INTERNATIONAL STANDARD

ISO/IEC/IEEE 8802-1AB

Second edition
2017-07

AMENDMENT 1
2023-07

Information technology — Telecommunications and information exchange between systems — Local and metropolitan area networks — Specific requirements —

Part 1AB: Station and media access control connectivity discovery

AMENDMENT 1: YANG data model

Technologies de l'information — Télécommunications et échange d'information entre systèmes — Réseaux locaux et métropolitains — Exigences spécifiques —

Partie 1AB: Découverte de connectivité des stations et du contrôle d'accès aux supports

AMENDEMENT 1: Modèle de données YANG

Reference number
ISO/IEC/IEEE 8802-1AB:2017/Amd.1:2023(E)

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Published in Switzerland

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IEEE Std 802.1ABcu™-2021
(Amendment to IEEE Std 802.1AB™-2016)

IEEE Standard for
Local and metropolitan area networks—

Station and Media Access Control Connectivity Discovery

Amendment 1: YANG Data Model

Developed by the

LAN/MAN Standards Committee
of the
IEEE Computer Society

Approved 8 December 2021

IEEE SA Standards Board

Abstract: This amendment to IEEE Std 802.1AB-2016 specifies a Unified Modeling Language (UML)-based information model and a YANG data model that allows configuration and status reporting for bridges and bridge components with regards to topology discovery.

Keywords: Bridged Local Area Networks, IEEE 802®, IEEE 802.1AB™, IEEE 802.1ABcu™, local area networks (LANs), MAC Bridges, metropolitan area networks, YANG

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PDF: ISBN 978-1-5044-8299-8 STD25172
Print: ISBN 978-1-5044-8300-1 STDPD25172

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Introduction

This introduction is not part of IEEE Std 802.1ABcu-2021, IEEE Standard for Local and metropolitan area networks—Station and Media Access Control Connectivity Discovery—Amendment 1: YANG Data Model.

The scope of this standard is to define a protocol and management elements, suitable for advertising information to stations attached to the same IEEE 802 LAN, for the purpose of populating physical topology and device discovery management information databases. The protocol facilitates the identification of stations connected by IEEE 802 LANs/MANs, their points of interconnection, and access points for management protocols.

This standard contains state-of-the-art material. The area covered by this standard is undergoing evolution. Revisions are anticipated within the next few years to clarify existing material, to correct possible errors, and to incorporate new related material. Information on the current revision state of this and other IEEE 802 standards may be obtained from

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Contents

IEEE Standard for Local and metropolitan area networks—

Station and Media Access Control Connectivity Discovery

Amendment 1: YANG Data Model

(This amendment is based on IEEE Std 802.1AB™-2016.)

NOTE—The editing instructions contained in this amendment define how to merge the material contained therein into the existing base standard and its amendments to form the comprehensive standard.

The editing instructions are shown in ***bold italic***. Four editing instructions are used: change, delete, insert, and replace. ***Change*** is used to make corrections in existing text or tables. The editing instruction specifies the location of the change and describes what is being changed by using ~~strikethrough~~ (to remove old material) and underscore (to add new material). ***Delete*** removes existing material. ***Insert*** adds new material without disturbing the existing material. Deletions and insertions may require renumbering. If so, renumbering instructions are given in the editing instruction. ***Replace*** is used to make changes in figures or equations by removing the existing figure or equation and replacing it with a new one. Editing instructions, change markings, and this NOTE will not be carried over into future editions because the changes will be incorporated into the base standard.[6]

[6] Notes in text, tables, and figures are given for information only and do not contain requirements needed to implement the standard.

1. Overview

1.2 Purpose

Change 1.2 as follows:

~~An IETF MIB (IETF RFC 2922 [B9]) and a number of vendor specific MIBs have been created to describe a network's physical topology and associated systems within that topology.~~

This standard specifies the necessary protocol and management elements to

a) Facilitate multi-vendor inter-operability and the use of standard management tools to discover and make available physical topology information for network management.
b) Make it possible for network management to discover certain configuration inconsistencies or malfunctions that can result in impaired communication at higher layers.
c) Provide information to assist network management in making resource changes and/or re-configurations that correct configuration inconsistencies or malfunctions identified in b) above.
d) Provide IETF MIB (IETF RFC 2922 [B9]) to describe a network's physical topology and associated systems within that topology.
e) Provide YANG configuration and operational models supporting Station and Media Access Control Connectivity Discovery.

2. Normative references

Insert the following references into Clause 2 in alphanumeric order:

IEEE Std 802d™-2017, IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture—Amendment 1: Allocation of Uniform Resource Name (URN) Values in IEEE 802® Standards.[7, 8]

IETF RFC 6241, Network Configuration Protocol (NETCONF), June 2011.[9]

IETF RFC 6991, Common YANG Data Types, July 2013.

IETF RFC 7950, The YANG 1.1 Data Modeling Language, August 2016.

IETF RFC 8343, A YANG Data Model for Interface Management, March 2018.

IETF RFC 8349, A YANG Data Model for Routing Management (NMDA Version), March 2018.

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3. Definitions and numerical representation

3.1 Definitions

Change the first paragraph of 3.1 as follows (note change in footnote text):

For the purposes of this document, the following terms and definitions apply. The *IEEE Standards Dictionary Online* should be consulted for terms not defined in this clause.[10]

Insert new definitions at the end of 3.1 as follows:

YANG: IETF defined data modeling language, published as IETF RFC 7950.

YANG model: One or more YANG modules used to configure and monitor the managed element or system.

YANG module: The description of the data model used to configure and monitor the managed element or system. A YANG module defines a hierarchy of nodes that can be used for NETCONF-based (see IETF RFC 7803 [B13]) and RESTCONF-based (see IETF RFC 8040 [B14]) operations.

[10] *IEEE Standards Dictionary Online* ~~subscription~~ is available at: http://dictionary.ieee.org. ~~http://www.ieee.org/portal/innovate/products/standard/standards_dictionary.html~~

5. Conformance

5.3 Required capabilities

Change item n) in the lettered list of 5.3 as follows:

n) If neither SNMP nor YANG ~~is not~~ are supported, the system shall provide storage and retrieval capability equivalent to the functionality specified in 10.1 for the operating mode being implemented.

Insert new item o) after item n) in the lettered list of 5.3 as follows:

o) If YANG is supported, then the system shall conform to the LLDP management specifications in Clause 12 and shall implement the sections of the LLDP YANG module for the operating mode being implemented.

6. Principles of operation

Change the first paragraph of the introduction of Clause 6 as follows:

LLDP is a link layer protocol that allows an IEEE 802 LAN station to advertise the capabilities and current status of the system associated with an MSAP. The MSAP provides the MAC service to an LLC Entity, and that LLC Entity provides an LSAP to an LLDP agent that transmits and receives information to and from the LLDP agents of other stations attached to the same LAN. The information distributed and received in each LLDPDU is stored in one or more Management Information Bases (MIBs) or YANG modules. Figure 6-1 illustrates the LLDP agent and its relationship to its LLC Entity and MSAP, and to additional MIBs or YANG modules designed by the IETF, IEEE 802, and others.

Replace Figure 6-1 with the following figure (with YANG references added):

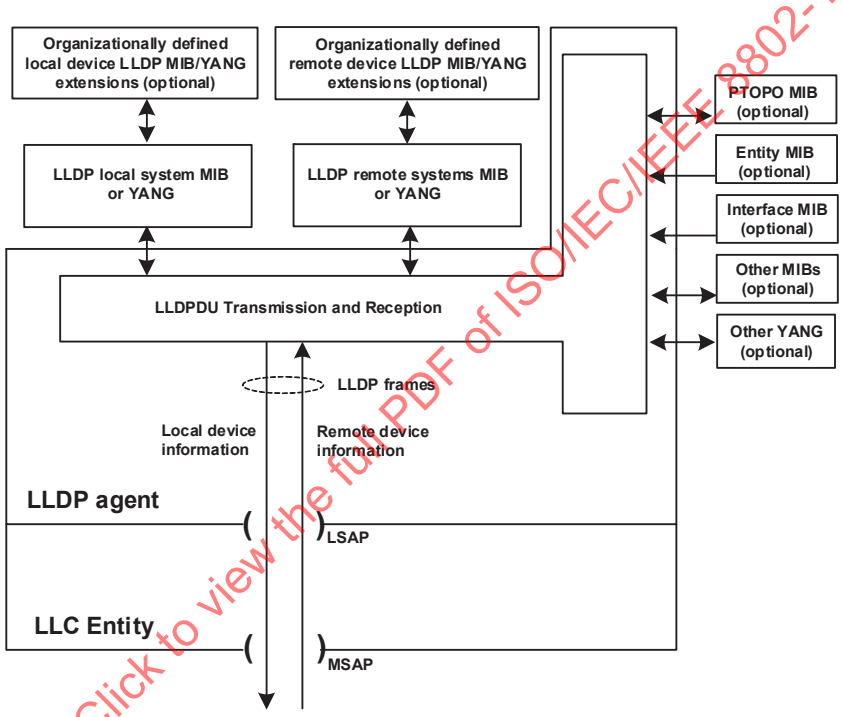

Figure 6-1—LLDP agent and its relationship to its LLC entity

Change the second paragraph of the introduction of Clause 6 as follows:

This clause describes general principles of LLDP operation. The following clauses specify transmission, reception, and addressing of LLPDUs (Clause 7); LLDPDU formats (Clause 8); operation of each LLDP agent in detail including state machines (Clause 9); management of LLDP (Clause 10); and the MIB module (Clause 11) or YANG module (Clause 12) used for LLDP management ~~(Clause 11)~~.

9. LLDP agent operation

9.2 State machines

9.2.5 Per-Agent variables

9.2.5.6 msgTxHold

Change 9.2.5.6 as follows:

This variable is used, as a multiplier of msgTxInterval, to determine the value of txTTL that is carried in LLDP frames transmitted by the LLDP agent. The recommended default value of msgTxHold is 4; this value can be changed by management to any value in the range 2~~1~~ through 10~~0~~.

Insert Clause 12 after Clause 11 as follows:

12. LLDP YANG definitions

This clause specifies YANG modules that provide control and status monitoring of systems and system components that implement functionality specified in this standard.

This clause:

a) Introduces the YANG framework that governs the naming and hierarchy of configuration and operational data structures in the data models, and the modeling of network interfaces (12.1).
b) Describes the information data model and its relationship to the operational processes and managed objects specified in the other clauses of this standard, and provides a UML representation of each data model (12.2).
c) Describes the structure of the data models, each of which comprises or makes use of one or more YANG modules (12.3).
d) Includes a relationship description of other modules imported in YANG modules (12.4).
e) Reviews security considerations applicable to each of the modules, with specific reference to data nodes in the YANG modules that compose the model (12.5).
f) Includes each of the YANG modules and its data schema (12.6).

12.1 Internet Standard Management Framework

This YANG module uses the YANG 1.1 Data Modeling Language as specified in IETF RFC 7950.

The YANG framework applies hierarchy in the following areas:

a) The uniform resource name (URN), as specified in IEEE Std 802d. The structure of the URN is such that ieee is the root (i.e., name-space identifier), followed by the standard, then the working group developing the standard.
b) The YANG objects form a hierarchy of configuration and operational data structures that define the YANG model.

12.2 Information model for LLDP management

The YANG objects are based on the TLVs detailed in 8.5 and 8.6, and the agent operation variables detailed in 9.1 and 9.2. A UML-like representation of the management model is provided in the following subclauses.

The purpose of a UML-like[11] diagram is to express the model design on a single piece of paper. The structure of the UML-like representation shows the name of the object followed by a list of properties for the object. The properties indicate its type and accessibility. It should be noted that the UML-like representation is meant to express simplified semantics for the properties. It is not meant to provide the specific datatype as used to encode the object in either MIB or YANG. In the UML-like representation, a box with a white background represents information that comes from sources outside of the IEEE. A box with a gray background represents objects that are defined by this IEEE Standard.

The YANG hierarchical structure that incorporates the LLDP YANG modules supported by this standard is represented by Figure 12-1. In the figures in this clause, items that are shaded gray are described in this

[11]A description of the UML-like diagrams used in this clause is provided at https://1.ieee802.org/uml-like-diagrams.

document, items with no background shading are defined elsewhere. The YANG data model is realized in two YANG modules. One module *ieee802-dot1ab-types* provides data types that are needed by the LLDP configuration and monitoring objects. The *ieee802-dot1ab-lldp* module provides the LLDP configuration and monitoring objects. The ability to augment the port container to support extension TLVs is also shown. The LLDP capabilities are not only applicable to IEEE Std 802.1Q bridges, but also (for example) end stations, and routers.

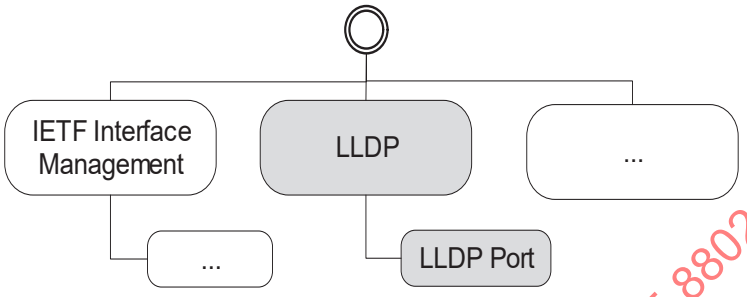

Figure 12-1—YANG root hierarchy with LLDP YANG modules

12.2.1 LLDP UML

The LLDP configuration and monitoring objects in Figure 12-2 show the objects that are applicable on a per-agent or chassis associated with the LLDP agent.

```
lldp
uint32  message-fast-tx;                    // (9.2.5.5) r-w
uint32  message-tx-hold-multiplier;         // (9.2.5.6) r-w
uint32  message-tx-interval;                // (9.2.5.7) r-w
uint32  reinit-delay;                       // (9.2.5.10) r-w
uint32  tx-credit-max;                      // (9.2.5.17) r-w
uint32  tx-fast-init;                       // (9.2.5.19) r-w
uint32  notification-interval;              // (9.2.5.7) r-w
remote-statistics
timestamp               last-change-time;   // r
zero-based-counter32    remote-inserts;     // r
zero-based-counter32    remote-deletes;     // r
zero-based-counter32    remote-drops;       // r
zero-based-counter32    remote-ageouts;     // r
local-system-data
enum    chassis-id-subtype;                 // (8.5.2.2) r
string  chassis-id;                         // (8.5.2.3) r
string  system-name;                        // (8.5.6.2) r
string  system-description;                 // (8.5.7.2) r
bits    system-capabilities-supported       // (8.5.8.1) r
bits    system-capabilities-enabled         // (8.5.8.2) r
```

Figure 12-2—LLDP configuration and monitoring objects

12.2.2 LLDP Port UML

The LLDP port configuration and monitoring objects in Figure 12-3 show the objects that are applicable to an LLDP port.

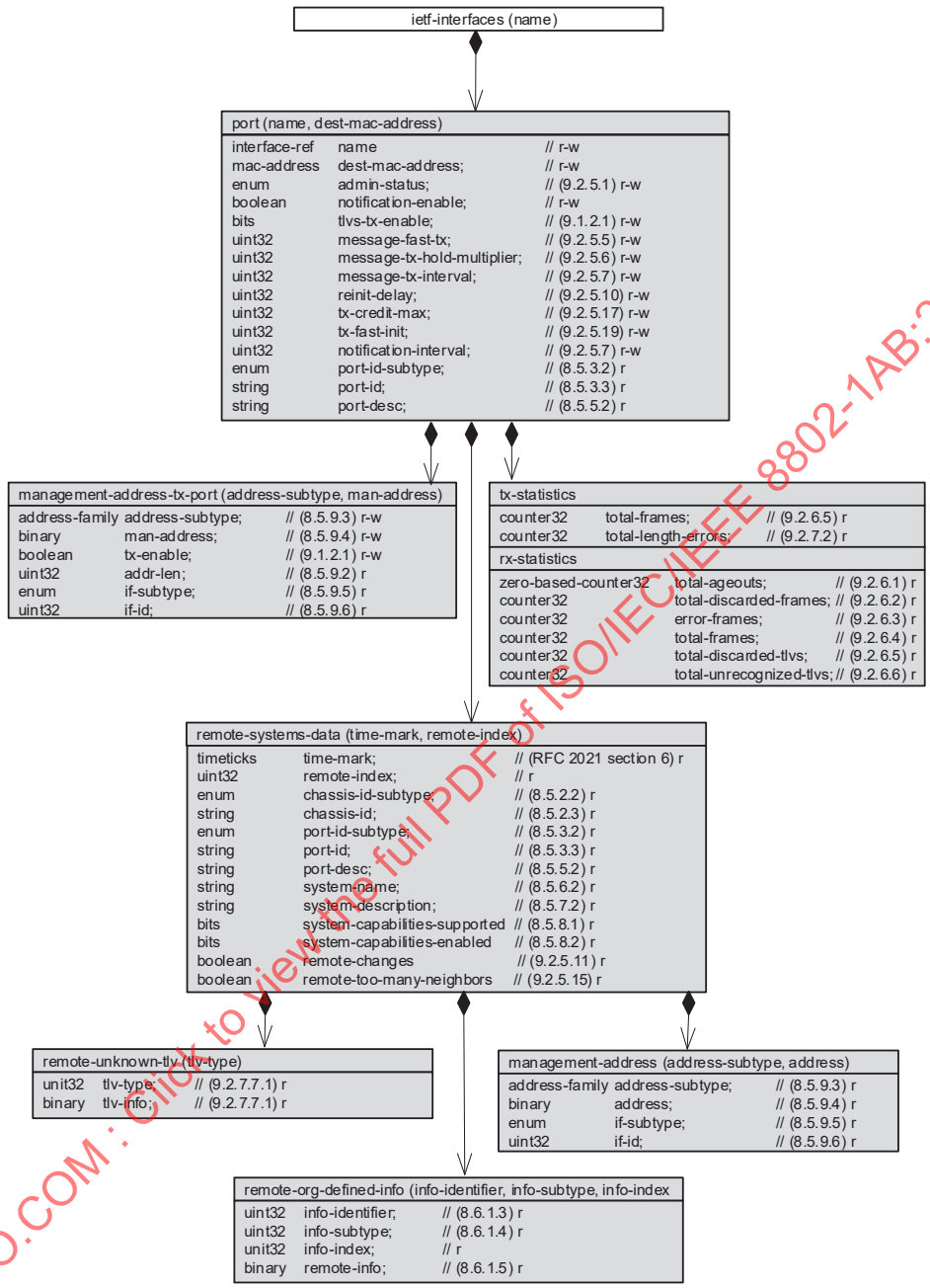

Figure 12-3—LLDP port configuration and monitoring objects

12.3 Structure of the LLDP YANG model

The IEEE YANG model specified in this standard is divided into two YANG modules. A summary of the modules contained in this clause is represented in Table 12-1.

Table 12-1—Structure of the YANG modules

Module	Subclause	Notes
ieee802-dot1ab-types	12.6.2.2	Type definitions used for LLDP YANG
ieee802-dot1ab-lldp	12.6.2.3	LLDP Generic Management

In the YANG module definitions below, if any discrepancy between the DESCRIPTION text and the corresponding definition in any other part of this standard occurs, the definitions outside this subclause take precedence.

12.3.1 Structure of the *ieee802-dot1ab-lldp* module

The *ieee802-dot1ab-lldp* YANG module is divided into several YANG branches (e.g., subtrees). A summary of the YANG subtrees associated with this module is presented in Table 12-2.

Table 12-2—Structure of the *ieee802-dot1ab-lldp* module

Branches	References	Notes
lldp		Link Layer Discovery Protocol (LLDP) configuration and operational information
message-fast-tx	9.2.5.5	
message-tx-hold-multiplier	9.2.5.6	
message-tx-interval	9.2.5.7	
reinit-delay	9.2.5.10	
tx-credit-max	9.2.5.17	
tx-fast-init	9.2.5.19	
notification-interval	9.2.5.7	
remote-statistics	10.5.2	LLDP remote operational statistics data
local-system-data	10.5.2	LLDP local system operational data
port	9.2.4	LLDP configuration information for a particular port
management-address-tx-port	8.5.9	Set of ports on which the local system management address instance will be transmitted
tx-statistics	9.2.6	LLDP frame transmission statistics for a particular port
rx-statistics	9.2.6	LLDP frame reception statistics for a particular port
remote-system-data		Information about a particular physical network connection

12.4 Relationship to other YANG modules

This clause describes how the *ieee802-dot1ab-lldp* YANG module is related to the YANG modules that are imported.

12.4.1 IEEE LLDP Types Module

The *ieee802-dot1ab-types* module provides reusable types that are used by the *ieee802-dot1ab-lldp* module.

12.4.2 IETF Routing Module

The *ietf-routing* YANG module (IETF RFC 8349) is a module defined by the IETF for management of a routing subsystem. This document only uses the address-family identity, which is used as the base identity for address families.

12.4.3 IETF YANG Types Module

The *ietf-yang-types* YANG module (IETF RFC 6991) contains a set of derived YANG types. This document leverages timestamp, timeticks, zero-based-counter32, and counter32.

12.4.4 IETF Interfaces YANG Module

The *ietf-interfaces* YANG module (IETF RFC 8343) contains a set of YANG definitions for managing network interfaces. This document models a port as an interface.

12.4.5 IEEE 802 Types Module

The *ieee802-types* module provides reusable types that are used in IEEE 802 standards.

The type for mac-addresses defined in *ieee802-types* has a pattern that allows upper and lower case letters. To avoid issues with string comparison, it is suggested to only use upper case for the letters in the hexadecimal numbers. Implementers using code comparing MAC addresses should note that there is still an issue with a difference between the IETF mac-address definition and the IEEE mac-address definition.

12.5 Security considerations

The YANG modules defined in this clause are designed to be accessed via a network configuration protocol (e.g., NETCONF protocol). In the case of NETCONF, the lowest NETCONF layer is the secure transport layer and the mandatory to implement secure transport is SSH. The NETCONF access control model provides the means to restrict access for particular NETCONF users to a pre-configured subset of all available NETCONF protocol operations and content.

It is the responsibility of a system's implementor and administrator to ensure that the protocol entities in the system that support NETCONF, and any other remote configuration protocols that make use of these YANG modules, are properly configured to allow access only to those users who have legitimate rights to read or write data nodes. This standard does not specify how the credentials of those users are to be stored or validated.

12.5.1 Security considerations of the *ieee802-dot1ab-lldp* YANG module

There are several management objects defined in the *ieee802-dot1ab-lldp* YANG module that are configurable (i.e., read-write) and/or operational (i.e., read-only). Such objects may be considered sensitive or vulnerable in some network environments. A network configuration protocol, such as NETCONF (IETF

RFC 6241), can support protocol operations that can edit or delete YANG module configuration data (e.g., edit-config, delete-config, copy-config). If this is done in a non-secure environment without proper protection, then negative effects on the network operation are possible.

The following objects in the *ieee802-dot1ab-lldp* YANG module can be manipulated to interfere with the operation of LLDP. This could, for example, be used to return incorrect information about neighbor nodes, or cause a denial-of-service attack.

lldp/message-fast-tx
lldp/message-tx-hold-multiplier
lldp/message-tx-interval
lldp/reinit-delay
lldp/tx-credit-max
lldp/tx-fast-init
lldp/notification-interval
lldp/port/name
lldp/port/dest-mac-address
lldp/port/admin-status
lldp/port/notification-enable
lldp/port/tlvs-tx-enable
lldp/port/message-fast-tx
lldp/port/message-tx-hold-multiplier
lldp/port/message-tx-interval
lldp/port/reinit-delay
lldp/port/tx-credit-max
lldp/port/tx-fast-init
lldp/port/notification-interval
lldp/port/management-address-tx-port/address-subtype
lldp/port/management-address-tx-port/man-address
lldp/port/management-address-tx-port/tx-enable

Some of the readable data in this YANG module may be considered sensitive or vulnerable in some network environments. It is important to control all types of access (e.g., including NETCONF get and get-config operations) to these objects and possibly to even encrypt the values of these objects when sending them over the network. For example the system name and other information about the remote systems could provide information about the configuration and topology of the network and could be considered a privacy threat.

12.6 Definition of the YANG modules[12,13]

12.6.1 YANG schema definitions

A simplified graphical representation of the data model is used in this document. The meaning of the symbols in these diagrams is as follows:

— Brackets "[" and "]" enclose list keys.
— Abbreviations before data node names: "rw" means configuration (read-write), and "ro" means state data (read-only).
— Symbols after data node names: "?" means an optional node, "!" means a presence container, and "*" denotes a list and leaf-list.

[12] *Copyright release for YANG modules*: Users of this standard may freely reproduce the YANG modules contained in this subclause so that they can be used for their intended purpose.

[13] An ASCII version of the YANG module(s) can be obtained by Web browser from the IEEE 802.1 Website at https://1.ieee802.org/yang-modules/.

— Parentheses enclose choice and case nodes, and case nodes are also marked with a colon (":").
— Ellipsis ("…") stand for contents of subtrees that are not shown.

12.6.1.1 YANG schema definition for *ieee802-dot1ab-lldp* YANG module

```
module: ieee802-dot1ab-lldp
  +--rw lldp
     +--rw message-fast-tx?              uint32
     +--rw message-tx-hold-multiplier?   uint32
     +--rw message-tx-interval?          uint32
     +--rw reinit-delay?                 uint32
     +--rw tx-credit-max?                uint32
     +--rw tx-fast-init?                 uint32
     +--rw notification-interval?        uint32
     +--ro remote-statistics
     |  +--ro last-change-time?   yang:timestamp
     |  +--ro remote-inserts?     yang:zero-based-counter32
     |  +--ro remote-deletes?     yang:zero-based-counter32
     |  +--ro remote-drops?       yang:zero-based-counter32
     |  +--ro remote-ageouts?     yang:zero-based-counter32
     +--ro local-system-data
     |  +--ro chassis-id-subtype?              ieee:chassis-id-subtype-type
     |  +--ro chassis-id?                      ieee:chassis-id-type
     |  +--ro system-name?                     string
     |  +--ro system-description?              string
     |  +--ro system-capabilities-supported?
     |  |       lldp-types:system-capabilities-map
     |  +--ro system-capabilities-enabled?
     |          lldp-types:system-capabilities-map
     +--rw port* [name dest-mac-address]
        +--rw name                           if:interface-ref
        +--rw dest-mac-address               ieee:mac-address
        +--rw admin-status?                  enumeration
        +--rw notification-enable?           boolean
        +--rw tlvs-tx-enable?                bits
        +--rw message-fast-tx?               uint32
        +--rw message-tx-hold-multiplier?    uint32
        +--rw message-tx-interval?           uint32
        +--rw reinit-delay?                  uint32
        +--rw tx-credit-max?                 uint32
        +--rw tx-fast-init?                  uint32
        +--rw notification-interval?         uint32
        +--rw management-address-tx-port* [address-subtype man-address]
        |  +--rw address-subtype    identityref
        |  +--rw man-address        lldp-types:man-addr-type
        |  +--rw tx-enable?         boolean
        |  +--ro addr-len?          uint32
        |  +--ro if-subtype?        lldp-types:man-addr-if-subtype
        |  +--ro if-id?             uint32
        +--ro port-id-subtype?               ieee:port-id-subtype-type
        +--ro port-id?                       ieee:port-id-type
        +--ro port-desc?                     string
        +--ro tx-statistics
        |  +--ro total-frames?          yang:counter32
        |  +--ro total-length-errors?   yang:counter32
        +--ro rx-statistics
        |  +--ro total-ageouts?             yang:zero-based-counter32
        |  +--ro total-discarded-frames?    yang:counter32
        |  +--ro error-frames?              yang:counter32
        |  +--ro total-frames?              yang:counter32
        |  +--ro total-discarded-tlvs?      yang:counter32
        |  +--ro total-unrecognized-tlvs?   yang:counter32
        +--ro remote-systems-data* [time-mark remote-index]
```

```
            +--ro time-mark                          yang:timeticks
            +--ro remote-index                       uint32
            +--ro remote-too-many-neighbors?         boolean
            +--ro remote-changes?                    boolean
            +--ro chassis-id-subtype?                ieee:chassis-id-subtype-type
            +--ro chassis-id?                        ieee:chassis-id-type
            +--ro port-id-subtype?                   ieee:port-id-subtype-type
            +--ro port-id?                           ieee:port-id-type
            +--ro port-desc?                         string
            +--ro system-name?                       string
            +--ro system-description?                string
            +--ro system-capabilities-supported?
            |       lldp-types:system-capabilities-map
            +--ro system-capabilities-enabled?
            |       lldp-types:system-capabilities-map
            +--ro management-address* [address-subtype address]
            |  +--ro address-subtype    identityref
            |  +--ro address            lldp-types:man-addr-type
            |  +--ro if-subtype?        lldp-types:man-addr-if-subtype
            |  +--ro if-id?             uint32
            +--ro remote-unknown-tlv* [tlv-type]
            |  +--ro tlv-type    uint32
            |  +--ro tlv-info?   binary
            +--ro remote-org-defined-info*
                    [info-identifier info-subtype info-index]
               +--ro info-identifier    uint32
               +--ro info-subtype       uint32
               +--ro info-index         uint32
               +--ro remote-info?       binary

   notifications:
     +---n remote-table-change
        +--ro remote-insert?    -> /lldp/remote-statistics/remote-inserts
        +--ro remote-delete?    -> /lldp/remote-statistics/remote-deletes
        +--ro remote-drops?     -> /lldp/remote-statistics/remote-drops
        +--ro remote-ageouts?   -> /lldp/remote-statistics/remote-ageouts
```

12.6.2 YANG data model definitions

12.6.2.1 Definition for the ieee802-types module

```
module ieee802-types {
  namespace urn:ieee:std:802.1Q:yang:ieee802-types;
  prefix ieee;
  organization
    "IEEE 802.1 Working Group";
  contact
    "WG-URL: http://ieee802.org/1/
    WG-EMail: stds-802-1-l@ieee.org

    Contact: IEEE 802.1 Working Group Chair
    Postal: C/O IEEE 802.1 Working Group
         IEEE Standards Association
         445 Hoes Lane
         Piscataway, NJ 08854
```

```
        USA

    E-mail: stds-802-1-chairs@ieee.org";
  description
    "This module contains a collection of generally useful derived data types
    for IEEE YANG models. Copyright(C) IEEE (2022). All rights reserved. This
    version of this YANG module is part of IEEE Std 802.1ABcu; see the
    standard itself for full legal notices.";
  revision 2022-03-16 {
    description
      "Published as part of IEEE Std 802.1ABcu.";
    reference
      "IEEE Std 802.1AB-2016";
  }
  revision 2020-06-04 {
    description
      "Published as part of IEEE Std 802.1Qcx-2020. Second version.";
    reference
      "IEEE Std 802.1Qcx-2020, Bridges and Bridged Networks - YANG Data Model
      for Connectivity Fault Management.";
  }
  revision 2018-03-07 {
    description
      "Published as part of IEEE Std 802.1Q-2018. Initial version.";
    reference
      "IEEE Std 802.1Q-2018, Bridges and Bridged Networks.";
  }
  typedef mac-address {
    type string {
      pattern "[0-9a-fA-F]{2}(-[0-9a-fA-F]{2}){5}";
    }
    description
      "The mac-address type represents a MAC address in the canonical format
      and hexadecimal format specified by IEEE Std 802. The hexidecimal
      representation uses uppercase characters.";
    reference
      "3.1 of IEEE Std 802-2014
      8.1 of IEEE Std 802-2014";
  }
  typedef chassis-id-subtype-type {
    type enumeration {
      enum chassis-component {
        value 1;
        description
          "Represents a chassis identifier based on the value of
          entPhysicalAlias object (defined in IETF RFC 2737) for a chassis
```

```
        component (i.e., an entPhysicalClass value of chassis(3))).";
    }
    enum interface-alias {
      value 2;
      description
        "Represents a chassis identifier based on the value of ifAlias
        object (defined in IETF RFC 2863) for an interface on the
        containing chassis.";
    }
    enum port-component {
      value 3;
      description
        "Represents a chassis identifier based on the value of
        entPhysicalAlias object (defined in IETF RFC 2737) for a port or
        backplane component (i.e., entPhysicalClass value of port(10) or
        backplane(4)), within the containing chassis.";
    }
    enum mac-address {
      value 4;
      description
        "Represents a chassis identifier based on the value of a unicast
        source address (encoded in network byte order and IEEE 802.3
        canonical bit order), of a port on the containing chassis as
        defined in IEEE Std 802-2014.";
    }
    enum network-address {
      value 5;
      description
        "Represents a chassis identifier based on a network address,
        associated with a particular chassis. The encoded address is
        actually composed of two fields. The first field is a single octet,
        representing the IANA AddressFamilyNumbers value for the specific
        address type, and the second field is the network address value.";
    }
    enum interface-name {
      value 6;
      description
        "Represents a chassis identifier based on the value of ifName
        object (defined in IETF RFC 2863) for an interface on the
        containing chassis.";
    }
    enum local {
      value 7;
      description
        "Represents a chassis identifier based on a locally defined value.";
    }
```

```
    }
    description
      "The source of a chassis identifier.";
    reference
      "IEEE Std 802-2014
      IETF RFC 2737
      IETF RFC 2863";
  }
  typedef chassis-id-type {
    type string {
      length "1..255";
    }
    description
      "The format of a chassis identifier string. Objects of this type are
      always used with an associated chassis-id-subtype object, which
      identifies the format of the particular chassis-id object instance.

      If the associated chassis-id-subtype object has a value of
      chassis-component, then the octet string identifies a particular
      instance of the entPhysicalAlias object (defined in IETF RFC 2737) for
      a chassis component (i.e., an entPhysicalClass value of chassis(3)).

      If the associated chassis-id-subtype object has a value of
      interface-alias, then the octet string identifies a particular instance
      of the ifAlias object (defined in IETF RFC 2863) for an interface on
      the containing chassis. If the particular ifAlias object does not
      contain any values, another chassis identifier type should be used.

      If the associated chassis-id-subtype object has a value of
      port-component, then the octet string identifies a particular instance
      of the entPhysicalAlias object (defined in IETF RFC 2737) for a port or
      backplane component within the containing chassis.

      If the associated chassis-id-subtype object has a value of mac-address,
      then this string identifies a particular unicast source address
      (encoded in network byte order and IEEE 802.3 canonical bit order), of
      a port on the containing chassis as defined in IEEE Std 802-2014.

      If the associated chassis-id-subtype object has a value of
      network-address, then this string identifies a particular network
      address, encoded in network byte order, associated with one or more
      ports on the containing chassis. The first octet contains the IANA
      Address Family Numbers enumeration value for the specific address type,
      and octets 2 through N contain the network address value in network
      byte order.
```

```
        If the associated chassis-id-subtype object has a value of
        interface-name, then the octet string identifies a particular instance
        of the ifName object (defined in IETF RFC 2863) for an interface on the
        containing chassis. If the particular ifName object does not contain
        any values, another chassis identifier type should be used.

        If the associated chassis-id-subtype object has a value of local, then
        this string identifies a locally assigned Chassis ID.";
      reference
        "IEEE Std 802-2014
        IETF RFC 2737
        IETF RFC 2863";
    }
    typedef port-id-subtype-type {
      type enumeration {
        enum interface-alias {
          value 1;
          description
            "Represents a port identifier based on the ifAlias MIB object,
            defined in IETF RFC 2863.";
        }
        enum port-component {
          value 2;
          description
            "Represents a port identifier based on the value of
            entPhysicalAlias (defined in IETF RFC 2737) for a port component
            (i.e., entPhysicalClass value of port(10)), within the containing
            chassis.";
        }
        enum mac-address {
          value 3;
          description
            "Represents a port identifier based on a unicast source address
            (encoded in network byte order and IEEE 802.3 canonical bit order),
            which has been detected by the agent and associated with a
            particular port (IEEE Std 802-2014).";
        }
        enum network-address {
          value 4;
          description
            "Represents a port identifier based on a network address, detected
            by the agent and associated with a particular port.";
        }
        enum interface-name {
          value 5;
          description
```

```
          "Represents a port identifier based on the ifName MIB object,
          defined in IETF RFC 2863.";
      }
      enum agent-circuit-id {
        value 6;
        description
          "Represents a port identifier based on the agent-local identifier
          of the circuit (defined in RFC 3046), detected by the agent and
          associated with a particular port.";
      }
      enum local {
        value 7;
        description
          "Represents a port identifier based on a value locally assigned.";
      }
    }
    description
      "The source of a particular type of port identifier.";
    reference
      "IEEE Std 802-2014
      IETF RFC 2737
      IETF RFC 2863
      IETF RFC 3046";
  }
  typedef port-id-type {
    type string {
      length "1..255";
    }
    description
      "The format of a port identifier string. Objects of this type are
      always used with an associated port-id-subtype object, which identifies
      the format of the particular port-id object instance.

      If the associated port-id-subtype object has a value of
      interface-alias, then the octet string identifies a particular instance
      of the ifAlias object (defined in IETF RFC 2863). If the particular
      ifAlias object does not contain any values, another port identifier
      type should be used.

      If the associated port-id-subtype object has a value of port-component,
      then the octet string identifies a particular instance of the
      entPhysicalAlias object (defined in IETF RFC 2737) for a port or
      backplane component.

      If the associated port-id-subtype object has a value of mac-address,
      then this string identifies a particular unicast source address
```

```
        (encoded in network byte order and IEEE 802.3 canonical bit order)
        associated with the port (IEEE Std 802-2014).

        If the associated port-id-subtype object has a value of
        network-address, then this string identifies a network address
        associated with the port. The first octet contains the IANA
        AddressFamilyNumbers enumeration value for the specific address type,
        and octets 2 through N contain the networkAddress address value in
        network byte order.

        If the associated port-id-subtype object has a value of interface-name,
        then the octet string identifies a particular instance of the ifName
        object (defined in IETF RFC 2863). If the particular ifName object does
        not contain any values, another port identifier type should be used.

        If the associated port-id-subtype object has a value of
        agent-circuit-id, then this string identifies a agent-local identifier
        of the circuit (defined in RFC 3046).

        If the associated port-id-subtype object has a value of local, then
        this string identifies a locally assigned port ID.";
      reference
        "IEEE Std 802-2014
        IETF RFC 2737
        IETF RFC 2863
        IETF RFC 3046";
    }
}
```

12.6.2.2 Definition for the *ieee802-dot1ab-types* module

```
module ieee802-dot1ab-types {
  yang-version "1.1";
  namespace urn:ieee:std:802.1Q:yang:ieee802-dot1ab-types;
  prefix lldp-types;
  organization
    "IEEE 802.1 Working Group";
  contact
    "WG-URL: http://ieee802.org/1/
    WG-EMail: stds-802-1-l@ieee.org
    Contact: IEEE 802.1 Working Group Chair
    Postal: C/O IEEE 802.1 Working Group
    IEEE Standards Association
         445 Hoes Lane
         Piscataway, NJ 08854
         USA

    E-mail: stds-802-1-chairs@ieee.org";
  description
```

```
    "Common types used within ieee802-dot1ab-lldp modules. Copyright(C) IEEE
    (2022). All rights reserved. This version of this YANG module is part of
    IEEE Std 802.1ABcu; see the standard itself for full legal notices.";
  revision 2022-03-15 {
    description
      "Published as part of IEEE Std 802.1ABcu.";
    reference
      "IEEE Std 802.1AB-2016";
  }
  typedef man-addr-if-subtype {
    type enumeration {
      enum unknown {
        value 1;
        description
          "Interface is not known.";
      }
      enum port-ref {
        value 2;
        description
          "Interface based on the port-ref MIB object.";
      }
      enum system-port-number {
        value 3;
        description
          "Interface based on the system port number.";
      }
    }
    description
      "Management address interface subtype.";
    reference
      "8.5.9.5 of IEEE Std 802.1AB-2016";
  }
  typedef man-addr-type {
    type string {
      pattern "[0-9A-F]{2}([0-9A-F]{2}){0,30}";
    }
    description
      "Management address associated with the LLDP agent.";
    reference
      "8.5.9.4 of IEEE Std 802.1AB-2016";
  }
  typedef system-capabilities-map {
    type bits {
      bit other {
        position 0;
        description
          "System has capabilities other than those listed below.";
      }
      bit repeater {
        position 1;
        description
          "System has repeater capability.";
      }
      bit bridge {
        position 2;
        description
          "System has bridge capability.";
      }
      bit wlan-access-point {
```

```
        position 3;
        description
          "System has WLAN access point capability.";
      }
      bit router {
        position 4;
        description
          "System has router capability.";
      }
      bit telephone {
        position 5;
        description
          "System has telephone capability.";
      }
      bit docsis-cable-device {
        position 6;
        description
          "System has DOCSIS Cable Device capability.";
        reference
          "IETF RFC 4639";
      }
      bit station-only {
        position 7;
        description
          "System has only station capability.";
      }
      bit cvlan-component {
        position 8;
        description
          "System has C-VLAN component functionality.";
      }
      bit svlan-component {
        position 9;
        description
          "System has S-VLAN component functionality.";
      }
      bit two-port-mac-relay {
        position 10;
        description
          "System has Two-port MAC Relay (TPMR) functionality.";
      }
    }
    description
      "This describes system capabilities.";
    reference
      "8.5.8.1 of IEEE Std 802.1AB-2016";
  }
  typedef port-list {
    type binary {
      length "0..512";
    }
    description
      "Each octet within this value specifies a set of eight ports, with the
      first octet specifying ports 1 through 8, the second octet specifying
      ports 9 through 16, etc. Within each octet, the most significant bit
      represents the lowest numbered port, and the least significant bit
      represents the highest numbered port. Thus, each port of the system is
      represented by a single bit within the value of this object. If that
      bit has a value of '1' then that port is included in the set of ports;
```

```
        the port is not included if its bit has a value of '0'.";
      reference
        "IETF RFC 2674 section 5";
    }
}
```

12.6.2.3 Definition for *ieee802-dot1ab-lldp* YANG module

```
module ieee802-dot1ab-lldp {
  yang-version "1.1";

  /*** NAMESPACE / PREFIX DEFINITION ***/
  namespace urn:ieee:std:802.1AB:yang:ieee802-dot1ab-lldp;
  prefix lldp;

  /*** LINKAGE (IMPORTS / INCLUDES) ***/
  import ieee802-dot1ab-types {
    prefix lldp-types;
  }
  import ietf-routing {
    prefix rt;
  }
  import ietf-yang-types {
    prefix yang;
  }
  import ietf-interfaces {
    prefix if;
  }
  import ieee802-types {
    prefix ieee;
  }

  /*** META INFORMATION ***/
  organization
    "Institute of Electrical and Electronics Engineers";
  contact
    "WG-URL: http://ieee802.org/1/
    WG-EMail: stds-802-1-l@ieee.org
    Contact: IEEE 802.1 Working Group Chair
    Postal: C/O IEEE 802.1 Working Group
    IEEE Standards Association
         445 Hoes Lane
         Piscataway, NJ 08854
         USA

    E-mail: stds-802-1-chairs@ieee.org";
```

```
  description
    "Management Information Base module for LLDP configuration, statistics,
    local system data, and remote systems data components. Copyright(C) IEEE
    (2022). All rights reserved. This version of this YANG module is part of
    IEEE Std 802.1ABcu; see the standard itself for full legal notices.";
  revision 2022-03-15 {
    description
      "Published as part of IEEE Std 802.1ABcu.";
    reference
      "IEEE Std 802.1AB-2016";
  }

  /*** GROUPING DEFINITIONS ***/
  grouping lldp-cfg {
    description
      "LLDP basic configuration group.";
    leaf message-fast-tx {
      type uint32 {
        range "1..3600";
      }
      units "ticks";
      default "1";
      description
        "Time interval in timer ticks between transmissions during fast
        transmission periods (i.e., txfast is non-zero).";
      reference
        "9.1.1, 9.2.5.5 of IEEE Std 802.1AB-2016";
    }
    leaf message-tx-hold-multiplier {
      type uint32 {
        range "2..10";
      }
      default "4";
      description
        "Multiplier of msg-tx-interval.";
      reference
        "9.2.5.6 of IEEE Std 802.1AB-2016";
    }
    leaf message-tx-interval {
      type uint32 {
        range "1..3600";
      }
      units "ticks";
      default "30";
      description
        "Time interval in timer ticks between transmissions during normal
```

```
        transmission periods (i.e., txFast is zero).";
      reference
        "9.1.1, 9.2.5.7 of IEEE Std 802.1AB-2016";
    }
    leaf reinit-delay {
      type uint32 {
        range "1..10";
      }
      units "second";
      default "2";
      description
        "Amount of delay (in units of seconds) from when admin-status becomes
        'disabled' until re-initialization is attempted.";
      reference
        "9.2.5.10 of IEEE Std 802.1AB-2016";
    }
    leaf tx-credit-max {
      type uint32 {
        range "1..10";
      }
      default "5";
      description
        "The maximum number of consecutive LLDPDUs that can be transmitted at
        any time.";
      reference
        "9.2.5.17 of IEEE Std 802.1AB-2016";
    }
    leaf tx-fast-init {
      type uint32 {
        range "1..8";
      }
      default "4";
      description
        "Initial value for the fast transmitting LLDPPDU.";
      reference
        "9.2.5.19 of IEEE Std 802.1AB-2016";
    }
    leaf notification-interval {
      type uint32 {
        range "1..3600";
      }
      units "second";
      default "30";
      description
        "Controls the transmission of LLDP notifications.";
      reference
```

```
        "9.2.5.7 of IEEE Std 802.1AB-2016";
    }
  }

  /*** SCHEMA DEFINITIONS ***/
  container lldp {
    description
      "Link Layer Discovery Protocol configuration and operational
      information.";
    uses lldp-cfg;
    container remote-statistics {
      config false;
      description
        "LLDP remote operational statistics data.";
      leaf last-change-time {
        type yang:timestamp;
        description
          "The value of sysUpTime object.";
        reference
          "11.5.1 of IEEE Std 802.1AB-2016:
          lldpV2StatsRemTablesLastChangeTime";
      }
      leaf remote-inserts {
        type yang:zero-based-counter32;
        units "table entries";
        description
          "The number of times the complete set of information advertised by
          a particular MSAP has been inserted into tables contained in
          remote-systems-data and lldpExtensions objects.";
        reference
          "11.5.1 of IEEE Std 802.1AB-2016: lldpV2StatsRemTablesInserts";
      }
      leaf remote-deletes {
        type yang:zero-based-counter32;
        units "table entries";
        description
          "The number of times the complete set of information advertised by
          a particular MSAP has been deleted from tables contained in
          remote-systems-data and lldpExtensions objects.";
        reference
          "11.5.1 of IEEE Std 802.1AB-2016: lldpV2StatsRemTablesDeletes";
      }
      leaf remote-drops {
        type yang:zero-based-counter32;
        units "table entries";
        description
```

```
        "The number of times the complete set of information advertised by
        a particular MSAP could not be entered into tables contained in
        remote-systems-data and lldpExtensions objects because of
        insufficient resources.";
      reference
        "11.5.1 of IEEE Std 802.1AB-2016: lldpV2StatsRemTablesDrops";
    }
    leaf remote-ageouts {
      type yang:zero-based-counter32;
      description
        "The number of times the complete set of information advertised by
        a particular MSAP has been deleted from tables contained in
        remote-systems-data and lldpExtensions objects because the
        information timeliness interval has expired.";
      reference
        "11.5.1 of IEEE Std 802.1AB-2016: lldpV2StatsRemTablesAgeouts";
    }
  }
  container local-system-data {
    config false;
    description
      "LLDP local system operational data.";
    leaf chassis-id-subtype {
      type ieee:chassis-id-subtype-type;
      description
        "The type of encoding used to identify the chassis associated with
        the local system.";
      reference
        "8.5.2.2 of IEEE Std 802.1AB-2016";
    }
    leaf chassis-id {
      type ieee:chassis-id-type;
      description
        "Chassis component associated with the local system.";
      reference
        "8.5.2.3 of IEEE Std 802.1AB-2016";
    }
    leaf system-name {
      type string {
        length "0..255";
      }
      description
        "System name of the local system.";
      reference
        "8.5.6.2 of IEEE Std 802.1AB-2016";
    }
```

```
    leaf system-description {
      type string {
        length "0..255";
      }
      description
        "System description of the local system.";
      reference
        "8.5.7.2 of IEEE Std 802.1AB-2016";
    }
    leaf system-capabilities-supported {
      type lldp-types:system-capabilities-map;
      description
        "System capabilities are supported on the local system.";
      reference
        "8.5.8.1 of IEEE Std 802.1AB-2016";
    }
    leaf system-capabilities-enabled {
      type lldp-types:system-capabilities-map;
      description
        "System capabilities that are enabled on the local system.";
      reference
        "8.5.8.2 of IEEE Std 802.1AB-2016";
    }
  }

  /* LLDP port configuration table */
  list port {
    key "name dest-mac-address";
    description
      "LLDP configuration information for a particular port.";
    leaf name {
      type if:interface-ref;
      description
        "The port name used to identify the port component (contained in
        the local chassis with the LLDP agent) associated with this entry.";
    }
    leaf dest-mac-address {
      type ieee:mac-address;
      description
        "Destination MAC address. The ieee:mac-address type has a pattern
        that allows upper and lower case letters. To avoid issues with
        string compairson, it is suggested to only use upper case for the
        letters in the hexadecimal numbers. Implementers using code
        comparing MAC addresses should note that there is still an issue
        with a difference between the IETF mac-address definition and the
        IEEE mac-address definition.";
```

```
    }
    leaf admin-status {
      type enumeration {
        enum tx-only {
          value 1;
          description
            "Transmit LLDP frames only.";
        }
        enum rx-only {
          value 2;
          description
            "Receive LLDP frames only.";
        }
        enum tx-and-rx {
          value 3;
          description
            "Transmit and Receive LLDP frames.";
        }
        enum disabled {
          value 4;
          description
            "Do Not Transmit or Receive LLDP frames.";
        }
      }
      default "tx-and-rx";
      description
        "Administrative status of the local LLDP agent.";
      reference
        "9.2.5.1 of IEEE Std 802.1AB-2016";
    }
    leaf notification-enable {
      type boolean;
      default "false";
      description
        "Notification status.";
    }
    leaf tlvs-tx-enable {
      type bits {
        bit port-desc {
          position 0;
          description
            "Transmit 'Port Description TLV'.";
        }
        bit sys-name {
          position 1;
          description
```

```
            "Transmit 'System Name TLV'.";
        }
        bit sys-desc {
          position 2;
          description
            "Transmit 'System Description TLV'.";
        }
        bit sys-cap {
          position 3;
          description
            "Transmit 'System Capabilities TLV'.";
        }
      }
      description
        "LLDP TLVs whose transmission is allowed on the local LLDP agent by
        the network management.";
      reference
        "9.1.2.1 of IEEE Std 802.1AB-2016";
    }
    uses lldp-cfg;
    list management-address-tx-port {
      key "address-subtype man-address";
      description
        "Set of ports (represented as a PortList) on which the local system
        management address instance will be transmitted.";
      leaf address-subtype {
        type identityref {
          base rt:address-family;
        }
        description
          "Type of address.";
        reference
          "8.5.9.3 of IEEE Std 802.1AB-2016";
      }
      leaf man-address {
        type lldp-types:man-addr-type;
        description
          "Management address associated with this TLV.";
        reference
          "8.5.9.4 of IEEE Std 802.1AB-2016";
      }
      leaf tx-enable {
        type boolean;
        default "false";
        description
          "Transmission enabled status.";
```