number field of the initial octet as a four bit binary integer with bit 7 the most significant bit.

Tag numbers ranging from 15 to 254 (inclusive) shall be encoded by setting the Tag Number field of the initial octet to B'1111' and following the initial tag octet by an octet containing the tag number represented as an eight-bit binary integer with bit 7 the most significant bit.

The encoding does not allow, nor does BACnet require, tag numbers larger than 254. The value B'11111111' of the subsequent octet is reserved by ASHRAE.

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20.2.1.3 Length/Value/Type

The content of the length/value/type field of the initial octet distinguishes between primitive and constructed encodings and specifies the length or value of primitive data. A primitive encoding is one in which the data do not contain other tagged encodings. A constructed encoding is one in which the data do contain other tagged encodings.

20.2.1.3.1 Primitive Data

If the data being encoded are application class BOOLEAN data, then the Boolean value shall be encoded by setting the length/value/type field of the initial octet to B'000' if the Boolean value is FALSE or B'001' if the Boolean value is TRUE. In this case, the length/value/type field shall be interpreted as a value.

If the data being encoded are primitive (that is, not constructed) and not application class BOOLEAN data, then the value of the data shall be encoded according to 20.2.2 through 20.2.14, and the length/value/type field of the initial tag octet shall specify the length of the primitive data in octets as follows:

Data length in octets ranging from zero to four (inclusive) shall be encoded in the length/value/type field of the initial octet as a three-bit binary integer with bit 2 the most significant bit.

Data length in octets ranging from 5 to 253 (inclusive) shall be encoded by setting the length/value/type field of the initial octet to B'101' and following the initial tag octet or, if the Tag Number has been extended, following the Tag Number extension octet by an octet containing the data length represented as an eight-bit binary integer with bit 7 the most significant bit.

Data length in octets ranging from 254 to 65535 (inclusive) shall be encoded by setting the length/value/type field of the initial octet to B'101' and following the initial tag octet or, if the Tag Number has been extended, following the Tag Number extension octet by an octet containing D'254' and two additional octets whose value contains the data length represented as a 16-bit binary integer with the most significant octet first.

Data length in octets ranging from 65536 to 2^{32}-1 (inclusive) shall be encoded by setting the length/value/type field of the initial octet to B'101' and following the initial tag octet or, if the Tag Number has been extended, following the Tag Number extension octet by an octet containing D'255' and four additional octets whose value contains the data length represented as a 32-bit binary integer with the most significant octet first.

Data lengths larger than 2^{32}-1 are not encodable using primitive tags.

Note that with the exception of 8-octet IEEE-754 double precision floating point values and certain bit, character, and octet strings, the length of BACnet application-tagged primitives will fit in the tag octet without extension.

20.2.1.3.2 Constructed Data

If the production being encoded contains tagged elements, then the encoding is called "constructed" and shall consist of

(a) an "opening" tag whose Tag Number field shall contain the value of the tag number, whose Class field shall indicate "context specific," and whose length/value/type field shall have the value B'110';
(b) the complete encoding, with tags, of the zero, one, or more elements that comprise the data;
(c) a "closing" tag, whose Class and Tag Number fields shall contain the same values as the "opening" tag and whose length/value/type field shall have the value B'111'.

In this case, the length/value/type fields of the "opening" and "closing" tags shall be interpreted as types.

Note that a contained tagged element may itself be a constructed element. This recursion does not result in ambiguous encoding, as each "opening" tag must have a corresponding "closing" tag that will be contained within any outer "opening" and "closing" tags.

20.2.1.4 Application Tags

The Tag Number field of an encoded BACnet application tag shall specify the application datatype as follows:

Tag Number: 0 = Null

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1 = Boolean
2 = Unsigned Integer
3 = Signed Integer (2's complement notation)
4 = Real (ANSI/IEEE-754 floating point)
5 = Double (ANSI/IEEE-754 double precision floating point)
6 = Octet String
7 = Character String
8 = Bit String
9 = Enumerated
10 = Date
11 = Time
12 = BACnetObjectIdentifier
13, 14, 15 = Reserved for ASHRAE

Note that all currently defined BACnet Application datatypes are primitively encoded.

20.2.1.5 Context-Specific Tags

The Tag Number field of an encoded BACnet context-specific tag shall contain the value of the context-specific tag number.

The data delimited by a context-specific tag may be either primitive or constructed.

20.2.2 Encoding of a Null Value

The encoding of a Null value shall be primitive, with no contents octet.

Example: Application-tagged null value
ASN.1 = NULL
Application Tag = Null (Tag Number = 0)
Encoded Tag = X'00'

20.2.3 Encoding of a Boolean Value

Application-tagged Boolean values shall be encoded within a single octet by setting the length/value/type field to B'000' if the value to be encoded is FALSE or B'001' if the value to be encoded is TRUE.

Example: Application-tagged Boolean value
ASN.1 = BOOLEAN
Value = FALSE
Application Tag = Boolean (Tag Number = 1)
Encoded Tag = X'10'

Context-tagged Boolean primitive data shall contain one contents octet. The value of this octet shall be B'00000000' if the value to be encoded is FALSE or B'00000001' if the value to be encoded is TRUE.

Example: Context-tagged Boolean value
ASN.1 = [2] BOOLEAN
Value = TRUE
Context Tag = 2
Encoded Tag = X'29'
Encoded Data = X'01'

NOTE: The Boolean datatype differs from the other datatypes in that the encoding of a context-tagged Boolean value is not the same as the encoding of an application-tagged Boolean value. This is done so that the application-tagged value may be encoded in a single octet, without a contents octet. While this same encoding could have been used for the context-tagged case, doing so would require that the context be known in order to distinguish between a length or a value in the length/value/type field. This was considered to be undesirable. See 20.2.20.

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20.2.4 Encoding of an Unsigned Integer Value

The encoding of an unsigned integer value shall be primitive, with at least one contents octet.

Unsigned integers shall be encoded in the contents octet(s) as binary numbers in the range 0 to $(2^{8*L} - 1)$ where L is the number of octets used to encode the value and L is at least one. Values encoded into more than one octet shall be conveyed with the most significant octet first. All unsigned integers shall be encoded in the smallest number of octets possible. That is, the first octet of any multi-octet encoded value shall not be X'00'.

Example: Application-tagged unsigned integer
ASN.1 = Unsigned
Value = 72
Application Tag = Unsigned Integer (Tag Number = 2)
Encoded Tag = X'21'
Encoded Data = X'48'

20.2.5 Encoding of a Signed Integer Value

The encoding of a signed integer value shall be primitive, with at least one contents octet.

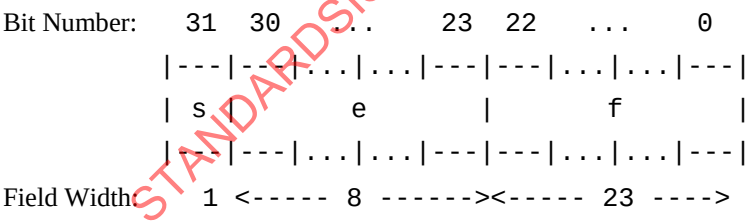
Signed integers shall be encoded in the contents octet(s) as binary numbers using 2's complement notation in the range $-2^{(8*L-1)}$ to $(2^{(8*L-1)} - 1)$ where L is the number of octets used to encode the value and L is at least one. Values encoded into more than one octet shall be conveyed most significant octet first. All signed integers shall be encoded in the smallest number of octets possible. That is, the first octet of any multi-octet encoded value shall not be X'00' if the most significant bit (bit 7) of the second octet is 0, and the first octet shall not be X'FF' if the most significant bit of the second octet is 1.

Example: Application-tagged signed integer
ASN.1 = INTEGER
Value = 72
Application Tag = Signed Integer (Tag Number = 3)
Encoded Tag = X'31'
Encoded Data = X'48'

20.2.6 Encoding of a Real Number Value

The encoding of a real number value shall be primitive, with four contents octets. Real numbers shall be encoded using the method specified in ANSI/IEEE Standard 754-1985, "IEEE Standard for Binary Floating-Point Arithmetic." This standard should be consulted for details. The multi-octet value shall be conveyed with the most significant (sign and exponent) octet first.

For the case of single precision real numbers, the encoding format is:



where the numbers indicate the field widths in bits. Non-zero values shall be represented by the equation $v = (-1)^s 2^{e-127}(1 \bullet f)$ where the symbol "•" signifies the binary point. Zero shall be indicated by setting s, e, and f to zero.

Example: Application-tagged single precision real
ASN.1 = REAL
Value = 72.0
Application Tag = Real (Tag Number = 4)
Encoded Tag = X'44'
Encoded Data = X'42900000'

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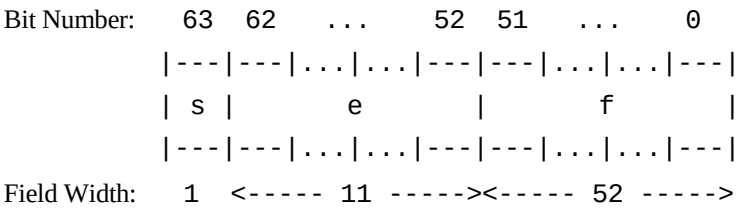
20.2.7 Encoding of a Double Precision Real Number Value

The encoding of a double precision real number value shall be primitive with eight contents octets. Double precision real numbers shall be encoded using the method specified in ANSI/IEEE Standard 754-1985, "IEEE Standard for Binary Floating-Point Arithmetic." This standard should be consulted for details. The multi-octet value shall be conveyed most significant (sign and exponent) octet first.

For the case of double precision real numbers, the encoding format is:



where the numbers indicate the field widths in bits. Non-zero values shall be represented by the equation $v = (-1)^s 2^{e-1023}(1 \bullet f)$ where the symbol "•" signifies the binary point. Zero shall be indicated by setting s, e, and f to zero.

Example: Application-tagged double precision real

ASN.1 =	Double
Value =	72.0
Application Tag =	Double (Tag Number = 5)
Encoded Tag =	X'55'
Extended Length =	X'08'
Encoded Data =	X'4052000000000000'

ANSI/IEEE-754 Extended Precision format is not supported by BACnet.

20.2.8 Encoding of an Octet String Value

The encoding of an octet string value shall be primitive.

The encoding shall contain zero, one, or more contents octets equal in value to the octets in the data value, in the order in which they appear in the data value, and with the most significant bit of an octet of the data value aligned with the most significant bit of an octet of the contents octets.

Example: Application-tagged octet string

ASN.1 =	OCTET STRING
Value =	X'1234FF'
Application Tag =	Octet String (Tag Number = 6)
Encoded Tag =	X'63'
Encoded Data =	X'1234FF'

20.2.9 Encoding of a Character String Value

The encoding of a character string value shall be primitive.

The encoding shall contain an initial contents octet, and zero, one, or more additional contents octets equal in value to the octets in the data value, in the order in which they appear in the data value, i.e., most significant octet first, and with the most significant bit of an octet of the data value aligned with the most significant bit of an octet of the contents octets.

The initial octet shall specify the character set with the following encoding:

X'00'	ISO 10646 (UTF-8)
X'01'	IBM™/Microsoft™ DBCS
X'02'	JIS X 0208
X'03'	ISO 10646 (UCS-4)

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X'04' ISO 10646 (UCS-2)
X'05' ISO 8859-1

Other values of the initial octet are reserved by ASHRAE.
Example: Application-tagged character string

ASN.1 =	CharacterString
Value =	"This is a BACnet string!" (ISO 10646 UTF-8)
Application Tag =	Character String (Tag Number = 7)
Encoded Tag =	X'75'
Length Extension =	X'19'
Character Set =	X'00' (ISO 10646: UTF-8)
Encoded Data =	X'5468697320697320612042414436E657420737472696E6721'

In the case of IBM/Microsoft DBCS (X'01'), the initial octet shall be followed by two additional octets whose value shall represent an unsigned integer, with the most significant octet first, that shall indicate the Code Page to be presumed for the characters that follow.

Example: Application-tagged character string (DBCS)

ASN.1 =	CharacterString
Value =	"This is a BACnet String!" (IBM/Microsoft DBCS, code page 850)
Application Tag =	Character String (Tag Number = 7)
Encoded Tag =	X'75'
Length Extension =	X'1B'
Encoded Data =	X'0103525468697320697320612042414436E657420737472696E6721'

In the case of ISO 10646 UCS-2 (X'04') and UCS4 (X'03'), each character of the string shall be represented by two or four octets, respectively. The octet order for UCS-2 shall be Row-Cell. The octet order for UCS-4 shall be Group-Plane-Row-Cell.

Example: Application-tagged character string (UCS-2)

ASN.1 =	CharacterString
Value =	"This is a BACnet String!" (ISO 10646 UCS-2)
Application Tag =	Character String (Tag Number = 7)
Encoded Tag =	X'75'
Length Extension =	X'31'
Encoded Data =	X'0400540068006900730020006900730020006100200042004100430006E00650074002000730074007200690006E00670021'

20.2.10 Encoding of a Bit String Value

The encoding of a bit string value shall be primitive.

The contents octets for the primitive encoding shall contain an initial octet and zero or more subsequent octets containing the bit string. The initial octet shall encode, as an unsigned binary integer, the number of unused bits in the final subsequent octet. The number of unused bits shall be in the range zero to seven, inclusive.

Bit strings defined in this standard, e.g., the Status_Flags property, shall be encoded in the order of definition, with the first defined Boolean value in the most significant bit, i.e. bit 7, of the first subsequent octet. The bits in the bitstring shall be placed in bits 7 to 0 of the first subsequent octet, followed by bits 7 to 0 of the second subsequent octet, followed by bits 7 to 0 of each octet in turn, followed by as many bits as are needed of the final subsequent octet, commencing with bit 7. Undefined bits shall be zero.

If the bit string is empty, there shall be no subsequent octets, and the initial octet shall be zero.

Example: Application-tagged bit string

ASN.1 =	BIT STRING
Value =	B'10101'
Application Tag =	Bit String (Tag Number = 8)

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Encoded Tag = X'82'
Encoded Data = X'03A8'

20.2.11 Encoding of an Enumerated Value

The encoding of an enumerated value shall be primitive, with at least one contents octet.

Enumerated values shall be encoded in the contents octet(s) as binary numbers in the range 0 to $(2^{8*L} - 1)$ where L is the number of octets used to encode the value and L is at least one. Values encoded into more than one octet shall be conveyed most significant octet first. All enumerated values shall be encoded in the smallest number of octets possible. That is, the first octet of any multi-octet encoded value shall not be X'00'.

Example: Application-tagged enumeration
ASN.1 = BACnetObjectType
Value = ANALOG-INPUT (0)
Application Tag = Enumerated (Tag Number = 9)
Encoded Tag = X '91'
Encoded Data = X '00'

20.2.12 Encoding of a Date Value

The encoding of a date value shall be primitive, with four contents octets. Unless otherwise specified (e.g. UTC date), a date value generated by a device shall be a local date.

Date values shall be encoded in the contents octets as four binary integers. The first contents octet shall represent the year minus 1900; the second octet shall represent the month, with January = 1; the third octet shall represent the day of the month; and the fourth octet shall represent the day of the week, with Monday = 1. A value of X'FF' = D'255' in any of the four octets shall indicate that the corresponding value is unspecified and shall be considered a wildcard when matching dates. If all four octets = X'FF', the corresponding date may be interpreted as "any" or "don't care".

Neither an unspecified date nor a date pattern shall be used in date values that convey actual dates, such as in a TimeSynchronization-Request.

The processing of a day of week received in a service that is in the range 1 to 7 and is inconsistent with the values in the other octets shall be a local matter.

A number of special values for the month and day octets have been defined. The following special values shall not be used when conveying an actual date value, such as the Local_Date property of the Device object or in a TimeSynchronization-Request. A value of 13 in the second octet shall indicate odd months. A value of 14 in the second octet shall indicate even months. A value of 32 in the third octet shall indicate the last day of the month. A value of 33 in the third octet shall indicate odd days of the month. A value of 34 in the third octet shall indicate even days of the month.

Example: Application-tagged specific date value
ASN.1 = Date
Value = January 24, 1991 (Day of week = Thursday)
Application Tag = Date (Tag Number = 10)
Encoded Tag = X'A4'
Encoded Data = X'5B011804'

Example: Application-tagged date pattern value
ASN.1 = Date
Value = year = 1991, month is unspecified, day = 24, day of week is unspecified
Application Tag = Date (Tag Number = 10)
Encoded Tag = X'A4'
Encoded Data = X'5BFF18FF'

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20.2.13 Encoding of a Time Value

The encoding of a time value shall be primitive, with four contents octets. Unless otherwise specified (e.g. UTC time), a time value generated by a device shall be a local time.

Time values shall be encoded in the contents octets as four binary integers. The first contents octet shall represent the hour, in the 24-hour system (1 P.M. = D'13'); the second octet shall represent the minute of the hour; the third octet shall represent the second of the minute; and the fourth octet shall represent the fractional part of the second in hundredths of a second. A value of X'FF' = D'255' in any of the four octets shall indicate that the corresponding value is unspecified and shall be considered a wildcard when matching times. If all four octets = X'FF', the corresponding time may be interpreted as "any" or "don't care."

Neither an unspecified time nor a time pattern shall be used in time values that convey actual time, such as those presented by the Local_Time property of the Device object or in a TimeSynchronization-Request.

Example: Application-tagged specific time value

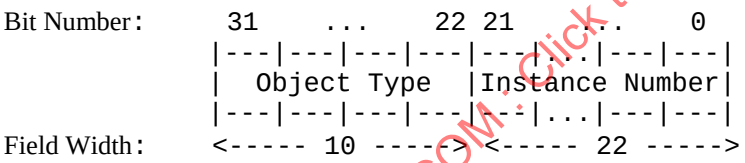
ASN.1 =	Time
Value =	17:35:45.17 (= 5:35:45.17 P.M.)
Application Tag =	Time (Tag Number = 11)
Encoded Tag =	X'B4'
Encoded Data =	X'11232D11'

20.2.14 Encoding of an Object Identifier Value

A BACnet Object Identifier value shall consist of two components:

(1) A 10-bit object type, representing the BACnetObjectType of the object, with bit 9 the most significant bit and bit 0 the least significant. For objects defined in this standard, the value for this field shall be determined by the BACnetObjectType enumeration in Clause 21.

(2) A 22-bit object instance number, with bit 21 the most significant bit and bit 0 the least significant.



The encoding of an object identifier value shall be primitive, with four contents octets as follows:

Bits 9 through 2 of the object type shall be encoded in bits 7 through 0 of the first contents octet. Bits 1 through 0 of the object type shall be encoded in bits 7 through 6 of the second contents octet.

Bits 21 through 16 of the object instance shall be encoded in bits 5 through 0 of the second contents octet. Bits 15 through 8 of the object instance shall be encoded in bits 7 through 0 of the third contents octet. Bits 7 through 0 of the object instance shall be encoded in bits 7 through 0 of the fourth contents octet.

Example: Application-tagged object identifier value

ASN.1 =	ObjectIdentifier
Value =	(Binary Input, 15)
Application Tag =	ObjectIdentifier (Tag Number = 12)
Encoded Tag =	X'C4'
Encoded Data =	X'00C0000F'

20.2.15 Encoding of a Tagged Value

The encoding of a tagged value shall be derived from the complete encoding of the corresponding data value.

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ISO 8824 defines the keywords "IMPLICIT" and "EXPLICIT," with "EXPLICIT" the default. Clause 21 begins with a "DEFINITION IMPLICIT TAGS," which changes the default to IMPLICIT. BACnet ASN.1 definitions are in terms of this default and use EXPLICIT only as an override.

If the "EXPLICIT" keyword is used in the production for the type, the encoding shall be constructed, and the contents octets shall be the complete base encoding, including tags.

If the "EXPLICIT" keyword is not used in the definition of the type, then

a) the encoding shall be constructed if the base encoding is constructed and shall be primitive otherwise, and either

b) the contents octets shall be the same as the contents octets of the base encoding if the base encoding is not primitively tagged application class Boolean or

c) the contents octet shall contain the value B'00000000' to denote a Boolean value of FALSE or B'00000001' to denote a Boolean value of TRUE if the base encoding is primitively tagged application class Boolean.

The context tag numbers shown in the following examples are for illustrative purposes only.

Example: Context-tagged null value

ASN.1 =	[3] NULL
Context Tag =	3
Encoded Tag =	X'38'

Example: Context-tagged Boolean value

ASN.1 =	[6] BOOLEAN
Value =	FALSE
Context Tag =	6
Encoded Tag =	X'69'
Encoded Data =	X'00'

Example: Context-tagged unsigned integer

ASN.1 =	[0] Unsigned
Value =	256
Context Tag =	0
Encoded Tag =	X'0A'
Encoded Data =	X'0100'

Example: Context-tagged signed integer

ASN.1 =	[5] INTEGER
Value =	-72
Context Tag =	5
Encoded Tag =	X'59'
Encoded Data =	X'B8'

Example: Context-tagged single precision real

ASN.1 =	[0] REAL
Value =	-33.3
Context Tag =	0
Encoded Tag =	X'0C'
Encoded Data =	X'C2053333'

Example: Context-tagged double precision real

ASN.1 =	[1] Double
Value =	-33.3
Context Tag =	1

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Encoded Tag =	X'1D'
Extended Length =	X'08'
Encoded Data =	X'C040A66666666666'

Example: Context-tagged octet string

ASN.1 =	[1] OctetString
Value =	X'4321'
Context Tag =	1
Encoded Tag =	X'1A'
Encoded Data =	X'4321'

Example: Context-tagged character string

ASN.1 =	[5] CharacterString
Value =	"This is a BACnet string!" (ISO 10646 UTF-8)
Context Tag =	5
Encoded Tag =	X'5D'
Length Extension =	X'19'
Character Set =	X'00' (ISO 10646 UTF-8)
Encoded Data =	X'546869732069732061204241436E6574207374726696E6721'

Example: Application-tagged character string with non-ANSI character

ASN.1 =	CharacterString
Value =	"Français" (ISO 10646 UTF-8)
Application Tag =	Character String (Tag Number = 7)
Encoded Tag =	X'75'
Length Extension =	X'0A'
Character Set =	X'00' (ISO 10646: UTF-8)
Encoded Data =	X'4672616EC3A7616973'

Example: Context-tagged bit string

ASN.1 =	[0] BIT STRING
Value =	B'10101'
Context Tag =	0
Encoded Tag =	X'0A'
Unused Bits in Last Octet =	X'03'
Encoded Data =	X'A8'

Example: Context-tagged enumeration

ASN.1 =	[9] BACnetObjectType
Value =	ANALOG-INPUT (0)
Context Tag =	9
Encoded Tag =	X'99'
Encoded Data =	X'00'

Example: Context-tagged date value

ASN.1 =	[9] Date
Value =	January 24, 1991 (Day of week = Thursday)
Context Tag =	9
Encoded Tag =	X'9C'
Encoded Data =	X'5B011805'

Example: Context-tagged time value

ASN.1 =	[4] Time
Value =	5:35:45.17 P.M. = 17:35:45.17
Context Tag =	4
Encoded Tag =	X'4C'

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Encoded Data = X'11232D11'

Example: Context-tagged object identifier value
ASN.1 = [4] ObjectIdentifier
Value = (Binary Input, 15)
Context Tag = 4
Encoded Tag = X'4C'
Encoded Data = X'00C0000F'

20.2.16 Encoding of a Sequence Value

The encoding of a sequence value shall consist of the complete encoding, including tags, of one data value from each of the types listed in the ASN.1 production for the sequence type, in the order of their appearance in the definition, unless the type was referenced with the keyword "OPTIONAL".

The encoding of a data value may, but need not, be present for a type that was referenced with the keyword "OPTIONAL". If present, it shall appear in the encoding at the point corresponding to the appearance of the type in the ASN.1 definition.

Example: SEQUENCE value
ASN.1 = BACnetDateTime
Value = January 24, 1991, 5:35:45.17 P.M.
Application Tag = Date (Tag Number = 10)
Encoded Tag = X'A4'
Encoded Data = X'5B011805'
Application Tag = Time (Tag Number = 11)
Encoded Tag = X'B4'
Encoded Data = X'11232D11'

Example: Context-tagged SEQUENCE value
ASN.1 = [0] BACnetDateTime
Value = January 24, 1991, 5:35:45.17 P.M.
Context Tag = 0
Encoded Tag = X'0E' (opening tag)
Application Tag =Date (Tag Number = 10)
Encoded Tag = X'A4'
Encoded Data = X'5B011805'
Application Tag = Time (Tag Number = 11)
Encoded Tag = X'B4'
Encoded Data = X'11232D11'
Encoded Tag = X'0F' (closing tag)

All ASN.1 productions of sequences that contain structured elements shall have distinct tags as necessary to permit unambiguous encoding and decoding of values. The follow example illustrates this requirement.

```
(incorrect usage)
Var1 ::= SEQUENCE {
        varn1 SEQUENCE {
                varn2   [1] INTEGER,
                varn3   [2] INTEGER OPTIONAL
                },
        varn4 SEQUENCE {
                varn5   [1] INTEGER OPTIONAL,
                varn6   [2] INTEGER
                }
        }
```

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```
(correct usage)
Var1 ::= SEQUENCE {
        varn1 SEQUENCE {
                varn2    [1] INTEGER,
                varn3    [2] INTEGER OPTIONAL
                },
        varn4 SEQUENCE {
                varn5    [3] INTEGER OPTIONAL,
                varn6    [4] INTEGER
                }
        }
```

20.2.17 Encoding of a Sequence-Of Value

The encoding of a sequence-of value shall consist of zero, one, or more complete encodings, including tags, of data values from the types listed in the ASN.1 definition.

The order of the encodings of the data values shall be the same as the order of the data values in the sequence-of value to be encoded.

Example: SEQUENCE OF primitive data

```
ASN.1 =              SEQUENCE OF INTEGER
Value =              1,2,4
Application Tag = Unsigned Integer (Tag Number = 2)
Encoded Tag =     X'21'
Encoded Data =    X'01'
Application Tag = Unsigned Integer (Tag Number = 2)
Encoded Tag =     X'21'
Encoded Data =    X'02'
Application Tag = Unsigned Integer (Tag Number = 2)
Encoded Tag =     X'21'
Encoded Data =    X'04'
```

Example: Context-tagged SEQUENCE OF primitive data

```
ASN.1 =              [1] SEQUENCE OF INTEGER
Value =              1,2,4
Encoded Tag =                X'1E' (Opening Tag)
        Application Tag = Unsigned Integer (Tag Number = 2)
        Encoded Tag =     X'21'
        Encoded Data =    X'01'
        Application Tag = Unsigned Integer (Tag Number = 2)
        Encoded Tag =     X'21'
        Encoded Data =    X'02'
        Application Tag = Unsigned Integer (Tag Number = 2)
        Encoded Tag =     X'21'
        Encoded Data =    X'04'
Encoded Tag =                X'1F' (Closing Tag)
```

Example: SEQUENCE OF constructed data

```
ASN.1 =              SEQUENCE OF BACnetDateTime
Value =              (January 24, 1991, 5:00 P.M.),
                     (January 24, 1991, 6:45 P.M.)
Application Tag = Date (Tag Number = 10)
Encoded Tag =     X'A4'
Encoded Data =    X'5B011804'
Application Tag = Time (Tag Number = 11)
Encoded Tag =     X'B4'
```

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Encoded Data = X'11000000'
Application Tag = Date (Tag Number = 10)
Encoded Tag = X'A4'
Encoded Data = X'5B011804'
Application Tag = Time (Tag Number = 11)
Encoded Tag = X'B4'
Encoded Data = X'122D0000'

20.2.18 Encoding of a Choice Value

The encoding of a CHOICE value shall be the same as the encoding of a value of the chosen type. The encoding may be primitive or constructed depending on the chosen type.

Example: CHOICE of primitive data
ASN.1 = BACnetTimeStamp
Value = 5:35:45.17 P.M. = 17:35:45.17
Context Tag = 0 (Choice for 'time' in BACnetTimeStamp)
Encoded Tag = X'0C'
Encoded Data = X'11232D11'

Example: CHOICE of constructed data
ASN.1 = BACnetTimeStamp
Value = January 24, 1991, 5:45.17 P.M.
Context Tag = 2 (Choice for 'dateTime' in BACnetTimeStamp)
Encoded Tag = X'2E' (Opening Tag)
Application Tag = Date (Tag Number = 10)
Encoded Tag = X'A4'
Encoded Data = X'5B011804'
Application Tag = Time (Tag Number = 11)
Encoded Tag = X'B4'
Encoded Data = X'11232D11'
Encoded Tag = X'2F' (Closing Tag)

20.2.19 Encoding of a Value of the ANY Type

The encoding of an ANY type shall be the complete encoding specified in this standard for the type of the value substituted for the placeholder ANY. This is represented in ASN.1 by ABSTRACT-SYNTAX.&Type.

20.2.20 Summary of the Tagging Rules

While the tagged portion of a BACnet PDU cannot be interpreted without knowledge of the context, the tagging rules described in 20.2 result in a tagged stream that can be unambiguously parsed even without *a priori* knowledge of the context.

(a) The first octet in a stream shall be a tag, either context specific or application class.

(b) If a tag is application class, then the format and extent of its data are known according to the definitions in 20.2. In particular, the data, if any, may be bypassed and the next tag in the stream found.

(c) If a tag is context specific and primitive, then it contains primitive (untagged) data of some type. The length/value/type field of the tag specifies the length of this data. Thus, while the datatype and format of the data may be unknown, its length is known exactly. This allows the data, if any, to be bypassed and the next tag in the stream found.

(d) If a tag is constructed (length/value/type = 6), then it is the opening tag of a pair. Following this tag shall be a sequence of zero or more tagged elements, followed by the closing tag of the pair with length/value/type = 7. The tagged stream between opening and closing tags may be parsed according to these same four rules via a process of recursive descent until only primitive tags are encountered or until no tags are encountered.

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21 FORMAL DESCRIPTION OF APPLICATION PROTOCOL DATA UNITS

This clause consists of an ASN.1 module that defines the BACnet APDUs and all necessary underlying datatypes. Clauses 13 through 17 contain many service parameters that are defined as conditional (C) or user optional (U). Both of these parameter types are designated as OPTIONAL in the ASN.1 productions to indicate that they may or may not be present in the PDU. The use of OPTIONAL in the ASN.1 production shall not supersede the conditional requirements defined in the service specification.

```
BACnetModule DEFINITIONS IMPLICIT TAGS ::=
BEGIN

--******************** APDU Definitions ********************

BACnetPDU ::= CHOICE {
        confirmed-request-PDU       [0] BACnet-Confirmed-Request-PDU,
        unconfirmed-request-PDU     [1] BACnet-Unconfirmed-Request-PDU,
        simpleACK-PDU               [2] BACnet-SimpleACK-PDU,
        complexACK-PDU              [3] BACnet-ComplexACK-PDU,
        segmentAck-PDU              [4] BACnet-SegmentACK-PDU,
        error-PDU                   [5] BACnet-Error-PDU,
        reject-PDU                  [6] BACnet-Reject-PDU,
        abort-PDU                   [7] BACnet-Abort-PDU
        }

BACnet-Confirmed-Request-PDU ::= SEQUENCE {
        pdu-type                    [0] Unsigned (0..15), -- 0 for this PDU type
        segmented-message           [1] BOOLEAN,
        more-follows                [2] BOOLEAN,
        segmented-response-accepted [3] BOOLEAN,
        reserved                    [4] Unsigned (0..3), -- must be set to zero
        max-segments-accepted       [5] Unsigned (0..7),   -- as per 20.1.2.4
        max-APDU-length-accepted    [6] Unsigned (0..15), -- as per 20.1.2.5
        invokeID                    [7] Unsigned (0..255),
        sequence-number             [8] Unsigned (0..255) OPTIONAL, -- only if segmented msg
        proposed-window-size        [9] Unsigned (1..127) OPTIONAL, -- only if segmented msg
        service-choice              [10] BACnetConfirmedServiceChoice,
        service-request             [11] BACnet-Confirmed-Service-Request OPTIONAL
-- Context-specific tags 0..11 are NOT used in header encoding
        }

BACnet-Unconfirmed-Request-PDU ::= SEQUENCE {
        pdu-type                    [0] Unsigned (0..15), -- 1 for this PDU type
        reserved                    [1] Unsigned (0..15), -- must be set to zero
        service-choice              [2] BACnetUnconfirmedServiceChoice,
        service-request             [3] BACnet-Unconfirmed-Service-Request
-- Context-specific tags 0..3 are NOT used in header encoding
        }

BACnet-SimpleACK-PDU ::= SEQUENCE {
        pdu-type                    [0] Unsigned (0..15), -- 2 for this PDU type
        reserved                    [1] Unsigned (0..15), -- must be set to zero
        invokeID                    [2] Unsigned (0..255),
        service-ACK-choice          [3] BACnetConfirmedServiceChoice
-- Context-specific tags 0..3 are NOT used in header encoding
        }
```

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```
BACnet-ComplexACK-PDU ::= SEQUENCE {
        pdu-type                [0] Unsigned (0..15), -- 3 for this PDU type
        segmented-message       [1] BOOLEAN,
        more-follows            [2] BOOLEAN,
        reserved                [3] Unsigned (0..3), -- must be set to zero
        invokeID                [4] Unsigned (0..255),
        sequence-number         [5] Unsigned (0..255) OPTIONAL, --only if segment
        proposed-window-size    [6] Unsigned (1..127) OPTIONAL, -- only if segment
        service-ACK-choice      [7] BACnetConfirmedServiceChoice,
        service-ACK             [8] BACnet-Confirmed-Service-ACK
-- Context-specific tags 0..8 are NOT used in header encoding
        }

BACnet-SegmentACK-PDU ::= SEQUENCE {
        pdu-type                [0] Unsigned (0..15), -- 4 for this PDU type
        reserved                [1] Unsigned (0..3), -- must be set to zero
        negative-ACK            [2] BOOLEAN,
        server                  [3] BOOLEAN,
        original-invokeID       [4] Unsigned (0..255),
        sequence-number         [5] Unsigned (0..255),
        actual-window-size      [6] Unsigned (1..127)
-- Context-specific tags 0..6 are NOT used in header encoding
        }

BACnet-Error-PDU ::= SEQUENCE {
        pdu-type                [0] Unsigned (0..15), -- 5 for this PDU type
        reserved                [1] Unsigned (0..15), -- must be set to zero
        original-invokeID       [2] Unsigned (0..255),
        error-choice            [3] BACnetConfirmedServiceChoice,
        error                   [4] BACnet-Error
-- Context-specific tags 0..4 are NOT used in header encoding
        }

BACnet-Reject-PDU ::= SEQUENCE {
        pdu-type                [0] Unsigned (0..15), -- 6 for this PDU type
        reserved                [1] Unsigned (0..15), -- must be set to zero
        original-invokeID       [2] Unsigned (0..255),
        reject-reason           [3] BACnetRejectReason
-- Context-specific tags 0..3 are NOT used in the header encoding
        }

BACnet-Abort-PDU ::= SEQUENCE {
        pdu-type                [0] Unsigned (0..15), -- 7 for this PDU type
        reserved                [1] Unsigned (0..7), -- must be set to zero
        server                  [2] BOOLEAN,
        original-invokeID       [3] Unsigned (0..255),
        abort-reason            [4] BACnetAbortReason
-- Context-specific tags 0..4 are NOT used in header encoding
        }
```

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```
********************** Confirmed Service Productions **********************

BACnetConfirmedServiceChoice ::= ENUMERATED {
-- Alarm and Event Services
        acknowledgeAlarm            (0),
        confirmedCOVNotification    (1),
        confirmedEventNotification  (2),
        getAlarmSummary             (3),
        getEnrollmentSummary        (4),
        getEventInformation         (29),
        subscribeCOV                (5),
        subscribeCOVProperty        (28),
        lifeSafetyOperation         (27),

-- File Access Services
        atomicReadFile              (6),
        atomicWriteFile             (7),

-- Object Access Services
        addListElement              (8),
        removeListElement           (9),
        createObject                (10),
        deleteObject                (11),
        readProperty                (12),
        readPropertyMultiple        (14),
        readRange                   (26),
        writeProperty               (15),
        writePropertyMultiple       (16),

-- Remote Device Management Services
        deviceCommunicationControl  (17),
        confirmedPrivateTransfer    (18),
        confirmedTextMessage        (19),
        reinitializeDevice          (20),

-- Virtual Terminal Services
        vtOpen                      (21),
        vtClose                     (22),
        vtData                      (23)

-- Removed Services
        -- formerly: authenticate           (24), removed in version 1 revision 11
        -- formerly: requestKey             (25), removed in version 1 revision 11
        -- formerly: readPropertyConditional (13), removed in version 1 revision 12

-- Services added after 1995
        -- readRange                (26)    see Object Access Services
        -- lifeSafetyOperation      (27)    see Alarm and Event Services
        -- subscribeCOVProperty     (28)    see Alarm and Event Services
        -- getEventInformation      (29)    see Alarm and Event Services
        }
-- Other services to be added as they are defined. All enumeration values in this production are reserved for definition by
-- ASHRAE. Proprietary extensions are made by using the ConfirmedPrivateTransfer or UnconfirmedPrivateTransfer
-- services. See Clause 23.
```

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```
BACnet-Confirmed-Service-Request ::= CHOICE {
-- Alarm and Event Services
        acknowledgeAlarm            [0]  AcknowledgeAlarm-Request,
        confirmedCOVNotification    [1]  ConfirmedCOVNotification-Request,
        confirmedEventNotification  [2]  ConfirmedEventNotification-Request,
        -- getAlarmSummary conveys no parameters
        getEnrollmentSummary        [4]  GetEnrollmentSummary-Request,
        getEventInformation         [29] GetEventInformation-Request,
        subscribeCOV                [5]  SubscribeCOV-Request,
        subscribeCOVProperty        [28] SubscribeCOVProperty-Request,
        lifeSafetyOperation         [27] LifeSafetyOperation-Request,

-- File Access Services
        atomicReadFile              [6]  AtomicReadFile-Request,
        atomicWriteFile             [7]  AtomicWriteFile-Request,

-- Object Access Services
        addListElement              [8]  AddListElement-Request,
        removeListElement           [9]  RemoveListElement-Request,
        createObject                [10] CreateObject-Request,
        deleteObject                [11] DeleteObject-Request,
        readProperty                [12] ReadProperty-Request,
        readPropertyMultiple        [14] ReadPropertyMultiple-Request,
        readRange                   [26] ReadRange-Request,
        writeProperty               [15] WriteProperty-Request,
        writePropertyMultiple       [16] WritePropertyMultiple-Request,

-- Remote Device Management Services
        deviceCommunicationControl  [17] DeviceCommunicationControl-Request,
        confirmedPrivateTransfer    [18] ConfirmedPrivateTransfer-Request,
        confirmedTextMessage        [19] ConfirmedTextMessage-Request,
        reinitializeDevice          [20] ReinitializeDevice-Request,

-- Virtual Terminal Services
        vtOpen                      [21] VT-Open-Request,
        vtClose                     [22] VT-Close-Request,
        vtData                      [23] VT-Data-Request

-- Removed Services
        -- formerly: authenticate                [24] This was removed in version 1 revision 11
        -- formerly: requestKey                  [25] This was removed in version 1 revision 11
        -- formerly: readPropertyConditional     [13] removed in version 1 revision 12

-- Services added after 1995
        -- readRange                  [26] see Object Access Services
        -- lifeSafetyOperation        [27] see Alarm and Event Services
        -- subscribeCOVProperty       [28] see Alarm and Event Services
        -- getEventInformation        [29] see Alarm and Event Services
        }
-- Context-specific tags 0..29 are NOT used in the encoding. The tag number is transferred as the service-choice parameter
-- in the BACnet-Confirmed-Request-PDU.
--
-- Other services will be added as they are defined. All choice values in this production are reserved for definition by
-- ASHRAE. Proprietary extensions are made by using the ConfirmedPrivateTransfer service. See Clause 23.
```

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```
BACnet-Confirmed-Service-ACK  ::= CHOICE {
-- This production represents the 'Result(+)' parameters defined for each confirmed service that returns one or more
-- parameters with 'Result(+)'.

-- Alarm and Event Services
        getAlarmSummary                 [3]   GetAlarmSummary-ACK,
        getEnrollmentSummary            [4]   GetEnrollmentSummary-ACK,
        getEventInformation             [29]  GetEventInformation-ACK,

-- File Access Services
        atomicReadFile                  [6]   AtomicReadFile-ACK,
        atomicWriteFile                 [7]   AtomicWriteFile-ACK,

-- Object Access Services
        createObject                    [10]  CreateObject-ACK,
        readProperty                    [12]  ReadProperty-ACK,
        readPropertyMultiple            [14]  ReadPropertyMultiple-ACK,
        readRange                       [26]  ReadRange-ACK,

-- Remote Device Management Services
        confirmedPrivateTransfer        [18]  ConfirmedPrivateTransfer-ACK,

-- Virtual Terminal Services
        vtOpen                          [21]  VT-Open-ACK,
        vtData                          [23]  VT-Data-ACK

-- Removed Services
        -- formerly: authenticate               [24] removed in version 1 revision 11
        -- formerly: readPropertyConditional    [13] removed in version 1 revision 12

-- Context-specific tags 3..29 are NOT used in the encoding. The tag number is transferred as the service-ACK-choice
-- parameter in the BACnet-ComplexACK-PDU.
--
-- Other services to be added as they are defined. All choice values in this production are reserved for definition by
-- ASHRAE. Proprietary extensions are made by using the ConfirmedPrivateTransfer service.
-- See Clause 23.
        }

********************** Confirmed Alarm and Event Services ******************

AcknowledgeAlarm-Request ::= SEQUENCE {
        acknowledgingProcessIdentifier  [0] Unsigned32,
        eventObjectIdentifier           [1] BACnetObjectIdentifier,
        eventStateAcknowledged          [2] BACnetEventState,
        timeStamp                       [3] BACnetTimeStamp,
        acknowledgmentSource            [4] CharacterString,
        timeOfAcknowledgment            [5] BACnetTimeStamp
        }

ConfirmedCOVNotification-Request ::= SEQUENCE {
        subscriberProcessIdentifier     [0] Unsigned32,
        initiatingDeviceIdentifier      [1] BACnetObjectIdentifier,
        monitoredObjectIdentifier       [2] BACnetObjectIdentifier,
        timeRemaining                   [3] Unsigned,
        listOfValues                    [4] SEQUENCE OF BACnetPropertyValue
        }
```

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```
ConfirmedEventNotification-Request ::= SEQUENCE {
        processIdentifier               [0] Unsigned32,
        initiatingDeviceIdentifier      [1] BACnetObjectIdentifier,
        eventObjectIdentifier           [2] BACnetObjectIdentifier,
        timeStamp                       [3] BACnetTimeStamp,
        notificationClass               [4] Unsigned,
        priority                        [5] Unsigned8,
        eventType                       [6] BACnetEventType,
        messageText                     [7] CharacterString OPTIONAL,
        notifyType                      [8] BACnetNotifyType,
        ackRequired                     [9] BOOLEAN OPTIONAL,
        fromState                       [10] BACnetEventState OPTIONAL,
        toState                         [11] BACnetEventState,
        eventValues                     [12] BACnetNotificationParameters OPTIONAL
        }

GetAlarmSummary-ACK ::= SEQUENCE OF SEQUENCE {
        objectIdentifier                BACnetObjectIdentifier,
        alarmState                      BACnetEventState,
        acknowledgedTransitions         BACnetEventTransitionBits
        }

GetEnrollmentSummary-Request ::= SEQUENCE {
        acknowledgmentFilter            [0] ENUMERATED {
                                                all             (0),
                                                acked           (1),
                                                not-acked       (2)
                                                },
        enrollmentFilter                [1] BACnetRecipientProcess OPTIONAL,
        eventStateFilter                [2] ENUMERATED {
                                                offnormal       (0),
                                                fault           (1),
                                                normal          (2),
                                                all             (3),
                                                active          (4)
                                                } OPTIONAL,
        eventTypeFilter                 [3] BACnetEventType OPTIONAL,
        priorityFilter                  [4] SEQUENCE {
                                                minPriority     [0] Unsigned8,
                                                maxPriority     [1] Unsigned8
                                                } OPTIONAL,
        notificationClassFilter         [5] Unsigned OPTIONAL
        }

GetEnrollmentSummary-ACK ::= SEQUENCE OF SEQUENCE {
        objectIdentifier                BACnetObjectIdentifier,
        eventType                       BACnetEventType,
        eventState                      BACnetEventState,
        priority                        Unsigned8,
        notificationClass               Unsigned OPTIONAL
        }

GetEventInformation-Request ::= SEQUENCE {
        lastReceivedObjectIdentifier    [0]  BACnetObjectIdentifier OPTIONAL
        }
```

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```
GetEventInformation-ACK ::= SEQUENCE {
        listOfEventSummaries    [0]  SEQUENCE OF SEQUENCE {
                objectIdentifier            [0]  BACnetObjectIdentifier,
                eventState                  [1]  BACnetEventState,
                acknowledgedTransitions     [2]  BACnetEventTransitionBits,
                eventTimeStamps             [3]  SEQUENCE SIZE (3) OF BACnetTimeStamp,
                notifyType                  [4]  BACnetNotifyType,
                eventEnable                 [5]  BACnetEventTransitionBits,
                eventPriorities             [6]  SEQUENCE SIZE (3) OF Unsigned
                },
        moreEvents              [1]  BOOLEAN
        }

LifeSafetyOperation-Request ::= SEQUENCE {
        requestingProcessIdentifier     [0]  Unsigned32,
        requestingSource                [1]  CharacterString,
        request                         [2]  BACnetLifeSafetyOperation,
        objectIdentifier                [3]  BACnetObjectIdentifier OPTIONAL
        }

SubscribeCOV-Request ::= SEQUENCE {
        subscriberProcessIdentifier     [0]  Unsigned32,
        monitoredObjectIdentifier       [1]  BACnetObjectIdentifier,
        issueConfirmedNotifications     [2]  BOOLEAN OPTIONAL,
        lifetime                        [3]  Unsigned OPTIONAL
        }

SubscribeCOVProperty-Request ::= SEQUENCE {
        subscriberProcessIdentifier     [0]  Unsigned32,
        monitoredObjectIdentifier       [1]  BACnetObjectIdentifier,
        issueConfirmedNotifications     [2]  BOOLEAN OPTIONAL,
        lifetime                        [3]  Unsigned OPTIONAL,
        monitoredPropertyIdentifier     [4]  BACnetPropertyReference,
        covIncrement                    [5]  REAL OPTIONAL
        }

************************** Confirmed File Access Services **************************

AtomicReadFile-Request ::= SEQUENCE {
        fileIdentifier      BACnetObjectIdentifier,
        accessMethod        CHOICE {
                                streamAccess    [0] SEQUENCE {
                                                        fileStartPosition       INTEGER,
                                                        requestedOctetCount     Unsigned
                                                        },
                                recordAccess    [1] SEQUENCE {
                                                        fileStartRecord         INTEGER,
                                                        requestedRecordCount    Unsigned
                                                        }
                                }
        }
```

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```
AtomicReadFile-ACK ::= SEQUENCE {
        endOfFile       BOOLEAN,
        accessMethod    CHOICE {
                        streamAccess    [0] SEQUENCE {
                                        fileStartPosition       INTEGER,
                                        fileData                OCTET STRING
                                        },
                        recordAccess    [1] SEQUENCE {
                                        fileStartRecord         INTEGER,
                                        returnedRecordCount     Unsigned,
                                        fileRecordData          SEQUENCE OF OCTET STRING
                                        }
                        }
        }

AtomicWriteFile-Request ::= SEQUENCE {
        fileIdentifier  BACnetObjectIdentifier,
        accessMethod    CHOICE {
                        streamAccess    [0] SEQUENCE {
                                        fileStartPosition   INTEGER,
                                        fileData            OCTET STRING
                                        },
                        recordAccess    [1] SEQUENCE {
                                        fileStartRecord     INTEGER,
                                        recordCount         Unsigned,
                                        fileRecordData      SEQUENCE OF OCTET STRING
                                        }
                        }
        }

AtomicWriteFile-ACK ::= CHOICE {
        fileStartPosition   [0] INTEGER,
        fileStartRecord     [1] INTEGER
        }

************************** Confirmed Object Access Services ************************

AddListElement-Request ::= SEQUENCE {
        objectIdentifier        [0] BACnetObjectIdentifier,
        propertyIdentifier      [1] BACnetPropertyIdentifier,
        propertyArrayIndex      [2] Unsigned OPTIONAL, -- used only with array datatype
        listOfElements          [3] ABSTRACT-SYNTAX.&Type
        }

CreateObject-Request ::= SEQUENCE {
        objectSpecifier         [0] CHOICE {
                                    objectType          [0] BACnetObjectType,
                                    objectIdentifier    [1] BACnetObjectIdentifier
                                    },
        listOfInitialValues     [1] SEQUENCE OF BACnetPropertyValue OPTIONAL
        }

CreateObject-ACK ::= BACnetObjectIdentifier
```

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```
DeleteObject-Request ::= SEQUENCE {
        objectIdentifier            BACnetObjectIdentifier
        }

ReadProperty-Request ::= SEQUENCE {
        objectIdentifier            [0] BACnetObjectIdentifier,
        propertyIdentifier          [1] BACnetPropertyIdentifier,
        propertyArrayIndex          [2] Unsigned OPTIONAL --used only with array datatype
                                                          -- if omitted with an array the entire array is referenced
        }

ReadProperty-ACK ::= SEQUENCE {
        objectIdentifier            [0] BACnetObjectIdentifier,
        propertyIdentifier          [1] BACnetPropertyIdentifier,
        propertyArrayIndex          [2] Unsigned OPTIONAL,--used only with array datatype
                                                          -- if omitted with an array the entire array is referenced
        propertyValue               [3] ABSTRACT-SYNTAX.&Type
        }

ReadPropertyMultiple-Request   ::= SEQUENCE {
        listOfReadAccessSpecs       SEQUENCE OF ReadAccessSpecification
        }

ReadPropertyMultiple-ACK ::= SEQUENCE {
        listOfReadAccessResults     SEQUENCE OF ReadAccessResult
        }

ReadRange-Request ::= SEQUENCE {
        objectIdentifier            [0]  BACnetObjectIdentifier,
        propertyIdentifier          [1]  BACnetPropertyIdentifier,
        propertyArrayIndex          [2]  Unsigned OPTIONAL,          -- used only with array datatype
        range                        CHOICE {
                                        byPosition              [3]  SEQUENCE {
                                                                        referenceIndex  Unsigned,
                                                                        count           INTEGER
                                                                        },
                                        -- context tag 4 is deprecated
                                        -- context tag 5 is deprecated
                                        bySequenceNumber        [6]  SEQUENCE {
                                                                        referenceIndex  Unsigned,
                                                                        count           INTEGER
                                                                        },
                                        byTime                  [7]  SEQUENCE {
                                                                        referenceTime   BACnetDateTime,
                                                                        count           INTEGER
                                                                        }
                                        } OPTIONAL
        }
```

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```
ReadRange-ACK ::= SEQUENCE {
        objectIdentifier            [0]  BACnetObjectIdentifier,
        propertyIdentifier          [1]  BACnetPropertyIdentifier,
        propertyArrayIndex          [2]  Unsigned OPTIONAL,  -- used only with array datatype
        resultFlags                 [3]  BACnetResultFlags,
        itemCount                   [4]  Unsigned,
        itemData                    [5]  SEQUENCE OF ABSTRACT-SYNTAX.&Type,
        firstSequenceNumber         [6] Unsigned32 OPTIONAL -- used only if 'Item Count' > 0 and the request was either of
                                                            -- type 'By Sequence Number' or 'By Time'
        }

RemoveListElement-Request ::= SEQUENCE {
        objectIdentifier            [0] BACnetObjectIdentifier,
        propertyIdentifier          [1] BACnetPropertyIdentifier,
        propertyArrayIndex          [2] Unsigned OPTIONAL, --used only with array datatypes
        listOfElements              [3] ABSTRACT-SYNTAX.&Type
        }

WriteProperty-Request ::= SEQUENCE {
                objectIdentifier            [0] BACnetObjectIdentifier,
                propertyIdentifier          [1] BACnetPropertyIdentifier,
                propertyArrayIndex          [2] Unsigned OPTIONAL, --used only with array datatype
                                                -- if omitted with an array the entire
                                                -- array is referenced
                propertyValue               [3] ABSTRACT-SYNTAX.&Type,
                priority                    [4] Unsigned8 (1..16) OPTIONAL --used only when property is commandable
        }

WritePropertyMultiple-Request ::= SEQUENCE {
        listOfwriteAccessSpecifications     SEQUENCE OF WriteAccessSpecification
        }

************************** Confirmed Remote Device Management Services ******************

DeviceCommunicationControl-Request ::= SEQUENCE {
        timeDuration        [0] Unsigned16 OPTIONAL,
        enable-disable      [1] ENUMERATED {
                                    enable              (0),
                                    disable             (1),
                                    disable-initiation  (2)
                                    },
        password            [2] CharacterString (SIZE(1..20)) OPTIONAL
        }

ConfirmedPrivateTransfer-Request ::= SEQUENCE {
        vendorID                    [0] Unsigned,
        serviceNumber               [1] Unsigned,
        serviceParameters           [2] ABSTRACT-SYNTAX.&Type OPTIONAL
        }

ConfirmedPrivateTransfer-ACK ::= SEQUENCE {
        vendorID                    [0] Unsigned,
        serviceNumber               [1] Unsigned,
        resultBlock                 [2] ABSTRACT-SYNTAX.&Type OPTIONAL
        }
```

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```
ConfirmedTextMessage-Request ::= SEQUENCE {
        textMessageSourceDevice     [0] BACnetObjectIdentifier,
        messageClass                [1] CHOICE {
                                            numeric     [0] Unsigned,
                                            character   [1] CharacterString
                                            } OPTIONAL,
        messagePriority             [2] ENUMERATED {
                                            normal      (0),
                                            urgent      (1)
                                            },
        message                     [3] CharacterString
        }

ReinitializeDevice-Request ::= SEQUENCE {
        reinitializedStateOfDevice      [0] ENUMERATED {
                                                coldstart       (0),
                                                warmstart       (1),
                                                startbackup     (2),
                                                endbackup       (3),
                                                startrestore    (4),
                                                endrestore      (5),
                                                abortrestore    (6)
                                                },
        password                        [1] CharacterString (SIZE (1..20)) OPTIONAL
        }

********************** Confirmed Virtual Terminal Services **********************

VT-Open-Request ::= SEQUENCE {
        vtClass                 BACnetVTClass,
        localVTSessionIdentifier    Unsigned8
        }

VT-Open-ACK ::= SEQUENCE {
        remoteVTSessionIdentifier       Unsigned8
        }

VT-Close-Request ::= SEQUENCE {
        listOfRemoteVTSessionIdentifiers  SEQUENCE OF Unsigned8
        }

VT-Data-Request ::= SEQUENCE {
        vtSessionIdentifier     Unsigned8,
        vtNewData               OCTET STRING,
        vtDataFlag              Unsigned (0..1)
        }

VT-Data-ACK ::= SEQUENCE {
        allNewDataAccepted      [0] BOOLEAN,
        acceptedOctetCount      [1] Unsigned OPTIONAL --present only if allNewDataAccepted = FALSE
        }
```

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********** Unconfirmed Request Productions **********

BACnetUnconfirmedServiceChoice ::= ENUMERATED {
    i-Am (0),
    i-Have (1),
    unconfirmedCOVNotification (2),
    unconfirmedEventNotification (3),
    unconfirmedPrivateTransfer (4),
    unconfirmedTextMessage (5),
    timeSynchronization (6),
    who-Has (7),
    who-Is (8),
    utcTimeSynchronization (9)
    }
-- Other services to be added as they are defined. All choice values in this production are reserved for definition by
-- ASHRAE. Proprietary extensions are made by using the UnconfirmedPrivateTransfer service. See Clause 23.
BACnet-Unconfirmed-Service-Request ::= CHOICE {
    i-Am [0] I-Am-Request,
    i-Have [1] I-Have-Request,
    unconfirmedCOVNotification [2] UnconfirmedCOVNotification-Request,
    unconfirmedEventNotification [3] UnconfirmedEventNotification-Request,
    unconfirmedPrivateTransfer [4] UnconfirmedPrivateTransfer-Request,
    unconfirmedTextMessage [5] UnconfirmedTextMessage-Request,
    timeSynchronization [6] TimeSynchronization-Request,
    who-Has [7] Who-Has-Request,
    who-Is [8] Who-Is-Request,
    utcTimeSynchronization [9] UTCTimeSynchronization-Request
    }
-- Context-specific tags 0..8 are NOT used in the encoding. The tag number is transferred as the service-choice parameter
-- in the BACnet-Unconfirmed-Request-PDU.
--
-- Other services to be added as they are defined. All choice values in this production are reserved for definition by
-- ASHRAE. Proprietary extensions are made by using the UnconfirmedPrivateTransfer service.
-- See Clause 23.

********** Unconfirmed Alarm and Event Services **********

UnconfirmedCOVNotification-Request ::= SEQUENCE {
    subscriberProcessIdentifier [0] Unsigned32,
    initiatingDeviceIdentifier [1] BACnetObjectIdentifier,
    monitoredObjectIdentifier [2] BACnetObjectIdentifier,
    timeRemaining [3] Unsigned,
    listOfValues [4] SEQUENCE OF BACnetPropertyValue
    }

UnconfirmedEventNotification-Request ::= SEQUENCE {
    processIdentifier [0] Unsigned32,
    initiatingDeviceIdentifier [1] BACnetObjectIdentifier,
    eventObjectIdentifier [2] BACnetObjectIdentifier,
    timeStamp [3] BACnetTimeStamp,
    notificationClass [4] Unsigned,
    priority [5] Unsigned8,
    eventType [6] BACnetEventType,
    messageText [7] CharacterString OPTIONAL,
    notifyType [8] BACnetNotifyType,

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```
        ackRequired                 [9] BOOLEAN OPTIONAL,
        fromState                   [10] BACnetEventState OPTIONAL,
        toState                     [11] BACnetEventState,
        eventValues                 [12] BACnetNotificationParameters OPTIONAL
        }

******************** Unconfirmed Remote Device Management Services ********************

I-Am-Request ::= SEQUENCE {
        iAmDeviceIdentifier         BACnetObjectIdentifier,
        maxAPDULengthAccepted       Unsigned,
        segmentationSupported       BACnetSegmentation,
        vendorID                    Unsigned
        }

I-Have-Request ::= SEQUENCE {
        deviceIdentifier    BACnetObjectIdentifier,
        objectIdentifier    BACnetObjectIdentifier,
        objectName          CharacterString
        }

UnconfirmedPrivateTransfer-Request ::= SEQUENCE {
        vendorID                [0] Unsigned,
        serviceNumber           [1] Unsigned,
        serviceParameters       [2] ABSTRACT-SYNTAX.&Type OPTIONAL
        }

UnconfirmedTextMessage-Request ::= SEQUENCE {
        textMessageSourceDevice     [0] BACnetObjectIdentifier,
        messageClass                [1] CHOICE {
                                            numeric     [0] Unsigned,
                                            character   [1] CharacterString
                                            } OPTIONAL,
        messagePriority             [2] ENUMERATED {
                                            normal      (0),
                                            urgent      (1)
                                            },
        message                     [3] CharacterString
        }

TimeSynchronization-Request ::= SEQUENCE {
        time    BACnetDateTime
        }

UTCTimeSynchronization-Request ::= SEQUENCE {
        time    BACnetDateTime
        }

Who-Has-Request ::= SEQUENCE {
        limits  SEQUENCE {
                        deviceInstanceRangeLowLimit     [0] Unsigned (0..4194303),
                        deviceInstanceRangeHighLimit    [1] Unsigned (0..4194303)
                        } OPTIONAL,
        object  CHOICE {
                        objectIdentifier                [2] BACnetObjectIdentifier,
                        objectName                      [3] CharacterString
```

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```
                    }
        }

Who-Is-Request ::= SEQUENCE {
        deviceInstanceRangeLowLimit     [0] Unsigned (0..4194303) OPTIONAL, -- must be used as a pair, see 16.10
        deviceInstanceRangeHighLimit    [1] Unsigned (0..4194303) OPTIONAL  -- must be used as a pair, see 16.10
        }

******************************** Error Productions ************************

BACnetAbortReason ::= ENUMERATED {
        other                               (0),
        buffer-overflow                     (1),
        invalid-apdu-in-this-state          (2),
        preempted-by-higher-priority-task   (3),
        segmentation-not-supported          (4),
        security-error                      (5),
        insufficient-security               (6),
        window-size-out-of-range            (7),
        application-exceeded-reply-time     (8),
        out-of-resources                    (9),
        tsm-timeout                         (10),
        apdu-too-long                       (11),
        ...
        }
        -- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values 64-255
        -- may be used by others subject to the procedures and constraints described in Clause 23.

BACnet-Error  ::= CHOICE {
        other                               [127] Error,
-- The remaining choices in this production represent the Result(-) parameters
-- defined for each confirmed service.

-- Alarm and Event Services
        acknowledgeAlarm                    [0]   Error,
        confirmedCOVNotification            [1]   Error,
        confirmedEventNotification          [2]   Error,
        getAlarmSummary                     [3]   Error,
        getEnrollmentSummary                [4]   Error,
        getEventInformation                 [29]  Error,
        subscribeCOV                        [5]   Error,
        subscribeCOVProperty                [28]  Error,
        lifeSafetyOperation                 [27]  Error,

-- File Access Services
        atomicReadFile                      [6]   Error,
        atomicWriteFile                     [7]   Error,

-- Object Access Services
        addListElement                      [8]   ChangeList-Error,
        removeListElement                   [9]   ChangeList-Error,
        createObject                        [10]  CreateObject-Error,
        deleteObject                        [11]  Error,
        readProperty                        [12]  Error,
        readPropertyMultiple                [14]  Error,
```

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```
        readRange                       [26] Error,
        writeProperty                   [15] Error,
        writePropertyMultiple           [16] WritePropertyMultiple-Error,

-- Remote Device Management Services
        deviceCommunicationControl      [17] Error,
        confirmedPrivateTransfer        [18] ConfirmedPrivateTransfer-Error,
        confirmedTextMessage            [19] Error,
        reinitializeDevice              [20] Error,

-- Virtual Terminal Services
        vtOpen                          [21] Error,
        vtClose                         [22] VTClose-Error,
        vtData                          [23] Error

-- Removed Services
        -- formerly: authenticate                   [24] removed in version 1 reviion 11
        -- formerly: requestKey                     [25] removed in version 1 reviion 11
        -- formerly: readPropertyConditional        [13] removed in version 1 revision 12

-- Services added after 1995
        -- readRange                    [26]  see Object Access  Services
        -- lifeSafetyOperation          [27]  see Alarm and Event Services
        -- subscribeCOVProperty         [28]  see Alarm and Event Services
        -- getEventInformation          [29]  see Alarm and Event Services
        }
-- Context-specific tags 0..29 and 127 are NOT used in the encoding. The tag number is transferred as the error-choice
-- parameter in the BACnet-Error-PDU.
--
-- Other services to be added as they are defined. All choice values in this production are reserved for definition by
-- ASHRAE. See Clause 23.

BACnetRejectReason ::= ENUMERATED {
        other                           (0),
        buffer-overflow                 (1),
        inconsistent-parameters         (2),
        invalid-parameter-data-type     (3),
        invalid-tag                     (4),
        missing-required-parameter      (5),
        parameter-out-of-range          (6),
        too-many-arguments              (7),
        undefined-enumeration           (8),
        unrecognized-service            (9),
        ...
        }
-- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values 64-255
-- may be used by others subject to the procedures and constraints described in Clause 23.

ChangeList-Error ::= SEQUENCE {
        errorType                       [0] Error,
        firstFailedElementNumber        [1] Unsigned
        }
```

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```
CreateObject-Error ::= SEQUENCE {
        errorType                       [0] Error,
        firstFailedElementNumber        [1] Unsigned
        }

ConfirmedPrivateTransfer-Error ::= SEQUENCE {
        errorType       [0] Error,
        vendorID        [1] Unsigned,
        serviceNumber   [2] Unsigned,
        errorParameters [3] ABSTRACT-SYNTAX.&Type OPTIONAL
        }

Error ::= SEQUENCE {
-- NOTE: The valid combinations of error-class and error-code are defined in Clause 18.
        error-class     ENUMERATED {
                        device          (0),
                        object          (1),
                        property        (2),
                        resources       (3),
                        security        (4),
                        services        (5),
                        vt              (6),
                        communication   (7),
                        ...
                        },
        -- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values
        -- 64-65535 may be used by others subject to the procedures and constraints described
        -- in Clause 23.

        error-code      ENUMERATED { -- see below for numerical order
                        abort-apdu-too-long                             (123),
                        abort-application-exceeded-reply-time           (124),
                        abort-buffer-overflow                           (51),
                        abort-insufficient-security                     (135),
                        abort-invalid-apdu-in-this-state                (52),
                        abort-other                                     (56),
                        abort-out-of-resources                          (125),
                        abort-preempted-by-higher-priority-task         (53),
                        abort-proprietary                               (55),
                        abort-security-error                            (136),
                        abort-segmentation-not-supported                (54),
                        abort-tsm-timeout                               (126),
                        abort-window-size-out-of-range                  (127),
                        access-denied                                   (85),
                        addressing-error                                (115),
                        bad-destination-address                         (86),
                        bad-destination-device-id                       (87),
                        bad-signature                                   (88),
                        bad-source-address                              (89),
                        bad-timestamp                                   (90),
                        busy                                            (82),
                        cannot-use-key                                  (91),
                        cannot-verify-message-id                        (92),
                        character-set-not-supported                     (41),
                        communication-disabled                          (83),
                        configuration-in-progress                       (2),
```

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```
correct-key-revision (93),
cov-subscription-failed (43),
datatype-not-supported (47),
delete-fdt-entry-failed (120),
device-busy (3),
destination-device-id-required (94),
distribute-broadcast-failed (121),
duplicate-message (95),
duplicate-name (48),
duplicate-object-id (49),
dynamic-creation-not-supported (4),
encryption-not-configured (96),
encryption-required (97),
file-access-denied (5),
file-full (128),
inconsistent-configuration (129),
inconsistent-object-type (130),
inconsistent-parameters (7),
inconsistent-selection-criterion (8),
incorrect-key (98),
internal-error (131),
invalid-array-index (42),
invalid-configuration-data (46),
invalid-data-type (9),
invalid-event-state (73),
invalid-file-access-method (10),
invalid-file-start-position (11),
invalid-key-data (99),
invalid-parameter-data-type (13),
invalid-tag (57),
invalid-time-stamp (14),
key-update-in-progress (100),
list-element-not-found (81),
log-buffer-full (75),
logged-value-purged (76),
malformed-message (101),
message-too-long (113),
missing-required-parameter (16),
network-down (58),
no-alarm-configured (74),
no-objects-of-specified-type (17),
no-property-specified (77),
no-space-for-object (18),
no-space-to-add-list-element (19),
no-space-to-write-property (20),
no-vt-sessions-available (21),
not-configured (132),
not-configured-for-triggered-logging (78),
not-cov-property (44),
not-key-server (102),
not-router-to-dnet (110),
object-deletion-not-permitted (23),
object-identifier-already-exists (24),
other (0),
operational-problem (25),
optional-functionality-not-supported (45),
```

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```
                out-of-memory                       (133),
                parameter-out-of-range              (80),
                password-failure                    (26),
                property-is-not-a-list              (22),
                property-is-not-an-array            (50),
                read-access-denied                  (27),
                read-bdt-failed                     (117),
                read-fdt-failed                     (119),
                register-foreign-device-failed      (118),
                reject-buffer-overflow              (59),
                reject-inconsistent-parameters      (60),
                reject-invalid-parameter-data-type  (61),
                reject-invalid-tag                  (62),
                reject-missing-required-parameter   (63),
                reject-parameter-out-of-range       (64),
                reject-too-many-arguments           (65),
                reject-undefined-enumeration        (66),
                reject-unrecognized-service         (67),
                reject-proprietary                  (68),
                reject-other                        (69),
                router-busy                         (111),
                security-error                      (114),
                security-not-configured             (103),
                service-request-denied              (29),
                source-security-required            (104),
                success                             (84),
                timeout                             (30),
                too-many-keys                       (105),
                unknown-authentication-type         (106),
                unknown-device                      (70),
                unknown-file-size                   (122),
                unknown-key                         (107),
                unknown-key-revision                (108),
                unknown-network-message             (112),
                unknown-object                      (31),
                unknown-property                    (32),
                unknown-subscription                (79),
                unknown-route                       (71),
                unknown-source-message              (109),
                unknown-vt-class                    (34),
                unknown-vt-session                  (35),
                unsupported-object-type             (36),
                value-not-initialized               (72),
                value-out-of-range                  (37),
                value-too-long                      (134),
                vt-session-already-closed           (38),
                vt-session-termination-failure      (39),
                write-access-denied                 (40),
                write-bdt-failed                    (116),
-- numerical order reference
                -- see other                        (0),
                -- formerly: authentication-failed  (1),  removed version 1 revision 11
                -- see configuration-in-progress    (2),
                -- see device-busy                  (3),
                -- see dynamic-creation-not-supported (4),
                -- see file-access-denied           (5),
```

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```
    -- formerly:incompatible-security-levels    (6), removed in version 1 revision 11
    -- see inconsistent-parameters              (7),
    -- see inconsistent-selection-criterion     (8),
    -- see invalid-data-type                    (9),
    -- see invalid-file-access-method           (10),
    -- see invalid-file-start-position          (11),
    -- formerly: invalid-operator-name          (12), removed in version 1 revision 11
    -- see invalid-parameter-data-type          (13),
    -- see invalid-time-stamp                   (14),
    -- formerly: key-generation-error           (15), removed in version 1 revision 11
    -- see missing required-parameter           (16),
    -- see no-objects-of-specified-type         (17),
    -- see no-space-for-object                  (18),
    -- see no-space-to-add-list-element         (19),
    -- see no-space-to-write-property           (20),
    -- see no-vt-sessions-available             (21),
    -- see property-is-not-a-list               (22),
    -- see object-deletion-not-permitted        (23),
    -- see object-identifier-already-exists     (24),
    -- see operational-problem                  (25),
    -- see password-failure                     (26),
    -- see read-access-denied                   (27),
    -- formerly: security-not-supported         (28), removed in version 1 revision 11
    -- see service-request-denied               (29),
    -- see timeout                              (30),
    -- see unknown-object                       (31),
    -- see unknown-property                     (32),
    -- this enumeration was removed             (33),
    -- see unknown-vt-class                     (34),
    -- see unknown-vt-session                   (35),
    -- see unsupported-object-type              (36),
    -- see value-out-of-range                   (37),
    -- see vt-session-already-closed            (38),
    -- see vt-session-termination-failure       (39),
    -- see write-access-denied                  (40),
    -- see character-set-not-supported          (41),
    -- see invalid-array-index                  (42),
    -- see cov-subscription-failed              (43),
    -- see not-cov-property                     (44),
    -- see optional-functionality-not-supported (45),
    -- see invalid-configuration-data           (46),
    -- see datatype-not-supported               (47),
    -- see duplicate-name                       (48),
    -- see duplicate-object-id                  (49),
    -- see property-is-not-an-array             (50),
    -- see abort-buffer-overflow                (51),
    -- see abort-invalid-apdu-in-this-state     (52),
    -- see abort-preempted-by-higher-priority-task (53),
    -- see abort-segmentation-not-supported     (54),
    -- see abort-proprietary                    (55),
    -- see abort-other                          (56),
    -- see  invalid-tag                         (57),
    -- see network-down                         (58),
    -- see reject-buffer-overflow               (59),
    -- see reject-inconsistent-parameters       (60),
    -- see reject-invalid-parameter-data-type   (61),
```

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```
        -- see reject-invalid-tag                          (62),
        -- see reject-missing-required-parameter           (63),
        -- see reject-parameter-out-of-range               (64),
        -- see reject-too-many-arguments                   (65),
        -- see reject-undefined-enumeration                (66),
        -- see reject-unrecognized-service                 (67),
        -- see reject-proprietary                          (68),
        -- see reject-other                                (69),
        -- see unknown-device                              (70),
        -- see unknown-route                               (71),
        -- see value-not-initialized                       (72),
        -- see invalid-event-state                         (73),
        -- see no-alarm-configured                         (74),
        -- see log-buffer-full                             (75)
        -- see logged-value-purged                         (76),
        -- see no-property-specified                       (77),
        -- see not-configured-for-triggered-logging        (78),
        -- see unknown-subscription                        (79),
        -- see parameter-out-of-range                      (80),
        -- see list-element-not-found                      (81),
        -- see busy                                        (82),
        -- see communication-disabled                      (83),
        -- see success                                     (84),
        -- see access-denied                               (85),
        -- see bad-destination-address                     (86),
        -- see bad-destination-device-id                   (87),
        -- see bad-signature                               (88),
        -- see bad-source-address                          (89),
        -- see bad-timestamp                               (90),
        -- see cannot-use-key                              (91),
        -- see cannot-verify-message-id                    (92),
        -- see correct-key-revision                        (93),
        -- see destination-device-id-required              (94),
        -- see duplicate-message                           (95),
        -- see encryption-not-configured                   (96),
        -- see encryption-required                         (97),
        -- see incorrect-key                               (98),
        -- see invalid-key-data                            (99),
        -- see key-update-in-progress                      (100),
        -- see malformed-message                           (101),
        -- see not-key-server                              (102),
        -- see security-not-configured                     (103),
        -- see source-security-required                    (104),
        -- see too-many-keys                               (105),
        -- see unknown-authentication-type                 (106),
        -- see unknown-key                                 (107),
        -- see unknown-key-revision                        (108),
        -- see unknown-source-message                      (109),
        -- see not-router-to-dnet                          (110),
        -- see router-busy                                 (111),
        -- see unknown-network-message                     (112),
        -- see message-too-long                            (113),
        -- see security-error                              (114),
        -- see addressing-error                            (115),
        -- see write-bdt-failed                            (116),
        -- see read-bdt-failed                             (117),
```

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```
                -- see register- foreign-device-failed          (118),
                -- see read-fdt-failed                          (119),
                -- see delete-fdt-entry-failed                  (120),
                -- see distribute-broadcast-failed              (121),
                -- see unknown-file-size                        (122),
                -- see abort-apdu-too-long                      (123),
                -- see abort-application-exceeded-reply-time    (124),
                -- see abort-out-of-resources                   (125),
                -- see abort-tsm-timeout                        (126),
                -- see abort-window-size-out-of-range           (127),
                -- see file-full                                (128),
                -- see inconsistent-configuration               (129),
                -- see inconsistent-object-type                 (130),
                -- see internal-error                           (131),
                -- see not-configured                           (132),
                -- see out-of-memory                            (133),
                -- see value-too-long                           (134),
                -- see abort-insufficient-security              (135),
                -- see abort-security-error                     (136),
                ...
                }
                -- Enumerated values 0-255 are reserved for definition by ASHRAE. Enumerated values
                -- 256-65535 may be used by others subject to the procedures and constraints described
                -- in Clause 23.
        }

WritePropertyMultiple-Error ::= SEQUENCE {
        errorType                       [0] Error,
        firstFailedWriteAttempt         [1] BACnetObjectPropertyReference
        }

VTClose-Error ::= SEQUENCE {
        errorType                       [0] Error,
        listOfVTSessionIdentifiers      [1] SEQUENCE OF Unsigned8 OPTIONAL
        }

-- ****************************** Application Types *********************************

-- The following productions are the definitions of the Application datatypes.
-- See 20.2.1.4.

-- NULL                 [APPLICATION 0], equivalent to [UNIVERSAL 5]

-- BOOLEAN              [APPLICATION 1], equivalent to [UNIVERSAL 1]

 Unsigned  ::=          [APPLICATION 2] INTEGER (0..MAX)

 Unsigned8  ::=         Unsigned (0..255)

 Unsigned16  ::=        Unsigned (0..65535)

 Unsigned32  ::=        Unsigned (0..4294967295)

-- INTEGER              [APPLICATION 3], equivalent to [UNIVERSAL 2]

-- REAL                 [APPLICATION 4], equivalent to [UNIVERSAL 9] ANSI/IEEE-754 single precision floating point
```

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```
 Double   ::=          [APPLICATION 5] OCTET STRING (SIZE(8)) -- ANSI/IEEE-754 double precision floating point

-- OCTET STRING       [APPLICATION 6], equivalent to [UNIVERSAL 4]

 CharacterString  ::= [APPLICATION 7] OCTET STRING -- see 20.2.9 for supported types

-- BIT STRING         [APPLICATION 8], equivalent to [UNIVERSAL 3]

-- ENUMERATED         [APPLICATION 9], equivalent to [UNIVERSAL 10]

Date ::= [APPLICATION 10] OCTET STRING (SIZE(4)) -- see 20.2.12
--       first octet      year minus 1900          X'FF' = unspecified
--       second octet     month (1.. 14)           1   = January
--                                                 13 = odd months
--                                                 14 = even months
--                                                 X'FF' = unspecified
--       third octet      day of month    (1..34), 32 = last day of month
--                                                 33 = odd days of month
--                                                 34 = even days of month
--                                                 X'FF' = unspecified
--       fourth octet     day of week     (1..7)   1 = Monday
--                                                 7 = Sunday
--                                                 X'FF' = unspecified

 Time  ::= [APPLICATION 11] OCTET STRING (SIZE(4)) -- see 20.2.13
--       first octet      hour            (0..23), (X'FF') = unspecified
--       second octet     minute          (0..59), (X'FF') = unspecified
--       third octet      second          (0..59), (X'FF') = unspecified
--       fourth octet     hundredths      (0..99), (X'FF') = unspecified

BACnetObjectIdentifier ::= [APPLICATION 12] OCTET STRING (SIZE(4)) -- see 20.2.14


-- ****************************** Base Types *********************************

BACnetAccessAuthenticationFactorDisable ::= ENUMERATED {
        none                    (0),
        disabled                (1),
        disabled-lost           (2),
        disabled-stolen         (3),
        disabled-damaged        (4),
        disabled-destroyed      (5),
        ...
        }
        -- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values
        -- 64-65535 may be used by others subject to the procedures and constraints described
        -- in Clause 23.

BACnetAccessCredentialDisable ::= ENUMERATED {
        none                    (0),
        disable                 (1),
        disable-manual          (2),
        disable-lockout         (3),
        ...
        }
```

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```
        -- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values
        -- 64-65535 may be used by others subject to the procedures and constraints described
        -- in Clause 23.

BACnetAccessCredentialDisableReason ::= ENUMERATED {
        disabled                        (0),
        disabled-needs-provisioning     (1),
        disabled-unassigned             (2),
        disabled-not-yet-active         (3),
        disabled-expired                (4),
        disabled-lockout                (5),
        disabled-max-days               (6),
        disabled-max-uses               (7),
        disabled-inactivity             (8),
        disabled-manual                 (9),
        ...
        }
        -- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values
        -- 64-65535 may be used by others subject to the procedures and constraints described
        -- in Clause 23.

BACnetAccessEvent ::= ENUMERATED {
        none                            (0),
        granted                         (1),
        muster                          (2),
        passback-detected               (3),
        duress                          (4),
        trace                           (5),
        lockout-max-attempts            (6),
        lockout-other                   (7),
        lockout-relinquished            (8),
        locked-by-higher-priority       (9),
        out-of-service                  (10),
        out-of-service-relinquished     (11),
        accompaniment-by                (12),
        authentication-factor-read      (13),
        authorization-delayed           (14),
        verification-required           (15),
        -- Enumerated values 128-511 are used for events which indicate that access has been denied.
        denied-deny-all                 (128),
        denied-unknown-credential       (129),
        denied-authentication-unavailable (130),
        denied-authentication-factor-timeout (131),
        denied-incorrect-authentication-factor (132),
        denied-zone-no-access-rights    (133),
        denied-point-no-access-rights   (134),
        denied-no-access-rights         (135),
        denied-out-of-time-range        (136),
        denied-threat-level             (137),
        denied-passback                 (138),
        denied-unexpected-location-usage (139),
        denied-max-attempts             (140),
        denied-lower-occupancy-limit    (141),
        denied-upper-occupancy-limit    (142),
        denied-authentication-factor-lost (143),
        denied-authentication-factor-stolen (144),
```

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```
        denied-authentication-factor-damaged        (145),
        denied-authentication-factor-destroyed      (146),
        denied-authentication-factor-disabled       (147),
        denied-authentication-factor-error          (148),
        denied-credential-unassigned                (149),
        denied-credential-not-provisioned           (150),
        denied-credential-not-yet-active            (151),
        denied-credential-expired                   (152),
        denied-credential-manual-disable            (153),
        denied-credential-lockout                   (154),
        denied-credential-max-days                  (155),
        denied-credential-max-uses                  (156),
        denied-credential-inactivity                (157),
        denied-credential-disabled                  (158),
        denied-no-accompaniment                     (159),
        denied-incorrect-accompaniment              (160),
        denied-lockout                              (161),
        denied-verification-failed                  (162),
        denied-verification-timeout                 (163),
        denied-other                                (164),
        ...
        }
        -- Enumerated values 0-511 are reserved for definition by ASHRAE. Enumerated values
        -- 512-65535 may be used by others subject to the procedures and constraints described
        -- in Clause 23.

BACnetAccessPassbackMode ::= ENUMERATED {
        passback-off    (0),
        hard-passback   (1),
        soft-passback   (2)
        }

BACnetAccessRule ::= SEQUENCE {
        timeRangeSpecifier      [0]     ENUMERATED {
                                            specified       (0),
                                            always          (1)
                                            },
        timeRange               [1]     BACnetDeviceObjectPropertyReference OPTIONAL,
                                        -- to be present if timeRangeSpecifier has the value "specified"
        locationSpecifier       [2]     ENUMERATED {
                                            specified       (0),
                                            all             (1)
                                            },
        location                [3]     BACnetDeviceObjectReference OPTIONAL,
                                        -- to be present if locationSpecifier has the value "specified"
        enable                  [4]     BOOLEAN
}

BACnetAccessThreatLevel ::= Unsigned(0..100)
```

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```
BACnetAccessUserType ::= ENUMERATED {
        asset           (0),
        group           (1),
        person          (2),
        ...
        }
        -- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values
        -- 64-65535 may be used by others subject to the procedures and constraints described
        -- in Clause 23.

BACnetAccessZoneOccupancyState ::= ENUMERATED {
        normal                  (0),
        below-lower-limit       (1),
        at-lower-limit          (2),
        at-upper-limit          (3),
        above-upper-limit       (4),
        disabled                (5),
        not-supported           (6),
        ...
        }
        -- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values
        -- 64-65535 may be used by others subject to the procedures and constraints described
        -- in Clause 23.

BACnetAccumulatorRecord ::= SEQUENCE {
        timestamp               [0] BACnetDateTime,
        presentValue            [1] Unsigned,
        accumulatedValue        [2] Unsigned,
        accumulatorStatus       [3] ENUMERATED {
                                        normal          (0),
                                        starting        (1),
                                        recovered       (2),
                                        abnormal        (3),
                                        failed          (4)
                                        }
        }

BACnetAction ::= ENUMERATED {
        direct          (0),
        reverse         (1)
        }

BACnetActionCommand ::= SEQUENCE {
        deviceIdentifier        [0] BACnetObjectIdentifier OPTIONAL,
        objectIdentifier        [1] BACnetObjectIdentifier,
        propertyIdentifier      [2] BACnetPropertyIdentifier,
        propertyArrayIndex      [3] Unsigned OPTIONAL,   --used only with array datatype
        propertyValue           [4] ABSTRACT-SYNTAX.&Type,
        priority                [5] Unsigned (1..16) OPTIONAL, --used only when property is commandable
        postDelay               [6] Unsigned OPTIONAL,
        quitOnFailure           [7] BOOLEAN,
        writeSuccessful         [8] BOOLEAN
        }

BACnetActionList ::= SEQUENCE{
        action     [0] SEQUENCE OF BACnetActionCommand
```

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```
}

BACnetAddress ::= SEQUENCE {
    network-number  Unsigned16,             -- A value of 0 indicates the local network
    mac-address     OCTET STRING            -- A string of length 0 indicates a broadcast
    }

BACnetAddressBinding ::= SEQUENCE {
    deviceObjectIdentifier      BACnetObjectIdentifier,
    deviceAddress               BACnetAddress
    }

BACnetAssignedAccessRights ::= SEQUENCE {
    assigned-access-rights      [0] BACnetDeviceObjectReference,
    enable                      [1] BOOLEAN
    }

BACnetAuthenticationFactor ::= SEQUENCE {
    format-type         [0] BACnetAuthenticationFactorType,
    format-class        [1] Unsigned,
    value               [2] OCTET STRING -- for encoding of values into this octet string see ANNEX P.
    }

BACnetAuthenticationFactorFormat ::= SEQUENCE {
    format-type         [0] BACnetAuthenticationFactorType,
    vendor-id           [1] Unsigned16 OPTIONAL,
    vendor-format       [2] Unsigned16 OPTIONAL
    }

BACnetAuthenticationFactorType ::= ENUMERATED {
    undefined                   (0),
    error                       (1),
    custom                      (2),
    simple-number16             (3),
    simple-number32             (4),
    simple-number56             (5),
    simple-alpha-numeric        (6),
    aba-track2                  (7),
    wiegand26                   (8),
    wiegand37                   (9),
    wiegand37-facility          (10),
    facility16-card32           (11),
    facility32-card32           (12),
    fasc-n                      (13),
    fasc-n-bcd                  (14),
    fasc-n-large                (15),
    fasc-n-large-bcd            (16),
    gsa75                       (17),
    chuid                       (18),
    chuid-full                  (19),
    guid                        (20),
    cbeff-A                     (21),
    cbeff-B                     (22),
    cbeff-C                     (23),
    user-password               (24)
    }
```

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```
BACnetAuthenticationPolicy ::= SEQUENCE {
        policy              [0] SEQUENCE OF SEQUENCE {
                                    credential-data-input   [0] BACnetDeviceObjectReference,
                                    index                   [1] Unsigned
                                    },
        order-enforced      [1] BOOLEAN,
        timeout             [2] Unsigned
        }

BACnetAuthenticationStatus ::= ENUMERATED {
        not-ready                           (0),
        ready                               (1),
        disabled                            (2),
        waiting-for-authentication-factor   (3),
        waiting-for-accompaniment           (4),
        waiting-for-verification            (5),
        in-progress                         (6)
        }

BACnetAuthorizationMode ::= ENUMERATED {
        authorize                           (0),
        grant-active                        (1),
        deny-all                            (2),
        verification-required               (3),
        authorization-delayed               (4),
        none                                (5),
        ...
        }
        -- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values
        -- 64-65535 may be used by others subject to the procedures and constraints described
        -- in Clause 23.

BACnetBackupState ::= ENUMERATED {
        idle                    (0),
        preparing-for-backup    (1),
        preparing-for-restore   (2),
        performing-a-backup     (3),
        performing-a-restore    (4),
        backup-failure          (5),
        restore-failure         (6)
}

BACnetBinaryPV ::= ENUMERATED {
        inactive    (0),
        active      (1)
        }

BACnetCalendarEntry ::= CHOICE {
        date        [0] Date,
        dateRange   [1] BACnetDateRange,
        weekNDay    [2] BACnetWeekNDay
        }

BACnetClientCOV ::= CHOICE {
        real-increment      REAL,
```

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```
        default-increment NULL
        }

BACnetCOVSubscription ::= SEQUENCE {
        recipient                   [0] BACnetRecipientProcess,
        monitoredPropertyReference  [1] BACnetObjectPropertyReference,
        issueConfirmedNotifications [2] BOOLEAN,
        timeRemaining               [3] Unsigned,
        covIncrement                [4] REAL OPTIONAL       -- used only with monitored
                                                            -- properties with a numeric datatype
        }

BACnetCredentialAuthenticationFactor ::= SEQUENCE {
        disable                 [0] BACnetAccessAuthenticationFactorDisable,
        authentication-factor   [1] BACnetAuthenticationFactor
        }

BACnetDailySchedule ::= SEQUENCE {
        day-schedule    [0] SEQUENCE OF BACnetTimeValue
        }

BACnetDateRange ::= SEQUENCE {  -- see Clause 20.2.12 for restrictions
        startDate       Date,
        endDate         Date
        }

BACnetDateTime ::= SEQUENCE {
        date            Date,   -- see Clause 20.2.12 for restrictions
        time            Time    -- see Clause 20.2.13 for restrictions
        }

BACnetDaysOfWeek ::= BIT STRING {
        monday          (0),
        tuesday         (1),
        wednesday       (2),
        thursday        (3),
        friday          (4),
        saturday        (5),
        sunday          (6)
        }

BACnetDestination ::= SEQUENCE {
        validDays                   BACnetDaysOfWeek,
        fromTime                    Time,
        toTime                      Time,
        recipient                   BACnetRecipient,
        processIdentifier           Unsigned32,
        issueConfirmedNotifications BOOLEAN,
        transitions                 BACnetEventTransitionBits
        }

BACnetDeviceObjectPropertyReference ::= SEQUENCE {
        objectIdentifier    [0]     BACnetObjectIdentifier,
        propertyIdentifier  [1]     BACnetPropertyIdentifier,
        propertyArrayIndex  [2]     Unsigned OPTIONAL,      -- used only with array datatype
                                                            -- if omitted with an array then
```

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```
                                                    -- the entire array is referenced
        deviceIdentifier        [3]     BACnetObjectIdentifier OPTIONAL
        }

BACnetDeviceObjectPropertyValue ::= SEQUENCE {
        deviceIdentifier        [0]     BACnetObjectIdentifier,
        objectIdentifier        [1]     BACnetObjectIdentifier,
        propertyIdentifier      [2]     BACnetPropertyIdentifier,
        arrayIndex              [3]     Unsigned  OPTIONAL,
        value                   [4]     ABSTRACT-SYNTAX.&Type
        }

BACnetDeviceObjectReference ::= SEQUENCE {
        deviceIdentifier        [0]     BACnetObjectIdentifier OPTIONAL,
        objectIdentifier        [1]     BACnetObjectIdentifier
        }

BACnetDeviceStatus ::= ENUMERATED {
        operational             (0),
        operational-read-only   (1),
        download-required       (2),
        download-in-progress    (3),
        non-operational         (4),
        backup-in-progress      (5),
        ...
        }
-- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values
-- 64-65535 may be used by others subject to the procedures and constraints described
-- in Clause 23.

BACnetDoorAlarmState ::= ENUMERATED {
        normal                  (0),
        alarm                   (1),
        door-open-too-long      (2),
        forced-open             (3),
        tamper                  (4),
        door-fault              (5),
        lock-down               (6),
        free-access             (7),
        egress-open             (8),
        ...
        }
-- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values
-- 64-65535 may be used by others subject to the procedures and constraints described
-- in Clause 23.

BACnetDoorSecuredStatus ::= ENUMERATED {
        secured         (0),
        unsecured       (1),
        unknown         (2)
        }

BACnetDoorStatus ::= ENUMERATED {
        closed          (0),
        opened          (1),
        unknown         (2)
```

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```
        }

BACnetDoorValue ::= ENUMERATED {
        lock                    (0),
        unlock                  (1),
        pulse-unlock            (2),
        extended-pulse-unlock   (3)
        }

BACnetEngineeringUnits ::= ENUMERATED {   -- See below for numerical order
-- Acceleration
        meters-per-second-per-second        (166),
--Area
        square-meters                       (0),
        square-centimeters                  (116),
        square-feet                         (1),
        square-inches                       (115),

--Currency
        currency1                           (105),
        currency2                           (106),
        currency3                           (107),
        currency4                           (108),
        currency5                           (109),
        currency6                           (110),
        currency7                           (111),
        currency8                           (112),
        currency9                           (113),
        currency10                          (114),

--Electrical
        milliamperes                        (2),
        amperes                             (3),
        amperes-per-meter                   (167),
        amperes-per-square-meter            (168),
        ampere-square-meters                (169),
        decibels                            (199),
        decibels-millivolt                  (200),
        decibels-volt                       (201),
        farads                              (170),
        henrys                              (171),
        ohms                                (4),
        ohm-meters                          (172),
        milliohms                           (145),
        kilohms                             (122),
        megohms                             (123),
        microsiemens                        (190),
        millisiemens                        (202),
        siemens                             (173),
        siemens-per-meter                   (174),
        teslas                              (175),
        volts                               (5),
        millivolts                          (124),
        kilovolts                           (6),
        megavolts                           (7),
        volt-amperes                        (8),
```

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```
        kilovolt-amperes                    (9),
        megavolt-amperes                    (10),
        volt-amperes-reactive               (11),
        kilovolt-amperes-reactive           (12),
        megavolt-amperes-reactive           (13),
        volts-per-degree-Kelvin             (176),
        volts-per-meter                     (177),
        degrees-phase                       (14),
        power-factor                        (15),
        webers                              (178),

--Energy
        joules                              (16),
        kilojoules                          (17),
        kilojoules-per-kilogram             (125),
        megajoules                          (126),
        watt-hours                          (18),
        kilowatt-hours                      (19),
        megawatt-hours                      (146),
        watt-hours-reactive                 (203),
        kilowatt-hours-reactive             (204),
        megawatt-hours-reactive             (205),
        btus                                (20),
        kilo-btus                           (147),
        mega-btus                           (148),
        therms                              (21),
        ton-hours                           (22),

--Enthalpy
        joules-per-kilogram-dry-air         (23),
        kilojoules-per-kilogram-dry-air     (149),
        megajoules-per-kilogram-dry-air     (150),
        btus-per-pound-dry-air              (24),
        btus-per-pound                      (117),

--Entropy
        joules-per-degree-Kelvin            (127),
        kilojoules-per-degree-Kelvin        (151),
        megajoules-per-degree-Kelvin        (152),
        joules-per-kilogram-degree-Kelvin   (128),

-- Force
        newton                              (153),

--Frequency
        cycles-per-hour                     (25),
        cycles-per-minute                   (26),
        hertz                               (27),
        kilohertz                           (129),
        megahertz                           (130),
        per-hour                            (131),

--Humidity
        grams-of-water-per-kilogram-dry-air (28),
        percent-relative-humidity           (29),
```

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--Length

micrometers	(194),
millimeters	(30),
centimeters	(118),
kilometers	(193),
meters	(31),
inches	(32),
feet	(33),

--Light

candelas	(179),
candelas-per-square-meter	(180),
watts-per-square-foot	(34),
watts-per-square-meter	(35),
lumens	(36),
luxes	(37),
foot-candles	(38),

--Mass

milligrams	(196),
grams	(195),
kilograms	(39),
pounds-mass	(40),
tons	(41),

--Mass Flow

grams-per-second	(154),
grams-per-minute	(155),
kilograms-per-second	(42),
kilograms-per-minute	(43),
kilograms-per-hour	(44),
pounds-mass-per-second	(119),
pounds-mass-per-minute	(45),
pounds-mass-per-hour	(46),
tons-per-hour	(156),

--Power

milliwatts	(132),
watts	(47),
kilowatts	(48),
megawatts	(49),
btus-per-hour	(50),
kilo-btus-per-hour	(157),
horsepower	(51),
tons-refrigeration	(52),

--Pressure

pascals	(53),
hectopascals	(133),
kilopascals	(54),
millibars	(134),
bars	(55),
pounds-force-per-square-inch	(56),
millimeters-of-water	(206),
centimeters-of-water	(57),
inches-of-water	(58),

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```
        millimeters-of-mercury          (59),
        centimeters-of-mercury          (60),
        inches-of-mercury               (61),

--Temperature
        degrees-Celsius                 (62),
        degrees-Kelvin                  (63),
        degrees-Kelvin-per-hour         (181),
        degrees-Kelvin-per-minute       (182),
        degrees-Fahrenheit              (64),
        degree-days-Celsius             (65),
        degree-days-Fahrenheit          (66),
        delta-degrees-Fahrenheit        (120),
        delta-degrees-Kelvin            (121),

--Time
        years                           (67),
        months                          (68),
        weeks                           (69),
        days                            (70),
        hours                           (71),
        minutes                         (72),
        seconds                         (73),
        hundredths-seconds              (158),
        milliseconds                    (159),

--Torque
        newton-meters                   (160),

--Velocity
        millimeters-per-second          (161),
        millimeters-per-minute          (162),
        meters-per-second               (74),
        meters-per-minute               (163),
        meters-per-hour                 (164),
        kilometers-per-hour             (75),
        feet-per-second                 (76),
        feet-per-minute                 (77),
        miles-per-hour                  (78),
--Volume
        cubic-feet                      (79),
        cubic-meters                    (80),
        imperial-gallons                (81),
        milliliters                     (197),
        liters                          (82),
        us-gallons                      (83),

--Volumetric Flow
        cubic-feet-per-second           (142),
        cubic-feet-per-minute           (84),
        cubic-feet-per-hour             (191),
        cubic-meters-per-second         (85),
        cubic-meters-per-minute         (165),
        cubic-meters-per-hour           (135),
        imperial-gallons-per-minute     (86),
        milliliters-per-second          (198),
```

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liters-per-second (87),
liters-per-minute (88),
liters-per-hour (136),
us-gallons-per-minute (89),
us-gallons-per-hour (192),

--Other

degrees-angular (90),
degrees-Celsius-per-hour (91),
degrees-Celsius-per-minute (92),
degrees-Fahrenheit-per-hour (93),
degrees-Fahrenheit-per-minute (94),
joule-seconds (183),
kilograms-per-cubic-meter (186),
kilowatt-hours-per-square-meter (137),
kilowatt-hours-per-square-foot (138),
megajoules-per-square-meter (139),
megajoules-per-square-foot (140),
no-units (95),
newton-seconds (187),
newtons-per-meter (188),
parts-per-million (96),
parts-per-billion (97),
percent (98),
percent-obscuration-per-foot (143),
percent-obscuration-per-meter (144),
percent-per-second (99),
per-minute (100),
per-second (101),
psi-per-degree-Fahrenheit (102),
radians (103),
radians-per-second (184),
revolutions-per-minute (104),
square-meters-per-Newton (185),
watts-per-meter-per-degree-Kelvin (189),
watts-per-square-meter-degree-kelvin (141),
per-mille (207),
grams-per-gram (208),
kilograms-per-kilogram (209),
grams-per-kilogram (210),
milligrams-per-gram (211),
milligrams-per-kilogram (212),
grams-per-milliliter (213),
grams-per-liter (214),
milligrams-per-liter (215),
micrograms-per-liter (216),
grams-per-cubic-meter (217),
milligrams-per-cubic-meter (218),
micrograms-per-cubic-meter (219),
nanograms-per-cubic-meter (220),
grams-per-cubic-centimeter (221),
becquerels (222),
kilobecquerels (223),
megabecquerels (224),
gray (225),
milligray (226),

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```
        microgray                                   (227),
        sieverts                                    (228),
        millisieverts                               (229),
        microsieverts                               (230),
        microsieverts-per-hour                      (231),
        decibels-a                                  (232),
        nephelometric-turbidity-unit                (233),
        pH                                          (234),
        grams-per-square-meter                      (235),
        minutes-per-degree-kelvin                   (236),

-- Numerical Order Reference
        -- see square-meters                        (0),
        -- see square-feet                          (1),
        -- see milliamperes                         (2),
        -- see amperes                              (3),
        -- see ohms                                 (4),
        -- see volts                                (5),
        -- see kilovolts                            (6),
        -- see megavolts                            (7),
        -- see volt-amperes                         (8),
        -- see kilovolt-amperes                     (9),
        -- see megavolt-amperes                     (10),
        -- see volt-amperes-reactive                (11),
        -- see kilovolt-amperes-reactive            (12),
        -- see megavolt-amperes-reactive            (13),
        -- see degrees-phase                        (14),
        -- see power-factor                         (15),
        -- see joules                               (16),
        -- see kilojoules                           (17),
        -- see watt-hours                           (18),
        -- see kilowatt-hours                       (19),
        -- see btus                                 (20),
        -- see therms                               (21),
        -- see ton-hours                            (22),
        -- see joules-per-kilogram-dry-air          (23),
        -- see btus-per-pound-dry-air               (24),
        -- see cycles-per-hour                      (25),
        -- see cycles-per-minute                    (26),
        -- see percent-relative-humidity            (29),
        -- see hertz                                (27),
        -- see grams-of-water-per-kilogram-dry-air  (28),
        -- see millimeters                          (30),
        -- see meters                               (31),
        -- see inches                               (32),
        -- see feet                                 (33),
        -- see watts-per-square-foot                (34),
        -- see watts-per-square-meter               (35),
        -- see lumens                               (36),
        -- see luxes                                (37),
        -- see foot-candles                         (38),
        -- see kilograms                            (39),
        -- see pounds-mass                          (40),
        -- see tons                                 (41),
        -- see kilograms-per-second                 (42),
        -- see kilograms-per-minute                 (43),
```

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-- see kilograms-per-hour (44),
-- see pounds-mass-per-minute (45),
-- see pounds-mass-per-hour (46),
-- see watts (47),
-- see kilowatts (48),
-- see megawatts (49),
-- see btus-per-hour (50),
-- see horsepower (51),
-- see tons-refrigeration (52),
-- see pascals (53),
-- see kilopascals (54),
-- see bars (55),
-- see pounds-force-per-square-inch (56),
-- see centimeters-of-water (57),
-- see inches-of-water (58),
-- see millimeters-of-mercury (59),
-- see centimeters-of-mercury (60),
-- see inches-of-mercury (61),
-- see degrees-Celsius (62),
-- see degrees-Kelvin (63),
-- see degrees-Fahrenheit (64),
-- see degree-days-Celsius (65),
-- see degree-days-Fahrenheit (66),
-- see years (67),
-- see months (68),
-- see weeks (69),
-- see days (70),
-- see hours (71),
-- see minutes (72),
-- see seconds (73),
-- see meters-per-second (74),
-- see kilometers-per-hour (75),
-- see feet-per-second (76),
-- see feet-per-minute (77),
-- see miles-per-hour (78),
-- see cubic-feet (79),
-- see cubic-meters (80),
-- see imperial-gallons (81),
-- see liters (82),
-- see us-gallons (83),
-- see cubic-feet-per-minute (84),
-- see cubic-meters-per-second (85),
-- see imperial-gallons-per-minute (86),
-- see liters-per-second (87),
-- see liters-per-minute (88),
-- see us-gallons-per-minute (89),
-- see degrees-angular (90),
-- see degrees-Celsius-per-hour (91),
-- see degrees-Celsius-per-minute (92),
-- see degrees-Fahrenheit-per-hour (93),
-- see degrees-Fahrenheit-per-minute (94),
-- see no-units (95),
-- see parts-per-million (96),
-- see parts-per-billion (97),
-- see percent (98),
-- see percent-per-second (99),

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```
        -- see per-minute                                (100),
        -- see per-second                                (101),
        -- see psi-per-degree-Fahrenheit                 (102),
        -- see radians                                   (103),
        -- see revolutions-per-minute                    (104),
        -- see currency1                                 (105),
        -- see currency2                                 (106),
        -- see currency3                                 (107),
        -- see currency4                                 (108),
        -- see currency5                                 (109),
        -- see currency6                                 (110),
        -- see currency7                                 (111),
        -- see currency8                                 (112),
        -- see currency9                                 (113),
        -- see currency10                                (114),
        -- see square-inches                             (115),
        -- see square-centimeters                        (116),
        -- see btus-per-pound                            (117),
        -- see centimeters                               (118),
        -- see pounds-mass-per-second                    (119),
        -- see delta-degrees-Fahrenheit                  (120),
        -- see delta-degrees-Kelvin                      (121),
        -- see kilohms                                   (122),
        -- see megohms                                   (123),
        -- see millivolts                                (124),
        -- see kilojoules-per-kilogram                   (125),
        -- see megajoules                                (126),
        -- see joules-per-degree-Kelvin                  (127),
        -- see joules-per-kilogram-degree-Kelvin         (128),
        -- see kilohertz                                 (129),
        -- see megahertz                                 (130),
        -- see per-hour                                  (131),
        -- see milliwatts                                (132),
        -- see hectopascals                              (133),
        -- see millibars                                 (134),
        -- see cubic-meters-per-hour                     (135),
        -- see liters-per-hour                           (136),
        -- see kilowatt-hours-per-square-meter           (137),
        -- see kilowatt-hours-per-square-foot            (138),
        -- see megajoules-per-square-meter               (139),
        -- see megajoules-per-square-foot                (140),
        -- see watts-per-square-meter-degree-kelvin      (141),
        -- see cubic-feet-per-second                     (142),
        -- see percent-obscuration-per-foot              (143),
        -- see percent-obscuration-per-meter             (144),
        -- see milliohms                                 (145),
        -- see megawatt-hours                            (146),
        -- see kilo-btus                                 (147),
        -- see mega-btus                                 (148),
        -- see kilojoules-per-kilogram-dry-air           (149),
        -- see megajoules-per-kilogram-dry-air           (150),
        -- see kilojoules-per-degree-Kelvin              (151),
        -- see megajoules-per-degree-Kelvin              (152),
        -- see newton                                    (153),
        -- see grams-per-second                          (154),
        -- see grams-per-minute                          (155),
```

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-- see tons-per-hour (156),
-- see kilo-btus-per-hour (157),
-- see hundredths-seconds (158),
-- see milliseconds (159),
-- see newton-meters (160),
-- see millimeters-per-second (161),
-- see millimeters-per-minute (162),
-- see meters-per-minute (163),
-- see meters-per-hour (164),
-- see cubic-meters-per-minute (165),
-- see meters-per-second-per-second (166),
-- see amperes-per-meter (167),
-- see amperes-per-square-meter (168),
-- see ampere-square-meters (169),
-- see farads (170),
-- see henrys (171),
-- see ohm-meters (172),
-- see siemens (173),
-- see siemens-per-meter (174),
-- see teslas (175),
-- see volts-per-degree-Kelvin (176),
-- see volts-per-meter (177),
-- see webers (178),
-- see candelas (179),
-- see candelas-per-square-meter (180),
-- see degrees-Kelvin-per-hour (181),
-- see degrees-Kelvin-per-minute (182),
-- see joule-seconds (183),
-- see radians-per-second (184),
-- see square-meters-per-Newton (185),
-- see kilograms-per-cubic-meter (186),
-- see newton-seconds (187),
-- see newtons-per-meter (188),
-- see watts-per-meter-per-degree-Kelvin (189),
-- see micro-siemens (190),
-- see cubic-feet-per-hour (191),
-- see us-gallons-per-hour (192),
-- see kilometers (193),
-- see micrometers (194),
-- see grams (195),
-- see milligrams (196),
-- see milliliters (197),
-- see milliliters-per-second (198),
-- see decibels (199),
-- see decibels-millivolt (200),
-- see decibels-volt (201),
-- see millisiemens (202),
-- see watt-hours-reactive (203),
-- see kilowatt-hours-reactive (204),
-- see megawatt-hours-reactive (205),
-- see millimeters-of-water (206),
-- see per-mille (207),
-- see grams-per-gram (208),
-- see kilograms-per-kilogram (209),
-- see grams-per-kilogram (210),
-- see milligrams-per-gram (211),

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```
        -- see milligrams-per-kilogram          (212),
        -- see grams-per-milliliter             (213),
        -- see grams-per-liter                  (214),
        -- see milligrams-per-liter             (215),
        -- see micrograms-per-liter             (216),
        -- see grams-per-cubic-meter            (217),
        -- see milligrams-per-cubic-meter       (218),
        -- see micrograms-per-cubic-meter       (219),
        -- see nanograms-per-cubic-meter        (220),
        -- see grams-per-cubic-centimeter       (221),
        -- see becquerels                       (222),
        -- see kilobecquerels                   (223),
        -- see megabecquerels                   (224),
        -- see gray                             (225),
        -- see milligray                        (226),
        -- see microgray                        (227),
        -- see sieverts                         (228),
        -- see millisieverts                    (229),
        -- see microsieverts                    (230),
        -- see microsieverts-per-hour           (231),
        -- see decibels-a                       (232),
        -- see nephelometric-turbidity-unit     (233),
        -- see pH                               (234),
        -- see grams-per-square-meter           (235),
        -- see minutes-per-degree-kelvin        (236),
        ...
        }
-- Enumerated values 0-255 are reserved for definition by ASHRAE. Enumerated values
-- 256-65535 may be used by others subject to the procedures and constraints described
-- in Clause 23.

BACnetEventLogRecord ::= SEQUENCE {
        timestamp       [0] BACnetDateTime,
        logDatum        [1] CHOICE {
                                log-status      [0] BACnetLogStatus,
                                notification    [1] ConfirmedEventNotification-Request,
                                time-change     [2] REAL
                                }
        }

BACnetEventParameter ::= CHOICE {

-- These choices have a one-to-one correspondence with the Event_Type enumeration with the  exception of the
-- complex-event-type, which is used for proprietary event types.

        change-of-bitstring     [0] SEQUENCE {
                                        time-delay              [0] Unsigned,
                                        bitmask                 [1] BIT STRING,
                                        list-of-bitstring-values [2] SEQUENCE OF BIT STRING
                                        },
        change-of-state         [1] SEQUENCE {
                                        time-delay      [0] Unsigned,
                                        list-of-values  [1] SEQUENCE OF BACnetPropertyStates
                                        },

        change-of-value         [2] SEQUENCE {
```

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```
                        time-delay          [0] Unsigned,
                        cov-criteria        [1] CHOICE {
                                                bitmask                         [0] BIT STRING,
                                                referenced-property-increment   [1] REAL
                                                }
                        },
command-failure         [3] SEQUENCE {
                        time-delay                      [0] Unsigned,
                        feedback-property-reference     [1] BACnetDeviceObjectPropertyReference
                        },

floating-limit          [4] SEQUENCE {
                        time-delay          [0] Unsigned,
                        setpoint-reference  [1] BACnetDeviceObjectPropertyReference,
                        low-diff-limit      [2] REAL,
                        high-diff-limit     [3] REAL,
                        deadband            [4] REAL
                        },
out-of-range            [5] SEQUENCE {
                        time-delay          [0] Unsigned,
                        low-limit           [1] REAL,
                        high-limit          [2] REAL,
                        deadband            [3] REAL
                        },
-- context tag 7 is deprecated
change-of-life-safety   [8] SEQUENCE {
                        time-delay                      [0] Unsigned,
                        list-of-life-safety-alarm-values [1] SEQUENCE OF BACnetLifeSafetyState,
                        list-of-alarm-values            [2] SEQUENCE OF BACnetLifeSafetyState,
                        mode-property-reference         [3] BACnetDeviceObjectPropertyReference
                        },
extended                [9] SEQUENCE {
                        vendor-id           [0] Unsigned16,
                        extended-event-type [1] Unsigned,
                        parameters          [2] SEQUENCE OF CHOICE {
                                                null        NULL,
                                                real        REAL,
                                                integer     Unsigned,
                                                boolean     BOOLEAN,
                                                double      Double,
                                                octet       OCTET STRING,
                                                bitstring   BIT STRING,
                                                enum        ENUMERATED,
                                                reference   [0] BACnetDeviceObjectPropertyReference
                                                }
                        },
buffer-ready            [10] SEQUENCE {
                        notification-threshold          [0] Unsigned,
                        previous-notification-count     [1] Unsigned32
                        },
unsigned-range          [11] SEQUENCE {
                        time-delay          [0] Unsigned,
                        low-limit           [1] Unsigned,
                        high-limit          [2] Unsigned
                        },
                        -- context tag 12 is reserved for future addenda
access-event            [13] SEQUENCE {
```

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```
                                    list-of-access-events           [0] SEQUENCE OF BACnetAccessEvent,
                                    access-event-time-reference [1] BACnetDeviceObjectPropertyReference
                                    },
        double-out-of-range         [14] SEQUENCE {
                                    time-delay          [0] Unsigned,
                                    low-limit           [1] Double,
                                    high-limit          [2] Double,
                                    deadband            [3] Double
                                    },
        signed-out-of-range         [15] SEQUENCE {
                                    time-delay          [0] Unsigned,
                                    low-limit           [1] INTEGER,
                                    high-limit          [2] INTEGER,
                                    deadband            [3] Unsigned
                                    },
        unsigned-out-of-range       [16] SEQUENCE {
                                    time-delay          [0] Unsigned,
                                    low-limit           [1] Unsigned,
                                    high-limit          [2] Unsigned,
                                    deadband            [3] Unsigned
                                    },
        change-of-characterstring [17] SEQUENCE {
                                    time-delay              [0] Unsigned,
                                    list-of-alarm-values    [1] SEQUENCE OF CharacterString
                                    },
        change-of-status-flags      [18] SEQUENCE {
                                    time-delay              [0] Unsigned,
                                    selected-flags          [1] BACnetStatusFlags
                                    }
        }

-- CHOICE [6] has been intentionally omitted. It parallels the complex-event-type CHOICE [6] of the
-- BACnetNotificationParameters production which was introduced to allow the addition of proprietary event
-- algorithms whose event parameters are not necessarily network-visible.

BACnetEventState ::= ENUMERATED {
        normal          (0),
        fault           (1),
        offnormal       (2),
        high-limit      (3),
        low-limit       (4),
        life-safety-alarm (5),
        ...
        }
-- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values
-- 64-65535 may be used by others subject to the procedures and constraints described
-- in Clause 23. The last enumeration used in this version is 5.

BACnetEventTransitionBits ::= BIT STRING {
        to-offnormal    (0),
        to-fault        (1),
        to-normal       (2)
        }
```

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```
BACnetEventType ::= ENUMERATED {
        change-of-bitstring         (0),
        change-of-state             (1),
        change-of-value             (2),
        command-failure             (3),
        floating-limit              (4),
        out-of-range                (5),
        -- complex-event-type       (6),  see comment below
        -- context tag 7 is deprecated
        change-of-life-safety       (8),
        extended                    (9),
        buffer-ready                (10),
        unsigned-range              (11),
        -- enumeration value 12 is reserved for future addenda
        access-event                (13),
        double-out-of-range         (14),
        signed-out-of-range         (15),
        unsigned-out-of-range       (16),
        change-of-characterstring   (17),
        change-of-status-flags      (18),
        ...
        }
-- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values
-- 64-65535 may be used by others subject to the procedures and constraints described
-- in Clause 23. It is expected that these enumerated values will correspond to the use of the
-- complex-event-type CHOICE [6] of the BACnetNotificationParameters production.

BACnetFileAccessMethod ::= ENUMERATED {
        record-access               (0),
        stream-access               (1)
        }

BACnetKeyIdentifier ::= SEQUENCE {
        algorithm                   [0] Unsigned8,
        key-id                      [1] Unsigned8
        }

BACnetLifeSafetyMode ::= ENUMERATED {
        off                         (0),
        on                          (1),
        test                        (2),
        manned                      (3),
        unmanned                    (4),
        armed                       (5),
        disarmed                    (6),
        prearmed                    (7),
        slow                        (8),
        fast                        (9),
        disconnected                (10),
        enabled                     (11),
        disabled                    (12),
        automatic-release-disabled  (13),
        default                     (14),
        ...
        }
-- Enumerated values 0-255 are reserved for definition by ASHRAE. Enumerated values
```

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```
-- 256-65535 may be used by others subject to procedures and constraints described in Clause 23.

BACnetLifeSafetyOperation ::= ENUMERATED {
        none                (0),
        silence             (1),
        silence-audible     (2),
        silence-visual      (3),
        reset               (4),
        reset-alarm         (5),
        reset-fault         (6),
        unsilence           (7),
        unsilence-audible   (8),
        unsilence-visual    (9),
        ...
        }
-- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values
-- 64-65535 may be used by others subject to procedures and constraints described in
-- Clause 23.

BACnetLifeSafetyState ::= ENUMERATED {
        quiet               (0),
        pre-alarm           (1),
        alarm               (2),
        fault               (3),
        fault-pre-alarm     (4),
        fault-alarm         (5),
        not-ready           (6),
        active              (7),
        tamper              (8),
        test-alarm          (9),
        test-active         (10),
        test-fault          (11),
        test-fault-alarm    (12),
        holdup              (13),
        duress              (14),
        tamper-alarm        (15),
        abnormal            (16),
        emergency-power     (17),
        delayed             (18),
        blocked             (19),
        local-alarm         (20),
        general-alarm       (21),
        supervisory         (22),
        test-supervisory    (23),
        ...
        }
-- Enumerated values 0-255 are reserved for definition by ASHRAE. Enumerated values
-- 256-65535 may be used by others subject to procedures and constraints described in Clause 23.

BACnetLimitEnable ::= BIT STRING {
        lowLimitEnable   (0),
        highLimitEnable  (1)
        }
```

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```
BACnetLockStatus ::= ENUMERATED {
        locked          (0),
        unlocked        (1),
        fault           (2),
        unknown         (3)
        }

BACnetLogData ::=  CHOICE {
        log-status      [0] BACnetLogStatus,
        log-data        [1] SEQUENCE OF CHOICE {
                                boolean-value   [0] BOOLEAN,
                                real-value      [1] REAL,
                                enum-value      [2] ENUMERATED,       -- Optionally limited to 32 bits
                                unsigned-value  [3] Unsigned,         -- Optionally limited to 32 bits
                                signed-value    [4] INTEGER,          -- Optionally limited to 32 bits
                                bitstring-value [5] BIT STRING,       -- Optionally limited to 32 bits
                                null-value      [6] NULL,
                                failure         [7] Error,
                                any-value       [8] ABSTRACT-SYNTAX.&Type  -- Optional
                                },
        time-change     [2] REAL
        }

BACnetLoggingType ::= ENUMERATED {
        polled          (0),
        cov             (1),
        triggered       (2),
        ...
        }
        -- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values
        -- 64-255 may be used by others subject to the procedures and constraints described
        -- in Clause 23.

BACnetLogMultipleRecord ::=  SEQUENCE {
        timestamp       [0] BACnetDateTime,
        logData         [1] BACnetLogData
        }

BACnetLogRecord ::=  SEQUENCE {
        timestamp       [0] BACnetDateTime,
        logDatum        [1] CHOICE {
                                log-status      [0] BACnetLogStatus,
                                boolean-value   [1] BOOLEAN,
                                real-value      [2] REAL,
                                enum-value      [3] ENUMERATED,       -- Optionally limited to 32 bits
                                unsigned-value  [4] Unsigned,     -- Optionally limited to 32 bits
                                signed-value    [5] INTEGER,      -- Optionally limited to 32 bits
                                bitstring-value [6] BIT STRING,-- Optionally limited to 32 bits
                                null-value      [7] NULL,
                                failure         [8] Error,
                                time-change     [9] REAL,
                                any-value       [10] ABSTRACT-SYNTAX.&Type  -- Optional
                                },
        statusFlags     [2] BACnetStatusFlags OPTIONAL
        }
```

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```
BACnetLogStatus ::= BIT STRING {
        log-disabled        (0),
        buffer-purged       (1),
        log-interrupted     (2)
        }

BACnetMaintenance ::= ENUMERATED {
        none                        (0),
        periodic-test               (1),
        need-service-operational    (2),
        need-service-inoperative    (3),
        ...
        }
-- Enumerated values 0-255 are reserved for definition by ASHRAE. Enumerated values
-- 256-65535 may be used by others subject to procedures and constraints described in
-- Clause 23.

BACnetNetworkSecurityPolicy ::= SEQUENCE {
        port-id                     [0] Unsigned8,
        security-level              [1] BACnetSecurityPolicy
        }

BACnetNodeType ::= ENUMERATED {
        unknown         (0),
        system          (1),
        network         (2),
        device          (3),
        organizational  (4),
        area            (5),
        equipment       (6),
        point           (7),
        collection      (8),
        property        (9),
        functional      (10),
        other           (11)
        }

BACnetNotificationParameters ::= CHOICE {
-- These choices have a one-to-one correspondence with the Event_Type enumeration with the exception of the
-- complex-event-type, which is used for proprietary event types.

        change-of-bitstring     [0] SEQUENCE {
                                        referenced-bitstring    [0] BIT STRING,
                                        status-flags            [1] BACnetStatusFlags
                                        },
        change-of-state         [1] SEQUENCE {
                                        new-state               [0] BACnetPropertyStates,
                                        status-flags            [1] BACnetStatusFlags
                                        },
        change-of-value         [2] SEQUENCE {
                                        new-value               [0] CHOICE {
                                                                        changed-bits    [0] BIT STRING,
                                                                        changed-value   [1] REAL
                                                                        },
                                        status-flags            [1] BACnetStatusFlags
                                        },
```

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```
command-failure         [3] SEQUENCE {
                            command-value           [0] ABSTRACT-SYNTAX.&Type,
                                                        -- depends on ref property
                            status-flags            [1] BACnetStatusFlags,
                            feedback-value          [2] ABSTRACT-SYNTAX.&Type
                                                        -- depends on ref property
                            },
floating-limit          [4] SEQUENCE {
                            reference-value         [0] REAL,
                            status-flags            [1] BACnetStatusFlags,
                            setpoint-value          [2] REAL,
                            error-limit             [3] REAL
                            },
out-of-range            [5] SEQUENCE {
                            exceeding-value         [0] REAL,
                            status-flags            [1] BACnetStatusFlags,
                            deadband                [2] REAL,
                            exceeded-limit          [3] REAL
                            },
complex-event-type      [6] SEQUENCE OF BACnetPropertyValue,
                        -- complex tag 7 is deprecated
change-of-life-safety   [8] SEQUENCE {
                            new-state               [0] BACnetLifeSafetyState,
                            new-mode                [1] BACnetLifeSafetyMode,
                            status-flags            [2] BACnetStatusFlags,
                            operation-expected      [3] BACnetLifeSafetyOperation
                            },
extended                [9] SEQUENCE {
                            vendor-id               [0] Unsigned16,
                            extended-event-type     [1] Unsigned,
                            parameters              [2] SEQUENCE OF CHOICE {
                                                        null            NULL,
                                                        real            REAL,
                                                        integer         Unsigned,
                                                        boolean         BOOLEAN,
                                                        double          Double,
                                                        octet           OCTET STRING,
                                                        bitstring       BIT STRING,
                                                        enum            ENUMERATED,
                                                        propertyValue [0] BACnetDeviceObjectPropertyValue
                                                        }
                            },
buffer-ready            [10] SEQUENCE {
                            buffer-property [0] BACnetDeviceObjectPropertyReference,
                            previous-notification   [1] Unsigned32,
                            current-notification    [2] Unsigned32
                            },
unsigned-range          [11] SEQUENCE {
                            exceeding-value         [0] Unsigned,
                            status-flags            [1] BACnetStatusFlags,
                            exceeded-limit          [2] Unsigned
                            },
                        -- context tag 12 is reserved for future addenda
access-event            [13] SEQUENCE {
                            access-event            [0] BACnetAccessEvent,
                            status-flags            [1] BACnetStatusFlags,
```

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```
                    access-event-tag        [2] Unsigned,
                    access-event-time       [3] BACnetTimeStamp,
                    access-credential       [4] BACnetDeviceObjectReference,
                    authentication-factor   [5] BACnetAuthenticationFactor OPTIONAL
                    },
        double-out-of-range  [14] SEQUENCE {
                    exceeding-value         [0] Double,
                    status-flags            [1] BACnetStatusFlags,
                    deadband                [2] Double,
                    exceeded-limit          [3] Double
                    },
        signed-out-of-range [15] SEQUENCE {
                    exceeding-value         [0] INTEGER,
                    status-flags            [1] BACnetStatusFlags,
                    deadband                [2] Unsigned,
                    exceeded-limit          [3] INTEGER
                    },
        unsigned-out-of-range [16] SEQUENCE {
                    exceeding-value         [0] Unsigned,
                    status-flags            [1] BACnetStatusFlags,
                    deadband                [2] Unsigned,
                    exceeded-limit          [3] Unsigned
                    },
        change-of-characterstring [17] SEQUENCE {
                    changed-value           [0] CharacterString,
                    status-flags            [1] BACnetStatusFlags,
                    alarm-value             [2] CharacterString
                    },
        change-of-status-flags [18] SEQUENCE {
                    present-value           [0] ABSTRACT-SYNTAX.&Type OPTIONAL,
                                            -- depends on referenced property
                    referenced-flags        [1] BACnetStatusFlags
                    }
        }

BACnetNotifyType ::= ENUMERATED {
        alarm           (0),
        event           (1),
        ack-notification (2)
        }

BACnetObjectPropertyReference ::= SEQUENCE {
        objectIdentifier        [0] BACnetObjectIdentifier,
        propertyIdentifier      [1] BACnetPropertyIdentifier,
        propertyArrayIndex      [2] Unsigned OPTIONAL  -- used only with array datatype
                                                       -- if omitted with an array the entire array is referenced
        }

BACnetObjectPropertyValue ::= SEQUENCE {
        objectIdentifier        [0] BACnetObjectIdentifier,
        propertyIdentifier      [1] BACnetPropertyIdentifier,
        propertyArrayIndex      [2] Unsigned OPTIONAL, -- used only with array datatype
                                                       -- if omitted with an array the entire array is referenced
        value                   [3] ABSTRACT-SYNTAX.&Type, --any datatype appropriate for the specified property
        priority                [4] Unsigned (1..16) OPTIONAL
        }
```

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```
BACnetObjectType ::= ENUMERATED { -- see below for numerical order
        access-credential           (32),
        access-door                 (30),
        access-point                (33),
        access-rights               (34),
        access-user                 (35),
        access-zone                 (36),
        accumulator                 (23),
        analog-input                (0),
        analog-output               (1),
        analog-value                (2),
        averaging                   (18),
        binary-input                (3),
        binary-output               (4),
        binary-value                (5),
        bitstring-value             (39),
        calendar                    (6),
        characterstring-value       (40),
        command                     (7),
        credential-data-input       (37),
        date-pattern-value          (41),
        date-value                  (42),
        datetime-pattern-value      (43),
        datetime-value              (44),
        device                      (8),
        event-enrollment            (9),
        event-log                   (25),
        file                        (10),
        global-group                (26),
        group                       (11),
        integer-value               (45),
        large-analog-value          (46),
        life-safety-point           (21),
        life-safety-zone            (22),
        load-control                (28),
        loop                        (12),
        multi-state-input           (13),
        multi-state-output          (14),
        multi-state-value           (19),
        network-security            (38),
        notification-class          (15),
        octetstring-value           (47),
        positive-integer-value      (48),
        program                     (16),
        pulse-converter             (24),
        schedule                    (17),
        structured-view             (29),
        time-pattern-value          (49),
        time-value                  (50),
        trend-log                   (20),
        trend-log-multiple          (27),
-- numerical order reference
        -- see analog-input         (0),
        -- see analog-output        (1),
        -- see analog-value         (2),
```

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```
        -- see binary-input             (3),
        -- see binary-output            (4),
        -- see binary-value             (5),
        -- see calendar                 (6),
        -- see command                  (7),
        -- see device                   (8),
        -- see event-enrollment         (9),
        -- see file                     (10),
        -- see group                    (11),
        -- see loop                     (12),
        -- see multi-state-input        (13),
        -- see multi-state-output       (14),
        -- see notification-class       (15),
        -- see program                  (16),
        -- see schedule                 (17),
        -- see averaging                (18),
        -- see multi-state-value        (19),
        -- see trend-log                (20),
        -- see life-safety-point        (21),
        -- see life-safety-zone         (22),
        -- see accumulator              (23),
        -- see pulse-converter          (24),
        -- see event-log                (25),
        -- see global-group             (26),
        -- see trend-log-multiple       (27),
        -- see load-control             (28),
        -- see structured-view          (29),
        -- see access-door              (30),
        -- value 31 is unassigned
        -- see access-credential        (32),
        -- see access-point             (33),
        -- see access-rights            (34),
        -- see access-user              (35),
        -- see access-zone              (36),
        -- see credential-data-input    (37),
        -- see network-security         (38),
        -- see bitstring-value          (39),
        -- see characterstring-value    (40),
        -- see date-pattern-value       (41),
        -- see date-value               (42),
        -- see datetime-pattern-value   (43),
        -- see datetime-value           (44),
        -- see integer-value            (45),
        -- see large-analog-value       (46),
        -- see octetstring-value        (47),
        -- see positive-integer-value   (48),
        -- see time-pattern-value       (49),
        -- see time-value               (50),
        ...
        }
-- Enumerated values 0-127 are reserved for definition by ASHRAE. Enumerated values
-- 128-1023 may be used by others subject to the procedures and constraints described
-- in Clause 23.
```

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```
BACnetObjectTypesSupported ::= BIT STRING {
        analog-input            (0),
        analog-output           (1),
        analog-value            (2),
        binary-input            (3),
        binary-output           (4),
        binary-value            (5),
        calendar                (6),
        command                 (7),
        device                  (8),
        event-enrollment        (9),
        file                    (10),
        group                   (11),
        loop                    (12),
        multi-state-input       (13),
        multi-state-output      (14),
        notification-class      (15),
        program                 (16),
        schedule                (17),
        averaging               (18),
        multi-state-value       (19),
        trend-log               (20),
        life-safety-point       (21),
        life-safety-zone        (22),
        accumulator             (23),
        pulse-converter         (24),
        event-log               (25),
        global-group            (26),
        trend-log-multiple      (27),
        load-control            (28),
        structured-view         (29),
        access-door             (30),
        -- value 31 is unassigned
        access-credential       (32),
        access-point            (33),
        access-rights           (34),
        access-user             (35),
        access-zone             (36),
        credential-data-input   (37),
        network-security        (38),
        bitstring-value         (39),
        characterstring-value   (40),
        date-pattern-value      (41),
        date-value              (42),
        datetime-pattern-value  (43),
        datetime-value          (44),
        integer-value           (45),
        large-analog-value      (46),
        octetstring-value       (47),
        positive-integer-value  (48),
        time-pattern-value      (49),
        time-value              (50)
        }
```

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```
BACnetOptionalCharacterString ::= CHOICE {
        null            NULL,
        characterString CharacterString
        }

BACnetPolarity ::= ENUMERATED {
        normal          (0),
        reverse         (1)
        }

BACnetPrescale ::= SEQUENCE {
        multiplier      [0] Unsigned,
        moduloDivide    [1] Unsigned
        }

BACnetPriorityArray ::= SEQUENCE SIZE (16) OF BACnetPriorityValue
        -- accessed as a BACnetARRAY

BACnetPriorityValue ::= CHOICE {
        null                NULL,
        real                REAL,
        enumerated          ENUMERATED,
        unsigned            Unsigned,
        boolean             BOOLEAN,
        signed              INTEGER,
        double              Double,
        time                Time,
        characterString     CharacterString,
        octetString         OCTET STRING,
        bitString           BIT STRING,
        date                Date,
        objectid            BACnetObjectIdentifier,
        constructedValue    [0] ABSTRACT-SYNTAX.&Type,
        datetime            [1]  BACnetDateTime
        }

BACnetProgramError ::= ENUMERATED {
        normal          (0),
        load-failed     (1),
        internal        (2),
        program         (3),
        other           (4),
        ...
        }
-- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values
-- 64-65535 may be used by others subject to the procedures and constraints described
-- in Clause 23.

BACnetProgramRequest ::= ENUMERATED {
        ready           (0),
        load            (1),
        run             (2),
        halt            (3),
        restart         (4),
        unload          (5)
        }
```

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```
BACnetProgramState ::= ENUMERATED {
        idle            (0),
        loading         (1),
        running         (2),
        waiting         (3),
        halted          (4),
        unloading       (5)
        }

BACnetPropertyAccessResult ::= SEQUENCE {
        objectIdentifier        [0] BACnetObjectIdentifier,
        propertyIdentifier      [1] BACnetPropertyIdentifier,
        propertyArrayIndex      [2] Unsigned OPTIONAL,-- used only with array datatype
                                    -- if omitted with an array then
                                    -- the entire array is referenced
        deviceIdentifier        [3] BACnetObjectIdentifier OPTIONAL,
        accessResult            CHOICE {
                                    propertyValue       [4] ABSTRACT-SYNTAX.&Type,
                                    propertyAccessError [5] Error
                                    }
        }

BACnetPropertyIdentifier ::= ENUMERATED { -- see below for numerical order
        absentee-limit                  (244),
        accepted-modes                  (175),
        access-alarm-events             (245),
        access-doors                    (246),
        access-event                    (247),
        access-event-authentication-factor  (248),
        access-event-credential         (249),
        access-event-tag                (322),
        access-event-time               (250),
        access-transaction-events       (251),
        accompaniment                   (252),
        accompaniment-time              (253),
        ack-required                    (1),
        acked-transitions               (0),
        action                          (2),
        action-text                     (3),
        activation-time                 (254),
        active-authentication-policy    (255),
        active-cov-subscriptions        (152),
        active-text                     (4),
        active-vt-sessions              (5),
        actual-shed-level               (212),
        adjust-value                    (176),
        alarm-value                     (6),
        alarm-values                    (7),
        align-intervals                 (193),
        all                             (8),
        all-writes-successful           (9),
        apdu-segment-timeout            (10),
        apdu-timeout                    (11),
        application-software-version    (12),
        archive                         (13),
```

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assigned-access-rights (256),
attempted-samples (124),
authentication-factors (257),
authentication-policy-list (258),
authentication-policy-names (259),
authentication-status (260),
authorization-mode (261),
auto-slave-discovery (169),
average-value (125),
backup-and-restore-state (338),
backup-failure-timeout (153),
backup-preparation-time (339),
base-device-security-policy (327),
belongs-to (262),
bias (14),
bit-mask (342),
bit-text (343),
buffer-size (126),
change-of-state-count (15),
change-of-state-time (16),
client-cov-increment (127),
configuration-files (154),
controlled-variable-reference (19),
controlled-variable-units (20),
controlled-variable-value (21),
count (177),
count-before-change (178),
count-change-time (179),
cov-increment (22),
cov-period (180),
cov-resubscription-interval (128),
covu-period (349),
covu-recipients (350),
credential-disable (263),
credential-status (264),
credentials (265),
credentials-in-zone (266),
database-revision (155),
date-list (23),
daylight-savings-status (24),
days-remaining (267),
deadband (25),
derivative-constant (26),
derivative-constant-units (27),
description (28),
description-of-halt (29),
device-address-binding (30),
device-type (31),
direct-reading (156),
distribution-key-revision (328),
do-not-hide (329),
door-alarm-state (226),
door-extended-pulse-time (227),
door-members (228),
door-open-too-long-time (229),
door-pulse-time (230),

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door-status (231),
door-unlock-delay-time (232),
duty-window (213),
effective-period (32),
elapsed-active-time (33),
entry-points (268),
enable (133), -- renamed from previous version
error-limit (34),
event-enable (35),
event-message-texts (351),
event-state (36),
event-time-stamps (130),
event-type (37),
event-parameters (83), -- renamed from previous version
exception-schedule (38),
exit-points (269),
expected-shed-level (214),
expiry-time (270),
extended-time-enable (271),
failed-attempt-events (272),
failed-attempts (273),
failed-attempts-time (274),
fault-values (39),
feedback-value (40),
file-access-method (41),
file-size (42),
file-type (43),
firmware-revision (44),
full-duty-baseline (215),
global-identifier (323),
group-members (345),
group-member-names (346),
high-limit (45),
inactive-text (46),
in-process (47),
input-reference (181),
instance-of (48),
integral-constant (49),
integral-constant-units (50),
interval-offset (195),
is-utc (344),
key-sets (330),
last-access-event (275),
last-access-point (276),
last-credential-added (277),
last-credential-added-time (278),
last-credential-removed (279),
last-credential-removed-time (280),
last-key-server (331),
last-notify-record (173),
last-restart-reason (196),
last-restore-time (157),
last-use-time (281),
life-safety-alarm-values (166),
limit-enable (52),
limit-monitoring-interval (182),

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```
    list-of-group-members                   (53),
    list-of-object-property-references      (54),
    local-date                              (56),
    local-time                              (57),
    location                                (58),
    lock-status                             (233),
    lockout                                 (282),
    lockout-relinquish-time                 (283),
    log-buffer                              (131),
    log-device-object-property              (132),
    log-interval                            (134),
    logging-object                          (183),
    logging-record                          (184),
    logging-type                            (197),
    low-limit                               (59),
    maintenance-required                    (158),
    manipulated-variable-reference          (60),
    manual-slave-address-binding            (170),
    masked-alarm-values                     (234),
    master-exemption                        (284),
    maximum-output                          (61),
    maximum-value                           (135),
    maximum-value-timestamp                 (149),
    max-apdu-length-accepted                (62),
    max-failed-attempts                     (285),
    max-info-frames                         (63),
    max-master                              (64),
    max-pres-value                          (65),
    max-segments-accepted                   (167),
    member-of                               (159),
    member-status-flags                     (347),
    members                                 (286),
    minimum-off-time                        (66),
    minimum-on-time                         (67),
    minimum-output                          (68),
    minimum-value                           (136),
    minimum-value-timestamp                 (150),
    min-pres-value                          (69),
    mode                                    (160),
    model-name                              (70),
    modification-date                       (71),
    muster-point                            (287),
    negative-access-rules                   (288),
    network-access-security-policies        (332),
    node-subtype                            (207),
    node-type                               (208),
    notification-class                      (17),     -- renamed from previous version
    notification-threshold                  (137),
    notify-type                             (72),
    number-of-apdu-retries                  (73),
    number-of-authentication-policies       (289),
    number-of-states                        (74),
    object-identifier                       (75),
    object-list                             (76),
    object-name                             (77),
    object-property-reference               (78),
```

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object-type (79),
occupancy-count (290),
occupancy-count-adjust (291),
occupancy-count-enable (292),
occupancy-exemption (293),
occupancy-lower-limit (294),
occupancy-lower-limit-enforced (295),
occupancy-state (296),
occupancy-upper-limit (297),
occupancy-upper-limit-enforced (298),
operation-expected (161),
optional (80),
out-of-service (81),
output-units (82),
packet-reorder-time (333),
passback-exemption (299),
passback-mode (300),
passback-timeout (301),
polarity (84),
positive-access-rules (302),
prescale (185),
present-value (85),
priority (86),
priority-array (87),
priority-for-writing (88),
process-identifier (89),
profile-name (168),
program-change (90),
program-location (91),
program-state (92),
proportional-constant (93),
proportional-constant-units (94),
protocol-object-types-supported (96),
protocol-revision (139),
protocol-services-supported (97),
protocol-version (98),
pulse-rate (186),
read-only (99),
reason-for-disable (303),
reason-for-halt (100),
recipient-list (102),
records-since-notification (140),
record-count (141),
reliability (103),
relinquish-default (104),
requested-shed-level (218),
requested-update-interval (348),
required (105),
resolution (106),
restart-notification-recipients (202),
restore-completion-time (340),
restore-preparation-time (341),
scale (187),
scale-factor (188),
schedule-default (174),
secured-status (235),

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security-pdu-timeout (334),
security-time-window (335),
segmentation-supported (107),
setpoint (108),
setpoint-reference (109),
setting (162),
shed-duration (219),
shed-level-descriptions (220),
shed-levels (221),
silenced (163),
slave-address-binding (171),
slave-proxy-enable (172),
start-time (142),
state-description (222),
state-text (110),
status-flags (111),
stop-time (143),
stop-when-full (144),
structured-object-list (209),
subordinate-annotations (210),
subordinate-list (211),
supported-formats (304),
supported-format-classes (305),
supported-security-algorithms (336),
system-status (112),
threat-authority (306),
threat-level (307),
time-delay (113),
time-of-active-time-reset (114),
time-of-device-restart (203),
time-of-state-count-reset (115),
time-synchronization-interval (204),
time-synchronization-recipients (116),
total-record-count (145),
trace-flag (308),
tracking-value (164),
transaction-notification-class (309),
trigger (205),
units (117),
update-interval (118),
update-key-set-timeout (337),
update-time (189),
user-external-identifier (310),
user-information-reference (311),
user-name (317),
user-type (318),
uses-remaining (319),
utc-offset (119),
utc-time-synchronization-recipients (206),
valid-samples (146),
value-before-change (190),
value-set (191),
value-change-time (192),
variance-value (151),
vendor-identifier (120),
vendor-name (121),

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```
        verification-time               (326),
        vt-classes-supported            (122),
        weekly-schedule                 (123),
        window-interval                 (147),
        window-samples                  (148),
        zone-from                       (320),
        zone-members                    (165),
        zone-to                         (321),
-- -numerical order reference
        -- see ack-required            (1),
        -- see action                  (2),
        -- see action-text             (3),
        -- see active-text             (4),
        -- see active-vt-sessions      (5),
        -- see alarm-value             (6),
        -- see alarm-values            (7),
        -- see all                     (8),
        -- see all-writes-successful   (9),
        -- see apdu-segment-timeout    (10),
        -- see apdu-timeout            (11),
        -- see application-software-version (12),
        -- see archive                 (13),
        -- see bias                    (14),
        -- see change-of-state-count   (15),
        -- see change-of-state-time    (16),
        -- see notification-class      (17),
        -- this property  deleted      (18),
        -- see controlled-variable-reference (19),
        -- see controlled-variable-units (20),
        -- see controlled-variable-value (21),
        -- see cov-increment           (22),
        -- see date-list               (23),
        -- see daylight-savings-status (24),
        -- see deadband                (25),
        -- see derivative-constant     (26),
        -- see derivative-constant-units (27),
        -- see description             (28),
        -- see description-of-halt     (29),
        -- see device-address-binding  (30),
        -- see device-type             (31),
        -- see effective-period        (32),
        -- see elapsed-active-time     (33),
        -- see error-limit             (34),
        -- see event-enable            (35),
        -- see event-state             (36),
        -- see event-type              (37),
        -- see exception-schedule      (38),
        -- see fault-values            (39),
        -- see feedback-value          (40),
        -- see file-access-method      (41),
        -- see file-size               (42),
        -- see file-type               (43),
        -- see firmware-revision       (44),
        -- see high-limit              (45),
        -- see inactive-text           (46),
        -- see in-process              (47),
```

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```
    -- see instance-of                          (48),
    -- see integral-constant                    (49),
    -- see integral-constant-units              (50),
    -- formerly: issue-confirmed-notifications  (51),   removed in version 1 revision 4.
    -- see limit-enable                         (52),
    -- see list-of-group-members                (53),
    -- see list-of-object-property-references   (54),
    -- enumeration value 55 is unassigned
    -- see local-date                           (56),
    -- see local-time                           (57),
    -- see location                             (58),
    -- see low-limit                            (59),
    -- see manipulated-variable-reference       (60),
    -- see maximum-output                       (61),
    -- see max-apdu-length-accepted             (62),
    -- see max-info-frames                      (63),
    -- see max-master                           (64),
    -- see max-pres-value                       (65),
    -- see minimum-off-time                     (66),
    -- see minimum-on-time                      (67),
    -- see minimum-output                       (68),
    -- see min-pres-value                       (69),
    -- see model-name                           (70),
    -- see modification-date                    (71),
    -- see notify-type                          (72),
    -- see number-of-apdu-retries               (73),
    -- see number-of-states                     (74),
    -- see object identifier                    (75),
    -- see object-list                          (76),
    -- see object-name                          (77),
    -- see object-property-reference            (78),
    -- see object type                          (79),
    -- see optional                             (80),
    -- see out-of-service                       (81),
    -- see output-units                         (82),
    -- see event-parameters                     (83),
    -- see polarity                             (84),
    -- see present value                        (85),
    -- see priority                             (86),
    -- see priority-array                       (87),
    -- see priority-for-writing                 (88),
    -- see process-identifier                   (89),
    -- see program-change                       (90),
    -- see program-location                     (91),
    -- see program-state                        (92),
    -- see proportional-constant                (93),
    -- see proportional-constant-units          (94),
    --  formerly: protocol-conformance-class    (95),   removed in version 1 revision 2.
    -- see protocol-object-types-supported      (96),
    -- see protocol-services-supported          (97),
    -- see protocol-version                     (98),
    -- see read-only                            (99),
    -- see reason-for-halt                      (100),
    -- formerly: recipient                      (101),  removed in version 1 revision 4.
    -- see recipient-list                       (102),
    -- reliability                              (103),
```

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```
-- see relinquish-default                    (104),
-- see required                              (105),
-- see resolution                            (106),
-- see segmentation-supported                (107),
-- see setpoint                              (108),
-- see setpoint-reference                    (109),
-- see state-text                            (110),
-- see status-flags                          (111),
-- see system-status                         (112),
-- see time-delay                            (113),
-- see time-of-active-time-reset             (114),
-- see time-of-state-count-reset             (115),
-- see time-synchronization-recipients       (116),
-- see units                                 (117),
-- see update-interval                       (118),
-- see utc-offset                            (119),
-- see vendor-identifier                     (120),
-- see vendor-name                           (121),
-- see vt-classes-supported                  (122),
-- see weekly-schedule                       (123),
-- see attempted-samples                     (124),
-- see average-value                         (125),
-- see buffer-size                           (126),
-- see client-cov-increment                  (127),
-- see cov-resubscription-interval           (128),
--  formerly: current-notify-time            (129),   removed in version 1 revision 3.
-- see event-time-stamps                     (130),
-- see log-buffer                            (131),
-- see log-device-object-property            (132),
-- see enable                                (133),   log-enable was renamed to enable in version 1 revision 5
-- see log-interval                          (134),
-- see maximum-value                         (135),
-- see minimum-value                         (136),
-- see notification-threshold                (137),
-- formerly: previous-notify-time            (138),   removed in version 1 revision 3.
-- see protocol-revision                     (139),
-- see records-since-notification            (140),
-- see record-count                          (141),
-- see start-time                            (142),
-- see stop-time                             (143),
-- see stop-when-full                        (144),
-- see total-record-count                    (145),
-- see valid-samples                         (146),
-- see maximum-value-timestamp               (149),
-- see minimum-value-timestamp               (150),
-- see variance-value                        (151),
-- see active-cov-subscriptions              (152),
-- see backup-failure-timeout                (153),
-- see configuration-files                   (154),
-- see database-revision                     (155),
-- see direct-reading                        (156),
-- see last-restore-time,                    (157),
-- see maintenance-required                  (158),
-- see member-of                             (159),
-- see mode                                  (160),
-- see operation-expected                    (161),
```

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```
        -- see setting                                  (162),
        -- see silenced                                 (163),
        -- see tracking-value                           (164),
        -- see zone-members                             (165),
        -- see life-safety-alarm-values                 (166),
        -- see max-segments-accepted                    (167),
        -- see profile-name                             (168),
        -- see auto-slave-discovery                     (169),
        -- see manual-slave-address-binding             (170),
        -- see slave-address-binding                    (171),
        -- see slave-proxy-enable                       (172),
        -- see last-notify-record                       (173),
        -- see schedule-default                         (174),
        -- see accepted-modes                           (175),
        -- see adjust-value                             (176),
        -- see count                                    (177),
        -- see count-before-change                      (178),
        -- see count-change-time                        (179),
        -- see cov-period                               (180),
        -- see input-reference                          (181),
        -- see limit-monitoring-interval                (182),
        -- see logging-object                           (183),
        -- see logging-record                           (184),
        -- see prescale                                 (185),
        -- see pulse-rate                               (186),
        -- see scale                                    (187),
        -- see scale-factor                             (188),
        -- see update-time                              (189),
        -- see value-before-change                      (190),
        -- see value-set                                (191),
        -- see value-change-time                        (192),
        -- see align-intervals                          (193),
        -- enumeration value 194 is unassigned
        -- see interval-offset                          (195),
        -- see last-restart-reason                      (196),
        -- see logging-type                             (197),
        -- enumeration values 198-201 are unassigned
        -- see restart-notification-recipients          (202),
        -- see time-of-device-restart                   (203),
        -- see time-synchronization-interval            (204),
        -- see trigger                                  (205),
        -- see utc-time-synchronization-recipients      (206),
        -- see node-subtype                             (207),
        -- see node-type                                (208),
        -- see structured-object-list                   (209),
        -- see subordinate-annotations                  (210),
        -- see subordinate-list                         (211),
        -- see actual-shed-level                        (212),
        -- see duty-window                              (213),
        -- see expected-shed-level                      (214),
        -- see full-duty-baseline                       (215),
        -- enumeration values 216-217 are unassigned
        -- see requested-shed-level                     (218),
        -- see shed-duration                            (219),
        -- see shed-level-descriptions                  (220),
        -- see shed-levels                              (221),
```

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```
-- see state-description                    (222),
-- enumeration values 223-225 are unassigned
-- see door-alarm-state                     (226),
-- see door-extended-pulse-time             (227),
-- see door-members                         (228),
-- see door-open-too-long-time              (229),
-- see door-pulse-time                      (230),
-- see door-status                          (231),
-- see door-unlock-delay-time               (232),
-- see lock-status                          (233),
-- see masked-alarm-values                  (234),
-- see secured-status                       (235),
-- enumeration values 236-243 are unassigned
-- see absentee-limit                       (244),
-- see access-alarm-events                  (245),
-- see access-doors                         (246),
-- see access-event                         (247),
-- see access-event-authentication-factor   (248),
-- see access-event-credential              (249),
-- see access-event-time                    (250),
-- see access-transaction-events            (251),
-- see accompaniment                        (252),
-- see accompaniment-time                   (253),
-- see activation-time                      (254),
-- see active-authentication-policy         (255),
-- see assigned-access-rights               (256),
-- see authentication-factors               (257),
-- see authentication-policy-list           (258),
-- see authentication-policy-names          (259),
-- see authentication-status                (260),
-- see authorization-mode                   (261),
-- see belongs-to                           (262),
-- see credential-disable                   (263),
-- see credential-status                    (264),
-- see credentials                          (265),
-- see credentials-in-zone                  (266),
-- see days-remaining                       (267),
-- see entry-points                         (268),
-- see exit-points                          (269),
-- see expiry-time                          (270),
-- see extended-time-enable                 (271),
-- see failed-attempt-events                (272),
-- see failed-attempts                      (273),
-- see failed-attempts-time                 (274),
-- see last-access-event                    (275),
-- see last-access-point                    (276),
-- see last-credential-added                (277),
-- see last-credential-added-time           (278),
-- see last-credential-removed              (279),
-- see last-credential-removed-time         (280),
-- see last-use-time                        (281),
-- see lockout                              (282),
-- see lockout-relinquish-time              (283),
-- see master-exemption                     (284),
-- see max-failed-attempts                  (285),
-- see members                              (286),
```

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```
        -- see muster-point                          (287),
        -- see negative-access-rules                 (288),
        -- see number-of-authentication-policies     (289),
        -- see occupancy-count                       (290),
        -- see occupancy-count-adjust                (291),
        -- see occupancy-count-enable                (292),
        -- see occupancy-exemption                   (293),
        -- see occupancy-lower-limit                 (294),
        -- see occupancy-lower-limit-enforced        (295),
        -- see occupancy-state                       (296),
        -- see occupancy-upper-limit                 (297),
        -- see occupancy-upper-limit-enforced        (298),
        -- see passback-exemption                    (299),
        -- see passback-mode                         (300),
        -- see passback-timeout                      (301),
        -- see positive-access-rules                 (302),
        -- see reason-for-disable                    (303),
        -- see supported-formats                     (304),
        -- see supported-format-classes              (305),
        -- see threat-authority                      (306),
        -- see threat-level                          (307),
        -- see trace-flag                            (308),
        -- see transaction-notification-class        (309),
        -- see user-external-identifier              (310),
        -- see user-information-reference            (311),
        -- enumeration values 312-316 are unassigned
        -- see user-name                             (317),
        -- see user-type                             (318),
        -- see uses-remaining                        (319),
        -- see zone-from                             (320),
        -- see zone-to                               (321),
        -- see access-event-tag                      (322),
        -- see global-identifier                     (323),
        -- enumeration values 324-325 are unassigned
        -- see verification-time                     (326),
        -- see base-device-security-policy           (327),
        -- see distribution-key-revision             (328),
        -- see do-not-hide                           (329),
        -- see key-sets                              (330),
        -- see last-key-server                       (331),
        -- see network-access-security-policies      (332),
        -- see packet-reorder-time                   (333),
        -- see security-pdu-timeout                  (334),
        -- see security-time-window                  (335),
        -- see supported-security-algorithms         (336),
        -- see update-key-set-timeout                (337),
        -- see backup-and-restore-state              (338),
        -- see backup-preparation-time               (339),
        -- see restore-completion-time               (340),
        -- see restore-preparation-time              (341),
        -- see bit-mask                              (342),
        -- see bit-text                              (343),
        -- see is-utc                                (344),
        -- see group-members                         (345),
        -- see group-member-names                    (346),
        -- see member-status-flags                   (347),
```

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```
        -- see requested-update-interval        (348),
        -- see covu-period                      (349),
        -- see covu-recipients                  (350),
        -- see event-message-texts              (351),
        ...
        }

-- The special property identifiers all, optional, and required are reserved for use in the
-- ReadPropertyMultiple service or services not defined in this standard.
--
-- Enumerated values 0-511 are reserved for definition by ASHRAE. Enumerated values 512-4194303 may be used by
-- others subject to the procedures and constraints described in Clause 23.

BACnetPropertyReference ::= SEQUENCE {
        propertyIdentifier          [0] BACnetPropertyIdentifier,
        propertyArrayIndex          [1] Unsigned OPTIONAL  --used only with array datatype
                                                           -- if omitted with an array the entire array is referenced
        }

BACnetPropertyStates ::= CHOICE {
-- This production represents the possible datatypes for properties that
-- have discrete or enumerated values. The choice must be consistent with the
-- datatype of the property referenced in the Event Enrollment Object.

        boolean-value               [0] BOOLEAN,
        binary-value                [1] BACnetBinaryPV,
        event-type                  [2] BACnetEventType,
        polarity                    [3] BACnetPolarity,
        program-change              [4] BACnetProgramRequest,
        program-state               [5] BACnetProgramState,
        reason-for-halt             [6] BACnetProgramError,
        reliability                 [7] BACnetReliability,
        state                       [8] BACnetEventState,
        system-status               [9] BACnetDeviceStatus,
        units                       [10] BACnetEngineeringUnits,
        unsigned-value              [11] Unsigned,
        life-safety-mode            [12] BACnetLifeSafetyMode,
        life-safety-state           [13] BACnetLifeSafetyState,
        restart-reason              [14] BACnetRestartReason,
        door-alarm-state            [15] BACnetDoorAlarmState,
        action                      [16] BACnetAction,
        door-secured-status         [17] BACnetDoorSecuredStatus,
        door-status                 [18] BACnetDoorStatus,
        door-value                  [19] BACnetDoorValue,
        file-access-method          [20] BACnetFileAccessMethod,
        lock-status                 [21] BACnetLockStatus,
        life-safety-operation       [22] BACnetLifeSafetyOperation,
        maintenance                 [23] BACnetMaintenance,
        node-type                   [24] BACnetNodeType,
        notify-type                 [25] BACnetNotifyType,
        security-level              [26] BACnetSecurityLevel,
        shed-state                  [27] BACnetShedState,
        silenced-state              [28] BACnetSilencedState,
                                    -- context tag 29 reserved for future addenda
        access-event                [30] BACnetAccessEvent,
        zone-occupancy-state        [31] BACnetAccessZoneOccupancyState,
```

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```
        access-credential-disable-reason    [32] BACnetAccessCredentialDisableReason,
        access-credential-disable           [33] BACnetAccessCredentialDisable,
        authentication-status               [34] BACnetAuthenticationStatus,
        backup-state                        [36] BACnetBackupState,
        ...
        }
-- Tag values 0-63 are reserved for definition by ASHRAE. Tag values of 64-254 may be used by others to
-- accommodate vendor specific properties that have discrete or enumerated values, subject to the constraints described
-- in Clause 23.

BACnetPropertyValue ::= SEQUENCE {
        propertyIdentifier          [0] BACnetPropertyIdentifier,
        propertyArrayIndex          [1] Unsigned OPTIONAL,  -- used only with array datatypes
                                                            -- if omitted with an array the entire array is referenced
        value                       [2] ABSTRACT-SYNTAX.&Type, -- any datatype appropriate for the specified property
        priority                    [3] Unsigned (1..16) OPTIONAL  -- used only when property is commandable
        }

BACnetRecipient ::= CHOICE {
        device    [0] BACnetObjectIdentifier,
        address   [1] BACnetAddress
        }

BACnetRecipientProcess ::= SEQUENCE {
        recipient           [0] BACnetRecipient,
        processIdentifier   [1] Unsigned32
        }

BACnetReliability ::= ENUMERATED {
        no-fault-detected           (0),
        no-sensor                   (1),
        over-range                  (2),
        under-range                 (3),
        open-loop                   (4),
        shorted-loop                (5),
        no-output                   (6),
        unreliable-other            (7),
        process-error               (8),
        multi-state-fault           (9),
        configuration-error         (10),
        -- enumeration value 11 is reserved for a future addendum
        communication-failure       (12),
        member-fault                (13),
        ...
        }
-- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values
-- 64-65535 may be used by others subject to the procedures and constraints described
-- in Clause 23.
```

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```
BACnetRestartReason ::= ENUMERATED {
        unknown                 (0),
        coldstart               (1),
        warmstart               (2),
        detected-power-lost     (3),
        detected-powered-off    (4),
        hardware-watchdog       (5),
        software-watchdog       (6),
        suspended               (7),
        ...
        }
    -- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values 64-255
    -- may be used by others subject to the procedures and constraints described in Clause 23.

BACnetResultFlags ::= BIT STRING {
        first-item              (0),
        last-item               (1),
        more-items              (2)
        }

BACnetScale ::= CHOICE {
        floatScale      [0] REAL,
        integerScale    [1] INTEGER
        }

BACnetSecurityKeySet ::= SEQUENCE {
        key-revision            [0] Unsigned8,          -- 0 if key set is not configured
        activation-time         [1] BACnetDateTime, -- UTC time, all wild if unknown
        expiration-time         [2] BACnetDateTime, -- UTC time, all wild if infinite
        key-ids                 [3] SEQUENCE OF BACnetKeyIdentifier
        }

BACnetSecurityLevel ::= ENUMERATED {
        incapable               (0),    -- indicates that the device is configured to not use security
        plain                   (1),
        signed                  (2),
        encrypted               (3),
        signed-end-to-end       (4),
        encrypted-end-to-end    (5)
        }

BACnetSecurityPolicy ::= ENUMERATED {
        plain-non-trusted       (0),
        plain-trusted           (1),
        signed-trusted          (2),
        encrypted-trusted       (3)
        }

BACnetShedLevel ::= CHOICE {
        percent         [0]     Unsigned,
        level           [1]     Unsigned,
        amount          [2]     REAL
        }
```

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```
BACnetShedState ::= ENUMERATED {
        shed-inactive           (0),
        shed-request-pending    (1),
        shed-compliant          (2),
        shed-non-compliant      (3)
        }

BACnetSegmentation ::= ENUMERATED {
        segmented-both          (0),
        segmented-transmit      (1),
        segmented-receive       (2),
        no-segmentation         (3)
        }

BACnetServicesSupported ::= BIT STRING {
-- Alarm and Event Services
        acknowledgeAlarm                (0),
        confirmedCOVNotification        (1),
        confirmedEventNotification      (2),
        getAlarmSummary                 (3),
        getEnrollmentSummary            (4),
        -- getEventInformation          (39),
        subscribeCOV                    (5),
        -- subscribeCOVProperty         (38),
        -- lifeSafetyOperation          (37),

-- File Access Services
        atomicReadFile                  (6),
        atomicWriteFile                 (7),

-- Object Access Services
        addListElement                  (8),
        removeListElement               (9),
        createObject                    (10),
        deleteObject                    (11),
        readProperty                    (12),
        readPropertyMultiple            (14),
        -- readRange                    (35),
        writeProperty                   (15),
        writePropertyMultiple           (16),

-- Remote Device Management Services
        deviceCommunicationControl      (17),
        confirmedPrivateTransfer        (18),
        confirmedTextMessage            (19),
        reinitializeDevice              (20),

-- Virtual Terminal Services
        vtOpen                          (21),
        vtClose                         (22),
        vtData                          (23),

-- Removed Services
        -- formerly: readPropertyConditional (13), removed in version 1 revision 12
        -- formerly: authenticate         (24), removed in version 1 revision 11
        -- formerly: requestKey           (25), removed in version 1 revision 11
```

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```
-- Unconfirmed Services
        i-Am                            (26),
        i-Have                          (27),
        unconfirmedCOVNotification      (28),
        unconfirmedEventNotification    (29),
        unconfirmedPrivateTransfer      (30),
        unconfirmedTextMessage          (31),
        timeSynchronization             (32),
        -- utcTimeSynchronization       (36),
        who-Has                         (33),
        who-Is                          (34),

-- Services added after 1995
        readRange                       (35), -- Object Access Service
        utcTimeSynchronization          (36), -- Remote Device Management Service
        lifeSafetyOperation             (37), -- Alarm and Event Service
        subscribeCOVProperty            (38), -- Alarm and Event Service
        getEventInformation             (39)  -- Alarm and Event Service
        }

BACnetSetpointReference ::= SEQUENCE {
        setpointReference [0] BACnetObjectPropertyReference OPTIONAL
        }

BACnetSilencedState ::= ENUMERATED {
        unsilenced      (0),
        audible-silenced (1),
        visible-silenced (2),
        all-silenced    (3),
        ...
        }
-- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values
-- 64-65535 may be used by others subject to procedures and constraints described in
-- Clause 23.

BACnetSpecialEvent ::= SEQUENCE {
        period                  CHOICE {
                                        calendarEntry           [0] BACnetCalendarEntry,
                                        calendarReference       [1] BACnetObjectIdentifier
                                                                },
        listOfTimeValues        [2] SEQUENCE OF BACnetTimeValue,
        eventPriority           [3] Unsigned (1..16)
        }

BACnetStatusFlags ::= BIT STRING {
        in-alarm        (0),
        fault           (1),
        overridden      (2),
        out-of-service  (3)
        }
```

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```
BACnetTimeStamp ::= CHOICE {
        time                [0]     Time,
        sequenceNumber      [1]     Unsigned (0..65535),
        dateTime            [2]     BACnetDateTime
        }

BACnetTimeValue ::= SEQUENCE {
        time            Time,
        value           ABSTRACT-SYNTAX.&Type  -- any primitive datatype; complex types cannot be decoded
        }

BACnetVTClass ::= ENUMERATED {
        default-terminal    (0),
        ansi-x3-64          (1),
        dec-vt52            (2),
        dec-vt100           (3),
        dec-vt220           (4),
        hp-700-94           (5),
        ibm-3130            (6),
        ...
        }
-- Enumerated values 0-63 are reserved for definition by ASHRAE. Enumerated values
-- 64-65535 may be used by others subject to the procedures and constraints described
-- in Clause 23.

BACnetVTSession ::= SEQUENCE {
        local-vtSessionID       Unsigned8,
        remote-vtSessionID      Unsigned8,
        remote-vtAddress        BACnetAddress
        }

BACnetWeekNDay ::= OCTET STRING (SIZE (3))
--      first octet     month (1..14)           1 =January
--                                              13 = odd months
--                                              14 = even months
--                                              X'FF' = any month
--      second octet    weekOfMonth where:      1 = days numbered 1-7
--                                              2 = days numbered 8-14
--                                              3 = days numbered 15-21
--                                              4 = days numbered 22-28
--                                              5 = days numbered 29-31
--                                              6 = last 7 days of this month
--                                              X'FF' = any week of this month
--      third octet     dayOfWeek (1..7) where  1 = Monday
--                                              7 = Sunday
--                                              X'FF' = any day of week
```

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```
ReadAccessResult ::= SEQUENCE {
        objectIdentifier            [0] BACnetObjectIdentifier,
        listOfResults               [1] SEQUENCE OF SEQUENCE {
                propertyIdentifier          [2] BACnetPropertyIdentifier,
                propertyArrayIndex          [3] Unsigned OPTIONAL, -- used only with array datatype
                                                                   -- if omitted with an array the entire
                                                                   -- array is referenced
                readResult          CHOICE  {
                                            propertyValue           [4] ABSTRACT-SYNTAX.&Type,
                                            propertyAccessError     [5] Error
                                            }
                } OPTIONAL
        }

ReadAccessSpecification ::= SEQUENCE {
        objectIdentifier            [0] BACnetObjectIdentifier,
        listOfPropertyReferences    [1] SEQUENCE OF BACnetPropertyReference
        }

WriteAccessSpecification ::= SEQUENCE {
        objectIdentifier                    [0] BACnetObjectIdentifier,
        listOfProperties                    [1] SEQUENCE OF BACnetPropertyValue
        }

END
```

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22 CONFORMANCE AND INTEROPERABILITY

BACnet defines a comprehensive set of object types and application services in the sense that communication requirements among all levels of control in a distributed, hierarchical building automation system are addressed. There is a need to account for the reality that not all devices in a building automation system need to support the full functionality of BACnet in order to perform their tasks.

To reach the overarching goal of this standard - communication between disparate building automation and control devices, possibly from different manufacturers - two distinct conditions must be met: 1) each implemented BACnet capability must precisely conform to the requirements of this standard; and 2) devices that seek to interoperate must implement precisely complementary BACnet capabilities appropriate to the desired form of interoperation. This clause defines how these conditions are to be met and what it means to conform to BACnet.

22.1 Conformance to BACnet

This subclause specifies the requirements that shall be met in order to conform with BACnet.

22.1.1 Protocol Implementation Conformance Statement (PICS)

All devices conforming to the BACnet protocol shall have a Protocol Implementation Conformance Statement (PICS) that identifies all of the portions of BACnet that are implemented. This PICS shall contain all of the information described in 22.1.1.1 and shall be in the format found in Annex A.

22.1.1.1 PICS Contents

A PICS is a written document, created by the manufacturer of a device, that identifies the particular options specified by BACnet that are implemented in the device. A BACnet PICS is considered a public document that is available for use by any interested party. At a minimum, a BACnet PICS shall convey the following information.

(a) Basic information identifying the vendor and describing the BACnet device.

(b) The BACnet Interoperability Building Blocks supported by the device (see Annex K).

(c) The standardized BACnet device profile to which the device conforms, if any (see Annex L).

(d) All non-standard application services that are supported along with an indication for each service of whether the device can initiate the service request, respond to a service request, or both.

(e) A list of all standard and proprietary object types that are supported.

(f) For each object type supported,

1. any optional properties that are supported,
2. which properties can be written-to using BACnet services,
3. if the objects can be dynamically created or deleted using BACnet services,
4. any restrictions on the range of data values for properties.

(g) The data link layer option options, both real and virtual, supported. (See Annexes H and J).

(h) Whether segmented requests are supported.

(i) Whether segmented responses are supported.

22.1.2 Conformance Test

In order to conform to the BACnet protocol, all devices shall pass a conformance test that verifies the correct implementation of the standard object types and services indicated in the PICS. This conformance test shall consist of a collection of test cases drawn from a standard test suite in such a way as to test each object type and service for which support is claimed (positive test) and to test for an appropriate response to errors and standard services and objects that are not implemented to

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ensure the absence of detrimental behavior (negative test). The details of these tests are prescribed in the companion standard, "Testing Conformance to BACnet," ASHRAE 135.1.

22.1.3 Data Link and Physical Layers

To conform to the BACnet protocol, all devices shall support one of the five data link layer options, defined in Clauses 7 through 11, and one of the physical layers compatible with that data link layer, except as indicated in 22.1.4.

22.1.4 Conformance with Non-Standard Data Link Layer

Special circumstances may require that a device support a data link and physical layer technology that is not one of the BACnet options in order to interoperate with other networked devices in a particular situation. Such a device may be said to conform to BACnet with a non-standard data link layer, provided that the criteria in 22.1.1 through 22.1.2 are met.

A device conforming to the BACnet protocol under the provisions of this subclause may use non-standard protocol layers other than the data link and physical layers, provided that the non-standard protocol is used to convey a standard BACnet LSDU that contains application and network layer information defined by this standard and encoded according to the rules of Clause 20 and Clause 6. Segmentation of the BACnet LSDU is permitted. Annex H provides examples of this for the Department of Defense Internet protocols and the Novell Internetwork Datagram Protocol.

22.1.5 Minimum Device Requirements

A device that conforms to the BACnet protocol and contains an application layer shall:

(a) contain exactly one Device object,
(b) execute the ReadProperty service,
(c) execute the Who-Has and Who-Is services (and thus initiate the I-Have and I-Am services) unless the device is an MS/TP slave device,
(d) execute the WriteProperty service if the device executes the WritePropertyMultiple, AddListElement or RemoveListElement services,
(e) allow the WriteProperty service to modify any properties that are modifiable by the AddListElement or RemoveListElement services, and
(f) execute the WriteProperty service if the device contains any objects with properties that are required to be writable.

22.2 BACnet Interoperability

BACnet is intended to provide a single, uniform standard for building control systems, the ultimate goal of which is "interoperability." Interoperability means the ability of disparate control system devices to work together toward a common objective through the digital exchange of relevant information. Although interoperability is often thought of in terms of interconnecting equipment from multiple manufacturers, it is also possible to envision interoperating systems from a single vendor, possibly equipment of different vintages. Thus, while BACnet enables multi-vendor interoperability, it in no way requires it.

22.2.1 Interoperability Areas

"Interoperability areas" (IAs) are intended to describe the functionality that is important in practical automation and control systems to achieve specific operational objectives. The five IAs delineated in this standard are data sharing, alarm and event management, scheduling, trending, and device and network management. Each IA implies a set of capabilities. Each capability, in turn, requires that specific elements of BACnet be implemented in a particular device to enable interoperability in a known and predictable manner with a minimum of field engineering. The selection of which BACnet elements are required for a particular type of device is indicated in the device profiles presented in Annex L. This section describes the specific capabilities associated with each IA.

22.2.1.1 Data Sharing

"Data sharing" is the exchange of information between BACnet devices. It may be uni-directional or bi-directional. Interoperability in this area permits the collection of data for archival storage, graphics, and reports, the sharing of common sensor or calculated values between devices, carrying out interlocked control strategies, and the modification of setpoints or other operational parameters of BACnet objects.

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22.2.1.2 Alarm and Event Management

"Alarm and event management" is the exchange of data between BACnet devices related to the occurrence of a predefined condition that meets specific criteria. Such conditions are called "events" and may be the basis for the initiation of a particular control action in response or the simple logging of the event's occurrence. The event may also be deemed to represent a condition that constitutes an "alarm", requiring human acknowledgment and intervention. Interoperability in this area permits the annunciation and acknowledgment of alarms; the display of data indicating the basis for the alarm annunciation; the sharing of events for the purpose of logging or distributed control applications; modification of alarm limits and routing; and the production of summaries of the occurrence of such alarms and events.

BACnet defines two different mechanisms for generating alarms and events. One is called "intrinsic reporting" because it relies on the use of properties that are part of or "intrinsic" to the object that is being monitored for alarms or events. The other mechanism is called "algorithmic change reporting." Algorithmic change reporting is more general but it also requires the overhead of an additional object called the Event Enrollment object. The intrinsic reporting method is preferred under circumstances where it meets the objectives of the intended application. See Clause 13.

22.2.1.3 Scheduling

"Scheduling" is the exchange of data between BACnet devices related to the establishment and maintenance of dates and times at which specified output actions are to be taken. Interoperability in this area permits the use of date and time schedules for starting and stopping equipment and changing control setpoints as well as other analog or binary parameters.

22.2.1.4 Trending

"Trending" is the accumulation of records consisting of a timestamp and a set of one or more logged data values. These records are collected at specified rates for a specified duration. The values are those of specific properties of specific objects. "Trending" is distinguished from the real-time plotting of data in that the data are usually destined for long-term storage and the sampling intervals are usually longer. Interoperability in this area permits the establishment of logging parameters and the subsequent retrieval and storage of logged data.

22.2.1.5 Device and Network Management

"Device and network management" is the exchange of data between BACnet devices concerning the operation and status of the devices comprising the BACnet internetwork. Interoperability in this area permits determining which devices are present on a given network and some of their operational capabilities, including which objects they maintain; the ability to start up and shut down communication from a particular device; the ability to synchronize the time in those devices that maintain clocks; the ability to reinitialize the operation of a device's computer; the ability to establish connections as needed; and the ability to change the connection configuration.

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23 EXTENDING BACnet TO ACCOMMODATE VENDOR PROPRIETARY INFORMATION

The objective of BACnet is to provide the mechanisms by which building automation equipment may exchange information. To aid in interoperability, BACnet defines a standardized set of data structures, called objects, which contain information that is common to most building systems. BACnet may also be used to exchange non-standardized information between devices that understand this information. There are four independent areas where BACnet may be extended to exchange non-standard information:

(a) A vendor may define proprietary extended values for enumerations used in BACnet.
(b) A vendor may invoke a proprietary service using the PrivateTransfer services.
(c) A vendor may add new proprietary properties to a standard object.
(d) A vendor may define new proprietary object types.

In each of these cases, the BACnet messages implicitly reference a vendor identification code that serves to unambiguously specify which vendor's proprietary enumerations, services, properties, or objects were intended. Vendor identification codes are administrated by ASHRAE and are assigned one per vendor. The special Vendor_Identifier of zero is permanently assigned to ASHRAE. The Vendor_Identifier for a given device may be determined by reading the Vendor_Identifier property of the Device object. A list of vendor identification codes may be obtained from the ASHRAE Manager of Standards.

23.1 Extending Enumeration Values

There may be instances when it is necessary for a vendor to extend BACnet by including additional possible values to an enumeration. This is accomplished by using enumeration values that are greater than the range reserved for BACnet for a given enumeration type. Table 23-1 defines those enumerations that may be extended and the range of enumerated values reserved for BACnet use. All other enumerations, which do not appear in Table 23-1, shall not be extended.

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Table 23-1. Extensible Enumerations

Enumeration Name	Reserved Range	Maximum Value
error-class	0-63	65535
error-code	0-255	65535
BACnetAbortReason	0-63	255
BACnetDeviceStatus	0-63	65535
BACnetDoorAlarmState	0-255	65535
BACnetEngineeringUnits	0-255	65535
BACnetEventState	0-63	65535
BACnetEventType	0-63	65535
BACnetLifeSafetyMode	0-255	65535
BACnetLifeSafetyState	0-255	65535
BACnetLifeSafetyOperation	0-63	65535
BACnetLoggingType	0-63	255
BACnetMaintenance	0-255	65535
BACnetObjectType	0-127	1023
BACnetProgramError	0-63	65535
BACnetPropertyIdentifier	0-511	4194303
BACnetPropertyStates	0-63	254
BACnetReliability	0-63	65535
BACnetRejectReason	0-63	255
BACnetRestartReason	0-63	255
BACnetSilencedState	0-63	65535
BACnetVTClass	0-63	65535
BACnetAccessAuthenticationFactorDisable	0-63	65535
BACnetAccessCredentialDisable	0-63	65535
BACnetAccessCredentialDisableReason	0-63	65535
BACnetAccessEvent	0-511	65535
BACnetAccessUserType	0-63	65535
BACnetAccessZoneOccupancyState	0-63	65535
BACnetAuthorizationMode	0-63	65535

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23.2 Using the PrivateTransfer Services to Invoke Non-Standardized Services

BACnet defines a set of application layer services that are specifically tailored to integrating building control systems. While this standard prescribes a set of application layer services that is intended to be comprehensive, vendors are free to create additional services. Standard services shall be used when possible.

Vendors may add proprietary services to BACnet using the PrivateTransfer services to invoke them. The service types and arguments are not restricted by BACnet, but they shall be conveyed using the Confirmed or Unconfirmed PrivateTransfer services. The protocol mechanisms used in the handling of these APDUs shall perform as specified in this standard.

The format of proprietary application layer services, invoked using PrivateTransfer, shall follow the encoding rules of this standard.

When using the PrivateTransfer service, it is important to note that segmentation is not permitted for Error APDUs. The implementor shall ensure that the parameters in the Error APDU do not expand to the point where segmentation is required.

23.3 Adding Proprietary Properties to a Standardized Object

BACnet defines a set of standard objects, each with a set of standard properties that can be accessed and manipulated with BACnet services. BACnet allows a vendor to add proprietary properties to extend the capabilities of a standard object. Proprietary properties receive the same support from BACnet services as standard properties and therefore can be accessed and manipulated in a manner identical to standard properties.

Objects may indicate conformance to an object profile by use of the Profile_Name property.

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If a proprietary property is to be a commandable property, additional properties that fulfill the role of the standard Priority_Array and Relinquish_Default properties shall be provided for each commandable property. The priority arbitration mechanism described in Clause 19 shall apply.

Vendors may add proprietary properties to a standard object by modifying the object definition within a device. Proprietary properties are enumerated with Property_Identifier values of 512 and above. These property identifiers can be used in any BACnet service that uses a Property_Identifier as a parameter.

Proprietary property identifiers implicitly reference the Vendor_Identifier property of the Device object in the device where they reside. It is entirely possible, and expected, that different vendors will use the same enumeration values to represent completely different properties.

23.4 Adding Proprietary Object Types to BACnet

To accommodate building applications where the defined set of standardized objects is not adequate, BACnet allows a vendor to add proprietary object types. Standard object types shall be used when possible. To enhance extensibility, BACnet provides the same support for proprietary objects as for standard objects.

Objects may indicate conformance to an object profile by use of the Profile_Name property.

23.4.1 Proprietary Object_Type Enumerations

Vendors may add proprietary object types to BACnet by extending the BACnetObjectType enumeration. Proprietary object types are enumerated with Object_Type values of 128 and above. These Object_Type values may be used in any BACnet service that uses an Object_Type as a parameter.

23.4.2 Proprietary Property Datatypes

The properties of vendor proprietary objects may include both standard and proprietary datatypes. Proprietary datatypes may only be constructed from application datatypes defined in 20.2.1.4.

23.4.3 Required Properties in Proprietary Object Types

Non-standard object types shall support the following properties:

Object_Identifier
Object_Name
Object_Type

These properties shall be implemented to behave as they would in standard BACnet objects. This means that the Object_Identifier and Object_Name properties shall be unique within the BACnet device that maintains them. The Object_Name string shall be at least one character in length and shall consist of only printable characters.

23.5 Restrictions on Extending BACnet

The following restrictions to extending BACnet apply:

(a) APDU types 8 through 15 are reserved for future ASHRAE use.

(b) Services may be added only via the Confirmed- and UnconfirmedPrivateTransfer services. That is, the enumerations BACnetConfirmedServiceChoice and BACnetUnconfirmedServiceChoice may not be extended.

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24 NETWORK SECURITY

This clause defines a security architecture for BACnet. Network security in BACnet is optional. The intent of this architecture is to provide peer entity, data origin, and operator authentication, as well as data confidentiality and integrity. Other aspects of communications security, such as authorization policies, access control lists, and non-repudiation, are not defined by this standard. Systems that require these functions may add them to BACnet by using the proprietary extensibility features provided for by this architecture, or by some other proprietary means.

24.1 Overview

The BACnet network security architecture provides device authentication, data hiding, and user authentication. This has been accomplished within the constraints that BACnet security should allow for:

(a) Application to all BACnet media types (BACnet/IP, MS/TP, etc.)
(b) Application to all BACnet device types (devices, routers, BBMDs)
(c) Application to all message types (broadcast, unicast, confirmed, and unconfirmed)
(d) Application to all message layers (BVLL, network, and application)
(e) Placing non-security-aware devices, if physically secure, behind a secure proxy firewall router
(f) Placing secure devices on non-security-aware networks.

To achieve these network security goals, the BACnet standard is extended with a set of network layer security messages. Other security standards, such as IPsec and Kerberos, were designed to operate only on TCP/IP networks and as such do not meet the above requirements. However, the BACnet security architecture was developed by applying the best security practices of those standards that fit the requirements listed above.

24.1.1 Security Layer

The security functionality is added into the BACnet stack as a set of network layer messages. As such, there is no actual security layer, although the discussion of security processing is easiest to understand if it is conceptually separated into a distinct layer. For this reason the security processing and the related messages are referred to as the security layer although in fact they are part of the network layer.

24.1.2 Shared Keys

The BACnet security model relies on the use of shared secrets called keys. Device and user authentication is achieved through the use of message signatures and shared signature keys. Data hiding is achieved through encryption of the secure payload and shared encryption keys.

In BACnet security, keys are always distributed as key pairs, where one half is the signature key and the other half is the encryption key. There are 6 types of key pairs: General-Network-Access, User-Authenticated, Application-Specific, Installation, Distribution, and Device-Master.

The General-Network-Access key is used for broadcast network layer messages, for encryption tunnels, and by user interface devices that cannot authenticate, or are not trusted to authenticate, a user. All devices must be given the General-Network-Access key pair to interoperate on a BACnet network. BACnet server devices that receive requests signed with the General-Network-Access key should assume that the User Id and User Role fields included in the message may not have been properly authenticated by the source device and may want to restrict access accordingly.

The User-Authenticated key is distributed to client devices that are trusted to authenticate a user's identity by some means, or to devices that do not contain a user interface (where the user identity to use in BACnet messages is configured into the device and is not based on human interaction). This key is also distributed to BACnet server devices that restrict operations based on the identity of an authenticated user. Servers that receive requests that are signed with the User-Authenticated key can assume that the User Id and User Role fields included in the message has been properly authenticated by the client device, or was configured into a trusted device with no user interface. While the client device may restrict a user's actions based on its authorization policies prior to sending the message, the server device is also free to restrict access based on the received User Id and User Role.

An Application-Specific key may be used to provide security boundaries between application areas, such as access control and HVAC. Application-Specific keys are distributed only to those devices sharing a particular application and can thus be limited to highly secure communication. Devices using Application-Specific keys for highly secure communications should

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be designed to be able to restrict which services can be executed with lesser keys. For example, such devices might be configured to disallow time synchronization or network configuration via the General-Network-Access key.

Installation keys are distributed temporarily to small sets of devices, usually the configuration tool of a technician and a set of BACnet devices that require configuration. These keys are provided to allow temporary access to a specific set of controllers through a configuration tool that would not normally have access to the BACnet network. There may be multiple Installation keys in use by different devices simultaneously, so that different configuration tools could use different Installation keys, if desired.

The Distribution keys are used to distribute the General-Network-Access, User-Authenticated, and Application-Specific keys, which may change over time as needed to meet local security policies. They are also used to distribute the temporary Installation keys.

The Device-Master keys are used only for the distribution of the Distribution keys and remain the most secure of all key types because they are unique for every device and their use on the wire is very limited.

24.1.3 Securing Messages

Security is applied at the network layer by creating a new NPDU message type. Plain BACnet messages are secured by placing the NSDU portion of the message into the Payload of a Security-Payload message. Therefore, when a BACnet APDU is encapsulated with security information, it is transported as a network layer message and the control bit in the NPCI is changed to indicate that the message now contains a network layer message rather than an APDU. The security header will indicate that the encapsulated message is an APDU so that this information is not lost. Upon unwrapping this message, this control bit will change back so that the plain NPDU will once again indicate that it contains an APDU.

For NPDUs and BVLLs containing NPDUs, the portion of the message starting with the network layer Message_Type field is placed into the Payload of a Security-Payload message. For BVLL messages that do not contain an NPDU, the original BVLL is embedded in a Secure BVLL message.

The basic level of security that can be applied to a BACnet message consists of signing each message using HMAC (keyed-hash message authentication algorithm) and MD5 or SHA-256 (commonly used hash algorithms), and of marking each message with the source and destination Device instances, a Message Id and a timestamp. Including source and destination addresses and source and destination device instances assures that messages cannot be spoofed or redirected. However, this requires that all secure devices, even routers and BBMDs, contain an application layer and device object.

Message Id fulfills several purposes in securing BACnet messages. It is used to detect the replay of messages, to associate security responses with security requests, and along with the Timestamp field, to provide variability in otherwise identical messages.

Timestamp is used mainly for prevention of message replay but also serves as a source of variability in the message content so that messages that are repeated frequently do not generate the same signature. The clocks of secure devices must be loosely synchronized. If a timestamp on a message is outside the security time window, then an error is returned and clock issues need to be addressed. Within the security time window, Message Ids are checked to confirm that a message has not been replayed.

A higher level of security is provided by encrypting BACnet messages so that the content of the message cannot be determined without the possession of an appropriate key. Even the length of the message can be obscured by using a varying amount of hidden padding.

24.1.4 Network Security Policies

There are two network trust levels - trusted and non-trusted. Networks can be designated as trusted due to being physically secure, or due to the use of protocol security (signatures and/or encryption). Non-trusted networks are those which are both physically non-secure and not configured to require protocol security.

BACnet messages that do not have any security information in them are referred to as "plain" messages. Therefore, there are four corresponding network security policies: plain-trusted (requires physical security; no protocol security applied), signed-trusted (physical security not required; secured with signatures), encrypted-trusted (physical security not required; secured with encryption), and plain-non-trusted (not physically secure; no signature or encryption applied). A common example of a plain-trusted network is an MSTP network where all devices are locked up and no direct network connections are available

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outside of the locked space. Devices that do not support the BACnet security messages must reside only on plain-trusted networks for their communications to be trusted by secure devices. A common example of a plain-non-trusted network would be the corporate LAN. However, the LAN may be re-designated as signed-trusted or encrypted-trusted by requiring all BACnet devices on the LAN to implement BACnet security and sign/encrypt all messages.

24.1.5 Device Level Security

Secure Devices are not restricted to residing on trusted networks (plain-trusted, signed-trusted, or encrypted-trusted). Secure devices may be located on non-trusted networks and rely on end-to-end (device level) security for secure communications. While trusted networks are created by setting the security policy for a network, and all devices on a trusted network must be configured with the security policy of the network, end-to-end security is determined on a device by device and request by request basis.

Secure BACnet devices are configured with a base device security policy that dictates the device's minimum level of security for sending or receiving messages. This policy may be higher than, but not lower than, the network access security policy.

Incapable Devices (devices that are not capable of processing BACnet security messages or those that have been configured to not be able to process BACnet security messages) must reside on a plain network (plain-trusted or plain-non-trusted). Secure devices can also reside on this same network, but their Base_Device_Security_Policy property must be set to PLAIN if they need to communicate with the incapable devices. Even if the Base_Device_Security_Policy property is set to PLAIN for interoperability with incapable devices, the secure devices are free to use secured messages, for communicating with other secure devices, for any traffic that needs to be secured.

24.1.6 Secure Tunnel Mode

The standard allows for a tunnelling mode whereby plain and signed packets arriving at one end of the tunnel (e.g., router A on subnet A) can be tunnelled to another device (e.g., router B on subnet B across a non-physically-secure network segment). The tunnelling router applies encryption (and signature if needed) using the General-Network-Access key and forwards the packet along to the other end of tunnel. Control bits in the security header indicate that the packet has been tunnelled. If a packet is already encrypted, the tunnelling router passes the message as is.

To avoid inverted networks, it is recommended that only BACnet/IP be used for secure tunnels when connecting non-secure BACnet/IP or BACnet/Ethernet networks. BACnet/IP is preferred for secure tunnels since it is the only medium through which full size BACnet packets (1476 octets of APDU) can be transferred when security is enabled. In such installations, all BACnet products can take advantage of the secure tunnel, not just those that are security aware or only communicate with smaller PDU sizes.

24.1.7 User Authentication

The BACnet security architecture allows for multiple methods for user authentication. Currently only a single method of user authentication is defined: Proxied User Authentication.

Proxied User Authentication relies on site policy and trust of selected software to perform user authentication. To allow for some clients to be trusted to perform user authentication, and some clients that do not perform, or are not trusted to perform, user authentication, different security keys are provided. Clients with user interfaces that are trusted to perform user authentication are given the User-Authenticated key, or an Application-Specific key. Other clients that need access to the network but are not trusted to securely authenticate users are given the General-Network-Access key.

24.1.8 Key Distribution

BACnet security keys are distributed to all devices by a BACnet Key Server. The General-Network-Access, User-Authenticated, Application-Specific, and Installation keys are bundled into a set and distributed together with a single key revision number, each device receiving a specific set of keys appropriate for that device. While different devices may receive different key sets (differing in Application-Specific or Installation keys, for example), the key sets shall share the same revision number across all devices after a key distribution is complete.

Each BACnet device shall either have a unique factory-fixed Device-Master key, or support initiation of Request-Master-Key service and execution of the Set-Master-Key service. The Key Server will use a device's Device-Master key to securely provide the device with a device specific Distribution key. The Key Server will then use the Distribution key to send the device its set of security keys. Distribution keys are therefore revised separately from other keys, as they may change less frequently.

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A full description of the key distribution protocol is defined in Clause 24.21.3.

All secure devices shall support the key distribution messages defined in this standard. In addition, they may also support proprietary mechanisms for setting keys. For example, an installation tool may configure an initial key set as part of its programming and commissioning operations.

24.1.9 Deployment Options

Security deployment always involves careful consideration for balancing costs, complexity, and time of configuration and maintenance against the likelihood of various attack scenarios and the sensitivity of the data or actions being protected. This standard provides for a continuum of protection from very simple and coarse grained to very powerful and fine grained.

Using the architecture defined here, very simple deployments can be made. Some deployments may not require a live Key Server. In these cases, the function of the Key Server is performed by the installation tool(s) and all devices are given infinite duration keys so that no Key Server is needed after installation. In addition, all key values can be set to be the same value if only a moderate level of security is needed to protect moderately critical resources.

Also using the architecture defined here, highly specific and highly secure deployment requirements can be met by segregating collections of devices using Application-Specific keys and tightly controlling the distribution of those keys to a limited number of devices. In addition, a live Key Server can be used to distribute expiring keys periodically according to site policy. User information is provided so that fine grained authorization policies (e.g., access control lists) can be based on the source device and/or the source user or process. The authentication mechanism can be extended to support complex proprietary methods, if required.

24.1.10 Limitations and Attacks

Highly secure communications between peer devices requires not only the knowledge of the proper key(s), but also the knowledge of a peer device's device instance number as well. This is because there are attack scenarios where it may be possible for the source and destination address information (SNET, SADR, DNET, DADR) to be altered. The relative ease or difficulty of these attacks is affected by the site's physical access policies and the skill and equipment of the attackers.

Altering the addressing information may be accomplished by gaining physical access to a secured device and changing its MAC address (e.g., by changing its address switches), by causing its IP address to change (e.g., by spoofed DHCP messages or a physically inserted NAT device), or by placing it on another network, either by physically moving the device or by remotely rewiring the networks.

Secure devices should not allow their instance numbers to be changed by physical switches after installation; device instance numbers should only be changeable via secured communications with a configuration tool. Therefore, the device instance number is the most trustworthy form of identifying the source or destination of a message, and highly secured communications should always include the destination device instance number (the source instance is always known and always included).

Devices receiving messages where the device instance of the destination is unknown should act accordingly based on their internal policies for the operation being requested. The device instance of the source is always known and may be used by the destination device's internal policies for determining how to handle these messages. In many cases, the knowledge by the destination of the authorized source instances may be sufficient to relieve the source of having to know the destination's instance.

There are also ways to avoid the condition of a source device not knowing the instance of a destination. For example, the device instance form of a recipient address should be used rather than the address form, and services like "Subscribe COV" should record the requesting device instance along with its address.

Secure devices should restrict the setting of their device instance number to communications that are secured with an Installation key, which may be temporary and unique to the device. Site policies should restrict user access to software that is authorized to change instance numbers in secure devices. But since this software is likely the same software that can completely reprogram the devices, this policy may already be in place. Site policies should also restrict physical access to highly secured devices so that their internal memory cannot be physically tampered with. Here again, this is likely to be an existing policy for such devices.

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Many of the above attacks involve physical access to either secured devices themselves or to the wiring between devices. Given this opportunity, Denial of Service attacks are trivial and obvious and this standard does not address their prevention. However, to limit over-the-wire Denial of Service attacks, this standard allows some error conditions to be ignorable. For example, devices that want to hide from scanners are allowed to ignore messages that are using an unknown key or appear to be replayed.

In general, error responses are helpful for diagnosing or recovering from some forms of legitimate network problems, however, some devices may want to limit repeated error responses to repeated receipt of erroneous messages, which may actually be an attempt at a Denial of Service attack. Legitimate devices should be designed to recover from errors like outdated key sets or incorrect timestamps in a reasonable manner or should limit their rate of sending unsuccessful messages to avoid creating an inadvertent Denial of Service attack by repeatedly sending erroneous messages to other secure devices.

24.1.11 Minimum Device Requirements

In order to implement BACnet network security in a device, the device shall:

(a) have an application layer;
(b) support execution of WriteProperty;
(c) be able to track time;
(d) have non-volatile re-writable storage in which to retain some run-time and configuration data;
(e) not be an MS/TP slave.

In addition, it is recommended that secure devices have a real-time clock that is persistent across resets and extended power down periods.

24.2 Security Wrapper

All BACnet security messages use the same security wrapper consisting of a header, an optional body, and a required signature. The format of the wrapper is:

Table 24-1. Security Wrapper Format

Field Name	Size
Control	1 octet
Key Revision	1 octet
Key Identifier	2 octets
Source Device Instance	3 octets
Message Id	4 octets
Timestamp	4 octets
Destination Device Instance	3 octets
DNET	2 octets
DLEN	1 octet
DADR	Variable
SNET	2 octets
SLEN	1 octet
SADR	Variable
Authentication Mechanism	1 octet
Authentication Data	Variable
Service Data	Variable
Padding	Variable
Signature	16 octets

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All multi-octet fields shall be conveyed with the most significant octet first. The DADR and SADR fields shall be encoded as described in Clause 6.

24.2.1 Security Header Protocol Control Information

Each security message NPDU shall start with a control octet that includes indications of the presence or absence of particular security header fields.

Bit 7: 1 indicates that the Payload contains a network layer message or a Secure-BVLL.
0 indicates that the Payload contains an application layer message

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Bit 6: 1 indicates that the message is encrypted.
0 indicates that the message is not encrypted.
This bit is referred to as the 'encrypted flag' and shall always be 0 when calculating the signature for the message.

Bit 5: Reserved. Shall be 0.

Bit 4: 1 indicates that the Authentication Mechanism and Authentication Data fields are present.
0 indicates that the Authentication Mechanism and Authentication Data fields are absent.
The Authentication Mechanism and Authentication Data fields are optionally present on request messages but shall be absent from response messages (e.g., Complex Ack, Simple Ack, Security Response)

Bit 3: 1 indicates that the Security Wrapper should not be removed, except by the destination device. This bit shall be 1 if Bit 2 (the 'do-not-decrypt flag') is set to 1.
0 indicates that the Security Wrapper should be removed before placing the message on a plain network segment.
This bit is referred to as the 'do-not-unwrap flag'.

Bit 2: 1 indicates that encryption should not be removed, except by the destination device. If this bit is set to 1, then Bit 3 (the 'do-not-unwrap flag') shall be set to 1. This bit shall not be 1 when Bit 6 ('encrypted flag') is set to 0.
0 indicates that encryption should be removed before placing the message on a network segment that does not require encryption.
This bit is referred to as the 'do-not-decrypt flag'.

Bit 1: 1 indicates that the message was received from a plain-non-trusted network and that the security information was placed on the message by the router from the plain-non-trusted network to a trusted-signed or trusted-encrypted network. Routers should not route plain messages from plain-non-trusted network to a plain-trusted network.
0 indicates that the message originated on a trusted network, or that the originator applied the security header.
This bit is referred to as the 'non-trusted-source flag'.

Bit 0: 1 indicates that the message was secured by an intervening router.
0 indicates that the message was secured by the originator.
This bit is referred to as the 'secured-by-router flag'.

24.2.2 Key Revision

This field shall contain the key revision for the key identified by the Key Identifier field.

This field shall be 0 when the Key Identifier indicates the Device-Master key.

24.2.3 Key Identifier

The Key Identifier field specifies the key that is used to sign the message. If the do-not-decrypt flag has a value of 1, then it also specifies the key used to decrypt the message. If the do-not-decrypt flag has a value of 0, the General-Network-Access key is used to decrypt the message as it is the only key that is guaranteed to be known by intermediate routers (see Clause 24.21.1).

24.2.4 Source Device Instance

The Source Device Instance is the Device object instance of the device that applied security to the message.

The field shall be restricted to the range 0 through 4194302. This requires that all secure BACnet devices, even those that are only routers or BBMDs, contain an application layer and a Device object.

Note that this field cannot be used to identify the source device of a message when the secured-by-router flag is set as it will indicate the router's Device object instance.

24.2.5 Message Id

The Message Id is a 32 bit monotonically increasing counter value that is present in all secure messages. It is used for matching security responses to security requests, for preventing replay attacks, and along with the Timestamp provides variability between messages that might otherwise be identical.

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In the normal course of operation, a device shall not generate more than one message with the same Message Id within the security time window.

If a device does not remember its Message Id across resets, then the device may have problems communicating for the first security time window period. Such a condition should be expected if the device resets within the first security time window period of a previous reset, and it always resets its Message Id counter to the same value on reset. Waiting 2 * Security_Time_Window seconds before communicating will overcome this problem.

24.2.6 Timestamp

The Timestamp field, an unsigned 32 bit integer, indicates the time of the message in UTC as seconds since 12:00 AM January 1, 1970 (standard Unix timestamp).

24.2.7 Destination Device Instance

The Destination Device Instance is the Device object instance of the destination device for the message. A value of 4194303 shall be used in all broadcast messages and when the device instance of the destination device is unknown to the device applying the security. Secure devices shall attempt to determine the Device object instance of the destination device, and only if attempts to determine the value fail, shall a secure device resort to the use of 4194303 in unicast messages.

24.2.8 DNET/DLEN/DADR

These fields contain the values of the fields with the same name from the NPCI portion of the message. They are always present and are included in the security header to allow the signing of the values.

When the message is to be placed onto the destination network, or is received from the destination network, the NPCI will not contain the DNET/DLEN/DADR fields. Regardless of whether the NPCI contains the DNET/DLEN/DADR fields, the security header shall contain these fields and they shall contain the correct destination address information.

For the Update-Key-Set, Update-Distribution-Key, and Set-Master-Key, the DNET shall be set to 0 in the security header if the SNET was 0 in the corresponding Request-Key-Update or Request-Master-Key message.

24.2.9 SNET/SLEN/SADR

These fields correspond to the fields with the same name from the NPCI portion of the message. They are always present and are included in the security header to allow the signing of the values. As such, the values must be known and filled in by the device. This is in contrast to non-secure BACnet messages where these fields in the NPCI are only present when added by a router when routing remote messages.

When a security header is placed in a message by a router on behalf of another device, these fields shall contain the address information of the originating device and not the address information of the router.

There are exceptions where the values are not known and cannot be filled in by the sending device. In the What-Is-Network message, the SNET shall be set to 0. In the Request-Key-Update, and Request-Master-Key, the SNET shall be set to 0 only when the device does not know its network number. However, the SLEN and SADR shall be set to valid values, if they are known. In the case where a device temporarily does not know its own SADR, such as a BACnet/IP device behind a NAT firewall, the SLEN shall be set to 0 and the SADR shall be empty. These devices shall learn their SADR by reading the destination address of any properly authenticated message sent to it.

When the message is to be placed onto the source network, or is received from the source network, the NPCI will not contain the SNET/SLEN/SADR fields. Regardless, the security header shall contain these fields and they shall contain the correct source address information.

24.2.10 Authentication Mechanism

If present, the Authentication Mechanism field is a 1 octet value that indicates the user authentication mechanism being used. This field shall be present when the User-Authenticated or an Application-Specific key is used and the PDU type is one that initiates a request (see below). It shall be absent when the Device-Master, Distribution, or Installation key is used. And it shall be optional when the General-Network-Access key is used.

User authentication information is not useful in responses or transmission control. User authentication is useful in any PDU type that initiates a request:

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APDU PDU Types: Confirmed-Request, Unconfirmed-Request,

NPDU PDU Types: Initialize-Routing-Table, Establish-Connection-To-Network, Disconnect-Connection-To-Network,

BVLL Types: Write-Broadcast-Distribution-Table, Read-Broadcast-Distribution-Table, Register-Foreign-Device, Read-Foreign-Device-Table, Delete-Foreign-Device-Table-Entry.

It shall not be included in all other PDU types, but if it is present a receiving device shall ignore it. If user authentication information is provided in a segmented APDU, the authentication information shall be the same in all segments. User authentication information in response PDUs and transmission control PDUs shall not be present.

The proxied user authentication mechanism is indicated by a value of 0 and is the only standardized mechanism at this time.

Values in the range 200 through 255 are reserved for vendor specific mechanisms.

24.2.11 Authentication Data

The Authentication Data field is a variable length identifier that provides authentication information in a format specific to the mechanism defined by the Authentication Mechanism field.

This may be used by the server's authorization mechanism to verify that the user is allowed to perform the requested action.

A client device that authenticates users may be given the User-Authenticated key or an Application-Specific key. It shall indicate the authenticated user's identity when initiating communication.

This field is always at least three octets in length. The first two octets are an unsigned integer (most significant octet first) indicating the numeric User Id for the user that is authenticated for this message. The third octet is the user's role or group. The user role values are site specific values dictated by site policy and are used to group access rights. Example roles are: HVAC operator, technician, etc.

User Id values represent either unique human users, or processes within a BACnet system. Assignment of the values is based on local site policy, but they should be unique across all BACnet devices, such that User Id 1234, for example, means the same regardless of its source or destination.

User Roles 0 and 1 are reserved to mean "the system itself". User Role 0 is used for programmed device-to-device communication that is not initiated by human action. A User Role of 1 is used for device-to-device communication that is initiated by an "unknown human", such as the changing of a setpoint based on button presses on a thermostat.

Other User Role values may also be used for device-to-device communication to indicate a particular subsystem that is performing the action, but those values are not restricted by this standard and are taken from the same set of numbers as are used for human users and groups. The values 0 and 1 are the only ones that are reserved specifically for this purpose and shall not be assigned to human user roles.

User Id 0 is reserved to indicate that the source user is unknown. It is commonly used in conjunction with User Role 0 or 1.

If the Authentication Mechanism has a value of 0, then the Authentication Data field contains no further information since the authentication has been performed by the source.

If the Authentication Mechanism has a value of 1 through 199, then the next 2 octets of this field shall be an unsigned integer (most significant octet first) indicating the length, in octets, of the entire field. The meaning of the remaining octets is not currently defined by this version of this standard.

If the Authentication Mechanism has a value of 200 through 255, then the next 2 octets of this field shall be an unsigned integer (most significant octet first) indicating the length, in octets, of the entire field. Following that, the next 2 octets shall be an unsigned integer (most significant octet first) indicating a BACnet Vendor Identifier. The meaning of the remaining octets is defined by that vendor.

24.2.12 Service Data

The Service Data field contains security specific data. Its content varies by message type.

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The security NPCI message type values are:

X'0A': Challenge-Request
X'0B': Security-Payload
X'0C': Security-Response
X'0D': Request-Key-Update
X'0E': Update-Key-Set
X'0F': Update-Distribution-Key
X'10': Request-Master-Key
X'11': Set-Master-Key

24.2.13 Padding

The padding is present if and only if the message is encrypted. This field is sized to ensure that the length of the data being encrypted is a multiple of the encryption algorithm's block size. The padding field is added after the signature is calculated.

The last two octets of the padding field are a count (most significant octet first) that indicates the total number of octets of padding, including the count itself. The values of all remaining octets are unspecified.

Since the count includes itself, and cannot be zero, the padding field is always included if the message is encrypted.

The size of the padding field may be increased, by adding multiples of the block size to the minimum requirement, to allow devices to hide the true length of their encrypted messages.

24.2.14 Signature

The signature contains an HMAC of the message. See Clause 24.7.4 for details on generating the signature.

The signature (in whole or in part) is also used as the Initialization Vector for the encryption algorithm.

24.3 Security Messages

24.3.1 Challenge-Request

The Service Data for a Challenge-Request message has the following form:

Table 24-2. Challenge-Request Service Data

Message Field	Size	Description
Message Challenge	1 octet	When set to 1, this field indicates that the Challenge-Request is being sent in response to a message. Otherwise, the Challenge-Request is being sent for some other reason and the following fields contain random data.
Original Message Id	4 octets	The Message Id from the message that caused the device to issue the challenge.
Original Timestamp	4 octets	The timestamp from the message that caused the device to issue the challenge.

Any device that receives a secure BACnet message may, at the device's discretion, challenge the message source, unless the secure message was itself a Challenge-Request. Specific cases where a device may want to challenge a message source are as follows: on receipt of an I-Am or I-Am-Router-To-Network where the source address does not match a previously cached value, on receipt of a secure message where the source MAC address does not match the source address in the secured NPDU and both devices are on the same BACnet/IP network, on receipt of a message where SLEN in the security wrapper is 0, and on receipt of a unicast message where the Destination Device Instance is 4194303. When challenging a specific message, the Message Challenge field shall be set to 1.

A device may also arbitrarily Challenge another device simply by generating a Challenge-Request with a random Original Message Id, and any value for the Original Timestamp. When performing a challenge without reference to a specific message, the Message Challenge field shall be set to 0.

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Upon receipt of a Challenge-Request that authenticates correctly according to Clause 24.13, with a Message Challenge field set to 1, the device shall attempt to verify that it originated the message identified by Original Message Id. If the device verifies that it did in fact send the message, it shall respond with a Security-Response with a Response Code of Success. If the device is unable to verify that it sent the specified message such as would occur if its Message Id cache were to overflow, then the device shall send a Security-Response with the error code cannotVerifyMessageId. If the device determines that it did not send the message the device shall send a Security-Response with the error code unknownSourceMessage. The device shall also reset any response timer for the challenged security message to Security_PDU_Timeout.

A device shall wait its Security_PDU_Timeout as specified in its Network Security object before cancelling a request due to a lack of response.

Upon receipt of a Challenge-Request that authenticates correctly according to Clause 24.13, with a Message Challenge field set to 0, a device shall respond with a Security-Response with a Response Code of Success.

If the device is unable to generate truly random data for Challenge requests with a Message Challenge field set to 0, the original Message Id and Original Timestamp fields can be set to values not previously used (ever). To do so, the device needs to remember the last used values for these fields across resets.

Broadcasts of this Message Type shall be ignored.

Messages of this type shall be sent with the data_expecting_reply bit set to 1 in the NPCI.

Devices that do not know their own MAC address, such as BACnet/IP devices behind a NAT firewall, may use the Challenge-Request message to determine their own address by examining the DADR in the Security-Response message.

The possible error codes returned in response to a Challenge-Request are listed in Table 24-3 below. For more information on selecting an error code to return, see Clause 24.16.2.

Table 24-3. Challenge-Request Error Codes

Error Code	Ignorable	Description
securityNotConfigured	Yes	If the recipient is not configured for security on this port.
encryptionNotConfigured	Yes	If the Encrypted field is set to 1 and the receiving device is not configured to accept encrypted messages.
unknownKey	Yes	If the Key Identifier field indicates a security key that the receiving device does not know.
duplicateMessage	Yes	A message with the provided Message Id has already been received from the source device within the security time window.
unknownKeyRevision	Yes	If the Key Revision field indicates a revision that the receiving device does not know.
malformedMessage	Yes	If the message size is invalid, or security parameters are missing or malformed.
badSignature	Yes	If the signature is not correct. This error may also be indicated if a decryption error occurs.
badDestinationAddress	Yes	If the destination address information is missing or invalid.
badDestinationDeviceId	Yes	If the Destination Device Instance is not 4194303 and does not match the local device instance.
badSourceAddress	No	If the source address information (SNET/SLEN/SADR) is invalid.
unknownSourceMessage	No	The specified message was not sent by the

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		client. While devices are not required to track all messages that have been sent, if a device is capable of detecting that it did not send the specified message, it shall use this error code to indicate that it was not the source of the challenged message. If the device cannot detect that it did not send the message, it shall not return this error code.
cannotVerifyMessageId	No	The device cannot accurately ascertain whether or not it sent the specified message.
badTimestamp	No	The Timestamp in the security header of the message is not within the allowable timestamp window of the receiver.
destinationDeviceIdRequired	No	If the Destination Device Instance in the security header of a unicast message has the value 4194303 and the destination device requires this value to be set correctly for the operation requested. How a device determines whether or not it requires the Destination Device Instance to be set correctly in any particular request is a local matter.
encryptionRequired	No	If the encrypted flag is set to 0 and the server's policy requires encryption.
sourceSecurityRequired	No	If the secured-by-router flag is 1 and end-to-end security is required, or the Do-not-decrypt flag is 0 and end-to-end encryption is required for the operation requested.

24.3.2 Security-Payload

The Service Data for a Security-Payload message has the following form:

Table 24-4. Security-Payload Service Data

Message Field	Size	Description
Payload Length	2 octets	The number of octets of payload
Payload	Variable	The secured NSDU

The Security-Payload message is used to transfer non-security related BACnet messages between communicating parties. As with all secure BACnet messages, the message is signed and may be optionally encrypted.

If the recipient of this message cannot process the message for one of the reasons listed below, and if the message was unicast, a negative Security Response may be returned to the sender with a Response Code as shown in the following table. Positive Security-Response messages are not generated in response to a Security-Payload message.

The data_expecting_reply bit in the NPCI is set based on the message in the Payload parameter. If the data_expecting_reply bit in the NPCI is not set, devices are not required to send Security-Responses when reportable errors occur, even if the error condition is not ignorable. If the data_expecting_reply bit is set, then a Security-Response shall be sent if a non-ignorable error condition occurs.

The possible error codes returned in response to a Security-Payload message are listed in table 24-5 below. The 'Ignorable' column indicates whether the device is allowed to silently fail the request and not report the error condition to the requestor. For more information on selecting an error code to return, see Clause 24.16.2**.** Note that a device may ignore any request from a non-trusted source (non-trusted-source flag set by a router) even if the encountered error is not ignorable.

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Table 24-5. Security-Payload Error Codes

Error Code	Ignorable	Description
securityNotConfigured	Yes	If the recipient is not configured for security on this port.
encryptionNotConfigured	Yes	If the Encrypted field is set to 1 and the receiving device is not configured to accept encrypted messages.
unknownKey	Yes	If the Key Identifier field indicates a security key that the receiving device does not know.
duplicateMessage	Yes	A message with the provided Message Id has already been received from the source device within the security time window.
unknownKeyRevision	Yes	If the Key Revision field indicates a revision that the receiving device does not know.
malformedMessage	Yes	If the message size is invalid, or security parameters are missing or malformed.
badSignature	Yes	If the signature is not correct. This error may also be indicated if a decryption error occurs.
badDestinationAddress	Yes	If the destination address information is missing or invalid.
badDestinationDeviceId	Yes	If the Destination Device Instance is not 4194303 and does not match the local device instance.
badSourceAddress	No	If the source address information (SNET/SLEN/SADR) is invalid.
badTimestamp	No	The Timestamp in the security header of the message is not within the allowable timestamp window of the receiver.
destinationDeviceIdRequired	No	If the Destination Device Instance in the security header of a unicast message has the value 4194303 and the destination device requires this value to be set correctly for the operation requested. How a device determines whether or not it requires the Destination Device Instance to be set correctly in any particular request is a local matter.
encryptionRequired	No	If the Encrypted field is set to 0 and the server's policy requires encryption.
sourceSecurityRequired	No	If the secured-by-router flag is 1 and end-to-end security is required, or the Do-not-decrypt flag is 0 and end-to-end encryption is required for the operation requested.
incorrectKey	No	The key provided to secure the message does not indicate sufficient authority to perform the requested operation.
unknownAuthenticationType	No	If the user authentication method in the message is unknown to the device.
accessDenied	No	The network layer or BVLL request was denied due to insufficient authorization. See Clause 24.14.1 for more details.

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24.3.3 Security-Response

The Service Data for a Security-Response message has the following form:

Table 24-6. Security-Response Service Data

Message Field	Size	Description
Response Code	1 octet	The type of response (positive acknowledgement or error code).
Original Message Id	4 octets	The Message Id of the message that caused the response.
Original Timestamp	4 octets	The Timestamp of the message that caused the response.
Response Specific Parameters	Variable	The contents of this field are dependent on the value of the Response Code field.

This message is sent as a positive acknowledgement of another security message, or when a security error occurs and the reporting of that error is allowed by the security policy. A Security-Response message is not sent in response to a broadcast message, except by a Key Server in response to a broadcast Request-Key-Update is valid in all aspects, except for the timestamp. Certain errors may be suppressed if hiding from port scanners is desired.

The reaction of the recipient to this message is a local matter. Usually Security-Response messages that represent errors will be ignored, logged, or delivered to a human operator.

No errors shall be returned in response to a Security-Response message.

The Security-Response messages are sent in response to a security message and indicate a success or failure to process the message. All security responses shall be sent with the same level of security (signed or encrypted), with the same Key Identifier that the original message had except as described in Table 24-7. The Source Device Instance shall be equal to the Destination Device Instance of the original request, except if the Destination Device Instance was 4194303.

Table 24-7. Security-Response Security Level Exceptions

Response Code	Security Applied
securityNotConfigured	The Security-Response shall indicate the General-Network-Access key in the header's Key Identifier field, shall contain an all 0 signature, and shall not be encrypted. Clients receiving this error shall optionally report this error to a management entity, and then silently drop it.
encryptionNotConfigured	The Security-Response shall be secured with the General-Network-Access key, and shall not be encrypted.
unknownKeyRevision	The Security-Response shall be secured with the General-Network-Access key, and shall not be encrypted. If the local policy requires encryption, then no security response shall be generated.
unknownKey	The Security-Response shall be secured with the General-Network-Access key.

Security-Response messages shall not be sent in response to Security-Response messages.

Broadcasts of this Message Type shall be ignored.

Messages of this type shall be sent with the data_expecting_reply bit set to 0 in the NPCI.

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The following list defines the allowable security response codes and indicates which ones are general security error codes and which ones are authorization error codes. For further information on the differentiation of error codes, see Clause 24.16.2.

Table 24-8. Security Response Codes

Value	Response Code	Type
X'00'	success	
X'01'	accessDenied	Authorization
X'02'	badDestinationAddress	General
X'03'	badDestinationDeviceId	General
X'04'	badSignature	General
X'05'	badSourceAddress	General
X'06'	badTimestamp	General
X'07'	cannotUseKey	General
X'08'	cannotVerifyMessageId	General
X'09'	correctKeyRevision	General
X'0A'	destinationDeviceIdRequired	Authorization
X'0B'	duplicateMessage	General
X'0C'	encryptionNotConfigured	General
X'0D'	encryptionRequired	Authorization
X'0E'	incorrectKey	Authorization
X'0F'	invalidKeyData	General
X'10'	keyUpdateInProgress	General
X'11'	malformedMessage	General
X'12'	notKeyServer	General
X'13'	securityNotConfigured	General
X'14'	sourceSecurityRequired	Authorization
X'15'	tooManyKeys	General
X'16'	unknownAuthenticationType	Authorization
X'17'	unknownKey	General
X'18'	unknownKeyRevision	General
X'19'	unknownSourceMessage	General

Descriptions of Response Specific Parameters follow. Response Codes for which no Response Specific Parameters are defined have no Response Specific Parameters and shall be transmitted without a Response Specific Parameters field.

24.3.3.1 badTimestamp

The Response Specific Parameters for a badTimestamp error are:

Table 24-9. badTimestamp Response-Specific Parameters

Message Field	Size	Description
Expected Timestamp	4 octets	The current time of the device that generated the Security-Response message.

Devices that generate a badTimestamp error shall set the Timestamp field in the security header to the value provided in the original message to ensure that it will be accepted by the destination device. This is the only case where the Timestamp field in the security header does not represent the current time in the generating device.

24.3.3.2 cannotUseKey

The Response Specific Parameters for a cannotUseKey error are:

Table 24-10. cannotUseKey Response-Specific Parameters

Message Field	Size	Description

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Key	2 octets	The key identifier of the key that the device is incapable of using. If there is more than one key provided in the original request that the device cannot use, the first key encountered that the device cannot use shall be indicated.

24.3.3.3 incorrectKey

The Response Specific Parameters for an incorrectKey error are:

Table 24-11. incorrectKey Response-Specific Parameters

Message Field	Size	Description
Number Of Keys	1 octet	The number of Key Identifiers that follow
List Of Known Keys	n*2 octets	A list of n Key Identifiers that are known to the device.

The List Of Known Keys is populated with each of the Key Identifiers that the device knows. A device may optionally leave out of the List Of Known Keys any keys that the device knows will not grant sufficient access if the failed action is retried.

24.3.3.4 unknownAuthenticationType

The Response Specific Parameters for an unknownAuthenticationType error are:

Table 24-12. unknownAuthenticationType Response-Specific Parameters

Message Field	Size	Description
Original Authentication Mechanism	1 octet	The Authentication Mechanism from the original request.
Vendor Id	2 octets	If the value of the Original Authentication Mechanism is 200 through 255, then this shall be set to the Vendor Id provided with the Authentication Mechanism in the original message, otherwise this field shall be 0.

24.3.3.5 unknownKey

The Response Specific Parameters for a unknownKey error are:

Table 24-13. unknownKey Response-Specific Parameters

Message Field	Size	Description
Original Key	2 octets	The Key Identifier of the unknown key.

24.3.3.6 unknownKeyRevision

The Response Specific Parameters for an unknownKeyRevision error are:

Table 24-14. unknownKeyRevision Response-Specific Parameters

Message Field	Size	Description
Original Key Revision	1 octet	The Key revision that is unknown or otherwise invalid.

24.3.3.7 tooManyKeys

The Response Specific Parameters for a tooManyKeys error are:

Table 24-15. tooManyKeys Response-Specific Parameters

Message Field	Size	Description

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Maximum Number Of Keys	1 octet	The maximum number of keys that this device is capable of be configured with.

24.3.3.8 invalidKeyData

The Response Specific Parameters for a invalidKeyData error are:

Table 24-16. invalidKeyData Response-Specific Parameters

Message Field	Size	Description
Key	2 octets	The Key Identifier of the key that contains invalid key data.

24.3.4 Request-Key-Update

The Service Data for a Request-Key-Update message has the following form:

Table 24-17. Request-Key-Update Service Data

Message Field	Size	Description
Set 1 Key Revision	1 octet	The Key Revision of the device's first key set.
Set 1 Activation Time	4 octets	The UTC time, in seconds since 12:00 AM January 1, 1970, at which this key set becomes valid, before which the device shall not accept or generate messages with keys from the set. A value of 0 shall indicate that the key set is valid immediately.
Set 1 Expiration Time	4 octets	The UTC time, in seconds since 12:00 AM January 1, 1970, at which this key set expires after which the device shall no longer accept or generate messages with keys from the set. An indefinite expiration time is encoded as X'FFFFFFFF'.
Set 2 Key Revision	1 octet	The Key Revision of the device's second key set.
Set 2 Activation Time	4 octets	The UTC time, in seconds since 12:00 AM January 1, 1970, at which this key set becomes valid before which the device shall not accept or generate messages with keys from the set. A value of 0 shall indicate that the key set is valid immediately.
Set 2 Expiration Time	4 octets	The UTC time, in seconds since 12:00 AM January 1, 1970, at which this key set expires after which the device shall no longer accept or generate messages with keys from the set. An indefinite expiration time is encoded as X'FFFFFFFF'.
Distribution Key Revision	1 octet	The revision for the Distribution key.

This security message is used by secure devices that either do not have a valid key set, or want to ensure that both of the device's key sets are still the most current.

If a secure device does not have a valid Distribution key, it shall secure this message with its Device-Master key thus indicating to the Key Server that a Distribution key is required. If a key set has not been received, the revision number field shall be 0. In such cases the time fields are meaningless and are ignored by the Key Server.

Upon receipt of a valid Request-Key-Update message secured with the device's Device-Master key, a Key Server device shall respond to the device with an Update-Distribution-Key message and then send an Update-Key-Set message to the device.

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Upon receipt of a valid Request-Key-Update message secured with the device's Distribution key, a Key Server shall respond to the device with a Security-Response message with a Response Code of correctKeyRevision if the key revision data provided are the same as the Key Server has recorded for the device and the Key Server does not have an outstanding set of keys to send to the device. Otherwise the Key Server shall respond to the device with an Update-Key-Set message.

Key Servers shall not restrict execution of this service based on the Authentication Mechanism.

A device shall wait its Security_PDU_Timeout as specified in its Network Security object before cancelling a request due to a lack of response.

A device that receives no response, or receives an error of unknownKeyRevision in response to a Request-Key-Update secured with a Distribution key, should retry the request secured with the device's Device-Master key. This allows the device to obtain a new Distribution key and key set in those cases where the device and the Key Server have become out of sync.

Broadcasts of this Message Type shall be allowed. Non-key Server devices shall ignore broadcasts of this message.

Unicast messages of this type shall have the data_expecting_reply bit set to 1 in the NPCI.

The possible error codes returned in response to a Request-Key-Update are listed in Table 24-18 below. The 'Ignorable' column indicates whether the device is allowed to silently fail the request and not report the error condition to the requestor. For more information on selecting an error code to return, see Clause 24.16.2. When executing this service, incorrectKey shall be considered a general security error and not an authorization error.

Table 24-18. Request-Key-Update Error Codes

Error Code	Ignorable	Description
securityNotConfigured	Yes	If the recipient is not configured for security on this port
encryptionNotConfigured	Yes	If the Encrypted field is set to 1 and the server is not configured to accept encrypted messages.
incorrectKey	Yes	If the request is not secured with a Distribution key or Device-Master key.
duplicateMessage	Yes	A message with the provided Message Id has already been received from the source device within the security time window.
unknownKeyRevision	Yes	If the Key Revision field indicates a revision that the receiving device does not know.
malformedMessage	Yes	If the message size is invalid, or security parameters are missing or malformed.
badSignature	Yes	If the signature is not correct. This error may also be indicated if a decryption error occurs.
badDestinationAddress	Yes	If the destination address information is missing or invalid.
badDestinationDeviceId	Yes	If the Destination Device Instance is not 4194303 and does not match the local device instance.
badSourceAddress	No	If the source address information (SNET/SLEN/SADR) is invalid.
badTimestamp	No	The Timestamp in the security header of the message is not within the allowable timestamp window of the receiver.
destinationDeviceIdRequired	No	If the Destination Device Instance in the security header of a unicast message has the value 4194303 and the destination device requires this value to be set

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		correctly for the operation requested. How a device determines whether or not it requires the Destination Device Instance to be set correctly in any particular request is a local matter.
encryptionRequired	No	If the Encrypted field is set to 0 and the server's policy requires encryption.
notKeyServer	No	If the message was unicast and the receiving device is not configured as a Key Server for the requesting device.
correctKeyRevision	No	The device's current keys are valid and no updates for the device are pending.

24.3.5 Update-Key-Set

The Service Data for an Update-Key-Set message has the following form:

Table 24-19. Update-Key-Set Service Data

Message Field	Size	Description
Control Flags	1 octet	Control flags for the Update-Key-Set message.
Set 1 Key Revision	1 octet	The Key Revision of the device's first key set.
Set 1 Activation Time	4 octets	The UTC time, in seconds since 12:00 AM January 1, 1970, at which the device is allowed to start using the first key set. A value of 0 shall indicate that the key set is valid immediately.
Set 1 Expiration Time	4 octets	The UTC time, in seconds since 12:00 AM January 1, 1970, at which this key set expires after which the device shall no longer accept or generate message with keys from the set. An indefinite expiration time is encoded as X'FFFFFFFF'.
Set 1 Key Count	1 octet	The number of keys in the first key set.
Set 1 Keys	Variable	The first key set, consisting of a concatenated sequence of key entries.
Set 2 Key Revision	1 octet	The Key Revision of the device's second key set.
Set 2 Activation Time	4 octets	The UTC time, in seconds since 12:00 AM January 1, 1970, at which the device is allowed to start using the second key set. A value of 0 shall indicate that the key set is valid immediately.
Set 2 Expiration Time	4 octets	The UTC time, in seconds since 12:00 AM January 1, 1970, at which this key set expires after which the device shall no longer accept or generate message with keys from the set. An indefinite expiration time is encoded as X'FFFFFFFF'.
Set 2 Key Count	1 octet	The number of keys in the second key set.
Set 2 Keys	Variable	The second key set, consisting of a concatenated sequence of key entries.

This security message is used to provide keys to secure devices. This message shall always be signed and encrypted with the destination device's Distribution key.

The message can be used to provide a new key set, to modify an existing key set, or to invalidate an existing key set.

The Control Flags parameter is 1 octet containing a number of control flags as follows:

Bit 7: 1 indicates that Set 1 Key Revision, Set 1 Activation Time and Set 1 Expiration Time parameters are present.

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0 indicates that those parameters are not present.

Bit 6: 1 indicates that Set 1 Key Count and Set 1 Keys parameters are present.
0 indicates that those parameters are not present.

Bit 5: 1 indicates that Key Set 1 should be cleared before any updates are applied.
0 indicates that Key Set 1 should not be cleared before updates are applied.

Bit 4: 1 indicates that Set 2 Key Revision, Set 2 Activation Time and Set 2 Expiration Time parameters are present.
0 indicates that those parameters are not present.

Bit 3: 1 indicates that Set 2 Key Count and Set 2 Keys parameters are present.
0 indicates that those parameters are not present.

Bit 2: 1 indicates that Key Set 2 should be cleared before any updates are applied.
0 indicates that Key Set 2 should not be cleared before updates are applied.

Bit 1: 1 indicates more messages are expected in this sequence of update messages.
0 indicates that this is the final message in this sequence of update messages.

Bit 0: 1 indicates that the keys provided in the message shall be removed from the key sets.
0 indicates that the keys provided in the message shall be added to the key sets (or update the keys if they already exist in the key set).

Upon receipt of a valid Update-Key-Set message signed and encrypted with the device's Distribution key, the device shall apply the changes to its key set(s).

If key revision, activation time and expiration time are included in the message, they shall replace the key revision, activation time and expiration time values for the appropriate key set.

If keys are provided in the Update-Key-Set message, and Bit 0 indicates that keys shall be added or updated, the keys provided in the message shall be added to the appropriate key set if they do not already exist in the key set. If a key with the same Key Identifier already exists in the key set, then the value for the key shall be replaced with the new key value.

If keys are provided in the Update-Key-Set message, and Bit 0 indicates that keys shall be removed, any key with the matching Key Identifiers in the appropriate key set shall be removed. If a specified Key Identifier does not exist in the key set, the request shall succeed as if it had existed.

When Bit 0 is set, the Key Size for each key provided may be 0.

A device may optionally apply all changes to shadow key sets and only update the actual key sets when an Update-Key-Set message is received that has Bit 1 of the Control Flags parameter set to 0. As such, it is a local matter as to whether or not the modifications to the key sets take effect immediately, or when the final Update-Key-Set message is received.

When replacing key sets, a sequence of 1 or more Update-Key-Set messages is sent to the device. The first message in the sequence shall have bit 5 and/or bit 2 set to 1 to cause the existing key sets to be cleared. The final message in the sequence shall have bit 1 set to 0, and all other messages in the sequence shall have bit 1 set to 1. If the key set replacement can be described in a single message, then that message shall have bit 5 and/or bit 2 set to 1, and bit 1 set to 0.

This message can also be used to add, update or remove one or more keys from one or both of the key sets without replacing the complete key sets. In such cases, the initial message shall not have bit 5 and bit 2 of the Control Flags parameter set to 1.

When issuing multiple Update-Key-Set messages to a single device, the requesting device shall wait until a Security-Response message is received before issuing another Update-Key-Set message to the device. As these messages can take longer than normal to process, the requesting device shall wait at least Update_Key_Set_Timeout + APDU_Timeout as set in the destination device's Network Security and Device objects for a Security-Response from the device.

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In general, when replacing key sets, one of the messages in the sequence shall include the key revisions, activation and expiration times; the same message need not provide these values for both key sets. The key revisions, activation and expiration times can also be updated in a device without modifying the key sets.

Update-Key-Set messages shall be executed in order, and the keys shall be applied in the order found in the Update-Key-Set message. If there are duplicate revisions, expiration dates, or key values, then the last value shall take precedence.

If a key cannot be added to the device's key set, because the local key set table is full, or the key is not usable by the device, the keys preceding the problem key in the message shall be added, and the other keys shall not be added.

Upon executing the first of a sequence of Update-Key-Set messages, a device shall record the address of the Key Server in the Last_Key_Server property of the Network Security object. The device shall only accept subsequent Update-Key-Set messages in the sequence from the same Key Server. Well formed Update-Key-Set messages from other Key Servers shall result in a keyUpdateInProgress.

If a device is waiting for more Update-Key-Set messages and none are received in 5 * (Update_Key_Set_Timeout + APDU_Timeout), the device shall consider the sequence of Update-Key-Set messages complete. It is a local matter as to whether the device updates its key sets based on the partial sequence it received, or whether it drops all changes. When a Key Server is unable to complete the sequence of updates, it shall retry the complete sequence of updates at a later time.

Devices shall not restrict execution of this service based on the authentication mechanism; knowledge of the device's Distribution key shall always be sufficient authorization.

Each key entry in the message shall be of the form:

Table 24-20. Key Entry Description

Message Field	Size	Description
Key Identifier	2 octets	The Key Identifier for the key pairs
Key Size	1 octet	The size of the key, in octets.
Key	Variable	The key value, consisting of the signature key followed by the encryption key.

The correct key sizes by algorithm are:

Table 24-21. Key Sizes by Algorithm

Hash algorithm (key size bytes)	Encryption algorithm (key size bytes)	Key field size
MD5 (16)	AES (16)	32 octets
SHA-256 (32)	AES (16)	48 octets

Broadcasts of this Message Type shall be ignored.

Messages of this type shall have the data_expecting_reply bit set to 1 in the NPCI.

The possible error codes returned in response to an Update-Key-Set are listed in Table 24-22 below. The 'Ignorable' column indicates whether the device is allowed to silently fail the request and not report the error condition to the requestor. For more information on selecting an error code to return, see Clause 24.16.2.

Table 24-22. Update-Key-Set Error Codes

Error Code	Ignorable	Description
securityNotConfigured	Yes	If the recipient is not configured for security on this port.
incorrectKey	Yes	If the request is not secured with a Distribution key.
duplicateMessage	Yes	A message with the provided Message Id has already been received from the source device within the security time

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		window.
unknownKeyRevision	Yes	If the Key Revision field indicates a revision that the receiving device does not know.
malformedMessage	Yes	If the message size is invalid, or security parameters are missing or malformed.
badSignature	Yes	If the signature is not correct. This error may also be indicated if a decryption error occurs.
badDestinationAddress	Yes	If the destination address information is missing or invalid.
badDestinationDeviceId	Yes	If the Destination Device Instance is not 4194303 and does not match the local device instance.
badSourceAddress	No	If the source address information (SNET/SLEN/SADR) is invalid.
badTimestamp	No	The Timestamp in the security header of the message is not within the allowable timestamp window of the receiver.
destinationDeviceIdRequired	No	If the Destination Device Instance in the security header of a unicast message has the value 4194303 and the destination device requires this value to be set correctly for the operation requested. How a device determines whether or not it requires the Destination Device Instance to be set correctly in any particular request is a local matter.
encryptionRequired	No	If the Encrypted field is set to 0.
sourceSecurityRequired	No	If the secured-by-router flag is 1, or the Do-not-decrypt flag is 0.
keyUpdateInProgress	No	If an Update-Key-Set message is received from a different Key Server while waiting for more Update-Key-Set messages.
cannotUseKey	No	If the encryption or signature algorithm of any key provided in the key sets is based on an algorithm that the device does not support.
tooManyKeys	No	If the device cannot be configured with the number of keys provided for the key set.
invalidKeyData	No	If the key data provided for one of the keys does not match the size required for the specified algorithms.

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24.3.6 Update-Distribution-Key

The Service Data for a Update-Distribution-Key message has the following form:

Table 24-23. Update-Distribution-Key Service Data

Message Field	Size	Description

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Key Revision	1 octet	The Key Revision of the device's Distribution key.
Key	Variable	The new Distribution key.

This security message is used by the Key Server to provide Distribution keys to secure devices. This message shall always be signed and encrypted with the destination device's Device-Master key. The Key Revision field of the security header shall be ignored by the destination device (no revision is associated with the Device-Master Key).

This message is sent either to initially configure a Distribution key into a new device, to update a Distribution key in an existing device, or to provide a Distribution key at the request of a device.

Upon receiving a valid Update-Distribution-Key message signed and encrypted with the device's Device-Master key, a device shall replace its Distribution key and respond with a Security-Response message containing a Response Code of Success.

Devices shall not restrict execution of this service based on the authentication mechanism; knowledge of the device's Device-Master key shall always be sufficient authorization.

The Key field in the message shall be of the form specified in Table 24-20. The correct key sizes by algorithm are as given in Table 24-21.

As these messages can take longer than normal to process, the requesting device shall wait at least Update_Key_Set_Timeout + APDU_Timeout as set in the destination device's Network Security and Device objects for a Security-Response from the device.

Broadcasts of this Message Type shall be ignored.

Messages of this type shall have the data_expecting_reply bit set to 1 in the NPCI.

The possible error codes returned in response to an Update-Distribution-Key are listed in Table 24-24 below. The 'Ignorable' column indicates whether the device is allowed to silently fail the request and not report the error condition to the requestor. For more information on selecting an error code to return, see Clause 24.16.2**.**

Table 24-24. Update-Distribution-Key Error Codes

Error Code	Ignorable	Description
securityNotConfigured	Yes	If the recipient is not configured for security on this port.
incorrectKey	Yes	If the request is not secured with a Device-Master key.
duplicateMessage	Yes	A message with the provided Message Id has already been received from the source device within the security time window.
malformedMessage	Yes	If the message size is invalid, or security parameters are missing or malformed.
badSignature	Yes	If the signature is not correct. This error may also be indicated if a decryption error occurs.
badDestinationAddress	Yes	If the destination address information is missing or invalid.
badDestinationDeviceId	Yes	If the Destination Device Instance is not 4194303 and does not match the local device instance.
badSourceAddress	No	If the source address information (SNET/SLEN/SADR) is invalid.
badTimestamp	No	The Timestamp in the security header of the message is not within the allowable timestamp window of the receiver.
destinationDeviceIdRequired	No	If the Destination Device Instance in the

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		security header of a unicast message has the value 4194303 and the destination device requires this value to be set correctly for the operation requested. How a device determines whether or not it requires the Destination Device Instance to be set correctly in any particular request is a local matter.
encryptionRequired	No	If the Encrypted field is set to 0.
sourceSecurityRequired	No	If the secured-by-router flag is 1, or the Do-not-decrypt flag is 0.
cannotUseKey	No	If the encryption or signature algorithm of the distribution key provided is based on an algorithm that the device does not support.
invalidKeyData	No	If the key data provided for one of the keys does not match the size required for the specified algorithms.

24.3.7 Request-Master-Key

The Service Data for a Request-Master-Key message has the following form:

Table 24-25. Request-Master-Key Service Data

Message Field	Size	Description
Number of Supported Key Algorithms	1 octet	The number of encryption/signature algorithm pairs that follow.
Encryption and Signature Algorithms	Variable	Lists the encryption algorithms that device supports. Each algorithm is encoded in 1 octet as per Table 24-30

This security message is generated by a secure device to request a Device-Master key from a Key Server. It is expected that this message is only used when initially configuring a secure device to work with the Key Server and that the issuance of the request is the result of a physical interaction with the device. If a secure device times out waiting for a Set-Master-Key message, the length of the timeout shall be sufficient to allow for human interaction with the Key Server in order to allow the Key Server to respond to the request. This message is usually globally broadcast, but it may be unicast, or sent as a directed broadcast in order to get the message through legacy routers.

As the secure device cannot produce a signature, the message shall not include a valid signature (the signature shall be all zeros) nor be encrypted. The Key Identifier field shall be set to 0. This service might not work if either the Key Server or the destination device is connected to a network that requires encryption. Secure routers shall, by default, not drop these messages regardless of the network security policies although secure routers are allowed to be configured to drop these packets.

This service is inherently insecure and as such its use must be protected through safety precautions taken both by the implementers of secure BACnet devices and site setup personnel. The expectation is that site policy will dictate whether this service is to be used on a physically secure network, such as would be accomplished by attaching a BACnet device directly to the Key Server via a port dedicated for this purpose, or whether this service is allowed to be used on insecure networks during site setup.

A Key Server that receives this message, and is in a mode that allows it to respond to Request-Master-Key messages, or is instructed to respond by a user, shall record the algorithms that the device supports, and then generate a Set-Master-Key message in response. If the device does not support any signature or encryption algorithms allowed for use on the site, the Key Server shall report the deficiency to the user. The expectation is that a Key Server will only be in a mode that allows a response to this message if the Key Server has been specifically placed into such a mode. The method for placing a Key Server into a mode that will support execution of the Set-Master-Key service is a local matter. Key Servers are required to support such a mode.

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Secure BACnet devices that are not configured as Key Servers, and Key Servers that are not in a mode that allows a response shall silently drop this message.

Messages of this type shall have the data_expecting_reply bit set to 0 in the NPCI.

24.3.8 Set-Master-Key

The Service Data for a Set-Master-Key message has the following form:

Table 24-26. Set-Master-Key Service Data

Message Field	Size	Description
Key	variable	The Device-Master key.

This security message is sent by a Key Server in response to a Request-Master-Key message. This message shall not be encrypted by the source device. The message shall be signed with the Device-Master key thus allowing values for all of security header fields.

Secure BACnet devices shall ignore messages of this type unless they are specifically placed into a mode in which they will accept these messages. It is recommended that secure BACnet devices restore themselves to factory defaults, excluding network communication parameters, when this service is executed in order to protect against theft of confidential information.

When a device receives this message, and this device has requested and is waiting for a Device-Master key, the device shall accept the key from the message, and respond with a Security-Response with an error code of Success. In the case of failure, the device shall silently drop the request as it cannot secure a negative response and thus the response would not be able to be transmitted through the secure network to the Key Server.

See the Request-Master-Key description in Clause 24.3.7 for more details on the use of this service.

The Key field in the message shall be of the form specified in Table 24-20. The correct key sizes by algorithm are as given in Table 24-21.

Broadcasts of this Message Type shall be ignored.

Messages of this type shall have the data_expecting_reply bit set to 1 in the NPCI.

24.4 Securing an APDU

When an APDU is to be sent securely, the APDU portion of the message is placed into the Payload parameter of a Security-Payload message.

Security is applied at the network layer by creating a new NPDU message type. Therefore, when a BACnet APDU is encapsulated with security information, it is transported as a network layer message so the control bit in the NPCI is changed to indicate that the message now contains a network layer message rather than an APDU. The security header will indicate that the encapsulated message is an APDU so that this information is not lost. Upon unwrapping this message, this control bit will change back so that the resulting NPDU will once again indicate that it contains an APDU.

An example of a secured APDU follows.

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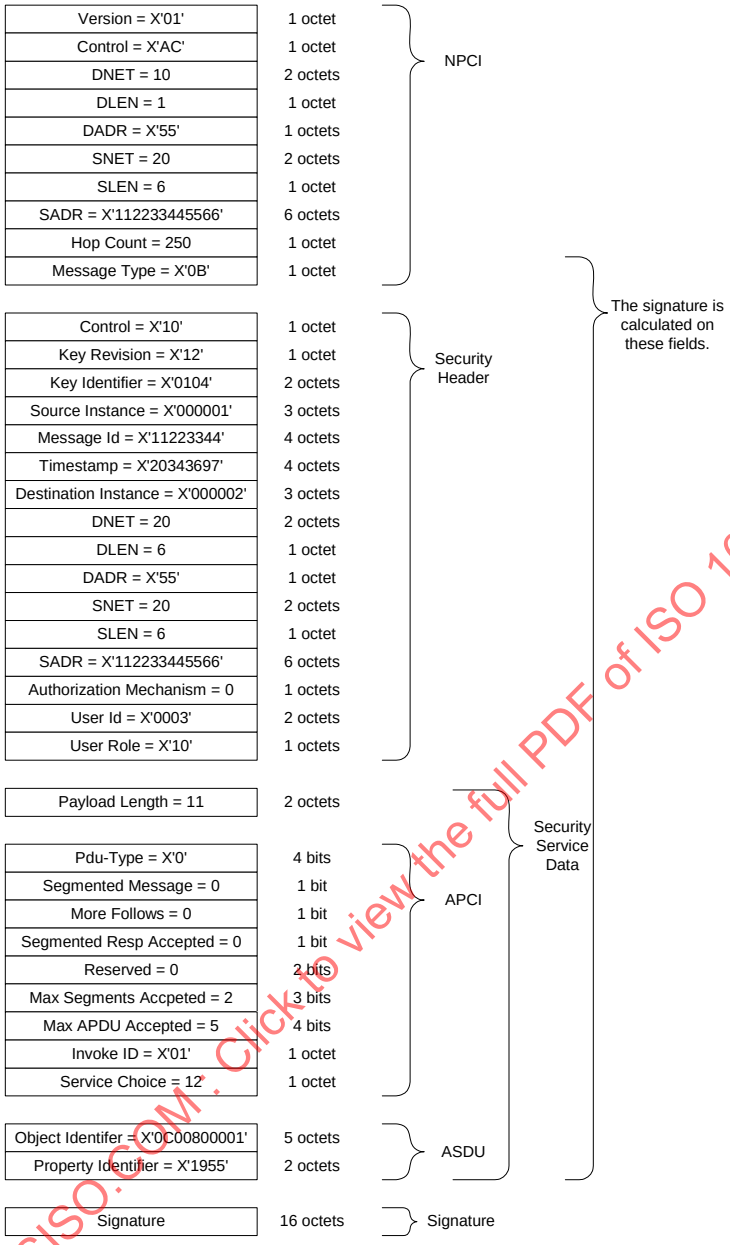

Figure 24-1. An example secured APDU (Read-Property).

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24.5 Securing an NPDU

To secure an NPDU, the NSDU (NPDU payload starting with the Message-Type field) shall be placed into the Payload field of a Security-Payload message.

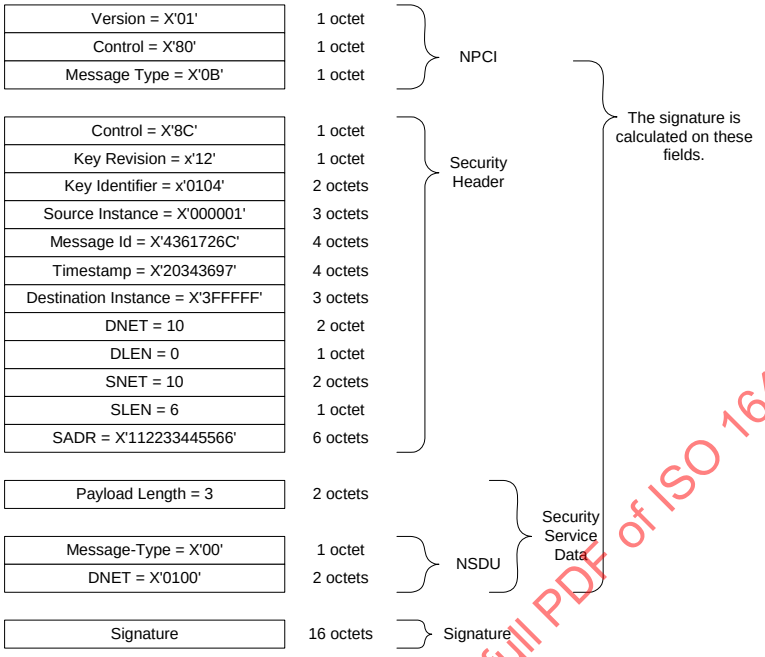

Figure 24-2. An example secured NPDU (Who-Is-Router-To-Network).

24.6 Securing a BVLL

BVLLs are divided into 2 groups: those that contain an NPDU, such as Original-Unicast-NPDU or Distribute-Broadcast-To-Network, and those that do not, such as Register-Foreign-Device or BVLL-Result.

To secure a BVLL message that does not contain an NPDU, the original BVLL shall be placed in the Service Data field of a Security Wrapper, and that Security Wrapper shall be used as the service data for a Secure-BVLL (BVLC Function X'0C'), message, as shown in Figure 24-3.

The ability to generate and consume Security Wrappers requires that the sender and receiver of secured BVLL messages are full BACnet devices with all the requirements thereof.

The Secure-BVLL message consists of the following fields:

Table 24-27. Secure-BVLL Message Fields

Field	Size	Description
BVLC Type	1-octet	BVLL for BACnet/IP (value = X'81')
BVLC Function	1-octet	Secure-BVLL (value = X'0C')
BVLC Length	2-octets	Length L, in octets, of the Secure-BVLL message and its contents up to and including the Signature. It includes the padding if the Secure-BVLL is encrypted.
Security Wrapper	variable	As described in the Security Wrapper clause.

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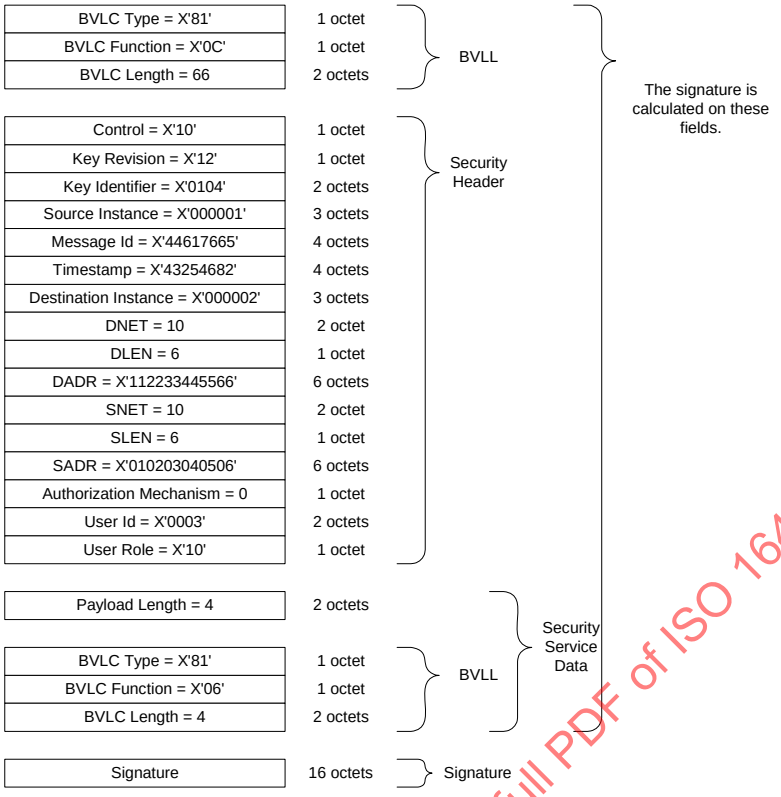

Figure 24-3. An example secured BVLL (Read-Foreign-Device-Table).

BVLL messages that contain an NPDU are transmitted without modification as specified in Annex J. However, there is no loss of security capability because those NPDUs may be secure NPDUs, containing their own Security Wrappers, based on the security policies of the network and sending device. If plain (non-secured) NPDUs are not desired in BVLL messages, then the network security policy of the BACnet/IP network should not be plain.

BBMDs do not perform wrapping/unwrapping functions on forwarded NPDUs the way routers do. The Network Security Policy that guides such operations in routers applies to an entire BACnet network, and BBMDs only serve to facilitate broadcasts between distant parts of a single network, which is governed by a single network security policy.

The possible error codes returned in response to a Secure-BVLL message are the same as for the Security-Payload message and are listed in

Table **24-5**. The 'Ignorable' column indicates whether the device is allowed to silently fail the request and not report the error condition to the requestor. For more information on selecting an error code to return, see Clause 24.16.2**.**

An example of a BVLL message containing a secure NPDU is shown in **Figure 24-4**.

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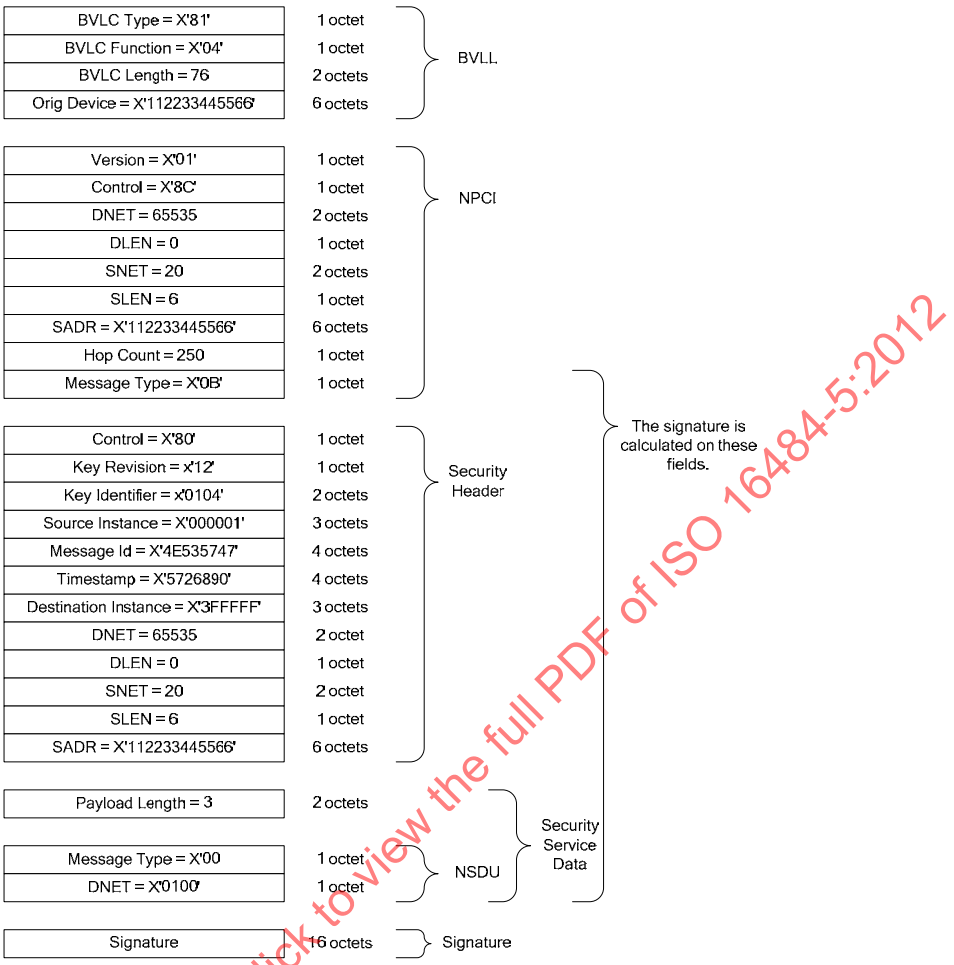

Figure 24-4. An example BVLL containing a Secured NPDU (Who-Is-Router-To-Network).

24.7 Securing Messages

The basic level of security that can be applied to a BACnet message consists of signing each message with an HMAC, and of marking each message with the source and destination device instances, a Message Id and a timestamp.

24.7.1 Message Id

The security header contains a monotonically increasing 32 bit Message Id which fulfills three purposes in securing BACnet messages. It is used to detect the replay of messages, to associate security responses with security requests and, along with the Timestamp field, to provide variability in otherwise identical messages.

To thwart replay, the Message Id is required to be unique across the security time window. This allows devices to track all received Message Id and Timestamp pairs over the security time window in order to detect replaying of messages.

To allow for a more compact Message Id cache, the Message Id is required to be monotonically increasing across the security time window.

24.7.2 Timestamp

The timestamp in the security header is used to detect the replay of messages.

The timestamp of a received message is compared to the device's local clock. If the timestamp is not within the security time window, then it is not accepted.

Timestamp along with Message Id provide variability in the message content so that messages that are repeated frequently do not generate the same signature.

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24.7.3 Device Identification

All secure messages include the Source Device Instance, Destination Device Instance, SNET, SLEN, SADR, DNET, DLEN, and DADR fields in the security header. The inclusion of these values allows the security signature to be calculated on the source and destination device identities in order to stop redirection and identity switching attacks.

Requiring SNET in every secure message imposes the requirement that all secure BACnet devices know their network numbers.

When the device that applies the security wrapper does not know the device instance of the destination device, and attempts to determine the value fail, or the protection provided by the device instance is not required for the operation requested, the value 4194303 shall be used.

When replying to a secure request, the Destination Device Instance can be set to the Source Device Instance of the original request except when the secured-by-router flag is true. In this case the Source Device Instance identifies the router that applied the security, not the device that originated the message.

24.7.4 Message Signature

The signature included in all secure messages is computed using HMAC and a secure hash algorithm.

24.7.4.1 Secure Hash Algorithms

The first step in generating the signature is to generate a hash of the message using the secure hash algorithm specified by the security key. The hash shall be computed over the message contents starting with the octet before the security header (the Message Type field from the containing NPCI) and ending with the last octet of the Service Data field. For Secure-BVLL messages the hash shall be computed over the message contents starting with the first octet of the BVLCI (BVLC Type) and ending with the last octet of the Service Data field.

The signature is always calculated before encryption or after decryption. Before calculating the signature, the encrypted flag of the control octet must be set to 0. Any padding required for encryption is not included in the input text of the signature.

A hash algorithm is considered "secure" because it is computationally infeasible either to find a message that corresponds to a given message digest, or to find two different messages that produce the same message digest. Any change to a message will, with a very high probability, result in a different message digest and thus verification failure.

The output of the secure hash algorithm will be used as the input to one of the keyed-hash message authentication code (HMAC) algorithms that follows.

24.7.4.1.1 MD5

The MD5 hash algorithm is defined by RFC1321. MD5 is included in the BACnet security framework as it is less computationally expensive than SHA-256. Sites whose security policies do not require SHA-256 may get better performance by using MD5. All secure BACnet devices shall support MD5 for use as a secure hash algorithm.

24.7.4.1.2 SHA-256

The SHA-256 hash algorithm is defined in NIST FIPS180-2. This algorithm is more computationally intensive than MD5, but is included in the BACnet security framework for use at sites that require it. All secure BACnet devices shall support SHA-256 for use as a secure hash algorithm.

24.7.4.2 HMAC

The HMAC algorithm is defined in section 5 of NIST FIPS198a. The leftmost 16 bytes of the HMAC output shall be used as the signature in secure BACnet messages.

24.7.5 Encrypted Messages

The BACnet security architecture allows for the encryption of a message's payload. The encryption of a BACnet message is done using AES. The definition of AES is contained in NIST FIPS 197.

When encrypting a BACnet message, the text to be encrypted starts with the Destination Device Instance and includes all fields in the security wrapper up to and including the Padding field.

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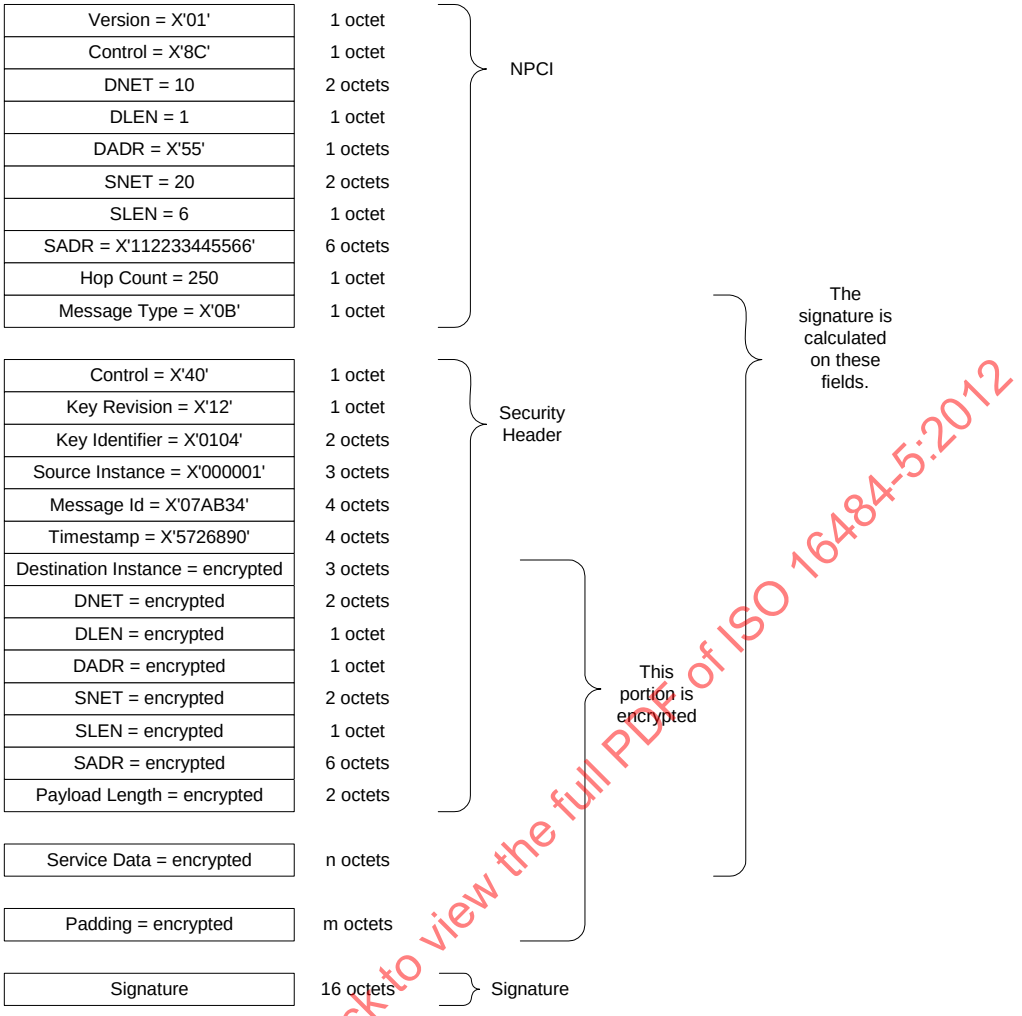

Figure 24-5. An example encrypted message.

24.7.5.1 Cipher Block Chaining (CBC)

In order to encrypt a complete BACnet message, cipher block chaining (CBC) mode is used. The standard formula for CBC is:

$$C_i = E(K, P_i \oplus C_{i-1}) \quad \text{for } i = 1,\ldots,k$$

where:
C_0 is the initialization vector,
C_i is the ith block of output,
K is the encryption key,
P_i is the ith block of the portion of the message to encrypt.
$\oplus$ is the XOR operation.
E is the encryption function.
k is the number of blocks that make up the input message.

The initialization vector consists of the first *B* bytes of the message signature where *B* is the block size. For AES the block size is 16. If *B* is larger than the size of the signature, then the signature shall be repeated a sufficient number of times to be larger than or equal to *B*.

24.8 Network Security Network Trust Levels

There are two trust levels that describe the capabilities and security requirements of a device.

24.8.1 Trusted Networks

A trusted network consists of devices that are trusted either inherently, or because all communications are secured by the protocol.

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When devices are inherently trusted, access to the devices and networks must be controlled. Depending on the installation policy, this may mean that there are no PCs and there are no direct network connections outside of locked space, or it may be that all devices are in locked cabinets and all network cabling is in metal conduit. The exact requirements will be determined on an installation by installation basis. Non-secured messages exchanged on these networks are trusted.

24.8.2 Non-trusted Networks

A non-trusted network is one where access to the network is not controlled, and as such no non-secured messages exchanged on the network can be trusted. Non-secured messages received from non-trusted networks must not be trusted. In order to identify such messages when they are routed onto trusted networks, the non-trusted-source flag is set to 1. This allows devices to identify and optionally ignore or drop messages from non-trusted networks.

Secure BACnet routers shall be configurable to route non-secured messages from non-trusted networks onto trusted networks. The mechanism for enabling and disabling this feature is a local matter.

24.9 Network Security Policies

There are four standard network security policy levels. The following definitions are presented in increasing order of security policy level.

The policy level for a network specifies the minimum level of security required for messages on the network. It also specifies the default level of security for messages that are forwarded onto a network. A secure router will change the security on a message when it is forwarded onto a network with a different security policy if not restricted by the do-not-unwrap and do-not-decrypt flags.

24.9.1 Plain-Non-Trusted

Plain-non-trusted networks have no security requirements, and are not physically secure. Devices on these networks are allowed to generate and consume messages that are not signed. Secure devices on plain-non-trusted networks should assume that all plain messages are suspect and only execute requests contained in plain messages that are considered harmless.

The router that connects a plain-non-trusted network to a network with a different security policy must be a secure router. If the router's security policy allows it to route non-secured messages from the plain-non-trusted network onto a secure network, the router shall add the security wrapper and set the non-trusted-source flag.

24.9.2 Plain-Trusted

Plain-trusted networks have no security requirements but are physically secure. Devices on these networks are allowed to generate and consume messages that are not signed or encrypted. Devices on plain-trusted networks may assume that all plain messages are from sources that are allowed to communicate on the network.

Devices on plain-trusted networks should treat plain messages in the same manner as secure messages that use the General-Network-Access key.

24.9.3 Signed-Trusted

Signed-trusted networks require that all messages be at least signed. All devices connected to signed-trusted networks must therefore be secure devices. All plain messages received on a signed-trusted network shall be silently dropped.

24.9.4 Encrypted-Trusted

Encrypted-trusted networks require that all messages be encrypted. All devices connected to encrypted-trusted networks must therefore be secure devices and support encryption. All non-encrypted messages received on an encrypted-trusted network shall be silently dropped with the notable exceptions of Set-Master-Key, Request-Master-Key and certain Security-Response messages.

24.10 Network Security

The BACnet security architecture allows both for secure networks and for end-to-end security. Secure networks are created by setting the security policy for the network and configuring all devices on the secure network with the security policy of the network. This is accomplished by setting the Network_Access_Security_Policies property of the Network Security object in all devices on the network. In addition to the Network_Access_Security_Policies property, Devices also have a Base_Device_Security_Policy property that indicates the minimum level of security that the device requires for non-network infrastructure requests. This policy dictates the device's minimum level of security for sending or receiving messages.

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Messages whose minimum security level is controlled by the Network_Access_Security_Policies are:

Who-Is-Router-To-Network,
I-Am-Router-To-Network,
I-Could-Be-Router-To-Network,
Reject-Message-To-Network,
Router-Busy-To-Network,
Router-Available-To-Network,
Establish-Connection-To-Network,
Disconnect-Connection-To-Network,
What-Is-Network-Number,
Network-Number-Is,
Register-Foreign-Device,
Who-Is,
I-Am

The minimum security level required for all other messages is specified by the Base_Device_Security_Policy.

Each security enabled router contains a network policy table that defines the security policy for each directly connected network. The network security policy table is defined by the Network_Access_Security_Policies property of the local Network Security object.

Where the Base_Device_Security_Policy property differs from an entry in the network security policy table, the higher of the two values shall dictate the minimum level of security for non-infrastructure communication to or from that network.

In contrast, end-to-end security is determined on a device by device and request by request basis. A security enabled device may contain a more detailed security policy to guide end-to-end secure communications. This policy may require security based on any number of factors, such as the service being requested, the object or property being operated on, the source of the request, etc. Note that when a device is located on a non-trusted plain network, the only way for the device to communicate to devices located on trusted plain networks is to use end-to-end security.

The limitations on device security policy are:

No secure devices shall require that requests be plain. If a device receives a well-formed valid secure request, the device is not allowed to return an error indicating that the message should have been sent plain.

No secure device connected to a network protected by a security proxy (see Clause 24.18) shall have a device policy that requires broadcast messages be secured.

If a network contains any incapable devices, then the local policy for the network must be 'plain-trusted' or 'plain-non-trusted'. If a network contains any devices that do not support encryption, then the local policy for the network must not be 'encrypted-trusted'.

The security policy of a network specifies the minimum security that messages must have if they are to be accepted from the network. A network that is physically secure might allow plain messages to be sent between local devices for efficiency reasons, but a router from that network might be configured to require signed or encrypted messages for communication beyond the local network.

24.11 End-to-End Security

In order to ensure that devices can determine the security expectations of peers, a response to a request shall use the same level of security as the request. For requests that result in a broadcast response, such as the unconfirmed application service Who-Is, the responding device is allowed to duplicate and send the response at other security levels as long as the other security levels do not violate the device's base local security policy or the network security policy over which the message is sent. The choice to send duplicates at other security levels is a local matter. Note that a device that is incapable of consuming a broadcast request due to its security level shall not respond in any way to the broadcast request.

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24.11.1 Determining Exceptional Security Requirements

A device is allowed to require a higher security level on a per-service, per-object, or per-property basis.

Where the base device security policies and network security policies of communicating devices do not indicate the need for encryption, a secure device that is not configured to know ahead of time the sensitivity of a particular piece of data that is to be written to another secure device should attempt to read that data first before writing it without encryption. This is to allow the receiving device an opportunity to indicate that the data requires encryption by returning the error class SECURITY and error code ENCRYPTION_REQUIRED. Upon receiving this error, the client device now knows that the data should not be transmitted in the clear. If the sending device is configured to know ahead of time which data needs encryption, then pre-reading is not necessary.

24.12 Wrapping and Unwrapping Secure Messages

Messages can be secured either at the source device or en route in a router. Where the security is added or upgraded depends on the security policies and capabilities of the source device, destination device, and intervening networks.

24.12.1 Wrapping and Unwrapping By Routers

The application and removal of secure wrappers to/from BACnet messages occur at different points in a BACnet network. Each secure device along the communication path will evaluate the level of security required for the message and whether or not the message shall be forwarded along its route, or dropped. The rules shall be evaluated in the order presented, and only the first matching shall be applied to a message.

When unwrapping messages, a router shall validate the security protocol control octet, signature and timestamp, and verify uniqueness of the Message Id across the timestamp window. If the security protocol control octet, signature or timestamp is invalid, or the Message Id is not unique, then the message shall not be routed. In such a case, the router shall either remain quiet, or respond with an appropriate security error code as described in Clause 24.3.

A router may optionally validate the source MAC address, and/or destination device instance, This validation may be done when security is passed on untouched, removed, or modified. If the validation fails, the router shall silently drop the packet.

When routing messages without changing the security of the packet, a router may optionally validate the security protocol control octet, signature and timestamp, and verify uniqueness of the Message Id across the timestamp window. If the validation fails, the router shall silently drop the packet. Routers may optionally pass Security-Response messages secured according to Table 24-7's exceptions even when the security of the message does not meet the minimum requirements of the source network.

The rules governing wrapping and routing of messages are:

A router not configured for security processing (i.e., contains no configured security policy table, or does not support security NPDUs) shall route all messages according to this standard's Clause 6 rules.

The remaining rules only apply to routers configured for security processing:

1. A message shall be dropped if any of the following are true:
   (a) The message is plain and was received on a network with a local policy of 'signed' or 'encrypted'.
   (b) The message is not encrypted and was received on a network with a local policy of 'encrypted'.
   (c) The message is signed or encrypted, the non-trusted-source flag is set and the message is to be placed onto a plain-trusted network.
2. A plain message shall be signed with the General-Network-Access key if the security policy of the outgoing port is 'signed'. The do-not-unwrap flag shall be set to 0 and the secured-by-router flag shall be set to 1. If the message was received on a non-trusted network, then the non-trusted-source flag shall be set to 1.
3. A plain message shall be signed and encrypted with the General-Network-Access key if the security policy of the outgoing port is 'encrypted'. The do-not-decrypt flag shall be set to 0 and the secured-by-router flag shall be set to 1. If the message was received on a non-trusted network, then the non-trusted-source flag shall be set to 1.
4. A signed message shall be encrypted using the General-Network-Access key if the security policy of the outgoing port is 'encrypted'. The do-not-decrypt flag shall be set to 0.
5. A signed message shall be unwrapped if the security policy of the outgoing port is 'plain' and the do-not-unwrap flag is set to 0.

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6. An encrypted message shall be decrypted and unwrapped if the security policy of the outgoing port is 'plain' and the do-not-decrypt and do-not-unwrap flags are set to 0.
7. An encrypted message shall be decrypted, but not unwrapped, if the security policy of the outgoing port is not 'encrypted' and the do-not-decrypt flag is set to 0.
8. All other messages shall be forwarded as is.

24.12.1.1 Routing Security Errors onto Plain Networks

When a router receives a security error that requires routing and the router has determined that the security wrapper should be removed before routing the message on, the router shall generate and forward a Reject-Message-To-Network message to the destination device. The reject reason shall be code 5 indicating that a security error stopped the original message from being processed by its destination device.

24.12.1.2 Routing To and From Plain Networks

Routers to plain networks shall enhance the security for the plain network and those devices interacting with them by providing bi-directional device id/address translation for all devices on the plain network.

The most secure form of device identification in a secure BACnet internetwork is the device instance. When messages are routed to and from a plain network, the device instance information is lost. To overcome this problem, secure routers to plain networks shall use device id/address translation replacing the SADR/DADR in messages with the device's instance.

When applying a security wrapper to route an incoming plain message onto a secure network, the router shall set, in the outgoing secure message, an SADR, in both the NPCI and the security wrapper, of length 3 that contains the source device's device instance, most significant octet first. If the message is a unicast message, the incoming DADR is expected to be a translated address, 3 octets in length, containing the destination device's instance. The router is responsible for locating the correct outgoing DADR for the specified destination device instance, and the correct device instance to use for the outgoing translated SADR for the source device.

When removing a security wrapper to route a secure message onto a plain network, the router shall set, in the outgoing plain message, an SADR, in the NPCI, of length 3, that contains the source device's device instance, most significant octet first. This source device instance will be available in the security wrapper of the incoming secure message, either in the Source Device Instance field if the security wrapper was applied by the source device, or in the SADR field if the security wrapper was applied by a router. If the message is a unicast message, the DADR is expected to be a translated address, 3 octets in length, containing the destination device's instance. The router is responsible for locating the correct outgoing untranslated DADR for the specified device on the plain network.

While the process of locating the correct DADR is a local matter, should a router be required to generate a request to find a device, the request should be restricted to the DNET specified in the request. If the DADR in a unicast request that is to be routed from a secure to a plain network, or from a plain to a secure network is not 3 octets in length, the request shall be dropped. In such cases the router shall generate and return a Reject-Message-To-Network message to the source device with a reject reason of 6 indicating the addressing information is erroneous. If the SADR is expected to be 3 octets in length when removing a security wrapper and it is not, a router shall drop the message and return a Reject-Message-To-Network message to the source device with a reject reason of 6 indicating the addressing information is erroneous.

24.12.2 Securing Response Messages

When a device responds to a secure request, whether it is a network layer request, an application layer request, or a BVLL request, the Security-Payload or Security-Response message(s) that contains the response shall be secured using the same key and to the same level (signed or encrypted and the same settings for do-not-unwrap flag and do-not-decrypt flag) as the request. This requires that security information associated with a request be passed along with the request as it moves between layers of the protocol so that it can be used to create a response that matches the request. The only exceptions to this requirement are when the responder is unable to provide the same level of security such as occurs when reporting certain security errors back to the requestor or when end-to-end security is required in which case the Do-not-unwrap flag is allowed to be set to 1.

There are some special cases where requests are to be secured as if they were a response to a previously received request. Unconfirmed requests sent in response to other unconfirmed requests such as I-Am-Router in response to a Who-Is-Router, I-Am in response to a Who-Is.

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COV notifications shall be secured using the same key and to the same level as the SubscribeCOV or SubscribeCOVProperty request that created the subscription.

The level to which event notifications are secured shall be a local matter and not dependant on the security of the services used to configure the Notification Class object that directs the events.

All requests that make up a Backup or Restore procedure shall be secured using the same key and to the same level as the initial ReinitializeDevice request. No operation within a Backup or Restore procedure shall require a different key or higher level of security if the initial ReinitializeDevice request succeeds.

24.13 Authenticating Messages

Whenever security is removed from a message, either at the destination device or en route through a router where the destination network policy differs from the source network, the message should be authenticated. The authentication process consists of validating, in order:

(1) validating the Security Header Protocol Control Information
(2) message signature.
(3) source MAC address.
(4) uniqueness of the Message Id.
(5) timestamp.
(6) destination device instance

24.13.1 Validating the Security Header Protocol Control Information

All devices that receive and process or routers that modify the security on a secure message that is to be forwarded onto another network shall validate the Security Header Protocol Control Information.

If the check fails, the message shall be silently dropped. The check is described in Figure 24-6.

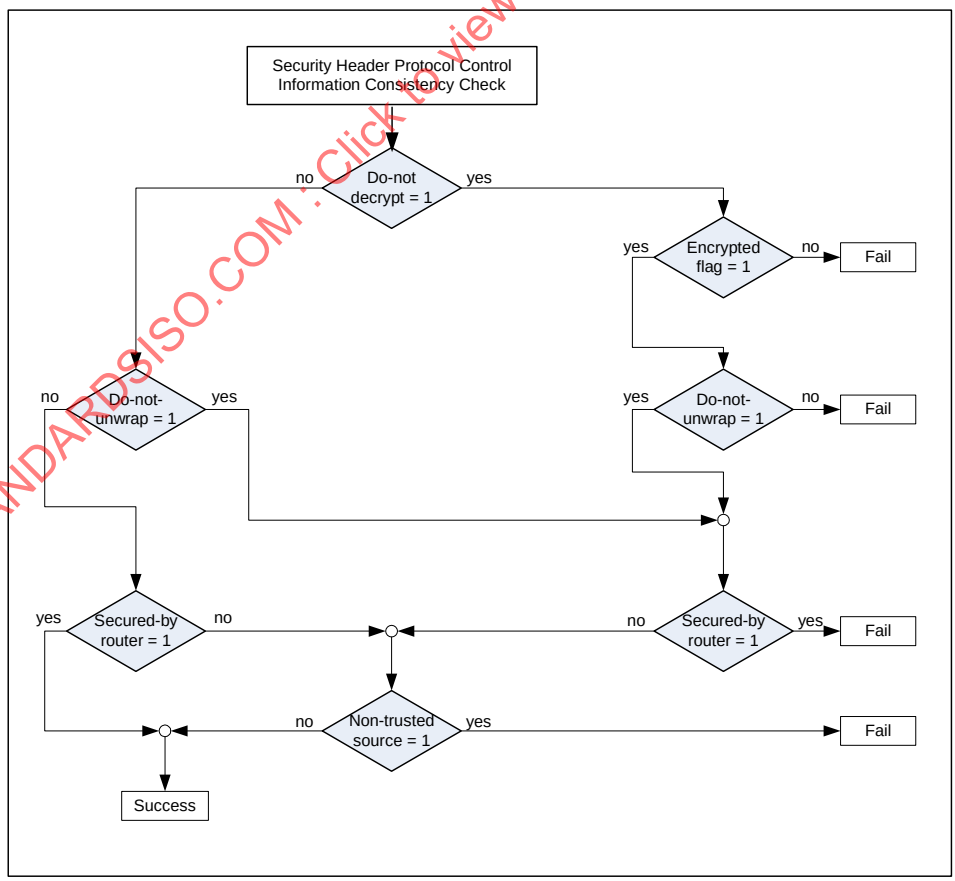

Figure 24-6: Security Header Protocol Control Information Consistency Check

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24.13.2 Validating the Signature

All secure devices that receive and process a secure message shall validate the signature of the message. Routers are not required to validate the signature of a message unless the router changes or removes the security wrapper of the message, or the router is final destination for the message.

The signature is validated by calculating the signature as described in Clause 24.7.4. The validation succeeds if the calculated signature is the same as the signature contained in the message.

If the received message is encrypted, before validating the signature, the padding has to be removed. Implementations shall verify that the padding length is less than the size of the security wrapper and that the remaining security wrapper after removal of the padding is at least as large as the smallest legal security wrapper.

If the message is a Security-Response conveying the error securityNotConfigured, the signature shall not be validated.

24.13.3 Validating the Source MAC Address

All devices that receive and process or forward a secure message have the option to validate the MAC address that the message was received from. Validation of the source MAC address is useful when network address translation (NAT) is in use within the BACnet inter-network.

When validating the source MAC address of a message, there are 3 cases to consider:

(1) The message originated from a device that resides on the network from which that the message was received.
(2) The message originated from a device that resides on a remote network.
(3) The message does not contain source MAC address information in the security header.

When a message is received from a local device, the MAC address should be compared to the signed SADR in the security header. If the values match, then the source MAC address validation succeeded. If the values do not match, then the check failed. If the check fails the receiving device has the option to challenge the source of the message by sending a Challenge-Request to the MAC address (not the SADR from the security header). This check would most likely be employed when the network is of a type where address translation is an expected behavior, such as BACnet/IP. If the challenge succeeds, then the source MAC address validation will be considered to have succeeded.

When a message is received from a remote device, the MAC address should be compared against any locally cached value for a router to the source network. If the MAC address matches the cached value, then the source MAC address validation succeeded. If the values do not match or the device does not have a locally cached router address for the network, then the check failed and the receiving device has the option to challenge the router of the message. If the challenge succeeds, then the source MAC address validation will be considered to have succeeded.

To challenge a router to a network, a device may send a secure unicast Who-Is-Router-To-Network to the MAC address from the message. If a valid secure I-Am-Router-To-Network is received in response, then the challenge will have succeeded.

An alternative method to challenging the router is to challenge the originator of the message, ensuring that the MAC address sent to is the address the original message was received from. If the challenge succeeds, then the source device is reachable via the address the message was received from. This is the only method that is available for validating the route to the Key Server when the device has not yet been provided with a General-Network-Access key.

If the SLEN field of the security header is 0, then the source address information is not present, and thus not signed. The only option for validating the source address is to challenge the source device. If the challenge succeeds, then the source MAC address validation will be considered to have succeeded.

24.13.4 Validating the Destination Device Instance

Secure messages include a Destination Device Instance field that indicates the device that the message is intended for. A secure device shall only accept a message that has either a Destination Device Instance field of 4194303 or its own device instance.

A secure device is allowed to refuse unicast requests that have a Destination Device Instance of 4194303. In such cases, the device shall respond with an error code of destinationDeviceIdRequired. While a device is allowed to refuse unicast requests

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with a Destination Device Instance of 4194303, it is strongly recommended that this not be a device's default approach. Doing so will result in the device being unable to interoperate with incapable devices from plain-trusted networks.

24.13.5 Validating the Message Id

All secure devices that receive and process a secure message shall validate the Message Id of the message. Routers are not required to validate the Message Id of a message unless the router modifies or removes the security wrapper of the message, or the router is the final destination for the message.

The Message Id cache is based on:

> Packet Reorder Time: a period of time across which out of order packets can be received without causing Message Id validation problems.
>
> Last Message Id: the largest Message Id received from a device more than Packet Reorder Time seconds ago. This value is stored for each device from which secure messages are received.

All secure devices shall cache data records about recently received valid messages. The cached data records shall consist of the Message Id, the source device instance, and the time at which the message was received. In addition, a Last Message Id value is stored for each secure device being communicated with.

When a message is received, the cache shall be checked and if the Message Id is already present in the cache, or if the Message Id is less than the Last Message Id (taking into account wrapping), then the Message Id validation shall fail. Otherwise the Message Id Validation shall succeed.

If the Message Id validation, destination device instance validation, timestamp validation, and signature validation all pass, then a new record shall be added to the cache and the Message Id validation shall succeed.

The cache holds Message Id, Timestamp, Source Device tuples that are received over the last Packet Reorder Time window. When an entry in the cache becomes older than Packet Reorder Time, the Message Id is compared to Last Message Id for the source device (taking into account wrapping) and if it is larger, Last Message Id is set the Message Id of the entry removed from the cache,

If no messages are received from a device within Security Time Window seconds, then Last Message Id is cleared for that device. This is to ensure that devices can wait Security Time Window seconds after power up and then safely re-use any Message Id without it being rejected as a duplicate.

The size of the cache is a local matter. Determining which entries to remove from the cache when it overflows is a local matter.

24.13.6 Validating the Timestamp

All secure devices that receive and process a secure message shall validate the Timestamp of the message. Routers shall not validate the Timestamp of a message unless the router changes or removes the security wrapper of the message, or the router is the final destination for the message.

The timestamp shall be checked against the clock of the receiving device. If the Timestamp is within +/- Security_Time_Window seconds of the local time, then the validation shall succeed, otherwise the validation shall fail.

24.14 User Authentication

The BACnet standard provides one standard user authentication mechanism.

24.14.1 Proxied User Authentication

The Proxied Authentication mechanism is identified by an Authentication Mechanism field value of 0. When using this mechanism, the Authentication Data field only contains the User Id and User Role. The User Id in the message is assumed to have been authenticated by the source device when the key is anything other than the General-Network-Access key. See also Clause 24.2.1.11.

The User Id identifies the user requesting the operation and the User Role identifies the role under which the user is performing the operation. Secure devices shall not expect to use a fixed set of User Ids or user Roles. User Ids and User

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Roles will be assigned during site installation and setup and as such shall be configurable in both client and server devices. Devices that are capable of providing User Id and User Role values in secure messages shall be capable of being configured to provide any User Id, User Role value pair for each of the users that it supports. Devices that do not ignore User Id and User Role values in received messages shall be capable of being configured to accept and process any User Id or User Role value. The method used to configure User Ids, User Roles and authorization rules is a local matter.

User Roles of 0 and 1 indicate that a request is initiated by "the system itself", that no user authentication was performed, and no user authentication was required. A User Id of 0 indicates that the actual user identity is unknown and is commonly used in conjunction with a User Role of 0 or 1.

A server device that receives a request with a User Id that is secured with the User-Authenticated key is allowed to apply local user authorization to determine whether the user is authorized to perform the requested service. If the user does not have sufficient rights for the operation, the server device shall return an error. For Confirmed-Request PDUs, a Complex-ACK-PDU or an Error-PDU conveying a class of SECURITY and an error code of WRITE_ACCESS_DENIED, READ_ACCESS_DENIED, or ACCESS_DENIED shall be returned. The error code returned depends on the service requested.. For BVLL and network layer messages that expect a response, a Security-Response message shall be returned that conveys the error code accessDenied. All other requests shall not result in errors being returned.

If a server is not configured to apply authorization rules, then the user authentication information may be ignored. If a server is configured to apply authorization rules and the message is secured with the General-Network-Access key, it is a local matter as to whether or not the request is granted. Exceptions to this rule are the Who-Is and Who-Has services which shall be executed.

The authorization scheme details, and the method of configuring and maintaining the scheme, are a local matter.

24.15 Time Synchronization Requirements

Because message timestamps are used to prevent replay attacks, secure devices are required to maintain the current time. Also, because message timestamps are in UTC, secure devices are required to support the UTC_Offset property in their Device object.

24.15.1 BACnet Time Synchronization Messages

Secure BACnet devices should not accept non-secured TimeSynchronization or UTCTimeSynchronization requests, unless the local network security policy is plain-trusted. Doing so will leave the secure device vulnerable to replay attacks.

24.15.2 Overcoming Non-synchronized Clocks

The network security architecture relies on devices having loosely synchronized clocks. If there are secure devices within the system whose clocks are not within the time window of each other, then those devices will be unable to communicate with each other and the system will be susceptible to replay attacks..

Devices that cannot keep accurate time are open to replay attacks as their clocks drift away from the clocks of the other secure BACnet devices. It is essential that Time-Synchronization is performed frequently enough to keep all device clocks well within Security_Time_Window seconds of each other.

It is worth noting that when a secure device is powered off for extremely long periods of time (years), the clock in the device may drift sufficiently far that it is no longer synchronized with the rest of the devices on the network.

24.15.2.1 Devices Without Real Time Clock Chips

Devices that do not keep time over a reset or while turned off will need to acquire the time before they can communicate safely.

The preferred method for determining the current time in such cases is for the device to use a special non-repeating Message Id that is remembered across resets. The device waits 2 * Security_Time_Window and then generates a Challenge request with the next special Message Id (note that there is no relationship between the Message Id used for this purpose and the last Message Id used by the device before it reset). The Challenge request shall be sent with an all 0 timestamp.

To generate the next special Message Id to use, a constant value is added to the previously used special Message Id. The constant, modulo 2^{32}, shall be prime. This ensures that when the value wraps, it wraps past 2^{32} to a previously unused value.

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Note that larger constants are generally better than smaller ones as more "entropy" is created making the signature, and any encryption, more secure.

If the secure device does not have the current key set, the Challenge request will have to be aimed at the Key Server and use the device's Distribution or Device Master key.

Other methods for determining time are described below. Each of the methods outlined requires that the device has the ability to generate a random value that will be used in the Message Id and/or Timestamp fields of the security header. Use of standard programming language random functions will not meet this requirement. The device must use its interaction with the outside world to generate a random value (inter-message delay, total network traffic, values found in DRAM if it is not cleared on startup, etc). If the same Message Id value is used each time on startup, then an attacker can record a sequence of messages when a device resets and then replay them at a later date when the device resets again.

24.15.2.1.1 Monitoring Broadcast Traffic

The device can determine the time by monitoring the network for broadcasts. If a broadcast is seen that is secure and validates, then the time can be taken from the message and used in a Challenge-Request containing a random Message Id and aimed at the source of the message. If the challenge succeeds, then the time can be accepted.

24.15.2.1.2 Monitoring For Any Traffic

The device can determine the time by monitoring the network for any traffic. Once a message is received, the source MAC address can be removed from the message and a Challenge-Request formed and sent to the source of the message. If the challenge succeeds, then the time can be accepted.

24.15.2.1.3 Wait For TimeSynchronization

The first two solutions may result in incorrect times being used by the device. If the device chooses a message from a device that has an invalid time, then the device will end up with the same invalid time.

A third option is for the device to be configured to challenge a time master on restart, or be programmed to remember the source address of the last successfully processed TimeSynchronization or UTCTimeSynchronization request and challenge this address on start up. The device should update its time only if the Challenge succeeds.

Alternatively, the device could wait for a TimeSynchronization or UTCTimeSynchronization request. When one is received, the device should challenge the message source and only accept the time if the Challenge succeeds.

24.16 Integrating the Security Layer into the BACnet Stack

24.16.1 Secure PDU Sizes

The addition of the BACnet security wrapper into the BACnet PDU reduces the amount of space for BACnet NSDUs and APDUs.

For secure devices, the value of the Max_APDU_Length_Accepted property of the Device object shall be calculated assuming the largest size of valid Authentication Data the device is configured to accept, and the largest encryption block size of any BACnet security encryption algorithm the device is configured to use.

Secure routers that are capable of routing between 2 BACnet/IP networks shall be capable of routing BACnet/IP messages that contain an NSDU of 2000 octets. This allows for 523 octets of authentication data to be included in the security header when transferring packets between BACnet/IP networks. All other BACnet routers are only required to support routing of message sizes indicated in Table 24-28.

In order to reduce the chance of inverted networks being used when security tunnels are in place, the maximum APDU for secure BACnet/IP segments is kept at 1476. To allow for this, the maximum length BACnet/IP NPDU is increased to 1562 for secure BACnet/IP messages. This allows full size non-secured APDUs to be secured and passed through BACnet/IP networks.

The following table of maximum NSDU and APDU lengths is calculated assuming an Authentication Mechanism of 1 with 2 octets of Authentication Data and an encryption block size of 16 octets.

Table 24-28. Maximum APDU Lengths for Secure BACnet Data Link Layers

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Data Link Technology	Maximum APDU Length
ISO 8802-3 ("Ethernet"), as defined in Clause 7	1411 octets
ARCNET, as defined in Clause 8	419 octets
MS/TP, as defined in Clause 9	419 octets
Point-To-Point, as defined in Clause 10	419 octets
LonTalk, as defined in Clause 11	131 octets
BACnet/IP, as defined in Annex J	1476 octets
ZigBee, as defined in Annex O	419 octets

When reporting the Max_APDU_Length_Accepted in the APCI of a ConfirmedRequest-PDU, a secure device might be forced to indicate a value smaller than indicated by its Device object. While this will result in successful communications, the network bandwidth usage of large segmented messages will be sub-optimal.

Therefore devices responding to ConfirmedRequest-PDUs may ignore the value indicated in the APCI and use the value indicated in the client's Device object instead, if it is known.

24.16.2 Selecting Error Codes

The security errors can be broken down into two groups: general security layer errors and authorization errors. General security layer errors are those that are required to be generated and returned by the security layer and indicate a problem with the formulation of the message itself. Authorization errors may be generated by the security layer, or they may be generated by another layer of the BACnet stack or by the device's application program.

The order in which the error conditions are checked is important. The general security layer errors are checked in the order they occur in the service's error table and are checked before any authorization errors. The order in which authorization errors are checked is not important except that the generic accessDenied error code shall not be generated if one of the other authorization error conditions exists. This ensures that knowledge imparted by the other authorization error codes is not lost through the over use of the accessDenied error code. It is recommended that the encryptionRequired error condition be checked before the incorrectKey error condition because this may help to reduce the amount of failure traffic produced.

If multiple error conditions are present, the condition that is checked first shall be the error that is returned.

Some of the error conditions are ignorable, subject to the restrictions made by the Do_Not_Hide property of the Network Security object. When an ignorable error occurs, it is a local matter as to whether the device returns the error or does not respond at all. Note that if multiple errors are present and the one that is checked first is ignorable, then the device has the choice to either return that error or not respond at all; the device does not have the option to return an error indicating one of the other error conditions that exist.

24.16.3 Communicating Security Parameters

While the BACnet Security Layer is responsible for securing BACnet PDUs, the other layers of the BACnet stack are usually the source of the security parameter information. For example, the determination of whether or not any of the data in an APDU requires a higher level of security than the device's default policy is made by the application program. The application, network and BVLL layers of the BACnet stack provide security information to the security layer via the security_parameters ICI parameter.

24.16.4 Detecting and Processing Security Errors

Security errors can be detected both by the security layer and also by the layer of the stack executing a request. For example, the security layer will detect problems with signatures whereas the application program will detect most authorization errors. The result is that some security errors are returned in Security-Responses and others will be returned in Error-PDUs or ComplexACK-PDUs.

When a security error is received by a device, the error information may need to be indicated to the other layers of the BACnet stack. The security layer indicates the error information via the N-REPORT.indication primitive. The application layer indicates security errors to the local application program via the SEC_ERR.indication primitive.

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Table 24-29 provides a discussion of the different security errors, the conditions that the errors indicate, and possible failover actions that devices can take.

Table 24-29. Security Errors

Description	Suggested Failover Actions
securityNotConfigured	
The recipient is not configured for security on this port. A Security-Response containing this error will not be signed nor encrypted by the source device.	If the source device is allowed to re-generate the request with no security (a 0 signature and not encrypted), do so otherwise fail the request. This error should be reported to a management entity and then silently dropped.
encryptionNotConfigured	
The Encrypted field is set to 1 and the receiving device is not configured to accept encrypted messages. A Security-Response that contains this error will not contain a valid Original Message Id as the responding device would be unable to decrypt the source message to obtain the MessageId. A Security-Response containing this error will never be encrypted by the originator although it may be encrypted by an intervening router.	Report to the stack layer that created the original request to allow it to decide if the request should be retried with different security parameters. Since the device cannot match it to a specific request, all outstanding requests sent with encryption to the specific device should be cancelled and retried.
unknownKey	
The Key Identifier field indicates a security key that the receiving device does not know.	Report the error to the stack layer that created the original request to allow it to decide if the request should be retried with different security parameters. If the original request was encrypted, the device that generated this error would not have been able to match it to a specific request, all outstanding requests sent with encryption using the specific key to the specific device should be cancelled and retried.
duplicateMessage	
A message with the provided Message Id has already been received from the source device within the security time window.	If the source device has restarted (within 2 * Security_Time_Window), this may be due to issues surrounding the initial MessageId used. In such cases, the device should stop all network traffic for a complete Security Time window, or retry with a larger Message Id. If traffic is to be halted, then indicate the error to the stack layer that created the original request so it has the option to retry later. If the source device has not recently restarted, then this error should be reported to a management entity.
unknownKeyRevision	
If the Key Revision field indicates a revision that the receiving device does not know. A Security-Response containing this error code should never be encrypted as the intended target will most likely not be able to decrypt the message.	If the source device has not recently checked its Key Revisions with the Key Server (definition of recently is a local matter), the device should check them using the Update-Key-Set message. This failover action should be taken by the security layer, not the application entity. The source device should either, resend the packet if the keys are found to be out of date, or indicate the error to the stack layer that created

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	the original request resulting in the request failing completely. If the source device has recently checked its Key Revisions, its local policy is to not check, or if its keys are found to be current, then this error should be reported to a management entity. It is advisable to report this problem to the management entity regardless because frequent occurrences of this error indicate a problem with key distribution or network robustness. The device that generates this error should also check its key revision with the Key Server if it has not done so recently and its key table does not indicate that the unknown key revision recently expired.
malformedMessage	
If the length of the data received is too short to contain the security header, service parameters and the signature or the size of padding is larger than possible for the data received, etc.	The error should be reported to a management entity and dropped silently.
badSignature	
If the signature is not correct. This error may also be indicated if a decryption error occurs. This error indicates that either the packet was tampered with, a network error occurred, the key values differ, or some other kind of attack is underway.	If the signature of the response is correct, then the key values are correct. In this case, the error should be reported to a management entity, and the packet retried. If the signature is not correct, then the error should be reported to a management entity and dropped silently.
badDestinationAddress	
If the destination address information is missing or invalid. This is an indication that the packet was modified on route, replayed to the wrong device, the physical structure of the network has been tampered with or the address-binding table in the source device is stale.	If the local binding table is stale in the source device, the source device should clear the entry and re-bind to the destination device. The source device should be able to determine if the local binding table was stale based on the information received in the Security-Response message. If the original packet is still available, resend it, otherwise indicate the problem to the stack layer that created the original request and let that layer regenerate the packet. If the binding table is not stale, report the problem to a management entity.
badDestinationDeviceId	
If the Destination Device Instance does not match the local device instance. This is either an indication that a redirection attack is being attempted, that the local device has recently changed its device instance, or that the source device has stale addressing information.	The source and destination devices should report the error to a management entity. If the destination device provides an error response to the source device, or if the source device times out waiting for a response, the source device should clear the entry in its local binding table and re-bind to the destination device.
badSourceAddress	
If the source address information is invalid. This is an indication that the general network configuration is incorrect (there is disagreement on network numbers between routers and devices), or that the physical structure of the network has been tampered with.	The source and destination devices should report the error to a management entity.

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badTimestamp	
The Timestamp in the security header of the message is not within the allowable timestamp window of the receiver. This indicates a problem with non-synchronized clocks, or an attempt to replay a message. The receiver of the Security-Response should be able to tell if it is a clock issue.	If it is a clock issue, the request could be re-tried with a timestamp adjusted to suit the other device. If it is not retried, the error should be indicated to the stack layer that created the original request and reported to a management entity.
destinationDeviceIdRequired	
If the Destination Device Instance in the security header of a unicast message has the value 4194303 and the destination device requires this value to be set correctly for the operation requested. This error may be generated by the application program and returned in an Error-PDU or ComplexAck-PDU.	The error should be reported to the stack layer that created the original request and the request should not be retried with the information because we cannot be sure that this is the device the application really should be communicating with and would thus thwart the protection the device was trying to achieve by returning the error.
unknownSourceMessage	
This error occurs when a Challenge fails.	The device should report the error to a management entity. The message that was being Challenged should be dropped and no response sent to its source device.
cannotVerifyMessageId	
This error occurs when a device has no record of sending the specified message. This may be sent if a device generates enough traffic that its local cache of message history has overflowed and it is unable to ascertain for sure that it did not send the message.	The device should report the error to a management entity. The message that was being Challenged should be dropped and no response sent to its source device.
encryptionRequired	
This error occurs when an operation requires encryption but the request was sent in the clear.	If the source device supports encryption for non-key exchange messages, it should retry the request with encryption. If the device does not support encryption, it should report the problem to a management entity.
sourceSecurityRequired	
If the secured-by-router flag is 1 and end-to-end security is required, or the Do-not-decrypt flag is 0 and end-to-end encryption is required for the operation requested. If the device's minimum security level requires end-to-end security this error is generated by the security layer. The equivalent application program error class and error code can also be returned by the application program if the requirement for end-to-end security is due to data specific rules. In such a case, the error will be returned in an Error-PDU or ComplexAck-PDU.	If the error is in a Security-Response, the error should be indicated to the stack layer that created the original request. The device should retry the request, with different security parameters.
incorrectKey	
The key provided to secure the message does not indicate sufficient authority to perform the requested operation. This error is usually returned by the application program in an Error-PDU or ComplexACK-PDU.	If the error is in a Security-Response, the error should be indicated to the stack layer that created the original request. The device should retry the request, with different security parameters.
notKeyServer	

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The device that received the Request-Key-Update message is not configured as a Key Server or is not configured as the Key Server for the requesting device.	This error usually indicates that the Key Server configured to provide keys for the source device has been moved. The device should retry the request using a broadcast address.
keyUpdateInProgress	
The destination device is performing a key update and is unable to perform the request action.	The error indicates that a different Key Server is updating the device. The problem should be reported to a management entity, and the Key Server should retry the operation at a later time.
cannotUseKey	
The destination device is unable to use a key provided by the Key Server.	This indicates that the Key Server has been configured to issue keys to a device that it is unable to accept. The Key Server should report the problem to a management entity and attempt to provide all other security keys to the device.
tooManyKeys	
The destination device is unable to fit all of the keys that the Key Server has provided.	This indicates that the Key Server has been configured to issue too many keys to a device. The Key Server should report the problem to a management entity.
invalidKeyData	
The desitnation device determined that the key data provided is invalid.	This indicates an implementation error in the Key Server or in the desitnation device. Both devices should report the problem to a management entity.
unknownAuthenticationType	
If the user authentication method in the message is unknown to the device. This error is usually returned by the security layer, but might be returned by the application program depending on which layer is responsible for authentication checks. It might also be that the device accepts the whole security request and passes it to the application program with authentication mechanism and data marked as "unknown", letting the device decide whether the operation can be allowed without knowing the authentication mechanism and the user requesting the action. Thus it lets the decision be that of the application program.	If other authentication methods are known, the request can be retried with one of those methods.
accessDenied	
The network layer or BVLL request was denied due to insufficient authorization. See Clause 24.14.1 for more details. While the security layer may return this error code, for application layer requests, the application program should use other related error codes in Error-PDUs and ComplexACK-PDUs.	There is no suggested failover action for this error condition.

24.16.5 Security Errors in Network Layer Initiated Packets

The network layer does not have a mechanism for returning errors in response to a message and thus the information that can be conveyed in response to an error is limited.

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If the network layer detects a security error condition, such as insufficient authorization, the network layer shall convey this information to the local security layer so that a Security-Response indicating the error condition can be generated. Non-security errors shall be handled as according to Clause 6.

Network layer messages that embody operations, in contrast to route discovery and traffic management, may require security stronger than the base security policies. The network layer messages that may require a higher level of security are: Initialize-Routing-Table Establish-Connection-To-Network, and Disconnect-Connection-To-Network. All other network layer messages shall be accepted if they are secured according to the network's security policy.

Reject-Message-To-Network messages shall be secured with the same level of security as the original request. This may result in intermediate routers being unable to process the Reject-Message-To-Network message. In such cases, the intermediate routers will not benefit from the information but the source device will.

24.16.6 Security Errors in BACnet/IP BVLL Initiated Packets

The BACnet/IP BACnet Virtual Link Layer does not have a mechanism for providing detailed error information. All it is able to indicate is that a request failed, it cannot provide details.

If the BACnet/IP BACnet Virtual Link Layer detects a security error condition, such as insufficient authorization, and the request was received in a Secure-BVLL, the layer shall convey this information to the local security layer so that a Security-Response indicating the error condition can be generated. Otherwise error conditions shall be handled according to Annex J.

Forwarded-NPDU, Distribute-Broadcast-To-Network, Original-Unicast-NPDU, Original-Broadcast-NPDU are just payload messages transferring packets from higher levels. They shall not require security higher than the network's local security policy (although any contained PDU may be rejected due to insufficient security by a higher layer of the BACnet stack).

BVLL messages that embody operations may require stronger security than the local network security policy. The BVLL messages that may require a higher level of security are: Delete-Foreign-Device-Table-Entry, Read-Broadcast-Distribution-Table, Read-Foreign-Device-Table, Register-Foreign-Device, Write-Broadcast-Distribution-Table. As with all responses BVLC-Result and all of the ACK BVLL PDUs shall be secured to the same level as the original request.

24.16.7 Data Hiding

In secure devices, some data within a device will not be available to all clients. Where a subset of data within an object, property, or service is restricted, a secure device shall hide the portion of the data for which access is restricted.

24.16.7.1 Hiding Properties

If an object in a secure device contains optional properties for which access to requires a higher level of security, those properties may be hidden by the secure device. The secure device has the option to return a security error (ACCESS_DENIED, READ_ACCESS_DENIED, or WRITE_ACCESS_DENIED), or to return a general error (UNKNOWN_PROPERTY). This method of data hiding is not available for required properties; restricted access to required properties has to be reported via a security error.

When a special property identifier (ALL or OPTIONAL) is used to access restricted optional properties, the device has the option to exclude the optional property completely from the result, or to include a security error in its place.

24.16.7.2 Hiding Array Elements

When elements in an array or list have different security requirements, the secure device shall hide elements of the property by making it appear that the elements do not even exist. The array or list will appear to be shorter, and entries that occur later in the property will be shifted down to fill the entries which are hidden. This approach to data hiding is not applicable to arrays or lists for which the length is mandated by the standard.

For example, when reading the Object_List property of the Device object with different security levels may result in a different value being returned. Where objects have to be completely hidden, the length of the Object_List should be adjusted so that entries do not show up.

24.16.7.3 Hiding Service Results

For services that report collections of data, such as the alarm summary services, the data returned by the service may change based on security of the request. For example, if a secure device contains alarm generating objects, for which access to

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requires a higher level of security, the alarm summarization services should not return entries for those objects regardless of whether they meet the summarization criteria or not.

A secure device does not have the option to leave out a required service response parameter, or in any other way modify a response such that it is inconsistent with the rules for that service response.

24.16.8 Device Identity

24.16.8.1 Security of Device Identity

The device instance is the only secure form of device identity. Network number and MAC address values should not be considered to be secure as these can be changed due to a network configuration change or can be manipulated through complicated attacks on a BACnet network.

When referring to another device such as is done in Notification_Class objects, it is always better to refer to the device via the device instance and not via the device's network number and MAC address. This is also better for handling cases where device MAC addresses may change, such as when DHCP is in use.

Devices should never use network number or MAC address information to make authorization decisions. The only device identity information that should be relied upon for making authorization decisions is the device instance.

24.16.8.2 Modifying A Device's Identity

Modifying identity information that is used by the security layer can result in problems within the layers of the stack. For example, changing a device's instance number or network number via a WriteProperty request may result in problems associating the response with the request.

When critical identity values (device instance, network number, MAC address) are modified by a service, the actual change of identity shall occur after the response has been sent so that the response is secured with the same identity that the request was secured with.

A device may, at the implementor's discretion, delay the application of identity value changes until the device is reset.

24.17 BACnet Security In A NAT Environment

A secure foreign device that resides behind a NAT cannot include a correct SADR in secure messages because the device does not know it. While BBMDs are given static IP addresses, a foreign device's address is not usually static. To overcome this issue, secure foreign devices that communicate through a NAT to reach the BACnet internetwork may first send a Challenge-Request message to the BBMD that they intend to register with as a foreign device. The resulting Security-Response will let them know their SADR as seen by other BACnet devices.

24.18 BACnet Security Proxy

In order to provide security for devices without requiring the devices themselves to be secure, a new type of device called a Security Proxy is defined.

A BACnet security proxy device is a secure router that strips and adds security on behalf of the devices "behind" it that are incapable of, or not configured for, secure communications. The proxy will remove security from messages destined for the protected devices, even if the do-not-unwrap or do-not-decrypt flags are set. The proxy will also determine when security should be applied to messages that are originated by protected devices and will apply it accordingly. The methods used by a security proxy device to determine when to apply security, what level of security, and what user information to use are local matters.

In its simplest form, a security proxy device protects a complete BACnet network or collection of BACnet networks but it is not restricted to operate in such a manner. A security proxy device could be implemented such that it protects a subset of the devices on the protected networks.

The BACnet security proxy functionality is optional and is not required to be supported by secure BACnet routers.

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24.19 Deploying Secure Device on Non-Security Aware Networks

Where a network is served by a BACnet router that does not forward globally broadcast unknown network messages, global broadcasts of security messages will not be routed. This limitation will restrict the methods used to deploy secure devices in existing networks.

In particular, a secure device will be unable to request security keys using broadcast Request-Master-Key or Request-Key-Update requests. There are three options for deployment in this situation:

(1) Connect the device to the Key Server's local network to receive the Device-Master key and Key Server address information.
(2) Provide the device's network number, MAC address and device instance manually to the Key Server and manually interact with the Key Server to get it to provide a Device-Master key to the device.
(3) Enter the Key Server's information into the Last_Key_Server property of the device's Network Security Object, and then cause the device to request a Device-Master key using a unicast Request_Master_Key directed at the device indicated by Last_Key_Server.

In order to ensure that other secured messages are routed by the legacy router, secure devices should refrain from relying on globally broadcast security messages for proper operation.

24.20 Deploying Secure Single Network Installations

BACnet security requires that all devices know their local network numbers. To make support for this requirement for simpler installers, secure devices can leverage the What-Is-Network-Number and Network-Number-Is services. While this decreases the installation work required, it results in problems when no routers are deployed in the installation.

To ensure that this does not cause problems during the installation process, it is recommended that all secure devices support an alternate method for configuring the local network number.

24.21 Security Keys

In BACnet security there are six types of keys: General-Network-Access, User-Authenticated, Installation, Application-Specific, Device-Master, and Distribution. Each key actually consists of a pair of key values, one used for signatures and one used for encryption.

The General-Network-Access key is used for device and object binding, for encryption tunnels, and by user interface devices that cannot authenticate or are not trusted to authenticate a user. All secure BACnet devices shall support use of the General-Network-Access key.

The User-Authenticated key is used by devices that are allowed to authenticate the user's identity that is included in BACnet messages. It is also given to devices that do not contain a user interface. All secure BACnet devices shall support use of the User-Authenticated key.

Installation keys are distributed to pairs of devices, usually the configuration tool of a technician and a set of BACnet devices that require configuration. These keys are provided to allow temporary access to a specific set of controllers through a configuration tool that should not normally have access to the BACnet network. All secure BACnet devices shall support use of the Installation key.

In order to provide security boundaries between application areas, such as access control and HVAC, the BACnet security framework provides Application-Specific keys. All secure devices shall support at least 1 Application Specific key; support for multiple Application-Specific keys is optional. The semantics of the Application-Specific keys are site-specific, and as such all devices shall not restrict which Application Specific key identifiers may be accepted into their key sets.

The Device-Master key is a unique key per device that is either given to the device before the device is installed, or provided to the device by the Key Server during installation. In theory, the Device-Master key is never changed for a device other than during initial site setup. In practice, a device's master key may have to be changed if a Key Server's key database is lost and cannot be recovered. The Device-Master key is only used to provide Distribution keys to devices.

Distribution keys are unique per device and are used only to distribute key sets.

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24.21.1 Key Identifiers

Keys are identified by their 2-octet key identifier. The identifier indicates which key is to be used and the signature and encryption algorithms that the key is used with.

The first octet of the Key Identifier field indicates the encryption and signature algorithms to be used. The values are:

Table 24-30. Key Identifier Algorithm Enumeration

Value	Algorithm (Encryption/ Signature)
0	AES / MD5
1	AES / SHA-256
2..255	Reserved

The second octet of the Key Identifier indicates the key being used. The values are:

Table 24-31. Key Identifier Key Number Enumeration

Value	Key number
0	(not used)
1	Device-Master
2	Distribution
3	Installation
4	General-Network-Access
5	User-Authenticated
6..127	Application-Specific Keys
128..255	Reserved

While the key identifier format would allow the specification of multiple keys of each type (such as the General-Network-Access key) differing only in the algorithms used, the intent is that only one key of each type would be used in practice.

24.21.2 Key Sets

A key set consists of all of the keys that a BACnet device is configured to have excluding the Device-Master key and the Distribution key, a time period during which the keys are valid and a key revision number. The key revision number applies to all of the keys in a key set.

A key shall not be used outside of the timeframe defined for the key set. To allow for variations in clocks between devices, a key's acceptability shall be determined by using the timestamp placed in the message by the sending device rather than the local time in the receiving device.

Each BACnet device has two key sets with possibly overlapping valid time periods. This allows a device to have a current and a new key set for transitioning between key sets. When a device contains 2 valid key sets, the device should secure messages with the newer of the two key sets as soon as its valid time period will allow.

If the key set's Expiration Date is X'FFFFFFFF', then the key set shall not expire. To allow for this deployment scenario, devices shall maintain key data in a non-volatile manner and shall not be dependent on a Key Server after a power up or reset.

A key revision of 0 indicates that the key set has not been configured. Therefore, when the key revision number wraps after being incremented past 255, it shall wrap back to 1, not 0. If the key set's revision number is 0, then any keys it contains shall be ignored.

24.21.3 Key Distribution

In general, the keys used by the BACnet security framework are not unique to each device, or device pair. The General-Network-Access key is shared by all of the BACnet devices and the User-Authenticated key is shared by most devices. In order to increase the security of the keys, they should be changed periodically.

Device-Master keys must be configured in a secure device and shared with the Key Server before the Key Server can provide keys to a device. Initial key distribution is discussed in more detail in Clause 24.22.3.

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Keys are distributed as a set, excluding the Distribution key which is distributed on its own. The key revision number applies to all of the keys in the key set.

To protect the keys, the distribution messages shall be encrypted. The encryption algorithm used for distribution of keys shall be the same encryption algorithm as used with the most secure key in the distribution.

24.22 Key Server

BACnet Key Servers are responsible for the generation and distribution of BACnet security keys. If automatic generation and distribution of security key updates is required, the BACnet installation will require a permanent Key Server that is responsible for generating and distributing keys to all of the BACnet devices.

The Key Server is configured with a list of the devices to update, the keys that each should be given, and the period at which the keys should be distributed. In addition, the Key Server shall allow the operator to initiate a key update at any time.

24.22.1 Key Generation

The Key Server will be responsible for generating all keys, except for factory-fixed Device-Master keys. The algorithm used to generate the keys shall be a local matter.

The Key Server shall take into account local security policy and device requirements when choosing the algorithms to assign to generated keys. In order for the General-Network-Access key to work with all devices, it has to use algorithms supported by all secure devices in the BACnet internetwork. The Key Server shall report the existence of devices that do not support the minimum security requirements of the local security policy to the local user or a management entity. When determining the algorithms for Device-Master and Distribution keys, the Key Server should select algorithms that are at least as strong as the algorithms used by keys that are to be distributed and protected by these keys.

Note that if a Key Server is configured to provide key sets frequently and if the key sets are given long expiration times, it is possible for the Key Revision to wrap within the expiration time and create conflicts between active Key Revision numbers. Key Server implementations should take care to avoid such situations.

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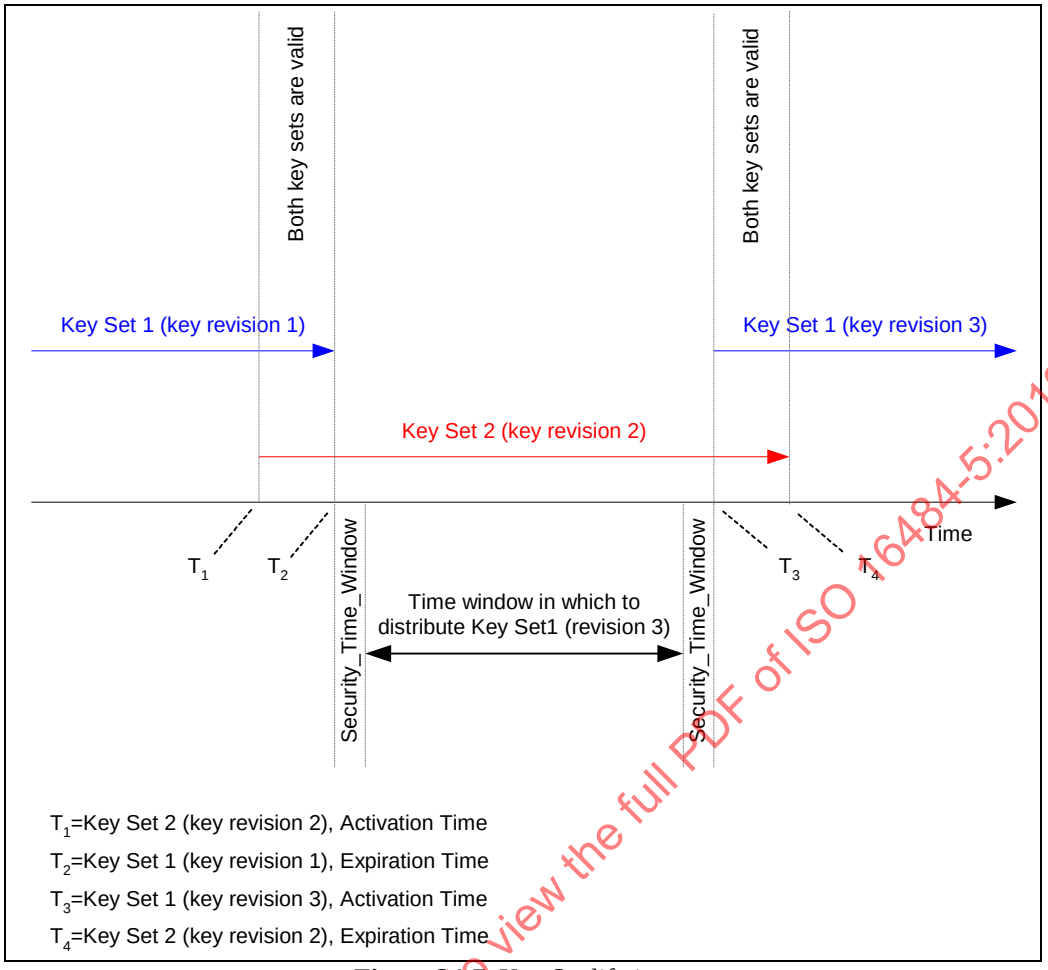

Figure 24-7: Key Set lifetimes.

The time window in which the Key Server has to distribute a new key set to all devices starts Security_Time_Window seconds after the key set expires and ends Security_Time_Window seconds before the replacement key set becomes active. If the Key Server does not complete the generation and distribution within this time window, some devices will be unable to communicate with each other. See **Figure 24-7**.

24.22.2 Distribution Method

When the Key Server has generated a new set of keys, the Key Server will increment the Key Revision and distribute the keys to each device. Each device receives the General-Network-Access key plus any other keys it has been authorized to receive. The set of keys are sent encrypted to the device using the Distribution key for that device. Distribution keys are delivered separately using the Device-Master key and need not be distributed as frequently as the key sets.

The Key Server packages the newly generated key set into an Update-Key-Set message, signs and encrypts the message with the device's Distribution key, and sends it to the device. Upon receipt of a valid sequence Update-Key-Set messages, the device shall update its key sets as directed. The device shall start using the new key set as soon as its valid time period will allow.

If the sending of the set of keys to the device is successful, the Key Server shall record the key revisions for both sets for the device. If the Key Server is unable to update the device, it shall re-try the update periodically until successful.

The Key Server shall update each device. If a device cannot be contacted, or the update fails, then the Key Server shall continue with the next device. The order in which the Key Server updates devices is a local matter.

If both of a device's key sets become invalid due to the current time being outside each key set's valid time period, then the device shall cease generating requests, other than Request-Key-Update messages signed with the device's Distribution key, or Device-Master key. The device shall periodically request a new key set from the Last_Key_Server. If the Key Server is on a

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remote network and the device does not know the MAC address of the router to use, then the device shall use a local MAC broadcast to transmit the Request-Key-Update message. If the device does not have a value for Last_Key_Server, or does not receive an update from the Last_Key_Server, the device shall globally broadcast, or send a sequence of directed broadcasts of, the Request-Key-Update message. The device shall not request a key set more than once every 5 minutes. If, upon power up, a device detects that its key sets have expired, the device shall wait at least 1 minute after power up before requesting a key set in order to allow the Key Server to distribute key sets after power outages.

When the Key Server receives a Request-Key-Update from a device where the Key Revision of the message's Distribution key does not match the recorded Distribution key for the device, the Key Server shall respond with an error code of unknownKeyRevision and then update the device's Distribution key set with an Update-Distribution-Key message.

For devices that the Key Server is unable to provide a key set to, the Key Server shall continue to periodically attempt to update the device using the Update-Key-Set message. The period at which the Key Server retries the key update is a local matter.

The Key Server shall periodically update each device's Distribution key. To update a device's Distribution Key, the Key Server sends the device an Update-Distribution-Key message that is signed and encrypted with the device's Device-Master key.

If a device loses its keys, it can request a new set by sending the Key Server a Request-Key-Update message signed with the device's Device-Master key. To such a request, the Key Server shall respond with an Update-Distribution-Key message.

Under normal operating conditions, after a device has received 2 sets of keys, the Key Server need only update 1 key set by replacing an expired key set with one that will activate at a future time.

24.22.3 Initial Key Distribution

A Key Server shall provide a mechanism for accepting manually input Device-Master keys. For example, the Key Server might have a user interface through which the Device-Master key values can be entered for each device, or the Key Server may be provided with a software tool that will provide keys to the Key Server through a secure channel. This mechanism allows for devices that have a fixed, factory configured, Device-Master key. All such devices shall provide a method of reporting the Device-Master key. For example, a device could have the Device-Master key printed on a tear-off label.

As an alternative to having predefined Device-Master keys, secure devices may optionally support initiation of the Request-Master-Key and execution of the Set-Master-Key messages. It is left up to site policy as to whether or not the use of these inherently insecure services is allowed during site setup.

For installations that do not use the Request-Master-Key and for devices that have factory-fixed Device-Master keys, Key Servers shall support interrogation of devices' Network Security objects in order to determine the encryption and signature algorithms supported before providing key sets.

24.22.4 Key Revision

The Key Revision is only incremented when the data for an existing key is changed (excluding Device Master, Distribution and Installation keys). The creation of new application keys (keys that here-to-for did not exist at all) will also not result in the Key Revision being incremented.

If the Key Server is reconfigured such that the keys that it supplies to a given device are changed (the device is supposed to be given a key it was not previously given, or is no longer supposed to receive a key it already has), the Key Server modifies the device's existing key sets without incrementing the Key Revision. The creation of, or expiration of, Installation Keys shall not result in the incrementing of the Key Revision for the current Key Sets.

24.22.5 Sites Without Key Servers

Secure BACnet sites are able to be deployed without a permanent Key Server. In such cases, a temporary Key Server is used to generate and distribute keys sets that do not expire. To do so, key set 1 shall be provided with an Expiration Date of X'FFFFFFFF' and key set 2 shall be uninitialized and provided with a Key Revision of 0.

Any Key Server that supports such deployment scenarios shall provide a mechanism for documenting all Keys in order to allow the same keys to be used when devices are added to the system at a later date. It is up to the building owner / operator to ensure that the Keys are in the possession of a building representative to allow for future upgrades.

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Key Servers that support such deployments shall provide a mechanism for accepting manually input keys. This will allow any such BACnet Key Server to be used to add new devices to an existing installation without the requirement that the original Key Server be used.

24.22.6 Multiple Key Servers

When there are multiple Key Servers in a BACnet installation, the method by which the Key Servers generate new key sets, distribute keys between themselves and determine which Key Server distributes keys to which devices is a local matter. In addition, the method for selecting which Key Server responds to any particular Request-Master-Key service, and the subsequent sharing of generated Device-Master keys between the Key Servers is a local matter. Multiple Key Server systems need to ensure that conflicting keys are not provided to secure devices by different Key Servers. The method for ensuring this is a local matter.

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25 REFERENCES

ANSI/EIA/CEA-709.1-B (2002), *Control Network Protocol Specification*.

ANSI/IEEE Standard 754 (1985), *IEEE Standard for Binary Floating-Point Arithmetic*.

ANSI/INCITS 92-1981 (R1998), (formerly ANSI X3.92-1981), *Data Encryption Algorithm.*

ANSI/INCITS X3.4-1986 (R1997), *Information Processing - Coded Character Sets - 7-Bit American National Standard Code for Information Interchange (7-bit ASCII)*.

ANSI/TIA/EIA-232-F-1997 (R2002), *Interface Between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange.*

ANSI/TIA/EIA-485-A-1998 (R2003), *Standard for Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems.*

ANSI X3.41-1974 (R1990), *American National Standard Code Extension Techniques for Use with the 7-bit Coded Character Set of American National Standard Code for Information Interchange.*

ATA 878.1 (1999), *ARCNET Local Area Network Standard*.

DDN Protocol Handbook, Volumes 1-3, NIC 50004, 50005, and 50006.

Echelon, *LonMark™ Layer 1-6 Interoperability Guidelines Version 3.3*.

FIPS 46-2 (1993), *Federal Information Processing Standards - Data Encryption Standard.*

FIPS 180-2 (2002), *Federal Information Processing Standards - Secure Hash Standard*

FIPS 197 (2002), *Federal Information Processing Standards - Advanced Encryption Standard*

IETF RFC 2616 (1999), *Hypertext Transfer Protocol - HTTP/1.1*, Internet Engineering Task Force

IETF RFC 2617 (1999), *HTTP Authentication: Basic and Digest Access Authentication*, Internet Engineering Task Force

IETF RFC 2246 (1999), *The TLS Protocol Version 1.0*, Internet Engineering Task Force

ISO 7498 (1984), *Information processing systems - Open Systems Interconnection - Basic Reference Model*.

ISO TR 8509 (1987), *Information processing systems - Open Systems Interconnection - service conventions*.

ISO 8649 (1988), *Information processing systems - Open Systems Interconnection - Service definition for the Association Control Service Element*.

ISO 8802-2 (1998), *Information processing systems - Local area networks - Part 2: Logical link control*.

ISO/IEC 8802-3 (2000), *Information processing systems - Local area networks - Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.*

ISO 8822 (1994), *Information processing systems - Open Systems Interconnection - Connection-oriented presentation service definition*.

ISO/IEC 8824 (1990), *Information technology - Open Systems Interconnection - Specification of Abstract Syntax Notation One (ASN.1)*.

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ISO/IEC 8825 (1990), *Information technology - Open Systems Interconnection - Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1).*

ISO 9545 (1994), *Information processing systems - Open Systems Interconnection - Application Layer Structure (ALS).*

ISO/IEC 10646-1 (2000), *IT - Universal Multiple-Octet Coded Character Set (UCS) - Part 1: Architecture and Basic Multilingual Plane.*

JIS C 6226 (1983), *Code of the Japanese Graphic Character Set for Information Interchange*. Japan Institute for Standardization.

Konnex Association, *Konnex Handbook Volume 3: System Specifications.*

Konnex Association, *Konnex Handbook Volume 3: System Specifications, Part 7: Interworking, Chapter 2: Datapoint Types.*

Konnex Association, *Konnex Handbook Volume 3: System Specifications, Part 7: Interworking, Chapter 3: Standard Identifier Tables, Annex 1 - Property Identifiers.*

Konnex Association, *Konnex Handbook Volume 7: Applications Descriptions.*

NETSCAPE SSL3 DRAFT302 (1996), *The SSL Protocol Version 3.0*, Netscape Communications

UNICODE Technical Report# 17-5: *Character Encoding Model*. The Unicode Consortium.

W3C (2000), *Simple Object Access Protocol (SOAP) 1.1*, World Wide Web Consortium

W3C (2001), *XML Schema Part 0: Primer*, World Wide Web Consortium

W3C (2001), *XML Schema Part 1: Structures*, World Wide Web Consortium

W3C (2001), *XML Schema Part 2: Datatypes*, World Wide Web Consortium

W3C (2003), *Extensible Markup Language (XML) 1.0 (Second Edition)*, World Wide Web Consortium

WS-I (2004), *WS-I Basic Profile 1.0*, Web Services Interoperability Organization

Sources for Reference Material

ANSI: American National Standards Institute, 25 West 43rd St., 4th Floor, New York , NY 10036.

DDN: Available from the Defense Data Network Information Center, SRI International, 333 Ravenswood Ave., Room EJ291, Menlo Park, CA 94025.

Echelon: Echelon Corporation, 550 Meridian Ave., San Jose, CA 95126.

EIA: Electronics Industries Alliance, 2500 Wilson Blvd. Arington, VA 22201.

EIBA: EIB Association (EIBA) s.c.r.l., Neerveldstraat / Rue de Neerveld 105, B-1200 Brussels, Belgium

FIPS: National Institute of Standards and Technology, Gaithersburg, MD 20899.

IEEE: The Institute of Electrical and Electronics Engineers, Inc., 3 Park Ave., 17th Floor, New York, NY 10016.

Internet Engineering Task Force, www.ietf.org.

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INCITS: The International Committee for Information Technology Standards (INCITS) is sponsored by the Information Technology Industry Council (ITI), 1250 Eye St. NW, Suite 200, Washington, DC 20005.

ISO: Available from ANSI.

JIS: Available from ANSI.

Konnex Association: Neerveldstraat / Rue de Neerveld 105, B-1200 Brussels, Belgium

LonMark International, 550 Meridian Avenue, San Jose, CA 95126.

Netscape Communications, www.netscape.com

The Unicode Consortium. P.O. Box 391476, Mountain View, CA 94039-1476, USA.

W3C: World Wide Web Consortium, www.w3.org

WS-I: Web Services Interoperability Organization, www.ws-i.org

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ANNEX A - PROTOCOL IMPLEMENTATION CONFORMANCE STATEMENT (NORMATIVE)

(This annex is part of this Standard and is required for its use.)

BACnet Protocol Implementation Conformance Statement

Date: _____
Vendor Name: _____
Product Name: _____
Product Model Number: _____
Application Software Version: _____ **Firmware Revision:** _____ **BACnet Protocol Revision:** _____

Product Description:

_____
_____
_____
_____
_____
_____
_____
_____

BACnet Standardized Device Profile (Annex L):

☐ **BACnet Operator Workstation (B-OWS)**
☐ **BACnet Advanced Operator Workstation (B-AWS)**
☐ **BACnet Operator Display (B-OD)**
☐ **BACnet Building Controller (B-BC)**
☐ **BACnet Advanced Application Controller (B-AAC)**
☐ **BACnet Application Specific Controller (B-ASC)**
☐ **BACnet Smart Sensor (B-SS)**
☐ **BACnet Smart Actuator (B-SA)**

List all BACnet Interoperability Building Blocks Supported (Annex K): _____
_____
_____

Segmentation Capability:

☐ Able to transmit segmented messages Window Size _____
☐ Able to receive segmented messages Window Size _____

Standard Object Types Supported:

An object type is supported if it may be present in the device. For each standard Object Type supported provide the following data:

1) Whether objects of this type are dynamically creatable using the CreateObject service
2) Whether objects of this type are dynamically deletable using the DeleteObject service

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3) List of the optional properties supported
4) List of all properties that are writable where not otherwise required by this standard
5) List of all properties that are conditionally writable where not otherwise required by this standard
6) List of proprietary properties and for each its property identifier, datatype, and meaning
7) List of any property range restrictions

Data Link Layer Options:

☐ BACnet IP, (Annex J)
☐ BACnet IP, (Annex J), Foreign Device
☐ ISO 8802-3, Ethernet (Clause 7)
☐ ATA 878.1, 2.5 Mb. ARCNET (Clause 8)
☐ ATA 878.1, EIA-485 ARCNET (Clause 8), baud rate(s) _____
☐ MS/TP master (Clause 9), baud rate(s): _____
☐ MS/TP slave (Clause 9), baud rate(s): _____
☐ Point-To-Point, EIA 232 (Clause 10), baud rate(s):_____
☐ Point-To-Point, modem, (Clause 10), baud rate(s): _____
☐ LonTalk, (Clause 11), medium: _____
☐ BACnet/Zigbee (Annex O) _____
☐ Other: _____

Device Address Binding:

Is static device binding supported? (This is currently necessary for two-way communication with MS/TP slaves and certain other devices.) ☐ Yes ☐ No

Networking Options:

☐ Router, Clause 6 - List all routing configurations, e.g., ARCNET-Ethernet, Ethernet-MS/TP, etc.
☐ Annex H, BACnet Tunneling Router over IP
☐ BACnet/IP Broadcast Management Device (BBMD)
Does the BBMD support registrations by Foreign Devices? ☐ Yes ☐ No
Does the BBMD support network address translation? ☐ Yes ☐ No

Character Sets Supported:

Indicating support for multiple character sets does not imply that they can all be supported simultaneously.

☐ ISO 10646 (UTF-8) ☐ IBM™/Microsoft™ DBCS ☐ ISO 8859-1
☐ ISO 10646 (UCS-2) ☐ ISO 10646 (UCS-4) ☐ JIS X 0208

If this product is a communication gateway, describe the types of non-BACnet equipment/networks(s) that the gateway supports:

_____
_____
_____

Network Security Options:

☐ Non-secure Device - is capable of operating without BACnet Network Security

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☐ Secure Device - is capable of using BACnet Network Security (NS-SD BIBB)
- ☐ Multiple Application-Specific Keys
- ☐ Supports encryption (NS-ED BIBB)
- ☐ Key Server (NS-KS BIBB)

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ANNEX B - GUIDE TO SPECIFYING BACnet DEVICES (INFORMATIVE)

(This annex is not part of this standard but is included for informative purposes only.)

The BIBBs (Annex K) and standardized BACnet device profiles (Annex L) are intended to be a useful tool for people who design, specify, or operate building automation systems that contain BACnet devices. This classification approach is a compromise between two conflicting goals. The first goal is to promote interoperability by limiting the various combinations of BACnet object types and services that can be supported and still conform to this standard. The other goal is to avoid unnecessarily restricting manufacturers of BACnet devices in the sense that they would be required to provide BACnet functionality that would never be used by a device except to meet a conformance requirement. Maximum interoperability would be achieved by requiring all BACnet devices to support exactly the same combination of standard object types and application services. On the other hand, complete flexibility for manufacturers would inevitably lead to such widespread variation in the particular object types and application services that are supported that many devices would only partially interoperate. Interoperability would be limited to the intersection of the application services and object types supported by the devices.

The idea behind the BIBB and device profile model is to combine the portions of the BACnet protocol that are needed to perform particular functions, and to identify those functions that a system designer would expect in a certain type of device. When designing or specifying BACnet devices for an automation system, it is appropriate to specify the device profile that best meets the needs of the application and any additional BIBBs that are also required. Devices can be expected to interoperate with respect to a given BIBB so long as one device implements the A-side functionality and the other device implements the B-side functionality.

A particular manufacturer may decide to build a product that supports more BIBBs than required by its device profile. This can be determined from the PICS.

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ANNEX C - FORMAL DESCRIPTION OF OBJECT TYPE STRUCTURES (INFORMATIVE)

(This annex is not part of this standard but is included for informative purposes only.)

ACCESS-CREDENTIAL ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
description	[28]	CharacterString OPTIONAL,
global-identifier	[323]	Unsigned32,
status-flags	[111]	BACnetStatusFlags,
reliability	[103]	BACnetReliability,
credential-status	[264]	BACnetBinaryPV,
reason-for-disable	[303]	SEQUENCE OF BACnetAccessCredentialDisableReason,
authentication-factors	[257]	SEQUENCE OF BACnetCredentialAuthenticationFactor, -- accessed as a BACnetARRAY
activation-time	[254]	BACnetDateTime,
expiry-time	[270]	BACnetDateTime ,
credential-disable	[263]	BACnetAccessCredentialDisable,
days-remaining	[267]	INTEGER OPTIONAL,
uses-remaining	[319]	INTEGER OPTIONAL,
absentee-limit	[244]	Unsigned OPTIONAL,
belongs-to	[262]	BACnetDeviceObjectReference OPTIONAL,
assigned-access-rights	[256]	SEQUENCE OF BACnetAssignedAccessRights, -- accessed as a BACnetARRAY
last-access-point	[276]	BACnetDeviceObjectReference OPTIONAL,
last-access-event	[275]	BACnetAccessEvent OPTIONAL,
last-use-time	[281]	BACnetDateTime OPTIONAL,
trace-flag	[308]	BOOLEAN OPTIONAL,
threat-authority	[306]	BACnetAccessThreatLevel OPTIONAL,
extended-time-enable	[271]	BOOLEAN OPTIONAL,
master-exemption	[284]	BOOLEAN OPTIONAL,
passback-exemption	[290]	BOOLEAN OPTIONAL,
occupancy-exemption	[293]	BOOLEAN OPTIONAL,
profile-name	[168]	CharacterString OPTIONAL

}

ACCESS-DOOR ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
present-value	[85]	BACnetDoorValue,
description	[28]	CharacterString OPTIONAL,
status-flags	[111]	BACnetStatusFlags,
event-state	[36]	BACnetEventState,
reliability	[103]	BACnetReliability,
out-of-service	[81]	BOOLEAN,
priority-array	[87]	BACnetPriorityArray,
relinquish-default	[104]	BACnetDoorValue,
door-status	[231]	BACnetDoorStatus OPTIONAL,
lock-status	[233]	BACnetLockStatus OPTIONAL,
secured-status	[235]	BACnetDoorSecuredStatus OPTIONAL,
door-members	[228]	SEQUENCE OF BACnetDeviceObjectReference OPTIONAL, --accessed as a BACnetARRAY
door-pulse-time	[230]	Unsigned,

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door-extended-pulse-time	[227]	Unsigned,
door-unlock-delay-time	[232]	Unsigned OPTIONAL,
door-open-too-long-time	[229]	Unsigned,
door-alarm-state	[226]	BACnetDoorAlarmState OPTIONAL,
masked-alarm-values	[234]	SEQUENCE OF BACnetDoorAlarmState OPTIONAL,
maintenance-required	[158]	BACnetMaintenance OPTIONAL,
time-delay	[113]	Unsigned OPTIONAL,
notification-class	[17]	Unsigned OPTIONAL,
alarm-values	[7]	SEQUENCE OF BACnetDoorAlarmState OPTIONAL,
fault-values	[39]	SEQUENCE OF BACnetDoorAlarmState OPTIONAL,
event-enable	[35]	BACnetEventTransitionBits OPTIONAL,
acked-transitions	[0]	BACnetEventTransitionBits OPTIONAL,
notify-type	[72]	BACnetNotifyType OPTIONAL,
event-time-stamps	[130]	SEQUENCE OF BACnetTimeStamp OPTIONAL, --accessed as a BACnetARRAY
event-message-texts	[351]	SEQUENCE SIZE(3) OF CharacterString OPTIONAL, -- accessed as a BACnetARRAY
profile-name	[168]	CharacterString OPTIONAL

}

ACCESS-POINT ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
description	[28]	CharacterString OPTIONAL,
status-flags	[111]	BACnetStatusFlags,
event-state	[36]	BACnetEventState,
reliability	[103]	BACnetReliability,
out-of-service	[81]	BOOLEAN,
authentication-status	[260]	BACnetAuthenticationStatus,
active-authentication-policy	[255]	Unsigned,
number-of-authentication-policies	[289]	Unsigned,
authentication-policy-list	[258]	SEQUENCE OF BACnetAuthenticationPolicy OPTIONAL, -- accessed as a BACnetARRAY
authentication-policy-names	[259]	SEQUENCE OF CharacterString OPTIONAL, -- accessed as a BACnetARRAY
authorization-mode	[261]	BACnetAuthorizationMode,
verification-time	[326]	Unsigned OPTIONAL,
lockout	[282]	BOOLEAN OPTIONAL,
lockout-relinquish-time	[283]	Unsigned OPTIONAL,
failed-attempts	[273]	Unsigned OPTIONAL,
failed-attempt-events	[272]	SEQUENCE OF BACnetAccessEvent OPTIONAL,
max-failed-attempts	[285]	Unsigned OPTIONAL,
failed-attempts-time	[274]	Unsigned OPTIONAL,
threat-level	[307]	BACnetAccessThreatLevel OPTIONAL,
occupancy-upper-limit-enforced	[298]	BOOLEAN OPTIONAL,
occupancy-lower-limit-enforced	[295]	BOOLEAN OPTIONAL,
occupancy-count-adjust	[291]	BOOLEAN OPTIONAL,
accompaniment-time	[253]	Unsigned OPTIONAL,
access-event	[247]	BACnetAccessEvent,
access-event-tag	[322]	Unsigned,
access-event-time	[250]	BACnetTimeStamp,
access-event-credential	[249]	BACnetDeviceObjectReference,
access-event-authentication-factor	[248]	BACnetAuthenticationFactor OPTIONAL,
access-doors	[246]	SEQUENCE OF BACnetDeviceObjectReference, -- accessed as a BACnetARRAY

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```
        priority-for-writing            [88]    Unsigned(1..16),
        muster-point                    [287]   BOOLEAN OPTIONAL,
        zone-to                         [321]   BACnetDeviceObjectReference OPTIONAL,
        zone-from                       [320]   BACnetDeviceObjectReference OPTIONAL,
        notification-class              [17]    Unsigned OPTIONAL,
        transaction-notification-class  [309]   Unsigned OPTIONAL,
        access-alarm-events             [245]   SEQUENCE OF BACnetAccessEvent OPTIONAL,
        access-transaction-events       [251]   SEQUENCE OF  BACnetAccessEvent OPTIONAL,
        event-enable                    [35]    BACnetEventTransitionBits OPTIONAL,
        acked-transitions               [0]     BACnetEventTransitionBits OPTIONAL,
        notify-type                     [72]    BACnetNotifyType OPTIONAL,
        event-time-stamps               [130]   SEQUENCE OF BACnetTimeStamp OPTIONAL,
                                                -- accessed as a BACnetARRAY
        event-message-texts             [351]   SEQUENCE SIZE(3) OF CharacterString OPTIONAL,
                                                -- accessed as a BACnetARRAY
        profile-name                    [168]   CharacterString    OPTIONAL
}

ACCESS-RIGHTS ::= SEQUENCE {
        object-identifier               [75]    BACnetObjectIdentifier,
        object-name                     [77]    CharacterString,
        object-type                     [79]    BACnetObjectType,
        description                     [28]    CharacterString OPTIONAL,
        global-identifier               [323]   Unsigned32,
        status-flags                    [111]   BACnetStatusFlags,
        reliability                     [103]   BACnetReliability,
        enable                          [133]   BOOLEAN,
        negative-access-rules           [288]   SEQUENCE OF BACnetAccessRule,
                                                -- accessed as a BACnetARRAY
        positive-access-rules           [302]   SEQUENCE OF BACnetAccessRule,
                                                -- accessed as a BACnetARRAY
        accompaniment                   [252]   BACnetDeviceObjectReference OPTIONAL,
        profile-name                    [168]   CharacterString OPTIONAL
}

ACCESS-USER ::= SEQUENCE {
        object-identifier               [75]    BACnetObjectIdentifier,
        object-name                     [77]    CharacterString,
        object-type                     [79]    BACnetObjectType,
        description                     [28]    CharacterString OPTIONAL,
        global-identifier               [323]   Unsigned32,
        status-flags                    [111]   BACnetStatusFlags,
        reliability                     [103]   BACnetReliability,
        user-type                       [318]   BACnetAccessUserType,
        user-name                       [317]   CharacterString OPTIONAL,
        user-external-identifier        [310]   CharacterString OPTIONAL,
        user-information-reference      [311]   CharacterString OPTIONAL,
        members                         [286]   SEQUENCE OF BACnetDeviceObjectReference OPTIONAL,
        member-of                       [159]   SEQUENCE OF BACnetDeviceObjectReference OPTIONAL,
        credentials                     [265]   SEQUENCE OF BACnetDeviceObjectReference,
        profile-name                    [168]   CharacterString OPTIONAL
}
```

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ACCESS-ZONE ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
description	[28]	CharacterString OPTIONAL,
global-identifier	[323]	Unsigned32,
occupancy-state	[296]	BACnetAccessZoneOccupancyState,
status-flags	[111]	BACnetStatusFlags,
event-state	[36]	BACnetEventState,
reliability	[103]	BACnetReliability,
out-of-service	[81]	BOOLEAN,
occupancy-count	[290]	Unsigned OPTIONAL,
occupancy-count-enable	[292]	BOOLEAN OPTIONAL,
adjust-value	[176]	INTEGER OPTIONAL,
occupancy-upper-limit	[297]	Unsigned OPTIONAL,
occupancy-lower-limit	[294]	Unsigned OPTIONAL,
credentials-in-zone	[266]	SEQUENCE OF BACnetDeviceObjectReference OPTIONAL,
last-credential-added	[277]	BACnetDeviceObjectReference OPTIONAL,
last-credential-added-time	[278]	BACnetDateTime OPTIONAL,
last-credential-removed	[279]	BACnetDeviceObjectReference OPTIONAL,
last-credential-removed-time	[280]	BACnetDateTime OPTIONAL,
passback-mode	[300]	BACnetAccessPassbackMode OPTIONAL,
passback-timeout	[301]	Unsigned OPTIONAL,
entry-points	[268]	SEQUENCE OF BACnetDeviceObjectReference,
exit-points	[269]	SEQUENCE OF BACnetDeviceObjectReference,
time-delay	[113]	Unsigned OPTIONAL,
notification-class	[17]	Unsigned OPTIONAL,
alarm-values	[7]	SEQUENCE OF BACnetAccessZoneOccupancyState OPTIONAL,
event-enable	[35]	BACnetEventTransitionBits OPTIONAL,
acked-transitions	[0]	BACnetEventTransitionBits OPTIONAL,
notify-type	[72]	BACnetNotifyType OPTIONAL,
event-time-stamps	[130]	SEQUENCE OF BACnetTimeStamp OPTIONAL,
		-- accessed as a BACnetARRAY
event-message-texts	[351]	SEQUENCE SIZE(3) OF CharacterString OPTIONAL,
		-- accessed as a BACnetARRAY
profile-name	[168]	CharacterString OPTIONAL

}

ACCUMULATOR ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
present-value	[85]	Unsigned,
description	[28]	CharacterString OPTIONAL,
device-type	[31]	CharacterString OPTIONAL,
status-flags	[111]	BACnetStatusFlags,
event-state	[36]	BACnetEventState,
reliability	[103]	BACnetReliability OPTIONAL,
out-of-service	[81]	BOOLEAN,
scale	[187]	BACnetScale,
units	[117]	BACnetEngineeringUnits,
prescale	[185]	BACnetPrescale OPTIONAL,
max-pres-value	[65]	Unsigned,
value-change-time	[192]	BACnetDateTime OPTIONAL,
value-before-change	[190]	Unsigned OPTIONAL,

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```
        value-set                   [191]   Unsigned OPTIONAL,
        logging-record              [184]   BACnetAccumulatorRecord OPTIONAL,
        logging-object              [183]   BACnetObjectIdentifier OPTIONAL,
        pulse-rate                  [186]   Unsigned OPTIONAL,
        high-limit                  [45]    Unsigned OPTIONAL,
        low-limit                   [59]    Unsigned OPTIONAL,
        limit-monitoring-interval   [182]   Unsigned OPTIONAL,
        notification-class          [17]    Unsigned OPTIONAL,
        time-delay                  [113]   Unsigned OPTIONAL,
        limit-enable                [52]    BACnetLimitEnable OPTIONAL,
        event-enable                [35]    BACnetEventTransitionBits OPTIONAL,
        acked-transitions           [0]     BACnetEventTransitionBits OPTIONAL,
        notify-type                 [72]    BACnetNotifyType OPTIONAL,
        event-time-stamps           [130]   SEQUENCE OF BACnetTimeStamp OPTIONAL,
                                            -- accessed as a BACnetARRAY
        event-message-texts         [351]   SEQUENCE SIZE(3) OF CharacterString OPTIONAL,
                                            -- accessed as a BACnetARRAY
        profile-name                [168]   CharacterString OPTIONAL
        }

ANALOG-INPUT ::= SEQUENCE {
        object-identifier           [75]    BACnetObjectIdentifier,
        object-name                 [77]    CharacterString,
        object-type                 [79]    BACnetObjectType,
        present-value               [85]    REAL,
        description                 [28]    CharacterString OPTIONAL,
        device-type                 [31]    CharacterString OPTIONAL,
        status-flags                [111]   BACnetStatusFlags,
        event-state                 [36]    BACnetEventState,
        reliability                 [103]   BACnetReliability OPTIONAL,
        out-of-service              [81]    BOOLEAN,
        update-interval             [118]   Unsigned OPTIONAL,
        units                       [117]   BACnetEngineeringUnits,
        min-pres-value              [69]    REAL OPTIONAL,
        max-pres-value              [65]    REAL OPTIONAL,
        resolution                  [106]   REAL OPTIONAL,
        cov-increment               [22]    REAL OPTIONAL,
        time-delay                  [113]   Unsigned OPTIONAL,
        notification-class          [17]    Unsigned OPTIONAL,
        high-limit                  [45]    REAL OPTIONAL,
        low-limit                   [59]    REAL OPTIONAL,
        deadband                    [25]    REAL OPTIONAL,
        limit-enable                [52]    BACnetLimitEnable OPTIONAL,
        event-enable                [35]    BACnetEventTransitionBits OPTIONAL,
        acked-transitions           [0]     BACnetEventTransitionBits OPTIONAL,
        notify-type                 [72]    BACnetNotifyType OPTIONAL,
        event-time-stamps           [130]   SEQUENCE OF BACnetTimeStamp OPTIONAL,
                                            -- accessed as a BACnetARRAY
        event-message-texts         [351]   SEQUENCE SIZE(3) OF CharacterString OPTIONAL,
                                            -- accessed as a BACnetARRAY
        profile-name                [168]   CharacterString OPTIONAL
        }

ANALOG-OUTPUT ::= SEQUENCE {
        object-identifier           [75]    BACnetObjectIdentifier,
        object-name                 [77]    CharacterString,
```

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```
    object-type                 [79]    BACnetObjectType,
    present-value               [85]    REAL,
    description                 [28]    CharacterString OPTIONAL,
    device-type                 [31]    CharacterString OPTIONAL,
    status-flags                [111]   BACnetStatusFlags,
    event-state                 [36]    BACnetEventState,
    reliability                 [103]   BACnetReliability OPTIONAL,
    out-of-service              [81]    BOOLEAN,
    units                       [117]   BACnetEngineeringUnits,
    min-pres-value              [69]    REAL OPTIONAL,
    max-pres-value              [65]    REAL OPTIONAL,
    resolution                  [106]   REAL OPTIONAL,
    priority-array              [87]    BACnetPriorityArray,
    relinquish-default          [104]   REAL,
    cov-increment               [22]    REAL OPTIONAL,
    time-delay                  [113]   Unsigned OPTIONAL,
    notification-class          [17]    Unsigned OPTIONAL,
    high-limit                  [45]    REAL OPTIONAL,
    low-limit                   [59]    REAL OPTIONAL,
    deadband                    [25]    REAL OPTIONAL,
    limit-enable                [52]    BACnetLimitEnable OPTIONAL,
    event-enable                [35]    BACnetEventTransitionBits OPTIONAL,
    acked-transitions           [0]     BACnetEventTransitionBits OPTIONAL,
    notify-type                 [72]    BACnetNotifyType OPTIONAL,
    event-time-stamps           [130]   SEQUENCE OF BACnetTimeStamp OPTIONAL,
                                        -- accessed as a BACnetARRAY
    event-message-texts         [351]   SEQUENCE SIZE(3) OF CharacterString OPTIONAL,
                                        -- accessed as a BACnetARRAY
    profile-name                [168]   CharacterString OPTIONAL
    }

ANALOG-VALUE ::= SEQUENCE {
    object-identifier           [75]    BACnetObjectIdentifier,
    object-name                 [77]    CharacterString,
    object-type                 [79]    BACnetObjectType,
    present-value               [85]    REAL,
    description                 [28]    CharacterString OPTIONAL,
    status-flags                [111]   BACnetStatusFlags,
    event-state                 [36]    BACnetEventState,
    reliability                 [103]   BACnetReliability OPTIONAL,
    out-of-service              [81]    BOOLEAN,
    units                       [117]   BACnetEngineeringUnits,
    priority-array              [87]    BACnetPriorityArray OPTIONAL,
    relinquish-default          [104]   REAL OPTIONAL,
    cov-increment               [22]    REAL OPTIONAL,
    time-delay                  [113]   Unsigned OPTIONAL,
    notification-class          [17]    Unsigned OPTIONAL,
    high-limit                  [45]    REAL OPTIONAL,
    low-limit                   [59]    REAL OPTIONAL,
    deadband                    [25]    REAL OPTIONAL,
    limit-enable                [52]    BACnetLimitEnable OPTIONAL,
    event-enable                [35]    BACnetEventTransitionBits OPTIONAL,
    acked-transitions           [0]     BACnetEventTransitionBits OPTIONAL,
    notify-type                 [72]    BACnetNotifyType OPTIONAL,
    event-time-stamps           [130]   SEQUENCE OF BACnetTimeStamp OPTIONAL,
                                        -- accessed as a BACnetARRAY
```

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```
        event-message-texts         [351]   SEQUENCE SIZE(3) OF CharacterString OPTIONAL,
                                            -- accessed as a BACnetARRAY
        profile-name                [168]   CharacterString OPTIONAL
        }

    AVERAGING ::= SEQUENCE {
        object-identifier           [75]    BACnetObjectIdentifier,
        object-name                 [77]    CharacterString,
        object-type                 [79]    BACnetObjectType,
        minimum-value               [136]   REAL,
        minimum-value-timestamp     [150]   BACnetDateTime OPTIONAL,
        average-value               [125]   REAL,
        variance-value              [151]   REAL OPTIONAL,
        maximum-value               [135]   REAL,
        maximum-value-timestamp     [149]   BACnetDateTime OPTIONAL,
        description                 [28]    CharacterString OPTIONAL,
        attempted-samples           [124]   Unsigned,
        valid-samples               [146]   Unsigned,
        object-property-reference   [78]    BACnetDeviceObjectPropertyReference,
        window-interval             [147]   Unsigned,
        window-samples              [148]   Unsigned,
        profile-name                [168]   CharacterString OPTIONAL
        }

    BINARY-INPUT ::= SEQUENCE {
        object-identifier           [75]    BACnetObjectIdentifier,
        object-name                 [77]    CharacterString,
        object-type                 [79]    BACnetObjectType,
        present-value               [85]    BACnetBinaryPV,
        description                 [28]    CharacterString OPTIONAL,
        device-type                 [31]    CharacterString OPTIONAL,
        status-flags                [111]   BACnetStatusFlags,
        event-state                 [36]    BACnetEventState,
        reliability                 [103]   BACnetReliability OPTIONAL,
        out-of-service              [81]    BOOLEAN,
        polarity                    [84]    BACnetPolarity,
        inactive-text               [46]    CharacterString OPTIONAL,
        active-text                 [4]     CharacterString OPTIONAL,
        change-of-state-time        [16]    BACnetDateTime OPTIONAL,
        change-of-state-count       [15]    Unsigned OPTIONAL,
        time-of-state-count-reset   [115]   BACnetDateTime OPTIONAL,
        elapsed-active-time         [33]    Unsigned32 OPTIONAL,
        time-of-active-time-reset   [114]   BACnetDateTime OPTIONAL,
        time-delay                  [113]   Unsigned OPTIONAL,
        notification-class          [17]    Unsigned OPTIONAL,
        alarm-value                 [6]     BACnetBinaryPV OPTIONAL,
        event-enable                [35]    BACnetEventTransitionBits OPTIONAL,
        acked-transitions           [0]     BACnetEventTransitionBits OPTIONAL,
        notify-type                 [72]    BACnetNotifyType OPTIONAL,
        event-time-stamps           [130]   SEQUENCE OF BACnetTimeStamp OPTIONAL,
                                            -- accessed as a BACnetARRAY
        event-message-texts         [351]   SEQUENCE SIZE(3) OF CharacterString OPTIONAL,
                                            -- accessed as a BACnetARRAY
        profile-name                [168]   CharacterString OPTIONAL
        }
```

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BINARY-OUTPUT ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
present-value	[85]	BACnetBinaryPV,
description	[28]	CharacterString OPTIONAL,
device-type	[31]	CharacterString OPTIONAL,
status-flags	[111]	BACnetStatusFlags,
event-state	[36]	BACnetEventState,
reliability	[103]	BACnetReliability OPTIONAL,
out-of-service	[81]	BOOLEAN,
polarity	[84]	BACnetPolarity,
inactive-text	[46]	CharacterString OPTIONAL,
active-text	[4]	CharacterString OPTIONAL,
change-of-state-time	[16]	BACnetDateTime OPTIONAL,
change-of-state-count	[15]	Unsigned OPTIONAL,
time-of-state-count-reset	[115]	BACnetDateTime OPTIONAL,
elapsed-active-time	[33]	Unsigned32 OPTIONAL,
time-of-active-time-reset	[114]	BACnetDateTime OPTIONAL,
minimum-off-time	[66]	Unsigned32 OPTIONAL,
minimum-on-time	[67]	Unsigned32 OPTIONAL,
priority-array	[87]	BACnetPriorityArray,
relinquish-default	[104]	BACnetBinaryPV,
time-delay	[113]	Unsigned OPTIONAL,
notification-class	[17]	Unsigned OPTIONAL,
feedback-value	[40]	BACnetBinaryPV OPTIONAL,
event-enable	[35]	BACnetEventTransitionBits OPTIONAL,
acked-transitions	[0]	BACnetEventTransitionBits OPTIONAL,
notify-type	[72]	BACnetNotifyType OPTIONAL,
event-time-stamps	[130]	SEQUENCE OF BACnetTimeStamp OPTIONAL, -- accessed as a BACnetARRAY
event-message-texts	[351]	SEQUENCE SIZE(3) OF CharacterString OPTIONAL, -- accessed as a BACnetARRAY
profile-name	[168]	CharacterString OPTIONAL

}

BINARY-VALUE ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
present-value	[85]	BACnetBinaryPV,
description	[28]	CharacterString OPTIONAL,
status-flags	[111]	BACnetStatusFlags,
event-state	[36]	BACnetEventState,
reliability	[103]	BACnetReliability OPTIONAL,
out-of-service	[81]	BOOLEAN,
inactive-text	[46]	CharacterString OPTIONAL,
active-text	[4]	CharacterString OPTIONAL,
change-of-state-time	[16]	BACnetDateTime OPTIONAL,
change-of-state-count	[15]	Unsigned OPTIONAL,
time-of-state-count-reset	[115]	BACnetDateTime OPTIONAL,
elapsed-active-time	[33]	Unsigned32 OPTIONAL,
time-of-active-time-reset	[114]	BACnetDateTime OPTIONAL,
minimum-off-time	[66]	Unsigned32 OPTIONAL,
minimum-on-time	[67]	Unsigned32 OPTIONAL,
priority-array	[87]	BACnetPriorityArray OPTIONAL,

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```
        relinquish-default          [104]   BACnetBinaryPV OPTIONAL,
        time-delay                  [113]   Unsigned OPTIONAL,
        notification-class          [17]    Unsigned OPTIONAL,
        alarm-value                 [6]     BACnetBinaryPV OPTIONAL,
        event-enable                [35]    BACnetEventTransitionBits OPTIONAL,
        acked-transitions           [0]     BACnetEventTransitionBits OPTIONAL,
        notify-type                 [72]    BACnetNotifyType OPTIONAL,
        event-time-stamps           [130]   SEQUENCE OF BACnetTimeStamp OPTIONAL,
                                            -- accessed as a BACnetARRAY
        event-message-texts         [351]   SEQUENCE SIZE(3) OF CharacterString OPTIONAL,
                                            -- accessed as a BACnetARRAY
        profile-name                [168]   CharacterString OPTIONAL
        }

BITSTRING-VALUE ::= SEQUENCE {
        object-identifier           [75]    BACnetObjectIdentifier,
        object-name                 [77]    CharacterString,
        object-type                 [79]    BACnetObjectType,
        description                 [28]    CharacterString OPTIONAL,
        present-value               [85]    BIT STRING,
        bit-mask                    [342]   BIT STRING OPTIONAL,
        bit-text                    [343]   SEQUENCE OF CharacterString OPTIONAL,
                                            -- accessed as a BACnetARRAY
        status-flags                [111]   BACnetStatusFlags,
        event-state                 [36]    BACnetEventState OPTIONAL,
        reliability                 [103]   BACnetReliability OPTIONAL,
        out-of-service              [81]    BOOLEAN OPTIONAL,
        priority-array              [87]    BACnetPriorityArray OPTIONAL,
        relinquish-default          [104]   BIT STRING OPTIONAL,
        cov-increment               [22]    BIT STRING OPTIONAL,
        time-delay                  [113]   Unsigned OPTIONAL,
        notification-class          [17]    Unsigned OPTIONAL,
        alarm-values                [6]     SEQUENCE OF BIT STRING OPTIONAL,
                                            -- accessed as a BACnetARRAY
        event-enable                [35]    BACnetEventTransitionBits OPTIONAL,
        acked-transitions           [0]     BACnetEventTransitionBits OPTIONAL,
        notify-type                 [72]    BACnetNotifyType OPTIONAL,
        event-time-stamps           [130]   SEQUENCE OF BACnetTimeStamp OPTIONAL,
                                            -- accessed as a BACnetARRAY
        event-message-texts         [351]   SEQUENCE SIZE(3) OF CharacterString OPTIONAL,
                                            -- accessed as a BACnetARRAY
        profile-name                [168]   CharacterString OPTIONAL
        }

CALENDAR ::= SEQUENCE {
        object-identifier           [75]    BACnetObjectIdentifier,
        object-name                 [77]    CharacterString,
        object-type                 [79]    BACnetObjectType,
        description                 [28]    CharacterString OPTIONAL,
        present-value               [85]    BOOLEAN,
        date-list                   [23]    SEQUENCE OF BACnetCalendarEntry,
        profile-name                [168]   CharacterString OPTIONAL
        }
```

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CHARACTERSTRING-VALUE ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
description	[28]	CharacterString OPTIONAL,
present-value	[85]	CharacterString,
status-flags	[111]	BACnetStatusFlags,
event-state	[36]	BACnetEventState OPTIONAL,
reliability	[103]	BACnetReliability OPTIONAL,
out-of-service	[81]	BOOLEAN OPTIONAL,
time-delay	[113]	Unsigned OPTIONAL,
priority-array	[87]	BACnetPriorityArray OPTIONAL,
relinquish-default	[104]	CharacterString OPTIONAL,
notification-class	[17]	Unsigned OPTIONAL,
alarm-values	[7]	SEQUENCE OF BACnetOptionalCharacterString OPTIONAL, -- accessed as a BACnetARRAY
fault-values	[39]	SEQUENCE OF BACnetOptionalCharacterString OPTIONAL, -- accessed as a BACnetARRAY
event-enable	[35]	BACnetEventTransitionBits OPTIONAL,
acked-transitions	[0]	BACnetEventTransitionBits OPTIONAL,
notify-type	[72]	BACnetNotifyType OPTIONAL,
event-time-stamps	[130]	SEQUENCE OF BACnetTimeStamp OPTIONAL, -- accessed as a BACnetARRAY
event-message-texts	[351]	SEQUENCE SIZE(3) OF CharacterString OPTIONAL, -- accessed as a BACnetARRAY
profile-name	[168]	CharacterString OPTIONAL

}

COMMAND ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
description	[28]	CharacterString OPTIONAL,
present-value	[85]	Unsigned,
in-process	[47]	BOOLEAN,
all-writes-successful	[9]	BOOLEAN,
action	[2]	SEQUENCE OF BACnetActionList, -- accessed as a BACnetARRAY
action-text	[3]	SEQUENCE OF CharacterString OPTIONAL, -- accessed as a BACnetARRAY
profile-name	[168]	CharacterString OPTIONAL

}

CREDENTIAL-DATA-INPUT ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
present-value	[85]	BACnetAuthenticationFactor,
description	[28]	CharacterString OPTIONAL,
status-flags	[111]	BACnetStatusFlags,
reliability	[103]	BACnetReliability OPTIONAL,
out-of-service	[81]	BOOLEAN,
supported-formats	[304]	SEQUENCE OF BACnetAuthenticationFactorFormat, -- accessed as BACnetARRAY
supported-format-classes	[305]	SEQUENCE OF Unsigned OPTIONAL, -- accessed as BACnetARRAY

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```
        update-time                 [189]   BACnetTimeStamp,
        profile-name                [168]   CharacterString OPTIONAL
        }

DATE-PATTERN-VALUE ::= SEQUENCE {
        object-identifier           [75]    BACnetObjectIdentifier,
        object-name                 [77]    CharacterString,
        object-type                 [79]    BACnetObjectType,
        description                 [28]    CharacterString OPTIONAL,
        present-value               [85]    Date,
        status-flags                [111]   BACnetStatusFlags,
        event-state                 [36]    BACnetEventState OPTIONAL,
        reliability                 [103]   BACnetReliability OPTIONAL,
        out-of-service              [81]    BOOLEAN OPTIONAL,
        priority-array              [87]    BACnetPriorityArray OPTIONAL,
        relinquish-default          [104]   Date OPTIONAL,
        profile-name                [168]   CharacterString OPTIONAL
        }

DATE-VALUE ::= SEQUENCE {
        object-identifier           [75]    BACnetObjectIdentifier,
        object-name                 [77]    CharacterString,
        object-type                 [79]    BACnetObjectType,
        description                 [28]    CharacterString OPTIONAL,
        present-value               [85]    Date,
        status-flags                [111]   BACnetStatusFlags,
        event-state                 [36]    BACnetEventState OPTIONAL,
        reliability                 [103]   BACnetReliability OPTIONAL,
        out-of-service              [81]    BOOLEAN OPTIONAL,
        priority-array              [87]    BACnetPriorityArray OPTIONAL,
        relinquish-default          [104]   Date OPTIONAL,
        profile-name                [168]   CharacterString OPTIONAL
        }

DATETIME-PATTERN-VALUE ::= SEQUENCE {
        object-identifier           [75]    BACnetObjectIdentifier,
        object-name                 [77]    CharacterString,
        object-type                 [79]    BACnetObjectType,
        description                 [28]    CharacterString OPTIONAL,
        present-value               [85]    BACnetDateTime,
        status-flags                [111]   BACnetStatusFlags,
        event-state                 [36]    BACnetEventState OPTIONAL,
        reliability                 [103]   BACnetReliability OPTIONAL,
        out-of-service              [81]    BOOLEAN OPTIONAL,
        priority-array              [87]    BACnetPriorityArray OPTIONAL,
        relinquish-default          [104]   BACnetDateTime OPTIONAL,
        is-utc                      [344]   BOOLEAN,
        profile-name                [168]   CharacterString OPTIONAL
        }

DATETIME-VALUE ::= SEQUENCE {
        object-identifier           [75]    BACnetObjectIdentifier,
        object-name                 [77]    CharacterString,
        object-type                 [79]    BACnetObjectType,
        description                 [28]    CharacterString OPTIONAL,
        present-value               [85]    BACnetDateTime,
```

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```
    status-flags                    [111]   BACnetStatusFlags,
    event-state                     [36]    BACnetEventState OPTIONAL,
    reliability                     [103]   BACnetReliability OPTIONAL,
    out-of-service                  [81]    BOOLEAN OPTIONAL,
    priority-array                  [87]    BACnetPriorityArray OPTIONAL,
    relinquish-default              [104]   BACnetDateTime OPTIONAL,
    is-utc                          [344]   BOOLEAN,
    profile-name                    [168]   CharacterString OPTIONAL
    }

DEVICE ::= SEQUENCE {
    object-identifier               [75]    BACnetObjectIdentifier,
    object-name                     [77]    CharacterString,
    object-type                     [79]    BACnetObjectType,
    system-status                   [112]   BACnetDeviceStatus,
    vendor-name                     [121]   CharacterString,
    vendor-identifier               [120]   Unsigned16,
    model-name                      [70]    CharacterString,
    firmware-revision               [44]    CharacterString,
    application-software-version    [12]    CharacterString,
    location                        [58]    CharacterString OPTIONAL,
    description                     [28]    CharacterString OPTIONAL,
    protocol-version                [98]    Unsigned,
    protocol-revision               [139]   Unsigned,
    protocol-services-supported     [97]    BACnetServicesSupported,
    protocol-object-types-supported [96]    BACnetObjectTypesSupported,
    object-list                     [76]    SEQUENCE OF BACnetObjectIdentifier,
                                            -- accessed as a BACnetARRAY
    structured-object-list          [209]   SEQUENCE OF BACnetObjectIdentifier OPTIONAL,
                                            -- accessed as a BACnetARRAY
    max-apdu-length-accepted        [62]    Unsigned,
    segmentation-supported          [107]   BACnetSegmentation,
    vt-classes-supported            [122]   SEQUENCE OF BACnetVTClass OPTIONAL,
    active-vt-sessions              [5]     SEQUENCE OF BACnetVTSession OPTIONAL,
    local-time                      [57]    Time OPTIONAL,
    local-date                      [56]    Date OPTIONAL,
    utc-offset                      [119]   INTEGER OPTIONAL,
    daylight-savings-status         [24]    BOOLEAN OPTIONAL,
    apdu-segment-timeout            [10]    Unsigned OPTIONAL,
    apdu-timeout                    [11]    Unsigned,
    number-of-apdu-retries          [73]    Unsigned,
    time-synchronization-recipients [116]   SEQUENCE OF BACnetRecipient OPTIONAL,
    max-master                      [64]    Unsigned(1..127) OPTIONAL,
                                            -- required for MS/TP master, see 12.11
    max-info-frames                 [63]    Unsigned OPTIONAL,
                                            -- required for MS/TP master, see 12.11
    device-address-binding          [30]    SEQUENCE OF BACnetAddressBinding,
    database-revision               [155]   Unsigned,
    configuration-files             [154]   SEQUENCE OF BACnetObjectIdentifier OPTIONAL,
                                            -- accessed as a BACnetARRAY
    last-restore-time               [157]   BACnetTimeStamp OPTIONAL,
    backup-failure-timeout          [153]   Unsigned16 OPTIONAL,
    backup-preparation-time         [339]   Unsigned16 OPTIONAL,
    restore-preparation-time        [341]   Unsigned16 OPTIONAL,
    restore-completion-time         [340]   Unsigned16 OPTIONAL,
    backup-and-restore-state        [338]   BACnetBackupState OPTIONAL,
```

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```
        active-cov-subscriptions            [152]   SEQUENCE OF BACnetCOVSubscription OPTIONAL,
        max-segments-accepted               [167]   Unsigned OPTIONAL,
        slave-proxy-enable                  [172]   SEQUENCE OF BOOLEAN OPTIONAL,
                                                    -- accessed as a BACnetARRAY
        auto-slave-discovery                [169]   SEQUENCE OF BOOLEAN OPTIONAL,
                                                    -- accessed as a BACnetARRAY
        slave-address-binding               [171]   SEQUENCE OF BACnetAddressBinding OPTIONAL,
        manual-slave-address-binding        [170]   SEQUENCE OF BACnetAddressBinding OPTIONAL,
        profile-name                        [168]   CharacterString OPTIONAL,
        last-restart-reason                 [196]   BACnetRestartReason OPTIONAL,
        time-of-device-restart              [203]   BACnetTimeStamp OPTIONAL,
        restart-notification-recipients     [202]   SEQUENCE OF BACnetRecipient OPTIONAL,
        utc-time-synchronization-recipients [206]   SEQUENCE OF BACnetRecipient OPTIONAL,
        time-synchronization-interval       [204]   Unsigned OPTIONAL,
        align-intervals                     [193]   BOOLEAN OPTIONAL,
        interval-offset                     [195]   Unsigned OPTIONAL
        }

EVENT-ENROLLMENT ::= SEQUENCE {
        object-identifier                   [75]    BACnetObjectIdentifier,
        object-name                         [77]    CharacterString,
        object-type                         [79]    BACnetObjectType,
        description                         [28]    CharacterString OPTIONAL,
        event-type                          [37]    BACnetEventType,
        notify-type                         [72]    BACnetNotifyType,
        event-parameters                    [83]    BACnetEventParameter,
        object-property-reference           [78]    BACnetDeviceObjectPropertyReference,
        event-state                         [36]    BACnetEventState,
        event-enable                        [35]    BACnetEventTransitionBits,
        acked-transitions                   [0]     BACnetEventTransitionBits,
        notification-class                  [17]    Unsigned,
        event-time-stamps                   [130]   SEQUENCE OF BACnetTimeStamp,
                                                    -- accessed as a BACnetARRAY
        event-message-texts                 [351]   SEQUENCE SIZE(3) OF CharacterString OPTIONAL,
                                                    -- accessed as a BACnetARRAY
        profile-name                        [168]   CharacterString OPTIONAL
        }

EVENT-LOG ::= SEQUENCE {
        object-identifier                   [75]    BACnetObjectIdentifier,
        object-name                         [77]    CharacterString,
        object-type                         [79]    BACnetObjectType,
        description                         [28]    CharacterString OPTIONAL,
        status-flags                        [111]   BACnetStatusFlags,
        event-state                         [36]    BACnetEventState,
        reliability                         [103]   BACnetReliability OPTIONAL,
        enable                              [133]   BOOLEAN,
        start-time                          [142]   BACnetDateTime OPTIONAL,
        stop-time                           [143]   BACnetDateTime OPTIONAL,
        stop-when-full                      [144]   BOOLEAN,
        buffer-size                         [126]   Unsigned32,
        log-buffer                          [131]   SEQUENCE OF BACnetEventLogRecord,
        record-count                        [141]   Unsigned32,
        total-record-count                  [145]   Unsigned32,
        notification-threshold              [137]   Unsigned32 OPTIONAL,
        records-since-notification          [140]   Unsigned32 OPTIONAL,
```

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last-notify-record	[173]	Unsigned32 OPTIONAL,
notification-class	[17]	Unsigned OPTIONAL,
event-enable	[35]	BACnetEventTransitionBits OPTIONAL,
acked-transitions	[0]	BACnetEventTransitionBits OPTIONAL,
notify-type	[72]	BACnetNotifyType OPTIONAL,
event-time-stamps	[130]	SEQUENCE OF BACnetTimeStamp OPTIONAL, --accessed as a BACnetARRAY
event-message-texts	[351]	SEQUENCE SIZE(3) OF CharacterString OPTIONAL, -- accessed as a BACnetARRAY
profile-name	[168]	CharacterString OPTIONAL

}

FILE ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
description	[28]	CharacterString OPTIONAL,
file-type	[43]	CharacterString,
file-size	[42]	Unsigned,
modification-date	[71]	BACnetDateTime,
archive	[13]	BOOLEAN,
read-only	[99]	BOOLEAN,
file-access-method	[41]	BACnetFileAccessMethod,
record-count	[141]	Unsigned OPTIONAL,
profile-name	[168]	CharacterString OPTIONAL

}

GLOBAL-GROUP ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
description	[28]	CharacterString OPTIONAL,
group-members	[345]	SEQUENCE OF BACnetDeviceObjectPropertyReference, -- accessed as a BACnetARRAY,
group-member-names	[346]	SEQUENCE OF CharacterString, OPTIONAL, -- accessed as a BACnetARRAY,
present-value	[85]	SEQUENCE OF BACnetPropertyAccessResult, -- accessed as a BACnetARRAY,
status-flags	[111]	BACnetStatusFlags,
event-state	[36]	BACnetEventState,
member-status-flags	[347]	BACnetStatusFlags,
reliability	[103]	BACnetReliability OPTIONAL,
out-of-service	[81]	BOOLEAN,
update-interval	[118]	Unsigned OPTIONAL,
requested-update-interval	[348]	Unsigned OPTIONAL,
cov-resubscription-interval	[128]	Unsigned OPTIONAL,
client-cov-increment	[127]	BACnetClientCOV OPTIONAL,
time-delay	[113]	Unsigned OPTIONAL,
notification-class	[17]	Unsigned OPTIONAL,
event-enable	[35]	BACnetEventTransitionBits OPTIONAL,
acked-transitions	[0]	BACnetEventTransitionBits OPTIONAL,
notify-type	[72]	BACnetNotifyType OPTIONAL,
event-time-stamps	[130]	SEQUENCE OF BACnetTimeStamp OPTIONAL, -- accessed as a BACnetARRAY
event-message-texts	[351]	SEQUENCE SIZE(3) OF CharacterString OPTIONAL, -- accessed as a BACnetARRAY

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```
        covu-period                 [349]   Unsigned OPTIONAL,
        covu-recipients             [350]   SEQUENCE OF BACnetRecipient OPTIONAL,
        profile-name                [168]   CharacterString OPTIONAL
        }

GROUP ::= SEQUENCE {
        object-identifier           [75]    BACnetObjectIdentifier,
        object-name                 [77]    CharacterString,
        object-type                 [79]    BACnetObjectType,
        description                 [28]    CharacterString OPTIONAL,
        list-of-group-members       [53]    SEQUENCE OF ReadAccessSpecification,
        present-value               [85]    SEQUENCE OF ReadAccessResult,
        profile-name                [168]   CharacterString OPTIONAL
        }

INTEGER-VALUE ::= SEQUENCE {
        object-identifier           [75]    BACnetObjectIdentifier,
        object-name                 [77]    CharacterString,
        object-type                 [79]    BACnetObjectType,
        description                 [28]    CharacterString OPTIONAL,
        present-value               [85]    INTEGER,
        status-flags                [111]   BACnetStatusFlags,
        event-state                 [36]    BACnetEventState OPTIONAL,
        reliability                 [103]   BACnetReliability OPTIONAL,
        out-of-service              [81]    BOOLEAN OPTIONAL,
        units                       [117]   BACnetEngineeringUnits,
        priority-array              [87]    BACnetPriorityArray OPTIONAL,
        relinquish-default          [104]   INTEGER OPTIONAL,
        cov-increment               [22]    Unsigned OPTIONAL,
        time-delay                  [113]   Unsigned OPTIONAL,
        notification-class          [17]    Unsigned OPTIONAL,
        high-limit                  [45]    INTEGER OPTIONAL,
        low-limit                   [59]    INTEGER OPTIONAL,
        deadband                    [25]    Unsigned OPTIONAL,
        limit-enable                [52]    BACnetLimitEnable OPTIONAL,
        event-enable                [35]    BACnetEventTransitionBits OPTIONAL,
        acked-transitions           [0]     BACnetEventTransitionBits OPTIONAL,
        notify-type                 [72]    BACnetNotifyType OPTIONAL,
        event-time-stamps           [130]   SEQUENCE OF BACnetTimeStamp OPTIONAL,
                                            -- accessed as a BACnetARRAY
        event-message-texts         [351]   SEQUENCE SIZE(3) OF CharacterString OPTIONAL,
                                            -- accessed as a BACnetARRAY
        profile-name                [168]   CharacterString OPTIONAL
        }

LARGE-ANALOG-VALUE ::= SEQUENCE {
        object-identifier           [75]    BACnetObjectIdentifier,
        object-name                 [77]    CharacterString,
        object-type                 [79]    BACnetObjectType,
        description                 [28]    CharacterString OPTIONAL,
        present-value               [85]    Double,
        status-flags                [111]    BACnetStatusFlags,
        event-state                 [36]    BACnetEventState OPTIONAL,
        reliability                 [103]   BACnetReliability OPTIONAL,
        out-of-service              [81]    BOOLEAN OPTIONAL,
        units                       [117]   BACnetEngineeringUnits,
```

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priority-array	[87]	BACnetPriorityArray OPTIONAL,
relinquish-default	[104]	Double OPTIONAL,
cov-increment	[22]	Double OPTIONAL,
time-delay	[113]	Unsigned OPTIONAL,
notification-class	[17]	Unsigned OPTIONAL,
high-limit	[45]	Double OPTIONAL,
low-limit	[59]	Double OPTIONAL,
deadband	[25]	Double OPTIONAL,
limit-enable	[52]	BACnetLimitEnable OPTIONAL,
event-enable	[35]	BACnetEventTransitionBits OPTIONAL,
acked-transitions	[0]	BACnetEventTransitionBits OPTIONAL,
notify-type	[72]	BACnetNotifyType OPTIONAL,
event-time-stamps	[130]	SEQUENCE OF BACnetTimeStamp OPTIONAL, -- accessed as a BACnetARRAY
event-message-texts	[351]	SEQUENCE SIZE(3) OF CharacterString OPTIONAL, -- accessed as a BACnetARRAY
profile-name	[168]	CharacterString OPTIONAL

}

LIFE-SAFETY-POINT ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
present-value	[85]	BACnetLifeSafetyState,
tracking-value	[164]	BACnetLifeSafetyState,
description	[28]	CharacterString OPTIONAL,
device-type	[31]	CharacterString OPTIONAL,
status-flags	[111]	BACnetStatusFlags,
event-state	[36]	BACnetEventState,
reliability	[103]	BACnetReliability,
out-of-service	[81]	BOOLEAN,
mode	[160]	BACnetLifeSafetyMode,
accepted-modes	[175]	SEQUENCE OF BACnetLifeSafetyMode,
time-delay	[113]	Unsigned OPTIONAL,
notification-class	[17]	Unsigned OPTIONAL,
life-safety-alarm-values	[166]	SEQUENCE OF BACnetLifeSafetyState OPTIONAL,
alarm-values	[7]	SEQUENCE OF BACnetLifeSafetyState OPTIONAL,
fault-values	[39]	SEQUENCE OF BACnetLifeSafetyState OPTIONAL,
event-enable	[35]	BACnetEventTransitionBits OPTIONAL,
acked-transitions	[0]	BACnetEventTransitionBits OPTIONAL,
notify-type	[72]	BACnetNotifyType OPTIONAL,
event-time-stamps	[130]	SEQUENCE OF BACnetTimeStamp OPTIONAL, --accessed as a BACnetARRAY
event-message-texts	[351]	SEQUENCE SIZE(3) OF CharacterString OPTIONAL, -- accessed as a BACnetARRAY
silenced	[163]	BACnetSilencedState,
operation-expected	[161]	BACnetLifeSafetyOperation,
maintenance-required	[158]	BACnetMaintenance OPTIONAL,
setting	[162]	Unsigned8 OPTIONAL,
direct-reading	[156]	REAL OPTIONAL,
units	[117]	BACnetEngineeringUnits OPTIONAL,
member-of	[159]	SEQUENCE OF BACnetDeviceObjectReference OPTIONAL,
profile-name	[168]	CharacterString OPTIONAL

}

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LIFE-SAFETY-ZONE ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
present-value	[85]	BACnetLifeSafetyState,
tracking-value	[164]	BACnetLifeSafetyState,
description	[28]	CharacterString OPTIONAL,
device-type	[31]	CharacterString OPTIONAL,
status-flags	[111]	BACnetStatusFlags,
event-state	[36]	BACnetEventState,
reliability	[103]	BACnetReliability,
out-of-service	[81]	BOOLEAN,
mode	[160]	BACnetLifeSafetyMode,
accepted-modes	[175]	SEQUENCE OF BACnetLifeSafetyMode,
time-delay	[113]	Unsigned OPTIONAL,
notification-class	[17]	Unsigned OPTIONAL,
life-safety-alarm-values	[166]	SEQUENCE OF BACnetLifeSafetyState OPTIONAL,
alarm-values	[7]	SEQUENCE OF BACnetLifeSafetyState OPTIONAL,
fault-values	[39]	SEQUENCE OF BACnetLifeSafetyState OPTIONAL,
event-enable	[35]	BACnetEventTransitionBits OPTIONAL,
acked-transitions	[0]	BACnetEventTransitionBits OPTIONAL,
notify-type	[72]	BACnetNotifyType OPTIONAL,
event-time-stamps	[130]	SEQUENCE OF BACnetTimeStamp OPTIONAL, -- accessed as a BACnetARRAY
event-message-texts	[351]	SEQUENCE SIZE(3) OF CharacterString OPTIONAL, -- accessed as a BACnetARRAY
silenced	[163]	BACnetSilencedState,
operation-expected	[161]	BACnetLifeSafetyOperation,
maintenance-required	[158]	BOOLEAN OPTIONAL,
zone-members	[165]	SEQUENCE OF BACnetDeviceObjectReference,
member-of	[159]	SEQUENCE OF BACnetDeviceObjectReference OPTIONAL,
profile-name	[168]	CharacterString OPTIONAL

}

LOAD-CONTROL ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
description	[28]	CharacterString OPTIONAL,
present-value	[85]	BACnetShedState,
state-description	[222]	CharacterString OPTIONAL,
status-flags	[111]	BACnetStatusFlags,
event-state	[36]	BACnetEventState,
reliability	[103]	BACnetReliability OPTIONAL,
requested-shed-level	[218]	BACnetShedLevel,
start-time	[142]	BACnetDateTime,
shed-duration	[219]	Unsigned,
duty-window	[213]	Unsigned,
enable	[133]	BOOLEAN,
full-duty-baseline	[215]	REAL OPTIONAL,
expected-shed-level	[214]	BACnetShedLevel,
actual-shed-level	[212]	BACnetShedLevel,
shed-levels	[221]	SEQUENCE OF Unsigned, -- accessed as a BACnetARRAY
shed-level-descriptions	[220]	SEQUENCE OF CharacterString, -- accessed as a BACnetARRAY
notification-class	[17]	Unsigned OPTIONAL,
time-delay	[113]	Unsigned OPTIONAL,

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```
        event-enable                    [35]    BACnetEventTransitionBits OPTIONAL,
        acked-transitions               [0]     BACnetEventTransitionBits OPTIONAL,
        notify-type                     [72]    BACnetNotifyType OPTIONAL,
        event-time-stamps               [130]   SEQUENCE OF BACnetTimeStamp OPTIONAL,
                                                -- accessed as a BACnetARRAY
        event-message-texts             [351]   SEQUENCE SIZE(3) OF CharacterString OPTIONAL,
                                                -- accessed as a BACnetARRAY
        profile-name                    [168]   CharacterString OPTIONAL
        }

LOOP ::= SEQUENCE {
        object-identifier               [75]    BACnetObjectIdentifier,
        object-name                     [77]    CharacterString,
        object-type                     [79]    BACnetObjectType,
        present-value                   [85]    REAL,
        description                     [28]    CharacterString OPTIONAL,
        status-flags                    [111]   BACnetStatusFlags,
        event-state                     [36]    BACnetEventState,
        reliability                     [103]   BACnetReliability OPTIONAL,
        out-of-service                  [81]    BOOLEAN,
        update-interval                 [118]   Unsigned OPTIONAL,
        output-units                    [82]    BACnetEngineeringUnits,
        manipulated-variable-reference  [60]    BACnetObjectPropertyReference,
        controlled-variable-reference   [19]    BACnetObjectPropertyReference,
        controlled-variable-value       [21]    REAL,
        controlled-variable-units       [20]    BACnetEngineeringUnits,
        setpoint-reference              [109]   BACnetSetpointReference,
        setpoint                        [108]   REAL,
        action                          [2]     BACnetAction,
        proportional-constant           [93]    REAL OPTIONAL,
        proportional-constant-units     [94]    BACnetEngineeringUnits OPTIONAL,
        integral-constant               [49]    REAL OPTIONAL,
        integral-constant-units         [50]    BACnetEngineeringUnits OPTIONAL,
        derivative-constant             [26]    REAL OPTIONAL,
        derivative-constant-units       [27]    BACnetEngineeringUnits OPTIONAL,
        bias                            [14]    REAL OPTIONAL,
        maximum-output                  [61]    REAL OPTIONAL,
        minimum-output                  [68]    REAL OPTIONAL,
        priority-for-writing            [88]    Unsigned (1..16),
        cov-increment                   [22]    REAL OPTIONAL,
        time-delay                      [113]   Unsigned OPTIONAL,
        notification-class              [17]    Unsigned OPTIONAL,
        error-limit                     [34]    REAL OPTIONAL,
        deadband                        [25]    REAL OPTIONAL,
        event-enable                    [35]    BACnetEventTransitionBits OPTIONAL,
        acked-transitions               [0]     BACnetEventTransitionBits OPTIONAL,
        notify-type                     [72]    BACnetNotifyType OPTIONAL,
        event-time-stamps               [130]   SEQUENCE OF BACnetTimeStamp OPTIONAL,
                                                -- accessed as a BACnetARRAY
        event-message-texts             [351]   SEQUENCE SIZE(3) OF CharacterString OPTIONAL,
                                                -- accessed as a BACnetARRAY
        profile-name                    [168]   CharacterString OPTIONAL
        }
```

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MULTI-STATE-INPUT ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
present-value	[85]	Unsigned, -- maximum value is restricted by the number-of-states
description	[28]	CharacterString OPTIONAL,
device-type	[31]	CharacterString OPTIONAL,
status-flags	[111]	BACnetStatusFlags,
event-state	[36]	BACnetEventState,
reliability	[103]	BACnetReliability OPTIONAL,
out-of-service	[81]	BOOLEAN,
number-of-states	[74]	Unsigned,
state-text	[110]	SEQUENCE OF CharacterString OPTIONAL, -- accessed as a BACnetARRAY
time-delay	[113]	Unsigned OPTIONAL,
notification-class	[17]	Unsigned OPTIONAL,
alarm-values	[7]	SEQUENCE OF Unsigned OPTIONAL,
fault-values	[39]	SEQUENCE OF Unsigned OPTIONAL,
event-enable	[35]	BACnetEventTransitionBits OPTIONAL,
acked-transitions	[0]	BACnetEventTransitionBits OPTIONAL,
notify-type	[72]	BACnetNotifyType OPTIONAL,
event-time-stamps	[130]	SEQUENCE OF BACnetTimeStamp OPTIONAL, -- accessed as a BACnetARRAY
event-message-texts	[351]	SEQUENCE SIZE(3) OF CharacterString OPTIONAL, -- accessed as a BACnetARRAY
profile-name	[168]	CharacterString OPTIONAL

}

MULTI-STATE-OUTPUT ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
present-value	[85]	Unsigned, -- maximum value is restricted by the number-of-states
description	[28]	CharacterString OPTIONAL,
device-type	[31]	CharacterString OPTIONAL,
status-flags	[111]	BACnetStatusFlags,
event-state	[36]	BACnetEventState,
reliability	[103]	BACnetReliability OPTIONAL,
out-of-service	[81]	BOOLEAN,
number-of-states	[74]	Unsigned,
state-text	[110]	SEQUENCE OF CharacterString OPTIONAL, -- accessed as a BACnetARRAY
priority-array	[87]	BACnetPriorityArray,
relinquish-default	[104]	Unsigned,
time-delay	[113]	Unsigned OPTIONAL,
notification-class	[17]	Unsigned OPTIONAL,
feedback-value	[40]	Unsigned OPTIONAL,
event-enable	[35]	BACnetEventTransitionBits OPTIONAL,
acked-transitions	[0]	BACnetEventTransitionBits OPTIONAL,
notify-type	[72]	BACnetNotifyType OPTIONAL,
event-time-stamps	[130]	SEQUENCE OF BACnetTimeStamp OPTIONAL, -- accessed as a BACnetARRAY
event-message-texts	[351]	SEQUENCE SIZE(3) OF CharacterString OPTIONAL, -- accessed as a BACnetARRAY
profile-name	[168]	CharacterString OPTIONAL

}

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MULTI-STATE-VALUE ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
present-value	[85]	Unsigned,
		-- maximum value is restricted by the number-of-states
description	[28]	CharacterString OPTIONAL,
status-flags	[111]	BACnetStatusFlags,
event-state	[36]	BACnetEventState,
reliability	[103]	BACnetReliability OPTIONAL,
out-of-service	[81]	BOOLEAN,
number-of-states	[74]	Unsigned,
state-text	[110]	SEQUENCE OF CharacterString OPTIONAL,
		-- accessed as a BACnetARRAY
priority-array	[87]	BACnetPriorityArray OPTIONAL,
relinquish-default	[104]	Unsigned OPTIONAL,
time-delay	[113]	Unsigned OPTIONAL,
notification-class	[17]	Unsigned OPTIONAL,
alarm-values	[7]	SEQUENCE OF Unsigned OPTIONAL,
fault-values	[39]	SEQUENCE OF Unsigned OPTIONAL,
event-enable	[35]	BACnetEventTransitionBits OPTIONAL,
acked-transitions	[0]	BACnetEventTransitionBits OPTIONAL,
notify-type	[72]	BACnetNotifyType OPTIONAL,
event-time-stamps	[130]	SEQUENCE OF BACnetTimeStamp OPTIONAL,
		--accessed as a BACnetARRAY
event-message-texts	[351]	SEQUENCE SIZE(3) OF CharacterString OPTIONAL,
		-- accessed as a BACnetARRAY
profile-name	[168]	CharacterString OPTIONAL

}

NETWORK-SECURITY ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
description	[28]	CharacterString OPTIONAL,
base-device-security-policy	[327]	BACnetSecurityLevel,
network-access-security-policies	[332]	SEQUENCE OF BACnetNetworkSecurityPolicy,
		-- accessed as a BACnetARRAY
security-time-window	[335]	Unsigned,
packet-reorder-time	[333]	Unsigned,
distribution-key-revision	[328]	Unsigned8,
key-sets	[330]	SEQUENCE SIZE(2) OF BACnetSecurityKeySet,
		-- accessed as a BACnetARRAY
last-key-server	[331]	BACnetAddressBinding,
security-pdu-timeout	[334]	Unsigned16,
update-key-set-timeout	[337]	Unsigned16,
supported-security-algorithms	[336]	SEQUENCE OF Unsigned8,
do-not-hide	[329]	BOOLEAN,
profile-name	[168]	CharacterString OPTIONAL

}

NOTIFICATION-CLASS ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,

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```
    description                 [28]    CharacterString OPTIONAL,
    notification-class          [17]    Unsigned,
    priority                    [86]    SEQUENCE SIZE(3) OF Unsigned,
                                        -- accessed as a BACnetARRAY
    ack-required                [1]     BACnetEventTransitionBits,
    recipient-list              [102]   SEQUENCE OF BACnetDestination,
    profile-name                [168]   CharacterString OPTIONAL
    }

OCTETSTRING-VALUE ::= SEQUENCE {
    object-identifier           [75]    BACnetObjectIdentifier,
    object-name                 [77]    CharacterString,
    object-type                 [79]    BACnetObjectType,
    description                 [28]    CharacterString OPTIONAL,
    present-value               [85]    OCTET STRING,
    status-flags                [111]   BACnetStatusFlags,
    event-state                 [36]    BACnetEventState OPTIONAL,
    reliability                 [103]   BACnetReliability OPTIONAL,
    out-of-service              [81]    BOOLEAN OPTIONAL,
    priority-array              [87]    BACnetPriorityArray OPTIONAL,
    relinquish-default          [104]   OCTET STRING OPTIONAL,
    profile-name                [168]   CharacterString OPTIONAL
    }

POSITIVE-INTEGER-VALUE ::= SEQUENCE {
    object-identifier           [75]    BACnetObjectIdentifier,
    object-name                 [77]    CharacterString,
    object-type                 [79]    BACnetObjectType,
    description                 [28]    CharacterString OPTIONAL,
    present-value               [85]    Unsigned,
    status-flags                [111]   BACnetStatusFlags,
    event-state                 [36]    BACnetEventState OPTIONAL,
    reliability                 [103]   BACnetReliability OPTIONAL,
    out-of-service              [81]    BOOLEAN OPTIONAL,
    units                       [117]   BACnetEngineeringUnits,
    priority-array              [87]    BACnetPriorityArray OPTIONAL,
    relinquish-default          [104]   Unsigned OPTIONAL,
    cov-increment               [22]    Unsigned OPTIONAL,
    time-delay                  [113]   Unsigned OPTIONAL,
    notification-class          [17]    Unsigned OPTIONAL,
    high-limit                  [45]    Unsigned OPTIONAL,
    low-limit                   [59]    Unsigned OPTIONAL,
    deadband                    [25]    Unsigned OPTIONAL,
    limit-enable                [52]    BACnetLimitEnable OPTIONAL,
    event-enable                [35]    BACnetEventTransitionBits OPTIONAL,
    acked-transitions           [0]     BACnetEventTransitionBits OPTIONAL,
    notify-type                 [72]    BACnetNotifyType OPTIONAL,
    event-time-stamps           [130]   SEQUENCE OF BACnetTimeStamp OPTIONAL,
                                        -- accessed as a BACnetARRAY
    event-message-texts         [351]   SEQUENCE SIZE(3) OF CharacterString OPTIONAL,
                                        -- accessed as a BACnetARRAY
    profile-name                [168]   CharacterString OPTIONAL
    }
```

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PROGRAM ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
program-state	[92]	BACnetProgramState,
program-change	[90]	BACnetProgramRequest,
reason-for-halt	[100]	BACnetProgramError OPTIONAL,
description-of-halt	[29]	CharacterString OPTIONAL,
program-location	[91]	CharacterString OPTIONAL,
description	[28]	CharacterString OPTIONAL,
instance-of	[48]	CharacterString OPTIONAL,
status-flags	[111]	BACnetStatusFlags,
reliability	[103]	BACnetReliability OPTIONAL,
out-of-service	[81]	BOOLEAN,
profile-name	[168]	CharacterString OPTIONAL

}

PULSE-CONVERTER ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,
object-type	[79]	BACnetObjectType,
description	[28]	CharacterString OPTIONAL,
present-value	[85]	REAL,
input-reference	[181]	BACnetObjectPropertyReference OPTIONAL,
status-flags	[111]	BACnetStatusFlags,
event-state	[36]	BACnetEventState,
reliability	[103]	BACnetReliability OPTIONAL,
out-of-service	[81]	BOOLEAN,
units	[117]	BACnetEngineeringUnits,
scale-factor	[188]	REAL,
adjust-value	[176]	REAL,
count	[177]	Unsigned,
update-time	[189]	BACnetDateTime,
count-change-time	[179]	BACnetDateTime,
count-before-change	[178]	Unsigned,
cov-increment	[22]	REAL OPTIONAL,
cov-period	[180]	Unsigned OPTIONAL,
notification-class	[17]	Unsigned OPTIONAL,
time-delay	[113]	Unsigned OPTIONAL,
high-limit	[45]	REAL OPTIONAL,
low-limit	[59]	REAL OPTIONAL,
deadband	[25]	REAL OPTIONAL,
limit-enable	[52]	BACnetLimitEnable OPTIONAL,
event-enable	[35]	BACnetEventTransitionBits OPTIONAL,
acked-transitions	[0]	BACnetEventTransitionBits OPTIONAL,
notify-type	[72]	BACnetNotifyType OPTIONAL,
event-time-stamps	[130]	SEQUENCE OF BACnetTimeStamp OPTIONAL, -- accessed as a BACnetARRAY
event-message-texts	[351]	SEQUENCE SIZE(3) OF CharacterString OPTIONAL, -- accessed as a BACnetARRAY
profile-name	[168]	CharacterString OPTIONAL

}

SCHEDULE ::= SEQUENCE {

object-identifier	[75]	BACnetObjectIdentifier,
object-name	[77]	CharacterString,

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```
        object-type                         [79]    BACnetObjectType,
        present-value                       [85]    ABSTRACT-SYNTAX.&Type,  -- Any datatype
        description                         [28]    CharacterString OPTIONAL,
        effective-period                    [32]    BACnetDateRange,
        weekly-schedule                     [123]   SEQUENCE SIZE(7) OF BACnetDailySchedule OPTIONAL,
                                                    -- accessed as a BACnetARRAY
        schedule-default                    [174]   ABSTRACT-SYNTAX.&Type, -- Any primitive datatype,
        exception-schedule                  [38]    SEQUENCE OF BACnetSpecialEvent OPTIONAL,
                                                    -- accessed as a BACnetARRAY
        list-of-object-property-references  [54]    SEQUENCE OF BACnetDeviceObjectPropertyReference,
        priority-for-writing                [88]    Unsigned (1..16),
        status-flags                        [111]   BACnetStatusFlags,
        reliability                         [103]   BACnetReliability,
        out-of-service                      [81]    BOOLEAN,
        profile-name                        [168]   CharacterString OPTIONAL
        }

STRUCTURED-VIEW ::= SEQUENCE {
        object-identifier                   [75]    BACnetObjectIdentifier,
        object-name                         [77]    CharacterString,
        object-type                         [79]    BACnetObjectType,
        description                         [28]    CharacterString OPTIONAL,
        node-type                           [208]   BACnetNodeType,
        node-subtype                        [207]   CharacterString OPTIONAL,
        subordinate-list                    [211]   SEQUENCE OF BACnetDeviceObjectReference,
                                                    -- accessed as a BACnetARRAY
        subordinate-annotations             [210]   SEQUENCE OF CharacterString OPTIONAL,
                                                    -- accessed as a  BACnetARRAY
        profile-name                        [168]   CharacterString OPTIONAL
        }

TIME-PATTERN-VALUE ::= SEQUENCE {
        object-identifier                   [75]    BACnetObjectIdentifier,
        object-name                         [77]    CharacterString,
        object-type                         [79]    BACnetObjectType,
        description                         [28]    CharacterString OPTIONAL,
        present-value                       [85]    Time,
        status-flags                        [111]   BACnetStatusFlags,
        event-state                         [36]    BACnetEventState OPTIONAL,
        reliability                         [103]   BACnetReliability OPTIONAL,
        out-of-service                      [81]    BOOLEAN OPTIONAL,
        priority-array                      [87]    BACnetPriorityArray OPTIONAL,
        relinquish-default                  [104]   Time OPTIONAL,
        profile-name                        [168]   CharacterString OPTIONAL
        }

TIME-VALUE ::= SEQUENCE {
        object-identifier                   [75]    BACnetObjectIdentifier,
        object-name                         [77]    CharacterString,
        object-type                         [79]    BACnetObjectType,
        description                         [28]    CharacterString OPTIONAL,
        present-value                       [85]    Time,
        status-flags                        [111]   BACnetStatusFlags,
        event-state                         [36]    BACnetEventState OPTIONAL,
        reliability                         [103]   BACnetReliability OPTIONAL,
        out-of-service                      [81]    BOOLEAN OPTIONAL,
```

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```
        priority-array                  [87]    BACnetPriorityArray OPTIONAL,
        relinquish-default              [104]   Time OPTIONAL,
        profile-name                    [168]   CharacterString OPTIONAL
        }

TREND-LOG ::= SEQUENCE {
        object-identifier               [75]    BACnetObjectIdentifier,
        object-name                     [77]    CharacterString,
        object-type                     [79]    BACnetObjectType,
        description                     [28]    CharacterString OPTIONAL,
        enable                          [133]   BOOLEAN,
        start-time                      [142]   BACnetDateTime OPTIONAL,
        stop-time                       [143]   BACnetDateTime OPTIONAL,
        log-device-object-property      [132]   BACnetDeviceObjectPropertyReference OPTIONAL,
        log-interval                    [134]   Unsigned OPTIONAL,
        cov-resubscription-interval     [128]   Unsigned OPTIONAL,
        client-cov-increment            [127]   BACnetClientCOV OPTIONAL,
        stop-when-full                  [144]   BOOLEAN,
        buffer-size                     [126]   Unsigned32,
        log-buffer                      [131]   SEQUENCE OF BACnetLogRecord,
        record-count                    [141]   Unsigned32,
        total-record-count              [145]   Unsigned32,
        notification-threshold          [137]   Unsigned32 OPTIONAL,
        records-since-notification      [140]   Unsigned32 OPTIONAL,
        last-notify-record              [173]   Unsigned32 OPTIONAL,
        event-state                     [36]    BACnetEventState,
        notification-class              [17]    Unsigned OPTIONAL,
        event-enable                    [35]    BACnetEventTransitionBits OPTIONAL,
        acked-transitions               [0]     BACnetEventTransitionBits OPTIONAL,
        notify-type                     [72]    BACnetNotifyType OPTIONAL,
        event-time-stamps               [130]   SEQUENCE OF BACnetTimeStamp OPTIONAL,
                                                --accessed as a BACnetARRAY
        event-message-texts             [351]   SEQUENCE SIZE(3) OF CharacterString OPTIONAL,
                                                -- accessed as a BACnetARRAY
        profile-name                    [168]   CharacterString OPTIONAL,
        logging-type                    [197]   BACnetLoggingType,
        align-intervals                 [193]   BOOLEAN OPTIONAL,
        interval-offset                 [195]   Unsigned OPTIONAL,
        trigger                         [205]   BOOLEAN OPTIONAL,
        status-flags                    [111]   BACnetStatusFlags,
        reliability                     [103]   BACnetReliability OPTIONAL
        }

TREND-LOG-MULTIPLE ::= SEQUENCE {
        object-identifier               [75]    BACnetObjectIdentifier,
        object-name                     [77]    CharacterString,
        object-type                     [79]    BACnetObjectType,
        description                     [28]    CharacterString OPTIONAL,
        status-flags                    [111]   BACnetStatusFlags,
        event-state                     [36]    BACnetEventState,
        reliability                     [103]   BACnetReliability OPTIONAL,
        enable                          [133]   BOOLEAN,
        start-time                      [142]   BACnetDateTime OPTIONAL,
        stop-time                       [143]   BACnetDateTime OPTIONAL,
        log-device-object-property      [132]   SEQUENCE OF BACnetDeviceObjectPropertyReference,
                                                --accessed as a BACnetARRAY
```

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```
logging-type                [197]  BACnetLoggingType,
log-interval                [134]  Unsigned,
align-intervals             [193]  BOOLEAN OPTIONAL,
interval-offset             [195]  Unsigned OPTIONAL,
trigger                     [205]  BOOLEAN OPTIONAL,
stop-when-full              [144]  BOOLEAN,
buffer-size                 [126]  Unsigned32,
log-buffer                  [131]  SEQUENCE OF BACnetLogMultipleRecord,
record-count                [141]  Unsigned32,
total-record-count          [145]  Unsigned32,
notification-threshold      [137]  Unsigned32 OPTIONAL,
records-since-notification  [140]  Unsigned32 OPTIONAL,
last-notify-record          [173]  Unsigned32 OPTIONAL,
notification-class          [17]   Unsigned OPTIONAL,
event-enable                [35]   BACnetEventTransitionBits OPTIONAL,
acked-transitions           [0]    BACnetEventTransitionBits OPTIONAL,
notify-type                 [72]   BACnetNotifyType OPTIONAL,
event-time-stamps           [130]  SEQUENCE OF BACnetTimeStamp OPTIONAL
                                   --accessed as a BACnetARRAY
event-message-texts         [351]  SEQUENCE SIZE(3) OF CharacterString OPTIONAL,
                                   -- accessed as a BACnetARRAY
profile-name                [168]  CharacterString OPTIONAL
}
```

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ANNEX D - EXAMPLES OF STANDARD OBJECT TYPES (INFORMATIVE)

(This annex is not part of this standard but is included for informative purposes.)

This annex provides examples of the BACnet standard object types defined in Clause 12.

D.1 Example of an Accumulator object

Property:	Object_Identifier =	(Accumulator, Instance 1)
Property:	Object_Name =	"Tenant 1"
Property:	Object_Type =	ACCUMULATOR
Property	Present_Value =	323
Property:	Description =	""
Property:	Device_Type =	"Electric Pulse"
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Event_State =	NORMAL
Property:	Out_Of_Service =	FALSE
Property:	Scale =	2
Property:	Units =	KILOWATT_HOURS
Property:	Prescale =	(1,10000)
Property:	Max_Pres_Value =	9999
Property:	Value_Change_Time =	(23-MAR-01,18:50:21.2)
Property:	Value_Before_Change =	0
Property:	Value_Set =	67
Property:	Logging_Record =	((13-JUL-01,13:00:00.2),120,1,NORMAL)
Property:	Logging_Object =	(Trend Log, Instance 100)
Property:	Pulse_Rate =	3
Property:	High_Limit =	15
Property:	Low_Limit =	0
Property:	Limit_Monitoring_Interval =	300
Property:	Notification_Class =	3
Property:	Time_Delay =	10
Property:	Limit_Enable =	{TRUE, FALSE}
Property:	Event_Enable =	{TRUE, FALSE, TRUE}
Property:	Acked_Transitions =	{TRUE, TRUE, TRUE}
Property:	Notify_Type =	ALARM
Property:	Event_Time_Stamps =	((12-JUL-01,18:50:21.2), (*-*-*,*:*:*.*), (12-JUL-01,19:01:34.0))

D.2 Example of an Analog Input Object

The following is an example of an Analog Input object that is used for mixed air temperature of an air handler. The object supports both COV and intrinsic reporting.

Property:	Object_Identifier =	(Analog Input, Instance 1)
Property:	Object_Name =	"1AH1MAT"
Property:	Object_Type =	ANALOG_INPUT
Property:	Present_Value =	58.1
Property:	Description =	"Mixed Air Temperature"
Property:	Device_Type =	"1000 OHM RTD"
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Event_State =	NORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE

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Property:	Update_Interval =	10
Property:	Units =	DEGREES_FAHRENHEIT
Property:	Min_Pres_Value =	-50.0
Property:	Max_Pres_Value =	250.0
Property:	Resolution =	0.1
Property:	COV_Increment =	0.2
Property:	Time_Delay =	10
Property:	Notification_Class =	3
Property:	High_Limit =	60.0
Property:	Low_Limit =	55.0
Property:	Deadband =	1.0
Property:	Limit_Enable =	{TRUE, TRUE}
Property:	Event_Enable =	{TRUE, FALSE, TRUE}
Property:	Acked_Transitions =	{TRUE, TRUE, TRUE}
Property:	Notify_Type =	EVENT
Property:	Event_Time_Stamps =	((23-MAR-95,18:50:21.2), (*-*-*,*:*:*.*), (23-MAR-95,19:01:34.0))

D.3 Example of an Analog Output Object

The following is an example of an Analog Output object that is used for a damper in an air handler. The object supports neither COV nor intrinsic reporting.

Property:	Object_Identifier =	(Analog Output, Instance 1)
Property:	Object_Name =	"1AH1DMPR"
Property:	Object_Type =	ANALOG_OUTPUT
Property:	Present_Value =	75.0
Property:	Description =	"Damper Actuator"
Property:	Device_Type =	"3-8 PSI Actuator"
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Event_State =	NORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:	Units =	PERCENT
Property:	Min_Pres_Value =	0.0
Property:	Max_Pres_Value =	100.0
Property:	Resolution =	0.1
Property:	Priority_Array =	{NULL, NULL, NULL, NULL, 75.0... NULL}
Property:	Relinquish_Default =	50.0

D.4 Example of an Analog Value Object

The following is an example of an Analog Value object that is used for enthalpy calculation. The object supports neither COV nor intrinsic reporting.

Property:	Object_Identifier =	(Analog Value, Instance 1)
Property:	Object_Name =	"1AH1ENTH"
Property:	Object_Type =	ANALOG_VALUE
Property:	Present_Value =	38.1
Property:	Description =	"Enthalpy"
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Event_State =	NORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:	Units =	BTUS-PER-POUND-DRY-AIR

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D.5 Example of an Averaging Object

The following is an example of an Averaging object that is used for determining average and maximum electrical demand. The object property it refers to is a standard analog input measuring KW. In the current period, one sample was missed.

Property:	Object_Identifier =	(Averaging, Instance 1)
Property:	Object_Name =	"FLR 12 DEMAND"
Property:	Object_Type =	AVERAGING
Property:	Minimum_Value =	2.4
Property:	Minimum_Value_Timestamp =	(16-DEC-1999,13:15:07.32)
Property:	Average_Value =	12.7
Property:	Maximum_Value =	18.8
Property:	Maximum_Value_Timestamp =	(16-DEC-1999,13:06:12.19)
Property:	Description =	"Floor 12 Electrical Demand"
Property:	Attempted_Samples =	15
Property:	Valid_Samples =	14
Property:	Object_Property_Reference =	(Analog Input, Instance 12)
Property:	Window_Interval =	900
Property:	Window_Samples =	15

D.6 Examples of a Binary Input Object

Example 1: A typical Binary Input object.

In this example, the Binary Input is connected to a high static pressure cutoff switch with normally open contacts. Exceeding the static pressure limit of the switch causes the normally open contacts to close. The ACTIVE state of the physical input indicates that the contacts are closed. The object supports both COV and intrinsic reporting.

Property:	Object_Identifier =	(Binary Input, Instance 1)
Property:	Object_Name =	"HighPressSwitch"
Property:	Object_Type =	BINARY_INPUT
Property:	Present_Value =	ACTIVE
Property:	Description =	"Penthouse Supply High Static"
Property:	Device_Type =	"ABC Pressure Switch"
Property:	Status_Flags =	{TRUE, FALSE, FALSE, FALSE}
Property:	Event_State =	OFFNORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:	Polarity =	NORMAL
Property:	Inactive_Text =	"Static Pressure OK"
Property:	Active_Text =	"High Pressure Alarm"
Property:	Change_Of_State_Time =	(23-MAR-1995, 19:01:34.0)
Property:	Change_Of_State_Count =	134
Property:	Time_Of_State_Count_Reset =	(1-JAN-1995, 00:00:00.0)
Property:	Elapsed_Active_Time =	401
Property:	Time_Of_Active_Time_Reset =	(1-JAN-1995, 00:00:00.0)
Property:	Time_Delay =	10
Property:	Notification_Class =	3
Property:	Alarm_Value =	ACTIVE
Property:	Event_Enable =	{TRUE, FALSE, TRUE}
Property:	Acked_Transitions =	{FALSE, TRUE, TRUE}
Property:	Notify_Type =	ALARM
Property:	Event_Time_Stamps =	((23-MAR-95,18:50:21.2), (*-*-*,*:*:*.*), (21-MAR-95,01:02:03.0))

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Example 2: A Binary Input object that is out-of-service.

In this second example, an open circuit has been found by the control system in the binary input described above. The input has been taken out of service.

Property:	Object_Identifier =	(Binary Input, Instance 1)
Property:	Object_Name =	"HighPressSwitch"
Property:	Object_Type =	BINARY_INPUT
Property:	Present_Value =	INACTIVE
Property:	Description =	"Penthouse Supply High Static"
Property:	Device_Type =	"ABC Pressure Switch"
Property:	Status_Flags =	{FALSE, TRUE, FALSE, TRUE}
Property:	Event_State =	NORMAL
Property:	Reliability =	OPEN_LOOP
Property:	Out_Of_Service =	TRUE
Property:	Polarity =	NORMAL
Property:	Inactive_Text =	"Static Pressure OK"
Property:	Active_Text =	"High Pressure Alarm"
Property:	Change_Of_State_Time =	(23-MAR-1995, 19:01:34.0)
Property:	Change_Of_State_Count =	135
Property:	Time_Of_State_Count_Reset =	(1-JAN-1995, 00:00:00.0)
Property:	Elapsed_Active_Time =	451
Property:	Time_Of_Active_Time_Reset =	(1-JAN-1995, 00:00:00.0)
Property:	Time_Delay =	10
Property:	Notification_Class =	3
Property:	Alarm_Value =	ACTIVE
Property:	Event_Enable =	{TRUE, FALSE, TRUE}
Property:	Acked_Transitions =	{TRUE, TRUE, TRUE}
Property:	Notify_Type =	ALARM
Property:	Event_Time_Stamps =	((21-MAR-95,01:09:34.0), (23-MAR-95,19:01:34.0), (21-MAR-95,01:11:21.2))

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D.7 Examples of a Binary Output Object

Example 1: A typical Binary Output object.

In this example, a fan is controlled by a binary output connected to a relay with normally closed contacts. The fan operates unless the relay is energized. The INACTIVE state of the binary output object is reversed by the polarity property to energize the relay and open the contacts turning off the fan. Note that in this example the Priority_Array contains all NULLs and thus Relinquish_Default determines the Present_Value. The object does not support intrinsic reporting.

Property:	Object_Identifier =	(Binary Output, Instance 1)
Property:	Object_Name =	"Floor3ExhaustFan"
Property:	Object_Type =	BINARY_OUTPUT
Property:	Present_Value =	INACTIVE
Property:	Description =	"Third floor bathroom exhaust fan"
Property:	Device_Type =	"ABC 100 Relay"
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Event_State =	NORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:	Polarity =	REVERSE

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Property:	Inactive_Text =	"Fan is turned off"
Property:	Active_Text =	"Fan is running"
Property:	Change_Of_State_Time =	(23-MAR-1995, 19:01:34.0)
Property:	Change_Of_State_Count =	47
Property:	Time_Of_State_Count_Reset =	(1-JAN-1995, 00:00:00.0)
Property:	Elapsed_Active_Time =	650
Property:	Time_Of_Active_Time_Reset =	(1-JAN-1995, 00:00:00.0)
Property:	Minimum_Off_Time =	100
Property:	Minimum_On_Time =	10
Property:	Priority_Array =	{NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL}
Property:	Relinquish_Default =	INACTIVE

Example 2: A Binary Output object that has been overridden.

In this second example, the fan has been found to be inoperable. Since the fan cannot operate until repaired, an operator has overridden the control system to maintain the fan in an inactive state.

Property:	Object_Identifier =	(Binary Output, Instance 1)
Property:	Object_Name =	"Floor3ExhaustFan"
Property:	Object_Type =	BINARY_OUTPUT
Property:	Present_Value =	INACTIVE
Property:	Description =	"Third floor bathroom exhaust fan"
Property:	Device_Type =	"ABC 100 Relay"
Property:	Status_Flags =	{FALSE, TRUE, TRUE, FALSE)
Property:	Event_State =	NORMAL
Property:	Reliability =	OPEN_LOOP
Property:	Out_Of_Service =	FALSE
Property:	Polarity =	REVERSE
Property:	Inactive_Text =	"Fan is turned off"
Property:	Active_Text =	"Fan is running"
Property:	Change_Of_State_Time =	(23-MAR-1995, 19:01:34.0)
Property:	Change_Of_State_Count =	134
Property:	Time_Of_State_Count_Reset =	(1-JAN-1995, 00:00:00.0)
Property:	Elapsed_Active_Time =	401
Property:	Time_Of_Active_Time_Reset =	(1-JAN-1995, 00:00:00.0)
Property:	Minimum_Off_Time =	100
Property:	Minimum_On_Time =	10
Property:	Priority_Array =	{NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL, NULL}
Property:	Relinquish_Default =	INACTIVE

D.8 Example of a Binary Value Object

In this example, the Binary Value is a mechanism that allows an exhaust fan to be enabled by an operator. The fan control logic uses this value to determine if the fan should operate but only if other conditions are met. For example, the fan may not be turned off if a fire alarm has occurred or if the system is shut down. The object does not support intrinsic reporting.

Property:	Object_Identifier =	(Binary Value, Instance 1)
Property:	Object_Name =	"ExhaustFanEnable"
Property:	Object_Type =	BINARY_VALUE
Property:	Present_Value =	ACTIVE
Property:	Description =	"Exhaust Fan Operator Enable"
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}

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Property:	Event_State =	NORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:	Inactive_Text =	"Enabled by Operator"
Property:	Active_Text =	"Fan Not Enabled by Operator"
Property:	Change_Of_State_Time =	(23-MAR-1995, 19:01:34.0)
Property:	Change_Of_State_Count =	134
Property:	Time_Of_State_Count_Reset =	(1-JAN-1995, 00:00:00.0)
Property:	Elapsed_Active_Time =	401
Property:	Time_Of_Active_Time_Reset =	(1-JAN-1995, 00:00:00.0)
Property:	Minimum_Off_Time =	0
Property:	Minimum_On_Time =	0
Property:	Priority_Array =	{NULL...NULL, ACTIVE}
Property:	Relinquish_Default =	INACTIVE

D.9 Example of a Calendar Object

The following is an example of a CALENDAR object that specifies the holidays for a school district.

Property:	Object_Identifier =	(Calendar, Instance 1)
Property:	Object_Name =	"HOLIDAYS"
Property:	Object_Type =	CALENDAR
Property:	Description =	"1995-1996 School District Holidays"
Property:	Present_Value =	TRUE
Property:	Date_List =	(((23-DEC-1995)-(3-JAN-1996)), (19-FEB-1996), (27-MAY-1996))

This is a calendar called "HOLIDAYS". Holidays are defined for Christmas Vacation between December 23 and January 3, for Presidents' Day on February 19, and for Memorial Day on May 27. On these dates the Present_Value of the calendar will be TRUE. On all other dates, the Present_Value will be FALSE. A real school calendar would likely have more members in the Date_List; only three are shown here for simplicity.

D.10 Examples of a Command Object

Example 1: Occupied and unoccupied zone

In this example, a particular zone of an office building has two temperature setpoints: one for unoccupied and one for occupied zone operation. The zone also has a lighting override to force lighting off during unoccupied periods. Setting the Present_Value of the COMMAND object to 1 will select unoccupied mode, while 2 will select occupied mode.

Assumed objects:

Object_Identifier	Object_Name	Object_Type
X'00800005'	ZONE43	ANALOG_VALUE
X'01000003'	LIGHTING43	BINARY_OUTPUT

Property:	Object_Identifier =	(Command, Instance 1)
Property:	Object_Name =	"ZONE43CONTROL"
Property:	Object_Type =	COMMAND
Property:	Description =	"Fourth Floor, West Wing Office Suite"
Property:	Present_Value =	1
Property:	In_Process =	FALSE
Property:	All_Writes_Successful =	TRUE

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Property:	Action =	{((,(Analog Value, Instance 5),Present_Value,,65.0,,TRUE,TRUE), (,(Binary Output, Instance 3),Present_Value, ,INACTIVE,8,1,TRUE,TRUE)), ((,(Analog Value, Instance 5), Present_Value,,72.0,,TRUE,TRUE), (,(Binary Output, Instance 3), Present_Value, ,ACTIVE,8,2,TRUE,TRUE))}
Property:	Action_Text =	{"Unoccupied", "Occupied"}

Example 2: Occupied and unoccupied zone.

This example builds on the previous example by adding communication between the device containing the COMMAND object and another device that controls an elevator subsystem. When the zone is placed in an unoccupied mode, that floor of the building is locked out for elevator service. In this example, the elevator subsystem is located in the BACnet device "DDC4".

Assumed objects:

Object_Identifier	Object_Name	Object_Type
X'00800005'	ZONE43	ANALOG_VALUE
X'01000003'	LIGHTING43	BINARY_OUTPUT
X'02000001'	DDC4	DEVICE
X'01400001'	FL4	BINARY_VALUE

Property:	Object_Identifier =	(Command, Instance 1)
Property:	Object_Name =	"ZONE43CONTROL"
Property:	Object_Type =	COMMAND
Property:	Description =	"Fourth Floor, West Wing Office Suite"
Property:	Present_Value =	2
Property:	In_Process =	FALSE
Property:	All_Writes_Successful =	TRUE
Property:	Action =	{((,(Analog Value, Instance 5), Present_Value,,65.0, 8,,TRUE,TRUE), (,(Binary Output, Instance 3), Present_Value, INACTIVE,8,1,TRUE,TRUE), ((Device, Instance 1), (Binary Value, Instance 1),Present_Value, ,INACTIVE, 8,1,TRUE,TRUE)), ((,(Analog Value, Instance 5), Present_Value,,72.0, 8,2,TRUE,TRUE), (,(Binary Output, Instance 3), Present_Value, ,ACTIVE,8,,TRUE,TRUE), ((Device, Instance 1), (Binary Value, Instance 1),Present_Value,,ACTIVE, 8,,TRUE,TRUE))}
Property:	Action_Text =	{"Unoccupied", "Occupied"}

D.11 Examples of a Device Object

Example 1: A "sophisticated" BACnet device.

Property:	Object_Identifier =	(Device, Instance 1)
Property:	Object_Name =	"AC1 System Controller"
Property:	Object_Type =	DEVICE
Property:	System_Status =	OPERATIONAL
Property:	Vendor_Name =	"ABC Controls"
Property:	Vendor_Identifier =	1001
Property:	Model_Name =	"1000 Plus"

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Property:	Firmware_Revision =	"1.2"
Property:	Application_Software_Version =	"V4.0 - April 12, 1989"
Property:	Location =	"Basement Mechanical Room"
Property:	Description =	"AC1 Controller"
Property:	Protocol_Version =	1
Property:	Protocol_Revision =	4
Property:	Protocol_Services_Supported =	B'111111111111111111111111111111111111'
Property:	Protocol_Object_Types_Supported =	B'11111111111111111'
Property:	Object_List =	((Analog Input, Instance 1), (Analog Input, Instance 2), ...)
Property:	Structured_Object_List =	((Structured View, Instance 1), (Structured View, Instance 2))
Property:	Max_APDU_Length_Accepted =	480
Property:	Segmentation_Supported =	SEGMENTED_BOTH
Property:	Max_Segments_Accepted =	16
Property:	VT_Classes_Supported =	(DEFAULT-TERMINAL, DEC-VT100)
Property:	Active_VT_Sessions	((29,5,1, X'0000C0B3EF13'),(23,8,2, X'05'))
Property:	Local_Time	12:34:56.78
Property:	Local_Date	29-SEP-1989, FRIDAY
Property:	UTC_Offset =	360
Property:	Daylight_Savings_Status =	FALSE
Property:	APDU_Segment_Timeout =	2000
Property:	APDU_Timeout =	3000
Property:	Number_Of_APDU_Retries =	3
Property:	Time_Synchronization_Recipients =	(Device, Instance 18)
Property:	Device_Address_Binding =	(((Device, Instance 1), 1, X'01'), ((Device, Instance 12), 1, X'17'), ((Device, Instance 40), 2, X'02608C41A606'), ...)
Property:	Database_Revision =	123
Property:	Configuration_Files =	((File, Instance 1), (File, Instance 2))
Property:	Last_Restore_Time =	(2, (29-SEP-1989, 01:00:00.0))
Property:	Backup_Failure_Timeout =	300
Property:	Backup_Preparation_Time =	60
Property:	Restore_Preparation_Time =	120
Property:	Restore_Completion_Time =	240
Property:	Backup_And_Restore_State =	IDLE
Property:	Active_COV_Subscriptions =	((((0, (Device, Instance 12)), 300), ((Analog Input, Instance 1),Present_Value),TRUE,100,1.0), (((0, (Device, Instance 40)), 600), ((Analog Input, Instance 1),Present_Value),TRUE,3,1.5))
Property:	Last_Restart_Reason =	DETECTED_POWERED_OFF
Property:	Restart_Notification_Recipients =	((0,X'FF')) -- This example uses an MS/TP broadcast address.
Property:	Time_Of_Device_Restart =	(02-SEP-2003, 12:34:56.78)

Example 2: A "simple" BACnet device.

Property:	Object_Identifier =	(Device, Instance 2)
Property:	Object_Name =	"Room 101 VAV Controller"
Property:	Object_Type =	DEVICE
Property:	System_Status =	DOWNLOAD_REQUIRED
Property:	Vendor_Name =	"XYZ Controls"
Property:	Vendor_Identifier =	1001
Property:	Model_Name =	"VAV 100"
Property:	Firmware_Revision =	"1.0"
Property:	Application_Software_Version =	"2-1-88"
Property:	Protocol_Version =	1

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Property:	Protocol_Revision =	1
Property:	Protocol_Services_Supported =	B'111101000000100100001000000111100011'
Property:	Protocol_Object_Types_Supported =	B'110110110100010001'
Property:	Object_List =	((Analog Input, Instance 1), (Analog Input, Instance 2), (Analog Output, Instance 1), (Binary Input, Instance 1), (Binary Output, Instance 1), (Device, Instance 9))
Property:	Max_APDU_Length_Supported =	50
Property:	Segmentation_Supported =	NO_SEGMENTATION
Property:	APDU_Segment_Timeout =	2000
Property:	APDU_Timeout =	60,000
Property:	Number_Of_APDU_Retries =	3
Property:	Max_Master	85
Property:	Max_Info_Frames	3
Property:	Device_Address_Binding =	(((Device, Instance 1), 1, X'01'), ((Device, Instance 12), 1, X'17'))
Property:	Database_Revision =	69
Property:	Last_Restart_Reason =	DETECTED_POWERED_OFF
Property:	Restart_Notification_Recipients =	((Device, Instance 18))
Property:	Time_Of_Device_Restart =	(04-OCT-2002, 02:04:06.08)

D.12 Examples of an Event Enrollment Object

The following Analog Input object is assumed for the examples below. All objects are assumed to be located in device 12.

ANALOG_INPUT

Property:	Object_Identifier =	(Analog Input, Instance 2)
Property:	Object_Name =	"Zone1_Temp"
Property:	Object_Type =	ANALOG_INPUT
Property:	Present_Value =	86.0
Property:	Description =	"Receptionist Lobby Temp"
Property:	Device_Type =	"PT 3K RTD"
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Event_State =	NORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:	Update_Interval =	5
Property:	Units =	DEGREES_FAHRENHEIT
Property:	Min_Pres_Value =	55.0
Property:	Max_Pres_Value =	95.0
Property:	Resolution =	0.1

Example 1: OUT_OF_RANGE event type.

This is an example of an OUT_OF_RANGE Event_Type. The State transition NORMAL to HIGH_LIMIT has not been acknowledged. The management of recipients is done through the use of a Notification Class object.

EVENT_ENROLLMENT

Property:	Object_Identifier =	(Event Enrollment, Instance 1)
Property:	Object_Name =	"Zone1_Alarm"
Property:	Object_Type =	EVENT_ENROLLMENT

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Property:	Description =	"Zone 1 Alarms"
Property:	Event_Type =	OUT_OF_RANGE
Property:	Notify_Type =	ALARM
Property:	Event_Parameters =	(30, 65.0, 85.0, 0.25)
Property:	Object_Property_Reference =	((Device, Instance 12),(Analog Input, Instance 2), Present_Value)
Property:	Event_State =	HIGH_LIMIT
Property:	Event_Enable =	(TRUE, TRUE, TRUE)
Property:	Acked_Transitions =	(FALSE, TRUE, TRUE)
Property:	Notification_Class =	1
Property:	Event_Time_Stamps =	((23-MAR-95,18:50:21.2), (*-*-*,*:*:*.*), (21-MAR-95,01:02:03.0))

Example 2: CHANGE_OF_VALUE_EVENT event type.

This is an example of a CHANGE_OF_VALUE Event_Type. The management of recipients is done through the use of optional properties of the Event Enrollment object instead of a Notification Class object.

EVENT_ENROLLMENT

Property:	Object_Identifier =	(Event Enrollment, Instance 2)
Property:	Object_Name =	"Zone1TempCOV"
Property:	Object_Type =	EVENT_ENROLLMENT
Property:	Description =	"Zone 1 Temperature COV"
Property:	Event_Type =	CHANGE_OF_VALUE
Property:	Notify_Type =	EVENT
Property:	Event_Parameters =	(5, 0.25)
Property:	Object_Property_Reference =	((Device, Instance 12),(Analog Input, Instance 2), Present_Value)
Property:	Event_State =	NORMAL
Property:	Event_Enable =	(TRUE, FALSE, FALSE)
Property:	Acked_Transitions =	(TRUE, TRUE, TRUE)
Property:	Event_Time_Stamps =	((23-MAR-95,18:50:21.2), (*-*-*,*:*:*.*), (23-MAR-95,19:01:34.0))

Example 3: CHANGE_OF_BITSTRING event type.

This example illustrates the use of a CHANGE_OF_BITSTRING event.

EVENT_ENROLLMENT

Property:	Object_Identifier =	(Event Enrollment, Instance 3)
Property:	Object_Name =	"Zone1 Rel"
Property:	Object_Type =	EVENT_ENROLLMENT
Property:	Description =	"Reliability alarm for zone 1 temperature"
Property:	Event_Type =	CHANGE_OF_BITSTRING
Property:	Notify_Type =	ALARM
Property:	Event_Parameters =	(30, B'0111', (B'0100', B'0010', B'0001', B'0110', B'0101', B'0011'))
Property:	Object_Property_Reference =	((Device, Instance 12),(Analog Input, Instance 2), Status_Flags)
Property:	Event_State =	NORMAL
Property:	Event_Enable =	(TRUE, TRUE, FALSE)
Property:	Acked_Transitions =	(TRUE, TRUE, TRUE)
Property:	Notification_Class	3
Property:	Event_Time_Stamps =	((23-MAR-95,18:50:21.2), (*-*-*,*:*:*.*),

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(23-MAR-95,19:01:34.0))

D.13 Example of a File Object

A File Object holding trend information:

Property:	Object_Identifier =	(File, Instance 7)
Property:	Object_Name =	"TREND_AI1"
Property:	Object_Type =	FILE
Property:	Description =	"Trend of AI1"
Property:	File_Type =	"TREND"
Property:	File_Size =	750
Property:	Modification_Date =	(1-NOV-1995, 08:30:49.0)
Property:	Archive =	FALSE
Property:	Read_Only =	FALSE
Property:	File_Access_Method=	RECORD_ACCESS
Property:	Record_Count =	150

D.14 Example of a Group Object

The following is an example of a group object that is used to reference temperatures in a particular zone of a building.

Property: Object_Identifier = (Group, Instance 1)
Property: Object_Name = "ZONE1_TEMPS"
Property: Object_Type = GROUP
Property: Description = "Zone 1 Temperature Group"
Property: List_Of_Group_Members = (((Analog Input, Instance 8),(Present_Value, Reliability, Description)),
((Analog Input, Instance 9),(Present_Value, Reliability, Description)),
((Analog Input, Instance 10),(Present_Value, Reliability, Description)),
((Analog Input, Instance 11),(Present_Value, Reliability, Description)),
((Analog Input, Instance 12),(Present_Value, Reliability, Description)))
Property: Present_Value = (((Analog Input, Instance 8), Present_Value, 69.7, Reliability,
NO_FAULT_DETECTED, Description, "Room 1"),
((Analog Input, Instance 9), Present_Value, 71.2, Reliability,
NO_FAULT_DETECTED, Description, "Room 2"),
((Analog Input, Instance 10), Present_Value, -50.0, Reliability,
UNRELIABLE_OTHER, Description, "Room 3"),
((Analog Input, Instance 11), Present_Value, 69.7, Reliability,
NO_FAULT_DETECTED, Description, "Room 4"),
((Analog Input, Instance 12), Present_Value, 73.3, Reliability,
NO_FAULT_DETECTED, Description, "Room 5"))

D.15 Example of a Life Safety Point Object

In this example, a smoke detector is represented as a Life Safety Point object.

Property:	Object_Identifier =	(Life Safety Point, Instance 2)
Property:	Object_Name =	"SMK3W"
Property:	Object_Type =	LIFE_SAFETY_POINT
Property:	Present_Value =	ALARM
Property:	Tracking_Value =	ALARM
Property:	Description =	"Floor 3, West Zone Smoke Detector"
Property:	Device_Type =	"Old Smokey model 123"
Property:	Status_Flags =	{TRUE, FALSE, FALSE, FALSE}
Property:	Event_State =	LIFE_SAFETY_ALARM

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Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:	Mode =	ON
Property:	Accepted_Modes =	{ENABLED, DISABLED, TEST}
Property:	Time_Delay =	10
Property:	Notification_Class =	39
Property:	Life_Safety_Alarm_Values =	(ALARM)
Property:	Alarm_Values =	(PREALARM)
Property:	Fault_Values =	(FAULT)
Property:	Event_Enable =	{TRUE, TRUE, TRUE}
Property:	Acked_Transitions =	{TRUE, TRUE, TRUE}
Property:	Notify_Type =	ALARM
Property:	Event_Time_Stamps =	((23-MAR-95, 18:50:21.2), (*-*-*, *:*:*.*), (23-MAR-95, 19:01:34.0))
Property:	Silenced =	SILENCE_AUDIBLE
Property:	Operation_Expected =	RESET_ALARM
Property:	Maintenance_Required =	NONE
Property:	Setting =	50
Property:	Direct_Reading =	84.3
Property:	Units =	PERCENT-OBSCURATION-PER-METER
Property:	Member_Of =	((Life Safety Zone, Instance 5))

D.16 Example of a Life Safety Zone Object

In this example, a fire zone is represented as a Life Safety Zone object.

Property:	Object_Identifier =	(Life Safety Zone, Instance 2)
Property:	Object_Name =	"SMK3"
Property:	Object_Type =	LIFE_SAFETY_ZONE
Property:	Present_Value =	PREALARM
Property:	Tracking_Value =	PREALARM
Property:	Description =	"Floor 3 Smoke"
Property:	Status_Flags =	{TRUE FALSE, FALSE, FALSE}
Property:	Event_State =	OFFNORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:	Mode =	ON
Property:	Accepted_Modes =	{ENABLED, DISABLED, TEST}
Property:	Time_Delay =	10
Property:	Notification_Class =	39
Property:	Life_Safety_Alarm_Values =	(ALARM)
Property:	Alarm_Values =	(PREALARM)
Property:	Fault_Values =	(FAULT)
Property:	Event_Enable =	{TRUE, TRUE, TRUE}
Property:	Acked_Transitions =	{TRUE, TRUE, TRUE}
Property:	Notify_Type =	ALARM
Property:	Event_Time_Stamps =	((23-MAR-95, 18:50:21.2), (*-*-*, *:*:*.*), (23-MAR-95,19:01:34.0))
Property:	Silenced =	UNSILENCED
Property:	Operation_Expected =	SILENCE_AUDIBLE
Property:	Maintenance_Required =	NONE
Property:	Zone_Members =	((Life Safety Point, Instance 22), (Life Safety Point, Instance 23))
Property:	Member_Of =	((Life Safety Zone, Instance 5))

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D.17 Example of a Loop Object

The following is an example of a LOOP object that is used for supply air temperature control of an air handler. The algorithm represented is a positioning PI algorithm of the following form:

Output = {Proportional_Constant * [Error + (Integral_Constant * "Integral of the Error")]} + Bias

Where: Error = (Process_Variable_Value - Setpoint) and "Integral of the Error" has units of °F-min.

Assumed objects:	Object_Identifier	Object_Name	Object_Type
	X'00400005'	AHU_VALVE	ANALOG_OUTPUT
	X'00000003'	AHU_SAT	ANALOG_INPUT
	X'00800007'	RESET_OAT	ANALOG_VALUE

The object supports COV reporting.

Property:	Object_Identifier =	(Loop, Instance 1)
Property:	Object_Name =	"AHU_SAT_LOOP"
Property:	Object_Type =	LOOP
Property:	Present_Value =	8.3
Property:	Description =	"Supply air temp. PI control"
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Event_State =	NORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:	Update_Interval =	1
Property:	Output_Units =	POUNDS_FORCE_PER_SQUARE_INCH
Property:	Manipulated_Variable_Reference =	((Analog Output, Instance 5),Present_Value)
Property:	Controlled_Variable_Reference =	((Analog Input, Instance 3), Present_Value)
Property:	Controlled_Variable_Value =	56.1
Property:	Controlled_Variable_Units =	DEGREES_FAHRENHEIT
Property:	Setpoint_Reference =	((Analog Value, Instance 7), Present_Value)
Property:	Setpoint =	57.0
Property:	Action =	DIRECT
Property:	Proportional_Constant =	0.5
Property:	Proportional_Constant_Units =	PSI_PER_DEGREE_FAHRENHEIT
Property:	Integral_Constant =	0.1
Property:	Integral_Constant_Units =	PER-MINUTE
Property:	Derivative_Constant =	0.0
Property:	Derivative_Constant_Units =	NO-UNITS
Property:	Bias =	9.0
Property:	Maximum_Output =	15.0
Property:	Minimum_Output =	3.0
Property:	Priority_For_Writing =	10
Property:	COV_Increment =	0.2
Property:	Time_Delay =	3
Property:	Notification_Class =	1
Property:	Error_Limit =	5.0
Property:	Deadband =	1.0
Property:	Event_Enable =	{TRUE, TRUE, TRUE}
Property:	Acked_Transitions =	{TRUE, TRUE, TRUE}
Property:	Notify_Type =	ALARM
Property:	Event_Time_Stamps =	((23-MAR-95,18:50:21.2), (*-*-*,*:*:*.*), (23-MAR-95,19:01:34.0))

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D.18 Examples of a Multi-state Input Object

Example 1 - Two-speed fan.

In this example Input #1 is connected to the "aux" contact on the low-speed starter and Input #2 is connected to the "aux" contact of the high-speed starter. If the low-speed starter is "off," then the high-speed starter is disabled. The table below shows the relationship between the two inputs and the present value. The actual logic used to determine and establish the present value is a local matter. The object supports intrinsic reporting.

Present Value	Low-Speed Starter	High-Speed Starter
1	OFF (inactive)	OFF (inactive)
2	ON (active)	OFF (inactive)
3	ON (active)	ON (active)

Property:	Object_Identifier =	(Multi-state Input, Instance 1)
Property:	Object_Name =	"Fan1_Input"
Property:	Object_Type =	MULTI_STATE_INPUT
Property:	Present_Value =	2
Property:	Description =	"2-speed Fan#1"
Property:	Device_Type =	"ZZZ Fan Motor"
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Event_State =	NORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:	Number_Of_States =	3
Property:	State_Text =	("Off", "On_Low", "On_High")
Property:	Time_Delay =	3
Property:	Notification_Class =	4
Property:	Alarm_Values =	(3)
Property:	Fault_Values =	(2)
Property:	Event_Enable =	{TRUE, TRUE, TRUE}
Property:	Acked_Transitions =	{TRUE, TRUE, TRUE}
Property:	Notify_Type =	EVENT
Property:	Event_Time_Stamps =	((23-MAR-95,18:50:21.2), (*-*-*,*:*:*.*), (23-MAR-95,19:01:34.0))

Example 2: Hand-off-auto switch.

In this example the contacts of a three-position hand-off-auto switch are monitored as binary inputs. If the first input is active, then the present value is set to 1 (hand); if the second input is active, the present value is 2 (off); and if the third input is active, then the present value is 3 (auto). The object does not support intrinsic reporting.

Property:	Object_Identifier =	(Multi-state Input, Instance 2)
Property:	Object_Name =	"H-O-A"
Property:	Object_Type =	MULTISTATE_INPUT
Property:	Present_Value =	1
Property:	Description =	"Hand-Off-Auto 1"
Property:	Device_Type =	"ZZZ switch"
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Event_State =	NORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE

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Property:	Number_Of_States =	3
Property:	State_Text =	("Hand", "Off", "Auto")

D.19 Examples of a Multi-state Output Object

Example 1: Two-speed fan.

In this example Output #1 is connected to the coil of the low-speed starter and Output #2 is connected to the coil of the high-speed starter. If the low-speed starter is "off," then the high-speed starter is disabled. The table below shows the relationship between the two outputs and the present value. The actual logic used to determine, establish, and use the present value is a local matter. The object supports intrinsic reporting.

Present Value	Low-Speed Starter	High-Speed Starter
1	OFF (inactive)	OFF (inactive)
2	ON (active)	OFF (inactive)
3	ON (active)	ON (active)

Property:	Object_Identifier =	(Multi-state Output, Instance 1)
Property:	Object_Name =	"Fan1_Output"
Property:	Object_Type =	MULTI_STATE_OUTPUT
Property:	Present_Value =	2
Property:	Description =	"2-speed Fan#1"
Property:	Device_Type =	"ABC Fan Model A-6"
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Event_State =	OFFNORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:	Number_Of_States =	3
Property:	State_Text =	{"Off", "On_Low", "On_High"}
Property:	Priority_Array =	{NULL, NULL...2...NULL}
Property:	Relinquish_Default =	1
Property:	Time_Delay =	3
Property:	Notification_Class =	4
Property:	Feedback_Value =	3
Property:	Event_Enable =	{TRUE, TRUE, TRUE}
Property:	Acked_Transitions =	{TRUE, TRUE, TRUE}
Property:	Notify_Type =	EVENT
Property:	Event_Time_Stamps =	((23-MAR-95,18:50:21.2), (*-*-*,*:*:*.*), (21-MAR-95,01:02:03.0))

Example 2: Three-position switch.

In this example the contacts of a three-position switch are controlled as binary outputs. If the present value is 1, the first output will be active. If the present value is 2, then the second output is active. If the present value is 3, then the third output is active. The object does not support intrinsic reporting.

Property:	Object_Identifier =	(Multi-state Output, Instance 2)
Property:	Object_Name =	"3-POS-SW"
Property:	Object_Type =	MULTI_STATE_OUTPUT
Property:	Present_Value =	1
Property:	Description =	"3 POSITION SWITCH #1"

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Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Event_State =	NORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:	Number_Of_States =	3
Property:	State_Text =	{"Position_1", "Position_2", "Position_3"}
Property:	Priority_Array =	{NULL...NULL}
Property:	Relinquish_Default =	1

D.20 Example of a Multi-state Value Object

Example 1 - Unit Ventilator Operating Mode.
In this example the Present_Value is being used to indicate the operating mode for a Unit Ventilator. The actual logic used to determine and establish the present value is a local matter.

Property:	Object_Identifier =	(Multi-state Value, Instance 1)
Property:	Object_Name =	"UV39"
Property:	Object_Type =	MULTISTATE_VALUE
Property:	Present_Value =	2
Property:	Description =	"UnitVent Room 39"
Property:	Status_Flags =	{FALSE,FALSE,FALSE,FALSE}
Property:	Event_State =	NORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:	Number_Of_States =	4
Property:	State_Text =	("Unoccupied","Warmup","Occupied","Setback")

D.21 Example of a Notification Class Object

The following is an example of a Notification Class object for critical system alarms that contains a time-dependent recipient list.

Property:	Object_Identifier =	(Notification Class, Instance 1)
Property:	Object_Name =	"Alarms1"
Property:	Object_Type =	NOTIFICATION_CLASS
Property	Description =	"Critical System Alarms"
Property:	Notification_Class =	1
Property:	Priority =	(3, 10, 10)
Property:	Ack_Required =	(TRUE, TRUE, TRUE)
Property:	Recipient_List =	(((Monday, Tuesday, Wednesday, Thursday, Friday), 6:00, 20:00, (Device, Instance 12), 21, TRUE, (TRUE, TRUE, TRUE)), ((Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday), 0:00, 6:00, (Device, Instance 18), 5, TRUE, (TRUE, TRUE, FALSE)), ((Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday), 20:00, 24:00, (Device, Instance 18), 5, TRUE, (TRUE, TRUE, FALSE)))

D.22 Examples of a Program Object

The following sections provide examples of several types of application programs that use the PROGRAM object as a network-visible representation of their activities and program-specific parameters. The vendor-specific properties shown are purely for illustrative purposes and do not in any way reflect requirements of the standard. In particular, mnemonic names are used for property identifiers to clarify the intended use shown in each example. The actual implementation of these properties will use numeric codes that are specific to each vendor, to represent each property that is not defined in the standard.

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Example 1: An averaging program.

In this example, the application program uses three properties, Value1, Value2, and Value3, as inputs and produces an output that is the average of the three, according to the formula

Average = (Value1+Value2+Value3)/3.

The program object has been extended through the addition of four vendor-specific properties: Value1, Value2, Value3, and Average.

Property:	Object_Identifier =	(Program, Instance 1)
Property:	Object_Name =	"SomeAverage"
Property:	Object_Type =	PROGRAM
Property:	Program_State =	RUNNING
Property:	Program_Change =	READY
Property:	Reason_For_Halt =	NORMAL
Property:	Description_Of_Halt =	"Normal"
Property:	Program_Location =	"Line 2"
Property:	Description =	"Average of Somethings"
Property:	Instance_Of =	"ThreeWayAverager"
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:*	Value1 =	10
Property:*	Value2 =	22
Property:*	Value3 =	28
Property:*	Average =	20

NOTE: Those properties that are shown above with an asterisk "*" are so-called vendor-specific properties. They are shown here for illustrative purposes and do not represent a requirement of the standard.

Example 2: A maximum flow program.

In this example, the application program uses three properties, Ref1, Ref2, and Ref3, as BACnetPropertyReferences pointing to properties of three other objects that serve as inputs and produces an output that is the maximum of the three, according to the formula

Max = Maximum_Of(Ref1,Ref2,Ref3).

The program object has been extended through the addition of four vendor-specific properties: Ref1, Ref2, Ref3, and Max.

Property:	Object_Identifier =	(Program, Instance 2)
Property:	Object_Name =	"MaxFlow"
Property:	Object_Type =	PROGRAM
Property:	Program_State =	RUNNING
Property:	Program_Change =	READY
Property:	Reason_For_Halt =	NORMAL
Property:	Description_Of_Halt =	"Normal"
Property:	Program_Location =	"Line 5"
Property:	Description =	"Maximum of three Flows"
Property:	Instance_Of =	"Max3Refs"
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:*	Ref1 =	((Analog Input, Instance 272), Present_Value)
Property:*	Ref2 =	((Analog Input, Instance 273), Present_Value)

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Property:*	Ref3 =	((Analog Input, Instance 274), Present_Value)
Property:*	Max =	45.6

NOTE: Those properties shown above with an asterisk "*" are so-called vendor-specific properties. They are shown here for illustrative purposes and do not represent a requirement of the standard.

D.23 Example of a Pulse Converter Object

Property:	Object_Identifier =	(Pulse Converter, Instance 1)
Property:	Object_Name =	"Meter 5"
Property:	Object_Type =	PULSE_CONVERTER
Property:	Description =	""
Property:	Present_Value =	125.0
Property:	Input_Reference =	((Accumulator, Instance 1), Present_Value)
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Event_State =	NORMAL
Property:	Out_Of_Service =	FALSE
Property:	Units =	LITERS_PER_HOUR
Property:	Scale_Factor =	0.5
Property:	Adjust_Value =	500.0
Property:	Count =	250
Property:	Update_Time =	(10-JUL-01,11:40:21.0),
Property:	Count_Change_Time =	(10-JUL-01,11:30:01.0),
Property:	Count_Before_Change =	523
Property:	COV_Increment =	10.0
Property:	COV_Period =	3600
Property:	Notification_Class =	5
Property:	Time_Delay =	0
Property:	High_Limit =	1000.0
Property:	Low_Limit =	0.0
Property:	Deadband =	0.0
Property:	Limit_Enable =	{FALSE, TRUE}
Property:	Event_Enable =	{TRUE, FALSE, TRUE}
Property:	Acked_Transitions =	{TRUE, TRUE, TRUE}
Property:	Notify_Type =	ALARM
Property:	Event_Time_Stamps =	((12-JUL-01,18:50:21.2), (*-*-*,*:*:*.*), (12-JUL-01,19:01:34.0))

D.24 Example of a Schedule Object

The following is an example of a Schedule object that is used to control a classroom during the school year. In this example, a different Schedule object is assumed to be defined for the remainder of the calendar year. The reference property of this schedule is the Present_Value of a Binary Output object, in device 12, that controls a rooftop unit providing conditioned air to room 208.

Property:	Object_Identifier =	(Schedule, Instance 2)
Property:	Object_Name =	"Rm208Sched"
Property:	Object_Type =	SCHEDULE
Property:	Present_Value =	ACTIVE
Property:	Description =	"Room 208 Schedule"
Property:	Effective_Period =	((5-SEP-1995)-(10-JUN-1996))

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Property:	Weekly_Schedule =	{((8:00,ACTIVE),(17:00,INACTIVE)), ((8:00,ACTIVE)), ((8:00,ACTIVE),(17:00,INACTIVE)), ((8:00,ACTIVE),(17:00,INACTIVE), (19:00,ACTIVE),(23:30,INACTIVE)), ((8:00,ACTIVE),(17:00,INACTIVE)), ((00:00,INACTIVE)), ((10:00,ACTIVE),(17:00,INACTIVE))}
Property:	Exception_Schedule =	{((23-NOV-1995),(0:00,INACTIVE),10), ((HOLIDAYS,(0:00,INACTIVE),11), ((5-MAR-1996)-(7-MAR-1996),((0:00,INACTIVE), (9:00,ACTIVE),(14:00,INACTIVE)),6), ((8-MAR-1996),((10:00,INACTIVE),(11:00,NULL)),7)}
Property:	List_Of_Object_Property_References =	((Device, Instance 12),(Binary Output, Instance 9), Present_Value)
Property:	Priority_For_Writing =	15
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Schedule_Default =	INACTIVE
Property:	Out_Of_Service =	FALSE

On normal Mondays, Wednesdays, and Fridays the rooftop is made ACTIVE at 8 A.M. and INACTIVE at 5 P.M. On normal Tuesdays, the rooftop is made ACTIVE at 8 A.M. and is not otherwise affected by the schedule. On normal Thursdays, the rooftop is made ACTIVE at 8 A.M., INACTIVE at 5 P.M., ACTIVE again at 7 P.M., and INACTIVE at 11:30 P.M. On Saturdays the rooftop is INACTIVE all day. On Sundays the rooftop is made ACTIVE at 10 A.M. and INACTIVE at 5 P.M

On Thursday, November 23, 1995, the normal Thursday schedule is overridden by the first SPECIALEVENT in the Exception_Schedule list, which sets the rooftop INACTIVE for the entire day.

On Monday, February 19, 1996, the normal Monday schedule is overridden by the second SPECIALEVENT in the Exception_Schedule list, which follows the HOLIDAYS calendar described in D.9. Since February 19, 1996, Presidents' Day, is in the HOLIDAYS object's Date_List, the TIMEVALUEs associated with the second SPECIALEVENT are followed, which set the rooftop INACTIVE for the entire day.

The third SPECIALEVENT overrides the normal schedule between March 5, 1996, and March 7, 1996, for a teachers' conference. On these three days, the rooftop is made ACTIVE at 9 A.M. and INACTIVE at 2 P.M.

The fourth SPECIALEVENT overrides the normal Friday schedule on March 8, 1996, to create an hour of inactivity in the middle of the day for maintenance. On this day, the rooftop is made ACTIVE at 8 A.M. (by the normal schedule), INACTIVE at 10 A.M. (by the exception schedule), ACTIVE again at 11 A.M. (by the exception relinquishing, and the normal schedule resuming) and INACTIVE at 5 P.M. (by the normal schedule).

D.25 Example of a Trend Log Object

The following is an example of a Trend Log object that periodically logs data from an object in a remote device and which performs buffer-ready notification via intrinsic reporting.

Property:	Object_Identifier =	(Trend Log, Instance 1)
Property:	Object_Name =	"Room 3Log"
Property:	Object_Type =	TREND_LOG
Property:	Description =	"Room 3 Temperature"
Property:	Enable =	TRUE
Property:	Log_DeviceObjectProperty =	((Device, Instance 100), Analog Input, Instance 3, Present_Value)
Property:	Log_Interval =	6,000
Property:	Stop_When_Full =	FALSE
Property:	Buffer_Size =	250
Property:	Log_Buffer =	(((23-MAR-1998,12:32:33.0), 72.0,(FALSE,FALSE,FALSE,FALSE)),

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		(23-MAR-1998,12:34:32.0),72.1,(FALSE,FALSE,FALSE,FALSE)),…)
Property:	Record_Count =	250
Property:	Total_Record_Count =	131040
Property:	Notification_Threshold =	83
Property:	Records_Since_Notification =	30
Property:	Last_Notify_Record =	131010
Property:	Event_State =	NORMAL
Property:	Notification_Class =	1
Property:	Event_Enable =	{FALSE, TRUE, TRUE}
Property:	Acked_Transitions =	{TRUE, TRUE, TRUE}
Property:	Notify_Type =	EVENT
Property:	Event_Time_Stamps=	((23-MAR-95, 18:50:21.2), (*-*-*,*:*:*.*), (23-MAR-95, 19:01:34.0))
Property:	Logging_Type =	POLLED
Property:	Align_Intervals =	FALSE
Property:	Interval_Offset =	0
Property:	Trigger =	FALSE
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Reliability =	NO_FAULT_DETECTED

D.26 Example of an Access Door object

This example of an access door represents the main entrance doors to an office building. The door is scheduled for UNLOCK at priority 10 but this has been overridden with a LOCK by the manual operator at priority 8. The door is currently locked but is opened which has resulted in a forced-open alarm condition. The door-open-too-long alarm is temporarily masked and will not generate this type of alarm regardless of how long the door is held open.

Property:	object-identifier =	(Access Door, Instance 1)
Property:	object-name =	"Main Entrance"
Property:	object-type =	ACCESS DOOR
Property:	present-value =	LOCK
Property:	description =	"Main entrance south building"
Property:	status-flags =	(TRUE, FALSE, TRUE, FALSE)
Property:	event-state =	OFFNORMAL
Property:	reliability =	NO_FAULT_DETECTED
Property:	out-of-service =	FALSE
Property:	priority-array =	{NULL, NULL, NULL, NULL, NULL, NULL, NULL, LOCK, NULL, UNLOCK, NULL, NULL, NULL, NULL, NULL, NULL}
Property:	relinquish-default =	LOCK
Property:	door-status =	OPENED
Property:	lock-status =	LOCKED
Property:	secured-status =	UNSECURED
Property:	door-members =	{(Multistate Input, Instance 1), (Binary Output, Instance 7), (Binary Input, Instance 1), (Schedule, Instance 4)}
Property:	door-pulse-time =	60
Property:	door-extended-pulse-time =	300
Property:	door-open-too-long-time =	300
Property:	door-alarm-state	FORCED_OPEN
Property:	masked-alarm-values =	{DOOR_OPEN_TOO_LONG}
Property:	maintenance-required =	NONE
Property:	time-delay =	0
Property:	notification-class =	1

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Property:	alarm-values =	{DOOR_OPEN_TOO_LONG, FORCED_OPEN, TAMPER}
Property:	fault-values =	{DOOR_FAULT}
Property:	event-enable =	{TRUE, FALSE, TRUE}
Property:	acked-transitions =	{FALSE, TRUE, TRUE}
Property:	notify-type =	ALARM
Property:	event-time-stamps =	((7-JAN-2006, 15:30:51.7), (*-*-*, *:*:*.*), (*-*-*, *:*:*.*))

D.27 Example of an Event Log Object

The following is an example of an Event Log object that logs event notifications and which performs buffer-ready notification via intrinsic reporting.

Property:	Object_Identifier =	(Event Log, Instance 1)
Property:	Object_Name =	"Event Log"
Property:	Object_Type =	EVENT_LOG
Property:	Description =	"All event notifications"
Property :	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Event_State =	NORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Enable =	TRUE
Property:	Stop_When_Full =	FALSE
Property:	Buffer_Size =	250
Property:	Log_Buffer =	(((23-MAR-2004,12:32:33.0), (0, (Device, Instance 20), (Analog Input, Instance 1), (23-MAR-2004,12:32:25.0), 1, 1, OUT_OF_RANGE, "Too Hot", ALARM, TRUE, NORMAL, HIGH_LIMIT, (105.1, (TRUE, FALSE, FALSE, FALSE), 2.0, 100.0)), …)
Property:	Record_Count =	953
Property:	Total_Record_Count =	1000
Property:	Notification_Threshold =	950
Property:	Records_Since_Notification =	3
Property:	Last_Notify_Record =	950
Property:	Notification_Class =	1
Property:	Event_Enable =	{FALSE, TRUE, TRUE}
Property:	Acked_Transitions =	{TRUE, TRUE, TRUE}
Property:	Notify_Type =	EVENT
Property:	Event_Time_Stamps =	((23-MAR-2004, 6:50:21.2),(*-*-*,*:*:*.*), (23-MAR-2004, 6:01:34.0))

D.28 Example of a Load Control object

Property:	Object_Identifier =	(Load_Control, Instance 1)
Property:	Object_Name =	"Load Control 1"
Property:	Object_Type =	LOAD CONTROL
Property:	Description =	"Chiller Load Control"
Property:	Present_Value =	SHED_COMPLIANT
Property:	State_Description =	"shedding compliant with request"
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Event_State =	NORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Requested_Shed_Level =	(Percent, 80)
Property:	Start_Time =	(1-JUL-2002,10:00:00.0)
Property:	Shed_Duration =	120
Property:	Duty_Window =	30
Property:	Enable =	TRUE

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Property:	Full_Duty_Baseline =	250.0
Property:	Expected_Shed_Level =	80
Property:	Actual_Shed_Level =	80
Property:	Shed_Levels =	(1, 3, 6, 9)
Property:	Shed_Level_Descriptions =	("switch to alternate energy", "setback 2 degrees", "dim lights 20%", "setback 4 degrees")
Property:	Notification_Class =	3
Property:	Time_Delay =	60
Property:	Event_Enable =	{TRUE, FALSE, TRUE}
Property:	Acked_Transitions =	{TRUE, TRUE, TRUE}
Property:	Notify_Type =	ALARM
Property:	Event_Time_Stamps =	((17-APR-2001,18:50:21.2), (*-*-*,*:*:*.*), (17-APR-2001,19:01:34.0))

D.29 Example of a Structured View object

In this example, the objects comprising an air handling unit application are structured using a Structured View Object.

Property:	Object_Identifier =	(Structured View, Instance 1)
Property:	Object_Name =	"AHU1"
Property:	Object_Type =	STRUCTURED_VIEW
Property:	Description =	"Air Handling Unit 1"
Property:	Node_Type =	equipment
Property:	Node_Subtype =	"AHU"
Property:	Subordinate_List =	((Schedule, Instance 4), (Analog Value, Instance 3), (Analog Value, Instance 4), ((Device, Instance 2), (Analog Input, Instance 1)), (Analog Input, Instance 1), (Analog Input, Instance 2), (Structured View, Instance 2), (Structured View, Instance 3), (Structured View, Instance 4))
Property:	Subordinate_Annotations =	("AHU1 Mode Schedule", "AHU1 Heating Setpoint", "AHU1 Cooling Setpoint", "Outside Air Temperature", "AHU1 Supply Air Temperature", "AHU1 Exhaust Air Temperature", "AHU1 Preheater Subsystem", "AHU1 Fan Supply Air Subsystem ", "AHU1 Fan Exhaust Air Subsystem")

D.30 Example of a Trend Log Multiple Object

The following is an example of a Trend Log Multiple object that logs data every 5 minutes from objects in remote device 100 and which performs buffer-ready notification via intrinsic reporting.

Property:	Object_Identifier =	(Trend Log Multiple, Instance 1)
Property:	Object_Name =	"Area 47 Log"
Property:	Object_Type =	TREND_LOG_MULTIPLE
Property:	Description =	"Area 47 Records"
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}

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Property:	Event_State =	NORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Enable =	TRUE
Property:	Log_DeviceObjectProperty =	(((Analog Input, Instance 3), Present_Value, (Device, Instance 100)), ((Analog Input, Instance 3), Status_Flags, (Device, Instance 100)), ((Binary Output, Instance 5), Present_Value, (Device, Instance 100)))
Property:	Logging_Type =	POLLED
Property:	Log_Interval =	30000
Property:	Align_Intervals =	TRUE
Property:	Interval_Offset =	15000
Property:	Stop_When_Full =	FALSE
Property:	Buffer_Size =	250
Property:	Log_Buffer =	(((23-MAR-2004,12:32:33.0),72.0,(FALSE,FALSE,FALSE,FALSE),ON), ((23-MAR-2004,12:34:32.0),72.1, (FALSE,FALSE,FALSE,FALSE),ON), …)
Property:	Record_Count =	250
Property:	Total_Record_Count =	131040
Property:	Notification_Threshold =	83
Property:	Records_Since_Notification =	30
Property:	Last_Notify_Record =	131010
Property:	Notification_Class =	1
Property:	Event_Enable =	{FALSE, TRUE, TRUE}
Property:	Acked_Transitions =	{TRUE, TRUE, TRUE}
Property:	Notify_Type =	EVENT
Property:	Event_Time_Stamps =	((23-MAR-2004, 18:50:21.2),(*-*-*,*:*:*.*), (23-MAR-2004, 18:01:34.0))

D.31 Example of a Network Security Object

The following is an example of a Network Security object that is found in a secure device that does not support routing.

Property:	Object_Identifier =	(Network Security, Instance 1)
Property:	Object_Name =	"Network Security Settings"
Property:	Object_Type =	NETWORK_SECURITY
Property:	Description =	"Encrypted Device"
Property:	Base_Device_Security_Policy =	ENCRYPTED
Property:	Network_Access_Security_Policies =	((40, PLAIN_NON_TRUSTED) , (50, ENCRYPTED_TRUSTED))
Property:	Security_Time_Window =	180
Property:	Packet_Reorder_Time =	1000
Property:	Distribution_Key_Revision =	32
Property:	Key_Sets =	((32, (1-OCT-2007, 00:00:00.0), (2-OCT-2007, 01:00:00.0), ((0,1),(0,2),(0,4),(0,5))), ((33, (2-OCT-2007, 00:00:00.0), (3-OCT-2007, 01:00:00.0), ((0,1),(0,2),(0,4),(0,5))))
Property:	Last_Key_Server =	((Device, Instance 40), 2, X'C0A80001BAC0')
Property:	Security_PDU_Timeout =	3000
Property:	Update_Key_Set_Timeout =	9000
Property:	Supported_Security_Algorithms =	(0, 1)
Property:	Do_Not_Hide =	TRUE
Property:	Profile_Name =	"0-Network Security Object Type"

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D.32 Example of an Access Point object

In this example, authentication and authorization at an entrance to a secured zone is represented as an Access Point object "Main Entrance 1". The secured zone to enter is assumed to be represented by an Access Zone object instance 23.

There are three Credential Data Input objects used, all located in remote Device 12:

(a) Proximity Card Reader - Instance 3
(b) PIN Keypad - Instance 4
(c) Iris Scanner - Instance 5

Three different authentication policies are defined and can be activated:

(a) OFFICE HOURS - Low Security - Proximity Card Reader or PIN Keypad
(b) LATE SHIFT - Medium Security Proximity Card Reader and PIN Keypad
(c) NIGHT - High Security - Proximity Card Reader and Iris Scanner

The current authorization mode is AUTHORIZE, authentication and authorization is in effect. The current authentication policy is set to "OFFICE-HOURS".

The Access Point is currently not locked down. The Access Point will go into a locked down state after three failed attempts. A failed attempt is specified to occur when one of the following access events are generated:

1. DENIED_UNKNOWN_CREDENTIAL - the credential is unknown
2. DENIED_ZONE_NO_ACCESS_RIGHTS - the credential does not have any access rights at the zone
3. DENIED_POINT_NO_ACCESS_RIGHTS - the credential does not have any access rights at the access point
4. DENIED_THREAT_LEVEL -the credential does not have a sufficient threat authority to enter at this access point

The current threat level is 20.

Access Door objects 44 and 45, local in the device, are controlled at a command priority 12.

Occupancy lower limit is not checked but upper limit is checked if present at the Access Zone. This access point will adjust the occupancy count of both the exit and entry zones when a credential holder passes through this access point.

The last event to occur at this access point was a passback violation which happened on March 21, 2008, at 6:50 PM as part of access transaction 1116. The authentication factor used is a 32-bit simple number and has a value of 1334234499. This authentication factor is contained in the credential object with instance 41445.

Property:	Object_Identifier =	(Access Point, Instance 2)
Property:	Object_Name =	"MAIN-ENTRANCE-01"
Property:	Object_Type =	ACCESS_POINT
Property:	Description =	"Main Entrance 1"
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Event_State =	(NORMAL)
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:	Authentication_Status	READY
Property:	Active_Authentication_Policy =	1
Property:	Number_Of_Authentication_Policies =	3
Property:	Authentication_Policy_List =	{
		((((Device, Instance 12) (Credential Data Input, Instance 3)),1),
		(((Device, Instance 12) (Credential Data Input, Instance 4)),1), FALSE, 0),
		((((Device, Instance 12) (Credential Data Input, Instance 3)),1),
		(((Device, Instance 12) (Credential Data Input, Instance 4)),2), TRUE, 0),

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		((((Device, Instance 12) (Credential Data Input, Instance 3)),1), (((Device, Instance 12) (Credential Data Input, Instance 5)),2), TRUE, 30)
}		
Property:	Authentication_Policy_Names =	("OFFICE_HOURS", "LATE_SHIFT", "NIGHT")
Property:	Authorization_Mode =	AUTHORIZE
Property:	Verification_Time =	15
Property:	Lockout =	FALSE
Property:	Lockout_Relinquish_Time =	60
Property:	Failed_Attempts =	0
Property:	Failed_Attempt_Events =	(DENIED_UNKNOWN_CREDENTIAL, DENIED_ZONE_NO_ACCESS_RIGHTS, DENIED_POINT_NO_ACCESS_RIGHTS, DENIED_THREAT_LEVEL)
Property:	Max_Failed_Attempts =	3
Property:	Failed_Attempts_Time =	10
Property:	Threat_Level =	20
Property:	Occupancy_Upper_Limit_Enforced =	TRUE
Property:	Occupancy_Lower_Limit_Enforced =	FALSE
Property:	Occupancy_Count_Adjust =	TRUE
Property:	Accompaniment_Time =	15
Property:	Access_Event =	PASSBACK_DETECTED
Property:	Access_Event_Tag	1116
Property:	Access_Event_Time =	((21 MAR 2008, FRIDAY), 18:50:21.2)
Property:	Access_Event_Credential =	(, (Access Credential, Instance 41445))
Property:	Access_Event_Authentication_Factor =	(SIMPLE_NUMBER32, 1334234499)
Property:	Access_Doors =	((, (Access Door, Instance 44)), (, (Access Door, Instance 45)))
Property:	Priority_For_Writing =	12
Property:	Muster_Point =	FALSE
Property:	Zone_To =	(, (Access Zone, Instance 23))
Property:	Zone_From =	(, (Access Zone, Instance 1))
Property:	Notification_Class =	39
Property:	Transaction_Notification_Class =	48
Property:	Access_Alarm_Events =	(DURESS, PASSBACK_DETECTED)
Property:	Access_Transaction_Events =	(GRANTED, DENIED_PASSBACK, AUTHENTICATION_FACTOR_READ, DENIED_UNKNOWN_CREDENTIAL, DENIED_ZONE_NO_ACCESS_RIGHTS, DENIED_POINT_NO_ACCESS_RIGHTS)
Property:	Event_Enable =	{TRUE, TRUE, TRUE}
Property:	Acked_Transitions =	{TRUE, TRUE, FALSE}
Property:	Notify_Type =	EVENT
Property:	Event_Time_Stamps =	((*-*-*, *:*:*.*), (*-*-*, *:*:*.*), ((21 MAR 2008, FRIDAY), 18:50:21.3))

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D.33 Example of an Access Zone object

In this example, an access controlled zone is represented as an Access Zone object. The same access controlled zone is represented in multiple devices and its global identifier is 23.

This Access Zone has an upper occupancy limit of 100. The zone will report an AT_UPPER_LIMIT alarm if the occupancy count becomes equal to the upper occupancy limit and will report an ABOVE_UPPER_LIMIT alarm if the count goes above the upper occupancy limit. The state of this zone is NORMAL because the current occupancy is below the occupancy upper

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limit. There are two access credentials currently in the zone. Passback detection is switched off.

The entry Access Points (Local Device, Instance 2 and 3) are leading into the zone and the exit Access Points (Local Device, Instance 12 and 13) are leading out of the Access Zone.

Property:	Object_Identifier =	(Access Zone, Instance 23)
Property:	Object_Name =	"OFFICE_MAIN_FLOOR"
Property:	Object_Type =	ACCESS_ZONE
Property:	Description =	"Office Main Floor"
Property:	Global_Identifier =	23
Property:	Occupancy_State =	NORMAL
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Event_State =	NORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:	Occupancy_Count =	2
Property:	Occupancy_Count_Enable =	TRUE
Property:	Adjust_Value =	0
Property:	Occupancy_Upper_Limit =	100
Property:	Occupancy_Lower_Limit =	0
Property:	Credentials_In_Zone =	((,(Access Credential, Instance 12110)), (,(Access Credential, Instance 12245)))
Property:	Last_Credential_Added =	(,(Access Credential, Instance 12110))
Property:	Last_Credential_Added_Time =	((16 APRIL 2008, WEDNESDAY), 09:05:23.1))
Property:	Last_Credential_Removed =	(,(Access Credential, Instance 14430))
Property:	Last_Credential_Removed_Time =	((16 APRIL 2008, WEDNESDAY), 08:59:46.8))
Property:	Passback_Mode =	PASSBACK_OFF
Property:	Passback_Timeout =	10
Property:	Entry_Points =	((,(Access Point, Instance 2)), (,(Access Point, Instance 3)))
Property:	Exit_Points =	((,(Access Point, Instance 12)), (,(Access Point, Instance 13)))
Property:	Time_Delay =	10
Property:	Notification_Class =	39
Property:	Alarm_Values =	(AT_UPPER_LIMIT, ABOVE_UPPER_LIMIT)
Property:	Event_Enable =	{TRUE, TRUE, TRUE}
Property:	Acked_Transitions =	{TRUE, TRUE, TRUE}
Property:	Notify_Type =	EVENT
Property:	Event_Time_Stamps =	((16 APRIL 2008, WEDNESDAY), 09:11:14.3)), (*-*-*,*:*:*.*), ((16 APRIL 2008, WEDNESDAY), 11:13:21.3)))

D.34 Example of an Access User object

In this example, the person Dorothy H. Miller is represented as an Access User object. Note that this is a fictitious person. The same access user is represented in multiple devices and its global identifier is 22457.

Property:	Object_Identifier =	(Access User, Instance 2)
Property:	Object_Name =	"Miller37"
Property:	Object_Type =	ACCESS_USER
Property:	Description =	"Dorothy H. Miller, CEO"
Property:	Global_Identifier =	22457
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Reliability =	NO_FAULT_DETECTED
Property:	User_Type =	PERSON
Property:	User_Name =	"Dorothy H. Miller"
Property:	User_External_Identifier =	"SSN-575-99-1234"
Property:	User_Information_Reference =	"HRMS:D93345666"

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Property:	Members =	((Access User, Instance 734), (Access User, Instance 41))
Property:	Member_Of =	((Access User, Instance 12), (Access User, Instance 1))
Property:	Credentials =	((Access Credential, Instance 12110), (Access Credential, Instance 41445))

D.35 Examples of Access Rights objects

Assumed objects:

Object_Identifier	Object_Name	Object_Type
(Device 12, Access Point, Instance 1)	Main Production Area Door	ACCESS_POINT
(Device 14, Access Point, Instance 7)	North Emergency Exit Door	ACCESS_POINT
(Access Zone, Instance 23)	Perimeter Doors	ACCESS_ZONE
(Schedule, Instance 44)	Night Shift Hours	SCHEDULE
(Access Credential, Instance 33)	Bob Smith	ACCESS_CREDENTIAL

In this first example, this Access Rights object defines the access rights of night shift workers of the facility. The rules state that credentials having this access right may access any of the perimeter doors (Access Zone, Instance 23) at any time with the exception of the north emergency exit door (Device 12, Access Point, Instance 7), for which access is never allowed. In addition, the main production area door (Device 14, Access Point, Instance 1) may be accessed during times when the night shift hours schedule (Schedule, Instance 44) is active. This access rights collection is represented only in a single device and therefore its global identifier is zero.

Property:	Object_Identifier =	(Access Rights, Instance 2)
Property:	Object_Name =	"Night Shift Rights"
Property:	Object_Type =	ACCESS_RIGHTS
Property:	Description =	"Access Rights for main production area at night shift"
Property:	Global_Identifier 0	
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Enable =	TRUE
Property:	Negative_Access_Rules =	((ALWAYS, ((*, Instance 4194303), *,,), SPECIFIED, ((Device, Instance 12), (Access Point, Instance 7)), TRUE))
Property:	Positive_Access_Rules =	((SPECIFIED, ((Schedule, Instance 44), Present_Value,,), SPECIFIED, ((Device, Instance 14), (Access Point, Instance 1)), TRUE), (ALWAYS, ((*, Instance 4194303), *,,), SPECIFIED, (,(Access Zone, Instance 23)), TRUE))

In this second example, this Access Rights object defines the access rules for visitors to this facility. The rules state that a visitor may have access to any door in the facility but that they must always be accompanied by Bob Smith (Access Credential, Instance 33).

Property:	Object_Identifier =	(Access Rights, Instance 9)
Property:	Object_Name =	"Visitor Access Rights"
Property:	Object_Type =	ACCESS_RIGHTS
Property:	Description =	"Access rights for accompanied visitors"
Property:	Enable =	TRUE
Property:	Negative_Access_Rules = ()	
Property:	Positive_Access_Rules =	((ALWAYS, ((*, Instance 4194303), *,,), ALL, (,(*, Instance 4194303)), TRUE))
Property:	Accompaniment =	(,(Access Credential, Instance 33))

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D.36 Example of an Access Credential object

This example of an Access Credential object represents the authentication factors assigned to a specific user who has the identical access rights. The credential is active and has two authentication factors assigned to it:

(1) Wiegand proximity card with facility code =131 (X'83') and card number 77 (X'004D'). This authentication factor has been disabled because it was lost.
(2) A FASC-N smart card with agency code = 9700 (X'25E4'), system site code = 1234 (X'04D2') and credential number = 123456 (X'0001E240').

The credential is valid from 1-MAR-2008 09:00 AM until 30-MAR-2009 11:59 PM and is valid for 30 uses. If the card is not used for 14 consecutive days, it will automatically become disabled.

The credential belongs to an Access User Instance 2 and has access rights, as specified by the local Access Rights object instance 1 and 77 assigned to it. The credential also has the local Access Rights object instance 219 assigned to it, but it has been disabled for this credential.

The credential has the extended access time flag enabled, but neither master exemption, passback exemption nor occupancy count exemption is set for this credential. The same credential is represented in multiple devices and its global identifier is 805281245.

Property:	Object_Identifier =	(Access Credential, Instance 33)
Property:	Object_Name =	"Manager Credential 33"
Property:	Object_Type =	ACCESS_CREDENTIAL
Property:	Description =	"Credential 1 Miller37"
Property:	Global_Identifier	805281245
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Credential_Status =	ACTIVE
Property:	Reason_For_Disable =	( )
Property:	Authentication_Factors =	((DISABLE_LOST,(WIEGAND26, 0, X'83004D')), (NONE, (FASC_N, 0, X'25E404D20001E240')))
Property:	Activation_Time =	((01 MAR 2008, SATURDAY), 09:00:00.0))
Property:	Expiry_Time =	((30 MAR 2009, MONDAY), 23:59:59.9))
Property:	Credential_Disable =	NONE
Property:	Days_Remaining =	-1
Property:	Uses_Remaining =	30
Property:	Absentee_Limit =	14
Property:	Belongs_To =	(Access User, Instance 2)
Property:	Assigned_Access_Rights =	(((,(Access Rights, Instance 1)), TRUE), ((,(Access Rights, Instance 77)), TRUE), ((,(Access Rights, Instance 219)), FALSE))
Property:	Last_Access_Point =	(,(Access Point, Instance 2))
Property:	Last_Access_Event =	PASSBACK_DETECTED
Property:	Last_Use_Time =	((8 APRIL 2008, TUESDAY), 11:11:33.2))
Property:	Trace_Flag =	FALSE
Property:	Threat_Authority =	50
Property:	Extended_Time_Enable =	TRUE
Property:	Master_Exemption =	FALSE
Property:	Passback_Exemption =	FALSE
Property:	Occupancy_ Exemption =	FALSE

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D.37 Example of an Credential Data Input object

This example of a credential data input object represents a card reader on the unsecure side of the door. This object supports two variants of the 16-bit facility and 32-bit card number format (FACILITY16_CARD32). These two variants are distinguished from each other by having a format class of 89 and 99 respectively. This object also supports the 37-bit Wiegand format (WIEGAND37).

A valid card was recently read with a facility code of 121 (X'0079') and a card number of 20926 (X'000051BE').

Property:	Object_Identifier =	(Credential Data Input, Instance 1)
Property:	Object_Name =	"Main Entrance Card Reader"
Property:	Object_Type =	CREDENTIAL_DATA_INPUT
Property:	Present_Value =	(FACILITY16_CARD32, 89, X'0079000051BE')
Property:	Description =	"Main entrance south building multi-format card reader"
Property:	Status_Flags =	(FALSE, FALSE, FALSE, FALSE)
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:	Supported_Formats =	((FACILITY16_CARD32, 0, 0), (FACILITY16_CARD32, 0, 0), (WIEGAND37, 0, 0))
Property:	Supported_Format_Classes =	(89,99,0)
Property:	Update_Time =	((7 JAN 2008, MONDAY), 15:30:51.70)

D.38 Example of a CharacterString Value object

Property:	Object_Identifier =	(CharacterString_Value, Instance 1)
Property:	Object_Name =	"SOMEIMPORTANTVALUE"
Property:	Object_Type =	CHARACTERSTRING_VALUE
Property:	Description =	"Some Description"
Property:	Present_Value =	"Some String Value"
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Event_State =	NORMAL
Property:	Reliability =	NO_FAULT_DETECTED
Property:	Out_Of_Service =	FALSE
Property:	Priority_Array=	{NULL, NULL, …, "Some String Value"}
Property:	Relinquish_Default=	""
Property:	Time_Delay =	10
Property:	Notification_Class =	3
Property:	Alarm_Values =	{"ALM","FLT"}
Property:	Event_Enable =	{TRUE,FALSE,TRUE}
Property:	Acked_Transitions =	{TRUE,TRUE,TRUE}
Property:	Notify_Type =	ALARM
Property:	Event_Time_Stamps =	((23-MAR-05,18:50:21.2), (*-*-*,*:*:*.*), (23-MAR-05,19:01:34.0))

D.39 Example of a DateTime Value object

Property:	Object_Identifier =	(DateTime_Value, Instance 1)
Property:	Object_Name =	"SOMEIMPORTANTVALUE"
Property:	Object_Type =	DATETIME_VALUE
Property:	Description =	"Some Description"
Property:	Present_Value =	(23-MAR-1998,12:32:33.0),
Property:	Status_Flags =	{FALSE, FALSE, FALSE, FALSE}
Property:	Event_State =	NORMAL

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Property: Reliability = NO_FAULT_DETECTED
Property: Is_UTC = FALSE
Property: Out_Of_Service = FALSE

D.40 Example of a Large Analog Value object

Property: Object_Identifier = (Large_Analog_Value, Instance 1)
Property: Object_Name = "SOMEIMPORTANTVALUE"
Property: Object_Type = LARGE_ANALOG_VALUE
Property: Description = "Some Description"
Property: Present_Value = 123456.789123456
Property: Status_Flags = {FALSE, FALSE, FALSE, FALSE}
Property: Event_State = NORMAL
Property: Reliability = NO_FAULT_DETECTED
Property: Out_Of_Service = FALSE
Property: Priority_Array= {NULL ,NULL, …, 123456.789123456}
Property: Relinquish_Default= 50.0
Property: Time_Delay = 10
Property: Notification_Class = 3
Property: High_Limit = 60.0
Property: Low_Limit = 55.0
Property: Deadband = 1.0
Property: Limit_Enable = {TRUE,TRUE}
Property: Event_Enable = {TRUE,FALSE,TRUE}
Property: Acked_Transitions = {TRUE,TRUE,TRUE}
Property: Notify_Type = ALARM
Property: Event_Time_Stamps = ((23-MAR-05,18:50:21.2),
(*-*-*,*:*:*.*),
(23-MAR-05,19:01:34.0))

D.41 Example of a BitString Value object

Property: Object_Identifier = (BitString_Value, Instance 1)
Property: Object_Name = "SOMEIMPORTANTVALUE"
Property: Object_Type = BITSTRING_VALUE
Property: Description = "Some Description"
Property: Present_Value = {FALSE,TRUE,FALSE}
Property: Bit_Text = {"Overheated","Needs Oil","Change Filter"}
Property: Status_Flags = {FALSE, FALSE, FALSE, FALSE}
Property: Event_State = NORMAL
Property: Reliability = NO_FAULT_DETECTED
Property: Out_Of_Service = FALSE
Property: COV_Increment = {TRUE,TRUE,FALSE}
Property: Time_Delay = 10
Property: Notification_Class = 3
Property: Alarm_Values = {{TRUE,TRUE,TRUE}}
Property: Bit_Mask = {TRUE,TRUE,TRUE}
Property: Event_Enable = {TRUE,FALSE,TRUE}
Property: Acked_Transitions = {TRUE,TRUE,TRUE}
Property: Notify_Type = ALARM
Property: Event_Time_Stamps = ((23-MAR-05,18:50:21.2),
(*-*-*,*:*:*.*),
(23-MAR-05,19:01:34.0))

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D.42 Example of an OctetString Value object

Property: Object_Identifier = (OctetString_Value, Instance 1)
Property: Object_Name = "SOMEIMPORTANTVALUE"
Property: Object_Type = OCTETSTRING_VALUE
Property: Description = "Some Description"
Property: Present_Value = {1,27,49,5,137}
Property: Status_Flags = {FALSE, FALSE, FALSE, FALSE}
Property: Event_State = NORMAL
Property: Reliability = NO_FAULT_DETECTED
Property: Out_Of_Service = FALSE

D.43 Example of a Time Value object

Property: Object_Identifier = (Time_Value, Instance 1)
Property: Object_Name = "SOMEIMPORTANTVALUE"
Property: Object_Type = TIME_VALUE
Property: Description = "Some Description"
Property: Present_Value = 12:34:56.77
Property: Status_Flags = {FALSE, FALSE, FALSE, FALSE}
Property: Event_State = NORMAL
Property: Reliability = NO_FAULT_DETECTED
Property: Out_Of_Service = FALSE
Property: Priority_Array= {NULL ,NULL, …, 12:34:56.77}
Property: Relinquish_Default= 00:00:00.00

D.44 Example of a Integer Value object

Property: Object_Identifier = (Integer_Value, Instance 1)
Property: Object_Name = "SOMEIMPORTANTVALUE"
Property: Object_Type = INTEGER_VALUE
Property: Description = "Some Description"
Property: Present_Value = -1238
Property: Status_Flags = {FALSE, FALSE, FALSE, FALSE}
Property: Event_State = NORMAL
Property: Reliability = NO_FAULT_DETECTED
Property: Out_Of_Service = FALSE
Property: Priority_Array= {NULL ,NULL, ..., 27... NULL}
Property: Relinquish_Default= -52
Property: Time_Delay = 10
Property: Notification_Class = 3
Property: High_Limit = 600
Property: Low_Limit = 50
Property: Deadband = 10
Property: Limit_Enable = {TRUE,TRUE}
Property: Event_Enable = {TRUE,FALSE,TRUE}
Property: Acked_Transitions = {TRUE,TRUE,TRUE}
Property: Notify_Type = ALARM
Property: Event_Time_Stamps = ((23-MAR-05,18:50:21.2),
(*-*-*,*:*:*.*),
(23-MAR-05,19:01:34.0))

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D.45 Example of an Positive Integer Value object

Property: Object_Identifier = (Positive Integer_Value, Instance 1)
Property: Object_Name = "SOMEIMPORTANTVALUE"
Property: Object_Type = POSITIVE_INTEGER_VALUE
Property: Description = "Some Description"
Property: Present_Value = 123456789
Property: Status_Flags = {FALSE, FALSE, FALSE, FALSE}
Property: Event_State = NORMAL
Property: Reliability = NO_FAULT_DETECTED
Property: Out_Of_Service = FALSE
Property: Priority_Array= {NULL ,NULL, …, 123456789}
Property: Relinquish_Default= 0
Property: Time_Delay = 10
Property: Notification_Class = 3
Property: High_Limit = 60000000
Property: Low_Limit = 0
Property: Deadband = 100
Property: Limit_Enable = {TRUE,FALSE}
Property: Event_Enable = {TRUE,FALSE,TRUE}
Property: Acked_Transitions = {TRUE,TRUE,TRUE}
Property: Notify_Type = ALARM
Property: Event_Time_Stamps = ((23-MAR-05,18:50:21.2),
(*-*-*,*:*:*.*),
(23-MAR-05,19:01:34.0))

D.46 Example of a Date Value object

Property: Object_Identifier = (Date_Value, Instance 1)
Property: Object_Name = "SOMEIMPORTANTVALUE"
Property: Object_Type = DATE_VALUE
Property: Description = "Some Description"
Property: Present_Value = (23-MAR-1998),
Property: Status_Flags = {FALSE, FALSE, FALSE, FALSE}
Property: Event_State = NORMAL
Property: Reliability = NO_FAULT_DETECTED
Property: Out_Of_Service = FALSE
Property: Priority_Array= {NULL ,NULL, …, (23-MAR-1998)}
Property: Relinquish_Default= (*-*-*)

D.47 Example of a DateTime Pattern Value object

Property: Object_Identifier = (DateTime_Pattern_Value, Instance 1)
Property: Object_Name = "SOMEIMPORTANTVALUE"
Property: Object_Type = DATETIME_PATTERN_VALUE
Property: Description = "Some Description"
Property: Present_Value = (23-MAR-*,12:*:*.*),
Property: Status_Flags = {FALSE, FALSE, FALSE, FALSE}
Property: Event_State = NORMAL
Property: Reliability = NO_FAULT_DETECTED
Property: Out_Of_Service = FALSE

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D.48 Example of a Time Pattern Value object

Property: Object_Identifier = (Time_Pattern_Value, Instance 1)
Property: Object_Name = "SOMEIMPORTANTVALUE"
Property: Object_Type = TIME_PATTERN_VALUE
Property: Description = "Some Description"
Property: Present_Value = 12:*:*.*
Property: Status_Flags = {FALSE, FALSE, FALSE, FALSE}
Property: Event_State = NORMAL
Property: Reliability = NO_FAULT_DETECTED
Property: Out_Of_Service = FALSE
Property: Priority_Array= {NULL ,NULL, …, 12:*:*.*}
Property: Relinquish_Default= 00:00:00.00

D.49 Example of a Date Pattern Value object

Property: Object_Identifier = (Date_Pattern_Value, Instance 1)
Property: Object_Name = "SOMEIMPORTANTVALUE"
Property: Object_Type = DATE_PATTERN_VALUE
Property: Description = "Some Description"
Property: Present_Value = (23-MAR-*),
Property: Status_Flags = {FALSE, FALSE, FALSE, FALSE}
Property: Event_State = NORMAL
Property: Reliability = NO_FAULT_DETECTED
Property: Out_Of_Service = FALSE
Property: Priority_Array= {NULL ,NULL, …, (23-MAR-*)}
Property: Relinquish_Default= (*-*-*)

D.50 Example of a Global Group Object

The following is an example of a group object that is used to reference temperatures in a particular zone of a building.

Property: Object_Identifier = (Global Group, Instance 1)
Property: Object_Name = "West Wing Group"
Property: Object_Type = GLOBAL_GROUP
Property: Description = "Critical West Wing Values"
Property: Group_Members = (
((Analog Input, Instance 8), Present_Value),
((Analog Input, Instance 8), Status_Flags),
((Life Safety Point, Instance 8), Present_Value),
((Life Safety Point, Instance 8), Mode),
((Life Safety Point, Instance 8), Status_Flags),
((Analog Input, Instance 9), Present_Value),
((Analog Input, Instance 9), Status_Flags),
((Life Safety Point, Instance 9), Present_Value),
((Life Safety Point, Instance 9), Mode),
((Life Safety Point, Instance 9), Status_Flags),
((Analog Input, Instance 10), Present_Value, Device, Instance 4)),
((Analog Input, Instance 10), Status_Flags, (Device, Instance 4)),
((Life Safety Point, Instance 10), Present_Value, (Device, Instance 4)),
((Life Safety Point, Instance 10), Mode, (Device, Instance 4)),
((Life Safety Point, Instance 10), Status_Flags, (Device, Instance 4)),
((Analog Input, Instance 11), Present_Value, (Device, Instance 4)),
((Analog Input, Instance 11), Status_Flags, (Device, Instance 4)),
((Life Safety Point, Instance 11), Present_Value, (Device, Instance 4)),

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```
                                ((Life Safety Point, Instance 11), Mode, (Device, Instance 4)),
                                ((Life Safety Point, Instance 11), Status_Flags, (Device, Instance 4))
                                )
Property:       Group_Member_Names = (
                        "Z8 Temp", "Z8 Temp Status", "Smoke Detector State", "Mode", "Health",
                        "Z9 Temp", "Z9 Temp Status", "Smoke Detector State", "Mode", "Health",
                        "Z10 Temp", "Z10 Temp Status", "Smoke Detector State", "Mode",
        "Health","Z11 Temp", "Z11 Temp Status", "Smoke Detector State", "Mode",
                        "Health"
                        )
Property:       Present_Value = (
                                ((Analog Input, Instance 8), Present_Value, 69.7),
                                ((Analog Input, Instance 8),
                                        Status_Flags,{FALSE, FALSE, FALSE,FALSE}),
                                ((Life Safety Point, Instance 8), Present_Value, QUIET)
                                ((Life Safety Point, Instance 8), Mode, ON),
                                ((Life Safety Point, Instance 8),
                                        Status_Flags, {FALSE, FALSE, FALSE,FALSE}),
                                ((Analog Input, Instance 9), Present_Value, 71.2),
                                ((Analog Input, Instance 9),
                                        Status_Flags,{FALSE, FALSE, FALSE,FALSE}),
                                ((Life Safety Point, Instance 9), Present_Value, QUIET),
                                ((Life Safety Point, Instance 9), Mode, ON),
                                ((Life Safety Point, Instance 9),
                                        Status_Flags, {FALSE, FALSE, FALSE,FALSE}),
                                ((Device, Instance 4), (Analog Input, Instance 10), Present_Value, -50),
                                ((Device, Instance 4), (Analog Input, Instance 10),
                                        Status_Flags, {TRUE,TRUE,FALSE,FALSE}),
                                ((Device, Instance 4), (Life Safety Point, Instance 10), Present_Value,QUIET),
                                ((Device, Instance 4), (Life Safety Point, Instance 10), Mode, ON),
                                ((Device, Instance 4), (Life Safety Point, Instance 10),
                                        Status_Flags, {FALSE, FALSE, FALSE, FALSE}),
                                ((Device, Instance 4) , (Analog Input, Instance 11), Present_Value, 69.7),
                                ((Device, Instance 4), (Analog Input, Instance 11),
                                        Status_Flags, {FALSE,FALSE, FALSE, FALSE}),
                                ((Device, Instance 4), (Life Safety Point, Instance 11), Present_Value,QUIET),
                                ((Device, Instance 4), (Life Safety Point, Instance 11), Mode, ON),
                                ((Device, Instance 4), (Life Safety Point, Instance 11)
                                        Status_Flags,{FALSE, FALSE, FALSE, FALSE})
                                )
Property:       Status_Flags =          {TRUE, TRUE, FALSE, FALSE}
Property:       Event_State =           FAULT
Property:       Member_Status_Flags =   {TRUE, TRUE, FALSE, FALSE}
Property:       Reliability =           UNRELIABLE_OTHER
Property:       Out_Of_Service  =       FALSE
Property:       Update_Interval =       10
Property:       Requested_Update_Interval =10
Property:       Time_Delay =            10
Property:       Notification_Class =    39
Property:       Event_Enable =          {TRUE, TRUE, TRUE}
Property:       Acked_Transitions =     {TRUE, TRUE, TRUE}
Property:       Notify_Type =           ALARM
Property:       Event_Time_Stamps =     ((23-MAR-01, 18:50:21.2),
                                        (*-*-*, *:*:*.*),
                                        (23-MAR-01, 19:01:34.0))
```

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Property: COVU_Period = 300
Property: COVU_Recipients = ((0,X")) -- local broadcast address

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ANNEX E - EXAMPLES OF BACnet APPLICATION SERVICES (INFORMATIVE)

(This annex is not part of this standard but is included for informative purposes only.)

This annex provides examples of the use of application services defined in Clauses 13-17. In these examples, the names of properties are spelled out in Mixed Case, the values of properties with a datatype of CharacterString are enclosed in double quotes ("), and the values of enumerated types are spelled out in UPPER CASE. No encoding of parameters is contained in the examples; only their unencoded, symbolic values are shown. The encoding for these examples may be found in Annex F.

E.1 Alarm and Event Services

E.1.1 Examples of the AcknowledgeAlarm Service

See section E.1.4 for the use of the AcknowledgeAlarm service in conjunction with the ConfirmedEventNotification service and section E.1.5 for use of the AcknowledgeAlarm service in conjunction with the UnconfirmedEventNotification service.

E.1.2 Example of the ConfirmedCOVNotification Service

The following example illustrates a notification that the present value of a monitored Analog Input object has changed.

Service =	ConfirmedCOVNotification
'Subscriber Process Identifier' =	18
'Initiating Device Identifier' =	(Device, Instance 4)
'Monitored Object Identifier' =	(Analog Input, Instance 10)
'Time Remaining' =	0
'List of Values' =	((Present_Value, 65.0), (Status_Flags, (FALSE, FALSE, FALSE, FALSE)))

E.1.3 Example of the UnconfirmedCOVNotification Service

The following example illustrates a notification that the present value of a monitored Analog Input object has changed.

Service =	UnconfirmedCOVNotification
'Subscriber Process Identifier' =	18
'Initiating Device Identifier' =	(Device, Instance 4)
'Monitored Object Identifier' =	(Analog Input, Instance 10)
'Time Remaining' =	0
'List of Values' =	((Present_Value, 65.0), (Status_Flags, (FALSE, FALSE, FALSE, FALSE)))

E.1.4 Example of the ConfirmedEventNotification Service

Assumed objects:	Object Identifier	Object Name	Object Type
	(Analog Input, Instance 2)	Zone1_Temp	ANALOG_INPUT

Consider an Analog Input called "Zone1_Temp" that supports intrinsic event reporting. Assume that the temperature in zone one has just risen to the point that it exceeds the high-limit value, causing the alarm to become active and the TO-OFFNORMAL bit in the Acked_Transitions property to be cleared. Further assume that there is no associated message text. The device will issue a ConfirmedEventNotification service request primitive with the following parameters:

Service =	ConfirmedEventNotification
'Process Identifier' =	1
'Initiating Device Identifier' =	(Device, Instance 4)
'Event Object Identifier' =	(Analog Input, Instance 2)

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'Time Stamp' =	16
'Notification Class' =	4
'Priority' =	100
'Event Type' =	OUT_OF_RANGE
'Notify Type' =	ALARM
'AckRequired' =	TRUE
'From State' =	NORMAL
'To State' =	HIGH_LIMIT
'Event Values' =	((Exceeding_Value, 80.1), (Status_Flags, (TRUE, FALSE, FALSE, FALSE)), (Deadband, 1.0), (Exceeded_Limit, 80.0))

This PDU will be sent to each device specified by the Notification Class object associated with this Analog Input. Assuming that the PDU is correctly received, a 'Result(+)' confirm primitive will be received from each recipient as a confirmation that the message was received. Because the 'AckRequired' parameter has a value of TRUE, it is expected that a human operator will be notified and will acknowledge the alarm. After this happens, an AcknowledgeAlarm indication primitive will be received. The parameters in this primitive will be:

Service =	AcknowledgeAlarm
'Acknowledging Process Identifier' =	1
'Event Object Identifier' =	(Analog Input, Instance 2)
'Event State Acknowledged' =	HIGH_LIMIT
'Time Stamp' =	16
'Acknowledgment Source' =	"MDL"
'Time Of Acknowledgment' =	(21-Jun-1992, 13:03:41.9)

The local BACnet device will locate the appropriate Analog Input object instance, set the TO-OFFNORMAL bit in the Acked_Transitions property, and issue a 'Result(+)' response primitive. Note that the 'Time Stamp' parameter is a sequence number in this example, and it has the value that was sent with the ConfirmedEventNotification.

E.1.5 Example of the UnconfirmedEventNotification Service

Assumed objects:	Object Identifier	Object Name	Object Type
	(Analog Input, Instance 2)	Zone1_Temp	ANALOG_INPUT

Consider an Analog Input called "Zone1_Temp" that supports intrinsic event reporting. Assume that the temperature in zone one has just risen to the point that it exceeds the high-limit value, causing the alarm to become active and the TO-OFFNORMAL bit in the Acked_Transitions property to be cleared. Further assume that there is no associated message text. The device will issue an UnconfirmedEventNotification service request primitive with the following parameters:

Service =	UnconfirmedEventNotification
'Process Identifier' =	1
'Initiating Device Identifier' =	(Device, Instance 9)
'Event Object Identifier' =	(Analog Input, Instance 2)
'Time Stamp' =	16
'Notification Class' =	4
'Priority' =	100
'Event Type' =	OUT_OF_RANGE
'Notify Type' =	ALARM
'AckRequired' =	TRUE
'From State' =	NORMAL
'To State' =	HIGH_LIMIT
'Event Values' =	((Present_Value, 80.1), (Status_Flags, (TRUE, FALSE, FALSE, FALSE)), (Deadband, 1.0), (High_Limit, 80.0))

This PDU will be sent to a particular recipient or broadcast locally, remotely, or globally depending on the value of the Recipient_List property of the Notification Class object associated with this Analog Input. Because the 'AckRequired' parameter

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has a value of TRUE, it is expected that a human operator will be notified and will acknowledge the alarm. After this happens, an AcknowledgeAlarm indication primitive will be received. The parameters in this primitive will be:

Service =	AcknowledgeAlarm
'Acknowledging Process Identifier' =	1
'Event Object Identifier' =	(Analog Input, Instance 2)
'Event State Acknowledged' =	HIGH_LIMIT
'Time Stamp' =	16
'Acknowledgment Source' =	"MDL"
'Time Of Acknowledgment' =	(21-Jun-1992, 13:03:41.9)

The local BACnet device will locate the appropriate Analog Input object instance, set the TO-OFFNORMAL bit in the Acked_Transitions property, and issue a 'Result(+)' response primitive. Note that the 'Time Stamp' parameter is a sequence number in this example, and it has the value that was sent with the UnconfirmedEventNotification.

E.1.6 Example of the GetAlarmSummary Service

Assumed objects:	Object Identifier	Object Name	Object Type
	(Analog Input, Instance 2)	Zone1_Temp	ANALOG_INPUT
	(Analog Input, Instance 3)	Zone2_Temp	ANALOG_INPUT

A BACnet device attempting to obtain a list of active alarms from another BACnet device would issue the following service request:

Service = GetAlarmSummary

A typical response to this request would be a 'Result(+)' containing no parameters, indicating that there are no active alarms, or a 'Result(+)', conveying a list of active alarms as shown below.

'List of Alarm Summaries' = (((Analog Input, Instance 2), HIGH_LIMIT, B'011'),
((Analog Input, Instance 3), LOW_LIMIT, B'111'))

Notice that the LOW_LIMIT from "Zone2_Temp" was previously acknowledged, but the HIGH_LIMIT from "Zone1_Temp" was not.

E.1.7 Examples of the GetEnrollmentSummary Service

Example 1: Obtain a summary of all alarms that are not acknowledged.

Assumed objects:	Object Identifier	Object Name	Object Type
	(Analog Input, Instance 2)	Zone1_Temp	ANALOG_INPUT
	(Event Enrollment, Instance 6)	CW_Flow_Alarm	EVENT_ENROLLMENT

Service =	GetEnrollmentSummary
'Acknowledgment Filter' =	NOT-ACKED

A typical response to this request would be a 'Result(+)' containing no parameters, indicating that there are no unacknowledged alarms, or a 'Result(+)', conveying a list of active alarms as shown below.

'List of Enrollment Summaries' = (((Analog Input, Instance 2), OUT_OF_RANGE, HIGH_LIMIT, 100, 4),
((Event Enrollment, Instance 6), CHANGE_OF_STATE, NORMAL, 50, 2))

Example 2: Obtain a summary of all event enrollments with a priority in the range 6-10 for which a particular device subscribes.

Assumed objects:	Object Identifier	Object Name	Object Type
	(Analog Input, Instance 2)	Zone1_Temp	ANALOG_INPUT

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(Analog Input, Instance 3)	Zone2_Temp	ANALOG_INPUT
(Analog Input, Instance 4)	Zone3_Temp	ANALOG_INPUT
(Event Enrollment, Instance 7)	CW_Temp_Alarm	EVENT_ENROLLMENT
(Device, Instance 17)	Console 1	DEVICE

Service = GetEnrollmentSummary
'Acknowledgment Filter' = ALL
'Enrollment Filter' = ((Device, Instance 17), 9)
'Priority Filter' = (6,10)

A typical response to this request would be a 'Result(+)' containing no parameters, indicating that there are no event enrollments that meet the specified criteria, or a 'Result(+)', conveying a list of Event Enrollment objects that do meet the criteria as shown below.

'List of Enrollment Summaries' = (((Analog Input, Instance 2), OUT_OF_RANGE, NORMAL, 8, 4),
((Analog Input, Instance 3), OUT_OF_RANGE, NORMAL, 8, 4),
((Analog Input, Instance 4), OUT_OF_RANGE, NORMAL, 8, 4),
((Event Enrollment, Instance 7), FLOATING_LIMIT, NORMAL, 3, 8))

E.1.8 Example of the GetEventInformation Service

Assumed objects:

Object Identifier	Object Name	Object Type
(Analog Input, Instance 2)	Zone1_Temp	ANALOG_INPUT
(Analog Input, Instance 3)	Zone2_Temp	ANALOG_INPUT

A BACnet device attempting to obtain a list of active events from another BACnet device would issue the following service request:

Service = GetEventInformation

A typical response to this request would be a 'Result(+)' containing no parameters, indicating that there are no active events, or a 'Result(+)', conveying a list of active events as shown below.

'List of Event Summaries' = (((Analog Input, Instance 2), HIGH_LIMIT, B'011', ((7-Jun-99,15:35:00.20),
(*-*-* *:*:*.*), (*-*-*,*:*:*.*)), ALARM, B'111', (15, 15, 20)),
((Analog Input, Instance 3), NORMAL, B'110', ((7-Jun-99, 15:40:00.00),
(*-*-*,*:*:*:*), (15:45:30.30)), ALARM, B'111', (15, 15, 20)),
FALSE)

Notice that the to NORMAL transition from Zone2_Temp has not been acknowledged.

E.1.9 Example of the LifeSafetyOperation Service

This example illustrates the use of the LifeSafetyOperation service to reset a trouble condition.

Service = LifeSafetyOperation
'Requesting Process Identifier' = 18
'Requesting Source' = "MDL"
'Request' = RESET
'Object Identifier' = (Life Safety Point, 1)

E.1.10 Example of the SubscribeCOV Service

This example illustrates the use of the SubscribeCOV service to subscribe indefinitely to COV notifications from an Analog Input object.

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Service = SubscribeCOV
'Subscriber Process Identifier' = 18
'Monitored Object Identifier' = (Analog Input, Instance 10)
'Issue Confirmed Notifications' = TRUE
'Lifetime' = 0

E.1.11 Example of the SubscribeCOVProperty Service

This example illustrates the use of the SubscribeCOVProperty service to subscribe to COV notifications on the present-value of an Analog Input object.

Service = SubscribeCOVProperty
'Subscriber Process Identifier' = 18
'Monitored Object Identifier' = (Analog Input, Instance 10)
'Issue Confirmed Notifications' = TRUE
'Lifetime' = 60
'Monitored Property' = (Present_Value)
'COV Increment' = 1.0

E.2 File Access Services

The following examples illustrate typical uses of files. The actual form and content of files is both vendor-specific and application-specific.

E.2.1 Examples of the AtomicReadFile Service

Example 1: Read data from a file.

Assumed objects:	Object Identifier	Object Name	Object Type
	(File, Instance 1)	ChillerData	FILE

Service = AtomicReadFile
'File Identifier' = (File, Instance 1)
'Stream Access':
'File Start Position' = 0
'Requested Octet Count' = 27

The 'Result(+)' parameters would be:

'End Of File' = FALSE
'Stream Access':
'File Start Position' = 0
'File Data' = "Chiller01 On-Time=4.3 Hours"

Example 2: Read record from a file.

Assumed objects:	Object Identifier	Object Name	Object Type
	(File, Instance 2)	ChillerTrendLog	FILE

Service = AtomicReadFile
'File Identifier' = (File, Instance 2)
'Record Access':
'File Start Record' = 14
'Requested Record Count' = 3

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The 'Result(+)' parameters would be:

'End Of File' = TRUE
'Record Access':
'File Start Record' = 14
'Returned Record Count' = 2
'File Record Data' = ((12:00,45.6), (12:15,44.8))

Notice that in this example not all of the requested data are returned.

E.2.2 Examples of the AtomicWriteFile Service

Example 1: Write data to a file.

Assumed objects:	Object Identifier	Object Name	Object Type
	(File, Instance 1)	ChillerData	FILE

Service = AtomicWriteFile
'File Identifier' = (File, Instance 1)
'Stream Access':
'File Start Position' = 30
'File Data' = "Chiller01 On-Time=4.3 Hours"

The 'Result(+)' parameters would be:

'Stream Access':
'File Start Position' = 30

Example 2: Append two records to a file.

Assumed objects:	Object Identifier	Object Name	Object Type
	(File, Instance 2)	ChillerTrendLog	FILE

Service = AtomicWriteFile
'File Identifier' = (File, Instance 2)
'Record Access':
'File Start Record' = -1
'Record Count' = 2
'File Record Data' = ((12:00,45.6),
(12:15,44.8))

The 'Result(+)' parameters would be:

'Record Access':
'File Start Record' = 14

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E.3 Object Access Services

E.3.1 Example of the AddListElement Service

Example 1. Adding members to a group object.

Assumed objects:	Object Identifier	Object Name	Object Type
	(Group, Instance 3)	AHU1_GRAPH	GROUP
	(Analog Input, Instance 9)	AHU1_SA_TEMP	ANALOG_INPUT
	(Analog Input, Instance 10)	AHU1_RA_TEMP	ANALOG_INPUT
	(Analog Input, Instance 11)	AHU1_OAD_POS	ANALOG_INPUT
	(Analog Input, Instance 12)	AHU1_SA_PRESS	ANALOG_INPUT
	(Analog Input, Instance 13)	AHU1_CW_VALVE	ANALOG_INPUT
	(Analog Input, Instance 14)	OA_TEMP	ANALOG_INPUT
	(Analog Input, Instance 15)	OA_HUMID	ANALOG_INPUT

Consider a BACnet device that contains the following group object used for a graphic display:

Property: Object_Identifier = (Group, Instance 3)
Property: Object_Name = "AHU1_GRAPH"
Property: Object_Type = GROUP
Property: Description = "Points for AHU1 graphic"
Property: List_Of_Group_Members = (((Analog Input, Instance 9), (Present_Value, Reliability)),
((Analog Input, Instance 10), (Present_Value, Reliability)),
((Analog Input, Instance 11), (Present_Value, Reliability)),
((Analog Input, Instance 12), (Present_Value, Reliability, Description)),
((Analog Input, Instance 13), (Present_Value, Reliability, Description)),
((Analog Input, Instance 14), (Present_Value)))
Property: Present_Value = (65.2, NO_FAULT_DETECTED, 72.4, NO_FAULT_DETECTED, 99,
NO_FAULT_DETECTED, 0.67, NO_FAULT_DETECTED, "Inches of water", 32,
NO_FAULT_DETECTED, " % open", 68.3)

The system operator has decided to upgrade the control software in AHU1 to use an enthalpy economizer cycle. As a result, the operator wants to add a humidity reading to "AHU1_GRAPH". The AddListElement Service primitive is used with the following parameters:

Service = AddListElement
'Object Identifier' = (Group, Instance 3)
'Property Identifier' = List_Of_Group_Members
'List of Elements' = ((Analog Input, Instance 15),(Present_Value, Reliability))

Assuming the service request succeeds, a 'Result(+)' service primitive will be issued and the object "AHU1_GRAPH" now has the properties:

Property: Object_Identifier = (Group, Instance 3)
Property: Object_Name = "AHU1_GRAPH"
Property: Object_Type = GROUP
Property: Description = "Points for AHU1 graphic"
Property: List_Of_Group_Members = (((Analog Input, Instance 9), (Present_Value, Reliability)),
((Analog Input, Instance 10), (Present_Value, Reliability)),
((Analog Input, Instance 11), (Present_Value, Reliability)),
((Analog Input, Instance 12), (Present_Value, Reliability, Description)),
((Analog Input, Instance 13), (Present_Value, Reliability, Description)),
((Analog Input, Instance 14), (Present_Value)),
((Analog Input, Instance 15), (Present_Value, Reliability)))

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Property: Present_Value = (65.2, NO_FAULT_DETECTED, 72.4, NO_FAULT_DETECTED, 99, NO_FAULT_DETECTED, 0.67, NO_FAULT_DETECTED, "Inches of water", 32, NO_FAULT_DETECTED, " % open", 68.3, 42.1, NO_FAULT_DETECTED)

NOTE: In this example the new element was added at the end of the list. This is a logical place because the list must be traversed to determine if the "new" element already exists. This standard does not require adding new list elements at the end.

E.3.2 Example of the RemoveListElement Service

Example 1: Removing a member of a group.

Assumed objects:

Object Identifier	Object Name	Object Type
(Group, Instance 3)	AHU1_GRAPH	GROUP
(Analog Input, Instance 9)	AHU1_SA_TEMP	ANALOG_INPUT
(Analog Input, Instance 10)	AHU1_RA_TEMP	ANALOG_INPUT
(Analog Input, Instance 11)	AHU1_OAD_POS	ANALOG_INPUT
(Analog Input, Instance 12)	AHU1_SA_PRESS	ANALOG_INPUT
(Analog Input, Instance 13)	AHU1_CW_VALVE	ANALOG_INPUT
(Analog Input, Instance 14)	OA_TEMP	ANALOG_INPUT

This is an example of using the RemoveListElement Service to change an existing group object. Assume that a group object "AHU1_GRAPH" is defined as:

Property: Object_Identifier = (Group, Instance 3)
Property: Object_Name = "AHU1_GRAPH"
Property: Object_Type = GROUP
Property: List_Of_Group_Members = (((Analog Input, Instance 9), (Present_Value, Reliability)),
((Analog Input, Instance 10), (Present_Value, Reliability)),
((Analog Input, Instance 11), (Present_Value, Reliability)),
((Analog Input, Instance 12), (Present_Value, Reliability, Description)),
((Analog Input, Instance 13), (Present_Value, Reliability, Description)),
((Analog Input, Instance 14),(Present_Value)))
Property: Present_Value = (65.2, NO_FAULT_DETECTED, 72.4, NO_FAULT_DETECTED, 99.0, NO_FAULT_DETECTED, 0.67, NO_FAULT_DETECTED, "Inches of water", 32.0, NO_FAULT_DETECTED, % open", 68.3)

A system operator is updating graphic displays and decides that the Description properties in this group are not really used and wishes to remove them. Even though Description is an element of a property list, it cannot be removed by this service because it is nested inside the List_Of_Group_Members. A two step process is required as shown below.

The following service request is issued:

Service = RemoveListElement
'Object Identifier' = (Group, Instance 3)
'Property Identifier' = "List_Of_Elements"
'List of Elements' = (((Analog Input, Instance 12), (Present_Value, Reliability, Description)),
((Analog Input, Instance 13), (Present_Value, Reliability, Description)))

This service request is successful and the status of the object "AHU1_GRAPH" at this point is:

Property: Object_Identifier = (Group, Instance 3)
Property: Object_Name = "AHU1_GRAPH"
Property: Object_Type = GROUP

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Property: List_Of_Group_Members = (((Analog Input, Instance 9), (Present_Value, Reliability)),
((Analog Input, Instance 10), (Present_Value, Reliability)),
((Analog Input, Instance 11), (Present_Value, Reliability)),
((Analog Input, Instance 14), (Present_Value)))
Property: Present_Value = (65.2, NO_FAULT_DETECTED, 72.4, NO_FAULT_DETECTED, 99.0,
NO_FAULT_DETECTED, 68.3)

The AddListElement service is now used to replace the group members that were removed but are still needed for the graphic display.

The following service request is issued:

Service = AddListElement
'Object Identifier' = (Group, Instance 3)
'Property Identifier' = "List_Of_Group_Members"
'List of Elements' = (((Analog Input, Instance 12), (Present_Value, Reliability)),
((Analog Input, Instance 13), (Present_Value, Reliability)))

This service request is successful and the "AHU1_GRAPH" is now in the desired form:

Property: Object_Identifier = (Group, Instance 3)
Property: Object_Name = "AHU1_GRAPH"
Property: Object_Type = GROUP
Property: List_Of_Group_Members = (((Analog Input, Instance 9), (Present_Value, Reliability)),
((Analog Input, Instance 10), (Present_Value, Reliability)),
((Analog Input, Instance 11), (Present_Value, Reliability)),
((Analog Input, Instance 14), (Present_Value))
((Analog Input, Instance 12), (Present_Value, Reliability)),
((Analog Input, Instance 13), (Present_Value, Reliability)))
Property: Present_Value = (65.2, NO_FAULT_DETECTED, 72.4, NO_FAULT_DETECTED, 99.0,
NO_FAULT_DETECTED, 68.3, 0.67, NO_FAULT_DETECTED, 32.0,
NO_FAULT_DETECTED)

E.3.3 Example of the CreateObject Service

This is an example of using the CreateObject service to create a file object to be used for a trend log.

Service = CreateObject
'Object Type' = FILE
'List of Initial Values' = ((Object_Name, "Trend 1"), (File_Access_Method, RECORD_ACCESS))

Assuming that the CreateObject service request was correctly received and the device has the ability to create a file object, a 'Result(+)' will be returned conveying the Object_Identifier of the newly created object.

'Object_Identifier' = (File, Instance 13)

Note that in this example only the File_Type and File_Access_Method properties of the new object are initialized as a side effect of the object creation. The other properties of the object will contain default values provided by the vendor. If these default values are not acceptable, then initial values for these properties may be included in the 'List of Initial Values' for the CreateObject service. Alternatively, any writable properties of the object may be initialized or written to via a WriteProperty or WritePropertyMultiple service request after the object is created.

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E.3.4 Example of the DeleteObject Service

Assumed objects:	Object Identifier	Object Name	Object Type
	(Group, Instance 6)	ZONE1_TEMPS	GROUP
	(Group, Instance 7)	NotDeletable	GROUP

Consider a BACnet device that contains two group objects, "ZONE1_TEMPS" and "NotDeletable". The object "NotDeleteable" was created and protected at configuration time and may not be deleted by this protocol service.

Example 1: The successful deletion of an object.

The following request service primitive is issued:

Service = DeleteObject
'Object Identifier' = (Group, Instance 6)

The object is deleted and the server issues a 'Result(+)' response primitive.

Example 2: An unsuccessful attempt to delete a group object.

The following request service primitive is issued:

Service = DeleteObject
'Object Identifier' = (Group, Instance 7)

This object is protected and cannot be deleted by this protocol service. The server issues the following response primitive.

'Result(-)'
'Error Type' = (SERVICES, OBJECT_NOT_DELETABLE)

E.3.5 Examples of the ReadProperty Service

Assumed objects:	Object Identifier	Object Name	Object Type
	(Analog Input, Instance 5)	SPACE_TEMP	ANALOG_INPUT

We wish to read the present value for an analog input called "SPACE_TEMP".

Service = ReadProperty
'ObjectIdentifier' = (Analog Input, Instance 5)
'PropertyIdentifier' = Present_Value

Assuming the target machine can locate the object with this ID and the requested properties, the result would be:

'ObjectIdentifier' = (Analog Input, Instance 5)
'PropertyIdentifier' = Present_Value
'Value' = 72.3

The result indicates that the present value of "SPACE_TEMP" is 72.3.

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E.3.6 Deleted Clause

This clause has been removed.

E.3.7 Examples of the ReadPropertyMultiple Service

Example 1: Parameters for reading multiple properties of a single object.

Assumed objects:	Object Identifier	Object Name	Object Type
	(Analog Input, Instance 16)	SPACE_TEMP	ANALOG_INPUT

We wish to read the Present_Value and Reliability of an analog point called "SPACE_TEMP".

Service = ReadPropertyMultiple
'List of Read Access Specifications' = ((Analog Input, Instance 16), (Present_Value,Reliability))

Assuming the target machine can locate the object with this identifier and the requested properties, the result would be:

'List of Read Access Results' = ((Analog Input, Instance 16), ((Present_Value, 72.3),
(Reliability, NO_FAULT_DETECTED)))

The result indicates that the present value of "SPACE_TEMP" is 72.3 and that it is reliable so far as the device can determine.

Example 2: Parameters for reading the properties of several objects.

Assumed objects:	Object Identifier	Object Name	Object Type
	(Analog Input, Instance 33)	CW_STEMP	ANALOG_INPUT
	(Analog Input, Instance 34)	CW_RTEMP	ANALOG_INPUT
	(Analog Input, Instance 35)	CW_FLOW	ANALOG_INPUT

Suppose we wish to access the present values of three analog inputs in a chilled water system whose properties are grouped together in objects called "CW_STEMP", "CW_RTEMP", and "CW_FLOW".

Service = ReadPropertyMultiple
'List of Read Access Specifications' = (((Analog Input, Instance 33), (Present_Value)),
((Analog Input, Instance 50), (Present_Value)),
((Analog Input, Instance 35), (Present_Value)))

Assuming successful access of two out of the three requested values:

'List of Read Access Results' = (((Analog Input, Instance 33), (Present_Value, 42.3)),
((Analog Input, Instance 50), (Present_Value, 'Property Access Error' =
(OBJECT, UNKNOWN_OBJECT))),
((Analog Input, Instance 35), (Present_Value, 435.7)))

This result indicates that the supply temperature was successfully accessed and is currently 42.3, and the flow is 435.7. But access to the present value of the return temperature failed. The error type related to this part of the request is in the Error Class OBJECT and the specific Error Code is UNKNOWN_OBJECT. This occurred because the object identifier was incorrect, possibly due to an operator error.

E.3.8 Example of the ReadRange Service

Assumed objects:	Object Identifier	Object Name	Object Type
	(Trend Log, Instance 1)	ROOM3TEMP	TREND_LOG

We wish to look at all the records for the last five minutes within a Trend Log's Log Buffer.

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Service = ReadRange
'ObjectIdentifier' = (Trend Log, Instance 1)
'PropertyIdentifier' = Log_Buffer
'Range'
'Time Range'
'Beginning Time' = (23-MAR-1998, 19:52:34.0)
'Ending Time' = (23-MAR-1998, 19:57:34.0)

A typical result might be:

'Result Flags' = (TRUE, TRUE, FALSE)
'Item Count' = 2
'Item Data' = (((23-MAR-1998, 19:54:27.0), 18.0, (FALSE,FALSE,FALSE,FALSE)),
((23-MAR-1998, 19:56:27.0), 18.1, (FALSE,FALSE,FALSE,FALSE)))

E.3.9 Examples of the WriteProperty Service

Assumed objects:

Object Identifier	Object Name	Object Type
(Analog Value, Instance 1)	HW_Setpoint	ANALOG_VALUE

We wish to modify the Present_Value of an Analog Value object with an Object_Name of "HW_Setpoint".

Service = WriteProperty
'ObjectIdentifier' = (Analog Value, Instance 1)
'PropertyIdentifier' = Present_Value
'PropertyValue' = 180.0

Assuming the target machine can locate the object with the specified Object_Identifier and modify the Present_Value property, the result would be the issuance of a 'Result(+)' primitive with no additional parameters. This acknowledgment would be conveyed to the service requester in a SimpleACK-PDU without parameters.

E.3.10 Examples of the WritePropertyMultiple Service

Assumed objects:

Object Identifier	Object Name	Object Type
(Analog Value, Instance 5)	Room 1 Temp Setpoint	ANALOG_VALUE
(Analog Value, Instance 6)	Room 2 Temp Setpoint	ANALOG_VALUE
(Analog Value, Instance 7)	Room 3 Temp Setpoint	ANALOG_VALUE

We wish to modify the Present_Value of three analog variable objects used in the control of three space temperature loops.

Service = WritePropertyMultiple
'List of Write Access Specifications' = (((Analog Value, Instance 5), (Present_Value, 67.0)),
((Analog Value, Instance 6), (Present_Value, 67.0)),
((Analog Value, Instance 7)', (Present_Value, 72.0)))

Assuming the responding BACnet-user can locate each of the three objects, the result would be the replacement of the former values of each of these properties with the provided values and the issuance of a 'Result(+)' primitive with no additional parameters. This acknowledgment would be conveyed to the service requester in a SimpleACK-PDU without parameters.

E.4 Remote Device Management Services

E.4.1 An Example of the DeviceCommunicationControl Service

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While troubleshooting a problem on a BACnet network, it becomes necessary to stop communication exchanges from a particular device for a period of five minutes. This is accomplished by means of the DeviceCommunicationControl Service as follows.

Service = DeviceCommunicationControl
'Time Duration' = 5
'Enable/Disable' = DISABLE
'Password' = "#egbdf!"

E.4.2 An Example of the ConfirmedPrivateTransfer Service

This is an example of a typical proprietary service request using a BACnet confirmed service.

Service = ConfirmedPrivateTransfer
'VendorID' = 25
'Service Number' = 8
'ServiceParameters' = (72.4, X'1649')

Assuming that the service is successfully executed but no results need to be returned to the requesting BACnet-user, a 'Result(+)' primitive will be returned conveying the following information.

'VendorID' = 25
'Service Number' = 8
'Result Block' = NIL

E.4.3 An Example of the UnconfirmedPrivateTransfer Service

This is an example of a typical proprietary service request using a BACnet unconfirmed service.

Service = UnconfirmedPrivateTransfer
'VendorID' = 18
'Service Number' = 12
'ServiceParameters' = (72.4, X'1649')

Since this is an unconfirmed service, no response is expected.

E.4.4 Example of the ReinitializeDevice Service

This example illustrates the use of the ReinitializeDevice service for requesting a WARMSTART for a device that requires a password with this service.

Service = ReinitializeDevice
'Reinitialized State of Device' = WARMSTART
'Password' = "AbCdEfGh"

If the password is successfully validated, a 'Result (+)' primitive will be returned and then the device will reinitialize. Otherwise, a 'Result (-)' primitive will be returned.

E.4.5 Examples of the ConfirmedTextMessageService

This example illustrates the use of the ConfirmedTextMessage service.

Service = ConfirmedTextMessage
'Text Message Source Device' = (Device, Instance 5)
'Message Priority' = NORMAL
'Message' = "P.M. required for PUMP347"

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If the ConfirmedTextMessage-Request was successfully received, a 'Result(+)' will be returned. Otherwise, a 'Result(-)' will be returned.

E.4.6 Examples of the UnconfirmedTextMessage Service

This example illustrates the use of the UnconfirmedTextMessage service.

```
Service =                       UnconfirmedTextMessage
'Text Message Source Device' =  (Device, Instance 5)
'Message Priority'  =           NORMAL
'Message' =                     "P.M. required for PUMP347"
```

E.4.7 Example of the TimeSynchronization Service

An example of parameter usage for the TimeSynchronization service follows.

```
Service =          TimeSynchronization
'Time'
        'Date' =  17-Nov-92
        'Time' = 22:45:30.7
```

This request will notify all remote devices that the current time is 30.7 seconds past 10:45 P.M. on November 17, 1992. The remote devices may use this information to update their internal clocks so that all devices will be synchronized.

E.4.8 Examples of the Who-Has and I-Have Services

Examples of the parameter usage for the Who-Has and I-Have services follow.

Example 1: Locating the device that contains an object for which the Object_Name is known.

Consider an attempt to locate an object with an object name of "OATemp":

```
Service =          Who-Has
'Object Name' =    "OATemp"
```

Assuming that there is exactly one device that has such an object, the following I-Have service indication would be received:

```
Service =               I-Have
'Device Identifier' =   (Device, Instance 8)
'Object Identifier' =   (Analog Input, Instance 3)
'Object Name' =         "OATemp"
```

Example 2: Locating the device that contains an object for which the Object_Identifier is known.

Consider an attempt to locate an object with an Object_Identifier of (Analog Input, Instance 3).

```
Service =               Who-Has
'Object Identifier' =   (Analog Input, Instance 3)
```

Assuming that there is exactly one device that has such an object, the following I-Have service indication would be received:

```
Service =               I-Have
'Device Identifier' =   (Device, Instance 8)
'Object Identifier'  =  (Analog Input, Instance 3)
'Object Name' =         "OATemp"
```

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E.4.9 Examples of the Who-Is and I-Am Services

Examples of parameter usage for the Who-Is and I-Am services follow.

Example 1: Establishing the network address of a device.

We wish to determine the network address of another BACnet Device, but only its Device Identifier is known.

Service = Who-Is
'Who-Is Device Identifier' = (Device, Instance 3)

Assuming that there is such a device on the network, it responds sometime later using the I-Am service:

Service = I-Am
'I-Am Device Identifier' = (Device, Instance 3)
'Max APDU Length Accepted' = 1024
'Segmentation Supported' = NO_SEGMENTATION
'Vendor Identifier' = 99

The MAC layer source address combined with the network layer SNET and SADR provide all of the addressing information needed to communicate with the device (Device, Instance 3).

Example 2: Finding out about all network devices.

Suppose we wish to determine which devices are currently on the local network.

Service = Who-Is Service

Each of the devices on the network answers, resulting in several I-Am service requests:

Service = I-Am
'I-Am Device Identifier' = (Device, Instance 1)
'Max APDU Length Accepted' = 480
'Segmentation Supported' = SEGMENTED_TRANSMIT
'Vendor Identifier' = 99

Service = I-Am
'I-Am Device Identifier' = (Device, Instance 2)
'Max APDU Length Accepted' = 206
'Segmentation Supported' = SEGMENTED_RECEIVE
'Vendor Identifier' = 33

Service = I-Am
'I-Am Device Identifier' = (Device, Instance 3)
'Max APDU Length Accepted' = 1024
'Segmentation Supported' = NO_SEGMENTATION
'Vendor Identifier' = 99

Service = I-Am
'I-Am Device Identifier' = (Device, Instance 4)
'Max APDU Length Accepted' = 128
'Segmentation Supported' = SEGMENTED_BOTH
'Vendor Identifier' = 66

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This procedure can be expanded to find out about all devices in a BACnet internet by including the global network address (X'FFFF') in the network layer header.

E.5 Virtual Terminal Services

Examples of parameter usage for the VT-Open, VT-Data, and VT-Close services follow. For readability purposes, some of the examples include imbedded control characters, such as carriage return. These are shown within text strings enclosed in curly braces, e.g., "{cr}{lf}text".

Establishing a Session with a Default Terminal:

We wish to create a VT-session with the Default-terminal style of operator interface in another BACnet Device.

Service = VT-Open
'VT-class' = ANSI_X3.64
'Local VT Session Identifier' = 5

Assuming that the target machine can create a new VT-session, the 'Result (+)' response might be:

'Remote VT Session Identifier' = 29

The result indicates that target device has accepted the request and created a new session.

Now that a session is established, the operator interface program in the remote device prompts us to sign-on by issuing a VT-Data request:

Service = VT-Data
'VT-session Identifier' = 5
'VT-new Data' = "{cr}{lf}Enter User Name:"
'VT-data Flag' = 0

Our operator interface display queue is empty so it can accept all of the incoming characters. Our VT-User therefore issues a 'Result (+)':

'All New Data Accepted' = TRUE

Eventually, our human operator enters his or her name in response to the prompt, causing a VT-Data request to be issued:

Service = VT-Data
'VT-session Identifier' = 29
'VT-new Data' = "FRED{cr}"
'VT-data Flag' = 0

The remote operator interface accepts the incoming characters as well and responds with 'Result (+)':

'All New Data Accepted' = TRUE

Then the remote operator interface echoes the entered characters and another prompt:

Service = VT-Data
'VT-session Identifier' = 5
'VT-new Data' = "FRED{cr}{lf}Enter Password:"
'VT-data Flag' = 1

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Our operator interface display queue is empty so it can accept all of the incoming characters. Our VT-User therefore issues 'Result (+)':

'All New Data Accepted' = TRUE

For some reason, FRED decides to cancel this virtual terminal session and signals the operator interface program to do so. The operator interface program issues a VT-Close request:

Service = VT-Close
'List of Remote VT Session Identifiers' = (29)

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ANNEX F - EXAMPLES OF APDU ENCODING (INFORMATIVE)

(This annex is not part of the standard but is included for informative purposes only.)

This annex illustrates the use of BACnet encoding rules by showing the encoded APDUs for the examples in Annex E.

F.1 Example Encodings for Alarm and Event Services

F.1.1 Encoding for Example E.1.1 - AcknowledgeAlarm Service

The encoding for example E.1.1 is included in F.1.4 and F.1.5.

F.1.2 Encoding for Example E.1.2 - ConfirmedCOVNotification Service

```
X'00'                   PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'02'                   Maximum APDU Size Accepted=206 octets
X'0F'                   Invoke ID=15
X'01'                   Service Choice=1 (ConfirmedCOVNotification-Request)

X'09'                   SD Context Tag 0 (Subscriber Process Identifier, L=1)
X'12'                   Subscriber Process Identifier=18
X'1C'                   SD Context Tag 1 (Initiating Device Identifier, L=4)
X'02000004'             Device, Instance 4
X'2C'                   SD Context Tag 2 (Monitored Object Identifier, L=4)
X'0000000A'             Analog Input, Instance Number=10
X'39'                   SD Context Tag 3 (Time Remaining, L=1)
X'00'                   Time Remaining=0
X'4E'                   PD Opening Tag 4 (List Of Values)
        X'09'               SD Context Tag 0 (Property Identifier, L=1)
        X'55'               85 (PRESENT_VALUE)
        X'2E'               PD Opening Tag 2 (Value)
                X'44'           Application Tag 4 (Real, L=4)
                X'42820000'     65.0
        X'2F'               PD Closing Tag 2 (Value)
        X'09'               SD Context Tag 0 (Property Identifier, L=1)
        X'6F'               111 (STATUS_FLAGS)
        X'2E'               PD Opening Tag 2 (Value)
                X'82'           Application Tag 8 (Bit String, L=2)
                X'0400'         0,0,0,0 (FALSE, FALSE, FALSE, FALSE)
        X'2F'               PD Closing Tag 2 (Value)
X'4F'                   PD Closing Tag 4 (List Of Values)
```

Assuming the service procedure executes correctly, a simple acknowledgment is returned:

```
X'20'                   PDU Type=2 (BACnet-SimpleACK-PDU)
X'0F'                   Invoke ID=15
X'01'                   Service ACK Choice=1 (ConfirmedCOVNotification)
```

F.1.3 Encoding for Example E.1.3 - UnconfirmedCOVNotification Service

```
X'10'                   PDU Type=1 (BACnet-Unconfirmed-Request-PDU)
X'02'                   Service Choice=2 (UnconfirmedCOVNotification-Request)

X'09'                   SD Context Tag 0 (Subscriber Process Identifier, L=1)
```

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```
X'12'                   18
X'1C'                   SD Context Tag 1 (Initiating Device Identifier, L=4)
X'02000004'             Device, Instance Number=4
X'2C'                   SD Context Tag 2 (Monitored Object Identifier, L=4)
X'0000000A'             Analog Input, Instance Number=10
X'39'                   SD Context Tag 3 (Time Remaining, L=1)
X'00'                   0
X'4E'                   PD Opening Tag 4 (List Of Values)
    X'09'                   SD Context Tag 0 (Property Identifier, L=1)
    X'55'                   85 (PRESENT_VALUE)
    X'2E'                   PD Opening Tag 2 (Value)
        X'44'                   Application Tag 4 (Real, L=4)
        X'42820000'             65.0
    X'2F'                   PD Closing Tag 2 (Value)
    X'09'                   SD Context Tag 0 (Property Identifier, L=1)
    X'6F'                   111 (STATUS_FLAGS)
    X'2E'                   PD Opening Tag 2 (Value)
        X'82'                   Application Tag 8 (Bit String, L=2)
        X'0400'                 0,0,0,0 (FALSE, FALSE ,FALSE, FALSE)
    X'2F'                   PD Closing Tag 2 (Value)
X'4F'                   PD Closing Tag 4 (List Of Values)
```

F.1.4 Encoding for Example E.1.4 - ConfirmedEventNotification Service

```
X'00'                   PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'02'                   Maximum APDU Size Accepted=206 octets
X'10'                   Invoke ID=16
X'02'                   Service Choice=2 (ConfirmedEventNotification-Request)
X'09'                   SD Context Tag 0 (Process Identifier, L=1)
X'01'                   Process Identifier=1
X'1C'                   SD Context Tag 1 (Initiating Device Identifier, L=4)
X'02000004'             Device, Instance 4
X'2C'                   SD Context Tag 2 (Event Object Identifier, L=4)
X'00000002'             Analog Input, Instance Number=2
X'3E'                   PD Opening Tag 3 (Time Stamp)
    X'19'                   SD Context Tag 1 (SequenceNumber, L=1)
    X'10'                   16
X'3F'                   PD Closing Tag 3 (Time Stamp)
X'49'                   SD Context Tag 4 (Notification Class, L=1)
X'04'                   4
X'59'                   SD Context Tag 5 (Priority, L=1)
X'64'                   100
X'69'                   SD Context Tag 6 (Event Type, L=1)
X'05'                   5 (OUT_OF_RANGE)
X'89'                   SD Context Tag 8 (Notify Type, L=1)
X'00'                   0 (ALARM)
X'99'                   SD Context Tag 9 (AckRequired, L=1)
X'01'                   TRUE
X'A9'                   SD Context Tag 10 (From State, L=1)
X'00'                   0 (NORMAL)
X'B9'                   SD Context Tag 11 (To State, L=1)
X'03'                   3 (HIGH_LIMIT)
X'CE'                   PD Opening Tag 12 (Event Values)
    X'5E'                   PD Opening Tag 5 (BACnetNotificationParameters, Choice 5=OUT_OF_RANGE)
        X'0C'                   SD Context Tag 0 (Exceeding Value, L=4)
        X'42A03333'             80.1
```

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```
                X'1A'           SD Context Tag 1 (Status Flags, L=2)
                X'0480'         1,0,0,0 (TRUE, FALSE, FALSE, FALSE)
                X'2C'           SD Context Tag 2 (Deadband, L=4)
                X'3F800000'     1.0
                X'3C'           SD Context Tag 3 (Exceeded Limit, L=4)
                X'42A00000'     80.0
        X'5F'               PD Closing Tag 5 (BACnetNotificationParameters)
X'CF'               PD Closing Tag 12 (Event Values)
```

Assuming the service procedure executes correctly, a simple acknowledgment is returned:

```
X'20'               PDU Type=2 (BACnet-SimpleACK-PDU)
X'10'               Invoke ID=16
X'02'               Service ACK Choice=2 (ConfirmedEventNotification)
```

At some future time, an AcknowledgeAlarm-Request is generated:

```
X'00'               PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'02'               Maximum APDU Size Accepted=206 octets
X'07'               Invoke ID=7
X'00'               Service Choice=0 (AcknowledgeAlarm-Request)

X'09'               SD Context Tag 0 (Acknowledging Process Identifier, L=1)
X'01'               Acknowledging Process Identifier=1
X'1C'               SD Context Tag 1 (Event Object Identifier, L=4)
X'00000002'         Analog Input, Instance Number=2
X'29'               SD Context Tag 2 (Event State Acknowledged, L=1)
X'03'               3 (HIGH_LIMIT)
X'3E'               PD Opening Tag 3 (Time Stamp)
        X'19'           SD Context Tag 1 (Sequence Number, L=1)
        X'10'           16
X'3F'               PD Closing Tag 3 (Time Stamp)
X'4C'               SD Context Tag 4 (Acknowledgment Source, L=4)
X'00'                   ISO 10646 (UTF-8) Encoding
X'4D444C'               "MDL"
X'5E'               PD Opening Tag 5 (Time Of Acknowledgment)
        X'2E'           PD Opening Tag 2 (Date Time)
                X'A4'           Application Tag 10 (Date, L=4)
                X'5C0615FF'     June 21, 1992
                X'B4'           Application Tag 11 (Time, L=4)
                X'0D032909'     13:03:41.9
        X'2F'           PD Closing Tag 2 (Date Time)
X'5F'               PD Closing Tag 5 (Time Of Acknowledgment)
```

Assuming the service procedure executes correctly, a simple acknowledgment is returned:

```
X'20'               PDU Type=2 (BACnet-SimpleACK-PDU)
X'07'               Invoke ID=7
X'00'               Service ACK Choice=0 (AcknowledgeAlarm)
```

F.1.5 Encoding for Example E.1.5 - UnconfirmedEventNotification Service

```
X'10'               PDU Type=1 (BACnet-Unconfirmed-Request-PDU)
X'03'               Service Choice=3 (UnconfirmedEventNotification-Request)

X'09'               SD Context Tag 0 (Process Identifier, L=1)
```

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X'01' 1
X'1C' SD Context Tag 1 (Initiating Device Identifier, L=4)
X'02000009' Device, Instance Number=9
X'2C' SD Context Tag 2 (Event Object Identifier, L=4)
X'00000002' Analog Input, Instance Number=2
X'3E' PD Opening Tag 3 (Time Stamp)
X'19' SD Context Tag 1 (SequenceNumber, L=1)
X'10' 16
X'3F' PD Closing Tag 3 (Time Stamp)
X'49' SD Context Tag 4 (Notification Class, L=1)
X'04' 4
X'59' SD Context Tag 5 (Priority, L=1)
X'64' 100
X'69' SD Context Tag 6 (Event Type, L=1)
X'05' 5 (OUT_OF_RANGE)
X'89' SD Context Tag 8 (Notify Type, L=1)
X'00' 0 (ALARM)
X'99' SD Context Tag 9 (AckRequired, L=1)
X'01' 1 (TRUE)
X'A9' SD Context Tag 10 (From State, L=1)
X'00' 0 (NORMAL)
X'B9' SD Context Tag 11 (To State, L=1)
X'03' 3 (HIGH_LIMIT)
X'CE' PD Opening Tag 12 (Event Values)
X'5E' PD Opening Tag 5 (BACnetNotificationParameters, Choice 5=OUT_OF_RANGE)
X'0C' SD Context Tag 0 (Exceeding Value, L=4)
X'42A03333' 80.1
X'1A' SD Context Tag 1 (Status Flags, L=2)
X'0480' 1,0,0,0 (TRUE, FALSE, FALSE, FALSE)
X'2C' SD Context Tag 2 (Deadband, L=4)
X'3F800000' 1.0
X'3C' SD Context Tag 3 (Exceeded Limit, L=4)
X'42A00000' 80.0
X'5F' PD Closing Tag 5 (BACnetNotificationParameters)
X'CF' PD Closing Tag 12 (Event Values)

At some future time, an AcknowledgeAlarm-Request is generated:

X'00' PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'02' Maximum APDU Size Accepted=206 octets
X'07' Invoke ID=7
X'00' Service Choice=0 (AcknowledgeAlarm-Request)

X'09' SD Context Tag 0 (Acknowledging Process Identifier, L=1)
X'01' Acknowledging Process Identifier=1
X'1C' SD Context Tag 1 (Event Object Identifier, L=4)
X'00000002' Analog Input, Instance Number=2
X'29' SD Context Tag 2 (Event State Acknowledged, L=1)
X'03' 3 (HIGH_LIMIT)
X'3E' PD Opening Tag 3 (Time Stamp)
X'19' SD Context Tag 1 (Sequence Number, L=1)
X'10' 16
X'3F' PD Closing Tag 3 (Time Stamp)
X'4C' SD Context Tag 4 (Acknowledgment Source, L=4)
X'00' ISO 10646 (UTF-8) Encoding
X'4D444C' "MDL"

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X'5E'			PD Opening Tag 5 (Time Of Acknowledgment)
	X'2E'		PD Opening Tag 2 (Date Time)
		X'A4'	Application Tag 10 (Date, L=4)
		X'5C0615FF'	June 21, 1992
		X'B4'	Application Tag 11 (Time, L=4)
		X'0D032909'	13:03:41.9
	X'2F'		PD Closing Tag 2 (Date Time)
X'5F'			PD Closing Tag 5 (Time Of Acknowledgment)

Assuming the service procedure executes correctly, a simple acknowledgment is returned:

X'20'	PDU Type=2 (BACnet-SimpleACK-PDU)
X'07'	Invoke ID=7
X'00'	Service ACK Choice=0 (AcknowledgeAlarm)

F.1.6 Encoding for Example E.1.6 - GetAlarmSummary Service

X'00'	PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'02'	Maximum APDU Size Accepted=206 octets
X'01'	Invoke ID=1
X'03'	Service Choice=3 (GetAlarmSummary-Request)

Assuming the service procedure executes correctly, a complex acknowledgment is returned:

X'30'	PDU Type=3 (BACnet-ComplexACK-PDU, SEG=0, MOR=0)
X'01'	Invoke ID=1
X'03'	Service ACK Choice=3 (GetAlarmSummary-ACK)
X'C4'	Application Tag 12 (Object Identifier, L=4) (Object Identifier)
X'00000002'	Analog Input, Instance Number=2
X'91'	Application Tag 9 (Enumerated, L=1) (Alarm State)
X'03'	3 (HIGH_LIMIT)
X'82'	Application Tag 8 (Bit String, L=2) (Acknowledged Transitions)
X'0560'	0,1,1 (FALSE, TRUE, TRUE)
X'C4'	Application Tag 12 (Object Identifier, L=4) (Object Identifier)
X'00000003'	Analog Input, Instance Number=3
X'91'	Application Tag 9 (Enumerated, L=1) (Alarm State)
X'04'	4 (LOW_LIMIT)
X'82'	Application Tag 8 (Bit String, L=2) (Acknowledged Transitions)
X'05E0'	1,1,1 (TRUE, TRUE, TRUE)

F.1.7 Encoding for Example E.1.7 - GetEnrollmentSummary Service

Example 1: Request encoding.

X'00'	PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'02'	Maximum APDU Size Accepted=206 octets
X'01'	Invoke ID=1
X'04'	Service Choice=4 (GetEnrollmentSummary-Request)
X'09'	SD Context Tag 0 (Acknowledgment Filter, L=1)
X'02'	2 (NOT_ACKED)

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Assuming the service procedure executes correctly, a complex acknowledgment is returned containing the requested values:

```
X'30'           PDU Type=3 (BACnet-ComplexACK-PDU, SEG=0, MOR=0)
X'01'           Invoke ID=1
X'04'           Service ACK Choice=4 (GetEnrollmentSummary-ACK)

X'C4'           Application Tag 12 (Object Identifier, L=4) (Object Identifier)
X'00000002'     Analog Input, Instance Number=2
X'91'           Application Tag 9 (Enumerated, L=1) (Event Type)
X'05'           5 (OUT_OF_RANGE)
X'91'           Application Tag 9 (Enumerated, L=1) (Event State)
X'03'           3 (HIGH_LIMIT)
X'21'           Application Tag 2 (Unsigned Integer, L=1) (Priority)
X'64'           100
X'21'           Application Tag 2 (Unsigned Integer, L=1) (Notification Class)
X'04'           4
X'C4'           Application Tag 12 (Object Identifier, L=4) (Object Identifier)
X'02400006'     Event Enrollment, Instance Number=6
X'91'           Application Tag 9 (Enumerated, L=1) (Event Type)
X'01'           1 (CHANGE_OF_STATE)
X'91'           Application Tag 9 (Enumerated, L=1) (Event State)
X'00'           0 (NORMAL)
X'21'           Application Tag 2 (Unsigned Integer, L=1) (Priority)
X'32'           50
X'21'           Application Tag 2 (Unsigned Integer, L=1) (Notification Class)
X'02'           2
```

Example 2: Request encoding.

```
X'00'           PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'02'           Maximum APDU Size Accepted=206 octets
X'02'           Invoke ID=2
X'04'           Service Choice=4 (GetEnrollmentSummary-Request)

X'09'           SD Context Tag 0 (Acknowledgment Filter, L=1)
X'00'           0 (ALL)
X'1E'           PD Opening Tag 1 (Enrollment Filter)
    X'0E'           PD Opening Tag 0 (Recipient)
        X'0C'           SD Context Tag 0 (Device, L=4)
        X'02000011'     Device, Instance Number=17
    X'0F'           PD Closing Tag 0 (Recipient)
    X'19'           SD Context Tag 1 (Process Identifier)
    X'09'           9
X'1F'           PD Closing Tag 1 (Enrollment Filter)
X'4E'           PD Opening Tag 4 (Priority Filter)
    X'09'           SD Context Tag 0 (MinPriority, L=1)
    X'06'           6
    X'19'           SD Context Tag 1 (MaxPriority, L=1)
    X'0A'           10
X'4F'           PD Closing Tag 4 (Priority Filter)
```

Assuming the service procedure executes correctly, a complex acknowledgment is returned containing the requested values:

```
X'30'           PDU Type=3 (BACnet-ComplexACK-PDU, SEG=0, MOR=0)
X'02'           Invoke ID=2
X'04'           Service ACK Choice=4 (GetEnrollmentSummary-ACK)
```

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X'C4'	Application Tag 12 (Object Identifier, L=4) (Object Identifier)
X'00000002'	Analog Input, Instance Number=2
X'91'	Application Tag 9 (Enumerated, L=1) (Event Type)
X'05'	5 (OUT_OF_RANGE)
X'91'	Application Tag 9 (Enumerated, L=1) (Event State)
X'00'	0 (NORMAL)
X'21'	Application Tag 2 (Unsigned Integer, L=1) (Priority)
X'08'	8
X'21'	Application Tag 2 (Unsigned Integer, L=1) (Notification Class)
X'04'	4
X'C4'	Application Tag 12 (Object Identifier, L=4) (Object Identifier)
X'00000003'	Analog Input, Instance Number=3
X'91'	Application Tag 9 (Enumerated, L=1) (Event Type)
X'05'	5 (OUT_OF_RANGE)
X'91'	Application Tag 9 (Enumerated, L=1) (Event State)
X'00'	0 (NORMAL)
X'21'	Application Tag 2 (Unsigned Integer, L=1) (Priority)
X'08'	8
X'21'	Application Tag 2 (Unsigned Integer, L=1) (Notification Class)
X'04'	4
X'C4'	Application Tag 12 (Object Identifier, L=4) (Object Identifier)
X'00000004'	Analog Input, Instance Number=4
X'91'	Application Tag 9 (Enumerated, L=1) (Event Type)
X'05'	5 (OUT_OF_RANGE)
X'91'	Application Tag 9 (Enumerated, L=1) (Event State)
X'00'	0 (NORMAL)
X'21'	Application Tag 2 (Unsigned Integer, L=1) (Priority)
X'08'	8
X'21'	Application Tag 2 (Unsigned Integer, L=1) (Notification Class)
X'04'	4
X'C4'	Application Tag 12 (Object Identifier, L=4) (Object Identifier)
X'02400007'	Event Enrollment, Instance Number=7
X'91'	Application Tag 9 (Enumerated, L=1) (Event Type)
X'04'	4 (FLOATING_LIMIT)
X'91'	Application Tag 9 (Enumerated, L=1) (Event State)
X'00'	0 (NORMAL)
X'21'	Application Tag 2 (Unsigned Integer, L=1) (Priority)
X'03'	3
X'21'	Application Tag 2 (Unsigned Integer, L=1) (Notification Class)
X'08'	8

F.1.8 Encoding for Example E.1.8 - GetEventInformation Service

X'02'	PDU Type = 0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=1)
X'02'	Maximum APDU Size Accepted = 206 octets
X'01'	Invoke ID = 1
X'1D'	Service Choice = 29 (GetEventInformation)

Assuming the service procedure executes correctly, a complex acknowledgment is returned:

X'30'	PDU Type = 3 (BACnet-ComplexACK-PDU, SEG=0, MOR=0)
X'01'	Invoke ID=01

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```
X'1D'                   Service ACK Choice = 29, (GetEventInformation-ACK)

X'0E'                       PD opening Tag 0
        X'0C'                   SD context Tag 0 (ObjectIdentifier, L=4)
        X'00000002'             Analog Input, Instance Number = 2
        X'19'                   SD context Tag 1 (Enumerated, L=1)
        X'03'                   3 (HIGH_LIMIT)
        X'2A'                   SD context Tag 2 (Bit String, L=2)
        X'0560'                 0,1,1 (FALSE, TRUE, TRUE)
        X'3E'                   PD opening Tag 3
            X'0C'               SD context Tag 0 (Time L=4)
            X'0F230014'             Time 15:35:00.20
            X'0C'               SD context Tag 0 (Time L=4)
            X'FFFFFFFF'             Time unspecified
            X'0C'                   SD context Tag 0 (Time L=4)
            X'FFFFFFFF'             Time unspecified
        X'3F'                   PD closing Tag 3
        X'49'                   SD context Tag 4 (Enumerated, L=1)
        X'00'                   0 (ALARM)
        X'5A'                   SD context Tag 5 (Bit String, L=2)
        X'05E0'                 1,1,1 (TRUE, TRUE, TRUE)
        X'6E'                   PD opening Tag 6
            X'21'               Application Tag 2 (Unsigned Integer, L=1)
            X'0F'               15 (Priority)
            X'21'               Application Tag 2 (Unsigned Integer, L=1)
            X'0F'               15 (Priority)
            X'21'               Application Tag 2 (Unsigned Integer, L=1)
            X'14'               20 (Priority)
        X'6F'                   PD closing Tag 6
        X'0C'                   SD context Tag 0 (ObjectIdentifier, L=4)
        X'00000003'             Analog Input, Instance Number = 3
        X'19'                   SD context Tag 1 (Enumerated, L=1)
        X'00'                   0 (NORMAL)
        X'2A'                   SD context Tag 2 (Bit String, L=2)
        X'05C0'                 1,1,0 (TRUE, TRUE, FALSE)
        X'3E'                   PD opening Tag 3
            X'0C'               SD context Tag 0 (Time L=4)
            X'0F280000'             Time 15:40:00.00
            X'0C'               SD context Tag 0 (Time L=4)
            X'FFFFFFFF'             Time unspecified
            X'0C'               SD context Tag 0 (Time L=4)
            X'0F2D1E1E'             15:45:30.30
        X'3F'                   PD closing Tag 3
        X'49'                   SD context Tag 4 (Enumerated, L=1)
        X'00'                   0 (ALARM)
        X'5A'                   SD context Tag 5 (Bit String, L=2)
        X'05E0'                 1,1,1 (TRUE, TRUE, TRUE)
        X'6E'                   PD opening Tag 6
            X'21'               Application Tag 2 (Unsigned Integer, L=1)
            X'0F'               15 (Priority)
            X'21'               Application Tag 2 (Unsigned Integer, L=1)
            X'0F'               15 (Priority)
            X'21'               Application Tag 2 (Unsigned Integer, L=1)
            X'14'               20 (Priority)
        X'6F'                   PD closing Tag 6
```

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X'0F' PD closing Tag 0
X'19' SD context Tag 1 (Boolean, L=1)
X'00' FALSE (More Events)

F.1.9 Encoding for Example E.1.9 - LifeSafetyOperation

X'00' PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'02' Maximum APDU Size Accepted=206 octets
X'0F' Invoke ID=15
X'1B' Service Choice=27 (LifeSafetyOperation-Request)

X'09' SD Context Tag 0 (Requesting Process Identifier, L=1)
X'12' 18
X'1C' SD Context Tag 1 (Requesting Source, L=4)
X'00' ISO 10646 (UTF-8) Encoding
X'4D444C' "MDL"
X'29' SD Context Tag 2 (Request, L=1)
X'04' 4 (RESET)
X'3C' SD Context Tag 3 (Object Identifier, L=4)
X'05400001' Life Safety Point, Instance Number = 1

Assuming the service procedure executes correctly, a simple acknowledgment is returned:

X'20' PDU Type=2 (BACnet-SimpleACK-PDU)
X'0F' Invoke ID=15
X'1B' Service ACK Choice=27 (LifeSafetyOperation)

F.1.10 Encoding for Example E.1.10 - SubscribeCOV

X'00' PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'02' Maximum APDU Size Accepted=206 octets
X'0F' Invoke ID=15
X'05' Service Choice=5 (SubscribeCOV-Request)

X'09' SD Context Tag 0 (Subscriber Process Identifier, L=1)
X'12' 18
X'1C' SD Context Tag 1 (Monitored Object Identifier, L=4)
X'0000000A' Analog Input, Instance Number=10
X'29' SD Context Tag 2 (Issue Confirmed Notifications, L=1)
X'01' 1 (TRUE)
X'39' SD Context Tag 3 (Lifetime, L=1)
X'00' 0

Assuming the service procedure executes correctly, a simple acknowledgment is returned:

X'20' PDU Type=2 (BACnet-SimpleACK-PDU)
X'0F' Invoke ID=15
X'05' Service ACK Choice=5 (SubscribeCOV)

F.1.11 Encoding for Example E.1.11 - SubscribeCOVProperty

X'00' PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'02' Maximum APDU Size Accepted=206 octets
X'0F' Invoke ID=15
X'1C' Service Choice=28 (SubscribeCOVProperty-Request)

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X'09' SD Context Tag 0 (Subscriber Process Identifier, L=1)
X'12' 18
X'1C' SD Context Tag 1 (Monitored Object Identifier, L=4)
X'0000000A' Analog Input, Instance Number=10
X'29' SD Context Tag 2 (Issue Confirmed Notifications, L=1)
X'01' 1 (TRUE)
X'39' SD Context Tag 3 (Lifetime, L=1)
X'3C' 60
X'4E' PD Opening Tag 4 (Monitored Property, L=1)
X'09' SD Context Tag 0 (Property Identifier, L=1)
X'55' 85 (PRESENT_VALUE)
X'4F' PD Closing Tag 4 (Property Identifier)
X'5C' SD Context Tag 5 (COV Increment, L=4)
X'3F800000' 1.0

Assuming the service procedure executes correctly, a simple acknowledgment is returned:

X'20' PDU Type=2 (BACnet-SimpleACK-PDU)
X'0F' Invoke ID=15
X'1C' Service ACK Choice=28 (SubscribeCOVProperty)

F.2 Example Encodings for File Access Services

F.2.1 Encoding for Example E.2.1 - AtomicReadFile Service

Example 1: Read data from a file.

X'00' PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'02' Maximum APDU Size Accepted=206 octets
X'00' Invoke ID=0
X'06' Service Choice=6 (AtomicReadFile-Request)

X'C4' Application Tag 12 (Object Identifier, L=4) (File Identifier)
X'02800001' File, Instance Number=1
X'0E' PD Opening Tag 0 (Stream Access)
X'31' Application Tag 3 (Signed Integer, L=1) (File Start Position)
X'00' 0
X'21' Application Tag 2 (Unsigned, L=1) (Requested Octet Count)
X'1B' 27
X'0F' PD Closing Tag 0 (Stream Access)

Assuming this service procedure executes correctly, a complex acknowledgment is returned:

X'30' PDU Type=3 (BACnet-ComplexACK-PDU, SEG=0, MOR=0)
X'00' Invoke ID=0
X'06' Service ACK Choice=6 (AtomicReadFile-ACK)

X'10' Application Tag 1 (Boolean, 0 (FALSE)) (End Of File)
X'0E' PD Opening Tag 0 (Stream Access)
X'31' Application Tag 3 (Signed Integer, L=1) (File Start Position)
X'00' 0
X'65' Application Tag 6 (Octet String, L>4)
X'1B' Extended Length=27
X'4368696C6C65723031204F6E2D54696D653D342E3320486F757273'

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```
                    "Chiller01 On-Time=4.3 Hours"
X'0F'               PD Closing Tag 0 (Stream Access)
```

Example 2: Read record from a file.

```
X'00'               PDU type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'02'               Maximum APDU Size Accepted=206 octets
X'12'               Invoke ID=18
X'06'               Service Request=6 (AtomicReadFile-Request)

X'C4'               Application Tag 12 (Object Identifier, L=4) (FileIdentifier)
X'02800002'         File, Instance Number=2
X'1E'               PD Opening Tag 1 (Record Access)
    X'31'               Application Tag 3 (Signed Integer, L=1) (File Start Record)
    X'0E'               14
    X'21'               Application Tag 2 (Unsigned, L=1) (Requested Record Count)
    X'03'               3
X'1F'               PD Closing Tag 1 (Record Access)
```

Assuming this service procedure executes correctly, a complex acknowledgment is returned:

```
X'30'               PDU Type=3 (BACnet-ComplexACK-PDU, SEG=0, MOR=0)
X'12'               Invoke ID=18
X'06'               Service ACK Choice=6 (AtomicReadFile-ACK)

X'11'               Application Tag 1 (Boolean, 1 (TRUE)) (End Of File)
X'1E'               PD Opening Tag 1(RecordAccess)
    X'31'               Application Tag 3 (Signed Integer, L=1) (File Start Record)
    X'0E'               14
    X'21'               Application Tag 2 (Unsigned, L=1) (Returned Record Count)
    X'02'               2
    X'65'               Application Tag 6 (Octet String, L>4) (File Record Data)
    X'0A'               Extended Length=10
    X'31323A30302C34352E36'  "12:00,45.6"
    X'65'               Application Tag 6 (Octet String, L>4) (File Record Data)
    X'0A'               Extended Length=10
    X'31323A31352C34342E38'  "12:15,44.8"
X'1F'               PD Closing Tag 1 (Record Access)
```

F.2.2 Encoding for Example F.2.2 - AtomicWriteFile Service

Example 1: Write data to a file.

```
X'00'               PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'02'               Maximum APDU Size Accepted=206 octets
X'55'               Invoke ID=85
X'07'               Service Choice=7 (AtomicWriteFile-Request)

X'C4'               Application Tag 12 (Object Identifier, L=4) (File Identifier)
X'02800001'         File, Instance Number=1
X'0E'               PD Opening Tag 0 (Stream Access)
    X'31'               Application Tag 3 (Signed Integer, L=1) (File Start Position)
    X'1E'               30
    X'65'               Application Tag 6 (Octet String, L>4) (File Data)
    X'1B'               Extended Length=27
    X'4368696C6C65723031204F6E2D54696D653D342E3320486F757273'
```

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"Chiller01 On-Time=4.3 Hours"
X'0F' PD Closing Tag 0 (Stream Access)

Assuming this service procedure executes correctly, a complex acknowledgment is returned:

X'30' PDU Type=3 (BACnet-ComplexACK-PDU, SEG=0, MOR=0)
X'55' Invoke ID=85
X'07' Service ACK Choice=7 (AtomicWriteFile-ACK)
X'09' SD Context Tag 0 (File Start Position, L=1)
X'1E' 30

Example 2: Append two records to a file.

X'00' PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'02' Maximum APDU Size Accepted=206 octets
X'55' Invoke ID=85
X'07' Service Choice=7 (AtomicWriteFile-Request)

X'C4' Application Tag 12 (Object Identifier, L=4) (File Identifier)
X'02800002' File, Instance Number=2
X'1E' PD Opening Tag 1 (Record Access)
X'31' Application Tag 3 (Signed Integer, L=1) (File Start Record)
X'FF' -1 (Append to End of File)
X'21' Application Tag 2 (Unsigned Integer, L=1) (Record Count)
X'02' 2
X'65' Application Tag 6 (Octet String, L>4) (File Record Data)
X'0A' Extended Length=10
X'31323A30302C34352E36' "12:00,45.6"'
X'65' Application Tag 6 (Octet String, L>4) (File Record Data)
X'0A' Extended Length=10
X'31323A31352C34342E38' "12:15,44.8"
X'1F' PD Closing Tag 1 (Record Access)

Assuming this service procedure executes correctly, a complex acknowledgment is returned:

X'30' PDU Type=3 (BACnet-ComplexACK-PDU, SEG=0, MOR=0)
X'55' Invoke ID=85
X'07' Service ACK Choice=7 (AtomicWriteFile-ACK)
X'19' SD Context Tag 1 (File Start Record, L=1)
X'0E' 14

F.3 Example Encodings for Object Access Services

F.3.1 Encoding for Example E.3.1 - AddListElement Service

X'00' PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'02' Maximum APDU Size Accepted=206 octets
X'01' Invoke ID=1
X'08' Service Choice=8 (AddListElement-Request)

X'0C' SD Context Tag 0 (Object Identifier, L=4)
X'02C00003' Group, Instance Number=3
X'19' SD Context Tag 1 (Property Identifier, L=1)
X'35' 53 (LIST_OF_GROUP_MEMBERS)
X'3E' PD Opening Tag 3 (List Of Elements)

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```
        X'0C'               SD Context Tag 0 (Object Identifier, L=4)
        X'0000000F'         Analog Input, Instance Number=15
        X'1E'               PD Opening Tag 1 (List Of Property References)
            X'09'               SD Context Tag 0 (Property Identifier, L=1)
            X'55'               85 (PRESENT_VALUE)
            X'09'               SD Context Tag 0 (Property Identifier, L=1)
            X'67'               103 (RELIABILITY)
        X'1F'               PD Closing Tag 1 (List Of Property References)
X'3F'               PD Closing Tag 3 (List Of Elements)
```

Assuming this service procedure executes correctly, a simple acknowledgment is returned:

```
X'20'               PDU Type=2 (BACnet-SimpleACK-PDU)
X'01'               Invoke ID=1
X'08'               Service ACK Choice=8 (AddListElement)
```

F.3.2 Encoding for Example E.3.2 - RemoveListElement Service

```
X'00'               PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'02'               Maximum APDU Size Accepted=206 octets
X'34'               Invoke ID=52
X'09'               Service Choice=9 (RemoveListElement-Request)

X'0C'               SD Context Tag 0 (Object Identifier, L=4)
X'02C00003'         Group, Instance Number=3
X'19'               SD Context Tag 1 (Property Identifier, L=1)
X'35'               53 (LIST_OF_GROUP_MEMBERS)
X'3E'               PD Opening Tag 3 (List Of Elements)
        X'0C'               SD Context Tag 0 (Object Identifier, L=4)
        X'0000000C'         Analog Input, Instance Number=12
        X'1E'               PD Opening Tag 1 (List Of Property References)
            X'09'               SD Context Tag 0 (Property Identifier, L=1)
            X'55'               85 (PRESENT_VALUE)
            X'09'               SD Context Tag 0 (Property Identifier, L=1)
            X'67'               103 (RELIABILITY)
            X'09'               SD Context Tag 0 (Property Identifier, L=1)
            X'1C'               28 (DESCRIPTION)
        X'1F'               PD Closing Tag 1 (List Of Property References)

        X'0C'               SD Context Tag 0 (Object Identifier, L=4)
        X'0000000D'         Analog Input, Instance Number=13
        X'1E'               PD Opening Tag 1 (List Of Property References)
            X'09'               SD Context Tag 0 (Property Identifier, L=1)
            X'55'               85 (PRESENT_VALUE)
            X'09'               SD Context Tag 0 (Property Identifier, L=1)
            X'67'               103 (RELIABILITY)
            X'09'               SD Context Tag 0 (Property Identifier, L=1)
            X'1C'               28 (DESCRIPTION)
        X'1F'               PD Closing Tag 1 (List Of Property References)
X'3F'               PD Closing Tag 3 (List Of Elements)
```

Assuming the service procedure executes correctly, a simple acknowledgment is returned:

```
X'20'               PDU Type=2 (BACnet-SimpleACK-PDU)
X'34'               Invoke ID=52
X'09'               Service ACK Choice=9 (RemoveListElement)
```

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This second part of the example re-inserts two of the three elements removed above:

```
X'00'                   PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'02'                   Maximum APDU Size Accepted=206 octets
X'35'                   Invoke ID=53
X'08'                   Service Choice=8 (AddListElement-Request)

X'0C'                   SD Context Tag 0 (Object Identifier, L=4)
X'02C00003'             Group, Instance Number=3
X'19'                   SD Context Tag 1 (Property Identifier, L=1)
X'35'                   53 (LIST_OF_GROUP_MEMBERS)
X'3E'                   PD Opening Tag 3 (List Of Elements)
    X'0C'                   SD Context Tag 0 (Object Identifier, L=4)
    X'0000000C'             Analog Input, Instance Number=12
    X'1E'                   PD Opening Tag 1 (List Of Property References)
        X'09'                   SD Context Tag 0 (Property Identifier, L=1)
        X'55'                   85 (PRESENT_VALUE)
        X'09'                   SD Context Tag 0 (Property Identifier, L=1)
        X'67'                   103 (RELIABILITY)
    X'1F'                   PD Closing Tag 1 (List Of Property References)

    X'0C'                   SD Context Tag 0 (Object Identifier, L=4)
    X'0000000D'             Analog Input, Instance Number=13
    X'1E'                   PD Opening Tag 1 (List Of Property References)
        X'09'                   SD Context Tag 0 (Property Identifier, L=1)
        X'55'                   85 (PRESENT_VALUE)
        X'09'                   SD Context Tag 0 (Property Identifier, L=1)
        X'67'                   103 (RELIABILITY)
    X'1F'                   PD Closing Tag 1 (List Of Property References)
X'3F'                   PD Closing Tag 3 (List Of Elements)
```

Assuming the service procedure executes correctly, a simple acknowledgment is returned:

```
X'20'                   PDU Type=2 (BACnet-SimpleACK-PDU)
X'35'                   Invoke ID=53
X'08'                   Service ACK Choice=8 (AddListElement)
```

F.3.3 Encoding for Example E.3.3 - CreateObject Service

```
X'00'                   PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'04'                   Maximum APDU Size Accepted=1024 octets
X'56'                   Invoke ID=86
X'0A'                   Service Choice=10 (CreateObject-Request)

X'0E'                   PD Opening Tag 0 (Object Specifier)
    X'09'                   SD Context Tag 0 (Object Type, L=1)
    X'0A'                   10 (File Object)
X'0F'                   PD Closing Tag 0 (Object Specifier)
X'1E'                   PD Opening Tag 1 (List Of Initial Values)
    X'09'                   SD Context Tag 0 (Property Identifier, L=1)
    X'4D'                   77 (OBJECT_NAME)
    X'2E'                   PD Opening Tag 2 (Value)
        X'75'                   Application Tag 7 (Character String, L>4)
        X'08'                   Extended Length=8
        X'00'                   ISO 10646 (UTF-8) Encoding
```

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```
                X'5472656E642031'       "Trend 1"
        X'2F'                   PD Closing Tag 2 (Value)

        X'09'                   SD Context Tag 0 (Property Identifier, L=1)
        X'29'                   41 (FILE_ACCESS_METHOD)
        X'2E'                   PD Opening Tag 2 (Value)
                X'91'                   Application Tag 9 (Enumerated, L=1)
                X'00'                   0 (RECORD_ACCESS)
        X'2F'                   PD Closing Tag 2 (Value)
X'1F'                   PD Closing Tag 1 (List Of Initial Values)
```

Assuming the service procedure executes correctly, an acknowledgment is returned conveying the new object identifier:

```
X'30'           PDU Type=3 (BACnet-ComplexACK-PDU, SEG=0, MOR=0)
X'56'           Invoke ID=86
X'0A'           Service ACK Choice=10 (CreateObject-ACK)
X'C4'           Application Tag 12 (Object Identifier, L=4)
X'0280000D'     File, Instance Number=13
```

F.3.4 Encoding for Example E.3.4 - DeleteObject Service

Example 1: A successful attempt to delete an object.

```
X'00'           PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'04'           Maximum APDU Size Accepted=1024 octets
X'57'           Invoke ID=87
X'0B'           Service Choice=11 (DeleteObject-Request)
X'C4'           Application Tag 12 (Object Identifier, L=4)
X'02C00006'     Group, Instance Number=6
```

Assuming the service procedure executes correctly, a simple acknowledgment is returned:

```
X'20'           PDU Type=2 (BACnet-SimpleACK-PDU)
X'57'           Invoke ID=87
X'0B'           Service ACK Choice=11 (DeleteObject)
```

Example 2: An unsuccessful attempt to delete an object.

```
X'00'           PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'04'           Maximum APDU Size Accepted=1024 octets
X'58'           Invoke ID=88
X'0B'           Service Choice=11 (DeleteObject-Request)

X'C4'           Application Tag 12 (Object Identifier, L=4)
X'02C00007'     Group, Instance Number=7
```

In this example, the object is assumed to be protected and cannot be deleted by this protocol service. The server issues the following response:

```
X'50'           PDU Type=5 (BACnet-Error-PDU)
X'58'           Original Invoke ID=88
X'0B'           Error Choice=11 (DeleteObject)
X'91'           Application Tag 9 (Enumerated, L=1) (Error Class)
X'01'           1 (OBJECT)
X'91'           Application Tag 9 (Enumerated, L=1) (Error Code)
```

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X'17' 23 (OBJECT_DELETION_NOT_PERMITTED)

F.3.5 Encoding for Example E.3.5 - ReadProperty Service

X'00' PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'00' Maximum APDU Size Accepted=50 octets
X'01' Invoke ID=1
X'0C' Service Choice=12 (ReadProperty-Request)

X'0C' SD Context Tag 0 (Object Identifier, L=4)
X'00000005' Analog Input, Instance Number=5
X'19' SD Context Tag 1 (Property Identifier, L=1)
X'55' 85 (PRESENT_VALUE)

This request produces the following result:

X'30' PDU Type=3 (BACnet-ComplexACK-PDU, SEG=0, MOR=0)
X'01' Invoke ID=1
X'0C' Service ACK Choice=12 (ReadProperty-ACK)

X'0C' SD Context Tag 0 (Object Identifier, L=4)
X'00000005' Analog Input, Instance Number=5
X'19' SD Context Tag 1 (Property Identifier, L=1)
X'55' 85 (PRESENT_VALUE)
X'3E' PD Opening Tag 3 (Property Value)
X'44' Application Tag 4 (Real, L=4)
X'4290999A' 72.3
X'3F' PD Closing Tag 3 (Property Value)

F.3.6 Deleted Clause

This clause has been removed.

F.3.7 Encoding for Example E.3.7 - ReadPropertyMultiple Service

Example 1: Reading multiple properties of a single object.

X'00' PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'04' Maximum APDU Size Accepted=1024 octets
X'F1' Invoke ID=241
X'0E' Service Choice=14 (ReadPropertyMultiple-Request)

X'0C' SD Context Tag 0 (Object Identifier, L=4)
X'00000010' Analog Input, Instance Number=16
X'1E' PD Opening Tag 1 (List Of Property References)
X'09' SD Context Tag 0 (Property Identifier, L=1)
X'55' 85 (PRESENT_VALUE)

X'09' SD Context Tag 0 (Property Identifier, L=1)
X'67' 103 (RELIABILITY)
X'1F' PD Closing Tag 1 (List Of Property References)

Assuming this service procedure executes correctly, a complex acknowledgment is returned:

X'30' PDU Type=3 (BACnet-ComplexACK-PDU, SEG=0, MOR=0)

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```
X'F1'                   Invoke ID=241
X'0E'                   Service ACK Choice=14 (ReadPropertyMultiple-ACK)

X'0C'                   SD Context Tag 0 (Object Identifier, L=4)
X'00000010'             Analog Input, Instance Number=16
X'1E'                   PD Opening Tag 1 (List Of Results)
    X'29'                   SD Context Tag 2 (Property Identifier, L=1)
    X'55'                   85 (PRESENT_VALUE)
    X'4E'                   PD Opening Tag 4 (Property Value)
        X'44'                   Application Tag 4 (Real, L=4)
        X'4290999A'             72.3
    X'4F'                   PD Closing Tag 4 (Property Value)

    X'29'                   SD Context Tag 2 (Property Identifier, L=1)
    X'67'                   103 (RELIABILITY)
    X'4E'                   PD Opening Tag 4 (Property Value)
        X'91'                   Application Tag 9 (Enumerated, L=1)
        X'00'                   0 (NO_FAULT_DETECTED)
    X'4F'                   PD Closing Tag 4 (Property Value)
X'1F'                   PD Closing Tag 1 (List Of Results)
```

Example 2: Reading properties of several objects.

```
X'00'                   PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'04'                   Maximum APDU Size Accepted=1024 octets
X'02'                   Invoke ID=2
X'0E'                   Service Choice=14 (ReadPropertyMultiple-Request)

X'0C'                   SD Context Tag 0 (Object Identifier, L=4)
X'00000021'             Analog Input, Instance Number=33
X'1E'                   PD Opening Tag 1 (List Of Property References)
    X'09'                   SD Context Tag 0 (Property Identifier, L=1)
    X'55'                   85 (PRESENT_VALUE)
X'1F'                   PD Closing Tag 1 (List Of Property References)

X'0C'                   SD Context Tag 0 (Object Identifier, L=4)
X'00000032'             Analog Input, Instance Number=50
X'1E'                   PD Opening Tag 1 (List Of Property References)
    X'09'                   SD Context Tag 0 (Property Identifier, L=1)
    X'55'                   85 (PRESENT_VALUE)
X'1F'                   PD Closing Tag 1 (List Of Property References)

X'0C'                   SD Context Tag 0 (Object Identifier, L=4)
X'00000023'             Analog Input, Instance Number=35
X'1E'                   PD Opening Tag 1 (List Of Property References)
    X'09'                   SD Context Tag 0 (Property Identifier, L=1)
    X'55'                   85 (PRESENT_VALUE)
X'1F'                   PD Closing Tag 1 (List Of Property References)
```

Assuming this service procedure executes correctly, a complex acknowledgment is returned:

```
X'30'                   PDU Type=3 (BACnet-ComplexACK-PDU, SEG=0, MOR=0)
X'02'                   Invoke ID=2
X'0E'                   Service ACK Choice=14 (ReadPropertyMultiple-ACK)
```

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```
X'0C'                   SD Context Tag 0 (Object Identifier, L=4)
X'00000021'             Analog Input, Instance Number=33
X'1E'                   PD Opening Tag 1 (List Of Results)
        X'29'                   SD Context Tag 2 (Property Identifier, L=1)
        X'55'                   85 (PRESENT_VALUE)

        X'4E'                   PD Opening Tag 4 (Property Value)
                X'44'                   Application Tag 4 (Real, L=4)
                X'42293333'             42.3
        X'4F'                   PD Closing Tag 4 (Property Value)
X'1F'                   PD Closing Tag 1 (List Of Results)

X'0C'                   SD Context Tag 0 (Object Identifier, L=4)
X'00000032'             Analog Input, Instance Number=50
X'1E'                   PD Opening Tag 1 (List Of Results)
        X'29'                   SD Context Tag 2 (Property Identifier, L=1)
        X'55'                   85 (PRESENT_VALUE)
        X'5E'                   PD Opening Tag 5 (Property Access Error)
                X'91'                   Application Tag 9 (Enumerated, L=1) (Error Class)
                X'01'                   1 (OBJECT)
                X'91'                   Application Tag 9 (Enumerated, L=1) (Error Code)
                X'1F'                   31 (UNKNOWN_OBJECT)
        X'5F'                   PD Closing Tag 5 (Property Access Error)
X'1F'                   PD Closing Tag 1 (List Of Results)

X'0C'                   SD Context Tag 0 (Object Identifier, L=4)
X'00000023'             Analog Input, Instance Number=35
X'1E'                   PD Opening Tag 1 (List Of Results)
        X'29'                   SD Context Tag 2 (Property Identifier, L=1)
        X'55'                   85 (PRESENT_VALUE)
        X'4E'                   PD Opening Tag 4 (Property Value)
                X'44'                   Application Tag 4 (Real, L=4)
                X'43D9D99A'             435.7
        X'4F'                   PD Closing Tag 4 (Property Value)
X'1F'                   PD Closing Tag 1 (List Of Results)
```

F.3.8 Encoding for Example E.3.8 - ReadRange Service

Example 1: Reading records from a Trend Log object.

```
X'02'                   PDU Type = 0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=1)
X'02'                   Maximum APDU Size Accepted = 206 octets
X'01'                   Invoke ID = 1
X'1A'                   Service Choice = (26), (ReadRange-Request)

X'0C'                   SD Context Tag 0 (Object Identifier, L=4)
X'05000001'             Trend Log, Instance Number = 1
X'19'                   SD Context Tag 1 (Property Identifier, L=1)
X'83'                   131 (LOG_BUFFER)
X'5E'                   PD Opening Tag 5 (Time Range)
        X'A4'                   Application Tag 10 (Date, L=4)
        X'620317FF'             March 23, 1998 (Day Of Week Unspecified)
        X'B4'                   Application Tag 11, (Time, L=4)
        X'13342200'             19:52:34.0
        X'A4'                   Application Tag 10 (Date, L=4)
        X'620317FF'             March 23, 1998 (Day Of Week Unspecified)
```

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```
        X'B4'               Application Tag 11, (Time, L=4)
        X'13392200'         19:57:34.0
X'5F'               PD Closing Tag 5 (Time Range)
```

Assuming the service procedure executes correctly, a complex acknowledgment is returned containing the requested data:

```
X'30'               PDU Type = 3 (BACnet-ComplexACK-PDU, SEG=0, MOR=0)
X'01'               Invoke ID=1
X'1A'               Service ACK Choice = (26), (ReadRange-ACK)

X'0C'               SD Context Tag 0 (Object Identifier, L=4)
X'05000001'         Trend Log, Instance Number = 1
X'19'               SD Context Tag 1 (Property Identifier, L=1)
X'83'               131 (LOG_BUFFER)
X'3A'               SD Context Tag 3 (Result Flags, L=2)
X'05C0'             1,1,0 (TRUE, TRUE, FALSE)
X'49'               SD Context Tag 4 (Item Count, L=1)
X'02'               2
X'5E'               PD Opening Tag 5 (Item Data)
        X'0E'               PD Opening Tag 0 (Timestamp)
                X'A4'               Application Tag 10 (Date, L=4)
                X'62031701'         Monday, March 23, 1998
                X'B4'               Application Tag 11, (Time, L=4)
                X'13361B00'         19:54:27.0
        X'0F'               PD Closing Tag 0 (Timestamp)
        X'1E'               PD Opening Tag 1 (Log Datum)
                X'2C'               SD Context Tag 2 (REAL, L=4)
                X'41900000'         18.0
        X'1F'               PD Closing Tag 1 (Log Datum)
        X'2A'               SD Context Tag 2 (Status Flags, L=2)
        X'0400'             0,0,0,0 (FALSE, FALSE, FALSE, FALSE)
        X'0E'               PD Opening Tag 0 (Timestamp)
                X'A4'               Application Tag 10 (Date, L=4)
                X'62031701'         Monday, March 23, 1998
                X'B4'               Application Tag 11, (Time, L=4)
                X'13381B00'         19:56:27.0
        X'0F'               PD Closing Tag 0 (Timestamp)
        X'1E'               PD Opening Tag 1 (Log Datum)
                X'2C'               SD Context Tag 2 (REAL, L=4)
                X'4190CCCD'         18.1
        X'1F'               PD Closing Tag 1 (Log Datum)
        X'2A'               SD Context Tag 2 (Status Flags, L=2)
        X'0400'             0,0,0,0 (FALSE, FALSE, FALSE, FALSE)
X'5F'               PD Closing Tag 5 (Item Data)
```

F.3.9 Encoding for Example E.3.9 - WriteProperty Service

```
X'00'               PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'04'               Maximum APDU Size Accepted=1024 octets
X'59'               Invoke ID=89
X'0F'               Service Choice=15 (WriteProperty-Request)

X'0C'               SD Context Tag 0 (Object Identifier, L=4)
X'00800001'         Analog Value, Instance Number=1
X'19'               SD Context Tag 1 (Property Identifier, L=1)
X'55'               85 (PRESENT_VALUE)
```

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```
X'3E'                   PD Opening Tag 3 (Property Value)
    X'44'                   Application Tag 4 (Real, L=4)
    X'43340000'             Property Value=180.0
X'3F'                   PD Closing Tag 3 (Property Value)
```

Assuming the service procedure executes correctly, a simple acknowledgment is returned:

```
X'20'                   PDU Type=2 (BACnet-SimpleACK-PDU)
X'59'                   Invoke ID=89
X'0F'                   Service ACK Choice=15 (WriteProperty)
```

F.3.10 Encoding for Example E.3.10 - WritePropertyMultiple Service

```
X'00'                   PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'04'                   Maximum APDU Size Accepted=1024 octets
X'01'                   Invoke ID=1
X'10'                   Service Choice=16 (WritePropertyMultiple-Request)

X'0C'                   SD Context Tag 0 (Object Identifier, L=4)
X'00800005'             Analog Value, Instance Number=5
X'1E'                   PD Opening Tag 1 (List Of Properties)
    X'09'                   SD Context Tag 0 (Property Identifier, L=1)
    X'55'                   85 (PRESENT_VALUE)
    X'2E'                   PD Opening Tag 2 (Property Value)
        X'44'                   Application Tag 4 (Real, L=4)
        X'42860000'             67.0
    X'2F'                   PD Closing Tag 2 (Property Value)
X'1F'                   PD Closing Tag 1 (List Of Properties)

X'0C'                   SD Context Tag 0 (Object Identifier, L=4)
X'00800006'             Analog Value, Instance Number=6
X'1E'                   PD Opening Tag 1 (List Of Properties)
    X'09'                   SD Context Tag 0 (Property Identifier, L=1)
    X'55'                   85 (PRESENT_VALUE)
    X'2E'                   PD Opening Tag 2 (Property Value)
        X'44'                   Application Tag 4 (Real, L=4)
        X'42860000'             67.0
    X'2F'                   PD Closing Tag 2 (Property Value)
X'1F'                   PD Closing Tag 1 (List Of Properties)

X'0C'                   SD Context Tag 0 (Object Identifier, L=4)
X'00800007'             Analog Value, Instance Number=7
X'1E'                   PD Opening Tag 1 (List Of Properties)
    X'09'                   SD Context Tag 0 (Property Identifier, L=1)
    X'55'                   85 (PRESENT_VALUE)
    X'2E'                   PD Opening Tag 2 (Property Value)
        X'44'                   Application Tag 4 (Real, L=4)
        X'42900000'             72.0
    X'2F'                   PD Closing Tag 2 (Property Value)
X'1F'                   PD Closing Tag 1 (List Of Properties)
```

Assuming the service procedure executes correctly, a simple acknowledgment is returned:

```
X'20'                   PDU Type=2 (BACnet-SimpleACK-PDU)
X'01'                   Invoke ID=1
X'10'                   Service ACK Choice=16 (WritePropertyMultiple)
```

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F.4 Example Encodings for Remote Device Management Services

F.4.1 Encoding for Example E.4.1 - DeviceCommunicationControl Service

X'00'	PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'04'	Maximum APDU Size Accepted=1024 octets
X'05'	Invoke ID=5
X'11'	Service Choice=17 (DeviceCommunicationControl-Request)
X'09'	SD Context Tag 0 (Time Duration, L=1)
X'05'	5
X'19'	SD Context Tag 1 (Enable-Disable, L=1)
X'01'	1 (DISABLE)
X'2D'	SD Context Tag 2 (Password, L>4)
X'08'	Extended Length=8
X'00'	ISO 10646 (UTF-8) Encoding
X'23656762646621'	"#egbdf!"

Assuming the service procedure executes correctly, a simple acknowledgment is returned:

X'20'	PDU Type=2 (BACnet-SimpleACK-PDU)
X'05'	Invoke ID=5
X'11'	Service ACK Choice=17 (DeviceCommunicationControl)

F.4.2 Encoding for Example E.4.2 - ConfirmedPrivateTransfer Service

X'00'		PDU Type=0 (BACnet Confirmed-Request-PDU) SEG=0, MOR=0, SA=0)
X'04'		Maximum APDU Size Accepted=1024 octets
X'55'		Invoke ID=85
X'12'		Service Choice=18 (ConfirmedPrivateTransfer)
X'09'		SD Context Tag 0 (Vendor ID, L=1)
X'19'		25 (XYZ Controls Company Limited)
X'19'		SD Context Tag 1 (Service Number, L=1)
X'08'		8 (XYZ Proprietary Service #8)
X'2E'		PD Opening Tag 2 (Service Parameters)
	X'44'	Application Tag 4 (Real, L=4)
	X'4290CCCD'	72.4
	X'62'	Application Tag 6 (Octet String, L=2)
	X'1649'	X'1649'
X'2F'		PD Closing Tag 2 (Service Parameters)

Assuming that the service is successfully executed but no results need to be returned to the requesting BACnet-user, a 'Result(+)' primitive will be returned using a BACnet-ComplexACK-PDU:

X'30'	PDU Type=3 (BACnet-ComplexACK-PDU, SEG=0, MOR=0)
X'55'	Invoke ID=85
X'12'	Service Choice=18 (ConfirmedPrivateTransfer-ACK)
X'09'	SD Context Tag 0 (Vendor ID, L=1)
X'19'	25
X'19'	SD Context Tag 1 (Service Number, L=1)
X'08'	8

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F.4.3 Encoding for Example E.4.3 - UnconfirmedPrivateTransfer Service

X'10'		PDU Type=1 (BACnet-Unconfirmed-Request-PDU)
X'04'		Service Choice=4 (UnconfirmedPrivateTransfer-Request)
X'09'		SD Context Tag 0 (Vendor ID, L=1)
X'19'		25
X'19'		SD Context Tag 1 (Service Number, L=1)
X'08'		8
X'2E'		PD Opening Tag 2 (Service Parameters)
	X'44'	Application Tag 4 (Real, L=4)
	X'4290CCCD'	72.4
	X'62'	Application Tag 6 (Octet String, L=2)
	X'1649'	X'1649'
X'2F'		PD Closing Tag 2 (Service Parameters)

F.4.4 Encoding for Example E.4.4 - ReinitializeDevice Service

X'00'	PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'01'	Maximum APDU Size Accepted=128 octets
X'02'	Invoke ID=2
X'14'	Service Choice=20 (ReinitializeDevice-Request)
X'09'	SD Context Tag 0 (Reinitialized State Of Device, L=1)
X'01'	1 (WARMSTART)
X'1D'	SD Context Tag 1 (Password, L>4)
X'09'	Extended Length=9
X'00'	ISO 10646 (UTF-8) Encoding
X'4162436445664768'	"AbCdEfGh"

Assuming this service procedure executes correctly, a simple acknowledgment is returned:

X'20'	PDU Type=2 (BACnet-SimpleACK-PDU)
X'02'	Invoke ID=2
X'14'	Service ACK Choice=20 (ReinitializeDevice)

F.4.5 Encoding for Example E.4.5 - ConfirmedTextMessageService

X'00'		PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'01'		Maximum APDU Size Accepted=128 octets
X'03'		Invoke ID=3
X'13'		Service Choice=19 (ConfirmedTextMessage-Request)
X'0C'		SD Context Tag 0 (Text Message Source Device, L=4)
X'02000005'		Device, Instance Number=5
X'29'		SD Context Tag 2 (Message Priority, L=1)
X'00'		0 (NORMAL)
X'3D'		SD Context Tag 3 (Message, L>4)
	X'18'	Extended Length=24
	X'00'	ISO 10646 (UTF-8) Encoding
	X'504D20726571756972656420666F722050554D50333437'	"PM required for PUMP347"

Assuming the service procedure executes correctly, a simple acknowledgment is returned:

X'20'	PDU Type=2 (BACnetSimpleACK-PDU)
X'03'	Invoke ID=3

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X'13' Service ACK Choice=19 (ConfirmedTextMessage)

F.4.6 Encoding for Example E.4.6 - UnconfirmedTextMessage Service

X'10' PDU Type=1 (BACnet-Unconfirmed-Request-PDU)
X'05' Service Choice=5 (UnconfirmedTextMessage-Request)

X'0C' SD Context Tag 0 (Text Message Source Device, L=4)
X'02000005' Device, Instance Number=5
X'29' SD Context Tag 2 (Message Priority, L=1)
X'00' 0 (NORMAL)
X'3D' SD Context Tag 3 (Message, L>4)
X'18' Extended Length=24
X'00' ISO 10646 (UTF-8) Encoding
X'504D20726571756972656420666F722050554D50333437' "PM required for PUMP347"

Note that no response is required for this message since it is of type unconfirmed.

F.4.7 Encoding for Example E.4.7 - TimeSynchronization Service

X'10' PDU Type=1 (BACnet-Unconfirmed-Service-Request-PDU)
X'06' Service Choice=6 (TimeSynchronization-Request)

X'A4' Application Tag 10 (Date, L=4)
X'5C0B11FF' November 17, 1992 (Day of Week Unspecified)
X'B4' Application Tag 11 (Time, L=4)
X'162D1E46' 22:45:30.70

F.4.8 Encoding for Example E.4.8 - Who-Has and I-Have Services

Example 1: Locating the device that contains an object for which the Object_Name is known.

X'10' PDU Type=1 (Unconfirmed-Service-Request-PDU)
X'07' Service Choice=7 (Who-Has-Request)

X'3D' SD Context Tag 3 (Object Name, L>4)
X'07' Extended Length=7
X'00' ISO 10646 (UTF-8) Encoding
X'4F4154656D70' "OATemp"

Assuming that exactly one other device has such an object, the following I-Have service indication would be received.

X'10' PDU Type=1 (Unconfirmed-Service-Request-PDU)
X'01' Service Choice=1 (I-Have-Request)

X'C4' Application Tag 12 (Object Identifier, L=4) (Device Identifier)
X'02000008' Device, Instance Number=8
X'C4' Application Tag 12 (Object Identifier, L=4) (Object Identifier)
X'00000003' Analog Input, Instance Number=3
X'75' Application Tag 7 (Character String, L>4) (Object Name)
X'07' Extended Length=7
X'00' ISO 10646 (UTF-8) Encoding
X'4F4154656D70' "OATemp"

Example 2: Locating the device that contains an object for which the Object_Identifier is known.

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X'10' PDU Type=1 (Unconfirmed-Service-Request-PDU)
X'07' Service Choice=7 (Who-Has-Request)

X'2C' SD Context Tag 2 (Object Identifier, L=4)
X'00000003' Analog Input, Instance Number=3

Assuming that exactly one other device has such an object, the following I-Have service indication would be received.

X'10' PDU Type=1 (Unconfirmed-Service-Request-PDU)
X'01' Service Choice=1 (I-Have-Request)

X'C4' Application Tag 12 (Object Identifier, L=4) (Device Identifier)
X'02000008' Device, Instance Number=8
X'C4' Application Tag 12 (Object Identifier, L=4) (Object Identifier)
X'00000003' Analog Input, Instance Number=3
X'75' Application Tag 7 (Character String, L>4) (Object Name)
X'07' Extended Length=7
X'00' ISO 10646 (UTF-8) Encoding
X'4F4154656D70' "OATemp"

F.4.9 Encoding for Example E.4.9 - Who-Is and I-Am Services

Example 1: Establishing the network address of a device with a known Device object identifier, i.e., instance number.

X'10' PDU Type=1 (Unconfirmed-Service-Request-PDU)
X'08' Service Choice=8 (Who-Is-Request)

X'09' SD Context Tag 0 (Device Instance Range Low Limit, L=1)
X'03' 3
X'19' SD Context Tag 1 (Device Instance Range High Limit, L=1)
X'03' 3

Assuming that there is such a device on the network, it responds some time later using the I-Am service:

X'10' PDU Type=1 (Unconfirmed-Service-Request-PDU)
X'00' Service Choice=0 (I-Am-Request)

X'C4' Application Tag 12 (Object Identifier, L=4) (I-Am Device Identifier)
X'02000003' Device, Instance Number=3
X'22' Application Tag 2 (Unsigned Integer, L=2) (Max APDU Length Accepted)
X'0400' 1024
X'91' Application Tag 9 (Enumerated, L=1) (Segmentation Supported)
X'03' 3 (NO_SEGMENTATION)
X'21' Application Tag 2 (Unsigned Integer, L=1) (Vendor ID)
X'63' 99

Example 2: Finding out about all network devices.

X'10' PDU Type=1 (Unconfirmed-Service-Request-PDU)
X'08' Service Choice=8 (Who-Is-Request)

Each device on the network responds using the I-Am service:

X'10' PDU Type=1 (Unconfirmed-Service-Request-PDU)
X'00' Service Choice=0 (I-Am-Request)

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X'C4'	Application Tag 12 (Object Identifier, L=4) (I-Am Device Identifier)
X'02000001'	Device, Instance Number=1
X'22'	Application Tag 2 (Unsigned Integer, L=2) (Max APDU Length Accepted)
X'01E0'	480
X'91'	Application Tag 9 (Enumerated, L=1) (Segmentation Supported)
X'01'	1 (SEGMENTED_TRANSMIT)
X'21'	Application Tag 2 (Unsigned Integer, L=1) (Vendor ID)
X'63'	99
X'10'	PDU Type=1 (Unconfirmed-Service-Request-PDU)
X'00'	Service Choice=0 (I-Am-Request)
X'C4'	Application Tag 12 (Object Identifier, L=4) (I-Am Device Identifier)
X'02000002'	Device, Instance Number=2
X'21'	Application Tag 2 (Unsigned Integer, L=1) (Max APDU Length Accepted)
X'CE'	206
X'91'	Application Tag 9 (Enumerated, L=1) (Segmentation Supported)
X'02'	2 (SEGMENTED_RECEIVE)
X'21'	Application Tag 2 (Unsigned Integer, L=1) (Vendor ID)
X'21'	33
X'10'	PDU Type=1 (Unconfirmed-Service-Request-PDU)
X'00'	Service Choice=0 (I-Am-Request)
X'C4'	Application Tag 12 (Object Identifier, L=4) (I-Am Device Identifier)
X'02000003'	Device, Instance Number=3
X'22'	Application Tag 2 (Unsigned Integer, L=2) (Max APDU Length Accepted)
X'0400'	1024
X'91'	Application Tag 9 (Enumerated, L=1) (Segmentation Supported)
X'03'	3 (NO_SEGMENTATION)
X'21'	Application Tag 2 (Unsigned Integer, L=1) (Vendor ID)
X'63'	99
X'10'	PDU Type=1 (Unconfirmed-Service-Request-PDU)
X'00'	Service Choice=0 (I-Am-Request)
X'C4'	Application Tag 12 (Object Identifier, L=4) (I-Am Device Identifier)
X'02000004'	Device, Instance Number=4
X'21'	Application Tag 2 (Unsigned Integer, L=1) (Max APDU Length Accepted)
X'80'	128
X'91'	Application Tag 9 (Enumerated, L=1) (Segmentation Supported)
X'00'	0 (SEGMENTED_BOTH)
X'21'	Application Tag 2 (Unsigned Integer, L=1) (Vendor ID)
X'42'	66

F.5 Example Encodings for Virtual Terminal Services

Establishing a VT session:

X'00'	PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'01'	Maximum APDU Size Accepted=128 octets

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X'50'	Invoke ID=80
X'15'	Service Choice=21 (VT-Open-Request)
X'91'	Application Tag 9 (Enumerated, L=1) (VT Class)
X'01'	1 (ANSI_X3.64)
X'21'	Application Tag 2 (Unsigned Integer, L=1) (Local VT Session Identifier)
X'05'	5

Assuming that the target device can create a new VT-session, a complex acknowledgment is returned:

X'30'	PDU Type=3 (BACnet-ComplexACK-PDU, SEG=0, MOR=0)
X'50'	Invoke ID=80
X'15'	Service Choice=21 (VT-Open-ACK)
X'21'	Application Tag 2 (Unsigned Integer, L=1) (Remote VT Session Identifier)
X'1D'	29

Terminal sign-on. The target device sends a prompt:

X'00'	PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'01'	Maximum APDU Size Accepted=128 octets
X'51'	Invoke ID=81
X'17'	Service Choice=23 (VT-Data-Request)
X'21'	Application Tag 2 (Unsigned Integer, L=1) (VT Session Identifier)
X'05'	5
X'65'	Application Tag 6 (Octet String, L>4) (VT New Data)
X'12'	Extended Length=18
X'0D0A456E7465722055736572204E616D653A'	"{cr}{lf}Enter User Name:"
X'21'	Application Tag 2 (Unsigned Integer, L=1) (VT Data Flag)
X'00'	0

Assuming that the operator interface device receives the data correctly, a complex acknowledgment is returned:

X'30'	PDU Type=3 (BACnet-ComplexACK-PDU, SEG=0, MOR=0)
X'51'	Invoke ID=81
X'17'	Service Choice=23 (VT-Data-ACK)
X'09'	SD Context Tag 0 (All New Data Accepted, L=1)
X'01'	1 (TRUE)

Entering user name:

X'00'	PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'01'	Maximum APDU Size Accepted=128 octets
X'52'	Invoke ID=82
X'17'	Service Choice=23 (VT-Data-Request)
X'21'	Application Tag 2 (Unsigned Integer, L=1) (VT Session Identifier)
X'1D'	29
X'65'	Application Tag 6 (Octet String, L>4) (VT New Data)
X'05'	Extended Length=5
X'465245440D'	"FRED{cr}"
X'21'	Application Tag 2 (Unsigned Integer, L=1) (VT Data Flag)
X'00'	0

To which the target device would respond:

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X'30'	PDU Type=3 (BACnet-ComplexACK-PDU, SEG=0, MOR=0)
X'52'	Invoke ID=82
X'17'	Service Choice=23 (VT-Data-ACK)
X'09'	SD Context Tag 0 (All New Data Accepted, L=1)
X'01'	1 (TRUE)

Entering password:

X'00'	PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'01'	Maximum APDU Size Accepted=128 octets
X'53'	Invoke ID=83
X'17'	Service Choice=23 (VT-Data-Request)
X'21'	Application Tag 2 (Unsigned Integer, L=1) (VT Session Identifier)
X'05'	5
X'65'	Application Tag 6 (Octet String, L>4) (VT New Data)
X'15'	Extended Length=21
X'465245440D0A456E7465722050617373776F72643A'	"FRED{cr}{lf}Enter Password:"
X'21'	Application Tag 2 (Unsigned Integer, L=1) (VT Data Flag)
X'01'	1

To which the target device would respond:

X'30'	PDU Type=3 (BACnet-ComplexACK-PDU, SEG=0, MOR=0)
X'53'	Invoke ID=83
X'17'	Service Choice=23 (VT-Data-ACK)
X'09'	SD Context Tag 0 (All New Data Accepted, L=1)
X'01'	1 (TRUE)

Terminal sign-off:

X'00'	PDU Type=0 (BACnet-Confirmed-Request-PDU, SEG=0, MOR=0, SA=0)
X'01'	Maximum APDU Size Accepted=128 octets
X'54'	Invoke ID=84
X'16'	Service Choice=22 (VT-Close-Request)
X'21'	Application Tag 2 (Unsigned Integer, L=1) (List Of Remote VT Session Identifiers)
X'1D'	29

Response:

X'20'	PDU Type=2 (BACnet-SimpleACK-PDU)
X'54'	Invoke ID=84
X'16'	Service ACK Choice=22 (VT-Close)

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ANNEX G - CALCULATION OF CRC (INFORMATIVE)

(This annex is not part of this standard but is included for informative purposes only.)

Historically, CRC generators have been implemented as shift registers with exclusive OR feedback. This provides an inexpensive way to process CRC information on a serial bit stream in hardware. Since commercial UARTs do not provide hardware calculation of CRC, UART-based protocols such as those described in Clauses 9 and 10 must perform this calculation with software. While this can be done one bit at a time, simulating a shift register with feedback, a much more efficient algorithm is possible that computes the CRC on an entire octet at once. This annex shows how the CRC may be computed in this manner. This algorithm is presented as an example and is not intended to restrict the vendor's implementation of the CRC calculation.

G.1 Calculation of the Header CRC

We begin with the diagram of a hardware CRC generator as shown in Figure G-1. The polynomial used is

$$X^8 + X^7 + 1$$

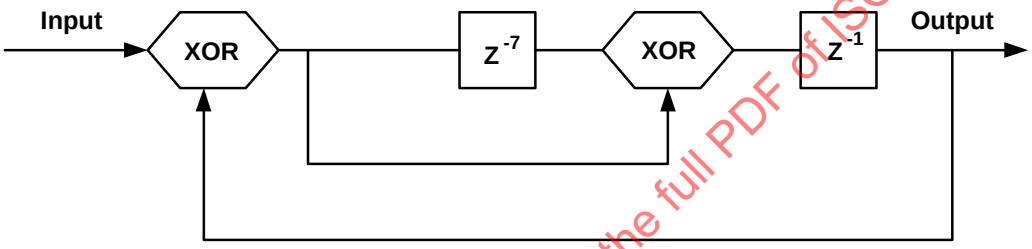

Figure G-1. Hardware header-CRC generator.

The hardware implementation operates on a serial bit stream, whereas our calculation must operate on entire octets. To this end, we follow the operation of the circuit through eight bits of data. The CRC shift register is initialized to X0 (input end) to X7 (output end), the input data is D0 to D7 (least significant bit first, as transmitted and received by a UART). Within each block below, the terms are exclusive OR'ed vertically.

```
input   register contents
   |-------------------------------|
D0| X0  X1  X2  X3  X4  X5  X6  X7 |
   |-------------------------------|
D1|     X0  X1  X2  X3  X4  X5  X6 |
   | D0                        D0  |
   | X7                        X7  |
   |-------------------------------|
D2|         X0  X1  X2  X3  X4  X5 |
   | D1  D0                    D1  |
   | X6  X7                    X6  |
   | D0                        D0  |
   | X7                        X7  |
   |-------------------------------|
D3|             X0  X1  X2  X3  X4 |
   | D2  D1  D0                D2  |
   | X5  X6  X7                X5  |
   | D1  D0                    D1  |
   | X6  X7                    X6  |
   | D0                        D0  |
   | X7                        X7  |
   |-------------------------------|
```

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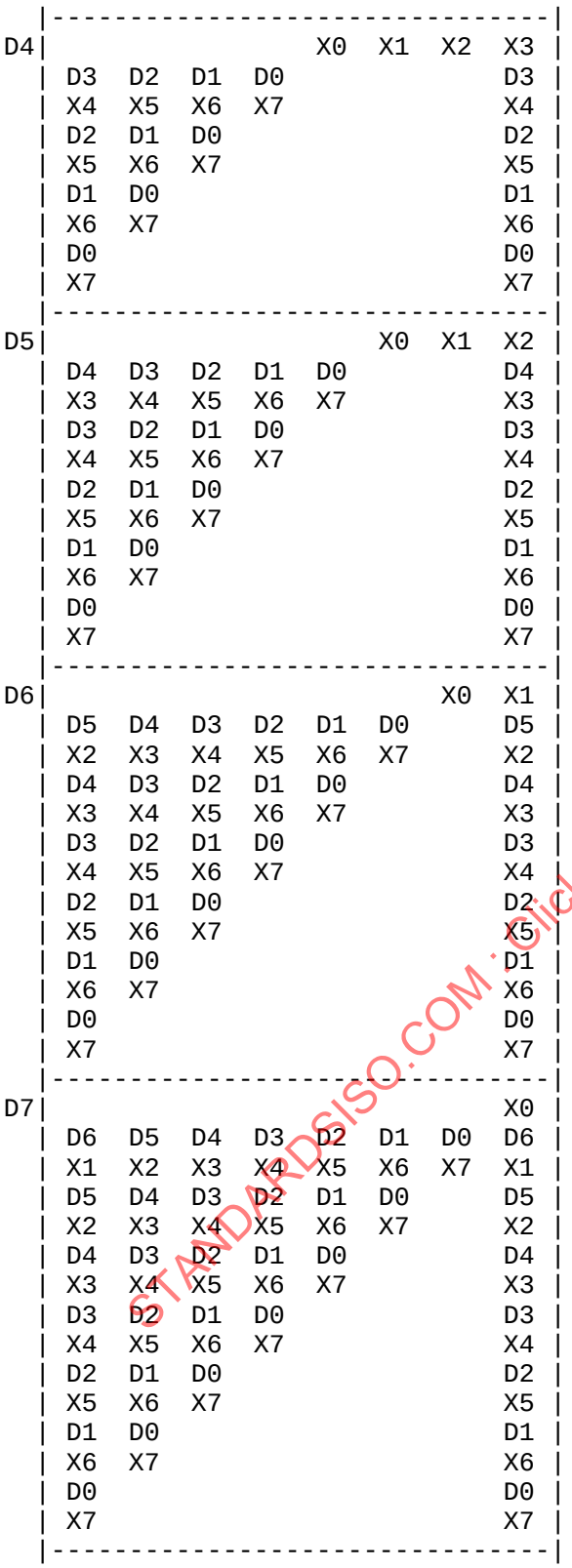

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```
|--------------------------------|
|                             D0 |
|                             X7 |
| D7  D6  D5  D4  D3  D2  D1  D7 |
| X0  X1  X2  X3  X4  X5  X6  X0 |
| D6  D5  D4  D3  D2  D1  D0  D6 |
| X1  X2  X3  X4  X5  X6  X7  X1 |
| D5  D4  D3  D2  D1  D0      D5 |
| X2  X3  X4  X5  X6  X7      X2 |
| D4  D3  D2  D1  D0          D4 |
| X3  X4  X5  X6  X7          X3 |
| D3  D2  D1  D0              D3 |
| X4  X5  X6  X7              X4 |
| D2  D1  D0                  D2 |
| X5  X6  X7                  X5 |
| D1  D0                      D1 |
| X6  X7                      X6 |
| D0                          D0 |
| X7                          X7 |
|--------------------------------|
```

The final block above is the net result of shifting an octet of data through the CRC generator. By performing the indicated exclusive OR operations, an octet can be processed into the CRC. In order to simplify the required shifting operations, we define X0 to be the most significant bit of the parallel representation and X7 to be the least significant. Since most microprocessors number bits in the opposite order, we rename the bits to correspond to standard microprocessor bit nomenclature. Let C7 = X0, C6 = X1, etc. The final block in the previous table thus becomes:

```
|--------------------------------|
| X0  X1  X2  X3  X4  X5  X6  X7 |
|--------------------------------|
| C7  C6  C5  C4  C3  C2  C1  C0 |
|--------------------------------|
|                             D0 |
|                             C0 |
| D7  D6  D5  D4  D3  D2  D1  D7 |
| C7  C6  C5  C4  C3  C2  C1  C7 |
| D6  D5  D4  D3  D2  D1  D0  D6 |
| C6  C5  C4  C3  C2  C1  C0  C6 |
| D5  D4  D3  D2  D1  D0      D5 |
| C5  C4  C3  C2  C1  C0      C5 |
| D4  D3  D2  D1  D0          D4 |
| C4  C3  C2  C1  C0          C4 |
| D3  D2  D1  D0              D3 |
| C3  C2  C1  C0              C3 |
| D2  D1  D0                  D2 |
| C2  C1  C0                  C2 |
| D1  D0                      D1 |
| C1  C0                      C1 |
| D0                          D0 |
| C0                          C0 |
|--------------------------------|
```

or, rearranging vertically (since exclusive OR is commutative) to minimize computation, and recognizing that any term exclusive OR'ed with itself may be eliminated:

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