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SERIES Q: SWITCHING AND SIGNALLING
Q3 interface

**Requirements and analysis for the management
interface of Ethernet Passive Optical
Networks (EPON)**

ITU-T Recommendation Q.838.1

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ITU-T Recommendation Q.838.1

Requirements and analysis for the management interface of Ethernet Passive Optical Networks (EPON)



Summary

This Recommendation is for the management of Ethernet Passive Optical Networks (EPON). The requirements and analysis for the management interface between EPON Element Management System (EMS) and Network Management System (NMS) are provided in this Recommendation, using the TMN interface specification methodology described in ITU-T Rec. M.3020. This interface is for the integrated management at the network layer as well as the element layer as required. In this Recommendation, a network element view combined with a network view of EPON managed entities are modelled according to a protocol-neutral information modelling approach, and the UML use case descriptions, class diagrams and sequence diagrams are also provided for both the requirements and the analysis of this management interface.

Source

ITU-T Recommendation Q.838.1 was approved on 7 October 2004 by ITU-T Study Group 4 (2001-2004) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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ITU-T Recommendation Q.838.1

Requirements and analysis for the management interface of Ethernet Passive Optical Networks (EPON)

1 Scope

This Recommendation specifies the requirements and analysis for the management interface between the Element Management System (EMS) and the Network Management System (NMS) of Ethernet Passive Optical Networks (EPON). It follows the interface specification methodology described in ITU-T Rec. M.3020. In this Recommendation, the EMS is an Operations System (OS) used to manage the individual network elements supporting EPON technologies as well as the networks between them. One or more systems may be required depending on the different supplier products and geographic distribution of the network elements in the network.

The NMS represents an integrated management OS across different technologies and supplier systems (multi-technology and multi-vendor OS).

The management functions covered in this Recommendation include configuration management, performance measurement parameters management, and loopback test in fault management. These management functions are described and divided by UML use cases in the requirements. The analysis provides the managed entities which support a protocol-neutral information model for EPON management, and also explains the static and dynamic relationships between these managed entities using UML class diagrams and sequence diagrams. This Recommendation does not cover all aspects about Ethernet management. Only those related to EPON management are addressed.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [1] ITU-T Recommendation M.3010 (2000), *Principles for a telecommunications management network*.
- [2] ITU-T Recommendation M.3020 (2000), *TMN interface specification methodology*.
- [3] ITU-T Recommendation M.3100 (1995), *Generic network information model*.
- [4] ITU-T Recommendation M.3100 (1999), *Generic network information model, Amendment 1*.
- [5] ITU-T Recommendation M.3100 (1998), *Generic network information model, Corrigendum 1*.
- [6] ITU-T Recommendation M.3100 (2003), *Generic network information model, Amendment 6*.
- [7] ITU-T Recommendation M.3100 (2004), *Generic network information model, Amendment 8*.
- [8] ITU-T Recommendation M.3200 (1997), *TMN management services and telecommunications managed areas: Overview*.

- [9] ITU-T Recommendation M.3400 (2000), *TMN management functions*.
- [10] ITU-T Recommendation X.721 (1992), *Information technology – Open Systems Interconnection – Structure of management information: Definition of management information*.
- [11] ITU-T Recommendation X.731 (1992), *Information technology – Open Systems Interconnection – Systems management: State management function*.
- [12] ITU-T Recommendation X.744 (1996), *Information technology – Open Systems Interconnection – Systems management: Software management function*.
- [13] ITU-T Recommendation X.745 (1993), *Information technology – Open Systems Interconnection – Systems management: Test management function*.
- [14] ITU-T Recommendation Q.827.1 (2004), *Requirements and analysis for the common management functions of NMS-EMS interfaces*.
- [15] ITU-T Recommendation Q.834.1 (2004), *ATM-PON requirements and managed entities for the network and network element views*.
- [16] ITU-T Recommendation Q.834.3 (2004), *A UML description for management interface requirements for broadband Passive Optical Networks*.
- [17] ITU-T Recommendation G.805 (2000), *Generic functional architecture of transport networks*.
- [18] ITU-T Recommendation G.809 (2003), *Functional architecture of connectionless layer networks*.
- [19] ITU-T Recommendation G.8010/Y.1306 (2004), *Architecture of Ethernet layer networks*.
- [20] ITU-T Recommendation G.982 (1996), *Optical access networks to support services up to the ISDN primary rate or equivalent bit rates*.
- [21] ITU-T Recommendation G.983.1 (1998), *Broadband optical access systems based on Passive Optical Networks (PON)*.
- [22] IEEE 802.3ah-2004, *IEEE Standard for information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method and physical layer specifications – Amendment: Media access control parameters, physical layers, and management parameters for subscriber access networks*.
- [23] IEEE 802.1D-2004, *IEEE standard for local and metropolitan area networks: Media Access Control (MAC) bridges*.
- [24] IEEE 802.1Q-2003, *IEEE standard for local and metropolitan area networks: Virtual bridged local area networks*.
- [25] IETF RFC 1493 (1993), *Definitions of managed objects for bridges*.
- [26] IETF RFC 2233 (1997), *The Interfaces Group MIB using SMIv2*.
- [27] IETF RFC 2358 (1998), *Definitions of managed objects for the Ethernet-like interface Types*.
- [28] IETF RFC 2495 (1999), *Definitions of managed objects for the DS1, E1, DS2 and E2 interface types*.
- [29] IETF RFC 2674 (1999), *Definitions of managed objects for bridges with traffic classes, multicast filtering and virtual LAN extensions*.

3 Terms and definitions

This Recommendation uses the following terms.

3.1 Definitions imported from ITU-T Rec. G.805

The following terms from ITU-T Rec. G.805 [17] are used in this Recommendation:

- bidirectional reference point;
- connection;
- connection point;
- link;
- link connection;
- termination connection point;
- trail;
- trail termination;
- trail termination sink;
- trail termination source.

3.2 Definitions imported from ITU-T Rec. G.809

The following terms from ITU-T Rec. G.809 [18] are used in this Recommendation:

- characteristic information;
- client/server relationship;
- connectionless trail;
- flow;
- flow domain;
- flow domain flow;
- flow point;
- flow point pool;
- flow point pool link;
- flow termination;
- flow termination sink;
- flow termination source;
- layer network;
- link flow.

3.3 Definitions imported from ITU-T Rec. G.982

The following terms from ITU-T Rec. G.982 [20] are used in this Recommendation:

- Optical Access Network (OAN);
- Optical Distribution Network (ODN).

3.4 Definitions imported from ITU-T Rec. G.983.1

The following term from ITU-T Rec. G.983.1 [21] is used in this Recommendation:

- Optical Network Termination (ONT).

3.5 Definitions imported from ITU-T Rec. Q.834.1

The following term from ITU-T Rec. Q.834.1 [15] is used in this Recommendation:

- Network Termination (NT).

3.6 Definitions imported from IEEE 802.3ah

The following terms from IEEE Standard 802.3ah [22] are used in this Recommendation:

- Optical Line Terminal (OLT);
- Optical Network Unit (ONU);
- Ranging;
- P2MP Discovery.

4 Abbreviations

This Recommendation uses the following abbreviations:

ASAP	Alarm Severity Assignment Profile
BER	Bit Error Rate
CFI	Canonical Format Indicator
cLink	component Link
CM	Configuration Management
CRC	Cyclic Redundancy Check
CTP	Connection Termination Point
E1	Digital signal level 1 at 2048 kbit/s
EMS	Element Management System
EPON	Ethernet Passive Optical Network
ETH	Ethernet MAC layer network
ETY _n	Ethernet physical layer network of order n
FCS	Frame Check Sequence
FD	Flow Domain
FDF	Flow Domain Flow
FDF _r	Flow Domain Fragment
FM	Fault Management
FP	Flow Point
FPP	Flow Point Pool
FS	Function Set
FTP	Flow Termination Point
HDB3	High Density Bipolar 3 code
ID	Identifier
ISDN	Integrated Services Digital Network
ITU-T	International Telecommunication Union – Telecommunication Standardization Sector

MAC	Media Access Control
MIB	Management Information Base
NE	Network Element
NMS	Network Management System
NNI	Network-to-Network Interface
NRZ	Non Return to Zero
NT	Network Termination
ODN	Optical Distribution Network
OLT	Optical Line Terminal
OMG	Object Management Group
ONT	Optical Network Termination
ONU	Optical Network Unit
OS	Operations System
P2MP	Point to Multi-Point
PHY	Ethernet Physical Layer Entity
PM	Performance Management
PON	Passive Optical Network
POTS	Plain Old Telephone Service
SBA	Static Bandwidth Assignment
TCI	Tag Control Information
TMN	Telecommunications Management Network
TP	Termination Point
TTP	Trail Termination Point
UML	Unified Modelling Language
UNI	User Network Interface
VID	VLAN ID
VLAN	Virtual Local Area Network
VPN	Virtual Private Network

5 General overview

Figure 5-1 illustrates the EPON system architecture. EMS is the management system linked to the OLT in this figure. This system is provided, along with the equipment, to a network owner operator. The OLT is a head-end digital terminal commonly located in the central office or some controlled environment structure. The ODN is a point-to-multipoint fibre infrastructure employing a passive splitter or coupler device for the fan out. The ONU provides the access network line termination function. The NT provides the user network interface line termination function. The ONT combines the functions of the ONU and NT in one piece of equipment. The reference point, indicated by the term UNI, denotes the user network interface.

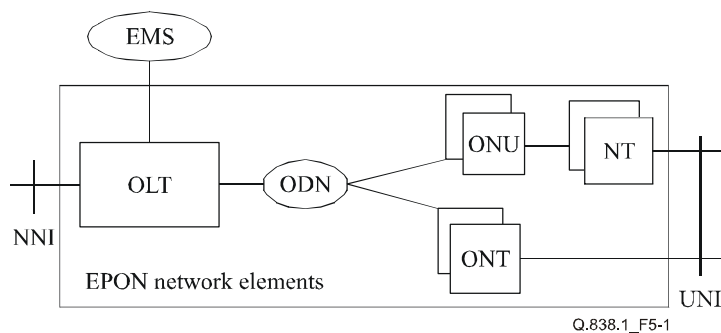
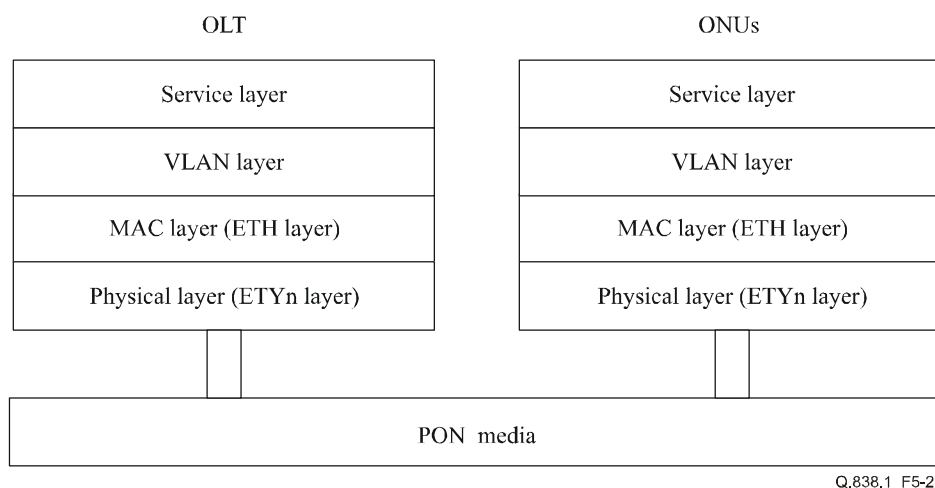


Figure 5-1/Q.838.1 – EPON system architecture

NOTE 1 – The terms OLT and ONU come from IEEE 802.3ah, while the term ONT comes from ITU-T Rec. G.983, and the term NT comes from ITU-T Rec. Q.834.1.

Figure 5-2 illustrates the layering model of EPON.



PON media	Passive Optical Network Media
Physical layer	Physical Layer of EPON, and it is named ETYn Layer in ITU-T Rec. G.8010/Y.1306
MAC layer	Media Access Control Layer of EPON, and it is named ETH Layer in ITU-T Rec. G.8010/Y.1306
VLAN layer	Virtual Local Area Network Layer (see Note 2)
Service layer	Service layer of EPON, such as IP, POTS, ISDN, and so on. (However, in the current version of this Recommendation, only E1 service is covered.)

Figure 5-2/Q.838.1 – EPON layering model

NOTE 2 – The notion of "VLAN Layer" is preliminary and will be deprecated in a subsequent amendment or correction of this Recommendation. According to ITU-T Rec. G.8010/Y.1306 there does not exist a separate VLAN characteristic information, and hence no VLAN layer in the sense of ITU-T Rec. G.809, but VLAN refers to a flow of ETH traffic units, at the MAC Layer, where each traffic unit has a VLAN Tag which includes a VLAN ID to identify the ETH VPN these frames belong to (see 6.3.2.5.3, 6.5.2 and Appendix III of G.8010/Y.1306).

Moreover, ITU-T Rec. G.8010/Y.1306 specifies the fragmentation of an ETH flow domain into ETH flow domain fragments (FDFr) and the partitioning of an ETH FPP link into ETH FPP component links (cLink) (see 6.3.2.5/G.8010/Y.1306). As a consequence, VLAN flow domains do not exist and VLAN ports are ETH flow points. Also, the FDFr should be considered the appropriate unit of connectivity within an ETH flow domain (a maximum flow aggregation so to say), and not the flow domain flow (FDF) which could be as tiny as a single traffic unit (i.e., an ETH frame).

When the VLAN Layer is deprecated, all VLAN layer-related managed entities will be replaced by corresponding G.8010/Y.1306-compliant, FDFr- or cLink-based managed entities.

The EMS shown in Figure 5-3 is used to manage the individual network elements supporting EPON technologies. One or more systems may be required depending on the different supplier products and geographic distribution of the elements in the network. The network layer management system shown as NMS in Figure 5-3 represents an integrated management OS across the different technologies and supplier systems. The logical representation shown by NMS may be realized by one or more physical interfaces. Figure 5-3 shows the Q interface addressed in this Recommendation.

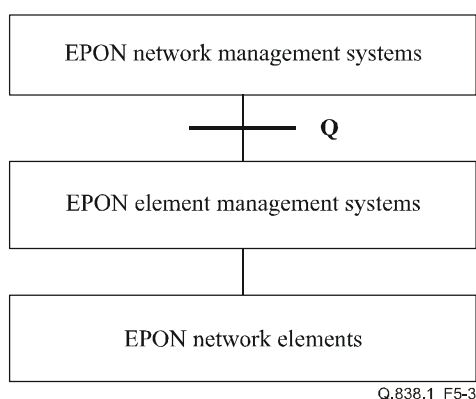


Figure 5-3/Q.838.1 – Reference interface

6 Requirements

6.1 Business level requirements

This Recommendation only focuses on the management interface between NMS and EMS for EPON, and the interface management functions associated with them. Through the interface, NMS can query and modify configuration information, and EMS can report changes in configuration, performance data, and fault information to NMS.

6.1.1 Actor roles

The actor in this Recommendation is NMS. NMS is the EPON network management system that manages the whole EPON systems by interacting with the suppliers' EMSs.

6.1.2 Telecommunications resources

Both the suppliers' EMSs and the managed EPON equipments are viewed as relevant telecommunications resources in this Recommendation.

6.1.3 High-level use case diagrams

This clause contains high-level UML use case diagrams that summarize the functionality and interfaces of EMS.

The first overview use case diagram (Figure 6-1) shows the main management function sets (FS) involved in the EPON management interface.

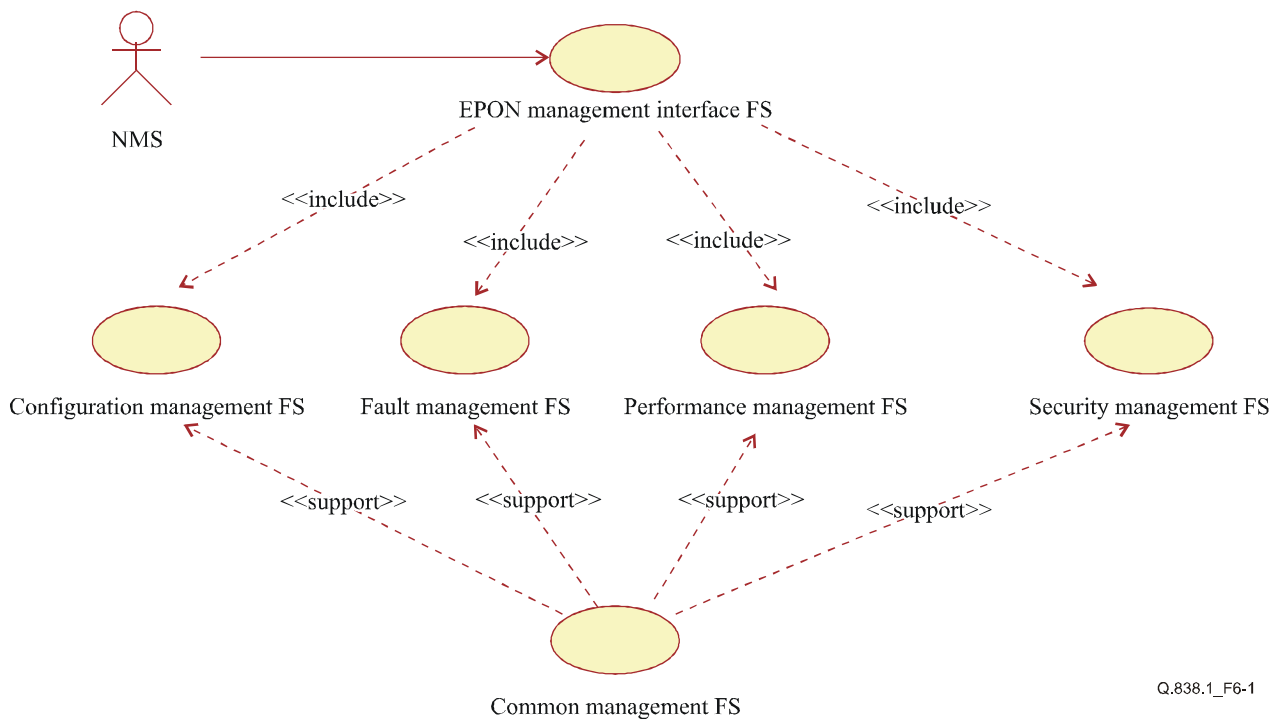


Figure 6-1/Q.838.1 – EPON management interface function set

The diagrams for common management can be found in 6.1.3/Q.827.1 [14]. See Figures 6-2, 6-3, 6-4, 6-5 in ITU-T Rec. Q.827.1 for details.

Figure 6-2 shows the functions involved in the Configuration management function set.

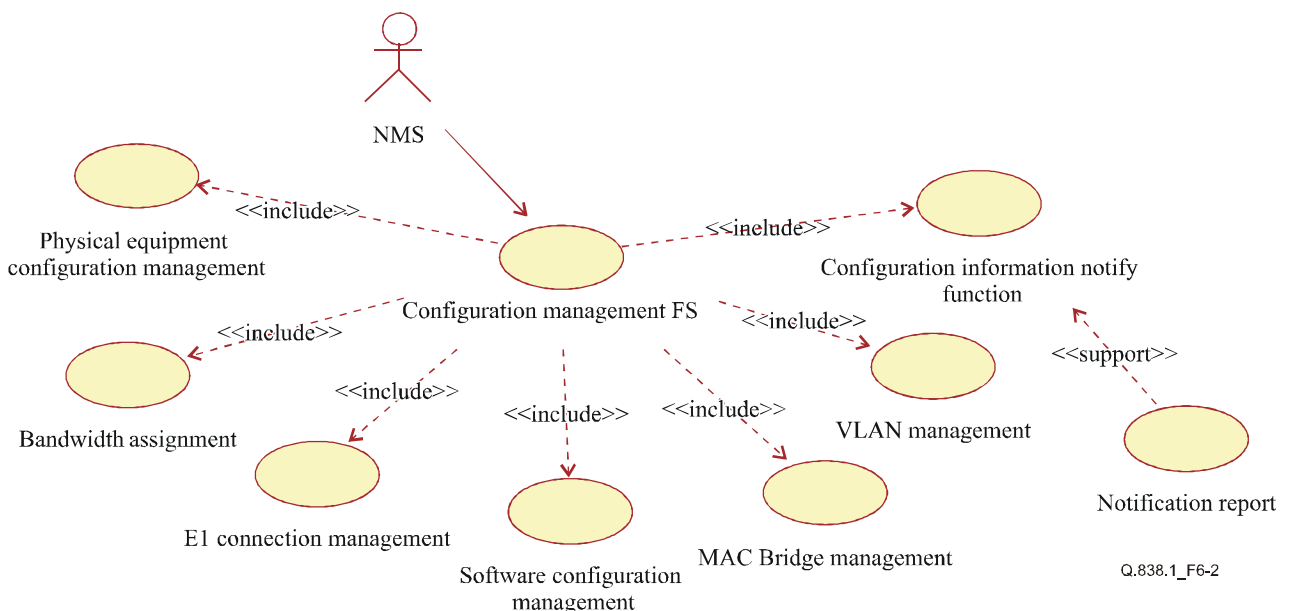


Figure 6-2/Q.838.1 – Configuration management function set

The use case diagrams for performance management function set can be found in 6.1.3/Q.827.1. See Figures 6-6, 6-7, 6-8 in ITU-T Rec. Q.827.1 for details.

The use case diagrams for Fault management function set can be found in section 6.1.3/Q.827.1. See Figures 6-9, 6-10 in ITU-T Rec. Q.827.1 for details. Besides, in this interface, the Loopback test management FS is also a subfunction set included in Fault management FS defined in ITU-T Rec. Q.827.1. Figure 6-3 shows the Loopback related functions.

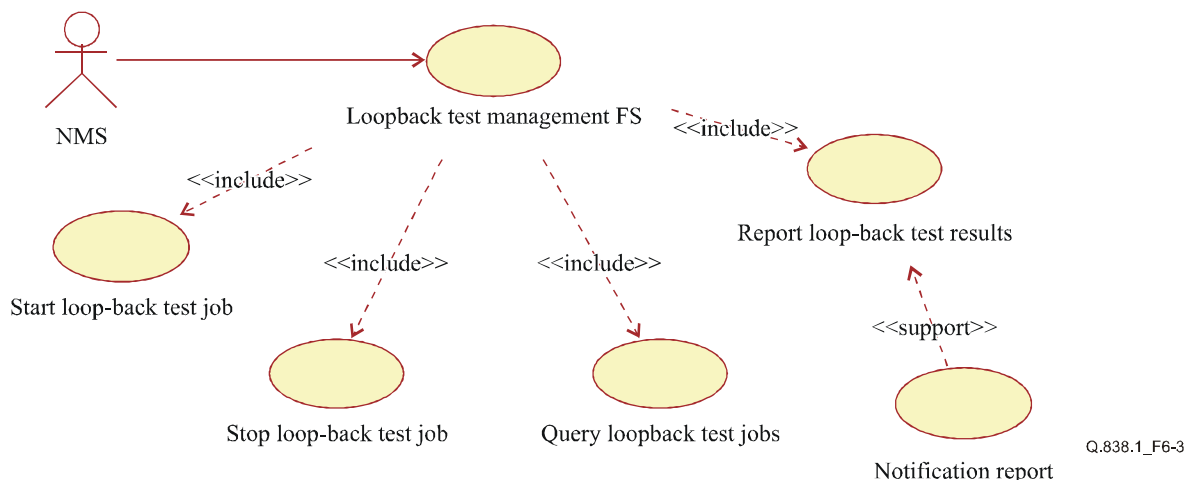


Figure 6-3/Q.838.1 – Loopback test management function set

6.2 Specification level requirements

This clause contains textual details for each of the use cases shown in the high-level use case diagrams of the previous clause. The details are provided to clarify the roles of external actors and telecommunications resources, to establish the basis for interactive diagrams in the analysis part, and to refine the previous high-level use case diagrams to a specification level. The conventions for use case details can be found in 6.2/Q.827.1.

The use case details are listed by the use case title shown in the use case diagrams of the previous clause.

6.2.1 Common management function set

The specification level requirements for Common management are described in 6.2.1/Q.827.1, which will be reused in this Recommendation.

6.2.2 Configuration management function set

6.2.2.1 Overview

Configuration management (CM) of EPON system contains physical equipment configuration management, bandwidth assignment, E1 connection management, software configuration management, MAC bridge configuration management and VLAN configuration management.

The basic CM functions involve creating or deleting configuration related managed entities (if applicable), querying or modifying configuration information of them, managing their relationships, and configuration information change notification functions.

6.2.2.2 Basic configuration management function set

6.2.2.2.1 Create managed entity

Summary: NMS can create a CM related managed entity through the management interface.

Assumptions: The communication between NMS and EMS is available. EMS supports the function of creating the specified managed entity.

Actors: NMS.

Preconditions: NMS needs to create a managed entity instance in EMS.

Description: NMS can send a request to EMS to create an instance of some specific managed entities. Usually, these managed entities represent some logical resources that can be dynamically created and configured, such as E1 connection or VLAN related entities. Those that are instantiated when EMS is initialized are not supposed to be created by NMS at the management interface. The parameters in the request include the class name of the managed entity, and a list of the attribute name and value pairs of the specified managed entity for creation. If the managed entity has been created successfully, EMS will then return the identifier of the managed entity and may send a corresponding object creation notification to NMS. If the creation fails, EMS will return error information.

Exceptions: Unknown Class Name; Creation Unsupported; Invalid Parameter; EMS Processing Error; Communication Error.

Post-conditions: The managed entity is created by EMS on the request of NMS. EMS may send the corresponding object creation notification to NMS.

6.2.2.2.2 Delete managed entity

Summary: NMS can delete a CM related managed entity(s) through the management interface.

Assumptions: The communication between NMS and EMS is available. EMS supports the function of deleting the specified managed entity(s).

Actors: NMS.

Preconditions: NMS no longer needs the specified managed entities in EMS. The specified managed entity(s) exists in EMS, and is not associated with or containing any other managed entities.

Description: NMS can send a request to delete a managed entity(s) in EMS. Usually, these managed entities represent some logical resources that can be dynamically created, deleted and configured, such as E1 connection or VLAN related entities. Those that are instantiated when EMS is initialized are not supposed to be deleted by NMS at the management interface. The parameter in the request is the list of IDs of the managed entities. The deletion will be carried in a nested and best effort way, that is, when a managed entity is specified for deletion, the managed entities it contains directly or indirectly are also to be deleted. If some of the contained managed entities cannot be deleted, their containing entity cannot be deleted either, which means no managed entity will exist as an isolated node. But all the deletable managed entities are deleted. If the managed entity(s) has been deleted successfully or partially successfully (not all the specified managed entities are deleted), EMS will return success or partial success information and may then send the corresponding object deletion notification(s) to NMS. EMS also specifies the list of undeleted managed entities and the corresponding reason for deletion failure. If the deletion fails completely or partially, EMS will return error information.

Exceptions: Unknown Managed Entity; Deletion Unsupported; EMS Processing Error; Communication Error.

Post-conditions: The specified managed entity(s) are deleted by EMS on the request of NMS, and the correlated network resources are also released. EMS may send the corresponding object deletion notification(s) to NMS.

6.2.2.2.3 Modify managed entity

Summary: NMS can modify the attribute values of one or more CM related managed entities in EMS through the management interface.

Assumptions: The communication between NMS and EMS is available. EMS supports the function of modifying the specified managed entity(s).

Actors: NMS.

Preconditions: NMS needs to change some parameter values of a managed entity(s) in EMS. The specified managed entity(s) exists in EMS. The specified attributes are modifiable.

Description: In this use case, NMS sends a request to EMS to modify one or more managed entities of the same class. The input parameters contain the class name of the managed entity(s), a list of entity IDs of the instances to be modified, and a list of the attribute names, the corresponding new values, and the operation type for modification (replace, add, remove, or set to default). If the modification succeeds, EMS will return success information and may send the corresponding attribute value change or state change notification(s). If the modification fails, EMS will return error information.

Exceptions: Unknown Managed Entity; Invalid Parameter; Attribute Not Modifiable; EMS Processing Error; Communication Error.

Post-conditions: The specified managed entity(s) is modified by EMS on the request of NMS. EMS may send the corresponding attribute value change or state change notification(s) to NMS. The new attribute values will take effect after the modification.

6.2.2.2.4 Query managed entity

Summary: NMS can query the attribute values of one or more CM related managed entities in EMS through the management interface.

Assumptions: The communication between NMS and EMS is available. EMS supports the function of querying the specified managed entity(s).

Actors: NMS.

Preconditions: NMS needs to query the attribute value information of a CM related managed entity(s) in EMS. The specified managed entity(s) exists in EMS.

Description: NMS can query the attribute values of one or more managed entities. The attributes that can be queried vary for different managed entities. In this use case, NMS sends a request to query one or more managed entities. The parameter in the request is the list of the managed entities to be queried. If the function succeeds, EMS will return the attribute values for the specified managed entities. Or else, EMS will return error information.

Exceptions: Unknown Managed Entity; EMS Processing Error; Communication Error.

Post-conditions: EMS returns all the attribute values of the specified managed entities.

6.2.2.3 Configuration information notify function

Summary: After a managed object has been created or deleted, or the attributes values or state of a managed object has changed, EMS may send a corresponding notification to NMS, in order to notify NMS what have changed within the equipment. This use case uses the notification report function included in the common management function set. The use case involves object creation notification, object deletion notification, attribute value change notification and state change notification. For details, please refer to "Notification Report" in 6.2.1.2.1/Q.827.1.

6.2.2.4 Physical equipment configuration management

Summary: NMS can query or modify the configuration information of physical equipments.

Assumptions: The communication between NMS and EMS is available. NMS has the authority to query or modify the configuration information of the physical equipments.

Actors: NMS.

Preconditions: NMS needs to query or modify the configuration information of the physical equipments.

Description: NMS can query or modify configuration attributes of EPON physical equipments, such as OLT, ONU, ONT, NT, Splitter, rack, shelf, circuit pack, physical ports in OLT, ONU or ONT. The configuration attributes of OLT, ONU, ONT and NT contain administrative state, operational state, location name, supplier name, alarm status, and alarm severity assignment profile pointer, etc. The configuration attributes of OLT, ONU or ONT, NT and splitter also contain pointer attributes indicating the downstream NEs and the upstream NE (if applicable). The splitter includes an attribute describing the number of branches. When querying the configuration information of physical equipments, the input parameter is the equipment ID and the attribute names to be retrieved. Then EMS processes the query request and returns the queried result. When modifying configuration information, the input parameters contain the equipment ID, the attribute names to be modified and the corresponding values. EMS then returns the results that indicate whether the operation succeeds or not.

Exceptions: Unknown Managed Entity, Invalid Parameter, EMS Processing Error, Communication Error.

Post-conditions: The configuration information of the physical equipments is returned or modified.

6.2.2.5 Bandwidth assignment

Summary: Bandwidth can be assigned dynamically or statically. The bandwidth assignment type can be chosen by setting a parameter of OLT. In the dynamic assignment procedure, OLT sets the upstream bandwidth for each ONU or ONT according to the request from ONUs or ONTs. The static assignment can be divided into upstream and downstream bandwidth assignment. Only static bandwidth assignment is addressed in this use case.

Assumptions: OLT, ONU or ONT have already been installed in the system. The Ranging procedures of ONUs or ONTs have finished. The communications between NMS and EMS, EMS and OLT, OLT and ONU/ONT are available.

Actors: NMS.

Preconditions: When EPON network is initialized, or some customer wants to change the bandwidth value to or from the customer's ONT/ONU, NMS needs to statically assign the bandwidth from or to ONUs or ONTs. The specified managed entities exist in EMS.

Description: In this use case, NMS sends a static bandwidth assignment request to EMS, which contains the following parameters: the type of assignment, the ID of OLT, the ID of ONU or ONT equipment, and the related bandwidth value. On receiving this request, EMS validates that the requested equipments exist and the corresponding resources are abundant to allocate the bandwidth. Then EMS will work out and modify the corresponding parameter values of the entities related to the bandwidth assignment. The static bandwidth assignment is divided into two types: the upstream bandwidth assignment and the downstream bandwidth assignment.

Exceptions: Unknown Managed Entities, Bandwidth Not Enough, Communication Error, EMS Processing Error.

Post-conditions: The upstream or downstream bandwidth of an ONU or an ONT has been statically allocated or changed. The corresponding attribute value change notifications may be sent to NMS.

6.2.2.6 E1 connection management

Summary: NMS can create or delete a connection between an E1 port on OLT and an E1 port on ONU or ONT equipment according to customers' requirements.

Assumptions: OLT, ONU or ONT support E1 port. OLT, ONU or ONT have already been installed in the system. The Ranging procedures of ONU or ONT have finished. The communications between NMS and EMS, EMS and OLT, OLT and ONU/ONT are available.

Actors: NMS.

Preconditions: NMS needs to create or delete a connection relationship between an E1 port on OLT and an E1 port on ONU or ONT equipment. The E1 ports involved in the request exist in EMS and are available.

Description: In this use case, NMS sends a request to EMS to create an E1 connection, which contains the following parameters: the ID of E1 port on OLT equipment, and the ID of E1 port on ONU or ONT equipment. On receiving this request, EMS will check whether the E1 ports both of ONU/ONT, and OLT are available, and whether the bandwidth resource is enough. If the resources are not available or any exception occurs, EMS will inform NMS that the connection creation operation fails along with the possible causes. Or else, EMS will then create the relationship between the two E1 ports and related managed entities.

NMS can also request to remove an E1 connection. In this case, the deletion request includes the E1 Connection Id. EMS makes resources formerly assigned to the connection available for use by any subsequent connection request, modifying managed entities tracking these resource values. It also removes logical managed entities associated with the connection.

Exceptions: Unknown E1 Port; E1 Port Not Available; Bandwidth Not Enough; Communication Error; EMS Processing Error.

Post-conditions: An E1 connection is created or deleted. And the related managed object instances are created, modified or deleted on the request.

6.2.2.7 Software configuration management

Summary: NMS can query the software information of NEs through the management interface.

Assumptions: EMS stores NE software information. The communication is available.

Actors: NMS.

Precondition: NMS needs to query the software information of one or more NEs. The specified software in EPON equipment exists in EMS.

Description: NMS sends a request to EMS to query the software information of NEs, which contains software ID, software version, user label, supplier name, operational state, administrative state, etc. The input parameter is the IDs of the NEs whose software information is to be queried. On receiving this request, EMS starts to process it. If the operation succeeds, EMS will return the corresponding software attributes information. If the operation fails, it will return error information. In addition, EMS is responsible to maintain the consistency of software information with the NEs. That is, when new software has been installed on a NE, or there are any changes in the software, such as software version upgrading, EMS shall update the corresponding NE software information in its database.

Exceptions: Unknown Managed Entity; EMS Processing Error; Communication Error.

Post-conditions: NE software information is returned by EMS.

6.2.2.8 MAC bridge configuration management

Summary: NMS can query or modify the information of a MAC bridge in an EPON NE, which involves the MAC bridge itself, MAC bridge ports, MAC bridge spanning tree protocol, and MAC bridge port spanning tree protocol.

Assumptions: The managed system supports the MAC bridge functionality for the specified NE. The communication is available.

Actors: NMS.

Preconditions: NMS needs to query or modify the MAC bridge information on a specified NE. The specified NE exists in EMS, and the NE supports the MAC bridge functionality.

Description: NMS sends a request to EMS to query or modify the MAC bridge information. It includes the information about MAC bridge, MAC bridge port, MAC bridge spanning tree protocol, and MAC bridge port spanning tree protocol. Where, the information of MAC bridge contains the attributes related to the MAC bridge of an equipment which supports MAC bridge functionality, such as the number of MAC ports, and whether the MAC bridge supports spanning tree protocol or not, etc. The information of MAC bridge port contains attributes such as port number, the list of MAC address for which this port serves, and whether this MAC bridge port supports spanning tree protocol or not, etc. The information of MAC bridge spanning tree protocol contains the detailed protocol information associated with the bridge, such as priority, the number of root port, and some time and numerical parameters which support the operation of this spanning tree protocol, for instance, root path cost, max age, and hello time, etc. The information of MAC bridge port spanning tree protocol contains the detailed protocol information associated with each MAC bridge port, such as port priority, port state, designated bridge root cost port and port path cost. On receiving this request, EMS starts to process it. If the operation succeeds, EMS will return or modify the corresponding MAC bridge attributes information. If the operation fails, it will return error information.

MAC bridge information entities exist in the EPON equipments which support MAC bridge functionality.

Exceptions: Unknown Managed Entity; Invalid Parameter; EMS Processing Error; Communication Error.

Post-conditions: The corresponding MAC bridge information is returned or modified by EMS as requested.

6.2.2.9 VLAN configuration management

Summary: NMS can query or modify the configuration information about VLAN, which contains the information about VLAN ports, VLAN tagging operations, and the priority of VLAN switching.

Assumptions: The managed system supports VLAN function. The communication is available.

Actors: NMS.

Preconditions: NMS needs to query or modify the VLAN management related information on a specified NE. The specified NE exists in EMS, and the NE supports the VLAN functionality.

Description: NMS sends a request to query or modify VLAN information. The information involves VLAN ports, VLAN tagging operations, and the priority of VLAN switching. Where, the information of VLAN port contains details about a logical port of a MAC bridge port associated with a VLAN tagging, such as the filter table for this VLAN port which identifies TCI values provisioned at the bridge port, and the forward operation which will be invoked when receiving a data frame, etc. The information of VLAN tagging operations configuration data contains the details about VLAN tagging, such as upstream VLAN tagging operation mode, upstream VLAN TCI value, downstream VLAN tagging operation mode, etc. The information of VLAN switching priority contains the mapping information between user priorities of VLAN and switching priorities of an Ethernet Switch. On receiving this request, EMS starts to process it. If the operation succeeds, EMS will return or modify the corresponding VLAN information. If the operation fails, it will return error information.

VLAN information exists in the EPON equipment supporting VLAN functionality, which is based on the MAC bridge functionality.

Exceptions: Unknown Managed Entity; Invalid Parameter; EMS Processing Error; Communication Error.

Post-conditions: The corresponding VLAN information is returned or modified by EMS as requested.

6.2.3 Performance management function set

The specification level requirements for common parts of Performance management (PM) are described in 6.2.3/Q.827.1, which will be reused in this Recommendation.

Measurement data is the main objective of all the other function sets in PM. A short summary of the requirements for EPON performance measurement data may include the following: the measurement of Ethernet port, PON port, E1 port and VLAN port. The measurement data of Ethernet port contains the number of octets received and transmitted on the port, the number of inbound and outbound packets discarded on the port, and the number of the incoming and outgoing packets that contain errors, etc. The measurement data of PON port includes the upstream and downstream BERs of the port. The measurement data of E1 port focuses on the parameters about error seconds, and unavailable seconds. As for the VLAN measurement data, the number of frames received and transmitted on a port, the number of frames discarded on a port, and the number of the overflowed frames are involved.

6.2.4 Fault management function set

6.2.4.1 Overview

The specification level requirements for the common parts of Fault management (FM) are described in 6.2.4/Q.827.1, which will be reused in this Recommendation.

For EPON specific network management, Fault Management FS also includes the information of loopback test. Loopback test management FS includes the following functions: Start Loopback Test Job, Stop Loopback Test Job, Query Loopback Test Job, and Report Loopback Test Results.

6.2.4.2 Loopback test function set

6.2.4.2.1 Start loopback test job

Summary: NMS can initiate a loopback test procedure by sending a request to EMS. The tests include but are not limited to the ONU loopback test.

Assumptions: The communication between NMS and EMS and the communication between EMS and the related NE is available. The test performer or test device of the NE is available. The NE has capabilities to conduct the test.

Actors: NMS.

Preconditions: NMS needs to execute a loopback test in order to get more information to resolve the complaint of a customer or to support a maintenance activity. The specified NE for testing exists in EMS.

Description: In this use case, NMS constructs a request to start a loopback test job. The request includes the data source type, the test type, the managed entity to be tested, the start time of the test, the end time of the test, and the time interval of reporting and logging test results. EMS identifies the EPON resource to be tested and the ancillary EPON resources that must participate in the test, and then returns the identifier for the test job. At the start time of the test job, EMS executes the test sequence in collaboration with the NEs. At the end of the test or each interval for reporting and logging, EMS will report the test results as well as record them in the log. The test results contain the upstream and downstream bit error ratio, packet loss ratio, the number of received octets, the number of transmitted octets, and the number of FCS errors.

Exceptions: Unknown Managed Entity; EMS Processing Error; Communication Error

Post-conditions: EMS starts the test job on the specified NE as requested. At each reporting interval, EMS will record the test result in the log as well as report them to NMS.

6.2.4.2.2 Stop loopback test job

Summary: NMS can request EMS to stop a running loopback test job through the management interface.

Assumptions: The communication between NMS and EMS and the communication between EMS and the related NE is available.

Actors: NMS.

Preconditions: NMS does not need EMS to perform the loopback test job any more. The specified test job exists in EMS.

Description: In this use case, NMS sends a request to stop a running loopback test job in EMS. The request parameter is the ID of the test job. If the operation succeeds, the specified test job will stop working and EMS will return success information. Otherwise it will return error information to NMS.

Exceptions: Unknown Test Job; EMS Processing Error; Communication Error.

Post-conditions: The specified test job is stopped by the request.

6.2.4.2.3 Query loopback test jobs

Summary: NMS can request EMS to query the parameter values of loopback test jobs through the management interface.

Assumptions: The communication between NMS and EMS is available.

Actors: NMS.

Preconditions: NMS needs to query the parameter information of one or more loopback test jobs in EMS. The specified test job(s) exists in EMS.

Description: In this use case, NMS sends a request to EMS to query the parameters of a loopback test job(s), which include: the test job ID, the data source of the test, the test type, the managed entity this test is performed on, the start and stop time of the test job, and the time interval for reporting and logging test results. The input parameter is the list of the test job ID(s). When the list is empty, the request is to query information of all the test jobs in EMS. If the operation succeeds, EMS will return the information of the test job(s). If the operation fails, it will return error information to NMS.

Exceptions: Unknown Test Job; EMS Processing Error; Communication Error.

Post-conditions: The corresponding information of the test job(s) is returned by EMS as requested.

6.2.4.2.4 Loopback test result report

Summary: The test results of a loopback test is generated and reported to NMS periodically according to the time interval specified when the test job is started. At each reporting interval, a corresponding "Loopback Test Result" notification will be sent to NMS, as well as logged as a log record, which can also be queried later using the "Query Log Records" function described in 6.2.1.3.2.1/Q.827.1.

6.2.5 Security management

For the specification level requirement of security management, please refer to 6.2.2.1/Q.834.3 [16].

7 Analysis

This clause provides the detailed analysis of the management interface. In the following clauses, the related managed entities and their relationships are fully analysed, and the diagrams in these clauses illustrate the static or dynamic relationships of the managed entities.

7.1 Conventions

In this clause, when specifying managed entities and their management operations, the following abbreviations are applied to indicate the qualifier of attributes, notifications or operation parameters.

- M: Mandatory.
- O: Optional.
- C: Conditional.
- R: Readable.
- W: Writable.
- S: Set by Create.

For the managed entities that are specific in EPON management, their names are suffixed by 'E' and with the first letter capitalized. For the managed entities providing just the controlling functions and may be reused in some other network technology-specific managements, their names do not contain this suffix, with the first letter capitalized. For the managed entities that are imported from other Recommendations, their names remain the same as imported.

7.2 Common management function set

7.2.1 Managed entities

7.2.1.1 Class diagram of common management entities

The class diagrams of common management entities can be found in 7.2.1.1/Q.827.1. The only addition for Figures 7-1/Q.827.1 and 7-2/Q.827.1 is to include two new managed entities LoopbackTestResultRecord and EPONAccessNetwork. Combining Figure 7-1/Q.827.1 and Figure 7-1 below will result in a complete inheritance diagram of Common management for this Recommendation. Combining Figure 7-2/Q.827.1 and Figure 7-2 below will result in a complete entities relationship diagram for Common management for this Recommendation

NOTE – EPONAccessNetwork is a sub-class of network, which will be used as a replacement in the Entities relation diagram in this Recommendation.

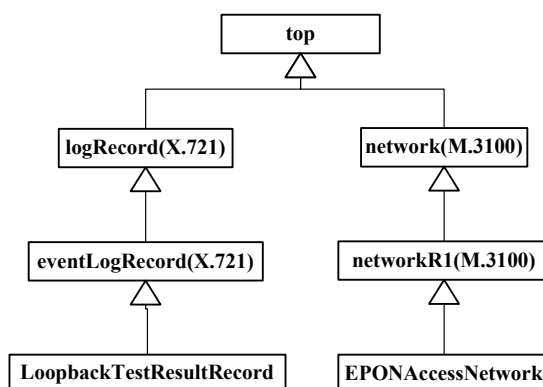


Figure 7-1/Q.838.1 – Additional inheritance diagram of common management

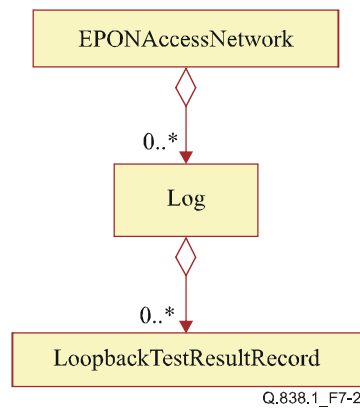


Figure 7-2/Q.838.1 – Additional containment diagram of common management

7.2.1.2 LoopbackTestResultRecord

Behaviour:
This managed object class is used to define the information stored in the log as a result of receiving loopback test result notifications. The managed object class is derived from eventLogRecord.
Attributes:
This managed object inherits all the attributes defined in eventLogRecord and also contains the attributes as defined in "LoopbackTestResult" notification. See 7.2.2.1 for details.
Relationships:
Multiple instances of this managed entity may be contained in an instance of the Log managed object.

7.2.1.3 EPONAccessNetwork

Behaviour:
This managed entity represents a set of managed entities which are visible at the NMS-EMS management interface and managed by one EMS. An instance of this managed entity is created when an EMS along with its managed resources are added to the EPON managing system. An instance of this managed entity is created when an EPON system is initialized, and it cannot be created or deleted as requested by a managing system. This managed entity derives from networkR1 and inherits the attributes and notifications of its super class.
Attributes:
This managed object inherits all the attributes defined in networkR1. There are no extra attributes to be added.
Relationships:
EPONAccessNetwork managed entity is composed of many transport entities and other controlling entities (e.g., Log defined in ITU-T Rec. Q.827.1). Only one instance of this managed object class exists for an EMS (This is the root managed object of an EMS).
Reportable Notifications:
This managed object inherits all the notifications defined in networkR1. There are no extra notifications to be added.

7.2.2 Notification report function

The notification header and all the possible notifications defined in 7.2.3.1 and 7.2.3.2 of ITU-T Rec. Q.827.1 will be reused in this Recommendation. In the following clause, the extended notifications specific for this Recommendation are provided.

7.2.2.1 Extended notification definitions

In this clause, only one extra notification is extended to 7.2.3.2/Q.827.1.

1) LoopbackTestResult

Parameters	Description	Type	Qualifier
testJobId	It identifies the loopback test job whose results are reported.	Integer	M
testResultDefinition	It identifies the result of a loopback test job. It is a set of structure, composed of the attributeName and the corresponding attributeValue, which include: the upstream bit error ratio, downstream bit error ratio, packet loss ratio, the number of received octets, the number of transmitted octets, and the number of FCS errors.	LIST of Name/Value pairs	M
timeInterval	This parameter identifies the time interval for EMS to report the test results.	Integer (Units: minutes)	M

7.3 Configuration management function set

7.3.1 Managed entities

7.3.1.1 Class diagram of configuration management entities

Figure 7-3 is the inheritance diagram of the configuration management related entities in network element view, and Figure 7-4 is the inheritance diagram of the configuration management related entities in network view.

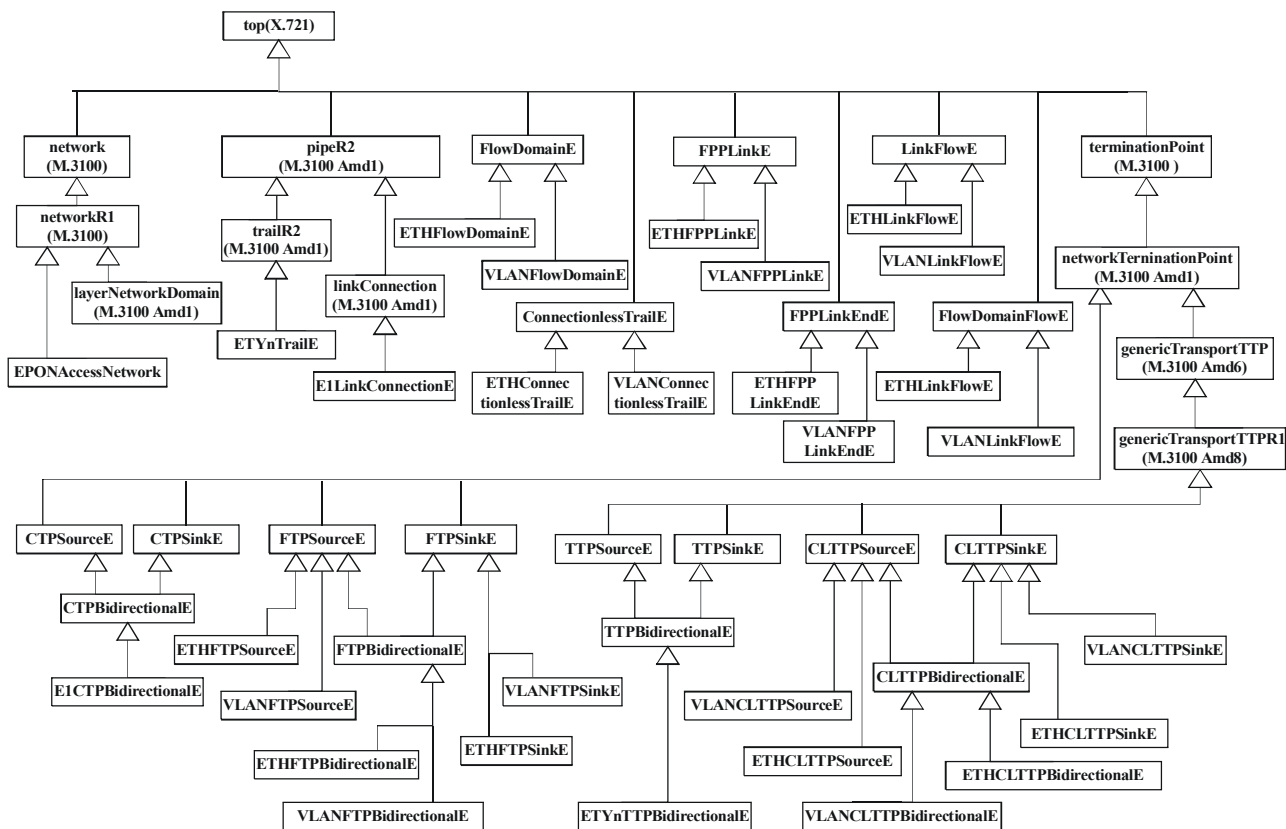
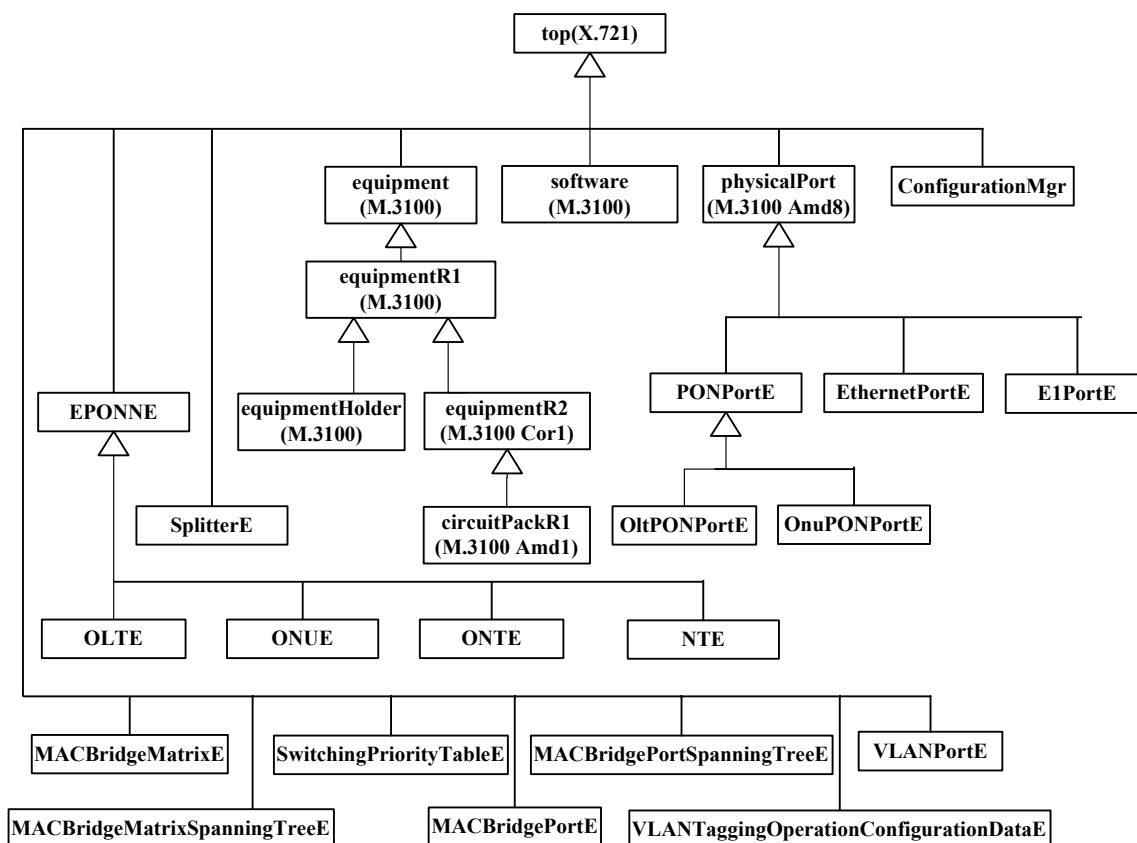


Figure 7-4/Q.838.1 – Inheritance diagram of managed entities in network view

NOTE 1 – See clause 5/Note 2 regarding the VLAN layer.

Figure 7-5 is the containment diagram of configuration management entities in both network element view and network view.

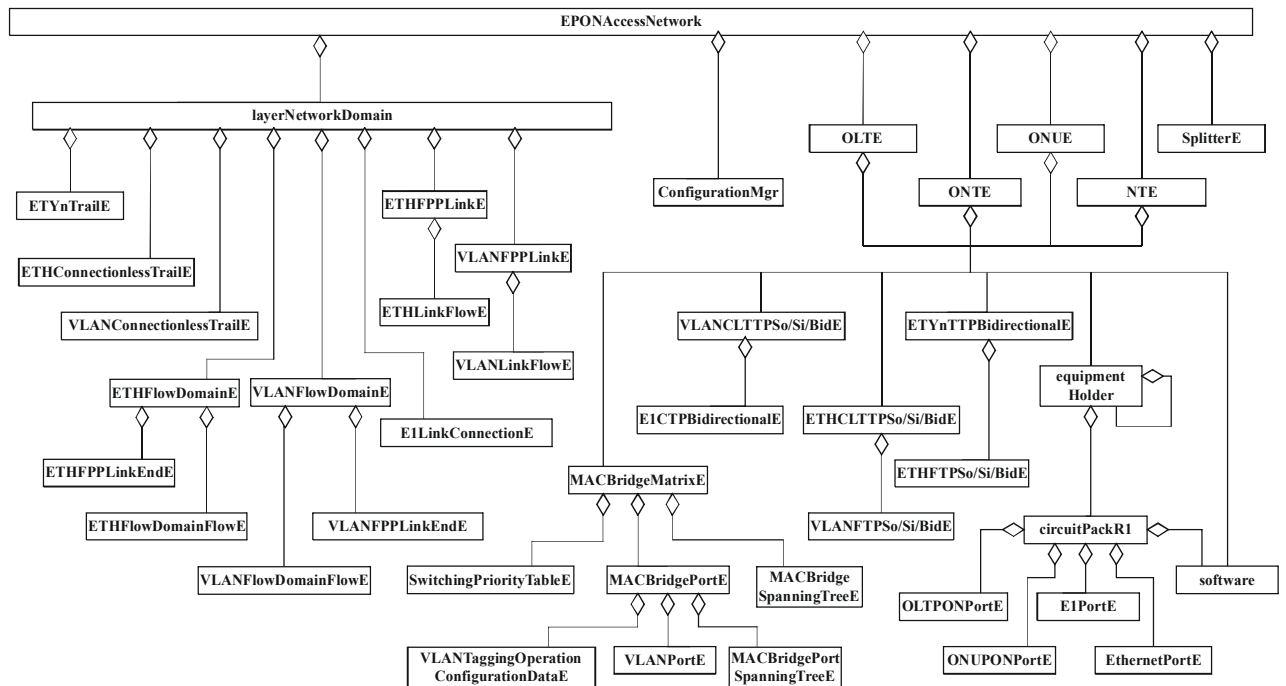


Figure 7-5/Q.838.1 – Containment diagram of configuration managed entities

NOTE 2 – See clause 5/Note 2 regarding the VLAN layer.

Figure 7-6 is the entity relationship diagram of EPON Network Elements.

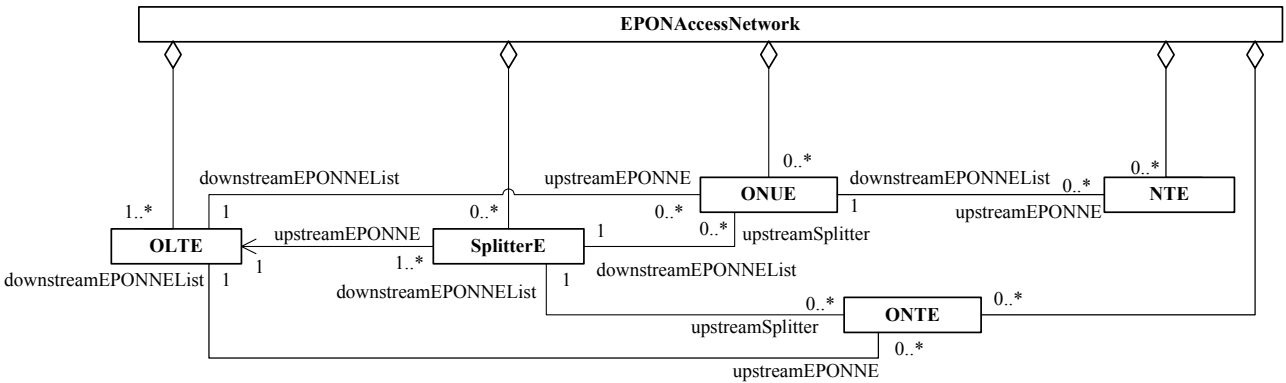


Figure 7-6/Q.838.1 – Entities-relationship diagram of configuration management – EPON NE

Figure 7-7 is the entity relationship diagram of entities related to layer network.