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IEEE Standard for
Local and metropolitan area networks

Station and Media Access Control Connectivity Discovery

IEEE Computer Society

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LAN/MAN Standards Committee

IEEE

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Local and metropolitan area networks

Station and Media Access Control Connectivity Discovery

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Abstract: This document defines a protocol and a set of managed objects that can be used for discovering the physical topology from adjacent stations in IEEE 802® LANs.
Keywords: link layer discovery protocol, management information base, topology discovery, topology information

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1. Overview

The Link Layer Discovery Protocol (LLDP) specified in this standard allows stations attached to an IEEE 802® LAN to advertise, to other stations attached to the same IEEE 802 LAN, the major capabilities provided by the system incorporating that station, the management address or addresses of the entity or entities that provide management of those capabilities, and the identification of the station's point of attachment to the IEEE 802 LAN required by those management entity or entities.

The information distributed via this protocol is stored by its recipients in a standard Management Information Base (MIB), making it possible for the information to be accessed by a Network Management System (NMS) using a management protocol such as the Simple Network Management Protocol (SNMP).

1.1 Scope

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 defines a protocol that:

a) Advertises connectivity and management information about the local station to adjacent stations on the same IEEE 802 LAN.

b) Receives network management information from adjacent stations on the same IEEE 802 LAN.

c) Operates with all IEEE 802 access protocols and network media.

d) Establishes a network management information schema and object definitions that are suitable for storing connection information about adjacent stations.

e) Provides compatibility with the IETF PTOPO MIB (IETF RFC 2922 [B15]).[1]

1.2 Purpose

An IETF Standard MIB (IETF RFC 2922 [B15]), as well as a number of vendor specific MIBs, have been created to describe a network's physical topology and associated systems within that topology. However, there is no standard protocol for populating these MIBs or communicating this information among stations on the IEEE 802 LAN.

[1]The numbers in brackets correspond to those in the bibliography in Annex A.

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.

NOTE—The LLDP protocol is designed to advertise information useful for discovering pertinent information about a remote port and to populate topology MIBs. It is not intended to act as a configuration protocol for remote systems, nor as a mechanism to signal control information between ports. During the operation of LLDP, it may be possible to discover configuration inconsistencies between systems on the same IEEE 802 LAN. LLDP does not provide a mechanism to resolve those inconsistencies. Rather, it provides a means to report discovered information to higher layer management entities. A port in this context is a single point of attachment to the LAN infrastructure.[2]

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

2. References

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of this publication, editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of ISO and IEC maintain registers of currently valid International standards.

Abstract Syntax Notation One (ASN.1): Specification of Basic Notation, ITU-T Rec. X.680 (2002) ISO/IEC 8824-1:2002.[3]

IEEE Std 802®-2001, IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture.[4, 5]

IEEE Std 802a™-2003, IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture—Amendment 1: Ethertypes for Prototype and Vendor-Specific Protocol Development.

IEEE Std 802.1D™-2004, Standard for Local and Metropolitan Area Networks: Media Access Control (MAC) Bridges.

IEEE Std 802.1Q™-1998, IEEE Standards for Local and Metropolitan Area Networks: Virtual Bridged Local Area Networks.

IEEE Std 802.1X™-2004, IEEE Standard for Local and Metropolitan Area Networks—Port-Based Network Access Control.

IEEE Std 802.3™-2002, Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.

IEEE Std 802.3ae™-2002, Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications—Amendment: Media Access Control (MAC) Parameters, Physical Layers, and Management Parameters for 10 Gb/s Operation.

IEEE Std 802.3af™-2003, Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications—Amendment: Data Terminal Equipment (DTE) Power via Media Dependent Interface (MDI).

IETF RFC 1493, Definitions of Managed Objects for Bridges, Decker, E., Langille, P., Rijsinghani, A., and McCloghrie, K., July 1993.[6]

IETF RFC 1812, Requirements for IP Version 4 Routers, Baker, F., June 1995.

IETF RFC 2108, Definitions of Managed Objects for IEEE 802.3 Repeater Devices using SMIv2, de Graaf, K., and Romascanu, D., February 1997.

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[3]ASN.1 standards are available on-line by Web browser at http://asn1.elibel.tm.fr/en/standards/index.htm#asn1.

[4]IEEE and 802 are registered trademarks in the U.S. Patent & Trademark Office, owned by the Institute of Electrical and Electronics Engineers, Incorporated.

[5]IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, Piscataway, NJ 08855, USA (http://standards.ieee.org).

[6]Internet RFCs are retrievable by FTP at ds.internic.net/rfc/rfcnnnn.txt, or by Web browser at http://www.ietf.org/rfc/rfcNNNN.txt (where NNNN is the RFC number prefixed with zeroes as necessary to make a four digit number), or call InterNIC at 1-800-444-4345 for information about receiving copies through the mail.

IETF RFC 2011, SNMPv2 Management Information Base for the Internet Protocol using SMIv2, McCloghrie, K., November 1996.

IETF RFC 2021, Remote Network Monitoring Management Information Base Version 2 using SMIv2, Waldbusser, S., January 1997.

IETF RFC 2669, DOCSIS Cable Device MIB Cable Device Management Information Base for DOCSIS compliant Cable Modems and Cable Modem Termination Systems, St. Johns, M., August 1999.

IETF RFC 2670, Radio Frequency (RF) Interface Management Information Base for MCNS/DOCSIS compliant RF interfaces, St. Johns, M., August 1999.

IETF RFC 2674, Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering and Virtual LAN Extensions, Bell, E., Smith, A., Langille, P., Rijhsinghani, A., and McCloghrie, K., August 1999.

IETF RFC 2683, IMAP4 Implementation Recommendations, Leiba, B., September 1999.

IETF RFC 2737, Entity MIB (Version 2), McCloghrie, K., and Bierman, A., December 1999.

IETF RFC 2863, The Interfaces Group MIB, McCloghrie, K. and Kastenholz, F., June 2000.

IETF RFC 3046, DHCP Relay Agent Information Option, Patrick, M., January 2001.

IETF RFC 3232, Assigned Numbers: RFC 1700 is Replaced by an On-line Database, Reynolds, J., January 2002.[7]

IETF RFC 3410, Introduction and Applicability Statements for Internet-Standard Management Framework, Case, J., Mundy, R.,Partain, D., and Stewart, B., December 2002.

IETF RFC 3418, Management Information Base (MIB) for the Simple Network Management Protocol (SNMP), Presuhn, R., ED., December 2002.

IETF RFC 3621, Power Ethernet MIB, Berger, A. and Romascanu, D., December 2003.

IETF RFC 3629, UTF-8, a transformation format of ISO 10646, Yergeau, F. November 2003.

IETF RFC 3636, Definitions of Managed Objects for IEEE 802.3 Medium Attachment Units (MAUs), Flick, J., September 2003.

[7]The IETF RFC 3232 ianaAddressFamilyNumbers on-line database module is accessible through a web page (currently, http://www.iana.org).

3. Definitions and numerical representation

3.1 Definitions

For purposes of this standard, the following terms and definitions apply. IEEE 100, *The Authoritative Dictionary of IEEE Standard Terms*, Seventh Edition [B2], as well as other referenced IEEE standards and IETF RFCs, should be referenced for terms not defined in this clause.

3.1.1 alpha-numeric information: Information that is encoded using the UTF-8 octet sequence [IETF RFC 3629].

3.1.2 chassis: A physical component incorporating one or more IEEE 802 LAN stations and their associated application functionality.

3.1.3 chassis identifier: An administratively assigned name that identifies the particular chassis within the context of an administrative domain that comprises one or more networks.

3.1.4 IEEE 802® LAN: Local area network (LAN) technologies that provide a media access control (MAC) Service equivalent to the MAC Service defined in ISO/IEC 15802-1. IEEE 802 LANs include IEEE Std 802.3, (CSMA/CD), IEEE Std 802.5™ (Token Ring), IEEE Std 802.11™ (Wireless), and ISO 9314-2 (FDDI) LANs.

3.1.5 IEEE 802® LAN station: An IEEE 802-compatible entity that incorporates all the necessary mechanisms to participate in media access control of an IEEE 802 LAN, and that is at least capable of providing the MAC service plus the mandatory capabilities of the LLC.

3.1.6 Link Layer Discovery Protocol (LLDP): A media-independent protocol intended to be run on all IEEE 802® LAN stations and to allow an LLDP agent to learn the connectivity and management information from adjacent stations.

3.1.7 LLDP agent: The protocol entity that implements LLDP for a particular IEEE 802® chassis.

3.1.8 MAC service access point (MSAP): The access point for MAC services provided to the LLC sublayer.

3.1.9 MSAP identifier: The identifier of a MAC service access point.

NOTE—In this standard, the concatenation of the chassis ID and the port ID is used by LLDP as an MSAP identifier, to identify the LLDP agent and physical port associated with an IEEE 802® LAN station.

3.1.10 management entity: The protocol entity that implements a particular network management protocol and that provides access support to a MIB associated with the protocol and implemented on a host chassis.

3.1.11 Management Information Base (MIB): The instantiation of MIB module.

3.1.12 Management Information Base module (MIB module): The specification or schema for a data base that can be populated with the information required to support a network management information system.

3.1.13 network: An interconnected group of systems, each comprising one or more IEEE 802® LAN stations.

3.1.14 Network Management System (NMS): A management system that is capable of utilizing the information in a MIB.

3.1.15 object identifier (OID): An identifier used to identify the type of a MIB object. Each MIB object's object type is named by an object identifier, an administratively assigned name.

3.1.16 physical network topology: The identification of systems, of IEEE 802® LAN stations that compose each system, and of the IEEE 802 LAN stations that attach to the same IEEE 802® LAN.

3.1.17 port: The entity in a chassis/system to support an MSAP. A port incorporates one and only one MSAP and identifies the collection of manageable entities that provide the MAC Service at the MSAP.

3.1.18 port identifier: An administratively assigned name that identifies the particular port within the context of a system, where the identification is convenient, local to the system, and persistent for the system's use and management (whereas the MAC address that globally identifies the MSAP can not be).

3.1.19 system: A managed collection of hardware and software components incorporating one or more chassises, stations and ports.

3.1.20 station only: A non-forwarding IEEE 802® LAN station such as a user workstation, network file server, or print server.

3.1.21 type, length, value (TLV): A short, variable length encoding of an information element consisting of sequential type, length, and value fields where the type field identifies the type of information, the length field indicates the length of the information field in octets, and the value field contains the information, itself.

3.2 Numerical representation

Decimal, hexadecimal, and binary numbers are used within this document. For clarity, decimal numbers are generally used to represent counts, hexadecimal numbers are used to represent addresses, and binary numbers are used to describe bit patterns within binary fields.

Decimal numbers are represented in their usual 0, 1, 2, … format. Hexadecimal numbers are represented by a string of one or more hexadecimal (0-9, A-F) digits followed by the subscript 16, except in C-code contexts, where they are written as `0x123EF2` etc. Binary numbers are represented by a string of one or more binary (0,1) digits, followed by the subscript 2. Thus the decimal number "26" may also be represented as "$1A_{16}$" or "11010_2".

MAC addresses and OUI/EUI values are represented as strings of 8-bit hexadecimal numbers separated by hyphens and without a subscript, as for example "01-80-C2-00-00-15" or "AA-55-11".

4. Acronyms and abbreviations

EUI	Extended Unique Identifier
IETF	Internet Engineering Task Force
LLC	logical link control (sublayer)
LLDP	Link Layer Discovery Protocol
LLDPDU	LLDP data unit
LSAP	link service access point
MAC	media access control (sublayer)
MDI	media dependent interface
MIB	Management Information Base (module)
MSAP	MAC service access point
MSDU	MAC service data unit
NMS	Network Management System
OID	object identifier
OUI	organizationally unique identifier
PHY	physical (sublayer)
PMD	physical media dependent (sublayer)
PVID	port VLAN ID
PPVID	port and protocol VLAN ID
PTOPO	the name of the IETF physical topology MIB
SNAP	Subnetwork Access Protocol
SNMP	Simple Network Management Protocol
STP	Spanning Tree Protocol
TLV	type length value
TTL	time to live (value)
VID	VLAN ID

5. Conformance

5.1 Terminology

For consistency with IEEE and existing IEEE 802.1™ standards, requirements placed upon conformant implementations of this standard are expressed using the following terminology:

a) ***shall*** is used for mandatory requirements;

b) ***may*** is used to describe implementation or administrative choices ("may" means "is permitted to," and hence, "may" and "may not" mean precisely the same thing);

c) ***should*** is used for recommended choices (the behaviors described by "should" and "should not" are both permissible but not equally desirable choices).

The PICS proforma provided in Annex B reflects the occurrences of the words shall, may, and should within the standard.

The standard avoids needless repetition and apparent duplication of its formal requirements by using ***is***, ***is not***, ***are***, and ***are not*** for definitions and the logical consequences of conformant behavior. Behavior that is permitted but is neither always required nor directly controlled by an implementor or administrator, or whose conformance requirement is detailed elsewhere, is described by ***can***. Behavior that never occurs in a conformant implementation or system of conformant implementations is described by ***cannot***. The word ***allow*** is used as a replacement for the cliche "Support the ability for", and the word ***capability*** means "can be configured to."

5.2 Required capabilities

A system for which conformance to this standard is claimed shall, for all ports for which support is claimed, include the following capabilities:

a) If port access is controlled by IEEE Std 802.1X-2004[8], LLDP exchanges shall be through the controlled port as specified in Clause 6.

b) The destination and source addressing shall conform to 8.1 and 8.2.

c) Ethertype encapsulation shall conform to 8.3.

d) LLDPDU recognition and reception shall conform to 8.4 and 10.3.1.

e) LLDPDU encapsulation shall conform to the specifications in 9.2.

f) The basic TLV format capability shall be implemented as defined in 9.4.

g) The basic management set of TLVs shall be implemented as defined in 9.5.

h) The Organizationally Specific TLV format capability shall be implemented as defined in 9.6.

i) The protocol shall conform to the specifications for all Clause 10 subclauses indicated in Table 10-1 for the particular operating mode (transmit only, receive only, or transmit and receive) being implemented.

j) If receipt of LLDPDUs is supported, for every set of TLVs (the basic management set and any organizationally specific sets) supported, support shall be implemented for receipt of every TLV defined in the set.

k) If transmission of LLDPDUs is supported, for every set of TLVs (the basic management set and any organizationally specific sets) supported, support shall be implemented for transmission of every TLV defined in the set.

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

l) If transmission of LLDPDUs is supported, for every set of TLVs (the basic management set and any organizationally specific sets) supported, a capability shall be implemented for users to determine which optional TLVs are transmitted in any particular LLDPDU.

m) If SNMP is supported, the system shall conform to the LLDP management specifications in Clause 11. and shall implement the sections of the basic LLDP MIB indicated in Table 12-1 for the operating mode being implemented.

n) If SNMP is not supported, the system shall provide storage and retrieval capability equivalent to the functionality specified in 11.1 for the operating mode being implemented.

5.3 Optional capabilities

A system for which conformance to this standard is claimed, for each port for which support is claimed, may:

a) Implement the entire IEEE 802.1 Organizationally Specific TLV extension set and the associated IEEE 802.1 MIB extension capability defined in Annex F.

b) Implement the entire IEEE 802.3 Organizationally Specific TLV extension set and the associated IEEE 802.3 MIB extension capability defined in Annex G.

6. Architectural overview

LLDP is a link layer protocol that is an optional part of the protocol stack of an IEEE 802 LAN station. Figure 6-1 indicates the hierarchical relationships of the LLDP agents and the LLDP entity to the LLC sublayers.

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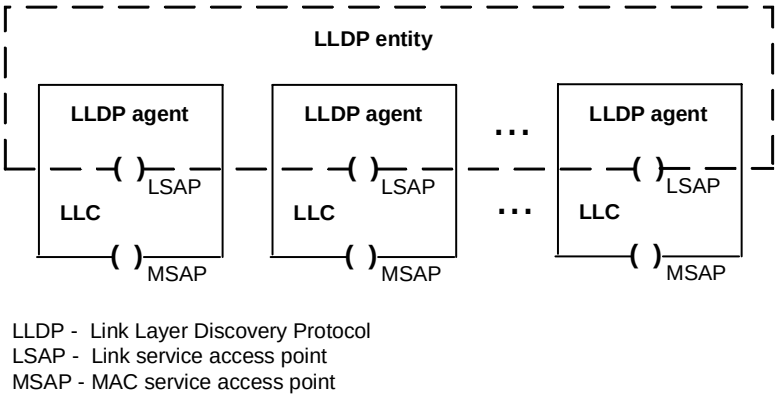

Figure 6-1—Architectural relationship between LLDP and the LLC

The logical link control (LLC) provides an LSAP for access to higher layers plus additional LSAPs for each implemented link layer protocol such as LLDP and STP. Figure 6-2 shows the LLDP block diagram with respect to its associated LSAP.

NOTE—For the purposes of this standard, the terms "LLC" and "LLC entity" include the service provided by the operation of entities that support protocol discrimination using an LLDP Ethertype, i.e., protocol discrimination based on the Type interpretation of the Ethertype field as specified in IEEE Std 802a-2003.

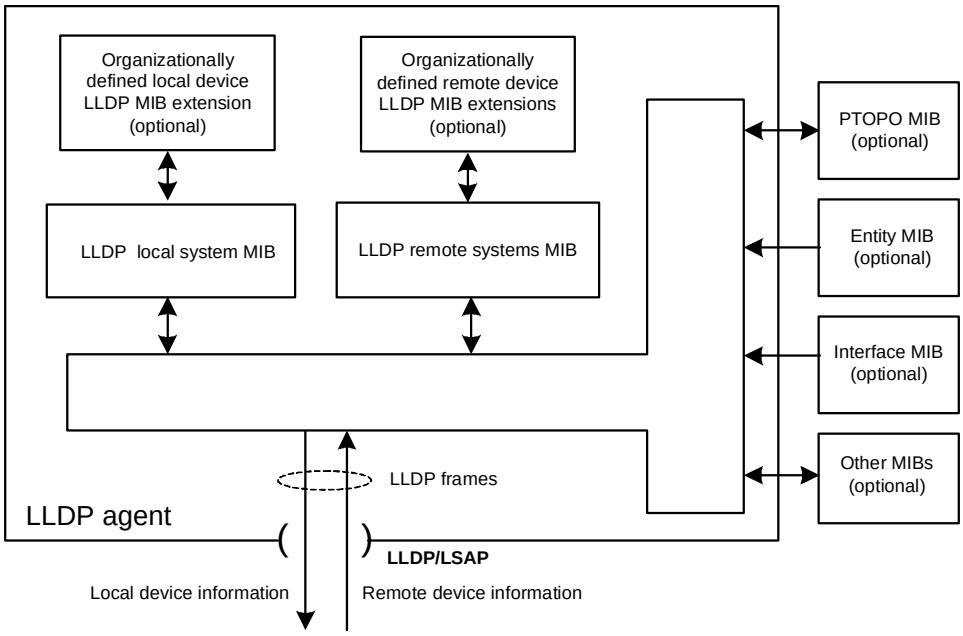

Figure 6-2—LLDP agent block diagram

If port access is controlled by IEEE Std 802.1X-2004, Clause 8, LLDP exchanges shall run on the controlled port. (See also IEEE Std 802.1D-2004, 7.12.7). In a bridge, LLDP operates as an LLC procedure over the bridge port and is therefore not affected by the spanning tree port state.

7. Principles of operation

LLDP uses the services of the LLC and the MAC to transmit and receive information to and from other LLDP agents, as defined in 8.1, 8.2, 8.3, and 8.4.

7.1 LLDP operational modes

LLDP is a one way protocol. An LLDP agent can transmit information about the capabilities and current status of the system associated with its MSAP identifier. The LLDP agent can also receive information about the capabilities and current status of the system associated with a remote MSAP identifier. However, LLDP agents are not provided any means of soliciting information from other LLDP agents via this protocol.

LLDP allows the transmitter and the receiver to be separately enabled, making it possible to configure an implementation to restrict the local LLDP agent either to transmit only or receive only, or to allow the local LLDP agent to both transmit and receive LLDP information.

7.2 Connectivity and management information

The information fields in each LLDP frame are contained in a Link Layer Discovery Protocol Data Unit (LLDPDU) as a sequence of short, variable length, information elements known as TLVs that each include type, length, and value fields where:

a) Type identifies what kind of information is being sent.

b) Length indicates the length of the information string in octets.

c) Value is the actual information that needs to be sent (for example, a binary bit map or an alpha-numeric string that can contain one or more fields).

Each LLDPDU includes four mandatory TLVs plus optional TLVs as selected by network management:

a) A Chassis ID TLV.

b) A Port ID TLV.

c) A Time To Live TLV.

d) From zero to n optional TLVs, as allowed by the space limitation of the LLDPDU.

e) An End Of LLDPDU TLV.

The chassis ID and the port ID values are concatenated to form a logical MSAP identifier that is used by the recipient to identify the sending LLDP agent/port. Both the chassis ID and port ID values can be defined in a number of convenient forms. Once selected however, the chassis ID/port ID value combination remains the same as long as the particular port remains operable.

A non-zero value in the TTL field of Time To Live TLV tells the receiving LLDP agent how long all information pertaining to this LLDPDU's MSAP identifier will be valid so that all the associated information can later be automatically discarded by the receiving LLDP agent if the sender fails to update it in a timely manner.

The End Of LLDPDU TLV marks the end of the LLDPDU.

The format for the LLDPDU is defined in 9.2. The TLV categories and the basic TLV format are defined in 9.3 and 9.4. The specific format and field contents for the Chassis ID TLV are defined in 9.5.2; for the Port ID TLV, in 9.5.3; for the Time To Live TLV in 9.5.4; and for the End Of LLDPDU TLV, in 9.5.1.

NOTE—A time to live (TTL) value of zero, tells the recipient LLDP agent that all the system information associated with the LLDPDU's MSAP identifier is to be deleted. This can be used, for example, to signal that the sending port has initiated a port shutdown procedure.

7.3 Optional information categories

Three sets of optional use TLVs are currently defined and may be used to describe the system and/or to assist in the detection of configuration inconsistencies associated the MSAP identifier:

a) Basic management TLV set (this set is required in all LLDP implementations):
   1) Port Description TLV.
   2) System Name TLV.
   3) System Description TLV.
   4) System Capabilities TLV (indicates both the system's capabilities and its current primary network function, such as end station, bridge, router).
   5) Management Address TLV.

b) IEEE 802.1 Organizationally Specific TLV set (this set is optional for all LLDP implementations).
   1) Port VLAN ID TLV.
   2) Port And Protocol VLAN ID TLV.
   3) VLAN Name TLV.
   4) Protocol Identity TLV.

c) IEEE 802.3 Organizationally Specific TLV set (this set is optional for all LLDP implementations).
   1) MAC/PHY Configuration/Status TLV (indicates the auto-negotiation capability and the duplex/speed status of IEEE 802.3 MAC/PHYs).
   2) Power Via MDI TLV (indicates the capabilities and current status of IEEE 802.3 PMDs that either require or are able to provide power over twisted-pair copper links).
   3) Link Aggregation TLV (indicates the current link aggregation status of IEEE 802.3 MACs).
   4) Maximum Frame Size TLV (indicates the maximum supported IEEE 802.3 frame size).

Table 9-1 includes a list of the currently defined optional TLVs in the basic management set and provides subclause references for their specific definitions.

Organizationally Specific TLVs can be defined by either the professional organizations or the individual vendors that are involved with the particular functionality being implemented within a system. The basic format and procedures for defining Organizationally Specific TLVs are provided in 9.6.

Annex F contains definitions of Organizationally Specific TLVs associated with IEEE Std 802.1. Annex G contains definitions of Organizationally Specific TLVs associated with IEEE Std 802.3. Annex E contains an informative discussion of how several Organizationally Specific TLVs could be used to detect potential problems in communications networks.

7.4 LLDP design principles

LLDP is designed to operate in a manner consistent with the principles of the Internet-standard Management Framework, which describes the separation of a data modeling language (for example, SMIv2) from content-specific data models (for example, the LLDP remote systems MIB), and from messages and protocol operations used to manipulate the data (for example, SNMPv3). Managed objects are accessed via a virtual information store (the MIB). MIB objects are generally accessed through SNMP. Objects in the MIB are defined using the mechanisms of the Structure of Management Information (SMI). For an overview of this structure, see section 7 of IETF RFC 3410.

Clause 12, Annex G, and Annex F include specifications for an LLDP MIB module and for IEEE 802.1 and IEEE 802.3 extension MIB modules that are compliant with the SMIv2 as defined in IETF STD 58, RFC 2578 [B10]; IETF STD 58, RFC 2579 [B11]; and IETF STD 58, RFC 2580 [B12].

7.5 TLV selection

Information for constructing the various TLVs to be sent is stored in the LLDP local system MIB. The selection of which particular TLVs to send is under control of the network manager. Information received from remote LLDP agents is stored in the LLDP remote systems MIB.

7.6 Transmission principles

Transmission can be initiated either by the expiration of a transmit countdown timing counter or by a change in the status or value in one or more of the information elements (managed objects) associated with the local system. When a transmit cycle is initiated, the LLDP manager extracts the managed objects from the LLDP local system MIB and formats this information into TLVs. The TLVs are inserted into the LLDPDU that is passed to the LLDP transmit module. The LLDP transmit module prepends addressing parameters to the LLDPDU as defined in 9.2, 9.3, and 9.4. The LLDPDU and TLV formats are defined in Clause 9 The LLDP transmit state machine is described in 10.4 and 10.5.4.

NOTES

1—Because a transmission cycle can be initiated whenever a change occurs within the LLDP local system MIB, it is possible that a series of successive changes over a short period of time could trigger a number of LLDP frames to be sent, each reporting only a single change, LLDP utilizes a transmission delay timer that can be set by network management to ensure that there is a defined minimum time between successive LLDP frame transmissions.

2—Under normal circumstances, the information in the receiving LLDP agent's remote systems MIB is refreshed periodically to avoid being discarded due to aging. To prevent the receiving LLDP agent's remote systems MIB information being aged out because a refresh frame has been lost in transmission, the sending LLDP agent will typically set the TTL value so that several refresh cycles will occur before the received MIB information will age out.

7.7 Reception principles

The LLDP receive module uses the services of the LLC entity to recognize that the incoming MA_UNITDATA.indication contains the correct combination of destination address and MSDU header values to identify it as being derived from an incoming LLDP frame. The LLDPDU recognition is defined in 8.4 and 10.3.1.

7.7.1 LLDPDU and TLV error handling

The LLDPDU is checked to ensure that it contains the correct sequence of mandatory TLVs and then each optional TLV is validated in succession. LLDPDUs and TLVs that contain detectable errors are discarded. TLVs that are not recognized, but that also contain no basic format errors, are assumed to be validated and are stored for possible later retrieval by network management (see 10.3.2 and 10.3.5).

7.7.2 LLDP remote systems MIB update

The LLDP remote systems MIB is updated after all TLVs have been validated. LLDP remote system MIB update procedures are defined in 10.3.3, 10.3.4, 10.3.5, 10.3.6, and 10.3.7. The LLDP receive state machine is described in 10.4 and 10.5.5.

7.8 Relationship between LLDP and IETF MIBs

LLDP is designed to operate in conjunction with MIBs defined by IETF, IEEE 802, and others. The following subclauses discuss the relationship between LLDP and IETF MIBs. LLDP agents automatically notify the managers of these MIBs whenever there is a value or status change in an LLDP MIB object.

LLDP managed objects for the local system are stored in the LLDP local system MIB. Information received from a remote LLDP agent is stored in the local LLDP agent's LLDP remote system MIB.

NOTE—In this standard, managed objects for an LLDP MIB module are defined as they would be for an SNMP MIB. However, it is not required for LLDP implementations to support SNMP to store and retrieve system data. LLDP agents need to have a place to store both information about the local system and information they have received about remote systems. No particular implementation is implied.

7.8.1 IETF Physical Topology MIB

The Physical Topology MIB (IETF RFC 2922 [B15]) allows a LLDP agent to expose learned physical topology information, using a standard MIB. LLDP is intended to support the PTOPO MIB.

NOTE—The LLDP MIB module is a logical superset of the IETF Physical Topology MIB, and from a functional point of view if the LLDP MIB module is implemented, there is no need to implement the PTOPO MIB defined in RFC 2922 [B15].

7.8.2 IETF Entity MIB

The Entity MIB (IETF RFC 2737) allows the physical component inventory and hierarchy to be identified. Chassis IDs passed in the LLDPDU may identify entPhysicalTable entries. SNMP agents that implement the LLDP MIB should implement the entPhysicalAlias object from the Entity MIB version 2 or higher.

7.8.3 IETF Interfaces MIB

The Interfaces MIB (IETF RFC 2863) provides a standard mechanism for managing network ports. Port IDs passed in the LLDPDU may identify ifTable (or entPhysicalTable) entries. SNMP agents that implement the LLDP MIB, should also implement the ifTable and ifXTable for the ports that are represented in the Interfaces MIB.

8. LLDPDU transmission, reception, and addressing

This standard is intended to be compatible with all IEEE 802 MACs.

LLDP uses the service provided by the LLDP/LSAP and LLC to transmit and receive LLDPDUs. Each LLDPDU is transmitted as a single MAC service request by an LLC entity that uses a single instance of the MAC Service provided at an MSAP. Each incoming LLDP frame is received at the MSAP by the LLC entity as a MAC service indication.

NOTE—For the purposes of this standard, the terms “LLC” and “LLC entity” include the service provided by the operation of entities that support protocol discrimination using an Ethertype, i.e., protocol discrimination based on the Ethertype field specified in IEEE Std 802a-2003.

The parameters of each service request and service indication comprise:

a) destination address.

b) source address.

c) Ethertype.

d) LLDPDU.

The LLDP Ethertype is prepended to the LLDPDU as shown in Figure 8-1 to form the MSDU of the corresponding MAC service request.

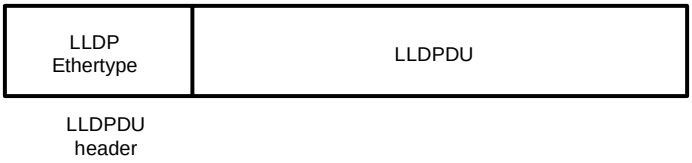

Figure 8-1—MSDU format

The values of the parameters used by LLDP, and their encoding by the LLC entity that supports the LLDP LSAP, are specified in the following subclauses.

8.1 Destination address

The destination address shall be as specified in Table 8-1. This address is within the range reserved by IEEE Std 802.1D-2004 for protocols constrained to an individual LAN, and ensures that the LLDPDU will not be forward by MAC Bridges that conform to IEEE Std 802.1D-2004.

Table 8-1—LLDP_Multicast address

Name	Value
LLDP_Multicast address	01-80-C2-00-00-0E

NOTE—This address has been selected from amongst those addresses that are not forwarded by MAC Bridges, or by VLAN-aware Bridges (see IEEE Std 802.1Q-1998).

8.2 Source address

The source address shall be the MAC address of the sending station or port.

8.3 Ethertype use and encoding

The Ethertype shall be the LLDP Ethertype specified in Table 8-2.

Table 8-2—LLDP Ethertype

Name	Value
LLDP Ethertype	88-CC

Where the LLC entity uses an MSAP that is supported by a specific media access control method (for example, IEEE Std 802.3-2002, IEEE Std 802.11-1999) or a media access control independent entity (for example, IEEE P802.1AE) that directly supports encoding of Ethertypes, the LLC entity shall encode the LLDP Ethertype as the two octet LLDPDU header in the MSDU of the corresponding MAC service request.

Where the LLC entity uses an MSAP that is supported by a specific media access control method (for example, IEEE Std 802.5) that does not directly support Ethertype encoding, the LLDP Ethertype shall be encoded in the octets of LLDPDU header according to the procedures specified in IEEE Std 802-2001 for Subnetwork Access Protocols (SNAP).

NOTES

1—The SNAP discriminator comprises the octets AA-AA-03-00-00-00 prepended to the LLDP Ethertype.

2—Annex D provides example LLDP transmission frame formats for both direct-encoded and SNAP-encoded LLDP Ethertype encoding methods.

8.4 LLDPDU reception

The LLDPDU shall be delivered to the LLDP receive module if, and only if, both the destination address and the Ethertype encoding are equal to the values defined in Table 8-1 and Table 8-2 respectively.

9. LLDPDU and TLV formats

9.1 LLDPDU bit and octet ordering conventions

All LLDPDUs shall contain an integral number of octets. The octets in an LLDPDU are numbered starting from 1 and increasing in the order they are put into the LLDP frame. The bits are numbered from 0 to 7, where 0 is the low-order bit.

When consecutive bits within an octet are used to represent a binary number, the highest bit number has the most significant value. When consecutive octets are used to represent a binary number, the lower octet number has the most significant value. All TLVs respect these bit and octet ordering conventions, thus allowing communications to take place.

9.2 LLDPDU format

The LLDPDU shall contain an ordered sequence of three mandatory TLVs followed by one or more optional TLVs plus an End Of LLDPDU TLV, as shown in Figure 9-1:

a) Three mandatory TLVs shall be included at the beginning of each LLDPDU and shall be in the order shown:
   1) Chassis ID TLV.
   2) Port ID TLV.
   3) Time To Live TLV.

b) Optional TLVs as selected by network management (may be inserted in any order).

c) The End Of LLDPDU TLV shall be the last TLV in the LLDPDU.

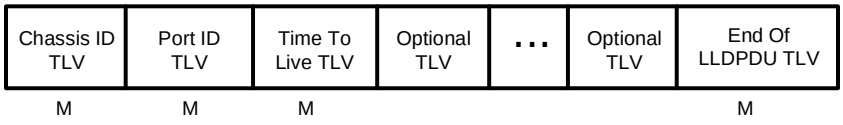

Figure 9-1—LLDPDU Format

The maximum length of the LLDPDU shall be the maximum information field length allowed by the particular transmission rate and protocol. In IEEE 802.3 MACs, for example, the maximum LLDPDU length is the maximum data field length for the basic, untagged MAC frame (1500 octets).

9.3 TLV categories

The TLVs are grouped into two general categories:

a) A set of TLVs that are considered to be basic to the management of network stations and that are a required capability of all LLDP implementations. Each TLV in this category is identified by an unique TLV type value that indicates the particular kind of information contained in the TLV.

b) Organizationally specific extension sets of TLVs that are defined by standards groups such as IEEE 802.1 and IEEE 802.3 and others to enhance management of network stations that are operating with particular media and/or protocols.

1) TLVs in this category are identified by a common TLV type value that indicates the TLV as belonging to the set of Organizationally Specific TLVs.
2) Each organization is identified by its organizationally unique identifier (OUI).
3) Organizationally Specific TLV subtype values indicate the kind of information contained in the TLV.

The basic TLV format and general field definition rules are defined in 9.4. Specific definitions and usage requirements for all basic management set TLVs are defined in 9.5. Usage rules/requirements that pertain to each individual basic TLV are contained in the definition for that particular TLV.

The basic format and the field definition/general usage rules/restrictions for Organizationally Specific TLVs are defined in 9.6. Specific definitions for IEEE 802.1 and IEEE 802.3 extension sets are contained in Annex F and Annex G.

Usage rules/requirements that pertain to each individual basic TLV are contained in the definition for that particular TLV.

9.4 Basic TLV format

Figure 9-2 shows the basic TLV format.

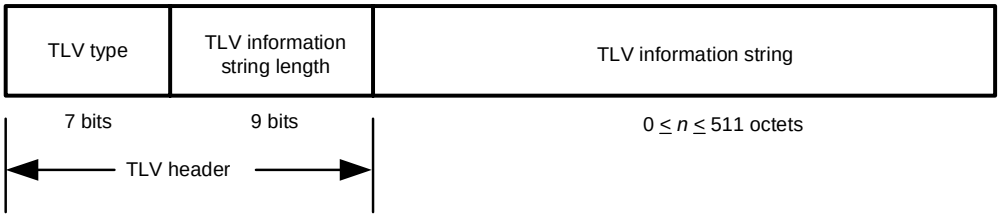

Figure 9-2—Basic TLV format

The TLV type field occupies the seven most significant bits of the first octet of the TLV format. The least significant bit in the first octet of the TLV format is the most significant bit of the TLV information string length field.

9.4.1 TLV type

The TLV type field is seven bits long and identifies the specific TLV. Two classes of TLVs are defined:

a) Mandatory TLVs that shall be included in each LLDPDU.
b) Optional TLVs that may be included some LLDPDUs.

Table 9-1 lists the currently defined TLVs, their identifying TLV type values, and whether they are mandatory or optional for inclusion in any particular LLDPDU.

Table 9-1—TLV type values

TLV type *	TLV name	Usage in LLDPDU	Subclause reference
0	End Of LLDPDU	Mandatory	Clause 9.5.1
1	Chassis ID	Mandatory	Clause 9.5.2
2	Port ID	Mandatory	Clause 9.5.3
3	Time To Live	Mandatory	Clause 9.5.4
4	Port Description	Optional	Clause 9.5.5
5	System Name	Optional	Clause 9.5.6
6	System Description	Optional	Clause 9.5.7
7	System Capabilities	Optional	Clause 9.5.8
8	Management Address	Optional	Clause 9.5.9
9–126	reserved	—	—
127	Organizationally Specific TLVs	Optional	IEEE 802.1 TLV set, Annex F IEEE 802.3 TLV set, Annex G

*TLVs with type values 0–8 are members of the basic management set.

9.4.2 TLV information string length

The TLV information string length field shall contain the length of the information string, in octets.

9.4.3 TLV information string

The information string:

a) May be fixed or variable length.

b) May include one or more information fields with associated subtype identifiers and field length designators as in, for example, the Management Address TLV (see 9.5.9).

c) May contain either binary or alpha-numeric information that is instance specific for the particular TLV type and/or subtype:

   1) Bit 0 in binary bit maps shall be the least significant bit in the field.

   2) The first octet of an alpha-numeric field shall be the most significant octet.

   3) Alpha-numeric information shall be encoded in UTF-8 [IETF RFC 3629].

9.5 Basic management TLV set formats and definitions

9.5.1 End Of LLDPDU TLV

The End Of LLDPDU TLV is a 2-octet, all-zero TLV that is used to mark the end of the TLV sequence in LLDPDUs. The format for this TLV is shown in Figure 9-3.

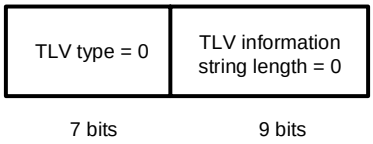

Figure 9-3—End Of LLDPDU TLV format

NOTE—Some IEEE 802 MACs require the data field in a frame to contain a minimum number of octets. For example, the IEEE 802.3 MAC adds pad octets to complete a minimum length data field if the user's data is less than the minimum required length. Since pad octets are unspecified, an End Of LLDPDU TLV is necessary to prevent non-zero pad octets from being interpreted by the receiving LLDP agent as another TLV.

9.5.2 Chassis ID TLV

The Chassis ID TLV is a mandatory TLV that identifies the chassis containing the IEEE 802 LAN station associated with the transmitting LLDP agent. There are several ways in which a chassis may be identified and a chassis ID subtype is used to indicate the type of component being referenced by the chassis ID field. Each LLDPDU shall contain one, and only one, Chassis ID TLV and the chassis ID field value shall remain constant for all LLDPDUs while the connection remains operational.

The Chassis ID TLV shall be the first TLV in the LLDPDU. Its format is shown in Figure 9-4.

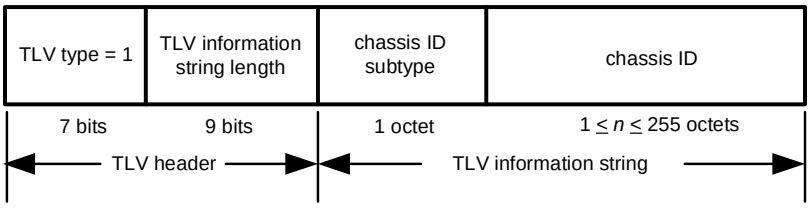

Figure 9-4—Chassis ID TLV format

9.5.2.1 TLV information string length

The TLV information string length field shall indicate the exact length, in octets, of the (chassis ID subtype + chassis ID) fields.

9.5.2.2 chassis ID subtype

The chassis ID subtype field shall contain an integer value indicating the basis for the chassis ID entity that is listed in the chassis ID field. The defined chassis ID subtypes and their preferred use order are listed in Table 9-2.

Table 9-2—Chassis ID subtype enumeration

ID subtype	ID basis	Reference
0	Reserved	—
1	Chassis component	EntPhysicalAlias when entPhysClass has a value of ‘chassis(3)’ (IETF RFC 2737)
2	Interface alias	IfAlias (IETF RFC 2863)
3	Port component	EntPhysicalAlias when entPhysicalClass has a value ‘port(10)’ or ‘backplane(4)’ (IETF RFC 2737)
4	MAC address	MAC address (IEEE Std 802-2001)
5	Network address	networkAddress *
6	Interface name	ifName (IETF RFC 2863)
7	Locally assigned	local†
8–255	Reserved	—

*networkAddress is an octet string that identifies a particular network address family and an associated network address that are encoded in network octet order. An IP address, for example, would be encoded with the first octet containing the IANA Address Family Numbers enumeration value for the specific address type and octets 2 through *n* containing the address value (for example, the encoding for C0-A8-FE-0A would indicate the IP version 4 address 192.168.254.10).

†local is an alpha-numeric string and is locally assigned.

9.5.2.3 chassis ID

The chassis ID field shall contain an octet string indicating the specific identifier for the particular chassis in this system. Because chassis ID and port ID values are concatenated to form the local MSAP identifier, the value chosen from Table 9-2 for the chassis ID shall be non-null.

9.5.2.4 Chassis ID TLV usage rules

An LLDPDU shall contain exactly one Chassis ID TLV.

9.5.3 Port ID TLV

The Port ID TLV is a mandatory TLV that identifies the port component of the MSAP identifier associated with the transmitting LLDP agent. As with the chassis, there are several ways in which a port may be identified. A port ID subtype is used to indicate how the port is being referenced in the Port ID field. Each LLDPDU shall contain one, and only one, Port ID TLV. The port ID value shall remain constant for all LLDPDUs while the transmitting port remains operational.

The chosen port shall be identified in an unambiguous manner (for example, backplane number, management entity, MAC address.).

The Port ID TLV shall be the second TLV in the LLDPDU. Its format is shown in Figure 9-5.

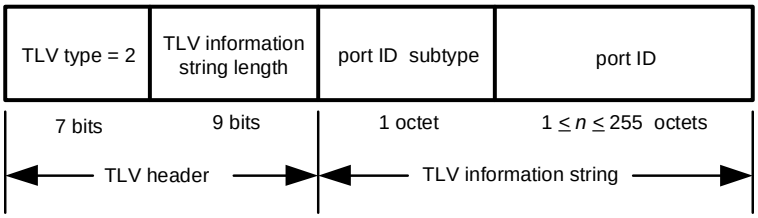

Figure 9-5—Port ID TLV format

9.5.3.1 TLV information string Length

The TLV information string length field shall indicate the length, in octets, of the (port ID subtype + port ID) fields.

9.5.3.2 port ID subtype

The port ID subtype field shall contain an integer value indicating the basis for the identifier that is listed in the port ID field. The defined port ID subtypes and their preferred use order are listed in Table 9-3.

Table 9-3—Port ID subtype enumeration

ID subtype	ID basis	References
0	Reserved	—
1	Interface alias	ifAlias (IETF RFC 2863)
2	Port component	entPhysicalAlias when entPhysicalClass has a value ‘port(10)’ or ‘backplane(4)’ (IETF RFC 2737)
3	MAC address	MAC address (IEEE Std 802-2001)
4	Network address	networkAddress *
5	Interface name	ifName (IETF RFC 2863)
6	Agent circuit ID	agent circuit ID (IETF RFC 3046)
7	Locally assigned	local †
8–255	Reserved	—

*networkAddress is an octet string that identifies a particular network address family and an associated network address that are encoded in network octet order. An IP address, for example, would be encoded with the first octet containing the IANA Address Family Numbers enumeration value for the specific address type and octets 2 through *n* containing the address value (for example, the encoding for C0-A8-FE-0A would indicate the IP version 4 address 192.168.254.10).

†local is an alpha-numeric string and is locally assigned.

9.5.3.3 port ID

The port ID field is an alpha-numeric string that contains the specific identifier for the port from which this LLDPDU was transmitted. Because chassis ID and port ID values are concatenated to form the local MSAP identifier, the value chosen from Table 9-3 for the port ID shall be non-null.

9.5.3.4 Port ID TLV usage rules

An LLDPDU shall contain exactly one Port ID TLV.

9.5.4 Time To Live TLV

The Time To Live TLV indicates the number of seconds that the recipient LLDP agent is to regard the information associated with this MSAP identifier to be valid.

a) When the TTL field is non-zero the receiving LLDP agent is notified to completely replace all information associated with this MSAP identifier with the information in the received LLDPDU.

b) When the TTL field is set to zero, the receiving LLDP agent is notified all system information associated with the LLDP agent/port is to be deleted. This TLV may be used, for example, to signal that the sending port has initiated a port shutdown procedure.

The Time To Live TLV is mandatory and shall be the third TLV in the LLDPDU. Its format is shown in Figure 9-6.

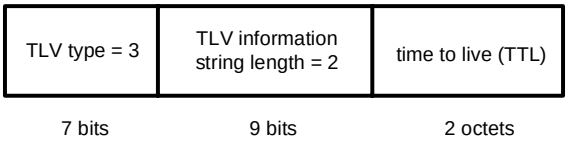

Figure 9-6—Time To Live TLV format

9.5.4.1 time to live (TTL)

The TTL field shall contain an integer value in the range $0 \leq t \leq 65535$ seconds and shall be set to the computed value of txTTL at the time the LLDPDU is constructed (see 10.5.4.1).

9.5.4.2 Time To Live TLV usage rules

An LLDPDU shall contain exactly one Time To Live TLV.

9.5.5 Port Description TLV

The Port Description TLV allows network management to advertise the IEEE 802 LAN station's port description. The format for this TLV is shown in Figure 9-7.

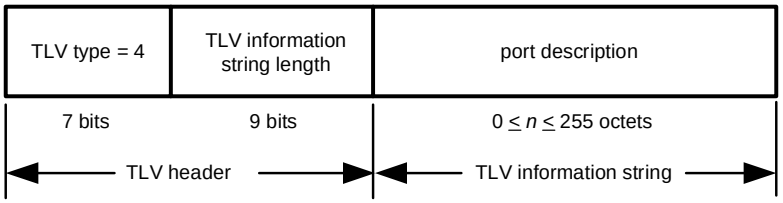

Figure 9-7—Port Description TLV format

9.5.5.1 TLV information string length

The TLV information string length field shall contain the exact length, in octets, of the port description field.

9.5.5.2 port description

The port description field shall contain an alpha-numeric string that indicates the port's description. If RFC 2863 is implemented, the ifDescr object should be used for this field.

9.5.5.3 Port Description TLV usage rules

An LLDPDU should not contain more than one Port Description TLV.

9.5.6 System Name TLV

The System Name TLV allows network management to advertise the system's assigned name. The format for this TLV is shown in Figure 9-8.

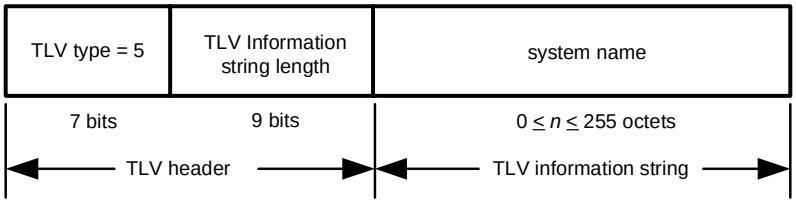

Figure 9-8—System Name TLV format

9.5.6.1 TLV information string length

The TLV information string length field shall contain the exact length, in octets, of the system name.

9.5.6.2 system name

The system name field shall contain an alpha-numeric string that indicates the system's administratively assigned name. The system name should be the system's fully qualified domain name. If implementations support IETF RFC 3418, the sysName object should be used for this field.

9.5.6.3 System Name TLV usage rules

An LLDPDU should not contain more than one System Name TLV.

9.5.7 System Description TLV

The System Description TLV allows network management to advertise the system's description. The format for this TLV is shown in Figure 9-9.

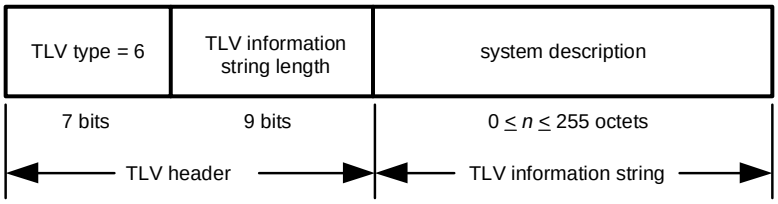

Figure 9-9—System Description TLV format

9.5.7.1 TLV information string length

The TLV information string length field shall indicate the exact length, in octets, of the system description.

9.5.7.2 system description

The system description field shall contain an alpha-numeric string that is the textual description of the network entity. The system description should include the full name and version identification of the system's hardware type, software operating system, and networking software. If implementations support IETF RFC 3418, the sysDescr object should be used for this field.

9.5.7.3 System Description TLV usage rules

An LLDPDU should not contain more than one System Description TLV.

9.5.8 System Capabilities TLV

The System Capabilities TLV is an optional TLV that identifies the primary function(s) of the system and whether or not these primary functions are enabled. Figure 9-10 shows the format of this TLV.

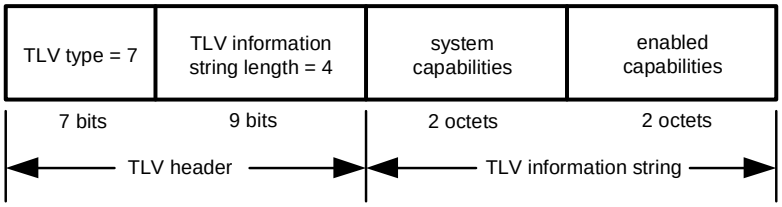

Figure 9-10—System Capabilities TLV format

9.5.8.1 system capabilities

The system capabilities field shall contain a bit-map of the capabilities that define the primary function(s) of the system. The bit positions for each function and the associated MIB or standard that are likely, but not guaranteed, to be supported are listed in Table 9-4. A binary one in the associated bit indicates the existence of that capability. Individual systems may indicate more than one implemented functional capability (for example, both a bridge and router capability).

Table 9-4—System capabilities

Bit	Capability	Reference
0	Other	—
1	Repeater	IETF RFC 2108
2	Bridge	IETF RFC 2674
3	WLAN Access Point	IEEE 802.11 MIB
4	Router	IETF RFC 1812
5	Telephone	IETF RFC 2011
6	DOCSIS cable device	IETF RFC 2669 and IETF RFC 2670
7	Station Only *	IETF RFC 2011
8–15	reserved	—

*The station only capability is intended for devices that implement only an end station capability. Bit 7 should not be set in conjunction with any other bits.

9.5.8.2 enabled capabilities

The enabled capabilities field shall contain a bit map of the primary functions listed in Table 9-4. A binary one in a bit position indicates that the function associated with that bit is currently enabled.

9.5.8.3 System Capabilities TLV usage rules

An LLDPDU should not contain more than one System Capabilities TLV.

If the system capabilities field does not indicate the existence of a capability that the enabled capabilities field indicates is enabled, the TLV will be interpreted as containing an error and shall be discarded.

9.5.9 Management Address TLV

The Management Address TLV identifies an address associated with the local LLDP agent that may be used to reach higher layer entities to assist discovery by network management. The TLV also provides room for the inclusion of both the system interface number and an object identifier (OID) that are associated with this management address, if either or both are known. Figure 9-11 shows the Management Address TLV format.

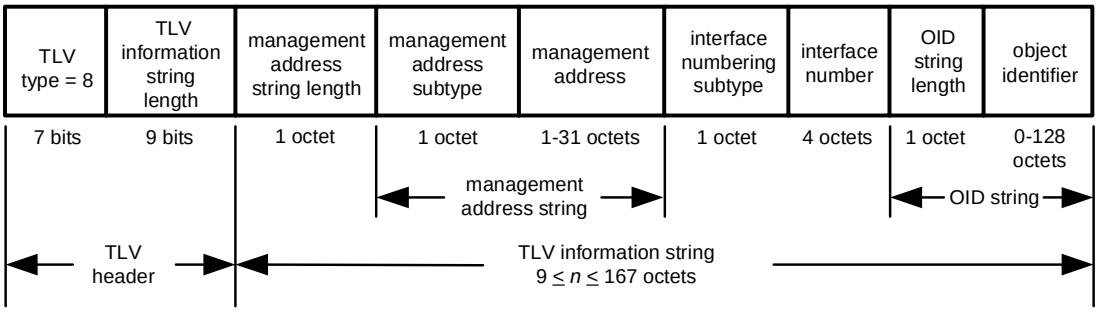

Figure 9-11—Management Address TLV format

9.5.9.1 TLV information string length

The TLV information string length field shall contain the length, in octets, of all the fields in the TLV information string.

9.5.9.2 management address string length

The management address string length field shall contain the length, in octets, of the (management address subtype + management address) fields.

9.5.9.3 management address subtype

The management address subtype field shall contain an integer value indicating the type of address that is listed in the management address field. Enumeration for this field is contained in the ianaAddressFamilyNumbers module of the IETF RFC 3232 on-line database that is accessible through a web page (currently, **http://www.iana.org**). The management address subtype is contained in the first octet of the management address string.

9.5.9.4 management address

The management address field shall contain an octet string indicating the particular management address associated with this TLV.

a) The returned address should be the most appropriate for management use, typically a layer 3 address such as the IPv4 address, 192.168.254.10 (see also Table 9-2, footnote 1).

b) If no management address is available, the return address should be the MAC address for the station or port.

9.5.9.5 interface numbering subtype

The interface numbering subtype field shall contain an integer value indicating the numbering method used for defining the interface number. Three values are currently defined:

1) Unknown.

2) ifIndex.

3) system port number.

9.5.9.6 interface number

The interface number field shall contain the assigned number within the system that identifies the specific interface associated with this management address. If the value of the interface subtype is unknown, this field shall be set to zero.

9.5.9.7 object identifier (OID) string length

The object identifier string length field shall contain the length, in octets, of the OID. A value of zero in this field indicates that the OID field is not provided.

9.5.9.8 object identifier

The object identifier field contains an OID that identifies the type of hardware component or protocol entity associated with the indicated management address. The OID shall be the value portion of the ASN.1 encoding of the object identifier [ASN.1]. If no OID is available, this field shall not be provided.

NOTE—The interface number and OID are included in this TLV to assist NMS discovery by indicating Enterprise Specific or other starting points for the search, such as the Interface or Entity MIB.

9.5.9.9 Management Address TLV usage rules

Management Address TLVs are subject to the following:

a) At least one Management Address TLV should be included in every LLDPDU.

b) Since there are typically a number of different addresses associated with a MSAP identifier, an individual LLDPDU may contain more than one Management Address TLV.

c) When Management Address TLV(s) are included in an LLDPDU, the included address(es) should be the address(es) offering the best management capability.

d) If more than one Management Address TLV is included in an LLDPDU, each management address shall be different from the management address in any other management address TLV in the LLDPDU.

e) If no management address is available, the MAC address may be used.

f) If an OID is included in the TLV, it shall be reachable by the management address.

g) If the network system is a VLAN bridge that implements the port and protocol based VLAN classification, every Management Address TLV that reports an address that is accessible on a port and protocol VLAN through the particular port should be accompanied by a port and protocol VLAN TLV that indicates the VLAN identifier (VID) associated with the management address reported by this TLV (see F.3.2).

9.6 Organizationally Specific TLVs

This TLV category is provided to allow different organizations, such as IEEE 802.1, IEEE 802.3, IETF, as well as individual software and equipment vendors, to define TLVs that advertise information to remote entities attached to the same media, subject to the following restrictions:

a) Information transmitted in an Organizationally Specific TLV is intended to be a one way advertisement. The TLV shall not solicit a response and shall not provide an acknowledgement.

b) Information transmitted in an Organizationally Specific TLV shall be independent from information in a TLV received from a remote port.

c) Information transmitted in one Organizationally Specific TLV shall not be concatenated with information transmitted in another TLV on the same media in order to provide a means for sending messages that are larger than would fit within a single TLV.

d) Information received in an Organizationally Specific TLV shall not be explicitly forwarded to other ports in the system.

e) Organizationally Specific TLVs shall conform to 9.4 and 9.6.1.

Each set of Organizationally Specific TLVs shall include associated LLDP MIB extensions and the associated TLV selection management variables and MIB/TLV cross reference tables (for example, see F.6 and G.6). Systems that implement LLDP and that also support standard protocols for which Organizationally Specific TLV extension sets have been defined shall support all TLVs and the LLDP MIB extensions defined for that particular TLV set.

Annex F and Annex G contain currently defined Organizationally Specific TLVs for IEEE 802.1 and IEEE 802.3, along with their associated LLDP MIB extensions and LLDP MIB/TLV cross reference tables. Organizations wishing to define TLVs for their use should use these annexes as examples. Future TLV definitions for IEEE 802 working groups should be included in annexes to this standard.

9.6.1 Basic Organizationally Specific TLV format

The basic format for Organizationally Specific TLVs is shown in Figure 9-12.

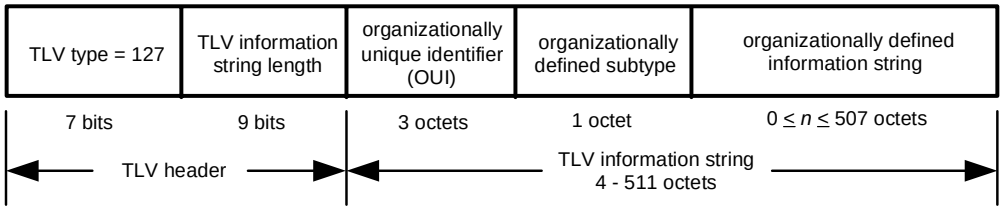

Figure 9-12—Basic format for Organizationally Specific TLVs

The following subclauses indicate how the individual fields shall be defined.

9.6.1.1 TLV type

The same Oganizationally Specific TLV type value, 127, shall be used for all organizationally defined TLVs.

9.6.1.2 TLV information string length

The TLV information string length field shall contain the length of the information string, in octets.

9.6.1.3 organizationally unique identifier (OUI)

The organizationally unique identifier field shall contain the organization's OUI as defined in Clause 9 of IEEE Std 802-2001.

9.6.1.4 organizationally defined subtype

The organizationally defined subtype field shall contain a unique subtype value assigned by the defining organization.

NOTE—Defining organizations are responsible for maintaining listings of organizationally defined subtypes in order to assure uniqueness.

9.6.1.5 organizationally defined information string

The actual format of the organizationally defined information string field is organizationally specific and can:

a) Contain either binary or alpha-numeric information that is instance specific for the particular TLV type and/or subtype. Alpha-numeric information should be encoded in UTF-8 (IETF RFC 3629).

b) Include one or more information fields with their associated field-type identifiers and field length designators similar to those in the Management Address TLV (see 9.5.9).

9.6.2 Organizationally Specific TLV usage rules

Organizations defining their own Organizationally Specific TLVs should include a subclause that defines any specific usage rules and/or specific conditions that will affect how the receiving LLDP agent shall treat the TLV.

The Organizationally Specific TLV usage rules should include:

a) The number of Organizationally Specific TLVs that may be contained in an LLDPDU and any additional information field subtypes that would identify differences between two TLVs with the same OUI and organizationally defined subtype (for example, see F.3.3 a).

b) Any error conditions that are specific to the particular Organizationally Specific TLV and the action that will be taken for each defined error condition (see F.3.3 b and c).

10. The protocol

This clause describes the protocol for a single port where the local LLDP agent manages LLDP operations for that port.

The local LLDP agent is responsible for causing the following tasks to be performed:

a) Maintaining current information in the LLDP local system MIB.

b) Extracting and formatting LLDP local system MIB information for transmission to the remote port LLDP agent(s) at regular intervals or whenever there is a change in the system condition or status.

c) Recognizing and processing received LLDP frames.

d) Maintaining current values in the LLDP remote system MIB.

e) Setting the variables somethingChangedLocal and somethingChangedRemote to notify the PTOPO MIB manager and MIB managers of other optional MIBs whenever a value or status change has occurred in one or more objects in the LLDP local system LLDP remote systems MIB.

LLDP allows implementations that support three different operating modes: transmit only mode, receive only, or both transmit and receive. Implementations of this protocol shall conform to the specifications each subclause indicated in Table 10-1 for the operating mode being implemented.

Table 10-1—Subclause/operating mode applicability

Subclause number	Subclause title	Transmit only	Receive only	Transmit and receive
10.1.1	LLDP transmit module initialization	M*	—	M
10.2.1	LLDP receive module initialization	—	M	M
10.2	Frame transmission	M	—	M
10.3	Frame reception	—	M	M
10.4	Notational conventions used in state machines	M	M	M
10.5.1	Global variables	M	M	M
10.5.2	Statistical counters	M	M	M
10.5.2.1	Transmission counters	M	—	M
10.5.2.2	Reception counters	—	M	M
10.5.3	Timers	M	M	M
10.5.3.1	Transmit state machine timers	M	—	M
10.5.3.4	Receive state machine timers	—	M	M
10.5.3.3	Transmit state machine timing parameters	M	—	M
10.5.3.4	Receive state machine timing parameters	—	M	M
10.5.4	Transmit state machine	M	—	M
10.5.5	Receive state machine	—	M	M

*M = mandatory

10.1 Protocol initialization

Because the local LLDP agent may be configured to both transmit and receive LLDP frames, to only transmit LLDP frames, or to only receive LLDP frames, separate protocol initialization processes are needed for frame transmission and reception.

10.1.1 LLDP transmit module initialization

During LLDP initialization or re-initialization of the transmit module, the local LLDP agent shall perform the following tasks:

a) If applicable, either the non-volatile configuration for the LLDP local system MIB shall be retrieved or the appropriate default values shall be assigned to all LLDP configuration variables.

b) The internal (implementation specific) data structures shall be initialized with appropriate local physical topology information.

c) The variable somethingChangedLocal shall be set to FALSE

d) Appropriate values shall be set for the following timing parameters:

   1) reinitDelay.
   2) msgTxHold.
   3) msgTxInterval.
   4) txDelay.

e) The variable adminStatus shall be interrogated to determine whether initialization should proceed further. If the value of adminStatus is ‘disabled’, LLDP transmit module initialization shall be halted until the variable portEnabled is equal to TRUE and the value of adminStatus is either of the following:

   1) enabledTxRx: the local LLDP agent can both transmit and receive LLDP frames.
   2) enabledTxOnly: the local LLDP agent can only transmit LLDP frames.

NOTE—It is both permissible and recommended to introduce a degree of stagger into starting the LLDP local agent initialization in multi-port implementations so that the timing of LLDP frame transmission cycles can be distributed among system ports. The method of accomplishing the stagger is an implementation issue and is beyond the scope of this standard.

10.1.2 LLDP receive module initialization

After the variable portEnabled is equal to TRUE, the LLDP receive module is initialized or re-initialized for frame reception. During this process, the local LLDP agent shall perform the following tasks:

a) The variable tooManyNeighbors shall be set to FALSE.

b) The adminStatus object shall be interrogated to determine whether initialization should proceed further. If the value of adminStatus is ‘disabled’, LLDP receive initialization shall be halted until the value of adminStatus is one of the following:

   1) enabledTxRx: the local LLDP agent can both transmit and receive LLDP frames.
   2) enabledRxOnly: the local LLDP agent can only receive LLDP frames.

c) All information in the remote systems MIB associated with this port shall be deleted.

10.2 Frame transmission

Frame transmission is a combined responsibility of the LLDP MIB manager and the LLDP transmit module. LLDP transmission shall conform to the following:

a) An active LLDP agent enabled for transmission shall initiate an LLDP frame transmission whenever either of the following events occur:

   1) Expiration of the transmission countdown timing counter, txTTR, associated with the LLDP local system MIB.

   2) A condition (status or value) change in one or more objects in the LLDP local system MIB.

b) To prevent a series of successive LLDP frame transmissions during a short period due to rapid changes in LLDP local systems MIB objects and to increase the probability that multiple, rather than single changes are reported in each frame, the local LLDP shall limit the LLDP frame transmission rate through use of a variable transmit delay timer that may be set by network management.

c) The LLDP agent shall suppress the transmission of multiple frames during a single transmission cycle if frame transmission cannot be restricted to a single port, but rather is transmitted through a group of ports attached to the same LAN segment (for example, in a repeater). In this case, a single port in the port group should be selected (in an implementation specific manner) to represent the port group. An LLDP agent should represent port groups as “backplanes”, in the LLDP local system MIB (and in the entPhysicalTable of the Entity MIB, rather than individual ports in either the Entity MIB or Interfaces MIB).

d) Actual transmission intervals for different ports on the same multi-port implementation should be staggered to prevent synchronization effects.

10.2.1 LLDPDU construction

Two types of LLDPDUs are defined:

a) Normal LLDPDUs where the purpose is to provide management information about the local station.

b) A special shutdown advisory LLDPDU indicating that the information about the local station that is maintained in the remote LLDP agent’s remote systems MIB is about to become invalid.

10.2.1.1 Normal LLDPDU construction

The LLDP local system MIB shall contain the information needed for constructing individual TLVs and shall include a capability that will allow network managers to select which optional TLVs are to be included in the LLDPDU (see 11.2.2).

When a new transmission cycle is indicated for an LLDP enabled port, the LLDP MIB manager shall extract the selected information from the LLDP local system MIB and shall construct an LLDPDU as defined in 9.1, containing:

a) Three mandatory TLVs as specified in 9.2:

   1) Chassis ID TLV (see 9.5.2).

   2) Port ID TLV (see 9.5.3).

   3) Time To Live TLV, with the TTL value set equal to txTTL (see 9.5.4).

b) Additional optional TLVs from either the basic management set or from one or more organizationally specific sets, as allowed by LLDPDU length restrictions and as selected in the LLDP local system MIB by network management (see Table 9-1, Table F-1, and Table G-1).

c) An End Of LLDPDU TLV.

Optional TLVs from the basic management set, such as the Management Address TLV, with different TLV type and subtype combinations as well as optional TLVs with different OUI and organizationally defined subtype combinations from one or more organizationally specific sets may be included within the same LLDPDU.

When the LLDPDU is complete, the MIB manager shall re-initialize the txTTR timing counter in the LLDP local system MIB.

10.2.1.2 Shutdown LLDPDU construction

A special procedure exists for the case in which a LLDP agent knows an associated port is about to become non-operational (for example, the adminStatus for the port is transitioning to 'disabled'). In the event a port, currently configured with LLDP frame transmission enabled, either becomes disabled for LLDP activity, or the interface is administratively disabled, a final LLDP shutdown LLDPDU may be sent with:

1) The Chassis ID and Port ID TLVs.
2) The Time To Live TLV with the TTL field set to zero.
3) An End Of LLDPDU TLV.

The LLDPDU shall not include any optional TLVs and should be transmitted before the interface is disabled.

NOTE—There is an inherent race condition between an interface knowing it is going down and its ability to send "one more frame." If possible, the actual termination of the connection should be delayed until after this frame is transmitted. In the event where adminStatus is transitioning to the disabled state and the LLDP agent will be shutting down, then this shutdown procedure should be executed for all local ports.

10.2.2 LLDP frame formatting/transmission

Upon receipt of an LLDPDU, the LLDP transmission module shall:

a) Prepend the appropriate source and destination addresses plus the LLDP Ethertype to the LLDPDU as defined in 8.1, 8.2, and 8.3 to complete the construction of the MA_UNITDATA.request.
b) Utilize the services of the LLC to pass the MA_UNITDATA.request to the MAC for final frame formatting and transmission.
c) Increment the statsFramesOutTotal counter.

10.3 Frame reception

LLDP frame reception consists of three phases: frame recognition, frame validation, and LLDP remote systems MIB updating. All error checking is done during frame validation.

10.3.1 LLDP frame recognition

The frame recognition is done at the LLDP/LSAP (see Figure 6-2) where the following frame elements shall be checked to determine whether:

a) The destination address value is the assigned LLDP_Multicast address defined in 8.1.
b) The Ethertype value is the LLDP Ethertype defined in 8.3 for the particular frame format.

If both of the above conditions are TRUE, the global variable rcvFrame shall be set to TRUE and the frame shall be sent to the LLDP receive module for validation.

10.3.2 LLDPDU validation

The receive module shall process each incoming LLDPDU as it is received. The statsFramesInTotal counter for the port shall be incremented and the LLDPDU shall be checked to verify the presence of the three mandatory TLVs at the beginning of the LLDPDU as defined in 9.2.

a) The first TLV shall be extracted:
    1) If the extracted TLV type value does not equal 1, the TLV is not a Chassis ID TLV:

i) The LLDPDU shall be discarded.

ii) The statsFramesDiscardedTotal and statsFramesInErrorsTotal counters shall both be incremented.

iii) The variable badFrame shall be set to TRUE.

iv) The procedure rxProcessFrame**()** shall be terminated.

2) If the extracted TLV type value equals 1, and the chassis ID TLV information string length is not within the range $2 \leq n \leq 256$:

i) The LLDPDU shall be discarded.

ii) The statsFramesDiscardedTotal and statsFramesInErrorsTotal counters shall both be incremented.

iii) The variable badFrame shall be set to TRUE.

iv) The procedure rxProcessFrame() shall be terminated.

3) If the extracted TLV type value equals 1, and the chassis ID TLV information string length is within the range $2 \leq n \leq 256$, the chassis ID value shall be extracted to become the first part of the MSAP identifier.

b) The second TLV shall be extracted:

1) If the extracted TLV type value does not equal 2, the TLV is not a Port ID TLV:

i) The LLDPDU shall be discarded.

ii) The statsFramesDiscardedTotal and statsFramesInErrorsTotal counters shall both be incremented.

iii) The variable badFrame shall be set to TRUE.

iv) The procedure rxProcessFrame() shall be terminated.

2) If the extracted TLV type value equals 2, and the port ID TLV information string length is not within the range $2 \leq n \leq 256$:

i) The LLDPDU shall be discarded.

ii) The statsFramesDiscardedTotal and statsFramesInErrorsTotal counters shall both be incremented.

iii) The variable badFrame shall be set to TRUE.

iv) The procedure rxProcessFrame() shall be terminated.

3) If the extracted TLV type value equals 2, and the port ID TLV information string length is within the range $2 \leq n \leq 256$, the port ID value shall be extracted and appended to the chassis ID value to complete construction of the MSAP identifier.

c) The third TLV shall be extracted:

1) If the extracted TLV type value does not equal 3, the TLV is not a Time To Live TLV.

i) The LLDPDU shall be discarded.

ii) The statsFramesDiscardedTotal and statsFramesInErrorsTotal counters shall both be incremented.

iii) The variable badFrame shall be set to TRUE.

iv) The procedure rxProcessFrame() shall be terminated.

2) If the extracted TLV type value equals 3, and the Time To Live TLV information string length is less than 2:

i) The LLDPDU shall be discarded.

ii) The statsFramesDiscardedTotal and statsFramesInErrorsTotal counters shall both be incremented.

iii) The variable badFrame shall be set to TRUE.

iv) The procedure rxProcessFrame() shall be terminated.

3) If the extracted TLV type value equals 3, and the Time To Live TLV information string length is greater than or equal to 2, the first two octets of the TLV information string shall be extracted and rxTTL shall be set to this value:

   i) If rxTTL equals zero, a shutdown frame has been received. The MSAP identifier and rxTTL shall be passed up to the LLDP MIB manager, and further LLDPDU validation shall be terminated.

   ii) If rxTTL is non-zero, LLDPDU validation shall continue and the remaining TLVs shall be validated.

Each of the remaining TLV information elements shall be decoded in succession as required by their particular TLV format definitions:

d) If the TLV type value equals 0, the TLV is the End Of LLDPDU TLV. The MSAP identifier, rxTTL, and all validated TLVs shall be passed to the LLDP manager for LLDP remote systems MIB updating.

e) If ($0 < TLV\_type\_value \leq 8$) the TLV is a member of the basic management set and shall be validated according to the general rules for all TLVs defined in 10.3.2.1 as well as any specific rules defined for the particular TLVs defined in 9.5.

f) If TLV_type_value is in the range of reserved TLV types in Table 9-1, the TLV is unrecognized and may be a basic TLV from a later LLDP version. The statsTLVsUnrecognizedTotal counter shall be incremented, and the TLV shall be assumed to be validated.

g) If the TLV type value is 127, the TLV is an Organizationally Specific TLV:

   1) If the TLV's OUI and organizationally defined subtype are recognized, the TLV shall be validated according to the general rules for all TLVs defined in 10.3.2.1 as well as the general rules for Organizationally Specific TLVs defined in 10.3.2.2 plus any specific rules defined for the particular TLV (see Annex F for IEEE 802.1 TLVs and Annex G for IEEE 802.3 TLVs).

   2) If the TLV's OUI and/or organizationally defined subtype are not recognized, the statsTLVsUnrecognizedTotal counter shall be incremented, and the TLV shall be assumed to be validated.

h) If the end of the LLDPDU has been reached, the MSAP identifier, rxTTL, and all validated TLVs shall be passed to the LLDP manager for LLDP remote systems MIB updating.

10.3.2.1 General validation rules for all TLVs

The value in the TLV information string length field shall be the value that is used to validate the TLV and to indicate the location of the next TLV in the LLDPDU.

All TLVs shall conform to the general validation rules listed in this subclause as well as any specific usage rules defined for the particular TLV (for example, see systems capabilities TLV usage rules in 9.5.8.3):

a) If the LLDPDU contains more than one Chassis ID TLV, Port ID TLV, or Time To Live TLV:

   1) The LLDPDU shall be discarded.

   2) The statsFramesDiscardedTotal and statsFramesInErrorsTotal counters shall both be incremented.

b) If the TLV information string length value is greater than the sum of the lengths of all fields contained in the TLV information string:

   1) The extra octets shall be ignored.

   2) The location of the next TLV shall be based on the TLV information string length value of the current TLV.

c) If the TLV information string length value is less than the sum of the lengths of the contained fields, the location of the next TLV is indeterminate:

1) The LLDPDU shall be discarded.
2) The statsFramesDiscardedTotal and statsFramesInErrorsTotal counters shall both be incremented.

d) If any TLV contains an error condition specified for that particular TLV (for example, see F.3.3):
1) The TLV shall be discarded.
2) The statsTLVsDiscardedTotal and statsFramesInErrorsTotal counters shall both be incremented.
3) The location of the next TLV shall be based on the TLV information string length value of the current TLV.

e) If any TLV extends past the physical end of the frame:
1) The TLV shall be discarded.
2) The statsTLVsDiscardedTotal and statsFramesInErrorsTotal counters shall both be incremented.

f) Any information following an End Of LLDPDU TLV shall be ignored.

NOTE—Usage rules for individual TLVs allow some TLVs to appear more than once in an LLDPDU. Duplicate TLVs may result in any one of the values being placed in the MIB, may but will not necessarily cause the discard stats to increment, and may cause the change marker for the MIB entry to change if any of the TLV copies change the value even if the value finally recorded is unchanged. The only thing guaranteed is that the MIB value will be set to one (unspecified) of the TLV values, and if that value is different to what was previously in the MIB then the change marker will be set.

10.3.2.2 General validation rules for all Organizationally Specific TLVs

If an Organizationally Specific TLV is not recognized by the receiving LLDP agent, the content of the TLV can be ignored but the TLV shall be stored in the LLDP remote systems MIB for possible retrieval by network management using the basic Organizationally Specific TLV format (see 9.6). If more than one unrecognized Organizationally Specific TLV is received with the same OUI and organizationally defined subtype, but with identifiable differences in the organizationally defined information strings, all copies shall be assigned a temporary identification index and stored.

10.3.3 TLV/MIB object value comparison

The LLDP MIB manager is responsible for updating and maintaining each LLDP remote systems MIB associated with the LLDP agent. It uses one control variable somethingChangedRemote to track when any change has occurred in the LLDP remote systems MIB due to new or different information in the TLVs from an incoming LLDPDU.

When an LLDPDU is passed up from the LLDP receive module, the LLDP MIB manager shall:

a) Set the flag variable somethingChangedRemote associated with the MSAP identifier to FALSE.
b) If rxTTL is zero, delete all information associated with the MSAP identifier from the LLDP remote systems MIB, set the variable somethingChangedRemote to TRUE, and wait for the next LLDPDU.
c) If rxTTL is non-zero and the LLDPDU's MSAP identifier is not associated with an existing LLDP remote systems MIB, check to determine if sufficient space exists in the LLDP remote systems MIB to accommodate the current LLDPDU:
1) If sufficient space exists, perform the LLDP remote systems MIB update procedure defined in 10.3.5.
2) If sufficient space does not exist, perform the "Too many neighbors" process defined in 10.3.4.
d) If rxTTL is non-zero and the LLDPDU's MSAP identifier is associated with an existing LLDP remote systems MIB, compare all current information in the LLDP remote systems MIB with the information in the TLVs just received:

1) If no differences are found, set the control variable rxChanges to FALSE, set the timing counter rxInfoTTL associated with the MSAP identifier to rxTTL, and wait for the next LLDPDU.
2) If any differences are found and there is sufficient space in the LLDP remote systems MIB to store the new LLDPDU, set the control variable rxChanges to TRUE and perform the LLDP remote systems MIB update process defined in 10.3.5.
3) If differences are found but there is not sufficient space to store the new LLDPDU, perform the "Too many neighbors" process defined in 10.3.4.

10.3.4 Too many neighbors

The amount of space needed in the LLDP remote systems MIB to accommodate the creation of several new MIB structures is beyond the scope of this standard. It may not always be possible to accommodate another new neighbor in implementations with limited memory. There are several possibilities for handling this case, including but not limited to the following examples:

a) Ignore and not process the new neighbor's information.
b) Delete the information from the oldest neighbor(s) until there is sufficient memory available to store the new neighbor's information.
c) Randomly delete neighbors until there is sufficient memory available to store the new neighbor's information.

The method of handling the case where a new entry in the remote systems MIB can not be created is beyond the scope of this standard, however it is necessary for the implementation to keep track of this case by properly updating the variable tooManyNeighbors and the tooManyNeighborsTimer. The variable tooMany-Neighbors identifies when there is insufficient space in the LLDP remote systems MIB to store information from all active neighbors. The tooManyNeighborsTimer indicates the minimum time that this condition will exist.

When there is insufficient space in the LLDP remote systems MIB to store information from a new neighbor something needs to be discarded. Either the received LLDPDU is discarded or existing information within the current remote systems MIB is discarded in order to make space for the new information received in the LLDPDU:

d) Set the flag variable tooManyNeighbors to TRUE.
e) If the information selected to be discarded is the information in the current LLDPDU:
    1) Set the tooManyNeighborsTimer as follows:

    tooManyNeighborsTimer = max (tooManyNeighborsTimer, rxTTL) (1)

    where rxTTL is the TTL value in the current LLDPDU

    2) Discard the current LLDPDU and increment the statsFramesDiscardedTotal counter.
    3) Wait for the next LLDPDU.
f) If the information selected to be discarded is currently in the LLDP remote systems MIB:
    1) Delete all information associated with the selected neighbor's MSAP identifier from the LLDP remote systems MIB.
    2) Set the tooManyNeighborsTimer as follows:

    tooManyNeighborsTimer = max (tooManyNeighborsTimer, rxInfoTTL) (2)

    where: rxInfoTTL = the selected neighbor's TTL value

    3) If sufficient space exists to store the information received in the current LLDPDU in the LLDP remote systems MIB, perform the MIB update process defined in 10.3.5.

4) If sufficient space still does not exist to store the information received in the current LLDPDU in the LLDP remote systems MIB, perform steps 1–3 again.

The variable tooManyNeighbors shall be automatically set to FALSE whenever the tooManyNeighborsTimer expires.

NOTE—To prevent numerous unnecessary deletions and additions to the PTOPO and other optional MIBs, during times when there are too many neighbors for the space available in the LLDP remote systems MIBs, the flag variable somethingChangedRemote associated with the deleted MIB information will not be set to TRUE. Rather, the associated MIB objects in the PTOPO and other MIBS will be allowed to age out.

10.3.5 LLDP remote systems MIB update

MIB space is available and an LLDP remote systems MIB update is needed:

a) Compare the MSAP identifier in the current LLDPDU with the MSAP identifiers in the LLDP remote systems MIB:
   1) If a match is found, replace all current information associated with the MSAP identifier in the LLDP remote systems MIB with the information in the current LLDPDU.
   2) If no match is found, create a new MIB structure to receive information associated with the new MSAP identifier, and set these MIB objects to the values indicated in their respective TLVs.

b) Set the timing counter rxInfoTTL associated with the MSAP identifier to rxTTL.

c) Set the flag variable somethingChangedRemote associated with the MSAP identifier to TRUE to notify the managers of PTOPO and other optional MIBs that something has changed in the LLDP remote systems MIB associated with that MSAP identifier.

If an incoming TLV is not recognized by the receiving LLDP agent, the TLV shall be stored in the LLDP remote systems MIB as follows:

d) If the TLV type value is in the range of the reserved TLV types in Table 9-1, the TLV may be from a later version of the basic management set and shall be stored according to the basic TLV format shown in Figure 9-2. These TLVs shall be indexed by their TLV type.

e) If the TLV type value is 127, the TLV is an Organizationally Specific TLV and shall be stored according to the basic format for Organizationally Specific TLVs shown in Figure 9-12. These TLVs shall be indexed by their OUI and organizationally defined TLV subtype.

10.3.6 LLDP remote systems rxInfoTTL timer expiration

If rxInfoTTL timer associated with an MSAP identifier expires, all information associated with that MSAP identifier shall be deleted and the flag variable somethingChangedRemote associated with the MSAP identifier shall be set to TRUE to notify the managers of IETF optional MIBs that something has changed in the LLDP remote systems MIB associated with that MSAP identifier.

10.3.7 LLDP local port/connection failure

If the local port or the connection to the remote system fails before a shutdown frame can be sent, the LLDP manager shall not delete objects in the LLDP remote systems MIB pertaining to information received from any MSAP identifier through that local port until the port is re-initialized or the associated rxInfoTTL timer expires.

10.4 Notational conventions used in state diagrams.

State diagrams are used to represent the operation of a function as a group of connected, mutually exclusive states. Only one state of a function can be active at any given time.

Each state is represented in the state diagram as a rectangular box, divided into two parts by a horizontal line. The upper part contains the state identifier, written in uppercase letters. The lower part contains any procedures that are executed on entry to the state.

All permissible transitions between states are represented by arrows, the arrowhead denoting the direction of the possible transition. Labels attached to arrows denote the condition(s) that shall be met in order for the transition to take place. A transition that is global in nature (i.e., a transition that occurs from any of the possible states if the condition attached to the arrow is met) is denoted by an open arrow; i.e., no specific state is identified as the origin of the transition.

On entry to a state, the procedures defined for the state (if any) are executed exactly once, in the order that they appear on the page. Each action is deemed to be atomic; i.e., execution of a procedure completes before the next sequential procedure starts to execute. No procedures execute outside of a state block. On completion of all of the procedures within a state, all exit conditions for the state (including all conditions associated with global transitions) are evaluated continuously until such a time as one of the conditions is met. All exit conditions are regarded as Boolean expressions that evaluate to TRUE or FALSE; if a condition evaluates to True, then the condition is met. When the condition associated with a global transition is met, it supersedes all other exit conditions, including UCT. The label UCT denotes an unconditional transition (i.e., UCT always evaluates to True). The label ELSE denotes a transition that occurs if none of the other conditions for transitions from the state are met (i.e., ELSE evaluates to TRUE if all other possible exit conditions from the state evaluate to FALSE).

A variable that is set to a particular value in a state block retains this value until a subsequent state block executes a procedure that modifies the value.

Where it is necessary to segment a state machine description across more than one diagram, a transition between two states that appear on different diagrams is represented by an exit arrow drawn with dashed lines, plus a reference to the diagram that contains the destination state. Similarly, dashed arrows and a dashed state box are used on the destination diagram to show the transition to the destination state. In a state machine that has been segmented in this way, any global transitions that can cause entry to states defined in one of the diagrams are deemed to be potential exit conditions for all of the states of the state machine, regardless of which diagram the state boxes appear in.

Should a conflict exist between the interpretation of a state diagram and either the corresponding global transition tables or the textual description associated with the state machine, the state diagram takes precedence.

The interpretation of the special symbols and operators used in the state diagrams is defined in Table 10-2; these symbols and operators are derived from the notation of the “C” programming language, ANSI X3.159.

Table 10-2—State machine symbols

Symbol	Interpretation
( )	Used to force the precedence of operators in Boolean expressions and to delimit the argument(s) of actions within state boxes.
;	Used as a terminating delimiter for actions within state boxes. Where a state box contains multiple actions, the order of execution follows the normal English language conventions for reading text.
=	Assignment action. The value of the expression to the right of the operator is assigned to the variable to the left of the operator. Where this operator is used to define multiple assignments, e.g., a = b = X the action causes the value of the expression following the right-most assignment operator to be assigned to all of the variables that appear to the left of the right-most assignment operator.
!	Logical NOT operator.
&&	Logical AND operator.
||	Logical OR operator.
if...then...	Conditional action. If the Boolean expression following the **if** evaluates to TRUE, then the action following the **then** is executed.
{statement 1, ... statement N}	Compound statement. Braces are used to group statements that are executed together as if they were a single statement.
!=	Inequality. Evaluates to TRUE if the expression to the left of the operator is not equal in value to the expression to the right.
==	Equality. Evaluates to TRUE if the expression to the left of the operator is equal in value to the expression to the right.
<	Less than. Evaluates to TRUE if the value of the expression to the left of the operator is less than the value of the expression to the right.
>	Greater than. Evaluates to TRUE if the value of the expression to the left of the operator is greater than the value of the expression to the right.
>=	Greater than or equal to. Evaluates to TRUE if the value of the expression to the left of the operator is either greater than or equal to the value of the expression to the right.
+	Arithmetic addition operator.
–	Arithmetic subtraction operator.

10.5 State machines

The operation of the protocol can be represented with two simple state machines and associated timing counters to indicate when local system managed object values need to be sent to refresh the values in remote LLDP agent's LLDP remote systems MIB and when object values in the local LLDP agent's remote systems MIB will become invalid:

a) Transmit state machine.

b) Receive state machine.

10.5.1 Global variables

Global variables are available for use by more than one state machine, and are used to perform inter-state-machine communication and initialization functions.

a) **adminStatus:** This is a per-port variable that indicates whether or not the local LLDP agent is enabled. The defined values for this variable are:

   1) enabledRxTx: the local LLDP agent can both transmit and receive LLDP frames through the port. 'enabledRxTx' is the adminStatus recommended default value.

   2) enabledTxOnly: the local LLDP agent can only transmit LLDP frames.

   3) enabledRxOnly: the local LLDP agent can only receive LLDP frames.

   4) disabled: the local LLDP agent can neither transmit or receive LLDP frames.

b) **portEnabled:** This variable is externally controlled. Its value reflects the operational state of the MAC service supporting the port. Its value is TRUE if the MAC service supporting the port is in an operable condition, otherwise it is FALSE.

10.5.2 Statistical counters

Statistical counters shall be provided to accumulate operational statistics on a per-port basis.

10.5.2.1 Transmission counters

The following counter has been defined for the transmit state machine:

a) **statsFramesOutTotal:** This counter provides a count of all LLDP frames transmitted.

10.5.2.2 Reception counters

The following counters have been defined for the receive state machine:

a) **statsAgeoutsTotal:** This counter provides a count of the times that a neighbor's information has been deleted from the LLDP remote systems MIB because the rxInfoTTL timer associated with the neighbor's MSAP has expired.

b) **statsFramesDiscardedTotal:** This counter provides a count of all LLDPDUs received and then discarded for any of the following reasons:

   1) One or more of the three mandatory TLVs at the beginning of the LLDPDU is missing, out of order or contains an out of range information string length.

   2) There is insufficient space in the remote systems MIB to store the LLDPDU.

c) **statsFramesInErrorsTotal:** This counter provides a count of all LLDPDUs received with one or more detectable errors.

d) **statsFramesInTotal:** This counter provides a count of all LLDP frames received.

e) **statsTLVsDiscardedTotal:** This counter provides a count of all TLVs received and then discarded for any reason.

f) **statsTLVsUnrecognizedTotal:** This counter provides a count of all TLVs received on the port that are not recognized by the LLDP local agent.

All statistical counters shall be four octets long. Counter values shall be maintained in the LLDP local control MIB on a continuing basis and shall not be deleted upon expiration of rxInfoTTL timing counters in the LLDP remote systems MIB or upon the receipt of a shutdown frame from a remote LLDP agent.

10.5.3 Timers

The timer used for LLDP state machines decrements countdown counters that keep time values for the all objects in the resident station's LLDP MIB. All counters shall:

a) Have a resolution of one second.

b) Have an integer value n, where $0 < n < 65535$ seconds.

c) Be started by loading an initial integer value.

d) Be decremented once per second as long as $n > 0$.

e) Represent the remaining time in the period.

10.5.3.1 Transmit state machine timers

The following timing counters have been defined for the transmit state machine:

a) **txShutdownWhile:** This timer indicates the number of seconds remaining until LLDP re-initialization can occur.

b) **txDelayWhile:** This timer introduces a minimum delay between transmission of successive LLDP frames.

c) **txTTR:** The transmit time to refresh timer indicates the number of seconds remaining until the local LLDP agent needs to send a new frame containing information from the LLDP local systems MIB to refresh the information in the remote LLDP agent's remote systems MIB.

10.5.3.2 Receive state machine timers

The following timing counters have been defined for the receive state machine:

a) **rxInfoTTL:** This timer indicates the number of seconds remaining until the information in all the objects in the LLDP remote systems MIB associated with the MSAP identifier will no longer be valid and need to be deleted.

b) **TooManyNeighborsTimer:** This timer indicates the number of seconds remaining during which it is known that an LLDP neighbor exists that may not be stored in the remote systems MIB.

10.5.3.3 Transmit state machine timing parameters

The following timing counters are used in conjunction with the timers defined in 10.5.3.1:

a) **msgTxHold:** This parameter is a multiplier on the msgTxInterval that determines the actual TTL value used in an LLDPDU. The recommended default value for msgTxHold is 4.

b) **msgTxInterval**: This parameter indicates the interval at which LLDP frames are transmitted on behalf of this LLDP agent. The recommended default value for msgTxInterval is 30 seconds.

c) **reinitDelay:** This parameter indicates the amount of delay from when adminStatus becomes "disabled' until re-initialization will be attempted. The recommended default value for reinitDelay is 2 seconds.

d) **txDelay:** This parameter indicates the delay between successive LLDP frame transmissions initiated by value or status changes in the LLDP local systems MIB. The value for txDelay is set by the following range formula:

$$1 \leq \text{txDelay} \leq (0.25 \times \text{msgTxInterval}) \quad (3)$$

The recommended default value for txDelay is 2 seconds.

10.5.3.4 Receive state machine timing parameters

There are no receive state machine timing parameters associated with the timers defined in 10.5.3.2.

10.5.4 Transmit state machine

The transmit state machine is used to format TLVs and to construct LLDPDUs with information extracted from MIB objects in the LLDP local system MIB.

10.5.4.1 Transmit state machine variables

a) **somethingChangedLocal:** This variable indicates that the status/value of one or more of the selected objects in the LLDP local system MIB has changed. It is also used as a flag to notify the managers of the PTOPO and other optional MIB that something has changed in the LLDP local systems MIB.

b) **txTTL:** This variable indicates the time remaining before information in the outgoing LLDPDU will no longer be valid. The TTL field in the Time To Live TLV is set to txTTL during LLDPDU construction (see 10.2.1.1). The value of txTTL depends on the following:

   1) During normal operation, txTTL is set according to the following:

$$(\text{msgTxInterval} \times \text{msgTxHold}) \leq \text{txTTL} \leq 65535 \quad (4)$$

   2) If adminStatus is transitioning to ‘disabled’ or portEnabled is transitioning to FALSE, txTTL shall be set to zero.

10.5.4.2 Transmit state machine procedures

Four procedures are defined for the transmit state machine.

10.5.4.2.1 mibConstrInfoLLDPDU ()

The mibConstrInfoLLDPDU () procedure constructs an information LLDPDU as defined in 10.2.1.1 according to the LLDPDU and associated basic TLV formats as specified in 9.2 and 9.4 plus any optional Organizationally Specific TLVs as specified in 9.6 and their associated individual organizationally defined formats (as, for example, in Annex F and Annex G).

NOTE—Because selection of which specific TLVs to include in an LLDPDU is a LLDP MIB management function, the transmit state machine does not include a separate procedure for this purpose (see 10.2.1.1).

10.5.4.2.2 mibConstrShutdownLLDPDU ()

The mibConstrShutdownLLDPDU () procedure constructs a shutdown LLDPDU as defined in 10.2.1.2 and according to the LLDPDU and the associated TLV formats specified in 9.2 and 9.5.

10.5.4.2.3 txFrame ()

The txFrame () procedure prepends the source and destinations addresses and the LLDP Ethertype to each LLDPDU as defined in 10.2.2 before it is sent to the MAC for transmission.

10.5.4.2.4 txInitializeLLDP ()

The txInitializeLLDP () procedure initializes the LLDP transmit module as defined in 10.1.1.

10.5.4.3 Transmit state machine diagram

The transmit state machine for an individual port is shown in Figure 10-1.

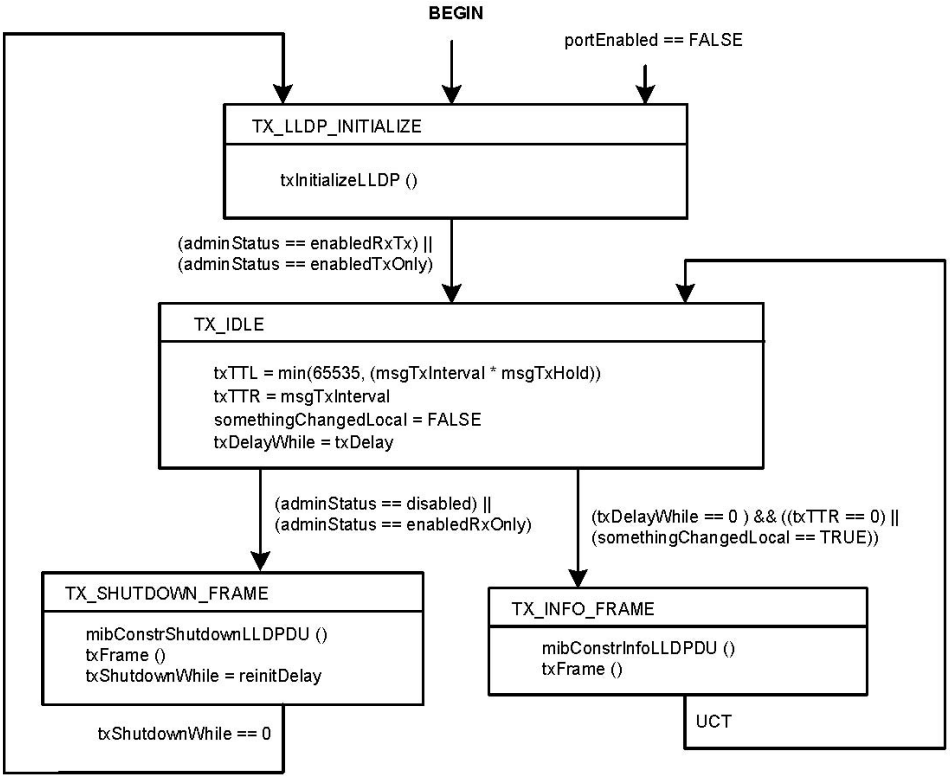

Figure 10-1—Transmit state machine

10.5.5 Receive state machine

10.5.5.1 Receive state machine variables

a) **badFrame:** This variable indicates that in incoming LLDPDU was unable to be validated because the LLDPDU failed validation and was discarded.

b) **rcvFrame:** This variable indicates that an LLDP frame has been recognized by the LLDP LSAP function and has been sent to the LLDP receive module (see 10.3.1).

c) **rxChanges:** This variable indicates that the incoming LLDPDU has been received with different TLV values from those currently in the LLDP remote systems MIB associated with the LLDPDU's MSAP identifier.

d) **rxInfoAge:** This variable indicates that the rxInfoTTL timing counter associated with a particular MSAP identifier in the LLDP remote systems MIB has expired.

e) **rxTTL:** This variable indicates the time to live value associated with all TLVs received in the current frame.

f) **somethingChangedRemote:** This per-MSAP variable is only set after all the information associated with the particular MSAP identifier has been updated in the LLDP remote systems MIB. The variable serves as an indication to the managers of the PTOPO and other optional MIBs that indicates one or more of the following, as defined in 10.3.3:

   1) That the status/value of one or more objects in the LLDP remote systems MIB associated with the particular MSAP identifier has changed.

   2) That the incoming LLDPDU contains an MSAP identifier requiring creation of a new MIB structure in the LLDP remote systems MIB to receive the information in the current LLDPDU.

   3) That information in the LLDP remote systems MIB associated with the MSAP identifier has been deleted.

g) **tooManyNeighbors:** This variable indicates that there is insufficient space in the LLDP remote systems MIB to store information from all connected active remote ports (see 10.3.4).

10.5.5.2 .Receive state machine procedures

10.5.5.2.1 mibDeleteObjects ()

The mibDeleteObjects () procedure deletes all information in the LLDP remote systems MIB associated with the MSAP identifier if an LLDPDU is received with an rxTTL value of zero (see 10.3.2) or the timing counter rxInfoTTL expires. (see 10.3.6).

10.5.5.2.2 mibUpdateObjects ()

The mibUpdateObjects () procedure updates the MIB objects corresponding to the TLVs contained in the received LLDPDU for the LLDP remote system indicated by the LLDP remote systems update process defined in 10.3.5.

NOTE—To avoid a race condition, the flag variable somethingChangedRemote is not set to TRUE until after the information in the LLDP remote systems MIB has been updated.

10.5.5.2.3 rxInitializeLLDP ()

The rxInitializeLLDP () procedure initializes the LLDP receive module as defined in 10.1.2.

10.5.5.2.4 rxProcessFrame ()

The rxProcessFrame () procedure:

a) Strips the protocol identification fields from the received frame and validates the TLVs contained in the LLDPDU as defined in 10.3.1 and 10.3.2.

b) Determines whether or not a MIB update may be required as defined in 10.3.3.

   1) If an update is required and sufficient space is available to store the LLDPDU information in the LLDP remote systems MIB, the control variable rxChanges is set to TRUE.

   2) If an update is not required, the control variable rxChanges is set to FALSE.

c) If sufficient space is not available, determines whether to discard the incoming LLDPDU from a new neighbor or to delete information from an existing neighbor that is already in the LLDP remote systems MIB, as defined in 10.3.4. The tooManyNeighborsTimer and the tooManyNeighbors flag variable are both set during this process.

NOTES

1—The variable badFrame is set to FALSE in the receive state machine state RX_FRAME before entering the procedure rxProcessFrame(). It is set to TRUE by rxProcessFrame() if the LLDPDU fails validation (see 10.3.2).

2—The flag variable tooManyNeighbors is automatically reset when the tooManyNeighborsTimer expires.

10.5.5.3 Receive state machine diagram

The receive state machine shown in Figure 10-2 is defined on a per-port basis.

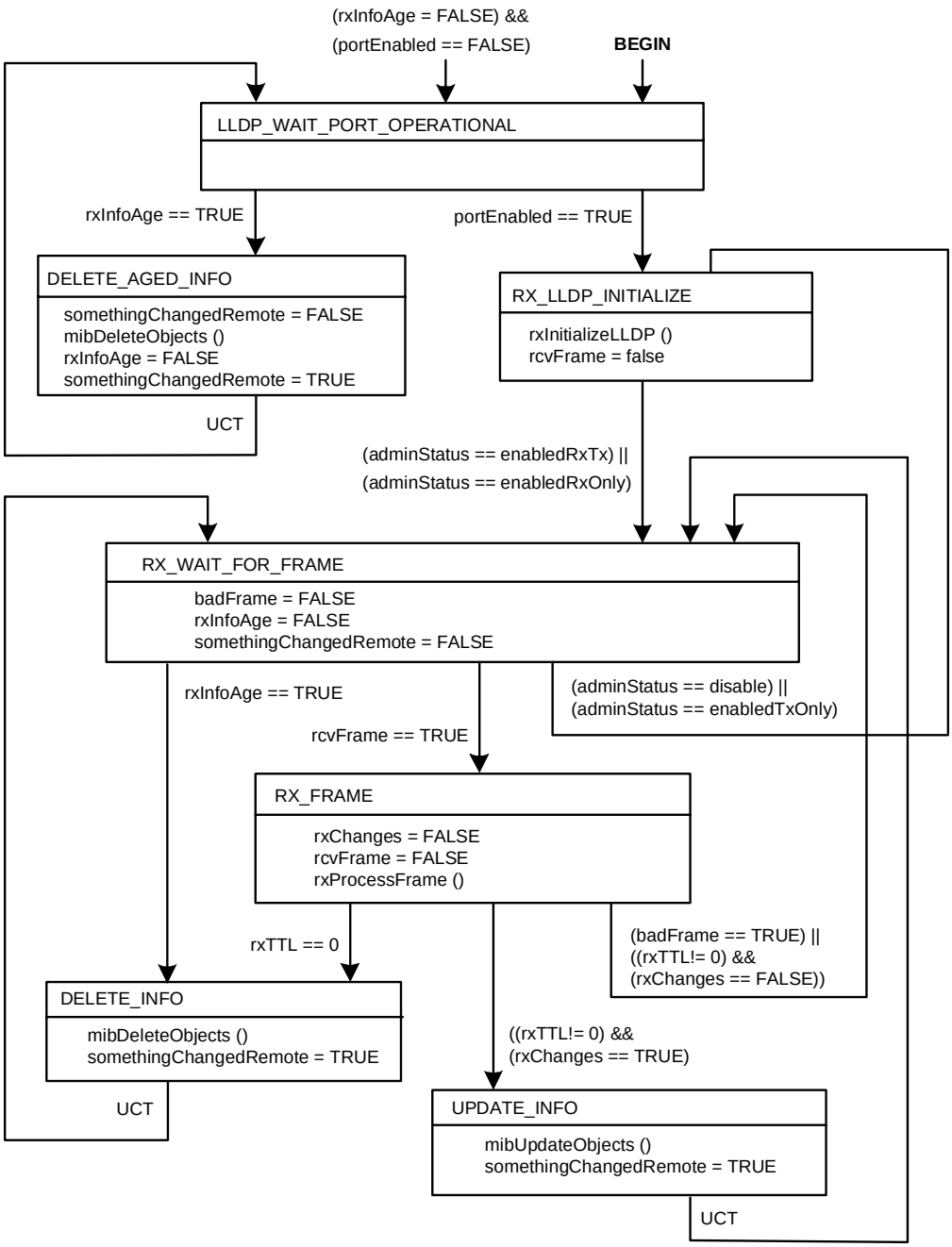

Figure 10-2—Receive state machine

11. LLDP management

This clause defines the set of managed objects and their functionality that allow administrative configuration and monitoring of LLDP operation.

11.1 Data storage and retrieval

LLDP agents need to have a place to store both information about the local system and information they have received about remote systems. Data storage and retrieval capability to support the functionality defined in Clause 8, Clause 9, Clause 10, and Clause 11 shall be provided. No particular implementation is implied.

11.2 The LLDP manager's responsibilities:

The LLDP manager has the following responsibilities:

a) Starting the transmit and receive state machines.

b) Providing a means for the network manager to select TLVs to be included in outgoing LLDPDUs.

c) Extracting the necessary information from the LLDP local system MIB and constructing the individual TLVs selected for insertion into the LLDPDU.

d) Prepending appropriate addressing and LLDP Ethertype to the LLDPDU before submitting the MA_UNITDATA.request for frame transmission.

e) Updating the LLDP remote systems MIB and monitoring for MIB object adds, deletions, and value changes.

f) Maintaining operational statistics.

11.2.1 Protocol initialization management

Protocol initialization consists of:

a) Retrieving non-volatile configuration values for the LLDP local system MIB.

b) Assigning default or management assigned values to LLDP configuration variables.

c) Loading physical topology information into their associated LLDP local system MIB objects.

11.2.2 TLV selection management

TLV selection management consists of providing the network manager with the means to select which specific TLVs are enabled for inclusion in an LLDPDU. The following LLDP variables cross reference to LLDP local systems configuration MIB tables indicating which specific TLVs are enabled for the particular port(s) on the system. The specific port(s) through which each TLV is enabled for transmission may be set (or reset) by the network manager:

a) **mibBasicTLVsTxEnable:** This variable lists the single-instance-use basic management TLVs, each with a bit map indicating the system ports through which the referenced TLV is enabled for transmission.

b) **mibMgmtAddrInstanceTxEnable:** This variable lists the different management addresses (by subtype) that are defined for the system, each with a bit map indicating the system ports through which the particular management address/subtype TLV is enabled for transmission.

NOTE—Implementers of new TLVs should be aware that provision needs to be made to allow similar network management selection of new TLVs and that doing so will require linkage to the LLDP MIB, regardless of whether or not the TLV is part of the basic management set or part of an Organizationally Specific TLV set.

11.2.3 Transmission management

Transmission management consists of:

a) Monitoring both somethingChangedLocal and txTTR to determine when a new transmission cycle is required.

b) Extracting the appropriate LLDP local system MIB information for the three mandatory TLVs and inserting them at the beginning of the LLDPDU in proper format order.

c) Extracting the appropriate LLDP local system MIB information for the selected optional TLVs and inserting them into the LLDPDU.

d) Appending an End Of LLDPDU TLV after the last optional TLV in the LLDPDU.

e) Maintaining length control during LLDPDU construction to ensure that the TLVs do not exceed the maximum length allowed for the LLDPDU.

f) Submitting the frame for transmission.

11.2.4 Reception management

Reception management consists of:

a) Receiving and parsing the incoming LLDPDUs.

b) Validating, and checking the types of the first three TLVs to ensure that they are the required type and in LLDPDU format order.

c) Validating optional TLVs and extracting information values.

d) Checking whether or not the current LLDPDU represents a new MSAP identifier.

e) Monitoring whether or not there is sufficient space available in the LLDP remote systems MIB for all active neighbors.

f) Arbitrating which information is to be discarded in cases where insufficient space is available in the LLDP remote systems MIB for all active neighbors.

g) Checking whether or not the received information represents a status or value change to the existing MIB object.

h) Updating remote systems MIB objects as necessary.

11.2.5 Performance management

Performance management consists of:

a) Monitoring the LLDP local system MIB update activities for status or value changes to selected MIB objects and:

   1) Setting the variable somethingChangedLocal to TRUE whenever a status/value change occurs.

   2) Initiating a new transmit cycle if the txDelayWhile timer has expired.

b) Monitoring the txTTR timer for countdown expiration and initiating a new transmit cycle if the txDelayWhile timer has expired.

c) Monitoring the rxInfoTTL timer for countdown expiration and:

   1) Deleting the associated objects from the LLDP remote systems MIB whenever the timing counter expires.

   2) Setting the variable somethingChangedRemote associated with the MSAP identifier to TRUE.

d) Monitoring rxTTL in the incoming LLDPDUs for shutdown indication and:

   1) Deleting the associated objects from the LLDP remote systems MIB whenever rxTTL = 0.

   2) Setting the variable somethingChangedRemote associated with the MSAP identifier to TRUE.

e) Monitoring the "tooManyNeighbors" process to determine whether an existing neighbor's information needs to be deleted and:
   1) Deleting the objects associated with a selected MSAP identifier from the LLDP remote systems MIB whenever existing information is selected to be deleted.
   2) Setting the variable somethingChangedRemote associated with the MSAP identifier to TRUE.

f) Monitoring the tooManyNeighborsTimer to determine when there is not sufficient space available to accommodate information from all active neighbors and setting the variable tooManyNeighbors associated with the port to FALSE when the tooManyNeighborsTimer expires.

g) Notifying the IETF MIB managers of the optional MIB modules whenever the variables somethingChangedLocal or somethingChangedRemote become TRUE.

h) Maintaining operational statistics regarding the LLDP frames sent and received.

11.3 Managed objects

Managed objects model the semantics of management operations. Operations upon a managed object supply information concerning, or facilitate control over, the process or entity associated with that managed object.

Management of LLDP is described in terms of the managed resources that are associated with individual TLVs and that support frame transmission and reception.

11.4 Data types

This subclause specifies the semantics of operations independent of their encoding in management protocol. The data types of the parameters of operations are defined for that specification.

The following data types are used:

a) Boolean.

b) Enumerated, for a collection of named values.

c) Unsigned, for all parameters specified as "number of" some quantity.

d) MAC address.

e) Time interval, an Unsigned value representing a positive integral number of seconds for all time out parameters.

f) Counter, for all parameters specified as a "count" of some quantity (all counters increment and wrap with a modulus of 2 to the power 32).

11.5 LLDP variables

LLDP managed objects fall into the following categories:

a) Status/control variables necessary for operation of the protocol.

b) Variables that accumulate operational statistics.

c) Variables that are required by the particular TLVs.

11.5.1 LLDP operational status and control

a) Global parameters and variables:
   1) **adminStatus:** The authority that controls whether or not a local LLDP agent is enabled for transmit and receive, transmit only, or receive only; or is disabled (10.5.1).

b) Transmit state machine parameters and variables:

1) **msgTxHold:** A multiplier on msgTxInterval used to compute the TTL value of txTTL (10.5.3.3).
2) **msgTxInterval:** The interval between successive transmit cycles (10.5.3.3).
3) **reinitDelay:** The delay after adminStatus becomes 'disable' before re-initialization is attempted (10.5.3.3).
4) **txDelay:** The minimum delay between successive LLDP frame transmissions (10.5.3.3).

c) Receive state machine parameters and variables:

1) **somethingChangedRemote:** An indication that the status/value of one or more selected objects in the LLDP remote systems MIB has changed or that all objects associated with a particular MSAP identifier have been deleted (10.5.5.1).
2) **tooManyNeighbors:** An indication that there is insufficient space in the LLDP remote systems MIB to store information from all active neighbors (10.5.5.1).

11.5.2 LLDP operational statistics counters

The following counters provide operational statistics on a per port basis:

a) Transmission counter:

1) **statsFramesOutTotal**: A count of all LLDP frames transmitted through the port (10.5.2).

b) Reception counters:

1) **statsAgeoutsTotal:** A count of the times that a neighbor's information is deleted from the LLDP remote systems MIB because of rxInfoTTL timer expiration (10.5.2).
2) **statsFramesDiscardedTotal:** A count of all LLDPDUs received and then discarded (10.5.2).
3) **statsFramesInErrorsTotal:** A count of all LLDPDUs received at the port with one or more detectable errors 10.5.2).
4) **statsFramesInTotal:** A count of all LLDP frames received at the port (10.5.2).
5) **statsTlvsDiscardedTotal:** A count of all TLVs received at the port and discarded for any reason (10.5.2).
6) **statsTLVsUnrecognizedTotal:** This counter provides a count of all TLVs not recognized by the receiving LLDP local agent (10.5.2).

11.5.3 TLV required variables

Variables in this category are defined by the requirements of the particular TLVs. They are maintained with reference to the local system in the LLDP local system MIB; and with reference to the remote system, in the LLDP remote systems MIB. TLV variables are outputs from the local LLDP agent and inputs to the remote LLDP agent.

Variables that pertain to basic set TLVs are listed below. Variables pertaining to Organizationally Specific TLVs are listed in Annex F for IEEE 802.1 defined extensions and in Annex F for IEEE 802.3 defined extensions.

11.5.3.1 Chassis ID TLV objects

a) **chassis ID subtype:** The type of identifier used for the chassis (see 9.5.2.2).
b) **chassis ID:** The identification assigned to the chassis containing the port (see 9.5.2.3).

11.5.3.2 Port ID TLV objects

a) **port ID subtype:** The type of identifier used for the port (see 9.5.3.2).

b) **port ID:** The identification assigned to the port (see 9.5.3.3).

11.5.3.3 Port description TLV object

a) **port description:** The port's description (see 9.5.5.2).

11.5.3.4 System name TLV object

a) **system name:** The system's assigned name (see 9.5.6.2).

11.5.3.5 System description TLV object

a) **system description:** The system's description (see 9.5.7.2).

11.5.3.6 System capabilities TLV objects

a) **system capabilities:** The primary capabilities of the system (see 9.5.8.1).

b) **enabled capabilities:** The system's enabled capabilities (see 9.5.8.2).

11.5.3.7 Management address TLV objects

a) **management address length:** The length of the management address (see 9.5.9.2).

b) **management address subtype:** The management address type (see 9.5.9.3).

c) **management address:** The management address (see 9.5.9.4).

d) **interface numbering subtype:** The interface type (see 9.5.9.5).

e) **interface number:** The interface number (see 9.5.9.6).

f) **OID length:** The object identifier length (see 9.5.9.7).

g) **OID:** The object identifier (see 9.5.9.8).

11.5.4 Relationship between LLDP variables and LLDP managed objects

Table 11-1 lists the relationship both between LLDP operational status/control variables and their corresponding LLDP CONFIG objects and between LLDP operational statistics variables and their corresponding LLDP STATS objects.

Table 11-1—LLDP variable/LLDP MIB object cross reference

MIB object category	LLDP variable	LLDP MIB object
LLDP CONFIG	adminStatus	lldpPortConfigAdminStatus
	msgTxHold	lldpMessageTxHoldMultiplier
	msgTxInterval	lldpMessageTxInterval
	reinitDelay	lldpReinitDelay
	txDelay	lldpTxDelay
BASIC TLV SELECTION	mibBasicTLVsTxEnable	lldpPortConfigTLVsTxEnable
	mibMgmtAddrInstanceTxEnable	lldpManAddrPortsTxEnable
LLDP STATS	statsAgeoutsTotal	lldpStatsRxPortAgeoutsTotal
	statsFramesDiscardedTotal	lldpStatsRxPortFramesDiscardedTotal
	statsFramesInErrorsTotal	lldpStatsRxPortFramesErrors
	statsFramesInTotal	lldpStatsRxPortFramesTotal
	statsFramesOutTotal	lldpStatsTxPortFramesTotal
	statsTLVsDiscardedTotal	lldpStatsRxPortTLVsDiscardedTotal
	statsTLVsUnrecognizedTotal	lldpStatsRxPortTLVsUnrecognizedTotal

Table 11-2 lists the relationship between the basic TLV variables and their corresponding LLDP local system MIB objects.

Table 11-2—Basic TLV variable/local system MIB object cross references

TLV name	TLV variable	LLDP local system MIB object
Chassis ID	chassis ID subtype	lldpLocChassisIdSubtype
	chassis ID	lldpLocChassisId
Port ID	port subtype	lldpLocPortIdSubtype
	port ID	lldpLocPortId_
Port Description	port description	lldpLocPortDesc_
System Name	system name	lldpLocSysName
System Description	system description	lldpLocSysDesc
System Capabilities	system capabilities	lldpLocSysCapSupported
	enabled capabilities	lldpLocSysCapEnabled
Management Address	management address length	lldpLocManAddrLen
	management address subtype	lldpLocManAddrSubtype
	management address	lldpLocManAddr
	interface numbering subtype	lldpLocManAddrIfSubtype
	interface number	lldpLocManAddrIfId
	OID	lldpLocManAddrOID

Table 11-3 lists the relationship between the basic TLV variables and their corresponding LLDP remote systems MIB objects.

Table 11-3—Basic TLV variable/remote systems MIB object cross references

TLV name	TLV variable	LLDP remote system MIB object
Chassis ID	chassis ID subtype	lldpRemChassisSubtype
	chassis ID	lldpRemChassisId
Port ID	port subtype	lldpRemPortIdSubtype
	port ID	lldpRemPortId
Port Description	port description	lldpRemPortDesc
System Name	system name	lldpRemSysName
System Description	system description	lldpRemSysDesc
System Capabilities	system capabilities	lldpRemSysCapSupported
	enabled capabilities	lldpRemSysCapEnabled
Management Address	management address subtype	lldpRemManAddrSubtype
	management address	lldpRemManAddr
	interface numbering subtype	lldpRemManAddrIfSubtype
	interface number	lldpRemManAddrIfId
	OID	lldpRemManAddrOID

12. LLDP MIB definitions

This clause defines the LLDP basic MIB for use with SNMP in TCP/IP based internets. In particular, it defines objects for managing the operation of LLDP based on the specifications of Clause 8, Clause 9, Clause 10, and Clause 11.

12.1 LLDP MIB design philosophy

LLDP MIBs are designed to operate in a manner consistent with the principles of the Internet-Standard Management Framework, which describes the separation of a data modeling language (for example, SMIv2) from content specific data models (for example the LLDP remote systems MIB), and from messages and protocol operations used to manipulate the data (for example SNMPv3). Managed objects are accessed via a virtual information store (the MIB). MIB objects are generally accessed through SNMP. Objects in the MIB are defined using the mechanisms of the Structure of Management Information (SMI). For an overview of this structure, see section 7 of IETF RFC 3410.

The LLDP MIB consists of two types of MIB modules, the mandatory basic MIB defined in this clause and from zero to n optional organizationally specific MIB extensions such as the IEEE 802.1 MIB in Annex F and the IEEE 802.3 MIB in Annex G.

Each MIB module is divided into two major sections as shown in Figure 12-1 to allow selective MIB support for the particular operating mode (transmit only, receive only, or both transmit and receive) being implemented.

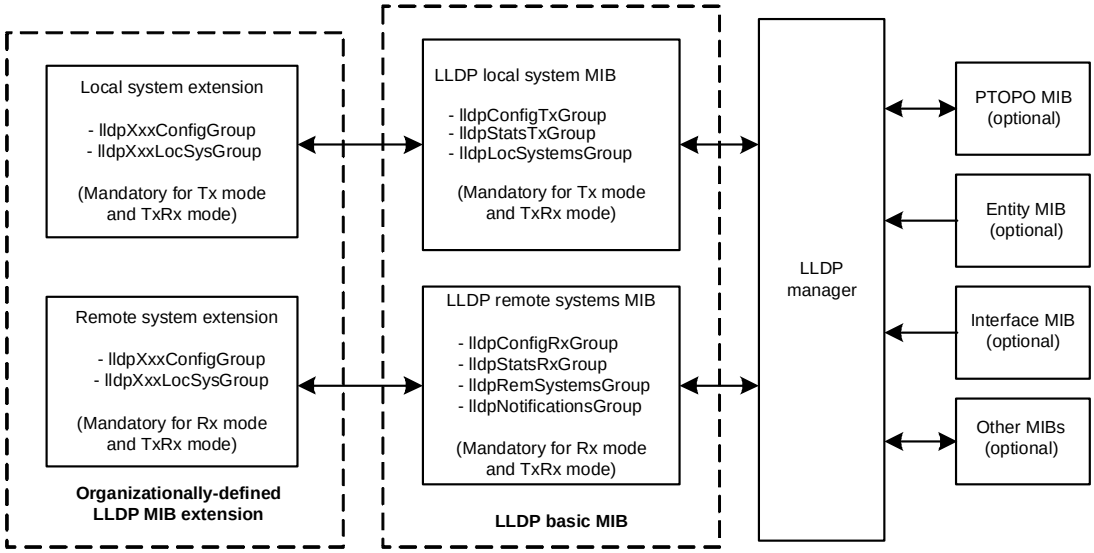

Figure 12-1—LLDP MIB block diagram

Table 12-1 summarizes the particular object groups that are required for each operating mode.The basic MIB shall comply with the MIB conformance section for the particular operating being supported.

Table 12-1—MIB object group operating mode applicability

MIB group	Rx mode	Tx mode	TxRx mode
lldpConfigRxGroup	M*	—	M
lldpConfigTxGroup	—	M	M
lldpStatsRxGroup	M	—	M
lldpStatsTxGroup	—	M	M
lldpLocSystemsGroup	—	M	M
lldpRemSystemsGroup	M	—	M
lldpNotificationsGroup	M	—	M

*Mandatory

12.2 LLDP MIB module [9,10]

In the following MIB module, should any discrepancy between the DESCRIPTION text and the corresponding definition in Clause 10 and Clause 11 occur, the definition in Clause 10 and Clause 11 shall take precedence.

```
LLDP-MIB DEFINITIONS ::= BEGIN

IMPORTS
    MODULE-IDENTITY, OBJECT-TYPE, Integer32, Counter32, NOTIFICATION-TYPE
        FROM SNMPv2-SMI
    TEXTUAL-CONVENTION, TimeStamp, TruthValue
        FROM SNMPv2-TC
    SnmpAdminString
        FROM SNMP-FRAMEWORK-MIB
    MODULE-COMPLIANCE, OBJECT-GROUP, NOTIFICATION-GROUP
        FROM SNMPv2-CONF
    TimeFilter, ZeroBasedCounter32
        FROM RMON2-MIB
    AddressFamilyNumbers
        FROM IANA-ADDRESS-FAMILY-NUMBERS-MIB;

lldpMIB MODULE-IDENTITY
    LAST-UPDATED "200505060000Z" -- May 06, 2005
    ORGANIZATION "IEEE 802.1 Working Group"
    CONTACT-INFO
            "  WG-URL: http://grouper.ieee.org/groups/802/1/index.html
             WG-EMail: stds-802-1@ieee.org

               Contact: Paul Congdon
                Postal: Hewlett-Packard Company
                        8000 Foothills Blvd.
                        Roseville, CA 95747
                        USA
```

[9]*Copyright release for MIBs:* Users of this standard may freely reproduce the MIB contained in this subclause so that it can be used for its intended purpose.

[10]An ASCII version of this MIB module can be obtained by Web browser from the IEEE 802.1 Website at http://www.ieee802.org/1/pages/MIBS.html.

```
                Tel: +1-916-785-5753
              E-mail: paul_congdon@hp.com"
    DESCRIPTION
            "Management Information Base module for LLDP configuration,
            statistics, local system data and remote systems data
            components.

            Copyright (C) IEEE (2005). This version of this MIB module
            is published as subclause 12.1 of IEEE Std 802.1AB™-2005;
            see the standard itself for full legal notices."
    REVISION "200505060000Z" -- May 06, 2005

    DESCRIPTION
            "Published as part of IEEE Std 802.1AB-2005 initial version."
   ::= { iso std(0) iso8802(8802) ieee802dot1(1) ieee802dot1mibs(1) 2 }

lldpNotifications            OBJECT IDENTIFIER ::= { lldpMIB 0 }
lldpObjects                  OBJECT IDENTIFIER ::= { lldpMIB 1 }
lldpConformance              OBJECT IDENTIFIER ::= { lldpMIB 2 }

--
-- LLDP MIB Objects
--

lldpConfiguration            OBJECT IDENTIFIER ::= { lldpObjects 1 }
lldpStatistics               OBJECT IDENTIFIER ::= { lldpObjects 2 }
lldpLocalSystemData          OBJECT IDENTIFIER ::= { lldpObjects 3 }
lldpRemoteSystemsData        OBJECT IDENTIFIER ::= { lldpObjects 4 }
lldpExtensions               OBJECT IDENTIFIER ::= { lldpObjects 5 }

--
-- ********************************************************
--
-- Textual Conventions
--
-- ********************************************************

LldpChassisIdSubtype ::= TEXTUAL-CONVENTION
    STATUS      current
    DESCRIPTION
            "This TC describes the source of a chassis identifier.

            The enumeration 'chassisComponent(1)' 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)').

            The enumeration 'interfaceAlias(2)' represents a chassis
            identifier based on the value of ifAlias object (defined in
            IETF RFC 2863) for an interface on the containing chassis.

            The enumeration 'portComponent(3)' 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.

            The enumeration 'macAddress(4)' 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 802-2001.

            The enumeration 'networkAddress(5)' 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.

            The enumeration 'interfaceName(6)' represents a chassis
            identifier based on the value of ifName object (defined in
            IETF RFC 2863) for an interface on the containing chassis.

            The enumeration 'local(7)' represents a chassis identifier
            based on a locally defined value."
    SYNTAX  INTEGER {
            chassisComponent(1),
            interfaceAlias(2),
            portComponent(3),
            macAddress(4),
            networkAddress(5),
            interfaceName(6),
            local(7)
    }

LldpChassisId ::= TEXTUAL-CONVENTION
    STATUS      current
    DESCRIPTION
            "This TC describes the format of a chassis identifier string.
            Objects of this type are always used with an associated
            LldpChassisIdSubtype object, which identifies the format of
            the particular LldpChassisId object instance.

            If the associated LldpChassisIdSubtype object has a value of
            'chassisComponent(1)', 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 LldpChassisIdSubtype object has a value
            of 'interfaceAlias(2)', 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 LldpChassisIdSubtype object has a value
            of 'portComponent(3)', 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 LldpChassisIdSubtype object has a value of
            'macAddress(4)', 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 802-2001.

            If the associated LldpChassisIdSubtype object has a value of
            'networkAddress(5)', 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 LldpChassisIdSubtype object has a value
            of 'interfaceName(6)', 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 LldpChassisIdSubtype object has a value of
            'local(7)', then this string identifies a locally assigned
            Chassis ID."
    SYNTAX      OCTET STRING (SIZE (1..255))

LldpPortIdSubtype ::= TEXTUAL-CONVENTION
    STATUS      current
    DESCRIPTION
            "This TC describes the source of a particular type of port
            identifier used in the LLDP MIB.

            The enumeration 'interfaceAlias(1)' represents a port
            identifier based on the ifAlias MIB object, defined in IETF
            RFC 2863.

            The enumeration 'portComponent(2)' 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.

            The enumeration 'macAddress(3)' 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 802-2001).

            The enumeration 'networkAddress(4)' represents a port
            identifier based on a network address, detected by the agent
            and associated with a particular port.

            The enumeration 'interfaceName(5)' represents a port
            identifier based on the ifName MIB object, defined in IETF
            RFC 2863.

            The enumeration 'agentCircuitId(6)' 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.

            The enumeration 'local(7)' represents a port identifier
            based on a value locally assigned."
```

```
    SYNTAX  INTEGER {
            interfaceAlias(1),
            portComponent(2),
            macAddress(3),
            networkAddress(4),
            interfaceName(5),
            agentCircuitId(6),
            local(7)
    }

LldpPortId ::= TEXTUAL-CONVENTION
    STATUS      current
    DESCRIPTION
            "This TC describes the format of a port identifier string.
            Objects of this type are always used with an associated
            LldpPortIdSubtype object, which identifies the format of the
            particular LldpPortId object instance.

            If the associated LldpPortIdSubtype object has a value of
            'interfaceAlias(1)', 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 LldpPortIdSubtype object has a value of
            'portComponent(2)', 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 LldpPortIdSubtype object has a value of
            'macAddress(3)', 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 802-2001).

            If the associated LldpPortIdSubtype object has a value of
            'networkAddress(4)', 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 LldpPortIdSubtype object has a value of
            'interfaceName(5)', 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 LldpPortIdSubtype object has a value of
            'agentCircuitId(6)', then this string identifies a agent-local
            identifier of the circuit (defined in RFC 3046).

            If the associated LldpPortIdSubtype object has a value of
            'local(7)', then this string identifies a locally
            assigned port ID."
    SYNTAX      OCTET STRING (SIZE (1..255))

LldpManAddrIfSubtype ::= TEXTUAL-CONVENTION
    STATUS      current
```



```
    DESCRIPTION
            "This TC describes the basis of a particular type of
            interface associated with the management address.

            The enumeration 'unknown(1)' represents the case where the
            interface is not known.

            The enumeration 'ifIndex(2)' represents interface identifier
            based on the ifIndex MIB object.

            The enumeration 'systemPortNumber(3)' represents interface
            identifier based on the system port numbering convention."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.9.5"

    SYNTAX  INTEGER {
            unknown(1),
            ifIndex(2),
            systemPortNumber(3)
    }

LldpManAddress ::= TEXTUAL-CONVENTION
    STATUS      current
    DESCRIPTION
            "The value of a management address associated with the LLDP
            agent that may be used to reach higher layer entities to
            assist discovery by network management.

            It should be noted that appropriate security credentials,
            such as SNMP engineId, may be required to access the LLDP
            agent using a management address. These necessary credentials
            should be known by the network management and the objects
            associated with the credentials are not included in the
            LLDP agent."
    SYNTAX      OCTET STRING (SIZE (1..31))

LldpSystemCapabilitiesMap ::= TEXTUAL-CONVENTION
    STATUS      current
    DESCRIPTION
            "This TC describes the system capabilities.

            The bit 'other(0)' indicates that the system has capabilities
            other than those listed below.

            The bit 'repeater(1)' indicates that the system has repeater
            capability.

            The bit 'bridge(2)' indicates that the system has bridge
            capability.

            The bit 'wlanAccessPoint(3)' indicates that the system has
            WLAN access point capability.

            The bit 'router(4)' indicates that the system has router
            capability.

            The bit 'telephone(5)' indicates that the system has telephone
            capability.
```

```
            The bit 'docsisCableDevice(6)' indicates that the system has
            DOCSIS Cable Device capability (IETF RFC 2669 & 2670).

            The bit 'stationOnly(7)' indicates that the system has only
            station capability and nothing else."
    SYNTAX  BITS {
            other(0),
            repeater(1),
            bridge(2),
            wlanAccessPoint(3),
            router(4),
            telephone(5),
            docsisCableDevice(6),
            stationOnly(7)
    }

LldpPortNumber ::= TEXTUAL-CONVENTION
    DISPLAY-HINT "d"
    STATUS     current
    DESCRIPTION
            "Each port contained in the chassis (that is known to the
            LLDP agent) is uniquely identified by a port number.

            A port number has no mandatory relationship to an
            InterfaceIndex object (of the interfaces MIB, IETF RFC 2863).
            If the LLDP agent is a IEEE 802.1D, IEEE 802.1Q bridge, the
            LldpPortNumber will have the same value as the dot1dBasePort
            object (defined in IETF RFC 1493) associated corresponding
            bridge port. If the system hosting LLDP agent is not an
            IEEE 802.1D or an IEEE 802.1Q bridge, the LldpPortNumber
            will have the same value as the corresponding interface's
            InterfaceIndex object.

            Port numbers should be in the range of 1 and 4096 since a
            particular port is also represented by the corresponding
            port number bit in LldpPortList."
    SYNTAX Integer32(1..4096)

LldpPortList ::= TEXTUAL-CONVENTION
    STATUS      current
    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"
    SYNTAX  OCTET STRING(SIZE(0..512))

--
-- ********************************************************
--
--                 L L D P    C O N F I G
--
```



```
-- ************************************************************
--

lldpMessageTxInterval OBJECT-TYPE
    SYNTAX      Integer32(5..32768)
    UNITS       "seconds"
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
            "The interval at which LLDP frames are transmitted on
            behalf of this LLDP agent.

            The default value for lldpMessageTxInterval object is
            30 seconds.

            The value of this object must be restored from non-volatile
            storage after a re-initialization of the management system."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.5.3.3"
    DEFVAL     { 30 }
    ::= { lldpConfiguration 1 }

lldpMessageTxHoldMultiplier OBJECT-TYPE
    SYNTAX      Integer32(2..10)
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
            "The time-to-live value expressed as a multiple of the
            lldpMessageTxInterval object. The actual time-to-live value
            used in LLDP frames, transmitted on behalf of this LLDP agent,
            can be expressed by the following formula: TTL = min(65535,
            (lldpMessageTxInterval * lldpMessageTxHoldMultiplier)) For
            example, if the value of lldpMessageTxInterval is '30', and
            the value of lldpMessageTxHoldMultiplier is '4', then the
            value '120' is encoded in the TTL field in the LLDP header.

            The default value for lldpMessageTxHoldMultiplier object is 4.

            The value of this object must be restored from non-volatile
            storage after a re-initialization of the management system."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.5.3.3"
    DEFVAL      { 4 }
    ::= { lldpConfiguration 2 }

lldpReinitDelay OBJECT-TYPE
    SYNTAX      Integer32(1..10)
    UNITS       "seconds"
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
            "The lldpReinitDelay indicates the delay (in units of
            seconds) from when lldpPortConfigAdminStatus object of a
            particular port becomes 'disabled' until re-initialization
            will be attempted.

            The default value for lldpReintDelay object is two seconds.

            The value of this object must be restored from non-volatile
```

```
            storage after a re-initialization of the management system."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.5.3.3"
    DEFVAL      { 2 }
    ::= { lldpConfiguration 3 }

lldpTxDelay OBJECT-TYPE
    SYNTAX      Integer32(1..8192)
    UNITS       "seconds"
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
            "The lldpTxDelay indicates the delay (in units
            of seconds) between successive LLDP frame transmissions
            initiated by value/status changes in the LLDP local systems
            MIB. The recommended value for the lldpTxDelay is set by the
            following formula:

               1 <= lldpTxDelay <= (0.25 * lldpMessageTxInterval)

            The default value for lldpTxDelay object is two seconds.

            The value of this object must be restored from non-volatile
            storage after a re-initialization of the management system."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.5.3.3"
    DEFVAL      { 2 }
    ::= { lldpConfiguration 4 }

lldpNotificationInterval OBJECT-TYPE
    SYNTAX      Integer32(5..3600)
    UNITS       "seconds"
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
            "This object controls the transmission of LLDP notifications.

            the agent must not generate more than one lldpRemTablesChange
            notification-event in the indicated period, where a
            'notification-event' is the transmission of a single
            notification PDU type to a list of notification destinations.
            If additional changes in lldpRemoteSystemsData object
            groups occur within the indicated throttling period,
            then these trap- events must be suppressed by the
            agent. An NMS should periodically check the value of
            lldpStatsRemTableLastChangeTime to detect any missed
            lldpRemTablesChange notification-events, e.g. due to
            throttling or transmission loss.

            If notification transmission is enabled for particular ports,
            the suggested default throttling period is 5 seconds.

            The value of this object must be restored from non-volatile
            storage after a re-initialization of the management system."
    DEFVAL { 5 }
    ::= { lldpConfiguration 5 }

--
-- lldpPortConfigTable: LLDP configuration on a per port basis
```



```
--

lldpPortConfigTable   OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpPortConfigEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The table that controls LLDP frame transmission on individual
            ports."
    ::= { lldpConfiguration 6 }

lldpPortConfigEntry   OBJECT-TYPE
    SYNTAX      LldpPortConfigEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "LLDP configuration information for a particular port.
            This configuration parameter controls the transmission and
            the reception of LLDP frames on those ports whose rows are
            created in this table."
     INDEX  { lldpPortConfigPortNum }
    ::= { lldpPortConfigTable 1 }

LldpPortConfigEntry ::= SEQUENCE {
      lldpPortConfigPortNum            LldpPortNumber,
      lldpPortConfigAdminStatus        INTEGER,
      lldpPortConfigNotificationEnable TruthValue,
      lldpPortConfigTLVsTxEnable       BITS }

lldpPortConfigPortNum   OBJECT-TYPE
    SYNTAX      LldpPortNumber
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The index value used to identify the port component
            (contained in the local chassis with the LLDP agent)
            associated with this entry.

            The value of this object is used as a port index to the
            lldpPortConfigTable."
    ::= { lldpPortConfigEntry 1 }

lldpPortConfigAdminStatus  OBJECT-TYPE
    SYNTAX INTEGER {
       txOnly(1),
       rxOnly(2),
       txAndRx(3),
       disabled(4)
    }
    MAX-ACCESS read-write
    STATUS     current
    DESCRIPTION
            "The administratively desired status of the local LLDP agent.

            If the associated lldpPortConfigAdminStatus object has a
            value of 'txOnly(1)', then LLDP agent will transmit LLDP
            frames on this port and it will not store any information
            about the remote systems connected.
```

```
            If the associated lldpPortConfigAdminStatus object has a
            value of 'rxOnly(2)', then the LLDP agent will receive,
            but it will not transmit LLDP frames on this port.

            If the associated lldpPortConfigAdminStatus object has a
            value of 'txAndRx(3)', then the LLDP agent will transmit
            and receive LLDP frames on this port.

            If the associated lldpPortConfigAdminStatus object has a
            value of 'disabled(4)', then LLDP agent will not transmit or
            receive LLDP frames on this port. If there is remote systems
            information which is received on this port and stored in
            other tables, before the port's lldpPortConfigAdminStatus
            becomes disabled, then the information will naturally age out."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.5.1"
    DEFVAL  { txAndRx }
   ::= { lldpPortConfigEntry 2 }

lldpPortConfigNotificationEnable OBJECT-TYPE
    SYNTAX     TruthValue
    MAX-ACCESS read-write
    STATUS     current
    DESCRIPTION
            "The lldpPortConfigNotificationEnable controls, on a per
            port basis, whether or not notifications from the agent
            are enabled. The value true(1) means that notifications are
            enabled; the value false(2) means that they are not."
    DEFVAL  { false }
   ::= { lldpPortConfigEntry 3 }

lldpPortConfigTLVsTxEnable OBJECT-TYPE
    SYNTAX      BITS {
            portDesc(0),
            sysName(1),
            sysDesc(2),
            sysCap(3)
    }
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
            "The lldpPortConfigTLVsTxEnable, defined as a bitmap,
            includes the basic set of LLDP TLVs whose transmission is
            allowed on the local LLDP agent by the network management.
            Each bit in the bitmap corresponds to a TLV type associated
            with a specific optional TLV.

            It should be noted that the organizationally-specific TLVs
            are excluded from the lldpTLVsTxEnable bitmap.

            LLDP Organization Specific Information Extension MIBs should
            have similar configuration object to control transmission
            of their organizationally defined TLVs.

            The bit 'portDesc(0)' indicates that LLDP agent should
            transmit 'Port Description TLV'.

            The bit 'sysName(1)' indicates that LLDP agent should transmit
            'System Name TLV'.
```



```
            The bit 'sysDesc(2)' indicates that LLDP agent should transmit
            'System Description TLV'.

            The bit 'sysCap(3)' indicates that LLDP agent should transmit
            'System Capabilities TLV'.

            There is no bit reserved for the management address TLV type
            since transmission of management address TLVs are controlled
            by another object, lldpConfigManAddrTable.

            The default value for lldpPortConfigTLVsTxEnable object is
            empty set, which means no enumerated values are set.

            The value of this object must be restored from non-volatile
            storage after a re-initialization of the management system."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.2.1.1"
    DEFVAL  { { } }
    ::= { lldpPortConfigEntry 4 }


--
-- lldpManAddrConfigTxPortsTable : selection of management addresses
--                                 to be transmitted on a specified set
--                                 of ports.
--

lldpConfigManAddrTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpConfigManAddrEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The table that controls selection of LLDP management address
            TLV instances to be transmitted on individual ports."
    ::= { lldpConfiguration 7 }

lldpConfigManAddrEntry  OBJECT-TYPE
    SYNTAX      LldpConfigManAddrEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "LLDP configuration information that specifies the set
            of ports (represented as a PortList) on which the local
            system management address instance will be transmitted.

            This configuration object augments the lldpLocManAddrEntry,
            therefore it is only present along with the management
            address instance contained in the associated
            lldpLocManAddrEntry entry.

            Each active lldpConfigManAddrEntry must be restored from
            non-volatile and re-created (along with the corresponding
            lldpLocManAddrEntry) after a re-initialization of the
            management system."
    AUGMENTS { lldpLocManAddrEntry }
    ::= { lldpConfigManAddrTable 1 }

LldpConfigManAddrEntry  ::= SEQUENCE {
    lldpConfigManAddrPortsTxEnable LldpPortList
```

```
}

lldpConfigManAddrPortsTxEnable  OBJECT-TYPE
    SYNTAX        LldpPortList
    MAX-ACCESS    read-write
    STATUS        current
    DESCRIPTION
            "A set of ports that are identified by a PortList, in which
            each port is represented as a bit. The corresponding local
            system management address instance will be transmitted on the
            member ports of the lldpManAddrPortsTxEnable.

            The default value for lldpConfigManAddrPortsTxEnable object
            is empty binary string, which means no ports are specified
            for advertising indicated management address instance."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.2.1.1"
    DEFVAL  { ''H }     -- empty binary string
    ::= { lldpConfigManAddrEntry 1 }


--
--  ********************************************************
--
--                  L L D P    S T A T S
--
--  ********************************************************
--
-- LLDP Stats Group

lldpStatsRemTablesLastChangeTime OBJECT-TYPE
    SYNTAX      TimeStamp
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The value of sysUpTime object (defined in IETF RFC 3418)
            at the time an entry is created, modified, or deleted in the
            in tables associated with the lldpRemoteSystemsData objects
            and all LLDP extension objects associated with remote systems.

            An NMS can use this object to reduce polling of the
            lldpRemoteSystemsData objects."
    ::= { lldpStatistics 1 }

lldpStatsRemTablesInserts OBJECT-TYPE
    SYNTAX      ZeroBasedCounter32
    UNITS       "table entries"
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The number of times the complete set of information
            advertised by a particular MSAP has been inserted into tables
            contained in lldpRemoteSystemsData and lldpExtensions objects.

            The complete set of information received from a particular
            MSAP should be inserted into related tables. If partial
            information cannot be inserted for a reason such as lack
            of resources, all of the complete set of information should
            be removed.
```



```
            This counter should be incremented only once after the
            complete set of information is successfully recorded
            in all related tables. Any failures during inserting
            information set which result in deletion of previously
            inserted information should not trigger any changes in
            lldpStatsRemTablesInserts since the insert is not completed
            yet or in lldpStatsRemTablesDeletes, since the deletion
            would only be a partial deletion. If the failure was the
            result of lack of resources, the lldpStatsRemTablesDrops
            counter should be incremented once."
    ::= { lldpStatistics 2 }

lldpStatsRemTablesDeletes   OBJECT-TYPE
    SYNTAX      ZeroBasedCounter32
    UNITS       "table entries"
    MAX-ACCESS  read-only
    STATUS      current

    DESCRIPTION
            "The number of times the complete set of information
            advertised by a particular MSAP has been deleted from
            tables contained in lldpRemoteSystemsData and lldpExtensions
            objects.

            This counter should be incremented only once when the
            complete set of information is completely deleted from all
            related tables. Partial deletions, such as deletion of
            rows associated with a particular MSAP from some tables,
            but not from all tables are not allowed, thus should not
            change the value of this counter."
    ::= { lldpStatistics 3 }

lldpStatsRemTablesDrops  OBJECT-TYPE
    SYNTAX      ZeroBasedCounter32
    UNITS       "table entries"
    MAX-ACCESS  read-only

    STATUS      current
    DESCRIPTION
            "The number of times the complete set of information
            advertised by a particular MSAP could not be entered into
            tables contained in lldpRemoteSystemsData and lldpExtensions
            objects because of insufficient resources."
    ::= { lldpStatistics 4 }

lldpStatsRemTablesAgeouts   OBJECT-TYPE
    SYNTAX      ZeroBasedCounter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The number of times the complete set of information
            advertised by a particular MSAP has been deleted from tables
            contained in lldpRemoteSystemsData and lldpExtensions objects
            because the information timeliness interval has expired.

            This counter should be incremented only once when the complete
            set of information is completely invalidated (aged out)
            from all related tables. Partial aging, similar to deletion
```

```
            case, is not allowed, and thus, should not change the value
            of this counter."
    ::= { lldpStatistics 5 }

--
-- TX statistics
--

lldpStatsTxPortTable  OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpStatsTxPortEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "A table containing LLDP transmission statistics for
            individual ports. Entries are not required to exist in
            this table while the lldpPortConfigEntry object is equal to
            'disabled(4)'."
    ::= { lldpStatistics 6 }

lldpStatsTxPortEntry   OBJECT-TYPE
     SYNTAX      LldpStatsTxPortEntry
     MAX-ACCESS  not-accessible
     STATUS      current
     DESCRIPTION
             "LLDP frame transmission statistics for a particular port.
             The port must be contained in the same chassis as the
             LLDP agent.

             All counter values in a particular entry shall be
             maintained on a continuing basis and shall not be deleted
             upon expiration of rxInfoTTL timing counters in the LLDP
             remote systems MIB of the receipt of a shutdown frame from
             a remote LLDP agent.

             All statistical counters associated with a particular
             port on the local LLDP agent become frozen whenever the
             adminStatus is disabled for the same port."
     INDEX  { lldpStatsTxPortNum }
     ::= { lldpStatsTxPortTable 1 }

LldpStatsTxPortEntry ::= SEQUENCE {
      lldpStatsTxPortNum                LldpPortNumber,
      lldpStatsTxPortFramesTotal        Counter32
}

lldpStatsTxPortNum   OBJECT-TYPE
    SYNTAX      LldpPortNumber
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The index value used to identify the port component
            (contained in the local chassis with the LLDP agent)
            associated with this entry.

            The value of this object is used as a port index to the
            lldpStatsTable."
    ::= { lldpStatsTxPortEntry 1 }
lldpStatsTxPortFramesTotal  OBJECT-TYPE
    SYNTAX        Counter32
```

```
    MAX-ACCESS    read-only
    STATUS        current
    DESCRIPTION
            "The number of LLDP frames transmitted by this LLDP agent
            on the indicated port."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.5.2.1"
    ::= { lldpStatsTxPortEntry 2 }

--
-- RX statistics
--

lldpStatsRxPortTable  OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpRxStatsPortEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "A table containing LLDP reception statistics for individual
            ports. Entries are not required to exist in this table while
            the lldpPortConfigEntry object is equal to 'disabled(4)'."
    ::= { lldpStatistics 7 }

lldpStatsRxPortEntry   OBJECT-TYPE
     SYNTAX      LldpRxStatsPortEntry
     MAX-ACCESS  not-accessible
     STATUS      current
     DESCRIPTION
             "LLDP frame reception statistics for a particular port.
             The port must be contained in the same chassis as the
             LLDP agent.

             All counter values in a particular entry shall be
             maintained on a continuing basis and shall not be deleted
             upon expiration of rxInfoTTL timing counters in the LLDP
             remote systems MIB of the receipt of a shutdown frame from
             a remote LLDP agent.

             All statistical counters associated with a particular
             port on the local LLDP agent become frozen whenever the
             adminStatus is disabled for the same port."
     INDEX  { lldpStatsRxPortNum }
     ::= { lldpStatsRxPortTable 1 }

LldpRxStatsPortEntry ::= SEQUENCE {
      lldpStatsRxPortNum                   LldpPortNumber,
      lldpStatsRxPortFramesDiscardedTotal  Counter32,
      lldpStatsRxPortFramesErrors          Counter32,
      lldpStatsRxPortFramesTotal           Counter32,
      lldpStatsRxPortTLVsDiscardedTotal    Counter32,
      lldpStatsRxPortTLVsUnrecognizedTotal Counter32,
      lldpStatsRxPortAgeoutsTotal          ZeroBasedCounter32
}

lldpStatsRxPortNum   OBJECT-TYPE
    SYNTAX      LldpPortNumber
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
```

```
            "The index value used to identify the port component
            (contained in the local chassis with the LLDP agent)
            associated with this entry.

            The value of this object is used as a port index to the
            lldpStatsTable."
    ::= { lldpStatsRxPortEntry 1 }

lldpStatsRxPortFramesDiscardedTotal OBJECT-TYPE
    SYNTAX        Counter32
    MAX-ACCESS read-only
    STATUS     current
    DESCRIPTION
            "The number of LLDP frames received by this LLDP agent on
            the indicated port, and then discarded for any reason.
            This counter can provide an indication that LLDP header
            formating problems may exist with the local LLDP agent in
            the sending system or that LLDPDU validation problems may
            exist with the local LLDP agent in the receiving system."
   REFERENCE
            "IEEE Std 802.1AB-2005 10.5.2.2"
   ::= { lldpStatsRxPortEntry 2 }

lldpStatsRxPortFramesErrors  OBJECT-TYPE
    SYNTAX        Counter32
    MAX-ACCESS    read-only
    STATUS        current
    DESCRIPTION
            "The number of invalid LLDP frames received by this LLDP
            agent on the indicated port, while this LLDP agent is enabled."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.5.2.2"
    ::= { lldpStatsRxPortEntry 3 }

lldpStatsRxPortFramesTotal OBJECT-TYPE
    SYNTAX        Counter32
    MAX-ACCESS    read-only
    STATUS        current
    DESCRIPTION
            "The number of valid LLDP frames received by this LLDP agent
            on the indicated port, while this LLDP agent is enabled."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.5.2.2"
    ::= { lldpStatsRxPortEntry 4 }

lldpStatsRxPortTLVsDiscardedTotal OBJECT-TYPE
    SYNTAX        Counter32
    MAX-ACCESS    read-only
    STATUS        current
    DESCRIPTION
            "The number of LLDP TLVs discarded for any reason by this LLDP
            agent on the indicated port."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.5.2.2"
    ::= { lldpStatsRxPortEntry 5 }

lldpStatsRxPortTLVsUnrecognizedTotal  OBJECT-TYPE
    SYNTAX        Counter32
    MAX-ACCESS    read-only
```



```
    STATUS        current
    DESCRIPTION
            "The number of LLDP TLVs received on the given port that
            are not recognized by this LLDP agent on the indicated port.

            An unrecognized TLV is referred to as the TLV whose type value
            is in the range of reserved TLV types (000 1001 - 111 1110)
            in Table 9.1 of IEEE Std 802.1AB-2005. An unrecognized
            TLV may be a basic management TLV from a later LLDP version."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.5.2.2"
    ::= { lldpStatsRxPortEntry 6 }

lldpStatsRxPortAgeoutsTotal   OBJECT-TYPE
    SYNTAX      ZeroBasedCounter32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The counter that represents the number of age-outs that
            occurred on a given port. An age-out is the number of
            times the complete set of information advertised by a
            particular MSAP has been deleted from tables contained in
            lldpRemoteSystemsData and lldpExtensions objects because
            the information timeliness interval has expired.

            This counter is similar to lldpStatsRemTablesAgeouts, except
            that the counter is on a per port basis. This enables NMS to
            poll tables associated with the lldpRemoteSystemsData objects
            and all LLDP extension objects associated with remote systems
            on the indicated port only.

            This counter should be set to zero during agent initialization
            and its value should not be saved in non-volatile storage.
            When a port's admin status changes from 'disabled' to
            'rxOnly', 'txOnly' or 'txAndRx', the counter associated with
            the same port should reset to 0. The agent should also flush
            all remote system information associated with the same port.

            This counter should be incremented only once when the
            complete set of information is invalidated (aged out) from
            all related tables on a particular port. Partial aging
            is not allowed, and thus, should not change the value of
            this counter."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.5.2.2"
    ::= { lldpStatsRxPortEntry 7 }

--  ********************************************************
--
--          L O C A L    S Y S T E M    D A T A
--
--  ********************************************************

lldpLocChassisIdSubtype  OBJECT-TYPE
    SYNTAX      LldpChassisIdSubtype
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The type of encoding used to identify the chassis
```

```
            associated with the local system."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.2.2"
    ::= { lldpLocalSystemData 1 }

lldpLocChassisId  OBJECT-TYPE
    SYNTAX      LldpChassisId
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The string value used to identify the chassis component
            associated with the local system."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.2.3"
    ::= { lldpLocalSystemData 2 }

lldpLocSysName  OBJECT-TYPE
    SYNTAX      SnmpAdminString (SIZE(0..255))
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The string value used to identify the system name of the
            local system. If the local agent supports IETF RFC 3418,
            lldpLocSysName object should have the same value of sysName
            object."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.6.2"
    ::= { lldpLocalSystemData 3 }

lldpLocSysDesc  OBJECT-TYPE
    SYNTAX      SnmpAdminString (SIZE(0..255))
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The string value used to identify the system description
            of the local system. If the local agent supports IETF RFC 3418,
            lldpLocSysDesc object should have the same value of sysDesc
            object."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.7.2"
    ::= { lldpLocalSystemData 4 }

lldpLocSysCapSupported OBJECT-TYPE
    SYNTAX      LldpSystemCapabilitiesMap
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The bitmap value used to identify which system capabilities
            are supported on the local system."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.8.1"
    ::= { lldpLocalSystemData 5 }

lldpLocSysCapEnabled  OBJECT-TYPE
    SYNTAX      LldpSystemCapabilitiesMap
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The bitmap value used to identify which system capabilities
```



```
            are enabled on the local system."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.8.2"
    ::= { lldpLocalSystemData 6 }


--
-- lldpLocPortTable : Port specific Local system data
--

lldpLocPortTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpLocPortEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains one or more rows per port information
            associated with the local system known to this agent."
    ::= { lldpLocalSystemData 7 }

lldpLocPortEntry OBJECT-TYPE
    SYNTAX      LldpLocPortEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Information about a particular port component.

            Entries may be created and deleted in this table by the
            agent."
    INDEX   { lldpLocPortNum }
    ::= { lldpLocPortTable 1 }

LldpLocPortEntry ::= SEQUENCE {
      lldpLocPortNum                LldpPortNumber,
      lldpLocPortIdSubtype          LldpPortIdSubtype,
      lldpLocPortId                 LldpPortId,
      lldpLocPortDesc               SnmpAdminString
}

lldpLocPortNum  OBJECT-TYPE
    SYNTAX      LldpPortNumber
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The index value used to identify the port component
            (contained in the local chassis with the LLDP agent)
            associated with this entry.

            The value of this object is used as a port index to the
            lldpLocPortTable."
    ::= { lldpLocPortEntry 1 }

lldpLocPortIdSubtype  OBJECT-TYPE
    SYNTAX      LldpPortIdSubtype
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The type of port identifier encoding used in the associated
            'lldpLocPortId' object."
    REFERENCE
```

```
            "IEEE Std 802.1AB-2005 9.5.3.2"
    ::= { lldpLocPortEntry 2 }

lldpLocPortId  OBJECT-TYPE
    SYNTAX      LldpPortId
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The string value used to identify the port component
            associated with a given port in the local system."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.3.3"
    ::= { lldpLocPortEntry 3 }

lldpLocPortDesc  OBJECT-TYPE
    SYNTAX      SnmpAdminString (SIZE(0..255))
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The string value used to identify the IEEE 802 LAN station's port
            description associated with the local system. If the local
            agent supports IETF RFC 2863, lldpLocPortDesc object should
            have the same value of ifDescr object."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.5.2"
    ::= { lldpLocPortEntry 4 }

--
-- lldpLocManAddrTable : Management addresses of the local system
--

lldpLocManAddrTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpLocManAddrEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains management address information on the
            local system known to this agent."
    ::= { lldpLocalSystemData 8 }

lldpLocManAddrEntry OBJECT-TYPE
    SYNTAX      LldpLocManAddrEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Management address information about a particular chassis
            component. There may be multiple management addresses
            configured on the system identified by a particular
            lldpLocChassisId. Each management address should have
            distinct 'management address type' (lldpLocManAddrSubtype) and
            'management address' (lldpLocManAddr.)

            Entries may be created and deleted in this table by the
            agent."
    INDEX   { lldpLocManAddrSubtype,
              lldpLocManAddr }
    ::= { lldpLocManAddrTable 1 }

LldpLocManAddrEntry ::= SEQUENCE {
```

```
      lldpLocManAddrSubtype    AddressFamilyNumbers,
      lldpLocManAddr           LldpManAddress,
      lldpLocManAddrLen        Integer32,
      lldpLocManAddrIfSubtype  LldpManAddrIfSubtype,
      lldpLocManAddrIfId       Integer32,
      lldpLocManAddrOID        OBJECT IDENTIFIER
}

lldpLocManAddrSubtype  OBJECT-TYPE
    SYNTAX      AddressFamilyNumbers
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The type of management address identifier encoding used in
            the associated 'lldpLocManagmentAddr' object."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.9.3"
    ::= { lldpLocManAddrEntry 1 }

lldpLocManAddr  OBJECT-TYPE
    SYNTAX      LldpManAddress
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The string value used to identify the management address
            component associated with the local system. The purpose of
            this address is to contact the management entity."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.9.4"
    ::= { lldpLocManAddrEntry 2 }

lldpLocManAddrLen  OBJECT-TYPE
    SYNTAX      Integer32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The total length of the management address subtype and the
            management address fields in LLDPDUs transmitted by the
            local LLDP agent.

            The management address length field is needed so that the
            receiving systems that do not implement SNMP will not be
            required to implement an iana family numbers/address length
            equivalency table in order to decode the management address."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.9.2"
    ::= { lldpLocManAddrEntry 3 }


lldpLocManAddrIfSubtype  OBJECT-TYPE
    SYNTAX      LldpManAddrIfSubtype
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The enumeration value that identifies the interface numbering
            method used for defining the interface number, associated
            with the local system."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.9.5"
```

```
    ::= { lldpLocManAddrEntry 4 }

lldpLocManAddrIfId  OBJECT-TYPE
    SYNTAX      Integer32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The integer value used to identify the interface number
            regarding the management address component associated with
            the local system."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.9.6"
    ::= { lldpLocManAddrEntry 5 }

lldpLocManAddrOID  OBJECT-TYPE
    SYNTAX      OBJECT IDENTIFIER
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The OID value used to identify the type of hardware component
            or protocol entity associated with the management address
            advertised by the local system agent."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.9.8"
    ::= { lldpLocManAddrEntry 6 }


--  ********************************************************
--
--          R E M O T E    S Y S T E M S    D A T A
--
--  ********************************************************

lldpRemTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpRemEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains one or more rows per physical network
            connection known to this agent. The agent may wish to ensure
            that only one lldpRemEntry is present for each local port,
            or it may choose to maintain multiple lldpRemEntries for
            the same local port.

            The following procedure may be used to retrieve remote
            systems information updates from an LLDP agent:

               1. NMS polls all tables associated with remote systems
                  and keeps a local copy of the information retrieved.
                  NMS polls periodically the values of the following
                  objects:
                     a. lldpStatsRemTablesInserts
                     b. lldpStatsRemTablesDeletes
                     c. lldpStatsRemTablesDrops
                     d. lldpStatsRemTablesAgeouts
                     e. lldpStatsRxPortAgeoutsTotal for all ports.

               2. LLDP agent updates remote systems MIB objects, and
                  sends out notifications to a list of notification
```



```
                destinations.

             3. NMS receives the notifications and compares the new
                values of objects listed in step 1.

                Periodically, NMS should poll the object
                lldpStatsRemTablesLastChangeTime to find out if anything
                has changed since the last poll. if something has
                changed, NMS will poll the objects listed in step 1 to
                figure out what kind of changes occurred in the tables.

                if value of lldpStatsRemTablesInserts has changed,
                then NMS will walk all tables by employing TimeFilter
                with the last-polled time value. This request will
                return new objects or objects whose values are updated
                since the last poll.

                if value of lldpStatsRemTablesAgeouts has changed,
                then NMS will walk the lldpStatsRxPortAgeoutsTotal and
                compare the new values with previously recorded ones.
                For ports whose lldpStatsRxPortAgeoutsTotal value is
                greater than the recorded value, NMS will have to
                retrieve objects associated with those ports from
                table(s) without employing a TimeFilter (which is
                performed by specifying 0 for the TimeFilter.)

                lldpStatsRemTablesDeletes and lldpStatsRemTablesDrops
                objects are provided for informational purposes."
    ::= { lldpRemoteSystemsData 1 }

lldpRemEntry OBJECT-TYPE
    SYNTAX      LldpRemEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Information about a particular physical network connection.
            Entries may be created and deleted in this table by the agent,
            if a physical topology discovery process is active."
    INDEX   {
           lldpRemTimeMark,
           lldpRemLocalPortNum,
           lldpRemIndex
    }
    ::= { lldpRemTable 1 }

LldpRemEntry ::= SEQUENCE {
      lldpRemTimeMark           TimeFilter,
      lldpRemLocalPortNum       LldpPortNumber,
      lldpRemIndex              Integer32,
      lldpRemChassisIdSubtype   LldpChassisIdSubtype,
      lldpRemChassisId          LldpChassisId,
      lldpRemPortIdSubtype      LldpPortIdSubtype,
      lldpRemPortId             LldpPortId,
      lldpRemPortDesc           SnmpAdminString,
      lldpRemSysName            SnmpAdminString,
      lldpRemSysDesc            SnmpAdminString,
      lldpRemSysCapSupported    LldpSystemCapabilitiesMap,
      lldpRemSysCapEnabled      LldpSystemCapabilitiesMap
}
```

```
lldpRemTimeMark  OBJECT-TYPE
    SYNTAX      TimeFilter
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "A TimeFilter for this entry. See the TimeFilter textual
            convention in IETF RFC 2021 and
            http://www.ietf.org/IESG/Implementations/RFC2021-Implementation.txt
            to see how TimeFilter works."
    REFERENCE
            "IETF RFC 2021 section 6"
    ::= { lldpRemEntry 1 }

lldpRemLocalPortNum  OBJECT-TYPE
    SYNTAX      LldpPortNumber
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The index value used to identify the port component
            (contained in the local chassis with the LLDP agent)
            associated with this entry. The lldpRemLocalPortNum
            identifies the port on which the remote system information
            is received.

            The value of this object is used as a port index to the
            lldpRemTable."
    ::= { lldpRemEntry 2 }

lldpRemIndex  OBJECT-TYPE
    SYNTAX      Integer32(1..2147483647)
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This object represents an arbitrary local integer value used
            by this agent to identify a particular connection instance,
            unique only for the indicated remote system.

            An agent is encouraged to assign monotonically increasing
            index values to new entries, starting with one, after each
            reboot. It is considered unlikely that the lldpRemIndex
            will wrap between reboots."
    ::= { lldpRemEntry 3 }

lldpRemChassisIdSubtype  OBJECT-TYPE
    SYNTAX      LldpChassisIdSubtype
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The type of encoding used to identify the chassis associated
            with the remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.2.2"
    ::= { lldpRemEntry 4 }

lldpRemChassisId  OBJECT-TYPE
    SYNTAX      LldpChassisId
    MAX-ACCESS  read-only
    STATUS      current
```

```
    DESCRIPTION
            "The string value used to identify the chassis component
            associated with the remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.2.3"
    ::= { lldpRemEntry 5 }

lldpRemPortIdSubtype  OBJECT-TYPE
    SYNTAX      LldpPortIdSubtype
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The type of port identifier encoding used in the associated
            'lldpRemPortId' object."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.3.2"
    ::= { lldpRemEntry 6 }

lldpRemPortId  OBJECT-TYPE
    SYNTAX      LldpPortId
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The string value used to identify the port component
            associated with the remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.3.3"
    ::= { lldpRemEntry 7 }

lldpRemPortDesc  OBJECT-TYPE
    SYNTAX      SnmpAdminString (SIZE(0..255))
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The string value used to identify the description of
            the given port associated with the remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.5.2"
    ::= { lldpRemEntry 8 }

lldpRemSysName  OBJECT-TYPE
    SYNTAX      SnmpAdminString (SIZE(0..255))
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The string value used to identify the system name of the
            remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.6.2"
    ::= { lldpRemEntry 9 }

lldpRemSysDesc  OBJECT-TYPE
    SYNTAX      SnmpAdminString (SIZE(0..255))
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The string value used to identify the system description
            of the remote system."
    REFERENCE
```

```
            "IEEE Std 802.1AB-2005 9.5.7.2"
    ::= { lldpRemEntry 10 }

lldpRemSysCapSupported OBJECT-TYPE
    SYNTAX      LldpSystemCapabilitiesMap
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The bitmap value used to identify which system capabilities
            are supported on the remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.8.1"
    ::= { lldpRemEntry 11 }

lldpRemSysCapEnabled  OBJECT-TYPE
    SYNTAX      LldpSystemCapabilitiesMap
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The bitmap value used to identify which system capabilities
            are enabled on the remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.8.2"
    ::= { lldpRemEntry 12 }

--
-- lldpRemManAddrTable : Management addresses of the remote system
--

lldpRemManAddrTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpRemManAddrEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains one or more rows per management address
            information on the remote system learned on a particular port
            contained in the local chassis known to this agent."
    ::= { lldpRemoteSystemsData 2 }

lldpRemManAddrEntry OBJECT-TYPE
    SYNTAX      LldpRemManAddrEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Management address information about a particular chassis
            component. There may be multiple management addresses
            configured on the remote system identified by a particular
            lldpRemIndex whose information is received on
            lldpRemLocalPortNum of the local system. Each management
            address should have distinct 'management address
            type' (lldpRemManAddrSubtype) and 'management address'
            (lldpRemManAddr.)

            Entries may be created and deleted in this table by the
            agent."
    INDEX   { lldpRemTimeMark,
              lldpRemLocalPortNum,
              lldpRemIndex,
              lldpRemManAddrSubtype,
```



```
              lldpRemManAddr
 }
    ::= { lldpRemManAddrTable 1 }

LldpRemManAddrEntry ::= SEQUENCE {
      lldpRemManAddrSubtype     AddressFamilyNumbers,
      lldpRemManAddr            LldpManAddress,
      lldpRemManAddrIfSubtype   LldpManAddrIfSubtype,
      lldpRemManAddrIfId        Integer32,
      lldpRemManAddrOID         OBJECT IDENTIFIER
}

lldpRemManAddrSubtype  OBJECT-TYPE
    SYNTAX      AddressFamilyNumbers
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The type of management address identifier encoding used in
            the associated 'lldpRemManagmentAddr' object."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.9.3"
    ::= { lldpRemManAddrEntry 1 }

lldpRemManAddr  OBJECT-TYPE
    SYNTAX      LldpManAddress
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The string value used to identify the management address
            component associated with the remote system. The purpose
            of this address is to contact the management entity."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.9.4"
    ::= { lldpRemManAddrEntry 2 }

lldpRemManAddrIfSubtype  OBJECT-TYPE
    SYNTAX      LldpManAddrIfSubtype
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The enumeration value that identifies the interface numbering
            method used for defining the interface number, associated
            with the remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.9.5"
    ::= { lldpRemManAddrEntry 3 }

lldpRemManAddrIfId  OBJECT-TYPE
    SYNTAX      Integer32
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The integer value used to identify the interface number
            regarding the management address component associated with
            the remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.9.6"
    ::= { lldpRemManAddrEntry 4 }
```

```
lldpRemManAddrOID  OBJECT-TYPE
    SYNTAX      OBJECT IDENTIFIER
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The OID value used to identify the type of hardware component
            or protocol entity associated with the management address
            advertised by the remote system agent."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.5.9.8"
    ::= { lldpRemManAddrEntry 5 }

--
-- lldpRemUnknownTLVTable : Unrecognized TLV information
--
lldpRemUnknownTLVTable  OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpRemUnknownTLVEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains information about an incoming TLV which
            is not recognized by the receiving LLDP agent. The TLV may
            be from a later version of the basic management set.

            This table should only contain TLVs that are found in
            a single LLDP frame. Entries in this table, associated
            with an MAC service access point (MSAP, the access point
            for MAC services provided to the LCC sublayer, defined
            in IEEE 100, which is also identified with a particular
            lldpRemLocalPortNum, lldpRemIndex pair) are overwritten with
            most recently received unrecognized TLV from the same MSAP,
            or they will naturally age out when the rxInfoTTL timer
            (associated with the MSAP) expires."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.3.2"
    ::= { lldpRemoteSystemsData 3 }

lldpRemUnknownTLVEntry OBJECT-TYPE
    SYNTAX      LldpRemUnknownTLVEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Information about an unrecognized TLV received from a
            physical network connection. Entries may be created and
            deleted in this table by the agent, if a physical topology
            discovery process is active."
    INDEX   {
           lldpRemTimeMark,
           lldpRemLocalPortNum,
           lldpRemIndex,
           lldpRemUnknownTLVType
    }
    ::= { lldpRemUnknownTLVTable 1 }

LldpRemUnknownTLVEntry ::= SEQUENCE {
      lldpRemUnknownTLVType     Integer32,
      lldpRemUnknownTLVInfo     OCTET STRING
}
```



```
lldpRemUnknownTLVType OBJECT-TYPE
    SYNTAX      Integer32(9..126)
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This object represents the value extracted from the type
            field of the TLV."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.3.5"
    ::= { lldpRemUnknownTLVEntry 1 }

lldpRemUnknownTLVInfo OBJECT-TYPE
    SYNTAX      OCTET STRING (SIZE(0..511))
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "This object represents the value extracted from the value
            field of the TLV."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.3.5"
    ::= { lldpRemUnknownTLVEntry 2 }

-- ----------------------------------------------------------------------------
-- Remote Systems Extension Table - Organizationally-Defined Information
-- ----------------------------------------------------------------------------
lldpRemOrgDefInfoTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpRemOrgDefInfoEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains one or more rows per physical network
            connection which advertises the organizationally defined
            information.

            Note that this table contains one or more rows of
            organizationally defined information that is not recognized
            by the local agent.

            If the local system is capable of recognizing any
            organizationally defined information, appropriate extension
            MIBs from the organization should be used for information
            retrieval."
    ::= { lldpRemoteSystemsData 4 }

lldpRemOrgDefInfoEntry OBJECT-TYPE
    SYNTAX      LldpRemOrgDefInfoEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Information about the unrecognized organizationally
            defined information advertised by the remote system.
            The lldpRemTimeMark, lldpRemLocalPortNum, lldpRemIndex,
            lldpRemOrgDefInfoOUI, lldpRemOrgDefInfoSubtype, and
            lldpRemOrgDefInfoIndex are indexes to this table. If there is
            an lldpRemOrgDefInfoEntry associated with a particular remote
            system identified by the lldpRemLocalPortNum and lldpRemIndex,
            there must be an lldpRemEntry associated with the same
            instance (i.e, using same indexes.) When the lldpRemEntry
            for the same index is removed from the lldpRemTable, the
```

```
            associated lldpRemOrgDefInfoEntry should be removed from
            the lldpRemOrgDefInfoTable.

            Entries may be created and deleted in this table by the
            agent."
    INDEX   { lldpRemTimeMark,
              lldpRemLocalPortNum,
              lldpRemIndex,
              lldpRemOrgDefInfoOUI,
              lldpRemOrgDefInfoSubtype,
              lldpRemOrgDefInfoIndex }
    ::= { lldpRemOrgDefInfoTable 1 }

LldpRemOrgDefInfoEntry ::= SEQUENCE {
      lldpRemOrgDefInfoOUI         OCTET STRING,
      lldpRemOrgDefInfoSubtype     Integer32,
      lldpRemOrgDefInfoIndex       Integer32,
      lldpRemOrgDefInfo            OCTET STRING
}

lldpRemOrgDefInfoOUI  OBJECT-TYPE
    SYNTAX      OCTET STRING (SIZE(3))
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The Organizationally Unique Identifier (OUI), as defined
            in IEEE Std 802-2001, is a 24 bit (three octets) globally
            unique assigned number referenced by various standards,
            of the information received from the remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.6.1.3"
    ::= { lldpRemOrgDefInfoEntry 1 }

lldpRemOrgDefInfoSubtype  OBJECT-TYPE
    SYNTAX      Integer32(1..255)
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The integer value used to identify the subtype of the
            organizationally defined information received from the
            remote system.

            The subtype value is required to identify different instances
            of organizationally defined information that could not be
            retrieved without a unique identifier that indicates the
            particular type of information contained in the information
            string."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.6.1.4"
    ::= { lldpRemOrgDefInfoEntry 2 }

lldpRemOrgDefInfoIndex  OBJECT-TYPE
    SYNTAX      Integer32(1..2147483647)
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This object represents an arbitrary local integer value
            used by this agent to identify a particular unrecognized
            organizationally defined information instance, unique only
```



```
            for the lldpRemOrgDefInfoOUI and lldpRemOrgDefInfoSubtype
            from the same remote system.

            An agent is encouraged to assign monotonically increasing
            index values to new entries, starting with one, after each
            reboot. It is considered unlikely that the
            lldpRemOrgDefInfoIndex will wrap between reboots."
    ::= { lldpRemOrgDefInfoEntry 3 }

lldpRemOrgDefInfo  OBJECT-TYPE
    SYNTAX      OCTET STRING(SIZE(0..507))
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The string value used to identify the organizationally
            defined information of the remote system. The encoding for
            this object should be as defined for SnmpAdminString TC."
    REFERENCE
            "IEEE Std 802.1AB-2005 9.6.1.5"
    ::= { lldpRemOrgDefInfoEntry 4 }


--
-- ********************************************************
--
--        L L D P   M I B   N O T I F I C A T I O N S
--
-- ********************************************************
--

lldpNotificationPrefix OBJECT IDENTIFIER ::= { lldpNotifications 0 }

lldpRemTablesChange NOTIFICATION-TYPE
    OBJECTS {
        lldpStatsRemTablesInserts,
        lldpStatsRemTablesDeletes,
        lldpStatsRemTablesDrops,
        lldpStatsRemTablesAgeouts
    }
    STATUS        current
    DESCRIPTION
            "A lldpRemTablesChange notification is sent when the value
            of lldpStatsRemTableLastChangeTime changes. It can be
            utilized by an NMS to trigger LLDP remote systems table
            maintenance polls.

            Note that transmission of lldpRemTablesChange
            notifications are throttled by the agent, as specified by the
            'lldpNotificationInterval' object."
   ::= { lldpNotificationPrefix 1 }


--
-- ********************************************************
--
--           L L D P   M I B   C O N F O R M A N C E
--
-- ********************************************************
--
```

```
lldpCompliances OBJECT IDENTIFIER ::= { lldpConformance 1 }
lldpGroups      OBJECT IDENTIFIER ::= { lldpConformance 2 }

-- compliance statements

lldpCompliance MODULE-COMPLIANCE
    STATUS  current
    DESCRIPTION
            "The compliance statement for SNMP entities which implement
            the LLDP MIB."
    MODULE  -- this module
        MANDATORY-GROUPS { lldpConfigGroup,
                           lldpConfigRxGroup,
                           lldpConfigTxGroup,
                           lldpStatsRxGroup,
                           lldpStatsTxGroup,
                           lldpLocSysGroup,
                           lldpRemSysGroup,
                           lldpNotificationsGroup
        }
    ::= { lldpCompliances 1 }

-- MIB groupings

lldpConfigGroup    OBJECT-GROUP
    OBJECTS {
        lldpPortConfigAdminStatus
    }
    STATUS  current
    DESCRIPTION
            "The collection of objects which are used to configure the
            LLDP implementation behavior.

            This group is mandatory for agents which implement the LLDP."
    ::= { lldpGroups 1 }

lldpConfigRxGroup    OBJECT-GROUP
    OBJECTS {
        lldpNotificationInterval,
        lldpPortConfigNotificationEnable
    }
    STATUS  current
    DESCRIPTION
            "The collection of objects which are used to configure the
            LLDP implementation behavior.

            This group is mandatory for agents which implement the LLDP
            and have the capability of receiving LLDP frames."
    ::= { lldpGroups 2 }

lldpConfigTxGroup    OBJECT-GROUP
    OBJECTS {
        lldpMessageTxInterval,
        lldpMessageTxHoldMultiplier,
        lldpReinitDelay,
        lldpTxDelay,
        lldpPortConfigTLVsTxEnable,
        lldpConfigManAddrPortsTxEnable
```



```
    }
    STATUS  current
    DESCRIPTION
            "The collection of objects which are used to configure the
            LLDP implementation behavior.

            This group is mandatory for agents which implement the LLDP
            and have the capability of transmitting LLDP frames."
    ::= { lldpGroups 3 }

lldpStatsRxGroup    OBJECT-GROUP
    OBJECTS {
        lldpStatsRemTablesLastChangeTime,
        lldpStatsRemTablesInserts,
        lldpStatsRemTablesDeletes,
        lldpStatsRemTablesDrops,
        lldpStatsRemTablesAgeouts,
        lldpStatsRxPortFramesDiscardedTotal,
        lldpStatsRxPortFramesErrors,
        lldpStatsRxPortFramesTotal,
        lldpStatsRxPortTLVsDiscardedTotal,
        lldpStatsRxPortTLVsUnrecognizedTotal,
        lldpStatsRxPortAgeoutsTotal
    }
    STATUS  current
    DESCRIPTION
            "The collection of objects which are used to represent LLDP
            reception statistics.

            This group is mandatory for agents which implement the LLDP
            and have the capability of receiving LLDP frames."
    ::= { lldpGroups 4 }

lldpStatsTxGroup    OBJECT-GROUP
    OBJECTS {
        lldpStatsTxPortFramesTotal
    }
    STATUS  current
    DESCRIPTION
            "The collection of objects which are used to represent LLDP
            transmission statistics.

            This group is mandatory for agents which implement the LLDP
            and have the capability of transmitting LLDP frames."
    ::= { lldpGroups 5 }

lldpLocSysGroup  OBJECT-GROUP
    OBJECTS {
        lldpLocChassisIdSubtype,
        lldpLocChassisId,
        lldpLocPortIdSubtype,
        lldpLocPortId,
        lldpLocPortDesc,
        lldpLocSysDesc,
        lldpLocSysName,
        lldpLocSysCapSupported,
        lldpLocSysCapEnabled,
        lldpLocManAddrLen,
        lldpLocManAddrIfSubtype,
```

```
        lldpLocManAddrIfId,
        lldpLocManAddrOID
    }
    STATUS  current
    DESCRIPTION
            "The collection of objects which are used to represent LLDP
            Local System Information.

            This group is mandatory for agents which implement the LLDP
            and have the capability of transmitting LLDP frames."
    ::= { lldpGroups 6 }

lldpRemSysGroup  OBJECT-GROUP
    OBJECTS {
        lldpRemChassisIdSubtype,
        lldpRemChassisId,
        lldpRemPortIdSubtype,
        lldpRemPortId,
        lldpRemPortDesc,
        lldpRemSysName,
        lldpRemSysDesc,
        lldpRemSysCapSupported,
        lldpRemSysCapEnabled,
        lldpRemManAddrIfSubtype,
        lldpRemManAddrIfId,
        lldpRemManAddrOID,
        lldpRemUnknownTLVInfo,
        lldpRemOrgDefInfo
    }
    STATUS  current
    DESCRIPTION
            "The collection of objects which are used to represent
            LLDP Remote Systems Information. The objects represent the
            information associated with the basic TLV set. Please note
            that even the agent doesn't implement some of the optional
            TLVs, it shall recognize all the optional TLV information
            that the remote system may advertise.

            This group is mandatory for agents which implement the LLDP
            and have the capability of receiving LLDP frames."
    ::= { lldpGroups 7 }

lldpNotificationsGroup  NOTIFICATION-GROUP
    NOTIFICATIONS {
        lldpRemTablesChange
    }
    STATUS  current
    DESCRIPTION
            "The collection of notifications used to indicate LLDP MIB
            data consistency and general status information.

            This group is mandatory for agents which implement the LLDP
            and have the capability of receiving LLDP frames."
    ::= { lldpGroups 8 }

END
```

12.3 Security considerations for LLDP base MIB module

There are a number of management objects defined in this MIB module with a MAX-ACCESS clause of read-write.[11] Such objects may be considered sensitive or vulnerable in some network environments. The support for SET operations in a non-secure environment without proper protection can have a negative effect on network operations.

a) Setting the following objects to incorrect values can result in an excessive number of LLDP packets being sent by the LLDP agent:
   1) lldpMessageTxInterval
   2) lldpTxDelay

b) Setting the object, lldpMessageTxHoldMultiplier, to incorrect values can cause the LLDP agent to transmit LLDPDUs with too-high TTL values, which affect the expiration time of objects grouped under lldpRemoteSystemsData identifier.

c) Setting the object, lldpReinitDelay, to too low a value can cause the transmit state machine to attempt excessive re-initializations.

d) Setting incorrect bits in the object, lldpPortConfigTLVsTxEnable, can cause the LLDP agent to transmit LLDPDUs with an undesired optional TLV sequence.

e) Setting incorrect bits in the object, lldpConfigManAddrPortsTxEnable, can cause the LLDP agent to advertise management addresses that were not meant to be disclosed and/or to omit addresses that were desired.

f) Setting the following objects to incorrect values can result in improper operation of the MIB notification process.
   1) llldpNotificationInterval
   2) lldpPortConfigNotificationEnable

g) Setting the object, lldpPorConfigAdminStatus, to the incorrect value can result in enabling a non-desired operational mode.

The following readable objects in this MIB module may be considered to be sensitive or vulnerable in some network environments:

h) Objects that are associated with the transmit mode
   1) lldpLocChassisIdSubtype
   2) lldpLocChassisId
   3) lldpLocPortIdSubtype
   4) lldpLocPortId
   5) lldpLocPortDesc
   6) lldpLocSysName
   7) lldpLocSysDesc
   8) lldpLocSysCapSupported
   9) lldpLocSysCapEnabled
   10) lldpLocManAddrLen
   11) lldpLocManAddrIfSubtype
   12) lldpLocManAddrIfId
   13) lldpLocManAddrOID

[11]In IETF MIB definitions, the MAX-ACCESS clause defines the type of access that is allowed for particular data elements in the MIB. An explanation of the MAX-ACCESS mappings is given in section 7.3 of IETF RFC 2578 [B10].

i) Objects that are associated with the receive mode

1) lldpNotificationInterval
2) lldpPortConfigNotificationEnable
3) lldpRemChassisIdSubtype
4) lldpRemChassisId
5) lldpRemPortIdSubtyp
6) lldpRemPortId
7) lldpRemPortDesc
8) lldpRemSysName
9) lldpRemSysDesc
10) lldpRemSysCapSupported
11) lldpRemSysCapEnabled
12) lldpRemManAddrIfSubtype
13) lldpRemManAddrIfId
14) lldpRemManAddrOID
15) lldpRemUnknownTLVInfo
16) lldpRemOrgDefInfo

This concern applies both to objects that describe the configuration of the local host, as well as for objects that describe information from the remote hosts, acquired via LLDP and displayed by the objects in this MIB module. It is thus important to control even GET and/or NOTIFY access to these objects and possibly to even encrypt the values of these objects when sending them over the network via SNMP.

SNMP versions prior to SNMPv3 did not include adequate security. Even if the network itself is secure (for example by using IPSec), even then, there is no control as to who on the secure network is allowed to access and GET/SET (read/change/create/delete) the objects in this MIB module.

Implementers should consider the security features as provided by the SNMPv3 framework (see RFC 3410, section 8), including full support for the SNMPv3 cryptographic mechanisms (for authentication and privacy).

Further, implementers should not deploy SNMP versions prior to SNMPv3. Instead**,** implementers should deploy SNMPv3 to enable cryptographic security. It is then a customer/operator responsibility to ensure that the SNMP entity giving access to an instance of this MIB module is properly configured to give access to the objects only to those principals (users) that have legitimate rights to indeed GET or SET (change/create/ delete) them.

Annex A

(informative)

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[B15] IETF RFC 2922, Physical Topology MIB, Bierman, A., and Jones, K., November 1998.

[12]ANSI publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10035, USA.

[13]IEEE publications are available from the Institute of Electrical and Electronic Engineers, 445 Hoes Lane, P.O. box 1331, Piscataway, NJ 08855-1331, USA. IEEE publications can be ordered on-line from the IEEE Standards Website: http://www.standards.ieee.org.

[14]Internet RFCs are retrievable by FTP at ds.internic.net/rfc/rfcnnnn.txt, or by Web browser at http://www.ietf.org/rfc/rfcNNNN.txt (where NNNN is the RFC number prefixed with zeroes as necessary to make a four digit number), or call InterNIC at 1-800-444-4345 for information about receiving copies through the mail.

Annex B

(normative)

PICS Proforma[15]

B.1 Introduction

The supplier of a protocol implementation that is claimed to conform to this standard shall complete the following Protocol Implementation Conformance Statement (PICS) proforma.

A completed PICS proforma is the PICS for the implementation in question. The PICS is a statement of which capabilities and options of the protocol have been implemented. The PICS can have a number of uses, including use:

a) By the protocol implementers, as a checklist to reduce the risk of failure to conform to the standard through oversight

b) By the supplier and acquirer—or potential acquirer—of the implementation, as a detailed indication of the capabilities of the implementation, stated relative to the common basis for understanding provided by the standard PICS proforma

c) By the user—or potential user—of the implementation, as a basis for initially checking the possibility of interworking with another implementation (note that although interworking can never be guaranteed, failure to interwork can often be predicted from incompatible PICs)

d) By a protocol tester, as the basis for selecting appropriate tests against which to assess the claim for conformance of the implementation

B.2 Abbreviations and special symbols

B.2.1 Status symbols

M Mandatory
O Optional
O.n Optional, but support of at least one of the group of options labeled by the same numeral *n* is required
X Prohibited
pred: Conditional-item symbol, including predicate identification: See B.3.4
¬ Logical negation, applied to a conditional item's predicate

B.2.2 General abbreviations

N/A Not applicable
PICS Protocol Implementation Conformance Statement

[15]*Copyright release for PICS proformas:* Users of this standard may freely reproduce the PICS proforma in this annex so that it can be used for its intended purpose and may further publish the completed PICS.

B.3 Instructions for completing the PICS proforma

B.3.1 General structure of the PICS proforma

The first part of the PICS proforma, implementation identification and protocol summary, is to be completed as indicated with the information necessary to identify fully both the supplier and the implementation.

The main part of the PICS proforma is a fixed-format questionnaire, divided into several subclauses, each containing a number of individual items. Answers to the questionnaire items are to be provided in the right-most column, either by simply marking an answer to indicate a restricted choice (usually Yes or No), or by entering a value or a set or range of values. (Note that there are some items in which two or more choices from a set of possible answers can apply; all relevant choices are to be marked.)

Each item is identified by an item reference in the first column. The second column contains the question to be answered; the third column records the status of the item—whether support is mandatory, optional, or conditional; see also B.3.4. The fourth column contains the reference or references to the material that specifies the item in the main body of this standard, and the fifth column provides the space for the answers.

A supplier may also provide (or be required to provide) further information, categorized as either Additional Information or Exception Information. When present, each kind of further information is to be provided in a further subclause of items labeled *Ai* or *Xi*, respectively, for cross-referencing purposes, where *i* is any unambiguous identification for the item (e.g., simply a numeral). There are no other restrictions on its format and presentation.

A completed PICS proforma, including any Additional Information and Exception Information, is the Protocol Implementation Conformation Statement for the implementation in question.

NOTE—Where an implementation is capable of being configured in more than one way, a single PICS may be able to describe all such configurations. However, the supplier has the choice of providing more than one PICS, each covering some subset of the implementation's configuration capabilities, in case that makes for easier and clearer presentation of the information.

B.3.2 Additional information

Items of Additional Information allow a supplier to provide further information intended to assist the interpretation of the PICS. It is not intended or expected that a large quantity will be supplied, and a PICS can be considered complete without any such information. Examples might be an outline of the ways in which a (single) implementation can be set up to operate in a variety of environments and configurations, or information about aspects of the implementation that are outside the scope of this standard but that have a bearing on the answers to some items.

References to items of Additional Information may be entered next to any answer in the questionnaire and may be included in items of Exception Information.

B.3.3 Exception information

It may occasionally happen that a supplier will wish to answer an item with mandatory status (after any conditions have been applied) in a way that conflicts with the indicated requirement. No preprinted answer will be found in the Support column for this: instead, the supplier shall write the missing answer into the Support column, together with an *Xi* reference to an item of Exception Information, and shall provide the appropriate rationale in the Exception item.

An implementation for which an Exception item is required in this way does not conform to this standard.

NOTE—A possible reason for the situation described above is that a defect in this standard has been reported, a correction for which is expected to change the requirement not met by the implementation.

B.3.4 Conditional status

B.3.4.1 Conditional items

The PICS proforma contains a number of conditional items. These are items for which both the applicability of the item itself, and its status if it does apply—mandatory or optional—are dependent upon whether or not certain other items are supported.

Where a group of items is subject to the same condition for applicability, a separate preliminary question about the condition appears at the head of the group, with an instruction to skip to a later point in the questionnaire if the "Not Applicable" answer is selected. Otherwise, individual conditional items are indicated by a conditional symbol in the Status column.

A conditional symbol is of the form "**pred:** S," where **pred** is a predicate as described in B.3.4.2, and S is a status symbol, M or 0.

If the value of the predicate is TRUE (see B.3.4.2), the conditional item is applicable, and its status is indicated by the status symbol following the predicate: the answer column is to be marked in the usual way. If the value of the predicate is FALSE, the "Not Applicable" (N/A)[16] answer is to be marked.

B.3.4.2 Predicates

A predicate is one of the following:

a) An item-reference for an item in the PICS proforma: The value of the predicate is TRUE if the item is marked as supported, and is FALSE otherwise.

b) A predicate-name, for a predicate defined as a boolean expression constructed by combining item-references using the boolean operator OR: The value of the predicate is TRUE if one or more of the items is marked as supported.

c) A predicate-name, for a predicate defined as a boolean expression constructed by combining item-references using the boolean operator AND: The value of the predicate is TRUE if all of the items are marked as supported.

d) The logical negation symbol "¬" prefixed to an item-reference or predicate-name: The value of the predicate is TRUE if the value of the predicate formed by omitting the "¬" symbol is FALSE, and vice versa.

Each item whose reference is used in a predicate or predicate definition, or in a preliminary question for grouped conditional items, is indicated by an asterisk[17] in the Item column.

[16](N/A) is currently not used in this PICs.

[17]Asterisks are currently not used in this PICs.

PICS proforma for IEEE Std 802.1AB-2005

B.3.5 Implementation identification

Supplier	
Contact point for queries about the PICS	
Implementation Name(s) and Version(s)	
Other information necessary for full identification—e.g., name(s) and version(s) of machines and/or operating system names	
NOTES 1—Only the first three items are required for all implementations; other information may be completed as appropriate in meeting the requirement for full identification. 2—The terms Name and Version should be interpreted appropriately to correspond with a supplier's terminology (e.g., Type, Series, Model).	

B.3.6 Protocol summary, IEEE Std 802.1AB-2005

Identification of protocol specification	IEEE Std 802.1AB-2005, Standard for Local and Metropolitan Area Networks: Station and Media Access Control Connectivity Discovery
Identification of amendments and corrigenda to the PICS proforma that have been completed as part of the PICS	Amd. : Corr. : Amd. : Corr. :
Have any Exception items been required? (See B.3.3: The answer Yes means that the implementation does not conform to IEEE Std 802.1AB)	No [ ] Yes [ ]

Date of Statement	

B.4 Major capabilities and options

Item	Feature	Status	References	Support
cntrlport	Are LLDP exchanges through a controlled port if port access is controlled by 802.1X	M	Clause 6	Yes [ ]
addr	Are LLDP addressing and LLDP Ethertype encoding in conformance with the defined requirements			
	DA = LLDP_Multicast address	M	8.1	Yes [ ]
	SA = station MAC address	M	8.2	Yes [ ]
	LLDP Ethertype encoding	M	8.3	Yes [ ]
lldpdu	Is the LLDPDU encapsulation in conformance with the TLV order specified by the LLDPDU format	M	8.3	Yes [ ]
tlvfmt	Is the basic TLV capability implemented	M	9.4	Yes [ ]
basictlv	Is each TLV in the basic management set implemented			
	End Of LLDPDU TLV	M	9.5.1	Yes [ ]
	Chassis ID TLV	M	9.5.2	Yes [ ]
	Port ID TLV	M	9.5.3	Yes [ ]
	Time To Live TLV	M	9.5.4	Yes [ ]
	Port Description TLV	M	9.5.5	Yes [ ]
	System Name TLV	M	9.5.6	Yes [ ]
	System Description TLV	M	9.5.7	Yes [ ]
	System Capabilities TLV	M	9.5.8	Yes [ ]
	Management Address TLV	M	9.5.9	Yes [ ]
xtlvfmt	Is the Organizationally Specific TLV capability implemented	M	9.6	Yes [ ]
oprmmode	Which of the following operational modes are implemented (one is mandatory, all are allowed)			
	Transmit and receive (if yes, answer both items **txmode** and **rxmode**)	O.1	7.1	Yes [ ] No [ ]
	Transmit only (if yes, answer item **txmode**, skip **rxmode**)	O.1	7.1	Yes [ ] No [ ]
	Receive only (if yes, skip item **txmode**, answer **rxmode**)	O.1	7.1	Yes [ ] No [ ]

Major capabilities and options (continued)

Item	Feature	Status	References	Support
txmode	If the transmit mode is implemented, is the transmit mode in conformance with all operational specifications indicated for the Tx mode in Table 10-1	M	Clause 10	Yes [ ]
rxmode	If the receive mode is implemented, is the receive module in conformance with all operational specifications indicated for the Tx mode in Table 10-1	M	Clause 10	Yes [ ]
lldpmib	Which type of data store/retrieval is implemented (one is mandatory)			
	SNMPbasic MIB is supported (if yes, answer item **snmpmib** and skip **equivstor**)	O.2	12.2	Yes [ ] No [ ]
	SNMP is not supported (if yes, answer **equivstor** and skip **snmpmib**)	O.2	11.1	Yes [ ] No [ ]
snmpmib	If the SNMP MIB is implemented, is the MIB module in conformance with the MIB sections indicated in Table 12-1 for the operating mode being implemented	M	12.2	Yes [ ]
equivstor	If the SNMP is not supported, is functionally equivalent storage and retrieval capability specified in Clause 8, Clause 9, Clause 10, and Clause 11 provided for the operating mode being implemented	M	11.1	Yes [ ]

Annex C

(informative)

PTOPO MIB update

The PTOPO MIB should be updated according to the following rules:

a) If any objects in the LLDP remote systems MIB age out, the equivalent objects in the PTOPO MIB should be deleted.

b) If the TTL value in the Time To Live TLV is zero, then the port is being shutdown and the PTOPO MIB objects associated with the MSAP identifier should be deleted.

c) If the TTL field is non-zero, then the appropriate ptopoRemEntry is found or created, based on the data elements included in the LLDP frame. If the indicated entry is dynamic (i.e., ptopoConnIsStatic is FALSE), then the current sysUpTime value is stored in the ptopoConnLastVerifyTime field for the entry.

d) If a ptopoRemEntry was added then the ptopoConnTabInserts counter is incremented.

e) If any ptopoRemEntry was added or deleted, or if information other than the ptopoRemLastVerify-Time changed for any entry due to the processing of this LLDP frame, the ptopoLastChangeTime object is set with the current sysUpTime, and a ptopoConfigChange trap event is generated. (See the PTOPO MIB for information on ptopoConfigChange trap generation.)

Annex D

(informative)

Example LLDP transmission frame formats

The LLDP MAC frame format is based on the particular transmission protocol. The following example formats illustrate the indicated LLDP Ethertype encoding method.

D.1 Direct-encoded LLDP frame format

The IEEE 802.3 LLDP frame format is shown in Figure D-1.

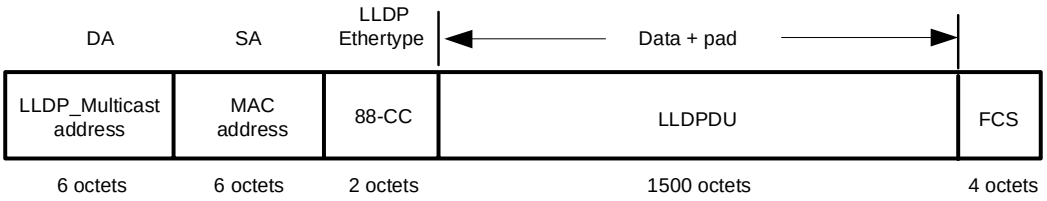
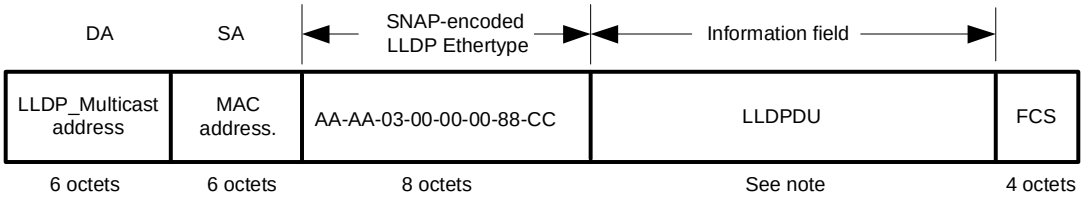


Figure D-1—IEEE 802.3 LLDP frame format

D.2 SNAP-encoded LLDP frame format

The Token Ring/FDDI LLDP frame format is shown in Figure D-2.



NOTE---the maximum length for the LLDPDU is dependent on the maximum information field size for the transmission rate and protocol. (See 9.1)

Figure D-2—Token Ring/FDDI LLDP frame format

Annex E

(informative)

Using LLDP to detect potential communication problems

E.1 Overview

Some of the attributes exchanged via LLDP may be used to detect certain mis-configurations that may impair station communication. Under certain circumstances, while LLDPDU exchange is possible, communication between two stations may be impaired because of partial component failure or improper manual configuration of local parameters. In these cases, analysis of the information exchanged within LLDP may be used to detect potential communication or configuration problems and notify the local management entity.

LLDP does not provide a means to resolve problems due to inconsistent configuration or component failure. These actions are clearly beyond the scope of this specification. LLDP does offer an advertisement of information that can be used to detect a limited set of such problems. Whether a problem truly exists or not is also a question of local management policy and interpretation of the advertised information. In many common installations, the information exchanged in the following TLVs can indicate the associated problems.

E.2 IEEE 802.1 Organizationally Specific TLVs

E.2.1 Port VLAN ID TLV

While it is not strictly an error to have two systems configured with different port VLAN ID (PVID) values connected to the same link, in practice it can represent a mis-configuration that is prohibiting two management interfaces from talking with one another. In many deployments of IEEE 802.1Q, a management interface for a system is accessible by a management addresses that is associated with the VLAN the port has been configured on. The network addresses for two systems assumed to be on the same VLAN can assume their addresses are on the same subnet, allowing direct communication. If the systems are actually configured to be on different VLANs, but happen to be connected to a common link with different views of what is the port VLAN on that link, communication problems between the management stacks may exist. Since the PVID is a locally administered value it is possible that it may be configured to be any valid value, however, it is common practice to have the PVID of two systems connected to the same link to be the same.

E.2.2 IEEE 802.1 Port and Protocol VLAN ID TLVs

The port and protocol VLAN IDs (PPVID) are untagged VLANs for a port, which when connected to a link with other port and protocol VLAN members, can have the same issues described with port VLAN IDs. The management addresses used to access management objects should be mapped to the correct VIDs so a remote manager can properly access the system.

Port and protocol VLANs have the additional complication that specific classification rules are used to map frames to the appropriate VLAN. In many cases these classification rules should be consistent between systems on the same link. The rules are represented in the IEEE 802.1Q management structures, but it would be excessive and redundant to advertise these rules in LLDP. However, knowing the set of ports attached to the link that are capable and enabled for port and protocol VLANs is valuable for detecting a possible mis-configuration. Ports that are using a management address reachable by a port and protocol VLAN may wish to have equivalent mapping rules for frames to VLANs. The IEEE 802.1Q MIB of each system enabled with port and protocol VLANs can be consulted to verify the mapping rules.

E.2.3 VLAN Name TLVs

The MIB of managed objects for bridges with VLAN extensions [RFC 2674] defines an object, dot1qVlanStaticName, which provides a name for a VLAN. Additionally, most VLAN bridge implementations provide some method for the network manager to administratively assign a name to a VLAN. While there is no requirement for the name of a VLAN on one bridge to be consistent with the name of the same VLAN on another bridge, it is common practice that these names would be the same.

Network managers typically assign meaningful names to VLANs. For example, a VLAN with VID 10 might be called the 'Management' VLAN from which all bridges on the LAN can be accessed by a network management utility. A VLAN with VID 408 might be called the 'Voice' VLAN on which IP Telephony equipment resides. Network managers might also assign names to VLANs that help indicate what subnet addresses are used by stations on that VLAN. For example, a VLAN with VID 23 might be called '192.168.254.0/24'. In any case, the network manager often uses the naming facility to provide meaningful and consistent names for the VLANs.

In situations where VLAN names have been consistently applied throughout the LAN, the information carried in the VLAN Name TLV may be used to detect a mis-configuration. The VLAN Name TLV essentially provides the mapping of a VID to a VLAN name as assigned by the network manager. The same VID with two different names will not prevent communication on the associated VLAN, however, the communication may not be what the network manager intended.

E.2.4 Protocol Identity TLVs

Protocols such as Spanning Tree Protocol, the Link Aggregation Control Protocol, and numerous vendor proprietary variations are responsible for maintaining the topology and connectivity of the network. While many of these protocols have mechanisms built into them that allow interpretability with older versions, different variations or alternate modes of operation, it is possible for some of these protocols to interact improperly with one another causing breaks in the topology or interruptions in an otherwise connected network.

The Protocol Identity TLV provides a way for stations to advertise protocols that are important to the operation of the network. A management entity may be able to diagnose connectivity issues by understanding the set of topology management protocols operating on peer network devices. Stations may also be able to discover peer protocol agents that operate a preferred version of a proprietary protocol and therefore eliminate the need to develop or execute multiple independent protocol discovery mechanisms.

E.3 IEEE 802.3 Organizationally Specific TLVs

E.3.1 MAC/PHY Configuration/Status TLV

It is possible for two ends of an IEEE 802.3 link to be configured with different duplex and/or speed settings and still establish some limited network connectivity. For example:

a) In IEEE 802.3 copper links, auto-negotiation can be overridden by manual configuration and may cause the link configuration to converge in an undesirable way. The auto-negotiation supported and auto-negotiation status fields of the auto-negotiation TLVs passed between two systems attached to the same link should indicate the same settings:
    1) If auto-negotiation is supported and enabled in both systems, there should be not duplex or speed differences. The current speed and duplex settings can be determined by comparing the 802.3 PMD supported functionality field settings to determine highest common denominator level as defined in IEEE Std 802.3-2002, Annex 28 B.3

2) If the received TLV indicates that auto-negotiation is supported but not enabled, the current duplex and speed settings of the sending system will be defined by the operational MAU type field in that TLV. These can be compared with the speed and duplex settings in the receiving system to determine whether there is a mismatch.

b) In fiber links supporting data rates less than 10 Gbits/second, full duplex IEEE 802.3 MAC/PHYs can also support half duplex operation:

1) The duplex configuration can not be auto-configured in full duplex MAC/PHYs and must be set by network management.

2) A received TLV with an operational MAU type that is different from the local system's operational MAU type can indicate the potential for frame loss.

E.3.2 Link Aggregation TLV

It is possible for one system to believe it has formed a link aggregation with a remote port while the other system is unaware of the aggregation. This type of configuration may cause network loops or unpredictable communication depending upon the distribution algorithm used to load balance traffic. This situation can occur with manual configuration of the link aggregation and the setting the LACP protocol to passive on both sides. It may also occur if manual link aggregations have been established by implementations that are not using the LACP protocol (while this approach is non-standard, it is in wide use today).

The Link Aggregation TLV informs the remote port whether or not the sending port believes it is currently in a link aggregation. It also provides Port ID information for the aggregated port so a management station can efficiently access the link aggregation management objects.

E.3.3 Power Via MDI TLV

An incompatibility of power classes may exist when there is a configuration inconsistency between the power sourcing equipment (PSE) and the powered device (PD). For example, if the PSE port supplies Class_2 (7.0 watts) and advertises it, but the PD port is class_0 (0.44 to 19.95 watts) and requires higher power (more than 7.0 watts) in some modes, connectivity problems may result.

E.3.4 Maximum Frame Size TLV

Differences in maximum frame size can result in loss of frames if a sending station transmits frames larger than the advertised maximum frame size supported by the receiving station. The Maximum Frame Size TLV can be used to detect mis-configurations or incompatibility between two stations with different maximum supported frame sizes.

Annex F

(normative)

IEEE 802.1 Organizationally Specific TLVs

F.1 Requirements of the IEEE 802.1 Organizationally Specific TLV set

If any IEEE 802.1 Organizationally Specific TLV is supported, all IEEE 802.1 Organizationally Specific TLVs shall be supported. All IEEE 802.1 Organizationally Specific TLVs shall conform to the LLDPDU bit and octet ordering conventions of 9.1.

The currently defined IEEE 802.1 Organizationally Specific TLVs are listed in Table F-1. Any adds or changes to these TLVs will be included in this annex.

Table F-1— IEEE 802.1 Organizationally Specific TLVs

IEEE 802.1 subtype	TLV name	Subclause reference
0	reserved	—
1	Port VLAN ID	F.2
2	Port And Protocol VLAN ID	F.3
3	VLAN Name	F.4
4	Protocol Identity	F.5
5 – 255	reserved	—

F.2 Port VLAN ID TLV

The Port VLAN ID TLV is an optional fixed length TLV that allows a VLAN bridge port to advertise the port's VLAN identifier (PVID) that will be associated with untagged or priority tagged frames (see IEEE 802.1Q-1998, 8.4.4).

Figure F-1 shows the Port VLAN ID TLV format.

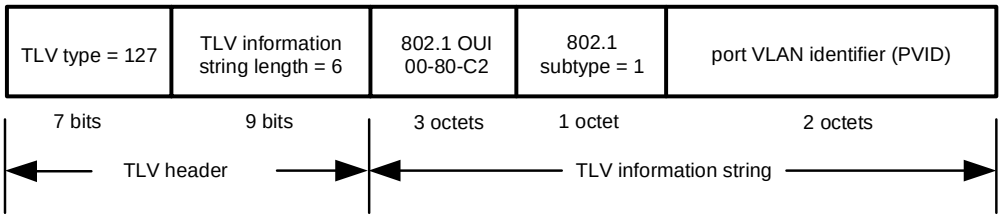


Figure F-1—Port VLAN ID TLV Format

F.2.1 port VLAN identifier (PVID)

The port VLAN identifier field shall contain the VLAN ID for the bridge port as defined in 8.4.4 of IEEE 802.1Q-1998. A value of zero shall be used if the system either does not know the PVID or does not support port-based VLAN operation.

F.2.2 Port VLAN ID usage rules

An LLDPDU should contain no more than one Port VLAN ID TLV.

F.3 Port And Protocol VLAN ID TLV

The Port And Protocol VLAN ID TLV is an optional TLV that allows a bridge port to advertise a port and protocol VLAN ID. Figure F-2 shows the Port And Protocol VLAN ID TLV format.

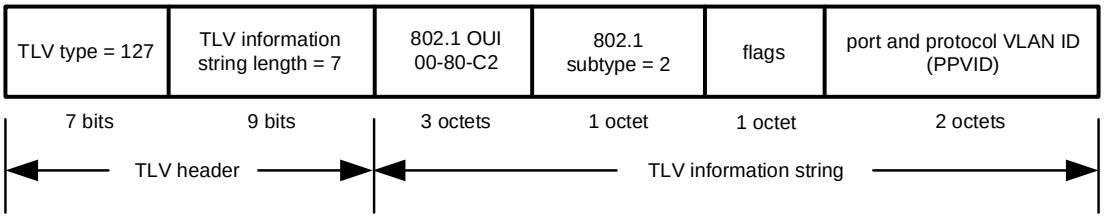


Figure F-2—Port And Protocol VLAN ID TLV Format

F.3.1 flags

The flags field shall contain a bit map indicating the port and protocol VLAN capability and status as defined in Table F-2.

Table F-2—Port and protocol capability/status

Bit	Function	Value/meaning
0	reserved	—
1	Port and protocol VLAN supported	1 = supported 0 = not supported
2	Port and protocol VLAN enabled	1 = enabled 0 = not enabled
3–7	reserved	(set to zero)

F.3.2 port and protocol VLAN ID (PPVID)

The port and protocol VLAN ID field shall contain the PPVID number for this IEEE 802 LAN station. If the port is not capable of supporting port and protocol VLANs and/or the port is not enabled with any port and protocol VLAN, the PPVID number should be zero.

F.3.3 Port And Protocol VLAN ID TLV usage rules

Port And Protocol VLAN ID TLVs are subject to the following rules:

a) If more than one Port And Protocol VLAN ID TLV is defined for a port, the PPVID value shall be different from any other PPVID defined for the port.

b) If the support bit (bit 1) of the flag field indicates that the port is not capable of supporting port and protocol VLANs but the enabled bit (bit 2) indicates that the port is enabled with one or more port and protocol VLANs, the Port And Protocol VLAN ID TLV will be interpreted as containing an error and will be discarded.

c) If the PPVID reference number is greater than 4094, the Port And Protocol VLAN ID TLV will be interpreted as containing an error and will be discarded.

F.4 VLAN Name TLV

The VLAN Name TLV is an optional TLV that allows an IEEE 802.1Q-compatible IEEE 802 LAN station to advertise the assigned name of any VLAN with which it is configured.

Figure F-3 shows the VLAN Name TLV format.

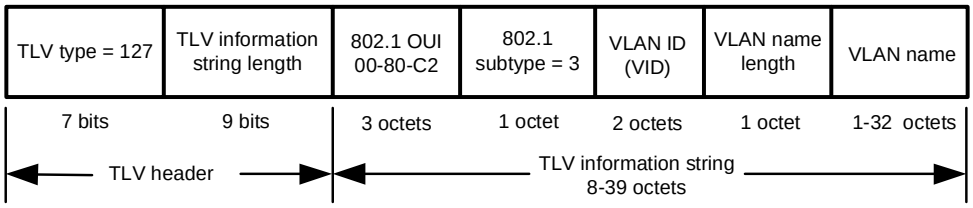


Figure F-3—VLAN Name TLV format

F.4.1 TLV information string length

The TLV information string length field shall contain the length, in octets, of the (VLAN name + 7).

F.4.2 VLAN ID (VID)

The VLAN ID field shall contain the VID number associated with the VLAN name.

F.4.3 VLAN name length

The VLAN name length field shall contain the length, in octets, of the VLAN name.

F.4.4 VLAN name

The VLAN name field shall contain the VLAN's name. If implementations support IETF RFC 2674, the dot1QVLANStaticName object should be used for this field.

F.4.5 VLAN Name TLV usage rules

If more than one VLAN Name TLV is defined for a port, the VLAN ID and the associated VLAN name combination shall be different from any other VLAN ID and VLAN name combination defined for the port.

F.5 Protocol Identity TLV

The Protocol Identity TLV is an optional TLV that allows an IEEE 802 LAN station to advertise particular protocols that are accessible through the port. Figure F-4 shows the protocol identity TLV format.

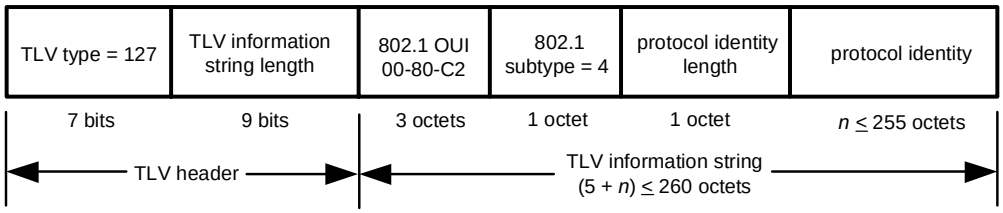


Figure F-4—Protocol Identity TLV format

F.5.1 TLV information string length

The TLV information string length field shall contain the length, in octets, of the (protocol identity + 5).

F.5.2 protocol identity length

The protocol identity length field shall contain the length, in octets, of the protocol identity.

F.5.3 protocol identity

The protocol identity field shall contain the first n octets of the protocol after the layer 2 addresses (i.e.for example, starting with the Ethertype field) that the sender would like to advertise. The value of *n* is determined by the need for the protocol to disambiguate itself. The protocol information string shall include enough octets to allow the receiver to correctly identify the protocol and its version. To advertise Spanning Tree Protocols, for example, the protocol identity field would need to include at least eight octets: IEEE 802.3 length (two octets), LLC addresses (two octets), IEEE 802.3 control (one octet), Protocol ID (two octets), and the protocol version (one octet).

F.5.4 Protocol Identity TLV usage rules

If more than one Protocol Identity TLV is defined for a port, the protocol identity field value shall be different from any other Protocol Identity TLV defined for the port.

F.6 IEEE 802.1 Organizationally Specific TLV management

F.6.1 IEEE 802.1 Organizationally Specific TLV selection management

TLV selection management consists of providing the network manager with the means to select which specific IEEE 802.1 Organizationally Specific TLVs are enabled for inclusion in an LLDPDU. The following LLDP variables cross reference to LLDP local systems configuration MIB tables indicate which specific TLVs are enabled for the particular port(s) on the system. The specific port(s) through which each TLV is enabled for transmission may be set (or reset) by the network manager:

a) **mibXdot1PortVlanTxEnable:** This variable lists the VLAN ID of the port through which the referenced TLV is enabled for transmission.

b) **mibXdot1VlanNameConfigTxEnable:** This variable lists the different VLAN name/PPVID TLVs that are defined for the system, each with a bit map indicating the system ports through which the particular VLAN name TLV is enabled for transmission.

c) **mibXdot1ProtoVlanConfigTxEnable:** This variable lists the port and protocol VLAN TLVs that are defined for the system, each with a bit map indicating the system ports through which the particular port and protocol VLAN TLV is enabled for transmission.

d) **mibXdot1ProtocolConfigTxEnable:** This variable lists the protocol identity TLVs that are defined for the system, each with a bit map indicating the system ports through which the particular protocol TLV is enabled for transmission.

F.6.2 IEEE 802.1 managed objects—TLV variables

F.6.2.1 Port VLAN ID TLV managed objects

a) **PVID:** The port VLAN identifier (see F.2.1).

F.6.2.2 Port And Protocol VLAN ID TLV managed objects

a) **Port and protocol VLAN supported:** A flag indicating whether port and protocol VLANs are supported (see F.3.1).

b) **Port and protocol VLAN enabled:** A flag indicating whether port and protocol VLANs are enabled (see F.3.1).

c) **PPVID:** The advertised port and protocol VLAN ID (see F.3.2).

F.6.2.3 VLAN Name TLV managed objects

a) **VID:** The VLAN ID associated with the VLAN name (see F.4.2).

b) **VLAN name length:** The length of the VLAN name (see F.4.3).

c) **VLAN name:** The VLAN's name (see F.4.4).

F.6.2.4 Protocol Identity TLV managed objects

a) **protocol identity length:** The length of the protocol identity (see F.5.2).

b) **protocol identity:** The protocol's identity (see F.5.3).

F.6.3 IEEE 802.1 Organizationally Specific TLV variable/MIB object cross reference

Table F-3 lists the relationship both between 802.3 TLV selection variables and their corresponding LLDP CONFIG objects.

Table F-3—802.1 Organizationally Specific TLV selection variable/LLDP MIB object cross reference

802.1 TLV selection variable	LLDP 802.1 MIB extension object
mibXdot1PortVlanTLVTxEnable	lldpXdot1configPortVlanTxEnable
mibXdot1VlanNameTLVsTxEnable	mibXdot1ConfigVlanNameTxEnable
mibXdot1ProtoVlanTLVsTxEnable	mibXdot1ConfigProtoVlanTxEnable
mibXdot1ProtocolTLVsTxEnable	mibXdot1ConfigProtocolTxEnable

F.6.4 IEEE 802.1 Organizationally Specific TLV/MIB object cross references

The cross references between the IEEE 802.1 Organizationally Specific TLVs and the LLDP local system MIB objects are listed in Table F-4.

Table F-4—IEEE 802.1 Organizationally Specific TLV/local system MIB cross references

TLV name	TLV variable	LLDP local system MIB Object
Port VLAN ID	PVID	lldpXdot1LocPortVlanId
Port And Protocol VLAN ID	port and protocol VLAN supported	lldpXdot1LocProtoVlanSupported
	port and protocol VLAN enabled	lldpXdot1LocProtoVlanEnabled
	PPVID	lldpXdot1LocProtoVlanId
VLAN Name	VID	lldpXdot1LocVlanId
	VLAN name length	lldpXdot1LocVlanName
	VLAN name	lldpXdot1LocVlanName
Protocol Identity	protocol identity length	lldpXdot1LocProtoId
	protocol identity	lldpXdot1LocProtoId

The cross references between the IEEE 802.1 Organizationally Specific TLVs and the LLDP remote systems MIB objects are listed in Table F-5.

Table F-5—IEEE 802.1 Organizationally Specific TLV/remote system MIB cross references

TLV name	TLV variable	LLDP remote systems MIB Object
Port VLAN ID	PVID	lldpXdot1RemPortVlanId
Port And Protocol VLAN ID	port and protocol VLAN supported	lldpXdot1RemProtoVlanSupported
	port and protocol VLAN enabled	lldpXdot1RemProtoVlanEnabled
	PPVID	lldpXdot1RemProtoVlanId
VLAN Name	VID	lldpXdot1RemVlanId
	VLAN name length	lldpXdot1RemVlanName
	VLAN name	lldpXdot1RemVlanName
Protocol Identity	protocol identity length	lldpXdot1RemProtoId
	protocol identity	lldpXdot1RemProtoId

F.7 IEEE 802.1/LLDP extension MIB

This MIB is designed to operate in a manner consistent with the principles of the Internet-Standard Management Framework, which describes the separation of a data modeling language (for example, SMIv2) from content specific data models (for example the LLDP remote systems MIB), and from messages and protocol operations used to manipulate the data (for example SNMPv3). Managed objects are accessed via a virtual information store (the MIB). MIB objects are generally accessed through SNMP. Objects in the MIB are defined using the mechanisms of the Structure of Management Information (SMI). For an overview of this structure, see section 7 of IETF RFC 3410.

However, it is not required for LLDP implementations to support SNMP to store and retrieve system data. LLDP agents need to have a place to store both information about the local system and information they have received about remote systems. No particular implementation is implied.

Table F-6 summarizes the particular object groups that are required for each operating mode. The implemented MIB shall comply with the MIB conformance section for the particular operating mode being supported.

Table F-6—802.1 extension MIB object group conformance requirements

MIB group	Rx mode	Tx mode	Tx/Rx mode
lldpXdot1LocSystemsGroup	M*	—	M
lldpXdot1RemSystemsGroup	—	M	M

*Mandatory

F.7.1 IEEE 802.1 LLDP extension MIB module [18],[19]

In the following MIB definition, should any discrepancy between the DESCRIPTION text and the corresponding definition in F.2, F.3, F.4, and F.5 of this annex occur, the definition in F.2, F.3, F.4, and F.5 shall take precedence.

```
LLDP-EXT-DOT1-MIB DEFINITIONS ::= BEGIN

IMPORTS
    MODULE-IDENTITY, OBJECT-TYPE, Integer32
        FROM SNMPv2-SMI
    TruthValue
        FROM SNMPv2-TC
    SnmpAdminString
        FROM SNMP-FRAMEWORK-MIB
    MODULE-COMPLIANCE, OBJECT-GROUP
        FROM SNMPv2-CONF
    lldpExtensions, lldpLocPortNum,
    lldpRemTimeMark, lldpRemLocalPortNum, lldpRemIndex,
    lldpPortConfigEntry
        FROM LLDP-MIB
   VlanId
        FROM Q-BRIDGE-MIB;

lldpXdot1MIB MODULE-IDENTITY
    LAST-UPDATED "200505060000Z" -- May 06, 2005
    ORGANIZATION "IEEE 802.1 Working Group"
    CONTACT-INFO
            "  WG-URL: http://grouper.ieee.org/groups/802/1/index.html
             WG-EMail: stds-802-1@ieee.org

              Contact: Paul Congdon
               Postal: Hewlett-Packard Company
                       8000 Foothills Blvd.
                       Roseville, CA 95747
                       USA
                  Tel: +1-916-785-5753
               E-mail: paul_congdon@hp.com"
    DESCRIPTION
            "The LLDP Management Information Base extension module for
            IEEE 802.1 organizationally defined discovery information.

            In order to assure the uniqueness of the LLDP-MIB,
            lldpXdot1MIB is branched from lldpExtensions using OUI value
            as the node.  An OUI/'company_id' is a 24 bit globally unique
            assigned number referenced by various standards.

            Copyright (C) IEEE (2005).  This version of this MIB module
            is published as Annex F.7.1 of IEEE Std 802.1AB-2005;
            see the standard itself for full legal notices."
    REVISION "200505060000Z" -- May 06, 2005
DESCRIPTION
            "Published as part of IEEE Std 802.1AB-2005 initial version."
-- OUI for IEEE 802.1 is 32962 (00-80-C2)
```

[18]*Copyright release for MIBs:* Users of this standard may freely reproduce the MIB contained in this subclause so that it can be used for its intended purpose.

[19]An ASCII version of this MIB module can be obtained by Web browser from the IEEE 802.1 Website at http://www.ieee802.org/1/pages/MIBS.html.


```
   ::= { lldpExtensions 32962 }

-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
--
-- Organizationally Defined Information Extension - IEEE 802.1
--
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------

lldpXdot1Objects    OBJECT IDENTIFIER ::= { lldpXdot1MIB 1 }

-- LLDP IEEE 802.1 extension MIB groups
lldpXdot1Config     OBJECT IDENTIFIER ::= { lldpXdot1Objects 1 }
lldpXdot1LocalData  OBJECT IDENTIFIER ::= { lldpXdot1Objects 2 }
lldpXdot1RemoteData OBJECT IDENTIFIER ::= { lldpXdot1Objects 3 }

-------------------------------------------------------------------------------
-- IEEE 802.1 - Configuration
-------------------------------------------------------------------------------
--
-- lldpXdot1ConfigPortVlanTable : configure the transmission of the
--                                Port VLAN-ID TLVs on set of ports.
--

lldpXdot1ConfigPortVlanTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot1ConfigPortVlanEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "A table that controls selection of LLDP Port VLAN-ID TLVs
            to be transmitted on individual ports."
    ::= { lldpXdot1Config 1 }

lldpXdot1ConfigPortVlanEntry  OBJECT-TYPE
    SYNTAX      LldpXdot1ConfigPortVlanEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "LLDP configuration information that controls the
            transmission of IEEE 802.1 organizationally defined Port
            VLAN-ID TLV on LLDP transmission capable ports.

            This configuration object augments the lldpPortConfigEntry of
            the LLDP-MIB, therefore it is only present along with the port
            configuration defined by the associated lldpPortConfigEntry
            entry.

            Each active lldpConfigEntry must be restored from non-volatile
            storage (along with the corresponding lldpPortConfigEntry)
            after a re-initialization of the management system."
    AUGMENTS { lldpPortConfigEntry }
    ::= { lldpXdot1ConfigPortVlanTable 1 }

LldpXdot1ConfigPortVlanEntry ::= SEQUENCE {
      lldpXdot1ConfigPortVlanTxEnable  TruthValue
}

lldpXdot1ConfigPortVlanTxEnable OBJECT-TYPE
```

```
    SYNTAX      TruthValue
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
            "The lldpXdot1ConfigPortVlanTxEnable, which is defined as
            a truth value and configured by the network management,
            determines whether the IEEE 802.1 organizationally defined
            port VLAN TLV transmission is allowed on a given LLDP
            transmission capable port.

            The value of this object must be restored from non-volatile
            storage after a re-initialization of the management system."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.2.1.1"
    DEFVAL  { false }
    ::= { lldpXdot1ConfigPortVlanEntry 1 }

--
-- lldpXdot1ConfigVlanNameTable : configure the transmission of the
--                                VLAN name instances on set of ports.
--

lldpXdot1ConfigVlanNameTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot1ConfigVlanNameEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The table that controls selection of LLDP VLAN name TLV
            instances to be transmitted on individual ports."
    ::= { lldpXdot1Config 2 }

lldpXdot1ConfigVlanNameEntry  OBJECT-TYPE
    SYNTAX      LldpXdot1ConfigVlanNameEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "LLDP configuration information that specifies the set of
            ports (represented as a PortList) on which the Local System
            VLAN name instance will be transmitted.

            This configuration object augments the lldpLocVlanEntry,
            therefore it is only present along with the VLAN Name instance
            contained in the associated lldpLocVlanNameEntry entry.

            Each active lldpXdot1ConfigVlanNameEntry must be restored
            from non-volatile storage (along with the corresponding
            lldpXdot1LocVlanNameEntry) after a re-initialization of the
            management system."
    AUGMENTS { lldpXdot1LocVlanNameEntry }
    ::= { lldpXdot1ConfigVlanNameTable 1 }

LldpXdot1ConfigVlanNameEntry ::= SEQUENCE {
      lldpXdot1ConfigVlanNameTxEnable  TruthValue
}

lldpXdot1ConfigVlanNameTxEnable  OBJECT-TYPE
    SYNTAX        TruthValue
    MAX-ACCESS    read-write
    STATUS        current
```



```
    DESCRIPTION
            "The boolean value that indicates whether the corresponding
            Local System VLAN name instance will be transmitted on the
            port defined by the given lldpXdot1LocVlanNameEntry.

            The value of this object must be restored from non-volatile
            storage after a re-initialization of the management system."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.2.1.1"
    DEFVAL  { false }
    ::= { lldpXdot1ConfigVlanNameEntry 1 }

--
-- lldpXdot1ConfigProtoVlanTable : configure the transmission of the
--                                 protocol VLAN instances on set
--                                 of ports.
--

lldpXdot1ConfigProtoVlanTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot1ConfigProtoVlanEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The table that controls selection of LLDP Port and Protocol
            VLAN ID TLV instances to be transmitted on individual ports."
    ::= { lldpXdot1Config 3 }

lldpXdot1ConfigProtoVlanEntry  OBJECT-TYPE
    SYNTAX      LldpXdot1ConfigProtoVlanEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "LLDP configuration information that specifies the set of
            ports (represented as a PortList) on which the Local System
            Protocol VLAN instance will be transmitted.

            This configuration object augments the lldpXdot1LocVlanEntry,
            therefore it is only present along with the Port and
            Protocol VLAN ID instance contained in the associated
            lldpXdot1LocVlanEntry entry.

            Each active lldpXdot1ConfigProtoVlanEntry must be restored
            from non-volatile storage (along with the corresponding
            lldpXdot1LocProtoVlanEntry) after a re-initialization of
            the management system."

    AUGMENTS { lldpXdot1LocProtoVlanEntry }
    ::= { lldpXdot1ConfigProtoVlanTable 1 }

LldpXdot1ConfigProtoVlanEntry ::= SEQUENCE {
      lldpXdot1ConfigProtoVlanTxEnable   TruthValue
}

lldpXdot1ConfigProtoVlanTxEnable OBJECT-TYPE
    SYNTAX        TruthValue
    MAX-ACCESS    read-write
    STATUS        current
    DESCRIPTION
            "The boolean value that indicates whether the corresponding
```

```
            Local System Port and Protocol VLAN instance will
            be transmitted on the port defined by the given
            lldpXdot1LocProtoVlanEntry.

            The value of this object must be restored from non-volatile
            storage after a re-initialization of the management system."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.2.1.1"
    DEFVAL  { false }
    ::= { lldpXdot1ConfigProtoVlanEntry 1 }

--
-- lldpXdot1ConfigProtocolTable : configure the transmission of the
--                                protocol instances on set
--                                of ports.
--

lldpXdot1ConfigProtocolTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot1ConfigProtocolEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The table that controls selection of LLDP Protocol
            TLV instances to be transmitted on individual ports."
    ::= { lldpXdot1Config 4 }

lldpXdot1ConfigProtocolEntry  OBJECT-TYPE
    SYNTAX      LldpXdot1ConfigProtocolEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "LLDP configuration information that specifies the set of
            ports (represented as a PortList) on which the Local System
            Protocol instance will be transmitted.

            This configuration object augments the lldpXdot1LocProtoEntry,
            therefore it is only present along with the Protocol instance
            contained in the associated lldpXdot1LocProtoEntry entry.

            Each active lldpXdot1ConfigProtocolEntry must be restored
            from non-volatile storage (along with the corresponding
            lldpXdot1LocProtocolEntry) after a re-initialization of the
            management system."
    AUGMENTS { lldpXdot1LocProtocolEntry }
    ::= { lldpXdot1ConfigProtocolTable 1 }

LldpXdot1ConfigProtocolEntry ::= SEQUENCE {
      lldpXdot1ConfigProtocolTxEnable   TruthValue
}

lldpXdot1ConfigProtocolTxEnable  OBJECT-TYPE
    SYNTAX        TruthValue
    MAX-ACCESS    read-write
    STATUS        current
    DESCRIPTION
            "The boolean value that indicates whether the corresponding
            Local System Protocol Identity instance will be transmitted
            on the port defined by the given lldpXdot1LocProtocolEntry.
```



```
            The value of this object must be restored from non-volatile
            storage after a re-initialization of the management system."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.2.1.1"
    DEFVAL  { false }
    ::= { lldpXdot1ConfigProtocolEntry 1 }

--------------------------------------------------------------------------------
-- IEEE 802.1 - Local System Information
--------------------------------------------------------------------------------
lldpXdot1LocTable  OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot1LocEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains one row per port for IEEE 802.1
            organizationally defined LLDP extension on the local system
            known to this agent."
    ::= { lldpXdot1LocalData 1 }

lldpXdot1LocEntry  OBJECT-TYPE
    SYNTAX      LldpXdot1LocEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Information about IEEE 802.1 organizationally defined
            LLDP extension."
    INDEX   { lldpLocPortNum }
    ::= { lldpXdot1LocTable 1 }

LldpXdot1LocEntry ::= SEQUENCE {
              lldpXdot1LocPortVlanId         Integer32
}

lldpXdot1LocPortVlanId OBJECT-TYPE
    SYNTAX      Integer32(0|1..4094)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The integer value used to identify the port's VLAN identifier
            associated with the local system.   A value of zero shall
            be used if the system either does not know the PVID or does
            not support port-based VLAN operation."
    REFERENCE
            "IEEE Std 802.1AB-2005 F.2.1"
    ::= { lldpXdot1LocEntry 1 }

--
-- lldpXdot1LocProtoVlanTable: Port and Protocol VLAN information
--

lldpXdot1LocProtoVlanTable  OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot1LocProtoVlanEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains one or more rows per Port and Protocol
            VLAN information about the local system."
    ::= { lldpXdot1LocalData 2 }
```

```
lldpXdot1LocProtoVlanEntry OBJECT-TYPE
    SYNTAX      LldpXdot1LocProtoVlanEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Port and protocol VLAN ID Information about a particular
            port component.  There may be multiple port and protocol VLANs,
            identified by a particular lldpXdot1LocProtoVlanId, configured
            on the given port."
    INDEX   { lldpLocPortNum,
              lldpXdot1LocProtoVlanId }
    ::= { lldpXdot1LocProtoVlanTable 1 }

LldpXdot1LocProtoVlanEntry ::= SEQUENCE {
      lldpXdot1LocProtoVlanId        Integer32,
      lldpXdot1LocProtoVlanSupported TruthValue,
      lldpXdot1LocProtoVlanEnabled   TruthValue
}

lldpXdot1LocProtoVlanId  OBJECT-TYPE
    SYNTAX      Integer32(0|1..4094)
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The integer value used to identify the port and protocol
            VLANs associated with the given port associated with the
            local system.  A value of zero shall be used if the system
            either does not know the protocol VLAN ID (PPVID) or does
            not support port and protocol VLAN operation."
    REFERENCE
            "IEEE Std 802.1AB-2005 F.3.2"
    ::= { lldpXdot1LocProtoVlanEntry 1 }

lldpXdot1LocProtoVlanSupported  OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The truth value used to indicate whether the given port
            (associated with the local system) supports port and protocol
            VLANs."
    REFERENCE
            "IEEE Std 802.1AB-2005 F.3.1"
    ::= { lldpXdot1LocProtoVlanEntry 2 }

lldpXdot1LocProtoVlanEnabled  OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The truth value used to indicate whether the port and
            protocol VLANs are enabled on the given port associated with
            the local system."
    REFERENCE
            "IEEE Std 802.1AB-2005 F.3.1"
    ::= { lldpXdot1LocProtoVlanEntry 3 }

--
```



```
-- lldpXdot1LocVlanNameTable : VLAN name information about the local system
--

lldpXdot1LocVlanNameTable  OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot1LocVlanNameEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains one or more rows per IEEE 802.1Q VLAN
            name information on the local system known to this agent."
    ::= { lldpXdot1LocalData 3 }

lldpXdot1LocVlanNameEntry OBJECT-TYPE
    SYNTAX      LldpXdot1LocVlanNameEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "VLAN name Information about a particular port component.
            There may be multiple VLANs, identified by a particular
            lldpXdot1LocVlanId, configured on the given port."
    INDEX   { lldpLocPortNum,
              lldpXdot1LocVlanId }
    ::= { lldpXdot1LocVlanNameTable 1 }

LldpXdot1LocVlanNameEntry ::= SEQUENCE {
      lldpXdot1LocVlanId     VlanId,
      lldpXdot1LocVlanName   SnmpAdminString
}

lldpXdot1LocVlanId  OBJECT-TYPE
    SYNTAX      VlanId
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The integer value used to identify the IEEE 802.1Q
            VLAN IDs with which the given port is compatible."
    REFERENCE
            "IEEE Std 802.1AB-2005 F.4.2"
    ::= { lldpXdot1LocVlanNameEntry 1 }

lldpXdot1LocVlanName  OBJECT-TYPE
    SYNTAX      SnmpAdminString (SIZE(1..32))
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The string value used to identify VLAN name identified by the
            Vlan Id associated with the given port on the local system.

            This object should contain the value of the dot1QVLANStaticName
            object (defined in IETF RFC 2674) identified with the given
            lldpXdot1LocVlanId."
    REFERENCE
            "IEEE Std 802.1AB-2005 F.4.4"
    ::= { lldpXdot1LocVlanNameEntry 2 }

--
-- lldpXdot1LocProtocolTable : Protocol Identity information
--
```

```
lldpXdot1LocProtocolTable  OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot1LocProtocolEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains one or more rows per protocol identity
            information on the local system known to this agent."
    REFERENCE
            "IEEE Std 802.1AB-2005 F.5"
    ::= { lldpXdot1LocalData 4 }

lldpXdot1LocProtocolEntry  OBJECT-TYPE
    SYNTAX      LldpXdot1LocProtocolEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Information about particular protocols that are accessible
            through the given port component.

            There may be multiple protocols, identified by particular
            lldpXdot1ProtocolIndex, and lldpLocPortNum."
    REFERENCE
            "IEEE Std 802.1AB-2005 F.5"
    INDEX   { lldpLocPortNum,
              lldpXdot1LocProtocolIndex }
    ::= { lldpXdot1LocProtocolTable 1 }

LldpXdot1LocProtocolEntry ::= SEQUENCE {
      lldpXdot1LocProtocolIndex Integer32,
      lldpXdot1LocProtocolId    OCTET STRING
}

lldpXdot1LocProtocolIndex  OBJECT-TYPE
    SYNTAX      Integer32(1..2147483647)
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This object represents an arbitrary local integer value used
            by this agent to identify a particular protocol identity."
    ::= { lldpXdot1LocProtocolEntry 1 }

lldpXdot1LocProtocolId  OBJECT-TYPE
    SYNTAX      OCTET STRING (SIZE (1..255))
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The octet string value used to identify the protocols
            associated with the given port of the local system."
    REFERENCE
            "IEEE Std 802.1AB-2005 F.5.3"
    ::= { lldpXdot1LocProtocolEntry 2 }


-- ------------------------------------------------------------------------
-- IEEE 802.1 - Remote System Information
-- ------------------------------------------------------------------------
lldpXdot1RemTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot1RemEntry
    MAX-ACCESS  not-accessible
```

```
    STATUS      current
    DESCRIPTION
            "This table contains one or more rows per physical network
            connection known to this agent.  The agent may wish to
            ensure that only one lldpXdot1RemEntry is present for
            each local port, or it may choose to maintain multiple
            lldpXdot1RemEntries for the same local port."
    ::= { lldpXdot1RemoteData 1 }

lldpXdot1RemEntry OBJECT-TYPE
    SYNTAX      LldpXdot1RemEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Information about a particular port component."
    INDEX   { lldpRemTimeMark,
              lldpRemLocalPortNum,
              lldpRemIndex }
    ::= { lldpXdot1RemTable 1 }

LldpXdot1RemEntry ::= SEQUENCE {
              lldpXdot1RemPortVlanId         Integer32
}

lldpXdot1RemPortVlanId OBJECT-TYPE
    SYNTAX      Integer32(0|1..4094)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The integer value used to identify the port's VLAN identifier
            associated with the remote system.  if the remote system
            either does not know the PVID or does not support port-based
            VLAN operation, the value of lldpXdot1RemPortVlanId should
            be zero."
    REFERENCE
            "IEEE Std 802.1AB-2005 F.2.1"
    ::= { lldpXdot1RemEntry 1 }

lldpXdot1RemProtoVlanTable  OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot1RemProtoVlanEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains one or more rows per Port and Protocol
            VLAN information about the remote system, received on the
            given port."
    ::= { lldpXdot1RemoteData 2 }

lldpXdot1RemProtoVlanEntry OBJECT-TYPE
    SYNTAX      LldpXdot1RemProtoVlanEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Port and protocol VLAN name Information about a particular
            port component.  There may be multiple protocol VLANs,
            identified by a particular lldpXdot1RemProtoVlanId, configured
            on the remote system."
    INDEX   { lldpRemTimeMark,
              lldpRemLocalPortNum,
```

```
              lldpRemIndex,
              lldpXdot1RemProtoVlanId }
    ::= { lldpXdot1RemProtoVlanTable 1 }

LldpXdot1RemProtoVlanEntry ::= SEQUENCE {
      lldpXdot1RemProtoVlanId        Integer32,
      lldpXdot1RemProtoVlanSupported TruthValue,
      lldpXdot1RemProtoVlanEnabled   TruthValue
}

lldpXdot1RemProtoVlanId  OBJECT-TYPE
    SYNTAX      Integer32(0|1..4094)
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The integer value used to identify the port and protocol
            VLANs associated with the given port associated with the
            remote system.

            If port and protocol VLANs are not supported on the given
            port associated with the remote system, or if the port is
            not enabled with any port and protocol VLAN, the value of
            lldpXdot1RemProtoVlanId should be zero."
    REFERENCE
            "IEEE Std 802.1AB-2005 F.3.2"
    ::= { lldpXdot1RemProtoVlanEntry 1 }

lldpXdot1RemProtoVlanSupported  OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The truth value used to indicate whether the given port
            (associated with the remote system) is capable of supporting
            port and protocol VLANs."
    REFERENCE
            "IEEE Std 802.1AB-2005 F.3.1"
    ::= { lldpXdot1RemProtoVlanEntry 2 }

lldpXdot1RemProtoVlanEnabled  OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The truth value used to indicate whether the port and
            protocol VLANs are enabled on the given port associated with
            the remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 F.3.1"
    ::= { lldpXdot1RemProtoVlanEntry 3 }


--
-- lldpXdot1RemVlanNameTable : VLAN name information of the remote
--                             systems
--

lldpXdot1RemVlanNameTable  OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot1RemVlanNameEntry
```



```
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains one or more rows per IEEE 802.1Q VLAN
            name information about the remote system, received on the
            given port."
    REFERENCE
            "IEEE Std 802.1AB-2005 F.4"
    ::= { lldpXdot1RemoteData 3 }

lldpXdot1RemVlanNameEntry OBJECT-TYPE
    SYNTAX      LldpXdot1RemVlanNameEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "VLAN name Information about a particular port component.
            There may be multiple VLANs, identified by a particular
            lldpXdot1RemVlanId, received on the given port."
    INDEX   { lldpRemTimeMark,
              lldpRemLocalPortNum,
              lldpRemIndex,
              lldpXdot1RemVlanId }
    ::= { lldpXdot1RemVlanNameTable 1 }

LldpXdot1RemVlanNameEntry ::= SEQUENCE {
      lldpXdot1RemVlanId     VlanId,
      lldpXdot1RemVlanName   SnmpAdminString
}

lldpXdot1RemVlanId  OBJECT-TYPE
    SYNTAX      VlanId
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "The integer value used to identify the IEEE 802.1Q
            VLAN IDs with which the given port of the remote system
            is compatible."
    REFERENCE
            "IEEE Std 802.1AB-2005 F.4.2"
    ::= { lldpXdot1RemVlanNameEntry 1 }

lldpXdot1RemVlanName  OBJECT-TYPE
    SYNTAX      SnmpAdminString (SIZE(1..32))
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The string value used to identify VLAN name identified by the
            VLAN Id associated with the remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 F.4.4"
    ::= { lldpXdot1RemVlanNameEntry 2 }

--
-- lldpXdot1RemProtocolTable : Protocol information of the remote systems
--

lldpXdot1RemProtocolTable  OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot1RemProtocolEntry
    MAX-ACCESS  not-accessible
```

```
    STATUS      current
    DESCRIPTION
            "This table contains one or more rows per protocol information
            about the remote system, received on the given port."
    ::= { lldpXdot1RemoteData 4 }

lldpXdot1RemProtocolEntry  OBJECT-TYPE
    SYNTAX      LldpXdot1RemProtocolEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Protocol information about a particular port component.
            There may be multiple protocols, identified by a particular
            lldpXdot1ProtocolIndex, received on the given port."
    INDEX   { lldpRemTimeMark,
              lldpRemLocalPortNum,
              lldpRemIndex,
              lldpXdot1RemProtocolIndex }
    ::= { lldpXdot1RemProtocolTable 1 }

LldpXdot1RemProtocolEntry ::= SEQUENCE {
      lldpXdot1RemProtocolIndex Integer32,
      lldpXdot1RemProtocolId    OCTET STRING
}

lldpXdot1RemProtocolIndex  OBJECT-TYPE
    SYNTAX      Integer32(1..2147483647)
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This object represents an arbitrary local integer value used
            by this agent to identify a particular protocol identity."
    ::= { lldpXdot1RemProtocolEntry 1 }

lldpXdot1RemProtocolId  OBJECT-TYPE
    SYNTAX      OCTET STRING (SIZE (1..255))
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The octet string value used to identify the protocols
            associated with the given port of remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 F.5.3"
    ::= { lldpXdot1RemProtocolEntry 2 }


-- ----------------------------------------------------------------------------
-- Conformance Information
-- ----------------------------------------------------------------------------

lldpXdot1Conformance OBJECT IDENTIFIER ::= { lldpXdot1MIB 2 }
lldpXdot1Compliances OBJECT IDENTIFIER ::= { lldpXdot1Conformance 1 }
lldpXdot1Groups      OBJECT IDENTIFIER ::= { lldpXdot1Conformance 2 }

-- compliance statements

lldpXdot1Compliance MODULE-COMPLIANCE
    STATUS  current
    DESCRIPTION
```



```
            "The compliance statement for SNMP entities which implement
            the IEEE 802.1 organizationally defined LLDP extension MIB."
    MODULE  -- this module
        MANDATORY-GROUPS { lldpXdot1ConfigGroup,
                           lldpXdot1LocSysGroup,
                           lldpXdot1RemSysGroup
        }
    ::= { lldpXdot1Compliances 1 }

-- MIB groupings

lldpXdot1ConfigGroup    OBJECT-GROUP
    OBJECTS {
        lldpXdot1ConfigPortVlanTxEnable,
        lldpXdot1ConfigVlanNameTxEnable,
        lldpXdot1ConfigProtoVlanTxEnable,
        lldpXdot1ConfigProtocolTxEnable
    }
    STATUS  current
    DESCRIPTION
            "The collection of objects which are used to configure the
            IEEE 802.1 organizationally defined LLDP extension
            implementation behavior.

            This group is mandatory for agents which implement the
            IEEE 802.1 organizationally defined LLDP extension."
    ::= { lldpXdot1Groups 1 }

lldpXdot1LocSysGroup  OBJECT-GROUP
    OBJECTS {
        lldpXdot1LocPortVlanId,
        lldpXdot1LocProtoVlanSupported,
        lldpXdot1LocProtoVlanEnabled,
        lldpXdot1LocVlanName,
        lldpXdot1LocProtocolId
    }
    STATUS  current
    DESCRIPTION
            "The collection of objects which are used to represent
            IEEE 802.1 organizationally defined LLDP extension associated
            with the Local Device Information.

            This group is mandatory for agents which implement the
            IEEE 802.1 organizationally defined LLDP extension in the
            TX mode."
    ::= { lldpXdot1Groups 2 }

lldpXdot1RemSysGroup  OBJECT-GROUP
    OBJECTS {
        lldpXdot1RemPortVlanId,
        lldpXdot1RemProtoVlanSupported,
        lldpXdot1RemProtoVlanEnabled,
        lldpXdot1RemVlanName,
        lldpXdot1RemProtocolId
    }
    STATUS  current
    DESCRIPTION
            "The collection of objects which are used to represent LLDP
            802.1 organizational extension Local Device Information.
```

```
            This group is mandatory for agents which implement the
            LLDP 802.1 organizational extension in the RX mode."
    ::= { lldpXdot1Groups 3 }

END
```

F.7.2 Security considerations for IEEE 802.1 LLDP extension MIB module

There are a number of management objects defined in this MIB module with a MAX-ACCESS clause of read-write.[20] Such objects may be considered sensitive or vulnerable in some network environments. The support for SET operations in a non-secure environment without proper protection can have a negative effect on network operations.

Setting the following objects to incorrect values can result in improper operation of LLDP when in the transmit mode:

a) lldpXdot1ConfigPortVlanTxEnable.

b) lldpXdot1ConfigVlanNameTxEnable.

c) lldpXdot1ConfigProtoVlanTxEnable.

d) lldpXdot1ConfigProtocolTxEnable.

The following readable objects in this MIB module may be considered to be sensitive or vulnerable in some network environments:

e) MIB objects that are related to the transmit mode:

   1) lldpXdot1LocPortVlanId.

   2) lldpXdot1LocProtoVlanSupported.

   3) lldpXdot1LocProtoVlanEnabled.

   4) lldpXdot1LocVlanName.

   5) lldpXdot1LocProtocolId.

f) MIB objects that are related to the receive mode:

   1) lldpXdot1RemPortVlanId.

   2) lldpXdot1RemProtoVlanSupported.

   3) lldpXdot1RemProtoVlanEnabled.

   4) lldpXdot1RemVlanName.

   5) lldpXdot1RemProtocolId.

This concern applies both to objects that describe the configuration of the local host, as well as for objects that describe information from the remote hosts, acquired via LLDP and displayed by the objects in this MIB module. It is thus important to control even GET and/or NOTIFY access to these objects and possibly to even encrypt the values of these objects when sending them over the network via SNMP.

SNMP versions prior to SNMPv3 did not include adequate security. Even if the network itself is secure (for example by using IPSec), even then, there is no control as to who on the secure network is allowed to access and GET/SET (read/change/create/delete) the objects in this MIB module.

[20]In IETF MIB definitions, the MAX-ACCESS clause defines the type of access that is allowed for particular data elements in the MIB. An explanation of the MAX-ACCESS mappings is given in section 7.3 of IETF RFC 2578 [B10].

Implementers should consider the security features as provided by the SNMPv3 framework (see RFC 3410, section 8), including full support for the SNMPv3 cryptographic mechanisms (for authentication and privacy).

Further, implementers should not deploy SNMP versions prior to SNMPv3. Instead**,** implementers should deploy SNMPv3 to enable cryptographic security. It is then a customer/operator responsibility to ensure that the SNMP entity giving access to an instance of this MIB module is properly configured to give access to the objects only to those principals (users) that have legitimate rights to indeed GET or SET (change/ create/delete) them.

F.8 PICS proforma for IEEE 802.1 Organizationally SpecificTLV extensions[21]

F.8.1 Implementation identification

Supplier	
Contact point for queries about the PICS	
Implementation Name(s) and Version(s)	
Other information necessary for full identification—e.g., name(s) and version(s) of machines and/or operating system names	
NOTES 1—Only the first three items are required for all implementations; other information may be completed as appropriate in meeting the requirement for full identification. 2—The terms Name and Version should be interpreted appropriately to correspond with a supplier's terminology (e.g., Type, Series, Model).	

F.8.2 Protocol summary, IEEE Std 802.1AB-2005

Identification of protocol specification	IEEE Std 802.1AB-2005, Standard for Local and Metropolitan Area Networks: Station and Media Access Control Connectivity Discovery
Identification of amendments and corrigenda to the PICS proforma that have been completed as part of the PICS	Amd. : Corr. : Amd. : Corr. :
Have any Exception items been required? (See B.3.3: The answer Yes means that the implementation does not conform to IEEE Std 802.1AB)	No [ ] Yes [ ]

Date of Statement	

[21]Instructions for completing the PICs Proforma are given in B.3.

F.8.3 Major capabilities and options

Item	Feature	Status	References	Support
dot1xset	Is the IEEE 802.1 Organizationally Specific TLV set implemented	O	Annex F	Yes [ ] No [ ]
dot1xtlv	Is each TLV in the IEEE 802.1 Organizationally Specific TLV set implemented Port VLAN ID TLV Port And Protocol VLAN ID TLV VLAN Name TLV Protocol Identity TLV	 dot1xtlv:M dot1xtlv:M dot1xtlv:M dot1xtlv:M	 F.2 F.3 F.4 F.5	 Yes [ ] Yes [ ] Yes [ ] Yes [ ]
lldpmib	Which type of MIB is implemented (one is mandatory) SNMP is supported (if yes, answer item **snmpmib** and skip **equivstor**) SNMP is not supported (if yes, answer **equivstor** and skip **snmpmib**)	 O.1 O.1	 F.7 F.7	 Yes [ ] No [ ] Yes [ ] No [ ]
snmpmib	If the SNMP MIB is implemented, is the MIB module in conformance with the MIB sections indicated in Table F-6 for the operating mode being implemented	M	F.7	Yes [ ]
equivstor	If the SNMP is not supported, is the provided storage and retieval capability functionally equivalent with the indicated specifications of this clause for the operating mode being implemented	M	F.2. F.3, F.4, F.5, and F.6	Yes [ ]

Annex G

(normative)

IEEE 802.3 Organizationally Specific TLVs

G.1 Requirements of the IEEE 802.3 Organizationally Specific TLV set

If any IEEE 802.3 Organizationally Specific TLV is supported, all IEEE 802.1 Organizationally Specific TLVs shall be supported. All IEEE 802.3 Organizationally Specific TLVs shall conform to the LLDPDU bit and octet ordering conventions of 9.1.

The currently defined IEEE 802.3 Organizationally Specific TLVs are listed in Table G-1. Any adds or changes to these TLVs will be included in this annex.

Table G-1—IEEE 802.3 Organizationally Specific TLVs

IEEE 802.3 subtype	TLV name	Subclause reference
0	reserved	—
1	MAC/PHY Configuration/Status	G.2
2	Power Via MDI	G.3
3	Link Aggregation	G.4
4	Maximum Frame Size	G.5
5–255	reserved	—

G.2 MAC/PHY Configuration/Status TLV

The MAC/PHY Configuration/Status TLV is an optional TLV that identifies:

a) The duplex and bit-rate capability of the sending IEEE 802.3 LAN node that is connected to the physical medium.

b) The current duplex and bit-rate settings of the sending IEEE 802.3 LAN node.

c) Whether these settings are the result of auto-negotiation during link initiation or of manual set override action.

Figure G-1 shows the format of this TLV.

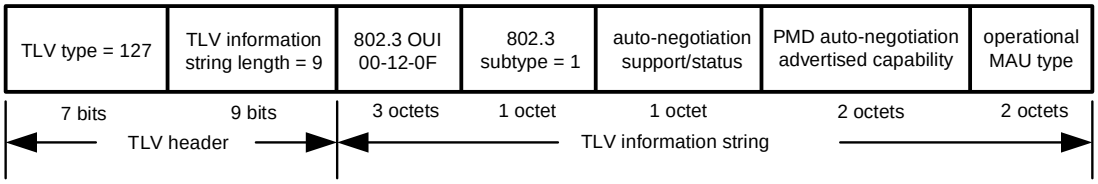


Figure G-1—MAC/PHY configuration/status TLV format

G.2.1 auto-negotiation support/status

The auto-negotiation support/status field shall contain a bit map that identifies the auto-negotiation support and current status of the local 802.3 LAN station as defined in Table G-2. If the auto-negotiation support bit (bit 0) is one and the auto-negotiation status bit (bit 1) is zero, the 802.3 PMD operating mode will be determined the operational MAU type field value rather than by auto-negotiation.

Table G-2—IEEE 802.3 auto-negotiation support/status

Bit	Function	Value/meaning	IETF RFC 3636 reference
0	Auto-negotiation support	1 = supported 0 = not supported	ifMauAutoNegSupported
1	Auto-negotiation status	1 = enabled 0 = not enabled	ifMauAutoNegAdminStatus
2–7	—	reserved	—

G.2.2 PMD auto-negotiation advertised capability field

The PMD auto-negotiation advertised capability field shall contain an integer value as defined by the ifMauAutoNegCapAdvertisedBits object in IETF RFC 3636.

G.2.3 operational MAU type

The operational MAU type field contains an integer value indicating the MAU type of the sending device. This value is derived from the list position of the corresponding dot3MauType as listed in RFC 3636 (or subsequent revisions) and is equal to the last number in the respective dot3MauType OID. For example, if the ifMauType object is dot3MauType1000BaseTHD which corresponds to ‘dot3MauType 29’, the numerical value of this field will be 29. For MAU types not listed in RFC 3636 (or subsequent revisions), the value of this field shall be set to zero. For more information, see IEEE Std 802.3-2002, IEEE Std 802.3ae-2002, and IEEE Std 802.3af-2004.

G.2.4 MAC/PHY Configuration/Status TLV usage rules

An LLDPDU should contain no more than one MAC/PHY Configuration/Status TLV.

G.3 Power Via MDI TLV

Three IEEE 802.3 PMD implementations (10BASE-T, 100BASE-TX, and 1000BASE-T) allow power to be supplied over the link for connected non-powered systems. The Power Via MDI TLV allows network management to advertise and discover the MDI power support capabilities of the sending IEEE 802.3 LAN station. Figure G-2 shows the format of this TLV.

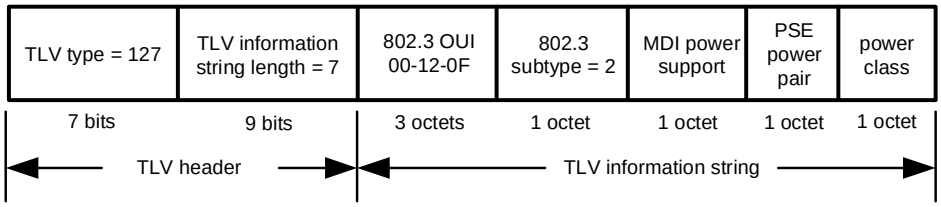


Figure G-2—Power Via MDI TLV format

G.3.1 MDI power support

The MDI power support field shall contain a bit-map of the MDI power capabilities and status as defined in Table G-3.

Table G-3—MDI power capabilities/status

Bit	Function	Value/meaning	IETF RFC 3621 object reference
0	Port class	1 = PSE 0 = PD	See note 1
1	PSE MDI power support	1 = supported 0 = not supported	See note 2 and note 3
2	PSE MDI power state	1 = enabled 0 = disabled	pethPsePortAdminEnable
3	PSE pairs control ability	1 = pair selection can be controlled 0 = pair selection can not be controlled	pethPsePortPowerPairContolAbility
4–7	reserved	—	—

NOTES

1—Port class information is implied by the support of the PSE or PD groups.

2—MDI power support information is implied by support of IETF RFC 3621.

3—If bit 1 is zero, bit 2 has no meaning.

G.3.2 PSE power pair

The PSE power pair field shall contain an integer value as defined by the pethPsePortPowerPairs object in IETF RFC 3621.

G.3.3 power class

The power class field shall contain an integer value as defined by the pethPsePortPowerClassifications object in IETF RFC 3621.

G.3.4 Power Via MDI TLV usage rules

An LLDPDU should contain no more than one Power Via MDI TLV.

G.4 Link Aggregation TLV

The Link Aggregation TLV indicates whether the link is capable of being aggregated, whether the link is currently in an aggregation, and if in an aggregation, the port identification of the aggregation. Figure G-3 shows the format for this TLV.

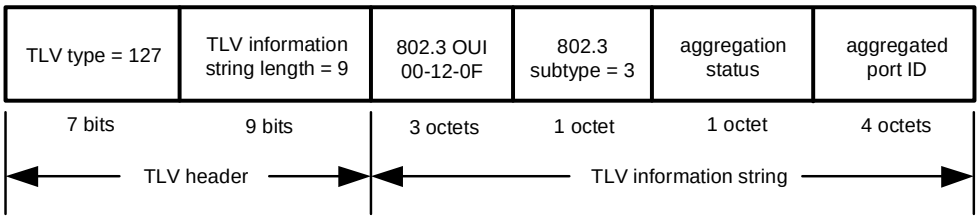


Figure G-3—Link Aggregation TLV format

G.4.1 aggregation status

The link aggregation status field shall contain a bit map of the link aggregation capabilities and the current aggregation status of the link as defined in Table G-4.

Table G-4—Link aggregation capability/status

Bit	Function	Value/meaning
0	Aggregation capability	0 = not capable of being aggregated 1 = capable of being aggregated
1	Aggregation status	0 = not currently in aggregation 1 = currently in aggregation
2–7	reserved	—

G.4.2 aggregated port ID

The aggregated port ID field shall contain the IEEE 802.3 aggregated port identifier, aAggPortID, derived from the ifNumber in the ifIndex for the interface (IEEE 802.3-2002, 30.7.2.1.1).

G.4.3 Link Aggregation TLV usage rules

An LLDPDU should contain no more than one Link Aggregation TLV.

G.5 Maximum Frame Size TLV

The Maximum Frame Size TLV indicates the maximum frame size capability of the implemented MAC and PHY. Figure G-4 shows the format of this TLV.

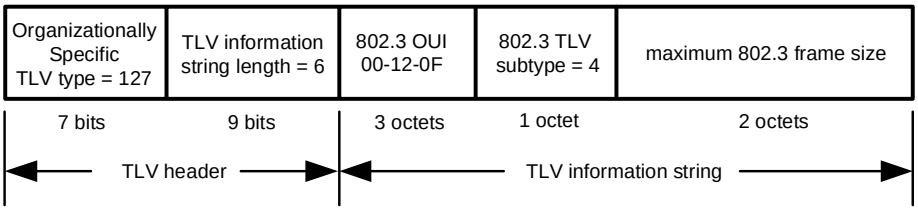


Figure G-4—Maximum Frame Size TLV format

G.5.1 maximum frame size

The maximum frame size field shall contain an integer value indicating the maximum supported frame size in octets as determined by the following:

a) If the MAC/PHY supports only the basic MAC frame format as defined in 3.1.1 of IEEE Std 802.3-2002, the maximum frame size field shall be set to 1518.

b) If the MAC/PHY supports an extension of the basic MAC frame format for Tagged MAC frames as defined 3.5 of IEEE 802.3-2002, the maximum frame size field shall be set to 1522.

c) If the MAC/PHY supports an extension of the MAC frame format that is different from either of the above, the maximum frame size field shall be set to the maximum value supported.

G.5.2 Maximum Frame Size TLV usage rules

An LLDPDU should contain no more than one Maximum Frame Size TLV.

G.6 IEEE 802.3 Organizationally Specific TLV selection management

TLV selection management consists of providing the network manager with the means to select which specific IEEE 802.3 Organizationally Specific TLVs are enabled for inclusion in an LLDPDU. The following LLDP variables cross reference to LLDP local systems configuration MIB tables indicate which specific TLVs are enabled for the particular port(s) on the system. The specific port(s) through which each TLV is enabled for transmission may be set (or reset) by the network manager:

a) **mibXdot3TLVsTxEnable:** This variable lists the single-instance use IEEE 802.3 Organizationally Specific TLVs, each with a bit map indicating the system ports through which the referenced TLV is enabled for transmission.

G.6.1 IEEE 802.3 managed objects—TLV variables

G.6.1.1 MAC/PHY Configuration/Status TLV managed objects

a) **Auto-negotiation support:** Indication of whether auto-negotiation is supported (see G.2.1).

b) **Auto-negotiation status:** Indication of whether auto-negotiation is enabled (see G.2.1).

c) **PMD auto-negotiation advertised capability:** The auto-negotiation and speed capabilities of the PMD (see G.2.2).

d) **operational MAU type:** The operational MAU type (see G.2.2).

G.6.1.2 Power Via MDI TLV managed objects

a) **Port class:** Indication of whether the port is PSE or PD (see G.3.1).

b) **PSE MDI power support:** Indication of whether MDI power is supported (see G.3.1).

c) **PSE MDI power state:** Indication of whether MDI power is enabled (see G.3.1).

d) **PSE Pairs control ability:** Indication of whether pair selection can be controlled (see G.3.1).

e) **PSE power pair:** Indication of which pair is powered (see G.3.2).

f) **power class:** Indication of the required power level required (see G.3.3).

G.6.1.3 Link Aggregation TLV managed objects

a) aggregation status: The capability and current aggregation status of the link (see G.4.1).

b) **aggregated port ID:** The aggregated port identifier (see G.4.2).

G.6.1.4 Maximum Frame Size TLV managed object

a) **maximum IEEE 802.3 frame size:** The maximum supported IEEE 802.3 frame size.

G.6.2 IEEE 802.3 Organizationally Specific TLV variable/LLDP MIB object cross reference

Table G-5 lists the relationship both between IEEE 802.3 TLV selection variables and the corresponding LLDP CONFIG object.

Table G-5—802.3 Organizationally Specific TLV selection variable/LLDP MIB object cross reference

IEEE 802.3 TLV selection variable	LLDP IEEE 802.3 MIB extension object
mibXdot3TLVsTxEnable	lldpXdot3PortConfigTLVsTxEnable

G.6.3 IEEE 802.3 Organizationally Specific TLV/MIB object cross references

The cross references between the IEEE 802.3 TLVs and the LLDP local system MIB objects are listed in Table G-6.

.

Table G-6—IEEE 802.3 Organizationally Specific TLV/local system MIB cross references

TLV name	TLV variable	LLDP local system MIB object
MAC/PHY Configuration/Status	Auto-negotiation support	lldpXdot3LocPortAutoNegSupported
	Auto-negotiation status	lldpXdot3LocPortAutoNegEnabled
	PMD auto-negotiation advertised capability	lldpXdot3LocPortAutoNegAdvCap
	operational MAU type	lldpXdot3LocPortOperMauType
Power Via MDI	Port class	lldpXdot3LocPowerPortClass
	PSE MDI power support	lldpXdot3LocPowerMDISupported
	PSE MDI power state	lldpXdot3LocPowerMDIEnabled
	PSE pairs control ability	lldpXdot3LocPowerPairControlable
	PSE power pair	lldpXdot3LocPowerPairs
	power class	lldpXdot3LocPowerClass
Link Aggregation	aggregation status	lldpXdot3LocLinkAggStatus
	aggregated port ID	lldpXdot3LocLinkAggPortId
Maximum Frame Size	maximum frame size	lldpXdot3LocMaxFrameSize

The cross references between the IEEE 802.3 TLVs and the LLDP remote system MIB objects are listed in Table G-7.

.

Table G-7—IEEE 802.3 Organizationally Specific TLV/remote systems MIB cross references

TLV name	TLV variable	LLDP remote systems MIB object
MAC/PHY Configuration/Status	Auto-negotiation support	lldpXdot3RemPortAutoNegSupported
	Auto-negotiation status	lldpXdot3RemPortAutoNegEnabled
	PMD auto-negotiation advertised capability	lldpXdot3RemPortAutoNegAdvCap
	operational MAU type	lldpXdot3RemPortOperMauType
Power Via MDI	Port class	lldpXdot3RemPowerPortClass
	PSE MDI power support	lldpXdot3RemPowerMDISupported
	PSE MDI power state	lldpXdot3RemPowerMDIEnabled
	PSE pairs control ability	lldpXdot3RemPowerPairControlable
	PSE power pair	lldpXdot3RemPowerPairs
	power class	lldpXdot3RemPowerClass
Link Aggregation	aggregation status	lldpXdot3RemLinkAggStatus
	aggregated port ID	lldpXdot3RemLinkAggPortId
Maximum Frame Size	maximum frame size	lldpXdot3RemMaxFrameSize

G.7 IEEE 802.1/LLDP extension MIB

This MIB is designed to operate in a manner consistent with the principles of the Internet-Standard Management Framework, which describes the separation of a data modeling language (for example, SMIv2) from content specific data models (for example the LLDP remote systems MIB), and from messages and protocol operations used to manipulate the data (for example SNMPv3). Managed objects are accessed via a virtual information store (the MIB). MIB objects are generally accessed through SNMP. Objects in the MIB are defined using the mechanisms of the Structure of Management Information (SMI). For an overview of this structure, see section 7 of IETF RFC 3410.

However, it is not required for LLDP implementations to support SNMP to store and retrieve system data. LLDP agents need to have a place to store both information about the local system and information they have received about remote systems. No particular implementation is implied.

Table G-8 summarizes the particular object groups that are required for each operating mode. The implemented MIB shall comply with the MIB conformance section for the particular operating mode being supported.

Table G-8—802.1 extension MIB object group conformance requirements

MIB group	Rx mode	Tx mode	Tx/Rx mode
lldpXdot3LocSystemsGroup	M*	—	M
lldpXdot3RemSystemsGroup	—	M	M

*Mandatory

G.7.1 IEEE 802.3 LLDP extension MIB module [22,23]

In the following MIB definition, should any discrepancy between the DESCRIPTION text and the corresponding definition in G.2, G.3, G.4, and G.5 of this annex occur, the definitions in G.2, G.3, G.4, and G.5 shall take precedence.

```
LLDP-EXT-DOT3-MIB DEFINITIONS ::= BEGIN

IMPORTS
    MODULE-IDENTITY, OBJECT-TYPE, Integer32
        FROM SNMPv2-SMI
    TEXTUAL-CONVENTION, TruthValue
        FROM SNMPv2-TC
    MODULE-COMPLIANCE, OBJECT-GROUP
        FROM SNMPv2-CONF
    lldpExtensions, lldpLocPortNum,
    lldpRemTimeMark, lldpRemLocalPortNum, lldpRemIndex,
    lldpPortConfigEntry
        FROM LLDP-MIB;

lldpXdot3MIB MODULE-IDENTITY
    LAST-UPDATED "200505060000Z" -- May 06, 2005
    ORGANIZATION "IEEE 802.1 Working Group"
    CONTACT-INFO
            "  WG-URL: http://grouper.ieee.org/groups/802/1/index.html
             WG-EMail: stds-802-1@ieee.org

              Contact: Paul Congdon
               Postal: Hewlett-Packard Company
                       8000 Foothills Blvd.
                       Roseville, CA 95747
                       USA
                  Tel: +1-916-785-5753
               E-mail: paul_congdon@hp.com"
    DESCRIPTION
            "The LLDP Management Information Base extension module for
            IEEE 802.3 organizationally defined discovery information.

            In order to assure the uniqueness of the LLDP-MIB,
            lldpXdot3MIB is branched from lldpExtensions using OUI value
            as the node.  An OUI/'company_id' is a 24 bit globally unique
            assigned number referenced by various standards.
```

[22] *Copyright release for MIBs:* Users of this standard may freely reproduce the MIB contained in this subclause so that it can be used for its intended purpose.

[23] An ASCII version of this MIB module can be obtained by Web browser from the IEEE 802.1 Website at http://www.ieee802.org/1/pages/MIBS.html.


```
            Copyright (C) IEEE (2005).  This version of this MIB module
            is published as Annex G.6.1 of IEEE Std 802.1AB-2005;
            see the standard itself for full legal notices."
    REVISION "200505060000Z" -- May 06, 2005
       DESCRIPTION
            "Published as part of IEEE Std 802.1AB-2005 initial version."
-- OUI for IEEE 802.3 is 4623 (00-12-0F)
   ::= { lldpExtensions 4623 }

--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--
-- Organizationally Defined Information Extension - IEEE 802.3
--
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------

lldpXdot3Objects    OBJECT IDENTIFIER ::= { lldpXdot3MIB 1 }

-- LLDP IEEE 802.3 extension MIB groups
lldpXdot3Config     OBJECT IDENTIFIER ::= { lldpXdot3Objects 1 }
lldpXdot3LocalData  OBJECT IDENTIFIER ::= { lldpXdot3Objects 2 }
lldpXdot3RemoteData OBJECT IDENTIFIER ::= { lldpXdot3Objects 3 }

-- textual conventions

LldpPowerPortClass ::= TEXTUAL-CONVENTION
    STATUS      current
    DESCRIPTION
            "This TC describes the Power over Ethernet (PoE) port class."
    SYNTAX  INTEGER {
            pClassPSE(1),
            pClassPD(2)
    }

LldpLinkAggStatusMap ::= TEXTUAL-CONVENTION
    STATUS      current
    DESCRIPTION
            "This TC describes the link aggregation status.

            The bit 'aggCapable(0)' indicates the link is capable of being
            aggregated.

            The bit 'aggEnabled(1)' indicates the link is currently in
            aggregation."
    SYNTAX  BITS {
            aggCapable(0),
            aggEnabled(1)
    }

--------------------------------------------------------------------------------
-- IEEE 802.3 - Configuration
--------------------------------------------------------------------------------

lldpXdot3PortConfigTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot3PortConfigEntry
    MAX-ACCESS  not-accessible
    STATUS      current
```

```
    DESCRIPTION
            "A table that controls selection of LLDP TLVs to be transmitted
            on individual ports."
    ::= { lldpXdot3Config 1 }

lldpXdot3PortConfigEntry  OBJECT-TYPE
    SYNTAX      LldpXdot3PortConfigEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "LLDP configuration information that controls the
            transmission of IEEE 802.3 organizationally defined TLVs on
            LLDP transmission capable ports.

            This configuration object augments the lldpPortConfigEntry of
            the LLDP-MIB, therefore it is only present along with the port
            configuration defined by the associated lldpPortConfigEntry
            entry.

            Each active lldpXdot3PortConfigEntry must be from non-volatile
            storage (along with the corresponding lldpPortConfigEntry)
            after a re-initialization of the management system."
    AUGMENTS { lldpPortConfigEntry }
    ::= { lldpXdot3PortConfigTable 1 }

LldpXdot3PortConfigEntry ::= SEQUENCE {
      lldpXdot3PortConfigTLVsTxEnable  BITS
}

lldpXdot3PortConfigTLVsTxEnable  OBJECT-TYPE
    SYNTAX      BITS {
            macPhyConfigStatus(0),
            powerViaMDI(1),
            linkAggregation(2),
            maxFrameSize(3)
    }
    MAX-ACCESS  read-write
    STATUS      current
    DESCRIPTION
            "The lldpXdot3PortConfigTLVsTxEnable, defined as a bitmap,
            includes the IEEE 802.3 organizationally defined set of LLDP
            TLVs whose transmission is allowed on the local LLDP agent by
            the network management.  Each bit in the bitmap corresponds
            to an IEEE 802.3 subtype associated with a specific IEEE
            802.3 optional TLV.  The bit 0 is not used since there is
            no corresponding subtype.

            The bit 'macPhyConfigStatus(0)' indicates that LLDP agent
            should transmit 'MAC/PHY configuration/status TLV'.

            The bit 'powerViaMDI(1)' indicates that LLDP agent should
            transmit 'Power via MDI TLV'.

            The bit 'linkAggregation(2)' indicates that LLDP agent should
            transmit 'Link Aggregation TLV'.

            The bit 'maxFrameSize(3)' indicates that LLDP agent should
            transmit 'Maximum-frame-size TLV'.
```



```
            The default value for lldpXdot3PortConfigTLVsTxEnable object
            is an empty set, which means no enumerated values are set.

            The value of this object must be restored from non-volatile
            storage after a re-initialization of the management system."
    REFERENCE
            "IEEE Std 802.1AB-2005 10.2.1.1"
    DEFVAL  { { } }
    ::= { lldpXdot3PortConfigEntry  1 }


--------------------------------------------------------------------------------
-- IEEE 802.3 - Local Device Information
--------------------------------------------------------------------------------
---
--- lldpXdot3LocPortTable: Ethernet Port AutoNeg/Speed/Duplex
---                        Information Table
---
---
lldpXdot3LocPortTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot3LocPortEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains one row per port of Ethernet port
            information (as a part of the LLDP 802.3 organizational
            extension) on the local system known to this agent."
    ::= { lldpXdot3LocalData 1 }

lldpXdot3LocPortEntry OBJECT-TYPE
    SYNTAX      LldpXdot3LocPortEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Information about a particular port component."
    INDEX   { lldpLocPortNum }
    ::= { lldpXdot3LocPortTable 1 }

LldpXdot3LocPortEntry ::= SEQUENCE {
              lldpXdot3LocPortAutoNegSupported     TruthValue,
              lldpXdot3LocPortAutoNegEnabled       TruthValue,
              lldpXdot3LocPortAutoNegAdvertisedCap OCTET STRING,
              lldpXdot3LocPortOperMauType          Integer32
}

lldpXdot3LocPortAutoNegSupported OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The truth value used to indicate whether the given port
            (associated with the local system) supports Auto-negotiation."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.2.1"
    ::= { lldpXdot3LocPortEntry 1 }

lldpXdot3LocPortAutoNegEnabled  OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS  read-only
```

```
    STATUS      current
    DESCRIPTION
            "The truth value used to indicate whether port
            Auto-negotiation is enabled on the given port associated
            with the local system."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.2.1"
    ::= { lldpXdot3LocPortEntry 2 }

lldpXdot3LocPortAutoNegAdvertisedCap OBJECT-TYPE
    SYNTAX      OCTET STRING(SIZE(2))
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "This object contains the value (bitmap) of the
            ifMauAutoNegCapAdvertisedBits object (defined in IETF RFC
            3636) which is associated with the given port on the
            local system."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.2.2"
    ::= { lldpXdot3LocPortEntry 3 }

lldpXdot3LocPortOperMauType  OBJECT-TYPE
    SYNTAX     Integer32(0..2147483647)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "An integer value that indicates the operational MAU type
            of the given port on the local system.

            This object contains the integer value derived from the
            list position of the corresponding dot3MauType as listed
            in IETF RFC 3636 (or subsequent revisions) and is equal
            to the last number in the respective dot3MauType OID.

            For example, if the ifMauType object is dot3MauType1000BaseTHD
            which corresponds to {dot3MauType 29}, the numerical value of
            this field will be 29. For MAU types not listed in RFC 3636
            (or subsequent revisions), the value of this field shall be
            set to zero."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.2.3"
    ::= { lldpXdot3LocPortEntry 4 }

---
---
--- lldpXdot3LocPowerTable: Power Ethernet Information Table
---
---
lldpXdot3LocPowerTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot3LocPowerEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains one row per port of power ethernet
            information (as a part of the LLDP 802.3 organizational
            extension) on the local system known to this agent."
    ::= { lldpXdot3LocalData 2 }
```



```
lldpXdot3LocPowerEntry OBJECT-TYPE
    SYNTAX      LldpXdot3LocPowerEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Information about a particular port component."
    INDEX   { lldpLocPortNum }
    ::= { lldpXdot3LocPowerTable 1 }

LldpXdot3LocPowerEntry ::= SEQUENCE {
              lldpXdot3LocPowerPortClass           LldpPowerPortClass,
              lldpXdot3LocPowerMDISupported        TruthValue,
              lldpXdot3LocPowerMDIEnabled          TruthValue,
              lldpXdot3LocPowerPairControlable     TruthValue,
              lldpXdot3LocPowerPairs               Integer32,
              lldpXdot3LocPowerClass               Integer32
}

lldpXdot3LocPowerPortClass  OBJECT-TYPE
    SYNTAX      LldpPowerPortClass
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The value that identifies the port Class of the given port
            associated with the local system."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.3.1"
    ::= { lldpXdot3LocPowerEntry 1 }

lldpXdot3LocPowerMDISupported  OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The truth value used to indicate whether the MDI power is
            supported on the given port associated with the local system."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.3.1"
    ::= { lldpXdot3LocPowerEntry 2 }

lldpXdot3LocPowerMDIEnabled  OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The truth value used to identify whether MDI power is
            enabled on the given port associated with the local system."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.3.1"
    ::= { lldpXdot3LocPowerEntry 3 }

lldpXdot3LocPowerPairControlable  OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The truth value is derived from the value of
            pethPsePortPowerPairsControlAbility object (defined in IETF
            RFC 3621) and is used to indicate whether the pair selection
```

```
            can be controlled on the given port associated with the
            local system."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.3.1"
    ::= { lldpXdot3LocPowerEntry 4 }

lldpXdot3LocPowerPairs  OBJECT-TYPE
    SYNTAX      Integer32(1|2)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "This object contains the value of the pethPsePortPowerPairs
            object (defined in IETF RFC 3621) which is associated with
            the given port on the local system."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.3.2"
    ::= { lldpXdot3LocPowerEntry 5 }

lldpXdot3LocPowerClass  OBJECT-TYPE
    SYNTAX      Integer32(1|2|3|4|5)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "This object contains the value of the
            pethPsePortPowerClassifications object (defined in IETF
            RFC 3621) which is associated with the given port on the
            local system."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.3.3"
    ::= { lldpXdot3LocPowerEntry 6 }

---
---
--- lldpXdot3LocLinkAggTable: Link Aggregation Information Table
---
---
lldpXdot3LocLinkAggTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot3LocLinkAggEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains one row per port of link aggregation
            information (as a part of the LLDP 802.3 organizational
            extension) on the local system known to this agent."
    ::= { lldpXdot3LocalData 3 }

lldpXdot3LocLinkAggEntry OBJECT-TYPE
    SYNTAX      LldpXdot3LocLinkAggEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Link Aggregation information about a particular port
            component."
    INDEX   { lldpLocPortNum }
    ::= { lldpXdot3LocLinkAggTable 1 }

LldpXdot3LocLinkAggEntry ::= SEQUENCE {
              lldpXdot3LocLinkAggStatus       LldpLinkAggStatusMap,
              lldpXdot3LocLinkAggPortId       Integer32
```



```
}

lldpXdot3LocLinkAggStatus OBJECT-TYPE
    SYNTAX      LldpLinkAggStatusMap
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The bitmap value contains the link aggregation capabilities
            and the current aggregation status of the link."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.4.1"
    ::= { lldpXdot3LocLinkAggEntry 1 }

lldpXdot3LocLinkAggPortId OBJECT-TYPE
    SYNTAX     Integer32(0|1..2147483647)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "This object contains the IEEE 802.3 aggregated port
            identifier, aAggPortID (IEEE 802.3-2002, 30.7.2.1.1),
            derived from the ifNumber of the ifIndex for the port
            component in link aggregation.

            If the port is not in link aggregation state and/or it
            does not support link aggregation, this value should be set
            to zero."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.4.2"
    ::= { lldpXdot3LocLinkAggEntry 2 }

---
---
--- lldpXdot3LocMaxFrameSizeTable: Maximum Frame Size information
---
---
lldpXdot3LocMaxFrameSizeTable  OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot3LocMaxFrameSizeEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains one row per port of maximum frame
            size information (as a part of the LLDP 802.3 organizational
            extension) on the local system known to this agent."
    ::= { lldpXdot3LocalData 4 }

lldpXdot3LocMaxFrameSizeEntry OBJECT-TYPE
    SYNTAX      LldpXdot3LocMaxFrameSizeEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Maximum Frame Size information about a particular port
            component."
    INDEX   { lldpLocPortNum }
    ::= { lldpXdot3LocMaxFrameSizeTable 1 }

LldpXdot3LocMaxFrameSizeEntry ::= SEQUENCE {
              lldpXdot3LocMaxFrameSize   Integer32
}
```

```
lldpXdot3LocMaxFrameSize OBJECT-TYPE
    SYNTAX      Integer32(0..65535)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "An integer value indicating the maximum supported frame
             size in octets on the given port of the local system."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.5.1"
    ::= { lldpXdot3LocMaxFrameSizeEntry 1 }


-- ----------------------------------------------------------------------------
-- IEEE 802.3 - Remote Devices Information
-- ----------------------------------------------------------------------------
---
---
--- lldpXdot3RemPortTable: Ethernet Information Table
---
---
lldpXdot3RemPortTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot3RemPortEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains Ethernet port information (as a part
            of the LLDP 802.3 organizational extension) of the remote
            system."
    ::= { lldpXdot3RemoteData 1 }

lldpXdot3RemPortEntry OBJECT-TYPE
    SYNTAX      LldpXdot3RemPortEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Information about a particular physical network connection."
    INDEX   { lldpRemTimeMark,
              lldpRemLocalPortNum,
              lldpRemIndex }
    ::= { lldpXdot3RemPortTable 1 }

LldpXdot3RemPortEntry ::= SEQUENCE {
              lldpXdot3RemPortAutoNegSupported     TruthValue,
              lldpXdot3RemPortAutoNegEnabled       TruthValue,
              lldpXdot3RemPortAutoNegAdvertisedCap OCTET STRING,
              lldpXdot3RemPortOperMauType          Integer32
}

lldpXdot3RemPortAutoNegSupported OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The truth value used to indicate whether the given port
            (associated with remote system) supports Auto-negotiation."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.2.1"
    ::= { lldpXdot3RemPortEntry 1 }
```



```
lldpXdot3RemPortAutoNegEnabled  OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The truth value used to indicate whether port
            Auto-negotiation is enabled on the given port associated
            with the remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.2.1"
    ::= { lldpXdot3RemPortEntry 2 }

lldpXdot3RemPortAutoNegAdvertisedCap  OBJECT-TYPE
    SYNTAX      OCTET STRING(SIZE(2))
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "This object contains the value (bitmap) of the
            ifMauAutoNegCapAdvertisedBits object (defined in IETF RFC
            3636) which is associated with the given port on the
            remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.2.2"
    ::= { lldpXdot3RemPortEntry 3 }

lldpXdot3RemPortOperMauType OBJECT-TYPE
    SYNTAX     Integer32(0..2147483647)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "An integer value that indicates the operational MAU type
            of the sending device.

            This object contains the integer value derived from the
            list position of the corresponding dot3MauType as listed in
            in IETF RFC 3636 (or subsequent revisions) and is equal
            to the last number in the respective dot3MauType OID.

            For example, if the ifMauType object is dot3MauType1000BaseTHD
            which corresponds to {dot3MauType 29}, the numerical value of
            this field will be 29. For MAU types not listed in RFC 3636
            (or subsequent revisions), the value of this field shall be
            set to zero."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.2.3"
    ::= { lldpXdot3RemPortEntry 4 }

---
---
--- lldpXdot3RemPowerTable: Power Ethernet Information Table
---
---
lldpXdot3RemPowerTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot3RemPowerEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains Ethernet power information (as a part
            of the LLDP 802.3 organizational extension) of the remote
```

```
            system."
    ::= { lldpXdot3RemoteData 2 }

lldpXdot3RemPowerEntry OBJECT-TYPE
    SYNTAX      LldpXdot3RemPowerEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Information about a particular physical network connection."
    INDEX   { lldpRemTimeMark,
              lldpRemLocalPortNum,
              lldpRemIndex }
    ::= { lldpXdot3RemPowerTable 1 }

LldpXdot3RemPowerEntry ::= SEQUENCE {
              lldpXdot3RemPowerPortClass           LldpPowerPortClass,
              lldpXdot3RemPowerMDISupported        TruthValue,
              lldpXdot3RemPowerMDIEnabled          TruthValue,
              lldpXdot3RemPowerPairControlable     TruthValue,
              lldpXdot3RemPowerPairs               Integer32,
              lldpXdot3RemPowerClass               Integer32
}

lldpXdot3RemPowerPortClass  OBJECT-TYPE
    SYNTAX      LldpPowerPortClass
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The value that identifies the port Class of the given port
            associated with the remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.3.1"
    ::= { lldpXdot3RemPowerEntry 1 }

lldpXdot3RemPowerMDISupported  OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The truth value used to indicate whether the MDI power
            is supported on the given port associated with the remote
            system."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.3.1"
    ::= { lldpXdot3RemPowerEntry 2 }

lldpXdot3RemPowerMDIEnabled  OBJECT-TYPE
    SYNTAX      TruthValue
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The truth value used to identify whether MDI power is
            enabled on the given port associated with the remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.3.1"
    ::= { lldpXdot3RemPowerEntry 3 }

lldpXdot3RemPowerPairControlable  OBJECT-TYPE
    SYNTAX      TruthValue
```



```
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The truth value is derived from the value of
            pethPsePortPowerPairsControlAbility object (defined in IETF
            RFC 3621) and is used to indicate whether the pair selection
            can be controlled on the given port associated with the
            remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.3.1"
    ::= { lldpXdot3RemPowerEntry 4 }

lldpXdot3RemPowerPairs  OBJECT-TYPE
    SYNTAX      Integer32(1|2)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "This object contains the value of the pethPsePortPowerPairs
            object (defined in IETF RFC 3621) which is associated with
            the given port on the remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.3.2"
    ::= { lldpXdot3RemPowerEntry 5 }

lldpXdot3RemPowerClass  OBJECT-TYPE
    SYNTAX      Integer32(1|2|3|4|5)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "This object contains the value of the
            pethPsePortPowerClassifications object (defined in IETF
            RFC 3621) which is associated with the given port on the
            remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.3.3"
    ::= { lldpXdot3RemPowerEntry 6 }

---
---
--- lldpXdot3RemLinkAggTable: Link Aggregation Information Table
---
---
lldpXdot3RemLinkAggTable OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot3RemLinkAggEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains port link aggregation information
            (as a part of the LLDP IEEE 802.3 organizational extension)
            of the remote system."
    ::= { lldpXdot3RemoteData 3 }

lldpXdot3RemLinkAggEntry OBJECT-TYPE
    SYNTAX      LldpXdot3RemLinkAggEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "Link Aggregation information about remote system's port
            component."
```

```
    INDEX   { lldpRemTimeMark,
              lldpRemLocalPortNum,
              lldpRemIndex }
    ::= { lldpXdot3RemLinkAggTable 1 }

LldpXdot3RemLinkAggEntry ::= SEQUENCE {
              lldpXdot3RemLinkAggStatus       LldpLinkAggStatusMap,
              lldpXdot3RemLinkAggPortId       Integer32
}

lldpXdot3RemLinkAggStatus OBJECT-TYPE
    SYNTAX      LldpLinkAggStatusMap
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "The bitmap value contains the link aggregation capabilities
            and the current aggregation status of the link."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.4.1"
    ::= { lldpXdot3RemLinkAggEntry 1 }

lldpXdot3RemLinkAggPortId OBJECT-TYPE
    SYNTAX     Integer32(0|1..2147483647)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "This object contains the IEEE 802.3 aggregated port
            identifier, aAggPortID (IEEE Std 802.3-2002, 30.7.2.1.1),
            derived from the ifNumber of the ifIndex for the port
            component associated with the remote system.

            If the remote port is not in link aggregation state and/or
            it does not support link aggregation, this value should be
            zero."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.4.2"
    ::= { lldpXdot3RemLinkAggEntry 2 }


---
---
--- lldpXdot3RemMaxFrameSizeTable: Maximum Frame Size information
---
---
lldpXdot3RemMaxFrameSizeTable  OBJECT-TYPE
    SYNTAX      SEQUENCE OF LldpXdot3RemMaxFrameSizeEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
            "This table contains one row per port of maximum frame
            size information (as a part of the LLDP IEEE 802.3 organizational
            extension) of the remote system."
    ::= { lldpXdot3RemoteData 4 }

lldpXdot3RemMaxFrameSizeEntry OBJECT-TYPE
    SYNTAX      LldpXdot3RemMaxFrameSizeEntry
    MAX-ACCESS  not-accessible
    STATUS      current
    DESCRIPTION
```



```
            "Maximum Frame Size information about a particular port
            component."
    INDEX   { lldpRemTimeMark,
              lldpRemLocalPortNum,
              lldpRemIndex }
    ::= { lldpXdot3RemMaxFrameSizeTable 1 }

LldpXdot3RemMaxFrameSizeEntry ::= SEQUENCE {
              lldpXdot3RemMaxFrameSize   Integer32
}

lldpXdot3RemMaxFrameSize OBJECT-TYPE
    SYNTAX      Integer32(0..65535)
    MAX-ACCESS  read-only
    STATUS      current
    DESCRIPTION
            "An integer value indicating the maximum supported frame
             size in octets on the port component associated with the
             remote system."
    REFERENCE
            "IEEE Std 802.1AB-2005 G.5.1"
    ::= { lldpXdot3RemMaxFrameSizeEntry 1 }


-- ----------------------------------------------------------------------------
-- Conformance Information
-- ----------------------------------------------------------------------------
lldpXdot3Conformance OBJECT IDENTIFIER ::= { lldpXdot3MIB 2 }
lldpXdot3Compliances OBJECT IDENTIFIER ::= { lldpXdot3Conformance 1 }
lldpXdot3Groups      OBJECT IDENTIFIER ::= { lldpXdot3Conformance 2 }

-- compliance statements

lldpXdot3Compliance MODULE-COMPLIANCE
    STATUS  current
    DESCRIPTION
            "The compliance statement for SNMP entities which implement
            the LLDP 802.3 organizational extension MIB."
    MODULE  -- this module
        MANDATORY-GROUPS { lldpXdot3ConfigGroup,
                           lldpXdot3LocSysGroup,
                           lldpXdot3RemSysGroup
        }
    ::= { lldpXdot3Compliances 1 }

-- MIB groupings

lldpXdot3ConfigGroup    OBJECT-GROUP
    OBJECTS {
        lldpXdot3PortConfigTLVsTxEnable
    }
    STATUS  current
    DESCRIPTION
            "The collection of objects which are used to configure the
            LLDP 802.3 organizational extension implementation behavior.

            This group is mandatory for agents which implement the
            LLDP 802.3 organizational extension."
    ::= { lldpXdot3Groups 1 }
```

```
lldpXdot3LocSysGroup  OBJECT-GROUP
    OBJECTS {
        lldpXdot3LocPortAutoNegSupported,
        lldpXdot3LocPortAutoNegEnabled,
        lldpXdot3LocPortAutoNegAdvertisedCap,
        lldpXdot3LocPortOperMauType,
        lldpXdot3LocPowerPortClass,
        lldpXdot3LocPowerMDISupported,
        lldpXdot3LocPowerMDIEnabled,
        lldpXdot3LocPowerPairControlable,
        lldpXdot3LocPowerPairs,
        lldpXdot3LocPowerClass,
        lldpXdot3LocLinkAggStatus,
        lldpXdot3LocLinkAggPortId,
        lldpXdot3LocMaxFrameSize
    }
    STATUS  current
    DESCRIPTION
            "The collection of objects which are used to represent LLDP
            802.3 organizational extension Local Device Information.

            This group is mandatory for agents which implement the
            LLDP 802.3 organizational extension in the TX mode."
    ::= { lldpXdot3Groups 2 }

lldpXdot3RemSysGroup  OBJECT-GROUP
    OBJECTS {
        lldpXdot3RemPortAutoNegSupported,
        lldpXdot3RemPortAutoNegEnabled,
        lldpXdot3RemPortAutoNegAdvertisedCap,
        lldpXdot3RemPortOperMauType,
        lldpXdot3RemPowerPortClass,
        lldpXdot3RemPowerMDISupported,
        lldpXdot3RemPowerMDIEnabled,
        lldpXdot3RemPowerPairControlable,
        lldpXdot3RemPowerPairs,
        lldpXdot3RemPowerClass,
        lldpXdot3RemLinkAggStatus,
        lldpXdot3RemLinkAggPortId,
        lldpXdot3RemMaxFrameSize
    }
    STATUS  current
    DESCRIPTION
            "The collection of objects which are used to represent LLDP
            802.3 organizational extension Local Device Information.

            This group is mandatory for agents which implement the
            LLDP 802.3 organizational extension in the RX mode."
    ::= { lldpXdot3Groups 3 }

END
```


G.7.2 Security considerations for IEEE 802.3 LLDP extension MIB module

There are a number of management objects defined in this MIB module with a MAX-ACCESS clause of read-write.[24] Such objects may be considered sensitive or vulnerable in some network environments. The support for SET operations in a non-secure environment without proper protection can have a negative effect on network operations.

Setting the object, lldpXdot3PortConfigTLVsTxEnable, to incorrect values can result in improper operation of LLDP.

The following readable objects in this MIB module may be considered to be sensitive of vulnerable in some network environments:

a) Objects that are associated with the transmit mode:
   1) lldpXdot3LocPortAutoNegSupported,
   2) lldpXdot3LocPortAutoNegEnabled,
   3) lldpXdot3LocPortAutoNegAdvertisedCap,
   4) lldpXdot3LocPortOperMauType,
   5) lldpXdot3LocPowerPortClass,
   6) lldpXdot3LocPowerMDISupported,
   7) lldpXdot3LocPowerMDIEnabled,
   8) lldpXdot3LocPowerPairControlable,
   9) lldpXdot3LocPowerPairs,
   10) lldpXdot3LocPowerClass,
   11) lldpXdot3LocLinkAggStatus,
   12) lldpXdot3LocLinkAggPortId,
   13) lldpXdot3LocMaxFrameSize
b) Objects that are associated with the receive mode:
   1) lldpXdot3RemPortAutoNegSupported,
   2) lldpXdot3RemPortAutoNegEnabled,
   3) lldpXdot3RemPortAutoNegAdvertisedCap,
   4) lldpXdot3RemPortOperMauType,
   5) lldpXdot3RemPowerPortClass,
   6) lldpXdot3RemPowerMDISupported,
   7) lldpXdot3RemPowerMDIEnabled,
   8) lldpXdot3RemPowerPairControlable,
   9) lldpXdot3RemPowerPairs,
   10) lldpXdot3RemPowerClass,
   11) lldpXdot3RemLinkAggStatus,
   12) lldpXdot3RemLinkAggPortId,
   13) lldpXdot3RemMaxFrameSize

This concern applies both to objects that describe the configuration of the local host, as well as for objects that describe information from the remote hosts, acquired via LLDP and displayed by the objects in this

[24]In IETF MIB definitions, the MAX-ACCESS clause defines the type of access that is allowed for particular data elements in the MIB. An explanation of the MAX-ACCESS mapping is given in section 7.3 of IETF RFC 2578 [B10].

MIB module. It is thus important to control even GET and/or NOTIFY access to these objects and possibly to even encrypt the values of these objects when sending them over the network via SNMP.

SNMP versions prior to SNMPv3 did not include adequate security. Even if the network itself is secure (for example by using IPSec), even then, there is no control as to who on the secure network is allowed to access and GET/SET (read/change/create/delete) the objects in this MIB module.

Implementers consider the security features as provided by the SNMPv3 framework (see RFC 3410, section 8), including full support for the SNMPv3 cryptographic mechanisms (for authentication and privacy).
Further, implementers should not deploy SNMP versions prior to SNMPv3. Instead, implementers should deploy SNMPv3 to enable cryptographic security. It is then a customer/operator responsibility to ensure that the SNMP entity giving access to an instance of this MIB module is properly configured to give access to the objects only to those principals (users) that have legitimate rights to indeed GET or SET (change/create/delete) them.

G.8 PICS proforma for IEEE 802.3 TLV extensions[25]

G.8.1 Implementation identification

Supplier	
Contact point for queries about the PICS	
Implementation Name(s) and Version(s)	
Other information necessary for full identification—e.g., name(s) and version(s) of machines and/or operating system names	
NOTES 1—Only the first three items are required for all implementations; other information may be completed as appropriate in meeting the requirement for full identification. 2—The terms Name and Version should be interpreted appropriately to correspond with a supplier's terminology (e.g., Type, Series, Model).	

G.8.2 Protocol summary, IEEE Std 802.1AB-2005

Identification of protocol specification	IEEE Std 802.1AB-2005, Standard for Local and Metropolitan Area Networks: Station and Media Access Control Connectivity Discovery
Identification of amendments and corrigenda to the PICS proforma that have been completed as part of the PICS	Amd. : Corr. : Amd. : Corr. :
Have any Exception items been required? (See B.3.3: The answer Yes means that the implementation does not conform to IEEE Std 802.1AB)	No [ ] Yes [ ]

Date of Statement	

[25]Instructions for completing the PICS Proforma are given in B.3.

G.8.3 Major capabiities and options

Item	Feature	Status	References	Support
dot3xset	Is the IEEE 802.3 Organizationally Specific TLV set implemented	O	Annex G	Yes [ ] No [ ]
dot3xtlv	Is each TLV in the IEEE 802.3 extension set implemented Auto-negotiation TLV Power Via MDI TLV Link Aggregation TLV Maximum Frame Size TLV	 dot3xtlv:M dot3xtlv:M dot3xtlv:M dot3xtlv:M	 G.2 G.3 G.4 G.5	 Yes [ ] Yes [ ] Yes [ ] Yes [ ]
lldpmib	Which type of MIB is implemented (one is mandatory) SNMP is supported (if yes, answer item **snmpmib** and skip **equivstor**) SNMP is not supported (if yes, answer **equivstor** and skip **snmpmib**)	 O.2 O.2	 G.7 G.7	 Yes [ ] No [ ] Yes [ ] No [ ]
snmpmib	If the SNMP MIB is implemented, is the MIB module in conformance with the MIB sections indicated in Table F-6 for the operating mode being implemented	M	G.7	Yes [ ]
equivstor	If the SNMP is not supported, is the provided storage and retieval capability functionally equivalent with the indicated specifications of this clause for the operating mode being implemented	M	G.2, G.3, G.4, G.5, and G.6	Yes [ ]