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AT&T OMCI Specification
Edition 2.0

Abstract

This document defines the AT&T technical specification for ITU-T xPON Interoperability.

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Revision History

Edition No.	Date	Author	Changes
1.0	10-19-16	Tim Bates, Bryan Walker, Warren Long, Sunny Chen, M. (Sri) Srikrishna	Update-addition of specific MEs and Architecture
1.1	2-3-17	Tim Bates, Bryan Walker, Warren Long, Sunny Chen, Mark Shostak, M. (Sri) Srikrishna	Added additional MEs 5.1.39 through 5.1.66 and included Application notes. Moved Architecture to Appendix B
2.0	3-31-17	Tim Bates, Bryan Walker, Warren Long, Sunny Chen, Mark Shostak, M. (Sri) Srikrishna	Restructured to better follow G.988 grouping of MEs based on services. Added Appendix with OMCI ME models specific to require services. Added attribute updates based on AT&T 's reviews with suppliers.

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1. Purpose of Document

This document defines the technical specification for AT&T xPON Interoperability. It is based on ITU G.988 and includes the AT&T network architecture and services required to be supported by OLT and ONU vendors.

Note: OMCI uses the term Optical Network Unit (ONU) to encompass both a "multiple subscriber device" as well as a "single subscriber device" generally referred to as an Optical Network Termination (ONT). An ONT is a special case of an ONU.

This document is applicable only to ONTs.

The included OMCI Managed Entities (ME) are a subset of G.988 and must be supported by any vendor Domain 1 (D1) implementation for AT&T. Each ME and its associated attributes are included and updated from G.988 to ensure both OLT and ONU required or expected behavior is clear.

Specific OMCI ME updates or requirements related to Domain 2 (D2) implementations will be added in future revisions of this document.

1.1 Document Scope

The document describes the following:

- Overview of AT&T's Lightspeed xPON Access Architecture
- OLT/ONU management architecture
- Domain 2 Management Model
- Mandatory Managed Entities
- OLT/ONU service related OMCI ME models

1.2 Document Conventions

This specification is consistent with G.988 regarding mandatory ME attributes and does not change a G.988 mandatory ME to optional but may provide a default value and not require the OLT/ONU to update/utilize the ME attribute. This is intended to cover cases where the attribute must be created by the OLT/ONU per the G.988 standard but the implementation for AT&T does not require usage of the specific ME attribute.

In some cases, G.988 "optional" ME attributes have been updated to "mandatory". This is to ensure both OLT and ONU implementations support its associated functionality.

Each OMCI ME will include an Application section to cover D1 verses D2 implementations where needed and an ME Relationships section which will cover specifics related to different services using the ME.

2. Current Lightspeed Network Overview

AT&T currently deploys the following GPON architecture as part of the overall Fiber to the Premesis (FTTP) solution for Lightspeed.

Figure 1 shows a high level deployment model for the GPON solution. The OLTs shown are ALU products; 7342 ISAM FTTU and the 7360 ISAM. This diagram shows the current solution using discrete ONT and RG as well a Residential Gateway (RG) with integrated ONT. The majority of this document applies to both of these implementations.

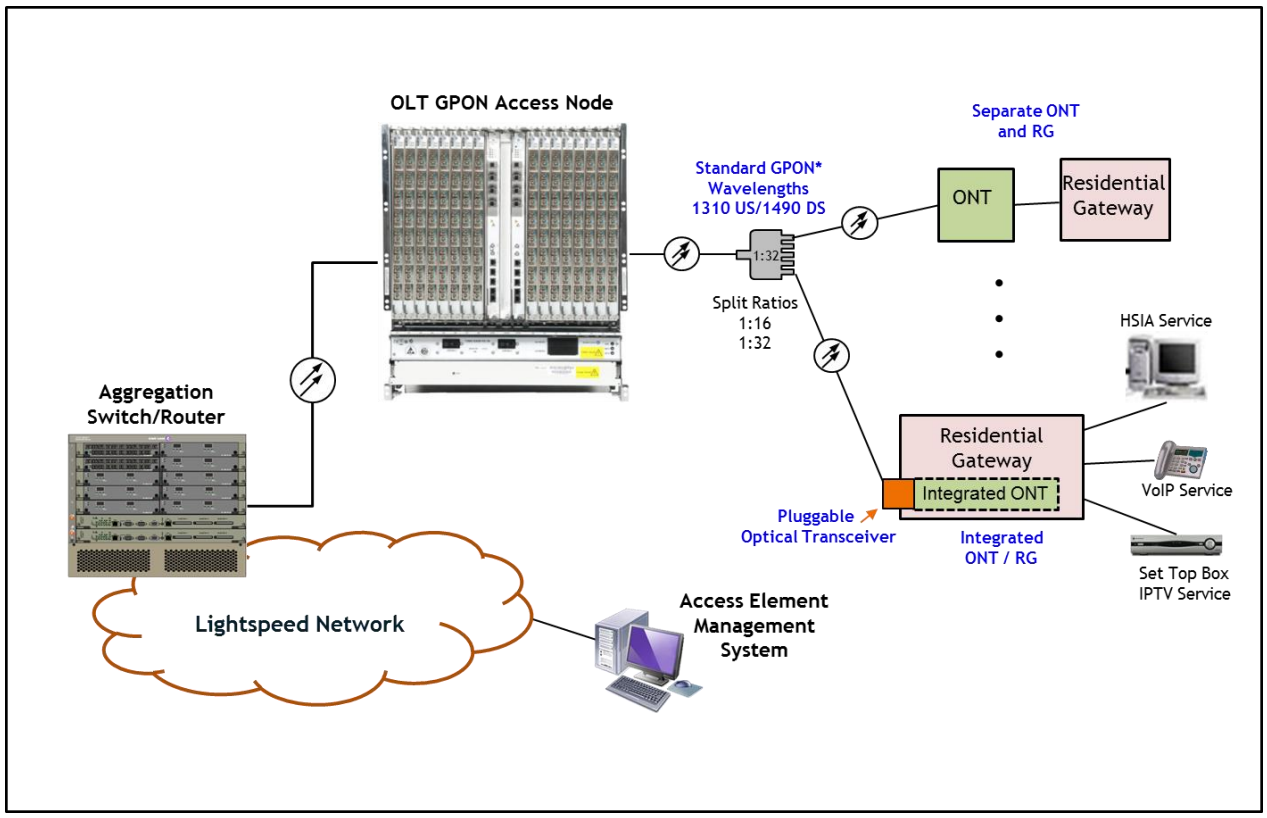

Figure 1 - GPON Architecture for Lightspeed

Figure 2 shows a high level deployment model for the xPON solution which will be deployed with the 7360 OLT using the xPON line cards.

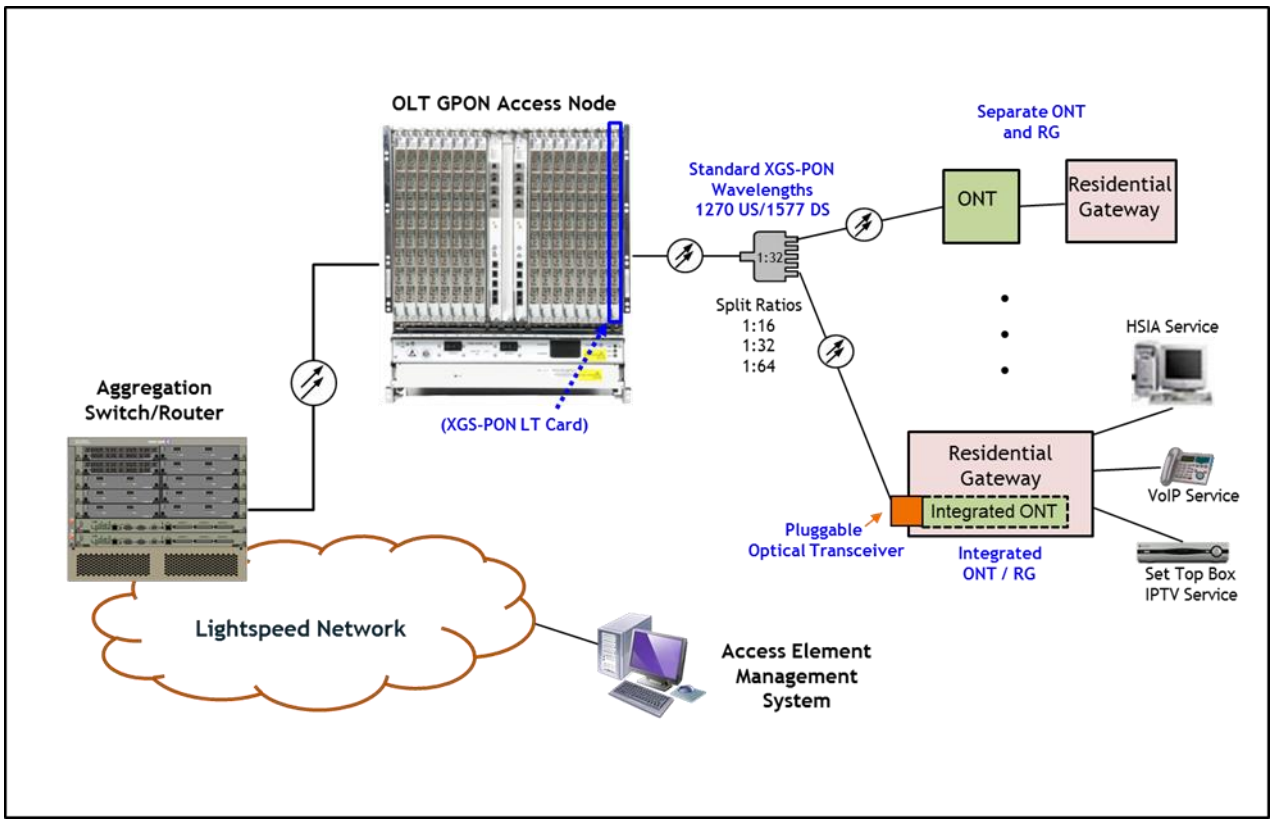

Figure 2 - XGS-PON Architecture for Lightspeed

3. Optical Distribution Network

AT&T has deployed the GPON solution in several scenarios including Greenfield, Brownfield, and overbuild.

Currently AT&T is utilizing a 1:32 PON split ratio and supports a 1:16 PON split scenario.

AT&T will be deploying the xPON solution in several scenarios including Greenfield, Brownfield, and overbuild.

Currently AT&T is utilizing a 1:32 PON split ratio. This split ratio is expected to be increased in the future to 1:64.

AT&T has plans to use a Coexistance Element (CEx) where G-PON, XGS-PON and NG-PON2 (future) can coexist on the same ODN.

4. ONU Management Overview

4.1 D1 Legacy Management Model

The overall OLT/ONU management architecture for Lightspeed is shown below in Figure 3. The OLT and ONUs are managed with the ALU 5520 AMS while the CPE or Residential Gateway is managed with the CMS. The AMS management traffic is all terminated on the OLT and the OLT uses ONU Management and Control Interface (OMCI) to manage the ONUs. The CPE/RG management traffic from the CMS is passed/tunneled through the OLT and ONU directly to the CPE/RG.

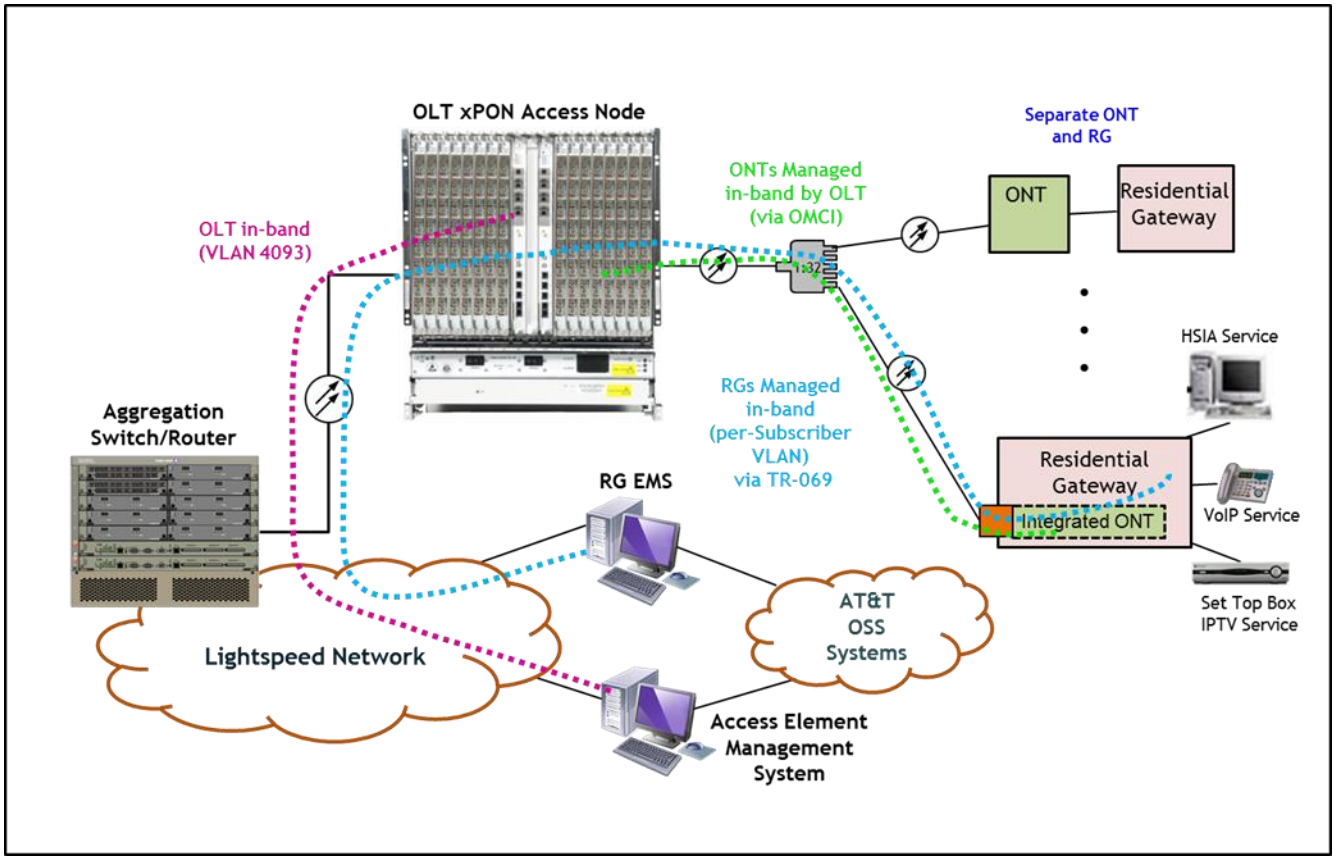

Figure 3 - Lightspeed xPON Management

4.2 Domain 2.0 Management Model

In AT&T Domain 2.0 deployment model, the control and management functions of the access device (OLT) will be disaggregated and implemented as shown in Figure 4.2.

AT&T vAccess Platform is comprised of:

- Access Controller
- Access Manager
- Virtual Access Network Interface Link Layer Abstraction (VANILLA)
- Physical Network device (AT&T Open OLT)

The OMCI management function is implemented in the software module VANILLA that provides a layer of abstraction for the underlying access device for control and management. On the north-bound interface VANILLA provides extensible set of abstract APIs and protocols to interface with access controller and manager and on the southbound side, VANILLA communicates to the physical network device (OLT) using open or vendor specific driver adapters.

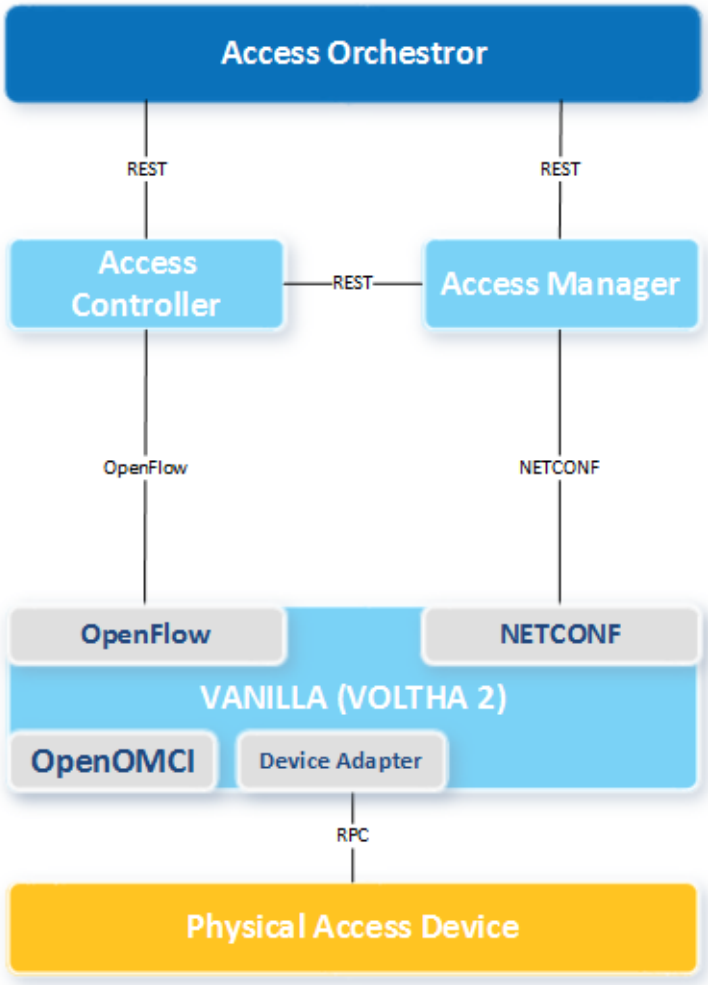

Figure 4 – vAccess Platform

4.3 Current ONU Activation

The ONU activation (registration) method requires that the ONU be ranged (range is one state in activation cycle), and basic capabilities negotiated with the OLT. Refer to G989.3 (or G.987.3) section 12 of ONU activation.

The LSBBT ONU activation tool automates the activation process without calling AT&T Care centers for assistance. This tool is located on the LSBBT HOME page. Using a Laptop, Smartphone/iPad, the I&M Technicians perform ONU Registration using the web-based LSBBT tool. This method contains a manual step where the on-site technician selects the appropriate ONU serial number to associate to the subscriber's BAN and ONU ID on the PON.

AT&T may also implement a Customer Self Install (CSI) method which will allow subscribers to install an ONU and RG without requiring an on-site technician. This method will use the OLT PON "New ONT" alarm which is forwarded North bound to BBNMS and triggers the automated activation and ONU ID assignment for the new ONU.

These methods do not require any special behavior for ONU ranging or activation at the PLOAM layer. The standard ITU-T G.988 method of establishing the ONU Management and Control Channel (OMCC) will apply.

4.4 PLOAM Layer Messaging

AT&T ONUs implement the standard xPON physical layer operation and management channel (PLOAM) for the GTC layer which includes ONU activation, OMCC establishment, encryption configuration, key management, and alarm signaling.

5. OMCI Managed Entities

The ONU Management and Control lnterface (OMCI), as specified in G.988, is used to provide an information path between OLT and ONU to exchange Operation, Administration, and Maintenance (OAM) information. This information is conveyed in the form of Managed Entities (MEs) that can be classified as standard MEs (standard MEs and standard MEs that are open to interpretation) and proprietary vendor specific MEs (G.988 proprietary extensions).

In addition to the OMCI Implementation Guide below describing the OMCI standard MEs, the ME relationship models as they relate to AT&T services are provided in Appendix A, section 7.

Any supplier must utilize AT&T MEs for its explicit purpose, for example, no updates should be made to any ME attribute except that is explicitly defined in this AT&T Interop Spec. The mandatory supported MEs are identified in **Table 1**.

ME #	Supported Managed Entity (AT&T Mandatory MEs)	AT&T Interop Spec Para.	G.988 Para.	G.984.4 Para.
2	ONU data (NOTE: In ITU-T G.984.4 and G.983.2 this was labeled ONT}	5.1.3	9.1.3	9.1.3
5	Cardholder (NOTE: Subscriber Line Cardholder in ITU-T G.983.2}	5.1.5	9.1.5	9.1.5
6	Circuit pack (NOTE: Subscriber Line Card in ITU-T G.983.2}	5.1.6	9.1.6	9.1.6
7	Software image	5.1.4	9.1.4	9.1.4
11	Physical path termination point Ethernet UNI	5.5.1	9.5.1	9.5.1
24	Ethernet performance monitoring history data	5.5.2	9.5.2	9.5.2
45	MAC bridge service profile	5.3.1	9.3.1	9.3.1
47	MAC bridge port configuration data	5.3.2	9.3.4	9.3.4
53	Physical Path Termination Point POTS UNI	5.9.1	9.9.1	9.9.1
58	Voice Service Profile	5.9.6	9.9.6	9.9.6
84	VLAN tagging filter data	5.3.4	9.3.11	9.3.11
130	IEEE 802.1p mapper service profile	5.3.3	9.3.10	9.3.10
131	OLT-G	5.12.2	9.12.2	9.12.2
133	ONU power shedding (NOTE – In [ITU-T G.984.4] this was labeled ONT)	5.1.7	9.1.7	9.1.7
134	IP Host Config Data	5.4.1	9.4.1	9.4.12
135	IP Host Performance Monitoring History Data	5.4.2	9.4.2	9.4.13
136	TCP/UDP Config Data	5.4.3	9.4.3	9.4.14
137	Network Address	5.12.3	9.12.3	9.12.3
138	VoIP Config Data	5.9.12	9.9.18	9.9.18
139	VoIP Voice CTP	5.9.4	9.9.4	9.9.4
142	VoIP media profile	5.9.5	9.9.5	9.9.5
143	RTP profile data	5.9.7	9.9.7	9.9.7
148	Authentication security method	5.12.4	9.12.4	9.12.4
150	SIP Agent Config Data	5.9.3	9.9.3	9.9.3
151	SIP Agent Performance Monitoring History Data	5.9.8	9.9.14	9.9.14

ME #	Supported Managed Entity (AT&T Mandatory MEs)	AT&T Interop Spec Para.	G.988 Para.	G.984.4 Para.
152	SIP Call Initiation Performance Monitoring History Data	5.9.9	9.9.15	9.9.15
153	SIP User Data	5.9.2	9.9.2	9.9.2
155	MGC Config data	5.9.10	9.9.16	9.9.16
156	MGC Performance Monitoring History Data	5.9.11	9.9.17	9.9.17
157	Large String	5.12.5	9.12.5	9.12.5
158	ONU remote debug	5.1.8	9.1.12	9.1.12
171	Extended VLAN tagging operation configuration data	5.3.5	9.3.13	9.3.13
256	ONU-G (NOTE – In [ITU-T G.984.4] this was called ONT-G)	5.1.1	9.1.1	9.1.1
257	ONU2-G (NOTE – In [ITU-T G.984.4] this was called ONT2-G)	5.1.2	9.1.2	9.1.2
262	T-CONT	5.2.2	9.2.2	9.2.2
263	ANI-G	5.2.1	9.2.1	9.2.1
264	UNI-G	5.12.1	9.12.1	9.12.1
266	GEM interworking termination point	5.2.4	9.2.4	9.2.4
268	GEM port network CTP	5.2.3	9.2.3	9.2.3
272	GAL Ethernet profile	5.2.6	9.2.7	9.2.7
273	Threshold data 1	5.12.6	9.12.6	9.12.6
274	Threshold data 2	5.12.7	9.12.7	9.12.7
277	Priority queue	5.2.8	9.2.10	9.11.1
278	Traffic scheduler	5.2.9	9.2.11	n/a
280	Traffic descriptor	5.2.10	9.2.12	n/a
281	Multicast GEM interworking termination point	5.2.5	9.2.5	9.2.5
287	OMCI	5.12.8	9.12.8	9.12.8
290	Dot1X port extension package	5.3.6	9.3.14	9.3.14
299	Dot1ag maintenance domain	5.3.7	9.3.19	9.3.19
300	Dot1ag maintenance association	5.3.8	9.3.20	9.3.20
302	Dot1ag MEP	5.3.9	9.3.22	9.3.22
305	Dot1ag CFM stack	5.3.10	9.3.25	9.3.25
309	Multicast operations profile	5.3.11	9.3.27	9.3.27
310	Multicast subscriber config info	5.3.12	9.3.28	9.3.28
312	FEC performance monitoring history data	5.2.7	9.2.9	9.2.9
321	Ethernet frame performance monitoring history data downstream	5.3.13	9.3.31	n/a
322	Ethernet frame performance monitoring history data upstream	5.3.14	9.3.30	n/a
329	Virtual Ethernet interface point	5.5.3	9.5.5	n/a
332	Enhanced Security Control	5.13.1	9.13.11	n/a
335	SNMP Configuration Data	5.12.9	9.12.15	n/a
336	ONU dynamic power management control	5.1.9	9.1.14	n/a
340	BBF TR-069 management server	5.12.10	9.12.16	n/a
341	GEM port network CTP performance monitoring history data	5.2.11	9.2.13	9.2.6
344	XG-PON TC Performance Monitoring History Data	5.2.12	9.2.15	n/a

ME #	Supported Managed Entity (AT&T Mandatory MEs)	AT&T Interop Spec Para.	G.988 Para.	G.984.4 Para.
345	XG-PON Downstream Management Performance Monitoring History Data	5.2.13	9.2.16	n/a
346	XG-PON upstream management performance monitoring history data	5.2.14	9.2.17	n/a
349	PoE control	5.5.4	9.5.6	n/a

Table 1 - AT&T Mandatory Supported MEs

The ME sections below follow the catagories and sequence used by theG.988 Specification.

5.1 Equipment Management

5.1.1 ONU-G (ME #256)

This managed entity represents the ONU as equipment. The ONU automatically creates an instance of this managed entity. It assigns values to read-only attributes according to data within the ONU itself.

This managed entity has evolved from the ONT-G of [ITU-T G.984.4].

Application

Represents the ONU as an equipment.

Relationships

In ITU-T G.984 and ITU-T G.987 applications, all other managed entities in this Recommendation are related directly or indirectly to the ONU-G entity.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. There is only one instance, number 0. (R) (mandatory) (2 bytes)

Vendor ID: This attribute identifies the vendor of the ONU. It is the same as the four most significant bytes of the ONU serial number as specified in [ITU-T G.984.3] and [ITU-T G.987.3]. (R) (mandatory) (4 bytes)

Version: This attribute identifies the version of the ONU as defined by the vendor. The character value 0 indicates that version information is not available or applicable. (R) (mandatory) (14 bytes)

Serial number: The serial number is unique for each ONU. It is defined in [ITU-T G.984.3] and [ITU-T G.987.3] and contains the vendor ID and version number. The first four bytes are an ASCII-encoded four-letter vendor ID. The second four bytes are a binary encoded serial number, under the control of the ONU vendor. (R) (mandatory) (8 bytes)

Traffic management option: This attribute identifies the upstream traffic management function implemented in the ONU. There are three options:

0 Priority controlled and flexibly scheduled upstream traffic. The traffic scheduler and priority queue mechanism are used for upstream traffic.

1 Rate controlled upstream traffic. The maximum upstream traffic of each individual connection is guaranteed by shaping.

2 Priority and rate controlled. The traffic scheduler and priority queue mechanism are used for upstream traffic. The maximum upstream traffic of each individual connection is guaranteed by shaping.

For a further explanation, see Appendix II.

Downstream priority queues are managed via the GEM port network CTP ME.

Upon ME instantiation, the ONU sets this attribute to the value that describes its implementation. The OLT must adapt its model to conform to the ONU's selection. (R) (mandatory) (1 byte)

Deprecated: This attribute is not used. If it is present, it should be set to 0. (R) (optional) (1 byte)

Battery backup: This Boolean attribute controls whether the ONU performs backup battery monitoring (assuming it is capable of doing so). False disables battery alarm monitoring; true enables battery alarm monitoring. (R, W) (mandatory) (1 byte)

Administrative state: This attribute locks (1) and unlocks (0) the functions performed by the ONU as an entirety. Administrative state is further described in [ITU-T G.988] clause A.1.6. (R, W) (mandatory) (1 byte)

Operational state: This attribute reports whether the managed entity is currently capable of performing its function. Valid values are enabled (0) and disabled (1). (R) (optional) (1 byte)

ONU survival time: This attribute indicates the minimum guaranteed time in milliseconds between the loss of external power and the silence of the ONU. This does not include survival time attributable to a backup battery. The value zero implies that the actual time is not known. (R) (optional) (1 byte)

Logical ONU ID: This attribute provides a way for the ONU to identify itself. It is a text string, null terminated if it is shorter than 24 bytes, with a null default value. The mechanism for creation or modification of this information is beyond the scope of this Recommendation, but might include for example a web page displayed to a user. (R) (optional) (24 bytes)

Logical password: This attribute provides a way for the ONU to submit authentication credentials. It is a text string, null terminated if it is shorter than 12 bytes, with a null default value. The mechanism for creation or modification of this information is beyond the scope of this Recommendation. (R) (optional) (12 bytes)

Credentials status: This attribute permits the OLT to signal to the ONU whether its credentials are valid or not. The behavior of the ONU is not specified, but might for example include displaying an error screen to the user. (R, W) (optional) (1 byte)

Values include:

0 Initial state, status indeterminate

1 Successful authentication

2 LOID error

3 Password error

4 Duplicate LOID

Other values are reserved.

Extended TC-layer options: This attribute is meaningful in ITU-T G.984 systems only. It is a bit map that defines whether the ONU supports (1) or does not support (0) various optional TC-layer capabilities of [ITU-T G.984.3]. Bits are assigned as follows:

Bit	Meaning
1 (LSB)	ITU-T G.984.3 Annex C, PON-ID maintenance.
2	ITU-T G.984.3 Annex D, PLOAM channel enhancements: swift_POPUP and Ranging_adjustment messages.
3..16	Reserved

(R) (optional) (2 bytes)

Actions

Get, set

Reboot: Reboot the ONU.

Test: Test the ONU. The test action can be used either to perform equipment diagnostics or to measure parameters such as received optical power, video output level, battery voltage, etc. Test and test result messages are defined in [ITU-T G.988] Annex A.

Synchronize time: This action synchronizes the start time of all performance monitoring managed entities of the ONU with the reference time of the OLT. All counters of all performance monitoring managed entities are cleared to 0 and restarted. Also, the value of the interval end time attribute of the performance monitoring managed entities is set to 0 and restarted. See [ITU-T G.988] clause I.4 for further discussion of PM.

Note: This function is intended only to establish rough 15-minute boundaries for PM collection. High precision time of day synchronization is a separate function, supported by the OLT-G managed entity.

Notifications

Test result: Test results are reported via a test result message if the test is invoked by a test command from the OLT.

Attribute value change

Number	Attribute value change	Description
1..7	N/A	
8	Op state	Operational state change
9	N/A	
10	LOID	Logical ONU ID
11	Lpw	Logical password
12..16	Reserved	

Alarm

Alarm number	Alarm	Description
0	Equipment alarm	Functional failure on an internal interface
1	Powering alarm	Loss of external power to battery backup unit. This alarm is typically derived through an external interface to a battery backup unit, and indicates that AC is no longer available to maintain battery charge.
2	Battery missing	Battery is provisioned but missing
3	Battery failure	Battery is provisioned and present but cannot recharge
4	Battery low	Battery is provisioned and present but its voltage is too low
5	Physical intrusion	Applies if the ONU supports detection such as door or box open
6	ONU self-test failure	ONU has failed autonomous self-test
7	Dying gasp	ONU is powering off imminently due to loss of power to the ONU itself. This alarm may be sent in conjunction with the powering alarm if the backup unit cannot supply power and the ONU is shutting down.
8	Temperature yellow	No service shutdown at present, but the circuit pack is operating beyond its recommended range.
9	Temperature red	Some services have been shut down to avoid equipment damage. The operational state of the affected PPTPs indicates the affected services.
10	Voltage yellow	No service shutdown at present, but the line power voltage is below its recommended minimum. Service restrictions may be in effect, such as permitting no more than N lines off-hook or ringing at one time.
11	Voltage red	Some services have been shut down to avoid power collapse. The operational state of the affected PPTPs indicates the affected services.
12	ONU manual power off	The ONU is shutting down because the subscriber has turned off its power switch.
13	Inv-Image	Software image is invalid (Note)
14	PSE overload yellow	Indicates that the ONU is nearing its maximum ability to supply the known PoE demand of the attached PDs. The thresholds for declaring and clearing this alarm are vendor-specific.
15	PSE overload red	Indicates that the ONU is unable to supply all of the PoE demand of the attached PDs and has removed or reduced power to at least one PD.
16..207	Reserved	
208..223	Vendor-specific alarms	Not to be standardized* (to be discussed before implemented)
Note: The ONU should declare this alarm only outside the software download process.		

5.1.2 ONU2-G (ME #257)

This managed entity contains additional attributes associated with a PON ONU. The ONU automatically creates an instance of this managed entity. Its attributes are populated according to data within the ONU itself.

This managed entity is the same as the ONT2-G of [ITU-T G.984.4], with extensions.

Application

This ME is an extension of the ONU as an equipment and contains additional attributes (in addition to the ONU-G) associated with the ONU.

Relationships

This managed entity is paired with the ONU-G entity.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. There is only one instance, number 0. (R) (mandatory) (2 bytes)

Equipment ID: This attribute may be used to identify the specific type of ONU. In some environments, this attribute may include the equipment CLEI code. (R) (mandatory) (20 bytes)

OMCC version: This attribute identifies the version of the OMCC protocol being used by the ONU. This allows the OLT to manage a network with ONUs that support different OMCC versions. Release levels of [ITU-T G.984.4] are supported with code points of the form 0x8y and 0x9y, where y is a hexadecimal digit in the range 0..F. Support for continuing revisions of this Recommendation is defined in the 0xAy range.

0x80 ITU-T G.984.4 (06/04)

NOTE – For historical reasons, this code point may also appear in ONUs that support later versions of [ITU-T G.984.4].

0x81 ITU-T G.984.4 2004 Amd.1 (06/05)
0x82 ITU-T G.984.4 2004 Amd.2 (03/06)
0x83 ITU-T G.984.4 2004 Amd.3 (12/06)
0x84 ITU-T G.984.4 2008 (02/08)
0x85 ITU-T G.984.4 2008 Amd.1 (06/09)
0x86 ITU-T G.984.4 2008 Amd.2 (2009). Baseline message set only, without the extended message set option
0x96 ITU-T G.984.4 2008 Amd.2 (2009). Extended message set option, in addition to the baseline message set.
0xA0 ITU-T G.988 (2010). Baseline message set only, without the extended message set option
0xA1 ITU-T G.988 Amd.1 (2011). Baseline message set only
0xA2 ITU-T G.988 Amd.2 (2012). Baseline message set only
0xA3 ITU-T G.988 (2012). Baseline message set only
0xB0 ITU-T G.988 (2010). Baseline and extended message set
0xB1 ITU-T G.988 Amd.1 (2011). Baseline and extended message set
0xB2 ITU-T G.988 Amd.2 (2012). Baseline and extended message set
0xB3 ITU-T G.988 (2012). Baseline and extended message set

(R) (mandatory) (1 byte)

Vendor product code: This attribute contains a vendor-specific product code for the ONU. (R) (mandatory) (2 bytes)

Security capability: This attribute advertises the security capabilities of the ONU. The following code points are defined:

0 Reserved
1 AES-128 payload encryption supported
2..255 Reserved

(R) (mandatory) (1 byte)

Security mode: This attribute specifies the current security mode of the ONU. All secure GEM ports in an ONU must use the same security mode at any given time. The following code points are defined:

0 Reserved
1 AES-128 algorithm
2..255 Reserved

Upon ME instantiation, the ONU sets this attribute to 1, AES-128. Attribute value 1 does not imply that any channels are encrypted; that process is negotiated at the PLOAM layer. It only signifies that AES with 128-bit keys is the security mode to be used on any channels that the OLT may choose to encrypt. (R, W) (mandatory) (1 byte)

Total priority queue number: This attribute reports the total number of upstream priority queues that are not associated with a circuit pack, but with the ONU in its entirety. Upon ME instantiation, the ONU sets this attribute to the value that represents its capabilities. (R) (mandatory) (2 bytes)

Total traffic scheduler number: This attribute reports the total number of traffic schedulers that are not associated with a circuit pack, but with the ONU in its entirety. The ONU supports null function, strict priority scheduling and WRR from the priority control and guarantee of minimum rate control points of view, respectively. If the ONU has no global traffic schedulers, this attribute is 0. (R) (mandatory) (1 byte)

Deprecated: This attribute should always be set to 1 by the ONU and ignored by the OLT. (R) (mandatory) (1 byte)

Total GEM port-ID number: This attribute reports the total number of GEM port-IDs supported by the ONU. The maximum value is specified in the corresponding transmission convergence (TC) Recommendations, [ITU-T G.984.3] or [ITU-T G.987.3]. Upon ME instantiation, the ONU sets this attribute to the value that represents its capabilities. (R) (mandatory) (2 bytes)

SysUpTime: This attribute counts 10 ms intervals since the ONU was last initialized. It rolls over to 0 when full (see [IETF RFC 1213]). (R) (mandatory) (4 bytes)

Connectivity capability: This attribute indicates the Ethernet connectivity models that the ONU can support. The value 0 indicates that the capability is not supported; 1 signifies support. The following code points are defined:

Bit	Model [Figure reference ITU-T 988]
1 (LSB)	N:1 bridging, Figure 8.2.2-3
2	1:M mapping, Figure 8.2.2-4

3	1:P filtering, Figure 8.2.2-5
4	N:M bridge-mapping, Figure 8.2.2-6
5	1:MP map-filtering, Figure 8.2.2-7
6	N:P bridge-filtering, Figure 8.2.2-8
7	N:MP bridge-map-filtering, Figure 8.2.2-9
8…16	Reserved

Note 1: It is not implied that an ONU may not support other connectivity models.

Note 2: Figures above can be found in ITU-T G.988

(R) (mandatory) (2 bytes)

Current connectivity mode: This attribute specifies the Ethernet connectivity model that the OLT wishes to use. The following code points are defined:

Value	Connectivity model
0	No selection (default)
1	N:1 bridging
2	1:M mapping
3	1:P filtering
4	N:M bridge-mapping
5	1:MP map-filtering
6	N:P bridge-filtering
7	N:MP bridge-map-filtering
8…255	Reserved

Note 2: It is not implied that an ONU supports a given connectivity model only when that model is explicitly selected by this attribute. The ONU is free to support additional models at any and all times.

(R, W) (mandatory) (1 byte)

QoS configuration flexibility: This attribute reports whether various managed entities in the ONU are fixed by the ONU's architecture or whether they are configurable. For backward compatibility, and if the ONU does not support this attribute, all such attributes are understood to be hard-wired. (R) (optional) (2 bytes)

Bit	Interpretation when bit value = 1
1 (LSB)	Priority queue ME: Port field of related port attribute is read-write and can point to any T-CONT or UNI port in the same slot
2	Priority queue ME: The traffic scheduler pointer is permitted to refer to any other traffic scheduler in the same slot
3	Traffic scheduler ME: T-CONT pointer is read-write
4	Traffic scheduler ME: Policy attribute is read-write

5	T-CONT ME: Policy attribute is read-write
6	Priority queue ME: Priority field of related port attribute is read-write
7..16	Reserved

Discussion:

To allow for the possibility that the OLT does not support flexible configuration, the ONU vendor must assure that the priority queues and traffic schedulers are configured in a meaningful and useful way by factory default, and that this default configuration is restored upon ONU initialization and MIB reset. The specifics of such a configuration are beyond the scope of this Recommendation.

The managed entity ID of both the T-CONT and traffic scheduler contains a slot number. Even when attributes in the above list are read-write, it is never permitted to change the slot number in a reference. That is, configuration flexibility never extends across slots. It is also not permitted to change the directionality of an upstream queue to downstream, or vice versa.

Priority queue scale factor: This specifies the scale factor of several attributes of the priority queue managed entity of section 5.2.8. The default value of this attribute is 1. (R, W) (optional) (2 bytes)

NOTE 3 – Some legacy implementations may take the queue scale factor from the GEM block length attribute of the ANI-G managed entity. That option is discouraged in new implementations.

Actions

Get, set

Notifications

D1 implimentation does not require the OMCC Version AVC.

Attribute value change

Number	Attribute value change	Description
1	N/A	
2	OMCC version	OMCC version supported in the ONU
3..11	N/A	
12..16	Reserved	

5.1.3 ONU Data (ME #2)

This managed entity models the MIB itself. [ITU-T G.988] clause I.1.3 explains the use of this managed entity with respect to MIB synchronization.

The ONU automatically creates an instance of this managed entity, and updates the associated attributes according to data within the ONU itself.

Application

Models the ONU Management Information Base (MIB) itself via the “Data Sync” attribute used for MIB synchronization between the Optical Line Terminal (OLT) and the ONU.

Relationships

One instance of this managed entity is contained in an ONU.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. There is only one instance, number 0. (R) (mandatory) (2 bytes)

MIB data sync: This attribute is used to check the alignment of the MIB of the ONU with the corresponding MIB in the OLT. MIB data sync relies on this attribute, which is a sequence number that can be checked by the OLT to see if the MIB snapshots for the OLT and ONU match. Refer to [ITU-T G.988] clause I.1.2.1 for a detailed description of this attribute. Upon ME instantiation, the ONU sets this attribute to 0. (R, W) (mandatory) (1 byte)

Actions

Get, set

Get all alarms: Latch a snapshot of the current alarm statuses of all managed entities and reset the alarm message counter.

Get all alarms next: Get the latched alarm status of the next managed entity (entities) within the current snapshot.

MIB reset: Reset the MIB data sync attribute to 0 and reset the MIB of the ONU to its default. The default MIB comprises those MEs that are designated mandatory in the corresponding Recommendation, along with other auto-created MEs whose existence is implicit in the architecture or physical configuration of the ONU.

For G-PON applications, the minimum default MIB comprises one instance of the ONU-G managed entity pair, one instance of the ONU data managed entity, and two instances of the software image managed entity.

MIB upload: Latch a snapshot (i.e., copy) of the current MIB. Not every managed entity or every attribute is included in a MIB upload. Table attributes are excluded. Only the control block attributes of performance monitoring MEs are uploaded. Other MEs and attributes, such as the PPTP for the local craft terminal, are excluded as documented in their specific definitions.

MIB upload next: Get the latched attribute values of the next managed entity (entities) within the current snapshot.

Notifications

None

5.1.4 Software Image (ME #7)

This managed entity models an executable software image stored in the ONU (documented here as its fundamental usage). It may also be used to represent an opaque vendor-specific file (vendor-specific usage).

Fundamental usage

The ONU automatically creates two instances of this managed entity upon the creation of each managed entity that contains independently-manageable software, either the ONU itself or an individual circuit pack. It populates ME attributes according to data within the ONU or the circuit pack.

Some pluggable equipment may not contain software. Others may contain software that is intrinsically bound to the ONU's own software image. No software image ME need exist for such equipment, though it may be convenient for the ONU to create them to support software version audit from the OLT. In this case, the dependent MEs would support only the get action.

A slot may contain various equipment over its lifetime, and if software image MEs exist, the ONU must automatically create and delete them as the equipped configuration changes. The identity of the software image is tied to the cardholder.

When an ONU controller packs are duplicated, each can be expected to contain two software image MEs, managed through reference to the individual controller packs themselves. When this occurs, the ONU should not have a global pair of software images MEs (instance 0), since an action (download, activate, commit) directed to instance 0 would be ambiguous.

Application

Models the executable software image stored in the ONU.

Relationships

Two instances of the software image managed entity are associated with each instance of the ONU or cardholder whose software is independently managed.

Attributes

Managed entity ID:	This attribute uniquely identifies each instance of this managed entity. The first byte indicates the physical location of the equipment hosting the software image, either the ONU (0) or a cardholder (1..254). The second byte distinguishes between the two software image ME instances (0..1). (R) (mandatory) (2 bytes)
Version:	This string attribute identifies the version of the software. (R) (mandatory) (14 bytes)
Is committed:	This attribute indicates whether the associated software image is committed (1) or uncommitted (0). By definition, the committed software image is loaded and executed upon reboot of the ONU and/or circuit pack. During normal operation, one software image is always committed, while the other is uncommitted. Under no circumstances are both software images allowed to be committed at the same time. On the other hand, both software images could be uncommitted at the same time if both were invalid. Upon ME instantiation, instance 0 is initialized to committed, while instance 1 is initialized to uncommitted (that is, the ONU ships from the factory with image 0 committed). (R) (mandatory) (1 byte)

Is active: This attribute indicates whether the associated software image is active (1) or inactive (0). By definition, the active software image is one that is currently loaded and executing in the ONU or circuit pack. Under normal operation, one software image is always active while the other is inactive. Under no circumstances are both software images allowed to be active at the same time. On the other hand, both software images could be inactive at the same time if both were invalid. (R) (mandatory) (1 byte)

Is valid: This attribute indicates whether the associated software image is valid (1) or invalid (0). By definition, a software image is valid if it has been verified to be an executable code image. The verification mechanism is not subject to standardization; however, it should include at least a data integrity (e.g., CRC) check of the entire code image. Upon ME instantiation or software download completion, the ONU validates the associated code image and sets this attribute according to the result. (R) (mandatory) (1 byte)

Product code: This attribute provides a way for a vendor to indicate product code information on a file. It is a character string, padded with trailing nulls if it is shorter than 25 bytes. (R) (optional) (25 bytes)

Image hash: This attribute is an MD5 hash of the software image. It is computed at completion of the end download action. (R) (optional) (16 bytes)

Actions

Get

For D1 implementations of Residential Gateways (RG) with integrated ONUs using a dual management architecture, the following GET actions are not applicable. The management of the software image will be done via a TR-069 RG management mechanism.

Software upgrade is described in [ITU-T G.988] clause I.3. All of the following actions are mandatory for ONUs with remotely manageable software.

Start download: Initiate a software download sequence. This action is valid only for a software image instance that is neither active nor committed.

Download section: Download a section of a software image. This action is valid only for a software image instance that is currently being downloaded (image 1 in state S2, image 0 in state S2').

End download: Signal the completion of a download image sequence, providing both CRC and version information for final verification. This action is valid only for a software image instance that is currently being downloaded (image 1 in state S2, image 0 in state S2').

Activate image: Load/execute a software image. When this action is applied to a software image that is currently inactive, execution of the current code image is suspended, the associated software image is loaded from non-volatile memory, and execution of this new code image is initiated (that is, the associated entity reboots on the previously inactive image). When this action is applied to a software image that is already active, a soft restart is performed. The software image is not reloaded from non-volatile memory; the current volatile code image is simply restarted. This action is only valid for a valid software image.

Commit image: Set the *is committed* attribute value to 1 for the target software image ME and set the *is committed* attribute value to 0 for the other software image. This causes the committed software image to be loaded and executed by the boot code upon subsequent start-ups. This action is only applicable when the target software image is valid.

Notifications

Attribute value change

Number	Attribute value change	Description
1	Version	
2	Is committed	
3	Is active	If an autonomous change to this attribute is associated with an ONU re-boot, the ONU should send the AVC (one for each primary software image instance) after the re-boot.
4	Is valid	
5	Product code	
6	Image hash	
7..16	Reserved	

5.1.5 Cardholder (ME #5)

The cardholder represents the fixed equipment slot configuration of the ONU. Each cardholder can contain 0 or 1 circuit packs; the circuit pack models equipment information that can change over the lifetime of the ONU, e.g., through replacement.

One instance of this managed entity exists for each physical slot in an ONU that has pluggable circuit packs. One or more instances of this managed entity may also exist in an integrated ONU, to represent virtual slots. Instances of this managed entity are created automatically by the ONU, and the status attributes are populated according to data within the ONU itself.

Slot 0 is intended to be used only in an integrated ONU. If an integrated ONU is modelled with a universal slot 0, it is required that it does not contain additional (non-zero) virtual slots. A cardholder for virtual slot 0 is required.

There is potential for conflict in the semantics of the expected plug-in unit type, the expected port count and the expected equipment ID, both when the slot is not populated and when a new circuit pack is inserted. The expected plug-in unit type and the plug-in type mismatch alarm are

mandatory, although *plug-and-play/unknown* (circuit pack type 255) may be used as a way to minimize their significance. It is recommended that an ONU deny the provisioning of inconsistent combinations of expected equipment attributes.

When a circuit pack is plugged into a cardholder, or when a cardholder is pre-provisioned to expect a circuit pack of a given type, it may trigger the ONU to instantiate a number of managed entities and update the values of others, depending on the circuit pack type. The ONU may also delete a variety of other managed entities when a circuit pack is reprovisioned to not expect a circuit pack or to expect a circuit pack of a different type. These actions are described in the definitions of the various managed entities.

Expected equipment ID and expected port count are alternate ways to trigger the same pre-provisioning effects. These tools may be useful if an ONU is prepared to accept more than one circuit pack of a given type but with different port counts, or if a circuit pack is a hybrid that matches none of the types in Table 2, but whose identification (e.g., part number) is known.

Application

Represents the fixed equipment slot configuration in the ONU for each physical slot.

D1 implementation should follow the contraints highlighted below.

D2 implementation specifics are yet to be defined but may require support of ME in its entiriety.

Relationships

An ONU may contain zero or more instances of the cardholder, each of which may contain an instance of the circuit pack managed entity. The slot ID, real or virtual, is a fundamental identification mechanism for managed entities that bear some relationship to a physical location.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. The ONU sets the first byte of this two-byte identifier to:

0 if the ONU contains pluggable equipment modules

1 if the ONU is a single piece of integrated equipment.

The second byte of this identifier is the slot number. In integrated ONUs, this byte may be used as a virtual slot or set to 0 to indicate a universal pseudo-slot.

Slot numbering schemes differ among vendors (TBD). It is only required that slot numbers be unique across the ONU. Up to 254 equipment slots are supported in the range 1..254 (Note 1). The value 0 is reserved for possible use in an integrated ONU to indicate a universal pseudo-slot. The value 255 is also reserved. (R) (mandatory) (2 bytes)

D1 slot numbering should be limited to slots 1-14. The following card type conventions should be followed by both OLT and ONU.

Slot Number	Card Type
1	10/100/1000 BASE-T

2	Plain old telephony service
3	TBD
4	TBD
5	TBD
6	TBD
7	TBD
8	TBD
9	TBD
10	TBD
11	TBD
12	TBD
13	TBD
14	Virtual Ethernet interface point

Note 1: Some xDSL managed entities use the two most significant bits of the slot number for other purposes. An ONU that supports these services may have slot limitations or restrictions.

Actual plug-in unit type: This attribute is equal to the type of the circuit pack in the cardholder, or 0 if the cardholder is empty. When the cardholder is populated, this attribute is the same as the type attribute of the corresponding circuit pack managed entity. Circuit pack types are defined inTable 2. (R) (mandatory) (1 byte)

The three following attributes permit the OLT to specify its intentions for any future equipped configuration of a slot. Once some or all of these are set, the ONU can proceed to instantiate circuit pack and PPTp MEs, along with other predeterminable MEs, and allow the OLT to create related discretionary MEs, thereby supporting service pre-provisioning.

Expected plug-in unit type: This attribute provisions the type of circuit pack for the slot. For type coding, see Table 2. The value 0 means that the cardholder is not provisioned to contain a circuit pack. The value 255 means that the cardholder is configured for plug-and-play. Upon ME instantiation, the ONU sets this attribute to 0. For integrated interfaces, this attribute may be used to represent the type of interface. (R, W) (mandatory) (1 byte)

Expected port count: This attribute permits the OLT to specify the number of ports it expects in a circuit pack. Prior to provisioning by the OLT, the ONU initializes this attribute to 0. (R, W) (optional) (1 byte)

Expected equipment ID: This attribute provisions the specific type of expected circuit pack. This attribute applies only to ONUs that do not have integrated interfaces. In some environments, this may contain the expected

equipment CLEI code. Upon ME instantiation, the ONU sets this attribute to all spaces. (R, W) (optional) (20 bytes)

Actual equipment ID: This attribute identifies the specific type of circuit pack, once it is installed. This attribute applies only to ONUs that do not have integrated interfaces. In some environments, this may include the equipment CLEI code. When the slot is empty or the equipment ID is not known, this attribute should be set to all spaces. (R) (optional) (20 bytes)

Protection profile pointer: This attribute specifies an equipment protection profile that may be associated with the cardholder. Its value is the least significant byte of the managed entity ID of the equipment protection profile with which it is associated, or 0 if equipment protection is not Id. (R) (optional) (1 byte)

Invoke protection switch: The OLT may use this attribute to control equipment protection switching. Code points have the following meaning when set by the OLT:

0 Release protection switch

1 Operate protection switch, protect cardholder unspecified

2 Operate protection switch, use first protect cardholder

3 Operate protection switch, use second protect cardholder

The ONU should deny attempts to switch to an unequipped, defective or already active protection cardholder.

Upon the get action from the OLT, this attribute should return the current value of the actual protection configuration. Code points are as defined above; the value 1 is never returned.

When circuit packs that support a PON IF function are switched, the response should be returned on the same PON that received the command. However, the OLT should also be prepared to accept a response on the redundant PON. (R, W) (optional) (1 byte)

ARC: See [ITU-T G.988] clause A.1.4.3. (R, W) (optional) (1 byte)

ARC interval: See [ITU-T G.988] clause A.1.4.3. (R, W) (optional) (1 byte)

Actions

Get, set

Notifications

The notifications below are optional for D1 ONU implementations.

Attribute value change

Number	Attribute value change	Description
1	Actual type	Actual type of circuit pack in cardholder
2..4	N/A	
5	Actual equipment id	Actual equipment ID of circuit pack in cardholder

6..7	N/A	
8	ARC	ARC timer expiration
9	N/A	
10..16	Reserved	

Alarm (Note 2)

Alarm number	Alarm	Description
0	Plug-in circuit pack missing	Configured circuit pack is not present. If this alarm is active, none of the mismatch alarms are declared.
1	Plug-in type mismatch alarm	Inserted circuit pack is wrong type
2	Improper card removal	Circuit pack has been removed without being de-provisioned or administratively locked. This is a redundant alarm that helps the OLT distinguish between transitions from state S2 to state S1 (Reference [ITU-T G.988] Figure 9.1.5-1) and transitions from state S4 to state S1. This alarm is sent only when a transition occurs from state S2 to state S1.
3	Plug-in equipment ID mismatch alarm	Inserted circuit pack has the wrong equipment ID
4	Protection switch	An autonomous equipment protection switch has occurred. This notification is reported by the protected cardholder.
5..207	Reserved	
208..223	Vendor-specific	Not to be standardized* (to be discussed before implemented)

Note 2: If no circuit pack is configured or if the cardholder is configured for plug-and-play with no expected equipment ID, no alarms are raised. No cardholder alarms are defined for ONUs with integrated interfaces.

Reference [ITU-T G.988] Figure 9.1.5-1 is a state diagram that describes insertion and removal of a particular circuit pack into/from a cardholder that is provisioned to a specific type or to plug-and-play.

Note 3: The state diagram is not applicable for ONUs with integrated interfaces.

Some of the following circuit pack types are obsolete in current applications. Their code points and definitions are reserved for backward compatibility, but in the interest of brevity, they are not listed.

Coding	Content	Description
0	No LIM	Default value
1..12	*See [ITU-T G.983.2]*	*Various ATM based UNIs*
13	C1.5 (DS1)	1.544 Mbit/s local (T-interface) module
14	C2.0 (E1)	2.048 Mbit/s local (T-interface) module
15	C6.3 (J2)	6.312 Mbit/s local (T-interface) module
16	C-DS1/E1	Configurable DS1/E1 module
17	C-DS1/E1/J1	Configurable DS1/E1/J1 module
18..21	*See [ITU-T G.984.4]*	Various CES services
22	10BASE-T	10BASE-T Ethernet LAN IF
23	100BASE-T	100BASE-T Ethernet LAN IF
24	10/100 BASE-T	10/100 BASE-T Ethernet LAN IF (Note)
25..27	*See [ITU-T G.983.2]*	*Various non-Ethernet LAN technologies*
28	C1.5 (J1)	1.544 Mbit/s local (T-interface) module
29..31	*See [ITU-T G.984.4]*	*Various ATM interfaces*
32	POTS	Plain old telephony service
33	ISDN-BRI	ISDN basic rate interface (deprecated)
34	Gigabit optical Ethernet	Gigabit Ethernet optical IF (Note)
35	xDSL	xDSL IF
36	SHDSL	SHDSL IF
37	VDSL	VDSL IF [ITU-T G.993.1]
38	Video service	Video module
39	LCT	Local craft terminal interface
40	802.11	Wireless interface [IEEE 802.11]
41	xDSL/POTS	Combination xDSL and POTS interfaces
42	VDSL/POTS	Combination VDSL [ITU-T G.993.1] and POTS interfaces
43	Common equipment	Circuit packs such as removable power supply modules or ONU controllers
44	Combined video UNI and PON interface	Circuit pack that combines both functions
45	Mixed services equipment	Circuit pack with several types of ANI and/or UNI. Suggested for use with the port mapping package managed entity.
46	MoCA	MoCA
47	10/100/1000 BASE-T	10/100/1000 BASE-T Ethernet LAN IF (Note)
48	VEIP	Virtual Ethernet interface point
49	10G Ethernet	10G Ethernet LAN I/F
50..191	Reserved	

Coding	Content	Description
192..223	Vendor-specific	Reserved for vendor use, Not to be standardized* (to be discussed before implemented)
224..236	Reserved	
237	XG-PON10G2488	XG-PON interface, 10G downstream and 2.488G upstream
238	XG-PON10G10	XG-PON interface, 10G downstream and 10G upstream
239	Mid-span PON reach extender UNI	The UNI of a mid-span PON reach extender
240	Mid-span PON reach extender ANI	The ANI of a mid-span PON reach extender
241	Mid-span PON reach extender upstream optical amplifier	Upstream optical amplifier 1270 or 1310 nm
242	Mid-span PON 2488/1244 reach extender downstream optical amplifier	2488/1244 1490 nm downstream optical amplifier with no corresponding RE ANI-G
243..247	*See [ITU-T G.984.4]*	*G-PON interfaces of* diverse *rates*
248	GPON24881244	GPON interface, 2488 Mbit/s downstream and 1244 Mbit/s upstream
249..254	*See [ITU-T G.983.2] and [ITU-T G.984.4]*	*G-PON and B-PON interfaces of* diverse *rates*
255	Plug-and-play/Unknown	Plug-and-play (for the cardholder managed entity only). Unrecognized module (for the circuit pack managed entity only)
Note: Code points 24 and 34 were used by some implementations to represent the 10/100/1000 BASE-T interface because code point 47 was not defined at the time. While code point 47 should be adopted for this interface at the earliest opportunity, interoperability may require the flexible recognition of these other code points.		

Table 2 - Plug-in Unit Types

5.1.6 Circuit Pack (ME #6)

This managed entity models a real or virtual circuit pack that is equipped in a real or virtual ONU slot. For ONUs with integrated interfaces, this managed entity may be used to distinguish available types of interfaces (the port mapping package is another way).

For ONUs with integrated interfaces, the ONU automatically creates an instance of this managed entity for each instance of the virtual cardholder managed entity. The ONU also creates an instance of this managed entity when the OLT provisions the cardholder to expect a circuit pack, that is, when the OLT sets the expected plug-in unit type or equipment ID of the cardholder to a circuit pack type, as defined in Table 2. The ONU also creates an instance of this managed entity when a circuit pack is installed in a cardholder whose expected plug-in unit type is 255 = plug-and-play, and whose equipment ID is not provisioned. Finally, when the cardholder is provisioned for plug-and-play, an instance of this managed entity can be created at the request of the OLT.

The ONU deletes an instance of this managed entity when the OLT de-provisions the circuit pack (i.e., when the OLT sets the expected plug-in unit type or equipment ID of the cardholder to 0 = no LIM). The ONU also deletes an instance of this managed entity on request of the OLT if the expected plug-in unit type attribute of the corresponding cardholder is equal to 255, plug-and-play, and the expected equipment ID is blank (a string of all spaces). ONUs with integrated interfaces do not delete circuit pack instances.

Note: Creation and deletion by the OLT is retained for backward compatibility.

Application

Models a real circuit pack (Ethernet PPTP UNI and POTS PPTP UNI) equipped in a real ONU slot (Cardholder).

Relationships

An instance of this managed entity is contained by an instance of the cardholder managed entity.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Its value is the same as that of the cardholder managed entity containing this circuit pack instance. (R, Set-by-create if applicable) (mandatory) (2 bytes)

Type: This attribute identifies the circuit pack type. This attribute is a code as defined in Table 2. The value 255 means unknown or undefined, i.e., the inserted circuit pack is not recognized by the ONU or is not mapped to an entry in Table 2. In the latter case, the equipment ID attribute may contain inventory information. Upon autonomous ME instantiation, the ONU sets this attribute to 0 or to the type of the circuit pack that is physically present. (R, Set-by-create if applicable) (mandatory) (1 byte)

Number of ports: This attribute is the number of access ports on the circuit pack. If the port mapping package is supported for this circuit pack, this attribute should be set to the total number of ports of all types. (R) (**mandatory**) (1 byte)

Serial number: The serial number is expected to be unique for each circuit pack, at least within the scope of the given vendor. Note that the serial number may contain the vendor ID and/or version number. For integrated ONUs, this value is identical to the value of the serial number attribute of the ONU-G managed entity. Upon creation in the absence of a physical circuit pack, this attribute comprises all spaces. (R) (mandatory) (8 bytes)

Version: This attribute is a string that identifies the version of the circuit pack as defined by the vendor. The value 0 indicates that version information is not available or applicable. For integrated ONUs, this value is identical to the value of the version attribute of the ONU-G managed entity. Upon creation in the absence of a physical circuit pack, this attribute comprises all spaces. (R) (mandatory) (14 bytes)

Vendor ID: This attribute identifies the vendor of the circuit pack. For ONUs with integrated interfaces, this value is identical to the value of the

vendor ID attribute of the ONU-G managed entity. Upon creation in the absence of a physical circuit pack, this attribute comprises all spaces. (R) (**mandatory**) (4 bytes)

Administrative state: This attribute locks (1) and unlocks (0) the functions performed by this managed entity. Administrative state is further described in clause [ITU-T G.988] A.1.6. (R, W) (mandatory) (1 byte)

Operational state: This attribute indicates whether or not the circuit pack is capable of performing its function. Valid values are enabled (0), disabled (1) and unknown (2). Pending completion of initialization and self-test on an installed circuit pack, the ONU sets this attribute to 2. (R) (optional) (1 byte)

Bridged or IP ind: This attribute specifies whether an Ethernet interface is bridged or derived from an IP router function.

0 Bridged

1 IP router

2 Both bridged and IP router functions

(R, W) (mandatory, only applicable for circuit packs with Ethernet interfaces) (1 byte)

Equipment ID: This attribute may be used to identify the vendor's specific type of circuit pack. In some environments, this attribute may include the CLEI code. Upon ME instantiation, the ONU sets this attribute to all spaces or to the equipment ID of the circuit pack that is physically present. (R) (**mandatory**) (20 bytes)

Card configuration: This attribute selects the appropriate configuration of configurable circuit packs. Table 2 specifies two configurable card types: C-DS1/E1 (code 16), and C-DS1/E1/J1 (code 17). Values are indicated below for the allowed card types and configurations.

Card Type	Configuration	Value
C-DS1/E1	DS1	0
	E1	1
C-DS1/E1/J1	DS1	0
	E1	1
	J1	2

Upon autonomous instantiation, this attribute is set to 0. (R, W, Set-by-create if applicable) (mandatory for configurable circuit packs) (1 byte)

Total T-CONT buffer number: This attribute reports the total number of T-CONT buffers associated with the circuit pack. Upon ME instantiation, the ONU sets this attribute to 0 or to the value supported by the physical circuit pack. (R) (mandatory for circuit packs that provide a traffic scheduler function) (1 byte)

Total priority queue number: This value reports the total number of priority queues associated with the circuit pack. Upon ME instantiation, the ONU sets the attribute to 0 or to the value supported by the physical circuit pack. (R) (mandatory for circuit packs that provide a traffic scheduler function) (1 byte)

Total traffic scheduler number: This value reports the total number of traffic schedulers associated with the circuit pack. The ONU supports null function, strict priority scheduling and WRR (weighted round robin) from the priority control and guarantee of minimum rate control points of view, respectively. If the circuit pack has no traffic scheduler, this attribute should be absent or have the value 0. Upon ME instantiation, the ONU sets the attribute to 0 or to the value supported by the physical circuit pack. (R) (mandatory for circuit packs that provide a traffic scheduler function) (1 byte)

Power shed override: This attribute allows ports to be excluded from the power shed control defined in section 5.1.7. It is a bit mask that takes port 1 as the MSB; a bit value of 1 marks the corresponding port to override the power shed timer. For hardware that cannot shed power per port, this attribute is a slot override rather than a port override, with any non-zero port value causing the entire circuit pack to override power shedding. (R, W) (optional) (4 bytes)

Actions

Get, set

Create, delete: Optional, only when plug-and-play is supported. **Optional for D1 ONU implementation.**

Reboot: Reboot the circuit pack. **Optional for D1 ONU implementation.**

Test: Test the circuit pack. The test action may be used either to perform equipment diagnostics or to measure parameters such as received optical power, video output level, battery voltage, etc. Test and test result messages are defined in [ITU-T G.988] Annex A.

Notifications

Attribute value change

Number	Attribute value change	Description
1..6	N/A	
7	Op state	Operational state change
8..14	N/A	
15..16	Reserved	

Alarms 1-5 are optional for D1 ONU implementation.

Alarm

Alarm number	Alarm	Description
0	Equipment alarm	A failure on an internal interface or failed self-test
1	Powering alarm	Fuse failure or failure of DC/DC converter
2	Self-test failure	Failure of circuit pack autonomous self-test
3	Laser end of life	Failure of transmit laser imminent
4	Temperature yellow	No service shutdown at present, but the circuit pack is operating beyond its recommended range.
5	Temperature red	Service has been shut down to avoid equipment damage. The operational state of the affected PPTPs indicates the affected services.
6..207	Reserved	
208..223	Vendor-specific alarms	Not to be standardized* (to be discussed before implemented)

5.1.7 ONU Power Shedding (ME #133)

This managed entity models the ONU's ability to shed services when the ONU goes into battery operation mode after AC power failure. Shedding classes are defined below, which may span multiple circuit pack types. This feature works in conjunction with the power shed override attribute of the circuit pack managed entity, which can selectively prevent power shedding of priority ports.

An ONU that supports power shedding automatically creates an instance of this managed entity.

The following table defines the binding of shedding class and PPTP type. The coding is taken from Table 2. In the case of hybrid circuit pack types, multiple shedding classes may affect a circuit pack if the hardware is capable of partial power shedding.

An ONU may choose to model its ports with the port mapping package of [ITU-T G.988] clause 9.1.8, rather than with real or virtual circuit packs. In this case, power shedding pertains to individual PPTPs, as listed in the second column of the table.

Shedding class	PPTP type	Coding	Content
ATM	ATM PPTP	*1..12*	*Various ATM UNIs*
CES	CES PPTP	13	C1.5 (DS1)
		14	C2.0 (E1)
		15	C6.3 (J2)
		16	C-DS1/E1
		17	C-DS1/E1/J1
Data	Ethernet PPTP	22	10BASE-T
		23	100BASE-T
		24	10/100 BASE-T
Frame	Unspecified	*25..27*	*Non-Ethernet LANs*
CES	CES PPTP	28	C1.5 (J1)
Sdh-sonet	Sdh-sonet	*29..31*	*ATM sdh-sonet interfaces*
Voice	POTS PPTP	32	POTS
	ISDN PPTP	33	ISDN BRI (deprecated)
Data	Ethernet PPTP	34	Gigabit optical Ethernet
DSL	xDSL PPTP	35	xDSL
	SHDSL	36	SHDSL
	VDSL PPTP	37	ITU-T G.993.1 VDSL
N/A	Video UNI	38	RF video service
N/A	LCT PPTP	39	Local craft terminal
Data	IEEE 802.11 PPTP	40	Wireless
Voice (DSL may also apply)	xDSL + POTS	41	xDSL/POTS
	VDSL + POTS	42	ITU-T G.993.1 VDSL/POTS
N/A	Unspecified	43	Common equipment
	Unspecified	44	Combined video, PON
	Unspecified	45	Mixed services (Power shedding based on port type)
Data	MOCA PPTP	46	MoCA
Data	Ethernet PPTP	47	10/100/1000 BASE-T
		49	10G Ethernet
N/A	PON PPTP	237..238	XG-PON ANIs
Video overlay	Video ANI PPTP		
Video return	Video RPD		

Application

An ONU that supports power shedding automatically creates an instance of this managed entity.

Relationships

One instance of this managed entity is associated with the ONU managed entity.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. There is only one instance, number 0. (R) (mandatory) (2 bytes)

Restore power timer reset interval: The time delay, in seconds, before resetting the power-shedding timers after full power restoration. Upon ME instantiation, the ONU sets this attribute to 0. (R, W) (mandatory) (2 bytes)

For each class of service, an interval attribute is defined below. The value 0 disables power shedding, while the value 1 enables immediate power shedding, that is, as soon as AC power fails. Other values specify the time, in seconds, to keep the service active after AC failure before shutting them down and shedding power. Upon ME instantiation, the ONU sets each of the interval attributes to 0.

Data class shedding interval: (R, W) (mandatory) (2 bytes)

Voice class shedding interval: This attribute only pertains to voice services that terminate on the ONU and are under the management control of the OMCI. (R, W) (mandatory) (2 bytes)

Video overlay class shedding interval: (R, W) (mandatory) (2 bytes)

Video return class shedding interval: (R, W) (mandatory) (2 bytes)

DSL class shedding interval: (R, W) (mandatory) (2 bytes)

ATM class shedding interval: (R, W) (mandatory) (2 bytes)

CES class shedding interval: (R, W) (mandatory) (2 bytes)

Frame class shedding interval: (R, W) (mandatory) (2 bytes)

Sdh-sonet class shedding interval: (R, W) (mandatory) (2 bytes)

Shedding status: Binary indication of power shedding status for each shedding class. If this two-byte field is depicted 0b ABCD EFGH IJKL MNOP, its bits are assigned:

A	Data class
B	Voice class
C	Video overlay class
D	Video return class
E	DSL class
F	ATM class
G	CES class
H	Frame class
I	Sdh-sonet class
J..P	Reserved and set to 0

The ONU sets each bit to 1 when power shedding is active, and clears it to 0 when the service is restored. (R) (optional) (2 bytes)

Actions

Get, set

Notifications

Attribute value change

Number	Attribute value change	Description
1..10	N/A	
11	Shedding status	State change of a shedding function
12..16	Reserved	

5.1.8 ONU remote debug (ME #158)

This managed entity is used to send vendor-specific debug commands to the ONU and receive vendor-specific replies back for processing on the OLT. This allows for the remote debugging of an ONU that may not be accessible by other means. The command format may have two modes, one being text and the other free format. In text format, both the command and reply are ASCII strings, but are otherwise unconstrained. In free format, the content and format of command and reply are vendor-specific.

An ONU that supports remote debugging automatically creates an instance of this managed entity. It is not reported during a MIB upload.

Relationships

One instance of this managed entity is associated with the ONU managed entity.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. There is only one instance, number 0. (R) (mandatory) (2 bytes)

Command format: This attribute defines the format of the command and reply attributes. The value 0 defines ASCII string format, while 1 specifies free format. (R) (mandatory) (1 byte)

Command: This attribute is used to send a command to the ONU. The format of the command is defined by the command format. If the format is ASCII string, the command should be null terminated unless the string is exactly 25 bytes long. The action of setting this attribute should trigger the ONU to discard any previous command reply information and execute the current debugging command. (W) (mandatory) (25 bytes)

Reply table: This attribute is used to pass reply information back to the OLT. Its format is defined by the command format attribute. The get, get next action sequence must be used with this attribute, since its size is unspecified. (R) (mandatory) (N bytes)

Actions

Get, get next, set

Notifications

None.

5.1.9 ONU Dynamic Power Management Control (ME #336)

This managed entity models the ONU's ability to enter power conservation modes in cooperation with the OLT in an ITU-T G.987 system. [ITU-T G.987.3] specifies two modes, doze and cyclic sleep.

An ONU that supports power conservation modes automatically creates an instance of this managed entity.

Relationships

One instance of this managed entity is associated with the ONU managed entity.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. There is only one instance, number 0. (R) (mandatory) (2 bytes)

Power reduction management capability: This attribute declares the ONU's support for managed power conservation modes, as defined in [ITU-T G.987.3]. It is a bit map in which the bit value 0 indicates no support for the specified mode, while the bit value 1 indicates that the ONU does support the specified mode. (R) (mandatory) (1 byte)

Bits are assigned as follows:

Bit	Meaning
1 (LSB)	Doze mode
2	Cyclic sleep mode
3..8	Reserved

Power reduction management mode: This attribute enables one or more of the ONU's managed power conservation modes. It is a bit map in which the bit value 0 disables the mode, while the value 1 enables the mode. Bit assignments are the same as those of the power reduction management capability attribute. The default value of each bit is 0. (R, W) (mandatory) (1 byte)

Itransinit: This attribute is the ONU vendor's statement of the complete transceiver initialization time: the time required for the ONU to regain full functionality when leaving the asleep state (i.e., turning on both the receiver and the transmitter and acquiring synchronization to the downstream flow), measured in units of 125-microsecond frames. The value zero indicates that the sleeping ONU can respond to a bandwidth grant without delay. (R) (mandatory) (2 bytes)

Itxinit: This attribute is the ONU vendor's statement of the transmitter initialization time: the time required for the ONU to regain full functionality when leaving the listen state (i.e., turning on the transmitter), measured in units of 125-microsecond frames. The value zero indicates that the dozing ONU can respond to a bandwidth grant without delay. (R) (mandatory) (2 bytes)

Maximum sleep interval: The Isleep attribute specifies the maximum time the ONU spends in its asleep or listen states, as a count of 125-microsecond frames. Local or remote events may truncate the ONU's sojourn in these states. The default value of this attribute is 0. (R, W) (mandatory) (4 bytes)

Minimum aware interval: The Iaware attribute specifies the time the ONU spends in its aware state, as a count of 125-microsecond frames, before it re-enters asleep or listen states. Local or remote events may independently cause the ONU to enter an active state rather than returning to a sleep state. The default value of this attribute is 0. (R, W) (mandatory) (4 bytes)

Minimum active held interval: The Ihold attribute specifies the minimum time during which the ONU remains in the active held state, as a count of 125-microsecond frames. Its initial value is zero. (R, W) (mandatory) (2 bytes)

Maximum sleep interval extension: This attribute designates maximum sleep interval values for doze mode and cyclic sleep mode separately. When it supports this attribute, the ONU ignores the value of the maximum sleep interval attribute.

Maximum sleep interval for doze mode	4 bytes
Maximum sleep interval for cyclic sleep mode	4 bytes

Maximum sleep interval for doze mode specifies the maximum time the ONU spends in its listen state, as a count of 125 microsecond frames. Local or remote events may truncate the ONU's sojourn in these states. The default value is 0.

Maximum sleep interval for cyclic sleep mode specifies the maximum time the ONU spends in its asleep state, as a count of 125 microsecond frames. Local or remote events may truncate the ONU's sojourn in these states. The default value is 0.

(R, W) (optional) (8 bytes)

Note: The dynamic power management control in EPON is basically the same as the function in [ITU-T G.987.3]. That is, EPON has two types of power-down modes, which are equivalent to doze mode and cyclic sleep mode, where the former is defined as Tx mode and the latter is defined as TRx mode in [b-IEEE P1904.1]. Moreover, listen state and asleep state are defined as POWER_DOWN state in [b-IEEE P1904.1].

Actions

Get, set

Notifications

None.

5.2 ANI Management, Traffic Management

5.2.1 ANI-G (ME #263)

This managed entity organizes data associated with each access network interface supported by a G-PON ONU. The ONU automatically creates one instance of this managed entity for each PON physical port.

Application

Represents the GPON Access Network Interface (ANI) supported by the ONU.

Relationships

An instance of this managed entity is associated with each instance of a physical PON interface.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Its value indicates the physical position of the PON interface. The first byte is the slot ID, defined in section 5.1.5. The second byte is the port ID. (R) (mandatory) (2 bytes)

SR indication: This Boolean attribute indicates the ONU's capability to report queue status for DBA. The value true means that status reporting is available for all T-CONTs that are associated with the ANI. (R) (mandatory) (1 byte)

Total T-CONT number: This attribute indicates the total number of T-CONTs that can be supported on this ANI. (R) (mandatory) (2 bytes)

GEM block length: This attribute specifies the queue occupancy reporting granularity for DBA, in units of bytes. This attribute is meaningful only in [ITU-T G.984.x] systems. (R, W) (mandatory) (2 bytes)

In ITU-T G.984 systems, the value set by the OLT is used by all T-CONTs on this ANI. Upon ME instantiation, the ONU sets this attribute to 48. See [ITU-T G.984.3] for further details.

In ITU-T G.987 systems, the unit for queue occupancy reporting is fixed in [ITU-T G.987.3] at 4 bytes.

Piggyback DBA reporting: This attribute indicates the ONU's piggyback DBA reporting format capabilities. [ITU-T G.984.3] defines two possible piggyback reporting modes. For reporting mode 0, the single field is the entire report. For reporting mode 1, the DBA report is two fields long. Mode 0 is mandatory for ITU-T G.984 ONUs that support piggyback DBA reporting; mode 1 is optional. [ITU-T G.987.3] allows only one mode, which should be reported in this attribute as code point 0.

The following coding indicates the ONU's piggyback DBA reporting mode capabilities:

0 Mode 0 only
1 Modes 0 and 1
2 Deprecated
3 Deprecated
4 Piggyback DBA reporting not supported

(R) (mandatory) (1 byte)

Deprecated: This attribute should be set to 0 by the ONU and ignored by the OLT. (R) (mandatory) (1 byte)

SF threshold: This attribute specifies the downstream BER threshold to detect the signal fail (SF) alarm. When this value is y, the BER threshold is 10^{-y}. Valid values are 3..8. Upon ME instantiation, the ONU sets this attribute to 5. (R, W) (mandatory) (1 byte)

SD threshold: This attribute specifies the downstream BER threshold to detect the signal degrade (SD) alarm. When this value is x, the BER threshold for SD is 10^{-x}. Valid values are 4..10. The SD threshold must be lower than the SF threshold; that is, x > y. Upon ME instantiation, the ONU sets this attribute to 9. (R, W) (mandatory) (1 byte)

ARC: See [ITU-T G.988] clause A.1.4.3. (R, W) (mandatory) (1 byte)

ARC interval: See [ITU-T G.988] clause A.1.4.3. (R, W) (mandatory) (1 byte)

Optical signal level: This attribute reports the current measurement of the total downstream optical signal level. Its value is a 2s complement integer referred to 1 mW (i.e., dBm), with 0.002 dB granularity. (R) (mandatory) (2 bytes)

Lower optical threshold: This attribute specifies the optical level the ONU uses to declare the downstream low received optical power alarm. Valid values are –127 dBm (coded as 254) to 0 dBm (coded as 0) in 0.5 dB increments. The default value 0xFF selects the ONU's internal policy. (R, W) (mandatory) (1 byte)

Upper optical threshold: This attribute specifies the optical level the ONU uses to declare the downstream high received optical power alarm. Valid values are –127 dBm (coded as 254) to 0 dBm (coded as 0) in 0.5 dB increments. The default value 0xFF selects the ONU's internal policy. (R, W) (mandatory) (1 byte)

ONU response time: This attribute indicates the ONU's actual response time. [ITU-T G.984.3] and [ITU-T G.987.3] specify that this attribute is in the range 34..36 microseconds. Although this attribute is expressed in nanoseconds, its accuracy is likely to be more coarse. Furthermore, the value may change from one activation cycle to the next. Valid values are:

0 (Null, function not supported)
34000 to 36000 (response time in nanoseconds)
All other values reserved

(R) (mandatory) (2 bytes)

Transmit optical level: This attribute reports the current measurement of mean optical launch power. Its value is a 2s complement integer referred to 1 mW (i.e., dBm), with 0.002 dB granularity. (R) (mandatory) (2 bytes)

Lower transmit power threshold: This attribute specifies the minimum mean optical launch power that the ONU uses to declare the low transmit optical power alarm. Its value is a 2s complement integer referred to 1 mW (i.e., dBm), with 0.5 dB granularity. The default value –63.5 (0x81) selects the ONU's internal policy. (R, W) (mandatory) (1 byte)

Upper transmit power threshold: This attribute specifies the maximum mean optical launch power that the ONU uses to declare the high transmit optical power alarm. Its value is a 2s complement integer referred to 1 mW (i.e., dBm), with 0.5 dB granularity. The default value –63.5 (0x81) selects the ONU's internal policy. (R, W) (mandatory) (1 byte)

Actions

Get, set

Test: Test the ANI-G. The test action can be used to perform optical line supervision tests; refer to [ITU-T G.988] Annex A.

Notifications

Attribute value change

Number	Attribute value change	Description
1..7	N/A	
8	ARC	Alarm reporting control cancellation
9..16	N/A	

Alarm

Alarm number	Alarm	Description
0	Low received optical power	Received downstream optical power below threshold.
1	High received optical power	Received downstream optical power above threshold.
2	SF	Bit error-based signal fail. Industry practice normally expects the BER to improve by at least an order of magnitude before clearing the alarm.
3	SD	Bit error-based signal degrade. Industry practice normally expects the BER to improve by at least an order of magnitude before clearing the alarm.
4	Low transmit optical power	Transmit optical power below lower threshold
5	High transmit optical power	Transmit optical power above upper threshold
6	Laser bias current	Laser bias current above threshold determined by vendor; laser end of life pending
7..207	Reserved	
208..223	Vendor-specific alarms	Not to be standardized* (to be discussed before implemented)

Test result: The ONU may report a test result autonomously if it performs self-test functions autonomously.

5.2.2 T-CONT (ME #262)

An instance of the traffic container managed entity T-CONT represents a logical connection group associated with a G-PON PLOAM layer alloc-ID. A T-CONT can accommodate GEM packets in priority queues or traffic schedulers that exist in the GEM layer.

The ONU autonomously creates instances of this ME. The OLT can discover the number of T-CONT instances via the ANI-G ME. When the ONU's MIB is reset or created for the first time, all supported T-CONTs are created. The OLT provisions alloc-IDs to the ONU via the PLOAM channel. Via the OMCI, the OLT must then set the alloc-ID attributes in the T-CONTs that it wants to activate for user traffic, to create the appropriate association with the allocation ID in the PLOAM channel. There should be a one-to-one relationship between allocation IDs and T-CONT MEs; the connection of multiple T-CONTs to a single allocation ID is undefined.

The allocation ID that matches the ONU-ID itself is defined to be the default alloc-ID. This alloc-ID is used to carry the OMCC. The default alloc-ID can also be used to carry user traffic, and hence

can be assigned to one of the T-CONT MEs. However, this OMCI relationship only pertains to user traffic, and the OMCC relationship is unaffected. It can also be true that the OMCC is not contained in any T-CONT ME construct; rather, that the OMCC remains outside of the OMCI, and that the OMCI is not used to manage the OMCC in any way. Multiplexing of the OMCC and user data in G-PON systems is discussed in [ITU-T G.988] clause B.2.4.

Application

Traffic/Transmission Container (T-CONT) represents a logical connection group associated with an Alloc-Id (Allocation Identifier) assigned by the OLT and used for upstream (US) user traffic (Unicast Data and POTS signaling and bearer).

Relationships

One or more instances of this managed entity are associated with an instance of a circuit pack that supports a PON interface function, or with the ONU-G itself.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. This two-byte number indicates the physical capability that realizes the T-CONT. It may be represented as 0xSSBB, where SS indicates the slot ID that contains this T-CONT (0 for the ONU as a whole), and BB is the T-CONT id, numbered by the ONU itself. T-CONTs are numbered in ascending order, with the range 0..255 in each slot. (R) (mandatory) (2 bytes)

Alloc-ID: This attribute links the T-CONT with the alloc-ID assigned by the OLT in the assign_alloc-ID PLOAM message. In [ITU-T G.984.3], legal values range from 0 to 0x0FFF, with some values having special meaning. In [ITU-T G.987.3], legal values range from 0 to 0x3FFF, with some values having special meaning. Prior to the setting of this attribute by the OLT, this attribute has an unambiguously unusable initial value, namely the value 0x00FF or 0xFFFF for ITU-T G.984 systems, and the value 0xFFFF for ITU-T G.987 systems. (R, W) (mandatory) (2 bytes)

Deprecated: The ONU should set this attribute to the value 1, and the OLT should ignore it. (R) (mandatory) (1 byte)

Policy: This attribute indicates the T-CONT's traffic scheduling policy. Valid values:

0 Null
1 Strict priority
2 WRR – Weighted round robin

(R, W) (mandatory) (1 byte)

Note: This attribute is read-only, unless otherwise specified by the QoS configuration flexibility attribute of the ONU2-G managed entity. If flexible configuration is not supported, the ONU should reject an attempt to set it with a parameter error result-reason code.

Actions

Get, set

Notifications

None.

5.2.3 GEM Port Network CTP (ME #268)

This managed entity represents the termination of a GEM port on an ONU. This managed entity aggregates connectivity functionality from the network view and alarms from the network element view as well as artefacts from trails.

Instances of the GEM port network Connection Termination Point (CTP) managed entity are created and deleted by the OLT. An instance of GEM port network CTP can be deleted only when no GEM interworking termination point or GEM port network CTP PM history data is associated with it. It is the responsibility of the OLT to make sure that the ONU configuration meets this condition.

In ITU-T G.984 systems, when a GEM port network CTP is created, its encryption state is by default not encrypted. If the OLT wishes to configure the GEM port to use encryption, it must send the appropriate PLOAM message. This applies equally to new CTPs and to CTPs that are re-created after a MIB reset.

In ITU-T G.987 systems, GEM ports are dynamically encrypted. If it is intended to encrypt the GEM port, the OLT must configure a key ring to be used, and the key must be known to the ONU at run time.

Application

Represents the origination/termination of a GEM port on an ONU for US and downstream (DS) Gigabit-capable passive optical network Encapsulated Method (GEM) (also refers generically to XGEM) frames (Unicast Data and POTS).

Relationships

An instance of the GEM port network CTP managed entity may be associated with an instance of the T-CONT and GEM interworking termination point managed entities.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

Port-ID: This attribute is the port-ID of the GEM port associated with this CTP. (R, W, Set-by-create) (mandatory) (2 bytes)

Note 1: While nothing forbids the existence of several GEM port network CTPs with the same port-ID value, downstream traffic is modelled as being delivered to all such GEM port network CTPs. Be aware of potential difficulties associated with defining downstream flows and aggregating PM statistics.

T-CONT pointer: This attribute points to a T-CONT instance. (R, W, Set-by-create) (mandatory) (2 bytes)

Direction: This attribute specifies whether the GEM port is used for UNI-to-ANI (1), ANI-to-UNI (2), or bidirectional (3) connection. (R, W, Set-by-create) (mandatory) (1 byte)

Traffic management pointer for upstream: If the traffic management option attribute in the ONU-G ME is 0 (priority controlled) or 2 (priority and rate controlled), this pointer specifies the priority queue ME serving this GEM port network CTP. If the traffic management option attribute is 1 (rate controlled), this attribute redundantly points to the T-CONT serving this GEM port network CTP. (R, W, Set-by-create) (mandatory) (2 bytes)

Traffic descriptor profile pointer for upstream: This attribute points to the instance of the traffic descriptor managed entity that contains the upstream traffic parameters for this GEM port network CTP. This attribute is used when the traffic management option attribute in the ONU-G ME is 1 (rate controlled), specifying the PIR/PBS to which the upstream traffic is shaped. This attribute is also used when the traffic management option attribute in the ONU-G ME is 2 (priority and rate controlled), specifying the CIR/CBS/PIR/PBS to which the upstream traffic is policed. (R, W, Set-by-create) (optional) (2 bytes)

See also Appendix II.

UNI counter: This attribute reports the number of instances of UNI-G managed entity associated with this GEM port network CTP. (R) (optional) (1 byte)

Priority queue pointer for downstream: This attribute points to the instance of the priority queue used for this GEM port network CTP in the downstream direction. It is the responsibility of the OLT to provision the downstream pointer in a way that is consistent with the bridge and mapper connectivity. If the pointer is null, downstream queueing is determined by other mechanisms in the ONU. (R, W, Set-by-create) (mandatory) (2 bytes)

NOTE 2 – If the GEM port network CTP is associated with more than one UNI (downstream multicast), the downstream priority queue pointer defines a pattern (e.g., queue number 3 for a given UNI) to be replicated (i.e., to queue number 3) at the other affected UNIs.

Encryption state:This attribute indicates the current state of the GEM port network CTP's encryption. Legal values are defined to be the same as those of the security mode attribute of the ONU2-G, with the exception that attribute value 0 indicates an unencrypted GEM port. (R) (optional) (1 byte)

Traffic descriptor profile pointer for downstream: This attribute points to the instance of the traffic descriptor managed entity that contains the downstream traffic parameters for this GEM port network CTP. This attribute is used when the traffic management option attribute in the ONU-G ME is 1 (rate controlled), specifying the PIR/PBS to which the downstream traffic is shaped. This attribute is also used when the traffic management option attribute in the ONU-G ME is 2 (priority and rate controlled), specifying the CIR/CBS/PIR/PBS to which the downstream traffic is policed. (R, W, Set-by-create) (optional) (2 bytes)

See also Appendix II.

Encryption key ring: This attribute is defined in ITU-T G.987 systems only. It specifies whether the associated GEM port is encrypted or not, and if so, which key ring it uses. (R, W, Set-by-create) (mandatory) (1 byte)

0 (default) No encryption. The downstream key index is ignored, and upstream traffic is transmitted with key index 0.
1 Unicast payload encryption in both directions. Keys are generated by the ONU and transmitted to the OLT via the PLOAM channel.
2 Broadcast (multicast) encryption. Keys are generated by the OLT and distributed via the OMCI.
3 Unicast encryption, downstream only. Keys are generated by the ONU and transmitted to the OLT via the PLOAM channel.
Other values are reserved.

Actions

Create, delete, get, set

Notifications

D1 implementation will not utililize the End-to-end LOC alarm.

Alarm

Alarm number	Alarm	Description
0..4	Reserved	
5	End-to-end loss of continuity	Loss of continuity can be detected when the GEM port network CTP supports a GEM interworking termination point. (optional)
6..207	Reserved	
208..223	Vendor-specific alarms	Not to be standardized* (to be discussed before implemented)

5.2.4 GEM Interworking Termination Point (ME #266)

An instance of this managed entity represents a point in the ONU where the interworking of a bearer service (usually Ethernet) to the GEM layer takes place. At this point, GEM packets are generated from the bearer bit stream (e.g., Ethernet) or the bearer bit stream is reconstructed from GEM packets.

Instances of this managed entity are created and deleted by the OLT.

Application

Represents the point in the ONU where the interworking of an Ethernet service (Unicast Data and POTS) to the GEM layer takes place.

Relationships

One instance of this managed entity exists for each transformation of a data stream into GEM frames and vice versa.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

GEM port network CTP connectivity pointer: This attribute points to an instance of the GEM port network CTP. (R, W, Set-by-create) (mandatory) (2 bytes)

Interworking option: This attribute identifies the type of non-GEM function that is being interworked. The options are:

0 Circuit-emulated TDM
1 MAC bridged LAN
2 Reserved
3 Reserved
4 Video return path
5 IEEE 802.1p mapper
6 Downstream broadcast
7 MPLS PW TDM service

(R, W, Set-by-create) (mandatory) (1 byte)

Service profile pointer: This attribute points to an instance of a service profile:

CES service profile	if interworking option = 0
MAC bridge service profile	if interworking option = 1
Video return path service profile	if interworking option = 4
IEEE 802.1p mapper service profile	if interworking option = 5
Null pointer	if interworking option = 6
CES service profile	if interworking option = 7

(R, W, Set-by-create) (mandatory) (2 bytes)

Note: The video return path service profile is defined in [ITU-T G.984.4].

Interworking termination point pointer: This attribute is used for the circuit emulation service and IEEE 802.1p mapper service without a MAC bridge. Depending on the service provided, it points to the associated instance of the following managed entities:

Physical path termination point CES UNI
Logical N × 64 kbit/s sub-port connection termination point
Physical path termination point Ethernet UNI

In all other GEM services, the relationship between the related service termination point and this GEM interworking termination point is derived from other managed entity relations; this attribute is set to a null pointer and not used. (R, W, Set-by-create) (mandatory) (2 bytes)

PPTP counter: This value reports the number of PPTP managed entity instances associated with this GEM interworking termination point. (R) (optional) (1 byte)

Operational state: This attribute indicates whether or not the managed entity is capable of performing its function. Valid values are enabled (0) and disabled (1). (R) (optional) (1 byte)

GAL profile pointer: This attribute points to an instance of the GAL profile. The relationship between the interworking option and the related GAL profile is:

Interworking option	GAL profile type
0	Null pointer
1	GAL Ethernet profile
3	GAL Ethernet profile for data service
4	GAL Ethernet profile for video return path
5	GAL Ethernet profile for IEEE 802.1p mapper
6	Null pointer
7	Null pointer

(R, W, Set-by-create) (mandatory) (2 bytes)

GAL loopback configuration: This attribute sets the loopback configuration when using GEM mode:

0 No loopback
1 Loopback of downstream traffic after GAL

The default value of this attribute is 0. When the interworking option is 6 (downstream broadcast), this attribute is not used. (R, W) (mandatory) (1 byte)

Actions

Create, delete, get, set

Notifications

Attribute value change

Number	Attribute value change	Description
1..5	N/A	
6	Op state	Operational state change
7..8	N/A	
9..16	Reserved	

Alarm

Alarm number	Alarm	Description
0	Deprecated	
1..207	Reserved	
208..223	Vendor-specific alarms	Not to be standardized* (to be discussed before implemented)

5.2.5 Multicast GEM Interworking Termination Point (ME #281)

An instance of this managed entity represents a point in a G-PON ONU where a multicast service interworks with the GEM layer. At this point, a multicast bit stream is reconstructed from GEM packets.

Instances of this managed entity are created and deleted by the OLT.

Multicast interworking GEM modes of operation

The default multicast operation of the PON is where all the multicast content streams are carried in one PON layer connection (GEM port). This connection is then specified in the first entry of the IPv4 or IPv6 multicast address table, as the case may be. This single entry also specifies an all-inclusive IP multicast destination address range (e.g., 224.0.0.0 to 239.255.255.255 in the case of IPv4). The ONU then filters the traffic based on either Ethernet MAC addresses or IP addresses. The associated GEM port network CTP ME specifies the GEM port-ID that supports all multicast connections.

In the default multicast operation, all multicast content streams are placed in one PON layer connection (GEM port). The OLT sets up a completely conventional model, a pointer from the multicast GEM interworking termination to a GEM port network CTP. The OLT configures the GEM port-ID of the GEM port network CTP into the appropriate multicast address table attribute(s), along with the other table fields that specify the range of IP multicast destination addresses. The ONU accepts the entire multicast stream through the designated GEM port, then filters the traffic based on either the Ethernet MAC address or IP destination address.

An optional multicast configuration supports separate multicast streams carried over separate PON layer connections, i.e., on separate GEM ports. This permits the ONU to filter multicast streams at the GEM level, which is efficient in hardware, while ignoring other multicast streams that may be of interest to other ONUs on the PON.

After configuring the explicit model for the first multicast GEM port, the OLT supports multiple multicast GEM ports by then configuring additional entries into the multicast address table(s), entries with different GEM port-IDs. The OMCI model is defined such that these ports are implicitly grouped together and served by the single explicit GEM port network CTP. No additional GEM network CTPs need be created or linked for the additional GEM ports.

Several multicast GEM interworking termination points can exist, each linked to separate bridge ports or mappers to serve different communities of interest in a complex ONU.

Discovery of multicast support

The OLT uses the multicast GEM IW TP entity as the means to discover the ONU's multicast capability. This entity is mandatory if multicast is supported by the ONU. If the OLT attempts to

create this entity on an ONU that does not support multicast, the create command fails. The create or set command also fails if the OLT attempts to exploit optional features that the ONU does not support, for example in attempting to write a multicast address table with more than a single entry or to create multiple multicast GEM interworking termination points.

This managed entity is defined by a similarity to the unicast GEM interworking termination point, and a number of its attributes are not meaningful in a multicast context. These attributes are set to 0 and not used, as indicated below.

Application

Represents a point in the ONU where a multicast service interworks with the GEM layer.

Relationships

An instance of this managed entity exists for each occurrence of transformation of GEM packets into a multicast data stream.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. The value 0xFFFF is reserved. (R, Set-by-create) (mandatory) (2 bytes)

GEM port network CTP connectivity pointer: This attribute points to an instance of the GEM port network CTP that is associated with this multicast GEM interworking termination point. (R, W, Set-by-create) (mandatory) (2 bytes)

Interworking option: This attribute identifies the type of non-GEM function that is being interworked. The option can be:

0 This value is a "no-op" or "don't care". It should be used when the multicast GEM IW TP is associated with several functions of different types. It can optionally be used in all cases, since the necessary information is available elsewhere. The previous code points are retained for backward compatibility:
1 MAC bridged LAN
3 Reserved
5 IEEE 802.1p mapper

(R, W, Set-by-create) (mandatory) (1 byte)

Service profile pointer: This attribute is set to 0 and not used. For backward compatibility, it may also be set to point to a MAC bridge service profile or IEEE 802.1p mapper service profile. (R, W, Set-by-create) (mandatory) (2 bytes)

Not used 1: This attribute is set to 0 and not used. (R, W, Set-by-create) (mandatory) (2 bytes)

PPTP counter: This attribute represents the number of instances of PPTP managed entities associated with this instance of the multicast GEM interworking termination point. This attribute conveys no information that is not available elsewhere; it may be set to 0xFF and not used. (R) (mandatory) (1 byte)

Operational state: This attribute indicates whether or not the managed entity is capable of performing its function. Valid values are enabled (0) and disabled (1). (R) (mandatory) (1 byte)

GAL profile pointer: This attribute is set to 0 and not used. For backward compatibility, it may also be set to point to a GAL Ethernet profile. (R, W, Set-by-create) (mandatory) (2 bytes)

Not used 2: This attribute is set to 0 and not used. (R, W, Set-by-create) (mandatory) (1 byte)

IPv4 multicast address table: This attribute maps IP multicast addresses to PON layer addresses. Each entry contains:

GEM port-ID	2 bytes
Secondary key	2 bytes
IP multicast destination address range start	4 bytes
IP multicast destination address range stop	4 bytes

The first four bytes of each entry are treated as a key into the list. The secondary key allows the table to contain more than a single range for a given GEM port.

A set action to a particular value overwrites any existing entry with the same first four bytes. If the last eight bytes of a set command are all zero, that entry is deleted from the list, as the IP address 0.0.0.0 is not valid.

(R, W) (mandatory) (12N bytes, where N is the number of entries in the list.)

IPv6 multicast address table: This attribute maps IPv6 multicast destination addresses to PON layer addresses. Each entry contains:

GEM port-ID	2 bytes
Secondary key	2 bytes
Least significant bytes, IP multicast destination address range start	4 bytes
Least significant bytes, IP multicast destination address range stop	4 bytes
Most significant bytes, IP destination address	12 bytes

The first four bytes of each entry are treated as a key into the list. The secondary key allows the table to contain more than a single range for a given GEM port.

A set action to a particular value overwrites any existing entry with the same first four bytes. If the last twenty bytes of a set command are all zero, that entry is deleted from the list.

(R, W) (optional) (24N bytes, where N is the number of entries in the list.)

Actions

Create, delete, get, get next, set

Set table (optional)

Notifications

Attribute value change

Number	Attribute value change	Description
1..5	N/A	
6	Op state	Operational state change
7..9	N/A	
10..16	Reserved	

Alarm

Alarm number	Alarm	Description
0	Deprecated	
1..207	Reserved	
208..223	Vendor-specific alarms	Not to be standardized* (to be discussed before implemented)

5.2.6 GAL Ethernet Profile (ME #272)

This managed entity organizes data that describe the GTC adaptation layer processing functions of the ONU for Ethernet services. It is used with the GEM interworking termination point managed entity.

Instances of this managed entity are created and deleted on request of the OLT.

Application

Describes GEM Adaptation Layer (GAL) processing functions of the ONU.

Relationships

An instance of this managed entity may be associated with zero or more instances of the GEM interworking termination point managed entity.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

Maximum GEM payload size: This attribute defines the maximum payload size generated in the associated GEM interworking termination point managed entity. (R, W, Set-by-create) (mandatory) (2 bytes)

Actions

Create, delete, get, set

Notifications

None.

5.2.7 FEC Performance Monitoring History Data (ME #312)

This managed entity collects performance monitoring data associated with PON downstream FEC counters. Instances of this managed entity are created and deleted by the OLT.

For a complete discussion of generic PM architecture, refer to [ITU-T G.988] clause I.4.

Application

This managed entity collects performance monitoring data associated with PON downstream FEC counters.

Relationships

An instance of this managed entity is associated with an instance of the ANI-G managed entity.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Through an identical ID, this managed entity is implicitly linked to an instance of the ANI-G. (R, Set-by-create) (mandatory) (2 bytes)

Interval end time: This attribute identifies the most recently finished 15-minute interval. (R) (mandatory) (1 byte)

Threshold data 1/2 ID: This attribute points to an instance of the threshold data 1 managed entity that contains PM threshold values. Since no threshold value attribute number exceeds 7, a threshold data 2 ME is optional. (R, W, Set-by-create) (mandatory) (2 bytes)

Corrected bytes: This attribute counts the number of bytes that were corrected by the FEC function. (R) (mandatory) (4 bytes)

Corrected code words: This attribute counts the code words that were corrected by the FEC function. (R) (mandatory) (4 bytes)

Uncorrectable code words: This attribute counts errored code words that could not be corrected by the FEC function. (R) (mandatory) (4 bytes)

Total code words: This attribute counts the total received code words. (R) (mandatory) (4 bytes)

FEC seconds: This attribute counts seconds during which there was a forward error correction anomaly. (R) (mandatory) (2 bytes)

Actions

Create, delete, get, set

Get current data

Notifications

D1 implementation will not set or utililize the TCA value for each alarm number 0-4.

Threshold crossing alert

Alarm number	Threshold crossing alert	Threshold value attribute # (Note)
0	Corrected bytes	1
1	Corrected code words	2
2	Uncorrectable code words	3
4	FEC seconds	4
Note: This number associates the TCA with the specified threshold value attribute of the threshold data 1 managed entity.		

5.2.8 Priority Queue (ME #277)

Note 1: In [ITU-T G.984.4], this is called a priority queue-G.

This managed entity specifies the priority queue used by a GEM port network CTP in the upstream direction. The upstream priority queue ME is also related to a T-CONT ME. By default, this relationship is fixed by the ONU hardware architecture, but some ONUs may also permit the relationship to be configured through the OMCI, as indicated by the QoS configuration flexibility attribute of the ONU2-G managed entity.

In the downstream direction, priority queues are associated with UNIs. Again, the association is fixed by default, but some ONUs may permit the association to be configured through the OMCI.

If an ONU as a whole contains priority queues, it instantiates these queues autonomously. Priority queues may also be localized to pluggable circuit packs, in which case the ONU creates and deletes them in accordance with circuit pack pre-provisioning and the equipped configuration.

The OLT can find all the queues by reading the priority queue managed entity instances. If the OLT tries to retrieve a non-existent priority queue, the ONU denies the get action with an error indication.

See also Appendix II in [ITU-T G.988],.

Priority queues can exist in the ONU core and circuit packs serving both UNI and ANI functions. Therefore, they can be indirectly created and destroyed through cardholder provisioning actions.

In the upstream direction, the weight attribute permits the configuring of an optional traffic scheduler. Several attributes support back pressure operation, whereby a back-pressure signal is sent backwards and causes the attached terminal to temporarily suspend sending data.

In the downstream direction, strict priority discipline among the queues serving a given UNI is the default, with priorities established through the related port attribute. If two or more non-empty queues have the same priority, capacity is allocated among them in proportion to their weights. Note that the details of the downstream model differ from those of the upstream model.

The yellow packet drop thresholds specify the drop probability for a packet that has been marked yellow (drop eligible) by a traffic descriptor or by external equipment such as a residential gateway. If the current average queue occupancy is less than the minimum threshold, the yellow packet drop probability is zero. If the current average queue occupancy is greater than or equal to the maximum threshold, the yellow packet drop probability is one. The yellow drop probability increases linearly

between 0 and max_p as the current average queue occupancy increases from the minimum to the maximum threshold.

The same model can be configured for green packets, those regarded as being within the traffic contract.

Drop precedence colour marking indicates the method by which a packet is marked as drop eligible (yellow). For DEI and PCP marking, a drop eligible indicator is equivalent to yellow colour; otherwise, the colour is green. For DSCP AF marking, the lowest drop precedence is equivalent to green; otherwise, the colour is yellow.

Application

Specifies the (Ethernet UNI and POTS UNI service) priority queue(s) used by a GEM port network CTP related to the T-CONT in the US direction and related to the User Network Interface (UNI) in the DS direction.

Relationships

One or more instances of this managed entity are associated with the ONU-G managed entity to model upstream priority queues if the traffic management option attribute in the ONU-G ME is 0 or 2.

One or more instances of this managed entity are associated with a physical path termination point UNI managed entity as downstream priority queues. Downstream priority queues may or may not be provided for a virtual Ethernet interface point.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. The most significant bit represents the direction (1: upstream, 0: downstream). The 15 least significant bits represent a queue ID. The queue ID is numbered in ascending order by the ONU itself. It is strongly encouraged that the queue ID be formulated to simplify finding related queues. One way to do this is to number the queues such that the related port attributes are in ascending order (for the downstream and upstream queues separately). The range of downstream queue ids is 0 to 0x7FFF and the range of upstream queue ids is 0x8000 to 0xFFFF. (R) (mandatory) (2 bytes)

Queue configuration option: This attribute identifies the buffer partitioning policy. The value 1 means that several queues share one buffer of maximum queue size, while the value 0 means that each queue has an individual buffer of maximum queue size. (R) (mandatory) (1 byte)

Maximum queue size: This attribute specifies the maximum size of the queue, in bytes, scaled by the priority queue scale factor attribute of the ONU2-G. (R) (mandatory) (2 bytes)

Note 2: In this and the other similar attributes of the priority queue ME, some legacy implementations may take the queue scale factor from the GEM block length attribute of the ANI-G managed entity. This option is discouraged in new implementations.

Allocated queue size: This attribute identifies the allocated size of this queue, in bytes, scaled by the priority queue scale factor attribute of the ONU2-G. (R, W) (mandatory) (2 bytes)

Discard-block counter reset interval: This attribute represents the interval in milliseconds at which the counter resets itself. (R, W) (mandatory) (2 bytes)

Threshold value for discarded blocks due to buffer overflow: This attribute specifies the threshold for the number of bytes (scaled by the priority queue scale factor attribute of the ONU2-G) discarded on this queue due to buffer overflow. Its value controls the declaration of the block loss alarm. (R, W) (mandatory) (2 bytes)

Related port: This attribute represents the slot, port/T-CONT and priority information associated with the instance of priority queue ME. This attribute comprises four bytes.

In the upstream direction, the first two bytes are the ME ID of the associated T-CONT, the first byte of which is a slot number, the second byte a T-CONT number. In the downstream direction, the first byte is the slot number and the second byte is the port number of the queue's destination port.

The last two bytes represent the priority of this queue. The range of priority is 0 to 0x0FFF. The value 0 indicates the highest priority and 0x0FFF indicates the lowest priority. The priority field is meaningful if multiple priority queues are associated with a T-CONT or traffic scheduler whose scheduling discipline is strict priority.

(R, W) (mandatory) (4 bytes)

Note 3: If flexible port configuration is supported, the related port attribute is meaningful only if the traffic scheduler pointer attribute value is null. Otherwise, the related port attribute is ignored.

Note 4: The related port attribute is read-only, unless otherwise specified by the QoS configuration flexibility attribute of the ONU2-G managed entity. If port flexibility is supported, the second byte, the port or T-CONT number, may be changed. If priority flexibility is supported, the third and fourth bytes may be changed. The OMCI set command must contain four bytes to match the attribute size, but the ONU must ignore all bytes that are not specified to be flexible.

If flexible configuration is not supported, the ONU should reject an attempt to set the related port with a parameter error result-reason code.

Traffic scheduler pointer: This attribute points to the traffic scheduler ME instance that is associated with this priority queue. This pointer is used when this priority queue is connected with a traffic scheduler. The default value is a null pointer (0). (R, W) (mandatory) (2 bytes)

Note 5: When the QoS configuration flexibility attribute of the ONU2-G managed entity allows flexible assignment of the traffic scheduler, the OLT may configure the traffic scheduler pointer to refer to any traffic scheduler in the same slot.

If traffic scheduler flexibility is not permitted by the QoS configuration flexibility attribute, the OLT may use the traffic scheduler pointer attribute only by pointing to another traffic scheduler ME that is associated with the same T-CONT as the priority queue itself.

The ONU should reject an attempt to violate these conditions with a parameter error result-reason code.

Weight: This attribute represents weight for WRR scheduling. At a given priority level, capacity is distributed to non-empty queues in proportion to their weights. In the upstream direction, this weight is meaningful if several priority queues are associated with a traffic scheduler or T-CONT whose policy is WRR. In the downstream direction, this weight is used by a UNI in a WRR fashion. Upon ME instantiation, the ONU sets this attribute to 1. (R, W) (mandatory) (1 byte)

Back pressure operation: This attribute enables (0) or disables (1) back pressure operation. Its default value is 0. (R, W) (mandatory) (2 bytes)

Back pressure time: This attribute specifies the duration in microseconds of the back-pressure signal. It can be used as a pause time for an Ethernet UNI. Upon ME instantiation, the ONU sets this attribute to 0. (R, W) (mandatory) (4 bytes)

Back pressure occur queue threshold: This attribute identifies the threshold queue occupancy, in bytes, scaled by the priority queue scale factor attribute of the ONU2-G, to start sending a back-pressure signal. (R, W) (mandatory) (2 bytes)

Back pressure clear queue threshold: This attribute identifies the threshold queue occupancy, in bytes, scaled by the priority queue scale factor attribute of the ONU2-G, to stop sending a back-pressure signal. (R, W) (mandatory) (2 bytes)

Packet drop queue thresholds: This attribute is a composite of four 2-byte values, a minimum and a maximum threshold, measured in bytes, scaled by the priority queue scale factor attribute of the ONU2-G, for green and yellow packets. The first value is the minimum green threshold, the queue occupancy below which all green packets are admitted to the queue. The second value is the maximum green threshold, the queue occupancy at or above which all green packets are discarded. The third value is the minimum yellow threshold, the queue occupancy below which all yellow packets are admitted to the queue. The fourth value is the maximum yellow threshold, the queue occupancy at or above which all yellow packets are discarded. The default is that all thresholds take the value of the maximum queue size. (R, W) (optional) (8 bytes)

Packet drop max_p: This attribute is a composite of two 1-byte values, the probability of dropping a coloured packet when the queue occupancy lies just below the maximum threshold for packets of that colour. The first value is the green packet max_p, and the second value is the yellow packet max_p. The probability, max_p, is determined by adding one to the unsigned value (0..255) of this attribute and dividing the result by 256. The default for each value is 255. (R, W) (optional) (2 bytes)

Queue drop w_q: This attribute determines the averaging coefficient, w_q, as described in Floyd and Jacobson [b-Floyd]. The averaging coefficient, w_q, is equal to 2-Queue_drop_w_q. For example, when queue drop_w_q has the value 9, the averaging coefficient, w_q, is 1/512 = 0.0019. The default value is 9. (R, W) (optional) (1 byte)

Drop precedence colour marking: This attribute specifies how drop precedence is marked on ingress packets to the priority queue. The default value is 0.

0 No marking (treat all packets as green)
1 Internal marking (from traffic descriptor ME)
2 DEI [IEEE 802.1ad]
3 PCP 8P0D [IEEE 802.1ad]
4 PCP 7P1D [IEEE 802.1ad]
5 PCP 6P2D [IEEE 802.1ad]
6 PCP 5P3D [IEEE 802.1ad]
7 DSCP AF class [IETF RFC 2597]

(R, W) (optional) (1 byte)

Actions

Get, set

Notifications

Alarm

Alarm number	Alarm	Description
0	Block loss	Content loss in excess of threshold. The alarm is cleared when the discard block counter reset interval next expires.
1..207	Reserved	
208..223	Vendor-specific alarms	Not to be standardized* (to be discussed before implemented)

5.2.9 Traffic Scheduler (ME #278)

Note 1: In [ITU-T G.984.4], this managed entity is called a traffic scheduler-G.

An instance of this managed entity represents a logical object that can control upstream GEM packets. A traffic scheduler can accommodate GEM packets after a priority queue or other traffic scheduler and transfer them towards the next traffic scheduler or T-CONT. Because T-CONTs and traffic schedulers are created autonomously by the ONU, the ONU vendor predetermines the most complex traffic handling model it is prepared to support; the OLT may use less than the ONU's full capabilities, but cannot ask for more. See [ITU-T G.988]Appendix II for more details.

After the ONU creates instances of the T-CONT ME, it then autonomously creates instances of the traffic scheduler ME.

Application

Controls the US GEM frames from a priority queue (Unicast Data and POTS) and transfers them towards a T-CONT when granted bandwidth by the OLT.

Relationships

The traffic scheduler ME may be related to a T-CONT or other traffic schedulers through pointer attributes.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. This two-byte number indicates the physical capability that realizes the traffic scheduler. The first byte is the slot ID of the circuit pack with which this traffic scheduler is associated. For a traffic scheduler that is not associated with a circuit pack, the first byte is 0xFF. The second byte is the traffic scheduler id,

assigned by the ONU itself. Traffic schedulers are numbered in ascending order with the range 0..0xFF in each circuit pack or in the ONU core. (R) (mandatory) (2 bytes)

T-CONT pointer: This attribute points to the T-CONT ME instance associated with this traffic scheduler. This pointer is used when this traffic scheduler is connected to the T-CONT directly; It is null (0) otherwise. (R, W) (mandatory) (2 bytes)

Note 2: This attribute is read-only unless otherwise specified by the QoS configuration flexibility attribute of the ONU2-G managed entity. If flexible configuration is not supported, the ONU should reject an attempt to set the T-CONT pointer attribute with a parameter error result-reason code.

Traffic scheduler pointer: This attribute points to another traffic scheduler ME instance that may serve this traffic scheduler. This pointer is used when this traffic scheduler is connected to another traffic scheduler; it is null (0) otherwise. (R) (mandatory) (2 bytes)

Policy: This attribute represents scheduling policy. Valid values include:

0 Null
1 Strict priority
2 WRR (weighted round robin)

The traffic scheduler derives priority or weight values for its tributary traffic schedulers or priority queues from the tributary MEs themselves.

(R, W) (mandatory) (1 byte)

Note 3: This attribute is read-only unless otherwise specified by the QoS configuration flexibility attribute of the ONU2-G managed entity. If flexible configuration is not supported, the ONU should reject an attempt to set the policy attribute with a parameter error result-reason code.

Priority/weight: This attribute represents the priority for strict priority scheduling or the weight for WRR scheduling. This value is used by the next upstream managed entity, as indicated by the T-CONT pointer attribute or traffic scheduler pointer attribute.

If the indicated pointer has policy = strict priority, this value is interpreted as a priority (0 is the highest priority, 255 the lowest).

If the indicated pointer has policy = WRR, this value is interpreted as a weight. Higher values receive more bandwidth.

Upon ME instantiation, the ONU sets this attribute to 0. (R, W) (mandatory) (1 byte)

Actions

Get, set

Notifications

None.

5.2.10 Traffic Descriptor (ME #280)

The traffic descriptor is a profile that allows for traffic management. A priority controlled ONU can point from a MAC bridge port configuration data ME to a traffic descriptor in order to implement traffic management (marking, policing). A rate controlled ONU can point to a traffic descriptor from either a MAC bridge port configuration data ME or a GEM port network CTP to implement traffic management (marking, shaping).

Packets are determined to be green, yellow or red as a function of the ingress packet rate and the settings in this ME. The colour indicates drop precedence (eligibility), subsequently used by the priority queue ME to drop packets conditionally during congestion conditions. Packet colour is also used by the optional mode 1 DBA status reporting function described in [ITU-T G.984.3]. Red packets are dropped immediately. Yellow packets are marked as drop eligible, and green packets are marked as not drop eligible, according to the egress colour marking attribute.

The algorithm used to determine the colour marking is specified by the meter type attribute. If [b-IETF RFC 4115] is used, then:

CIR_{4115} = CIR

EIR_{4115} = PIR – CIR (EIR: excess information rate)

CBS_{4115} = CBS

EBS_{4115} = PBS – CBS.

Application

N/A

Relationships

This ME is associated with a GEM port network CTP or a MAC bridge port configuration data managed entity.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

CIR: This attribute specifies the committed information rate, in byte/s. The default is 0. (R, W, Set-by-create) (optional) (4 bytes)

PIR: This attribute specifies the peak information rate, in byte/s. The default value 0 accepts the ONU's factory policy. (R, W, Set-by-create) (optional) (4 bytes)

CBS: This attribute specifies the committed burst size, in bytes. The default is 0. (R, W, Set-by-create) (optional) (4 bytes)

PBS: This attribute specifies the peak burst size, in bytes. The default value 0 accepts the ONU's factory policy. (R, W, Set-by-create) (optional) (4 bytes)

Colour mode: This attribute specifies whether the colour marking algorithm considers pre-existing marking on ingress packets (colour-aware) or ignores it (colour-blind). In colour-aware mode, packets can only be demoted (from green to yellow or red, or from yellow to red). The default value is 0.

0 Colour-blind
1 Colour-aware

(R, W, Set-by-create) (optional) (1 byte)

Ingress colour marking: This attribute is meaningful in colour-aware mode. It identifies how pre-existing drop precedence is marked on ingress packets. For DEI and PCP marking, a drop eligible indicator is equivalent to yellow; otherwise, the colour is green. For DSCP AF marking, the lowest drop precedence is equivalent to green; otherwise, the colour is yellow. The default value is 0.

0 No marking (ignore ingress marking)
2 DEI [IEEE 802.1ad]
3 PCP 8P0D [IEEE 802.1ad]
4 PCP 7P1D [IEEE 802.1ad]
5 PCP 6P2D [IEEE 802.1ad]
6 PCP 5P3D [IEEE 802.1ad]
7 DSCP AF class [IETF RFC 2597]

(R, W, Set-by-create) (optional) (1 byte)

Egress colour marking: This attribute specifies how drop precedence is to be marked by the ONU on egress packets. If set to internal marking only, the externally visible packet contents are not modified, but the packet is identified in a vendor-specific local way that indicates its colour to the priority queue ME. It is possible for the egress marking to differ from the ingress marking; for example, ingress PCP marking could be translated to DEI egress marking. The default value is 0.

0 No marking
1 Internal marking only
2 DEI [IEEE 802.1ad]
3 PCP 8P0D [IEEE 802.1ad]
4 PCP 7P1D [IEEE 802.1ad]
5 PCP 6P2D [IEEE 802.1ad]
6 PCP 5P3D [IEEE 802.1ad]
7 DSCP AF class [IETF RFC 2597]

(R, W, Set-by-create) (optional) (1 byte)

Meter type: This attribute specifies the algorithm used to determine the colour of the packet. The default value is 0.

0 Not specified
1 [b-IETF RFC 4115]
2 [b-IETF RFC 2698]

(R, Set-by-create) (optional) (1 byte)

Actions

Create, delete, get, set

Notifications

None.

5.2.11 GEM Port Network Ctp Performance Monitoring History Data (ME #341)

This managed entity collects GEM frame performance monitoring data associated with a GEM port network CTP. Instances of this managed entity are created and deleted by the OLT.

Note 1: One might expect to find some form of impaired or discarded frame count associated with a GEM port. However, the only impairment that might be detected at the GEM frame level would be

a corrupted GEM frame header. In this case, no part of the header could be considered reliable including the port ID. For this reason, there is no impaired or discarded frame count in this ME.

Note 2: This managed entity replaces the GEM port performance history data managed entity and is preferred for new implementations.

For a complete discussion of generic PM architecture, refer to [ITU-T G.988] clause I.4.

Relationships

An instance of this managed entity is associated with an instance of the GEM port network CTP managed entity.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Through an identical ID, this managed entity is implicitly linked to an instance of the GEM port network CTP. (R, Set-by-create) (mandatory) (2 bytes)

Interval end time: This attribute identifies the most recently finished 15-minute interval. (R) (mandatory) (1 byte)

Threshold data 1/2 ID: This attribute points to an instance of the threshold data 1 managed entity that contains PM threshold values. Since no threshold value attribute number exceeds 7, a threshold data 2 ME is optional. (R, W, Set-by-create) (mandatory) (2 bytes)

Transmitted GEM frames: This attribute counts GEM frames transmitted on the monitored GEM port. (R) (mandatory) (4 bytes)

Received GEM frames: This attribute counts GEM frames received correctly on the monitored GEM port. A correctly received GEM frame is one that does not contain uncorrectable errors and has a valid HEC. (R) (mandatory) (4 bytes)

Received payload bytes: This attribute counts user payload bytes received on the monitored GEM port. (R) (mandatory) (8 bytes)

Transmitted payload bytes: This attribute counts user payload bytes transmitted on the monitored GEM port. (R) (mandatory) (8 bytes)

Encryption key errors: This attribute is defined in ITU-T G.987 systems only. It counts GEM frames with erroneous encryption key indexes. If the GEM port is not encrypted, this attribute counts any frame with a key index not equal to 0. If the GEM port is encrypted, this attribute counts any frame whose key index specifies a key that is not known to the ONU. (R) (mandatory) (4 bytes)

Note 3: GEM PM ignores idle GEM frames.

Note 4: GEM PM counts each non-idle GEM frame, whether it contains an entire user frame or only a fragment of a user frame.

Actions

Create, delete, get, set

Get current data (mandatory)

Notifications

Threshold crossing alert

Alarm number	Threshold crossing alert	Threshold value attribute # (Note)
1	Encryption key errors	1
Note: This number associates the TCA with the specified threshold value attribute of the threshold data 1 managed entity.		

5.2.12 XG-PON TC Performance Monitoring History Data (ME #344)

This managed entity collects performance monitoring data associated with the XG-PON transmission convergence layer, as defined in [ITU-T G.987.3].

For a complete discussion of generic PM architecture, refer to [ITU-T G.988] clause I.4.

Relationships

An instance of this managed entity is associated with an ANI-G.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Through an identical ID, this managed entity is implicitly linked to an instance of the ANI-G. (R, Set-by-create) (mandatory) (2 bytes)

Interval end time: This attribute identifies the most recently finished 15-minute interval. (R) (mandatory) (1 byte)

Threshold data 1/2 ID: This attribute points to an instance of the threshold data 1 managed entity that contains PM threshold values. Since no threshold value attribute number exceeds 7, a threshold data 2 ME is optional. (R, W, Set-by-create) (mandatory) (2 bytes)

PSBd HEC error count: This attribute counts HEC errors in any of the fields of the downstream physical sync block. (R) (mandatory) (4 bytes)

XGTC HEC error count: This attribute counts HEC errors detected in the XGTC header. (R) (mandatory) (4 bytes)

Unknown profile count: This attribute counts the number of grants received whose specified profile was not known to the ONU. (R) (mandatory) (4 bytes)

Transmitted XGEM frames: This attribute counts the number of non-idle XGEM frames transmitted. If an SDU is fragmented, each fragment is an XGEM frame and is counted as such. (R) (mandatory) (4 bytes)

Fragment XGEM frames: This attribute counts the number of XGEM frames that represent fragmented SDUs, as indicated by the LF bit = 0. (R) (mandatory) (4 bytes)

XGEM HEC lost words count: This attribute counts the number of four-byte words lost because of an XGEM frame HEC error. In general, all XGTC payload following the error is lost, until the next PSBd event. (R) (mandatory) (4 bytes)

XGEM key errors: This attribute counts the number of downstream XGEM frames received with an invalid key specification. The key may be invalid for several reasons, among which are:

a) GEM port provisioned for clear text and key index not equal to 00,

b) no multicast key of the specified key index has been provided via the OMCI for a multicast GEM port,

c) no unicast key of the specified key index has been successfully negotiated (see [ITU-T G.987.3] clause 15.5 for key negotiation state machine),

d) GEM port specified to be encrypted and key index = 00,

e) key index = 11, a reserved value.

(R) (mandatory) (4 bytes)

XGEM HEC error count: This attribute counts the number of instances of an XGEM frame HEC error. (R) (mandatory) (4 bytes)

Actions

Create, delete, get, set

Get current data (optional)

Notifications

D1 implementation will not set or utililize the TCA value for each alarm number 1-6.

Threshold crossing alert

Alarm number	Threshold crossing alert	Threshold value attribute # (Note)
1	PSBd HEC error count	1
2	XGTC HEC error count	2
3	Unknown profile count	3
4	XGEM HEC loss count	4
5	XGEM key errors	5
6	XGEM HEC error count	6
Note: This number associates the TCA with the specified threshold value attribute of the threshold data 1 managed entity.		

5.2.13 XG-PON Downstream Management Performance Monitoring History Data (ME #345)

This managed entity collects performance monitoring data associated with the XG-PON transmission convergence layer, as defined in [ITU-T G.987.3]. It collects counters associated with downstream PLOAM and OMCI messages.

For a complete discussion of generic PM architecture, refer to [ITU-T G.988] clause I.4.

Relationships

An instance of this managed entity is associated with an ANI-G.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Through an identical ID, this managed entity is implicitly linked to an instance of the ANI-G. (R, Set-by-create) (mandatory) (2 bytes)

Interval end time: This attribute identifies the most recently finished 15-minute interval. (R) (mandatory) (1 byte)

Threshold data 1/2 ID: This attribute points to an instance of the threshold data 1 managed entity that contains PM threshold values. Since no threshold value attribute number exceeds 7, a threshold data 2 ME is optional. (R, W, Set-by-create) (mandatory) (2 bytes)

PLOAM MIC error count: This attribute counts MIC errors detected in downstream PLOAM messages, either directed to this ONU or broadcast to all ONUs. (R) (mandatory) (4 bytes)

Downstream PLOAM messages count: This attribute counts PLOAM messages received, either directed to this ONU or broadcast to all ONUs. (R) (mandatory) (4 bytes)

Profile messages received: This attribute counts the number of profile messages received, either directed to this ONU or broadcast to all ONUs. (R) (mandatory) (4 bytes)

Ranging_time messages received: This attribute counts the number of ranging_time messages received, either directed to this ONU or broadcast to all ONUs. (R) (mandatory) (4 bytes)

Deactivate_ONU-ID messages received: This attribute counts the number of deactivate_ONU-ID messages received, either directed to this ONU or broadcast to all ONUs. Deactivate_ONU-ID messages do not reset this counter. (R) (mandatory) (4 bytes)

Disable_serial_number messages received: This attribute counts the number of disable_serial_number messages received, whose serial number specified this ONU. (R) (mandatory) (4 bytes)

Request_registration messages received: This attribute counts the number of request_registration messages received. (R) (mandatory) (4 bytes)

Assign_alloc-ID messages received: This attribute counts the number of assign_alloc-ID messages received. (R) (mandatory) (4 bytes)

Key_control messages received: This attribute counts the number of key_control messages received, either directed to this ONU or broadcast to all ONUs. (R) (mandatory) (4 bytes)

Sleep_allow messages received: This attribute counts the number of sleep_allow messages received, either directed to this ONU or broadcast to all ONUs. (R) (mandatory) (4 bytes)

Baseline OMCI messages received count: This attribute counts the number of OMCI messages received in the baseline message format. (R) (mandatory) (4 bytes)

Extended OMCI messages received count: This attribute counts the number of OMCI messages received in the extended message format. (R) (mandatory) (4 bytes)

Assign_ONU-ID messages received: This attribute counts the number of assign_ONU-ID messages received since the last re-boot. (R) (mandatory) (4 bytes)

OMCI MIC error count: This attribute counts MIC errors detected in OMCI messages directed to this ONU. (R) (mandatory) (4 bytes)

Actions

Create, delete, get, set

Get current data (optional)

Notifications

D1 implementation will not set or utililize the TCA value for each alarm number 1-2.

Threshold crossing alert

Alarm number	Threshold crossing alert	Threshold value attribute # (Note)
1	PLOAM MIC error count	1
2	OMCI MIC error count	2
NOTE – This number associates the TCA with the specified threshold value attribute of the threshold data 1 managed entity.		

5.2.14 XG-PON Upstream Management Performance Monitoring History Data (ME #346)

This managed entity collects performance monitoring data associated with the XG-PON transmission convergence layer, as defined in [ITU-T G.987.3]. It counts upstream PLOAM messages transmitted by the ONU.

For a complete discussion of generic PM architecture, refer to [ITU-T G.988] clause I.4.

Relationships

An instance of this managed entity is associated with an ANI-G.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Through an identical ID, this managed entity is implicitly linked to an instance of the ANI-G. (R, Set-by-create) (mandatory) (2 bytes)

Interval end time: This attribute identifies the most recently finished 15-minute interval. (R) (mandatory) (1 byte)

Threshold data 1/2 ID: No thresholds are defined for this managed entity. For uniformity with other PM, the attribute is retained and shown as mandatory, but it should be set to a null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Upstream PLOAM message count: This attribute counts PLOAM messages transmitted upstream, excluding acknowledge messages. (R) (mandatory) (4 bytes)

Serial_number_ONU message count: This attribute counts Serial_number_ONU PLOAM messages transmitted. (R) (mandatory) (4 bytes)

Registration message count: This attribute counts registration PLOAM messages transmitted. (R) (mandatory) (4 bytes)

Key_report message count: This attribute counts key_report PLOAM messages transmitted. (R) (mandatory) (4 bytes)

Acknowledge message count: This attribute counts acknowledge PLOAM messages transmitted. It includes all forms of acknowledgement, including those transmitted in response to a PLOAM grant when the ONU has nothing to send. (R) (mandatory) (4 bytes)

Sleep_request message count: This attribute counts sleep_request PLOAM messages transmitted. (R) (mandatory) (4 bytes)

Actions

Create, delete, get, set

Get current data (optional)

Notifications

None.

5.3 Layer 2 data services

5.3.1 MAC Bridge Service Profile (ME #45)

This managed entity models a MAC bridge in its entirety; any number of ports may be associated with the bridge through pointers to the MAC bridge service profile managed entity. Instances of this managed entity are created and deleted by the OLT.

Application

Models an Ethernet MAC bridge.

Relationships

Bridge ports are modelled by MAC bridge port configuration data managed entities, any number of which can point to a MAC bridge service profile. The real-time status of the bridge is available from an implicitly linked MAC bridge configuration data ME.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. The first byte is the slot ID. In an integrated ONU, this value is 0. The second byte is the bridge group ID. (R, Set-by-create) (mandatory) (2 bytes)

Spanning tree ind: The Boolean value true specifies that a spanning tree algorithm is enabled. The value false disables (rapid) spanning tree. (R, W, Set-by-create) (mandatory) (1 byte)

Learning ind: The Boolean value true specifies that bridge learning functions are enabled. The value false disables bridge learning. (R, W, Set-by-create) (mandatory) (1 byte)

Port bridging ind: The Boolean value true specifies that bridging between UNI ports is enabled. The value false disables local bridging. (R, W, Set-by-create) (mandatory) (1 byte)

Priority: This attribute specifies the bridge priority in the range 0..65535. The value of this attribute is copied to the bridge priority attribute of the associated MAC bridge configuration data managed entity. (R, W, Set-by-create) (mandatory) (2 bytes)

Max age: This attribute specifies the maximum age (in 256ths of a second) of received protocol information before its entry in the spanning tree listing is discarded. The range is 0x0600 to 0x2800 (6..40 seconds) in accordance with [IEEE 802.1D]. (R, W, Set-by-create) (mandatory) (2 bytes)

Hello time: This attribute specifies how often (in 256ths of a second) the bridge advertises its presence via hello packets, while acting as a root or attempting to become a root. The range is 0x0100 to 0x0A00 (1..10 seconds). (R, W, Set-by-create) (mandatory) (2 bytes)

Note: [IEEE 802.1D] specifies the compatibility range for hello time to be 1..2 seconds.

Forward delay: This attribute specifies the forwarding delay (in 256ths of a second) when the bridge acts as the root. The range is 0x0400 to 0x1E00 (4..30 seconds) in accordance with [IEEE 802.1D]. (R, W, Set-by-create) (mandatory) (2 bytes)

Unknown MAC address discard: The Boolean value true specifies that MAC frames with unknown destination addresses be discarded. The value false specifies that such frames be forwarded to all allowed ports. (R, W, Set-by-create) (mandatory) (1 byte)

MAC learning depth: This attribute specifies the maximum number of UNI MAC addresses to be learned by the bridge. The default value 0 specifies that there is no administratively-imposed limit. (R, W, Set-by-create) (optional) (1 byte)

Dynamic filtering ageing time: This attribute specifies the age of dynamic filtering entries in the bridge database, after which unrefreshed entries are discarded. In accordance with [IEEE 802.1D] clause 7.9.2 and [IEEE 802.1Q] clause 8.8.3, the range is 10..1 000 000 seconds, with a resolution of 1 second and a default of 300 seconds. The value 0 specifies that the ONU use its internal default. (R, W, Set-by-create) (optional) (4 bytes)

Actions

Create, delete, get, set

Notifications

None.

5.3.2 MAC Bridge Port Configuration Data (ME #47)

This managed entity models a port on a MAC bridge. Instances of this managed entity are created and deleted by the OLT.

Application

Models ports (for Ethernet UNI service & POTS UNI service) on an Ethernet MAC bridge.

Relationships

- An instance of this managed entity is linked to an instance of the MAC bridge service profile. Additional bridge port control capabilities are provided by implicitly linked instances of some or all of:

- MAC bridge port filter table data
- MAC bridge port filter pre-assign table
- VLAN tagging filter data
- Dot1 rate limiter

Real-time status of the bridge port is provided by implicitly linked instances of:

- MAC bridge port designation data
- MAC bridge port bridge table data
- Multicast subscriber monitor

Bridge port PM collection is provided by implicitly linked instances of:

- MAC bridge port PM history data
- Ethernet frame PM history data upstream and downstream
- Ethernet frame extended PM (preferred)

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

Bridge ID pointer: This attribute points to an instance of the MAC bridge service profile. (R, W, Set-by-create) (mandatory) (2 bytes)

Port num: This attribute is the bridge port number. It must be unique among all ports associated with a particular MAC bridge service profile. (R, W, Set-by-create) (mandatory) (1 byte)

TP type: This attribute identifies the type of termination point associated with this MAC bridge port. Valid values are:

1 Physical path termination point Ethernet UNI
2 Interworking VCC termination point
3 IEEE 802.1p mapper service profile
4 IP host config data or IPv6 host config data
5 GEM interworking termination point
6 Multicast GEM interworking termination point
7 Physical path termination point xDSL UNI part 1
8 Physical path termination point VDSL UNI
9 Ethernet flow termination point
10 Reserved
11 Virtual Ethernet interface point
12 Physical path termination point MoCA UNI

(R, W, Set-by-create) (mandatory) (1 byte)

TP pointer: This attribute points to the termination point associated with this MAC bridge port. The TP type attribute indicates the type of the termination point; this attribute contains its instance identifier (ME ID). (R, W, Set-by-create) (mandatory) (2 bytes)

NOTE 1 – When the TP type is VDSL or xDSL, the two most significant bits may be used to indicate a bearer channel.

Port priority: This attribute denotes the priority of the port for use in (rapid) spanning tree algorithms. The range is 0..255. (R, W, Set-by-create) (optional) (2 bytes)

Port path cost: This attribute specifies the contribution of the port to the path cost towards the spanning tree root bridge. The range is 1..65535. (R, W, Set-by-create) (mandatory) (2 bytes)

Port spanning tree ind: The Boolean value true enables (R)STP LAN topology change detection at this port. The value false disables topology change detection. (R, W, Set-by-create) (mandatory) (1 byte)

Deprecated 1: This attribute is not used. If present, it should be ignored by both the ONU and the OLT, except as necessary to comply with OMCI message definitions. (R, W, Set-by-create) (optional) (1 byte)

Deprecated 2: This attribute is not used. If present, it should be ignored by both the ONU and the OLT, except as necessary to comply with OMCI message definitions. (R, W, Set-by-create) (1 byte) (optional)

Port MAC address: If the termination point associated with this port has a MAC address, this attribute specifies it. (R) (optional) (6 bytes)

Outbound TD pointer: This attribute points to a traffic descriptor that limits the traffic rate leaving the MAC bridge. (R, W) (optional) (2 byte)

Inbound TD pointer: This attribute points to a traffic descriptor that limits the traffic rate entering the MAC bridge. (R, W) (optional) (2 byte)

MAC learning depth: This attribute specifies the maximum number of MAC addresses to be learned by this MAC bridge port. The default value 0 specifies that there is no administratively-imposed limit. (R, W, Set-by-create) (optional) (1 byte)

Note 2: If this attribute is not zero, its value overrides the value set in the MAC learning depth attribute of the MAC bridge service profile.

Actions

Create, delete, get, set

Notifications

D1 implementation will not utililize the alarms below.

Alarm

Alarm number	Alarm	Description
0	Port blocking	This port has been blocked due to loop detection in accordance with [IEEE 802.1D] (Note).
1..207	Reserved	
208..223	Vendor-specific alarms	Not to be standardized* (to be discussed before implemented)
Note: To determine the state of a MAC bridge port, the OLT can read the port state attribute of the MAC bridge port designation data.		

5.3.3 IEEE 802.1p Mapper Service Profile (ME #130)

This managed entity associates the priorities of IEEE 802.1p [IEEE 802.1D] priority tagged frames with specific connections. This managed entity directs upstream traffic to the designated GEM ports. Downstream traffic arriving on any of the IEEE 802.1p mapper's GEM ports is directed to the mapper's root termination point. Other mechanisms exist to direct downstream traffic, specifically a direct pointer to a downstream queue from the GEM port network CTP. If such an alternative is used, it should be provisioned to be consistent with the flow model of the mapper.

Instances of this managed entity are created and deleted by the OLT.

Application

Associates (Ethernet UNI service & POTS UNI service) priorities of 802.1p tagged frames (priority p-bit value in a tagged Ethernet frame) to designated GEM ports in the US direction and directs the DS direction GEM ports to PPTP (Ethernet UNI & POTS UNI) fixed queues in ONU (if the priority queue used by the GEM port network CTP in the DS direction is Null).

Relationships

At its root, an instance of this ME may be associated with zero or one instance of a PPTP UNI, MAC bridge port configuration data, or any type of interworking termination point ME that carries IEEE 802 traffic. Each of its eight branches is associated with zero or one GEM interworking termination point.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

TP pointer: This attribute points to an instance of the associated termination point.

If the optional TP type attribute is not supported, the TP pointer indicates bridging mapping with the value 0xFFFF; the TP pointer may also point to a PPTP Ethernet UNI.

The TP type value 0 also indicates bridging mapping, and the TP pointer should be set to 0xFFFF.

In all other cases, the termination point type is determined by the TP type attribute.

(R, W, Set-by-create) (mandatory) (2 bytes)

Each of the following eight attributes points to the GEM interworking termination point associated with the stated P-bit value. The null pointer 0xFFFF specifies that frames with the associated priority are to be discarded.

Interwork TP pointer for P-bit priority 0: (R, W, Set-by-create) (mandatory) (2 bytes)

Interwork TP pointer for P-bit priority 1: (R, W, Set-by-create) (mandatory) (2 bytes)

Interwork TP pointer for P-bit priority 2: (R, W, Set-by-create) (mandatory) (2 bytes)

Interwork TP pointer for P-bit priority 3: (R, W, Set-by-create) (mandatory) (2 bytes)

Interwork TP pointer for P-bit priority 4: (R, W, Set-by-create) (mandatory) (2 bytes)

Interwork TP pointer for P-bit priority 5: (R, W, Set-by-create) (mandatory) (2 bytes)

Interwork TP pointer for P-bit priority 6: (R, W, Set-by-create) (mandatory) (2 bytes)

Interwork TP pointer for P-bit priority 7: (R, W, Set-by-create) (mandatory) (2 bytes)

Unmarked frame option: This attribute specifies how the ONU should handle untagged Ethernet frames received across the associated interface. Although it does not alter the frame in any way, the ONU routes the frame as if it were tagged with P bits (PCP field) according to the following code points:

0 Derive implied PCP field from DSCP bits of received frame
1 Set implied PCP field to a fixed value specified by the default P-bit assumption attribute

(R, W, Set-by-create) (mandatory) (1 byte)

Untagged downstream frames are passed through the mapper transparently.

DSCP to P-bit mapping: This attribute is valid when the unmarked frame option attribute is set to 0. The DSCP to P-bit attribute can be considered a bit string sequence of 64 three-bit groupings. The 64 sequence entries represent the possible values of the six-bit DSCP field. Each three-bit grouping specifies the P-bit value to which the associated DSCP value should be mapped. The unmarked frame is then directed to the GEM interworking termination point indicated by the interwork TP pointer mappings. (R, W) (mandatory) (24 bytes)

NOTE – If certain bits in the DSCP field are to be ignored in the mapping process, the attribute should be provisioned such that all possible values of those bits produce the same P-bit mapping. This can be applied to the case where instead of full DSCP, the operator wishes to adopt the priority mechanism based on IP precedence, which needs only the three most significant bits of the DSCP field.

Default P-bit assumption: This attribute is valid when the unmarked frame option attribute is set to 1. In its least significant bits, the default P-bit assumption attribute contains the default PCP field to be assumed. The unmodified frame is then directed to the GEM interworking termination point indicated by the interwork TP pointer mappings. (R, W, Set-by-create) (mandatory) (1 byte)

TP type: This attribute identifies the type of termination point associated with the mapper.

0 Mapper used for bridging-mapping (default)
1 Mapper directly associated with a PPTP Ethernet UNI
2 Mapper directly associated with an IP host config data or IPv6 host config data ME (*)
3 Mapper directly associated with an Ethernet flow termination point
4 Mapper directly associated with a PPTP xDSL UNI
5 Reserved
6 Mapper directly associated with a PPTP MoCA UNI
7 Mapper directly associated with a virtual Ethernet interface point (*)
8 Mapper directly associated with an interworking VCC termination point

(R, W, Set-by-create) (**mandatory**) (1 byte) (* possible option)

Actions

Create, delete, get, set

Notifications

None.

5.3.4 VLAN Tagging Filter Data (ME #84)

This managed entity organizes data associated with VLAN tagging. Instances of this managed entity are created and deleted by the OLT.

Application

Organizes data associated with (Ethernet UNI) frame tag filtering closer to the MAC Bridge when compared to the tagging operation using the EVTOCD ME that occurs closer to the UNI.

Relationships

An instance of this managed entity is associated with an instance of a MAC bridge port configuration data managed entity. By definition, tag filtering occurs closer to the MAC bridge than the tagging operation. Schematically, the ordering of the functions is:

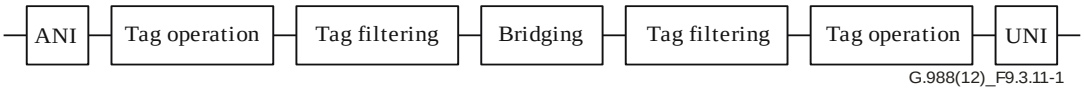

Figure 5 - ANI to UNI Tagging Flow

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Through an identical ID, this managed entity is implicitly linked to an instance of the MAC bridge port configuration data ME. (R, Set-by-create) (mandatory) (2 bytes)

VLAN filter list: This attribute is a list of provisioned TCI values for the bridge port. A TCI, comprising user priority, CFI and VID, is represented by 2 bytes. This attribute supports up to 12 VLAN entries. The first N are valid, where N is given by the number of entries attribute. (R, W, Set-by-create) (mandatory) (24 bytes)

Forward operation: When a frame passes through the MAC bridge port, it is processed according to the operation specified by this attribute, in accordance with Table 3. Figure 6 illustrates the treatment of frames according to the provisioned action possibilities. Tagged and untagged frames are treated separately, but both in accordance with the figure. While all forwarding operations are plausible, only actions 0x10 and 0x12 are necessary to construct a VLAN mapper and an 802.1p mapper, respectively. (R, W, Set-by-create) (mandatory) (1 byte)

Forward operation	Type of received frame	
	Tagged	Untagged
0x00	Bridging (a) (no investigation)	Bridging (a)
0x01	Discarding (c)	Bridging (a)
0x02	Bridging (a) (no investigation)	Discarding (c)
0x03	Action (h) (VID investigation)	Bridging (a)
0x04	Action (h) (VID investigation)	Discarding (c)
0x05	Action (g) (VID investigation)	Bridging (a)

Forward operation	Type of received frame	
	Tagged	Untagged
0x06	Action (g) (VID investigation)	Discarding (c)
0x07	Action (h) (user priority investigation)	Bridging (a)
0x08	Action (h) (user priority investigation)	Discarding (c)
0x09	Action (g) (user priority investigation)	Bridging (a)
0x0A	Action (g) (user priority investigation)	Discarding (c)
0x0B	Action (h) (TCI investigation)	Bridging (a)
0x0C	Action (h) (TCI investigation)	Discarding (c)
0x0D	Action (g) (TCI investigation)	Bridging (a)
0x0E	Action (g) (TCI investigation)	Discarding (c)
0x0F	Action (h) (VID investigation)	Bridging (a)
0x10	Action (h) (VID investigation)	Discarding (c)
0x11	Action (h) (user priority investigation)	Bridging (a)
0x12	Action (h) (user priority investigation)	Discarding (c)
0x13	Action (h) (TCI investigation)	Bridging (a)
0x14	Action (h) (TCI investigation)	Discarding (c)
0x15	Bridging (a) (no investigation)	Discarding (c)
0x16	Action (j) (VID investigation)	Bridging (a)
0x17	Action (j) (VID investigation)	Discarding (c)
0x18	Action (j) (user priority investigation)	Bridging (a)
0x19	Action (j) (user priority investigation)	Discarding (c)
0x1A	Action (j) (TCI investigation)	Bridging (a)
0x1B	Action (j) (TCI investigation)	Discarding (c)
0x1C	Action (h) (VID investigation)	Bridging (a)
0x1D	Action (h) (VID investigation)	Discarding (c)
0x1E	Action (h) (user priority investigation)	Bridging (a)
0x1F	Action (h) (user priority investigation)	Discarding (c)
0x20	Action (h) (TCI investigation)	Bridging (a)
0x21	Action (h) (TCI investigation)	Discarding (c)

Table 3 - Forward Operation Attribute Values

Table 3 contains duplicate entries due to simplification of the original set of actions.

Table 3 and the actions listed are discussed in detail below.

Number of entries: This attribute specifies the number of valid entries in the VLAN filter list. (R, W, Set-by-create) (mandatory) (1 byte)

Actions

Create, delete, get, set

Notifications

None.

Supplementary explanation

This section explains the actions specified in the forward operation attribute.

The format of an Ethernet frame for VLAN services is described in [IEEE 802.1Q] and [IEEE 802.1ad]:

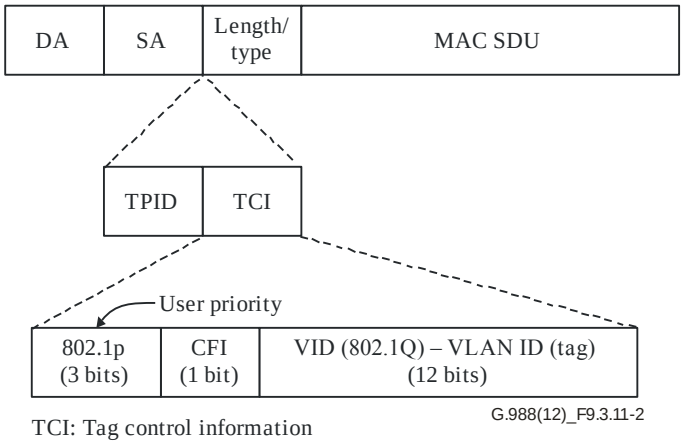

Figure 6 - Format of an Ethernet Frame for VLAN Services

a) Basic MAC bridge operation: All frames are accepted into the MAC bridging entity. Egress frames are forwarded from this port if either a) the frame's MAC destination address (DA) is listed in the MAC bridge port bridge table data for this port or b) the frame's DA does not appear in the MAC bridge port bridge table data for any port (flooding). The contents of the VLAN filter list attribute are not meaningful.

Note: Action (a) on a given port may imply egress flooding of a frame from other ports of the bridge. The possible VLAN tagging filter data MEs attached to the other ports override this action however, so the frame is only transmitted from another port if it also satisfies the forward operation attribute value established on that port.

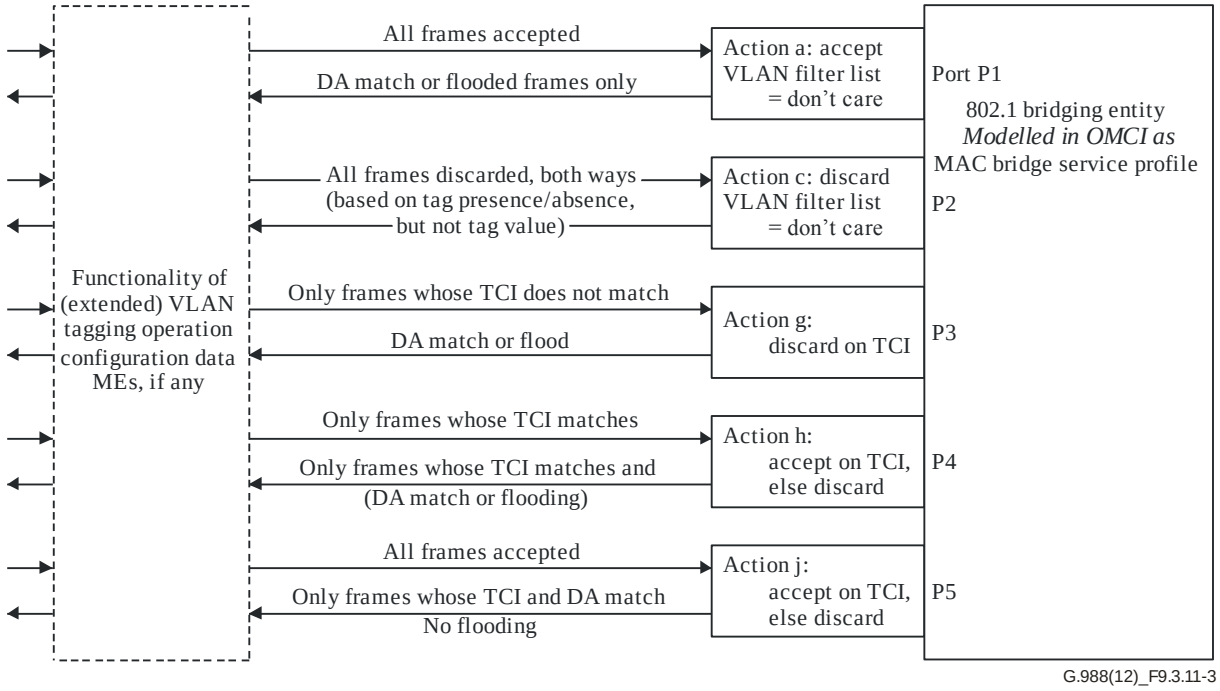

Figure 7 - Forwarding Behavior

Other possible actions are as follows:

c) Unconditional discarding: Frames in both directions are unconditionally discarded without an investigation of TCI or a MAC address. This action can be used to discard all tagged traffic or all untagged traffic at the port of attachment, depending on the forward operation attribute value. The contents of the VLAN filter list attribute are not meaningful.

g) Negative filtering by TCI: All frames are admitted into the bridging entity. If the specified fields in the TCI of a candidate egress frame match any entry in the VLAN filter list, the frame is not forwarded by this port. Otherwise, the frame is forwarded based on the destination MAC address, according to action (a).

h) Bidirectional positive filtering by TCI: Both ingress and egress frames are filtered on investigation of the TCI fields. If and only if the specified fields in the TCI of a candidate ingress frame match an entry in the VLAN filter list, the frame is admitted into the bridge. If, and only if the specified fields in the TCI of a candidate egress frame match an entry in the VLAN filter list, the frame is forwarded based on the destination MAC address, according to action (a).

j) Positive filtering by TCI and DA: All frames are admitted into the bridging entity. If the specified fields in the TCI of a candidate egress frame match any entry in the VLAN filter list, the frame is forwarded based on the destination MAC address. The frame is never flooded to this or other ports. If the specified TCI fields and DA do not both match, the frame is discarded.

Action codes b, d, e and f are not used.

5.3.5 Extended VLAN Tagging Operation Configuration Data (ME #171)

This managed entity organizes data associated with VLAN tagging. Regardless of its point of attachment, the specified tagging operations refer to the upstream direction. Instances of this managed entity are created and deleted by the OLT.

Application

VLAN tagging behavior of the ONT.

NOTE: There should be no proprietary MEs used by the OLT to implement this behavior.

Data Service:

This ME has rules defining the US/DS Data Service Ethernet frame VLAN tagging for the Ethernet UNI port. The US and DS rules are defined when the Data Service is provisioned for the Ethernet UNI port.

The current D1 Data service application is covered in Section 7.2. The expected upstream and downstream VLAN tagging behavior is detailed in that section.

H.248 VoIP Service:

This ME has rules defining the US/DS H.248 VoIP Service Ethernet frame VLAN tagging for the ONU. The US and DS rules are defined when the H.248 VoIP Service is provisioned for the ONU.

The current D1 Data service application is covered in Section 7.3. The expected upstream and downstream VLAN tagging behavior is detailed in that section.

Relationships

Zero or one instance of this managed entity may exist for an instance of any managed entity that can terminate or modify an Ethernet stream.

When this managed entity is associated with a UNI-side termination point, it performs its upstream classification and tagging operations before offering the upstream frame to other filtering, bridging or switching functions. In the downstream direction, the defined inverse operation is the last operation performed on the frame before offering it to the UNI-side termination.

When this managed entity is associated with an ANI-side termination point, it performs its upstream classification and tagging operations as the last step before transmission to the OLT, after having received the upstream frame from other filtering, bridging or switching functions. In the downstream direction, the defined inverse operation is the first operation performed on the frame before offering it to possible filter, bridge or switch functions.

Attributes

Managed entity ID: This attribute provides a unique number for each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

Association type: This attribute identifies the type of the ME associated with this extended VLAN tagging ME. Values are assigned as follows:

0 MAC bridge port configuration data
1 IEEE 802.1p mapper service profile
2 Physical path termination point Ethernet UNI
3 IP host config data or IPv6 host config data
4 Physical path termination point xDSL UNI

5 GEM interworking termination point
6 Multicast GEM interworking termination point
7 Physical path termination point MoCA UNI
8 Reserved
9 Ethernet flow termination point
10 Virtual Ethernet interface point
11 MPLS pseudowire termination point

(R, W, Set-by-create) (mandatory) (1 byte)

NOTE 1 – If a MAC bridge is configured, code points 1, 5 and 6 are associated with the ANI side of the MAC bridge. Code point 0 is associated with the ANI or UNI side, depending on the location of the MAC bridge port. The other code points are associated with the UNI side.

When the extended VLAN tagging ME is associated with the ANI side, it behaves as an upstream egress rule, and as a downstream ingress rule when the downstream mode attribute is equal to 0. When the extended VLAN tagging ME is associated with the UNI side, the extended VLAN tagging ME behaves as an upstream ingress rule, and as a downstream egress rule when the downstream mode attribute is equal to 0.

Received frame VLAN tagging operation table max size: This attribute indicates the maximum number of entries that can be set in the received frame VLAN tagging operation table. (R) (mandatory) (2 bytes)

Input TPID: This attribute gives the special TPID value for operations on the input (filtering) side of the table. Typical values include 0x88A8 and 0x9100. (R, W) (mandatory) (2 bytes)

Output TPID: This attribute gives the special TPID value for operations on the output (tagging) side of the table. Typical values include 0x88A8 and 0x9100. (R, W) (mandatory) (2 bytes)

Downstream mode: Regardless of its association, the rules of the received frame VLAN tagging operation table attribute pertain to upstream traffic. The downstream mode attribute defines the tagging action to be applied to downstream frames. In the downstream direction, the upstream default rules do not apply. For one-to-one VLAN mappings, the inverse is trivially defined. Many-to-one mappings are possible however, and these are treated as follows:

- If an upstream many-to-one mapping results from multiple operation rules producing the same ANI-side tag configuration, then the first matching rule in the list defines the inverse operation. The meaning of *match* depends on the value of the downstream mode attribute.
- If the many-to-one mapping results from "don't care" fields in the filter being replaced with provisioned fields in the ANI side tags, then the inverse is defined to set the corresponding fields on the ANI side to their lowest legal value.

If the upstream rule merely copies (i.e., no explicit value is specified in the filter field) an inbound tag value to an outbound tag value, the comparison in the downstream direction applies to all tag values. This applies separately to the VID and P-bit fields. For example, with a downstream mode of 2 and an upstream rule that translates the VID while carrying forward the P-bit value,

downstream frames that match the specified WAN-side VID will match any P-bit value and will translate the VID.

0 The operation performed in the downstream direction is the inverse of that performed in the upstream direction. Which treatment and filter fields are used for downstream filtering and the handling of unmatched frames are left to the implementation of the ONU.
1 Regardless of the filter rules, no operation is performed in the downstream direction. All downstream frames are forwarded unmodified.
2 Filter on VID and P-bit value. On a match, perform the inverse operation on both the VID and P-bit value. If no match is found, forward the frame unmodified.
3 Filter on VID only. On a match, perform the inverse VID operation only; pass the P bits through. If no match is found, forward the frame unmodified.
4 Filter on P-bit only. On a match, perform the inverse P-bit operation only; pass the VID through. If no match is found, forward the frame unmodified.
5 Filter on VID and P-bit value. On a match, perform the inverse operation on both the VID and P-bit value. If no match is found, discard the frame.
6 Filter on VID. On a match, perform the inverse operation on the VID only; pass the P bits through. If no match is found, discard the frame.
7 Filter on P-bit only. On a match, perform the inverse P-bit operation only; pass the VID through. If no match is found, discard the frame.
8 Regardless of the filter rules, discard all downstream traffic.

All other values are reserved. (R, W) (mandatory) (1 byte)

Received frame VLAN tagging operation table: This attribute is a table that filters and tags upstream frames. Each entry represents a tagging rule, comprising a filtering part (the first seven fields) and a treatment part (the last seven fields). Each incoming upstream packet is matched against each rule in list order. The first rule that matches the packet is selected as the active rule, and the packet is then treated according to that rule.

There are three categories of rules: zero-tag, single-tag, and double-tag rules. Logically, these categories are separate, and apply to their respective incoming frame types. In other words, a single-tag rule should not apply to a double-tagged frame, even though the single-tag rule might match the outer tag of the double-tagged frame.

Single-tag rules have a filter outer priority field = 15 (indicating no external tag), zero-tag rules have both filter priority fields = 15 (indicating no tags), and double-tag rules have both filter priority fields set to a value that differs from 15 (indicating two tags).

Each tagging rule is based on a *remove* or an *add* operation, where up to two tags can be removed or added. A modify operation is applied by the combination of *remove* and *add*.

By convention, when a single tag is added, the treatments use the inner tag data fields. This is true even for treatments where a single tag is added to a frame that already has a tag, i.e., added as a second tag. The outer tag data fields are used only when two tags are added by the same rule.

The terms *inner* and *outer* only have meaning with respect to the tags that are being filtered or added.

The first eight bytes of each entry are guaranteed to be unique, and are used to identify table entries (*list order*, above, refers to a sort on the first eight bytes). The OLT deletes a table entry by setting all of its last eight bytes to 0xFF.

When the table is created, the ONU should autonomously predefine three entries that list the default treatment (normal forwarding without filtering or modification) for untagged, single tagged, and double tagged frames. As an exception to the rule on ordered processing, these default rules are always considered as a last resort for frames that do not match any other rule. Best practice dictates that these entries not be deleted by the OLT; however, they can be modified to produce the desired default behaviour.

It should be noted that downstream frame treatment is defined by the downstream mode attribute and is not affected by the upstream default rules.

15, 4096, x, 15, 4096, x, 0, (0, 15, x, x, 15, x, x) – no tags

15, 4096, x, 14, 4096, x, 0, (0, 15, x, x, 15, x, x) – 1 tag

14, 4096, x, 14, 4096, x, 0, (0, 15, x, x, 15, x, x) – 2 tags

NOTE 2 – x is a "don't care" field and should be set to zero.

(R, W) (mandatory) (16N bytes, where N is the number of VLAN tagging rules)

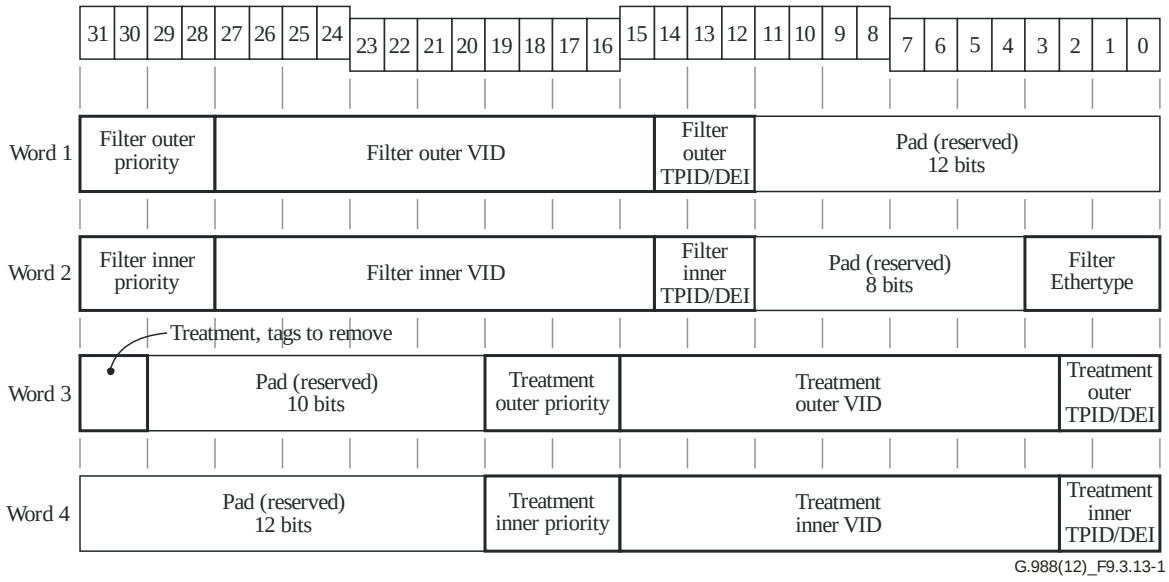

Figure 8 - Received Frame VLAN Tagging Operation Layout

Filter outer priority: (4 bits)
- 0..7 Filter received frames on this outer priority (P bit) value.
- 8 Do not filter on outer priority.
- 14 This is the default filter when no other two-tag rule applies.
- 15 This entry is not a double-tag rule; ignore all other outer tag filter fields.

Other values: reserved.

Filter outer VID: (13 bits)
- 0..4094 Filter received frames on this outer VID value.
- 4096 Do not filter on the outer VID.

Other values: reserved.

Filter outer TPID/DEI: (3 bits)
- 000 Do not filter on outer TPID field.
- 100 Outer TPID = 0x8100
- 101 Outer TPID = input TPID attribute value, don't care about DEI bit
- 110 Outer TPID = input TPID, DEI = 0
- 111 Outer TPID = input TPID, DEI = 1

Padding: (12 bits)

Filter inner priority: (4 bits)
- 0..7 Filter received frames on this inner priority value.
- 8 Do not filter on inner priority.
- 14 This is the default filter when no other one-tag rule applies.
- 15 This entry is a no-tag rule; ignore all other VLAN tag filter fields.

NOTE 3 – The filter Ethertype field is a valid criterion.

Other values: reserved.

Filter inner VID: (13 bits)
- 0..4094 Filter received frames on this inner VID value.
- 4096 Do not filter on the inner VID.

Other values: reserved.

Filter inner TPID/DEI: (3 bits)
- 000 Do not filter on inner TPID field.
- 100 Inner TPID = 0x8100
- 101 Inner TPID = input TPID attribute value, don't care about DEI bit
- 110 Inner TPID = input TPID, DEI = 0
- 111 Inner TPID = input TPID, DEI = 1

Padding: (8 bits)

Filter Ethertype: (4 bits) the Ethertype value on which to filter received frames, as listed below.

NOTE 4 – This filter is recommended for use on untagged frames or frames with priority tags only.
- 0 Do not filter on Ethertype.
- 1 Ethertype = 0x0800 (filter IPoE frames)
- 2 Ethertype = 0x8863 or 0x8864 (filter PPPoE frames)
- 3 Ethertype = 0x0806 (filter ARP frames)
- 4 Ethertype = 0x86DD (filter IPv6 IpoE frames)

Other values: reserved.

Treatment tags to remove: (2 bits)

0..2 Remove 0, 1 or 2 tags, respectively. If one tag is specified, then the outer tag is stripped from double-tagged frames.

3 Discard the frame. No symmetric downstream operation exists; i.e., this rule is ignored in the downstream direction.

Padding: (10 bits)

Treatment outer priority: (4 bits)

0..7 Add an outer tag, and insert this value as the priority in the outer VLAN tag.

8 Add an outer tag, and copy the outer priority from the inner priority of the received frame.

9 Add an outer tag, and copy the outer priority from the outer priority of the received frame.

10 Add an outer tag, and derive P bits from the DSCP field of the incoming frame according to the DSCP to P-bit mapping attribute.

15 Do not add an outer tag.

Other values: reserved.

Treatment outer VID: (13 bits)

0..4094 Use this value as the VID in the outer VLAN tag.

4096 Copy the outer VID from the inner VID of the received frame.

4097 Copy the outer VID from the outer VID of the received frame.

Other values: reserved.

Treatment outer TPID/DEI: (3 bits)

000 Copy TPID (and DEI, if present) from the inner tag of the received frame.

001 Copy TPID (and DEI, if present) from the outer tag of the received frame.

010 Set TPID = output TPID attribute value, copy DEI bit from the inner tag of the received frame

011 Set TPID = output TPID, copy DEI from the outer tag of the received frame

100 Set TPID = 0x8100

101 Reserved

110 Set TPID = output TPID, DEI = 0

111 Set TPID = output TPID, DEI = 1

Padding: (12 bits)

Treatment inner priority: (4 bits)

0..7 Add an inner tag, and insert this value as the priority to insert in the inner VLAN tag.

8 Add an inner tag, and copy the inner priority from the inner priority of the received frame.

9 Add an inner tag, and copy the inner priority from the outer priority of the received frame.

10 Add an inner tag, and derive P bits from the DSCP field of the incoming frame according to the DSCP to P-bit mapping attribute.

15 Do not add an inner tag.

Other values: reserved.

Treatment inner VID: (13 bits)

0..4094 Use this value as the VID in the inner VLAN tag.
4096 Copy the inner VID from the inner VID of the received frame.
4097 Copy the inner VID from the outer VID of the received frame.

Other values: reserved.

Treatment inner TPID/DEI: (3 bits)

000 Copy TPID (and DEI, if present) from the inner tag of the received frame.
001 Copy TPID (and DEI, if present) from the outer tag of the received frame.
010 Set TPID = output TPID attribute value, copy the DEI bit from the inner tag of the received frame.
011 Set TPID = output TPID, copy the DEI from the outer tag of the received frame.
100 Set TPID = 0x8100
101 Reserved
110 Set TPID = output TPID, DEI = 0
111 Set TPID = output TPID, DEI = 1

Associated ME pointer: This attribute points to the ME with which this extended VLAN tagging operation configuration data ME is associated. (R, W, Set-by-create) (mandatory) (2 bytes)

NOTE 5 – When the association type is xDSL, the two most significant bits may be used to indicate a bearer channel.

DSCP to P-bit mapping: This attribute specifies mapping from DSCP to P bits. The attribute can be considered a bit string sequence of 64 3-bit groups. The 64 sequence entries represent the possible values of the 6-bit DSCP field. Each 3-bit group specifies the P-bit value to which the associated DSCP value should be mapped. (R, W) (mandatory) (24 bytes)

NOTE 6 – If certain bits in the DSCP field are to be ignored in the mapping process, the attribute should be provisioned such that all possible values of those bits produce the same P-bit mapping. This can be applied to the case where instead of full DSCP, the operator wishes to adopt the priority mechanism based on IP precedence, which needs only the three MSBs of the DSCP field.

Actions

Create, delete, get, get next, set

Set table (optional)

Notifications

None.

Table 4 illustrates the rule structure for many of the common VLAN tagging operations. For brevity, the table omits columns for TPID/DEI, where the operator customizes the behaviour to a specific service model.

Action type	Filter					Treatment				
	Outer		Inner			Tags to remove	Outer		Inner	
	Priority	VID	Priority	VID	EtherType		Priority	VID	Priority	VID
Untagged frames										
Insert 1 full tag (X): F → X-F	15	4096	15	4096	0	0	15	N/A	Px	X
Default case, do nothing	15	4096	15	4096	0	0	15	N/A	15	N/A
Insert 2 tags (X,Y): F → Y-X-F	15	4096	15	4096	0	0	Py	Y	Px	X
Single tagged frames										
Insert 1 full tag (X): C-F → X-C-F	15	4096	8	C	0	0	15	N/A	Px	X
Insert 1 tag (X), copy priority: C-F → X-C-F	15	4096	8	C	0	0	15	N/A	8	X
Insert 2 tags (X,Y): C-F → Y-X-C-F	15	4096	8	C	0	0	Py	Y	Px	X
Modify tag: C-F → X-F	15	4096	8	C	0	1	15	N/A	Px	X
Modify tag, keep original priority: C-F → X-F	15	4096	8	C	0	1	15	N/A	8	X
Modify and insert tag: C-F → Y-X-F	15	4096	8	C	0	1	Py	Y	Px	X
Remove tag: C-F → F	15	4096	8	C	0	1	15	N/A	15	N/A
Insert two tags: C-F → Y-X-C-F	15	4096	8	C	0	0	Py	Y	Px	X
Default case, do nothing	15	4096	14	4096	0	0	15	N/A	15	N/A
Double tagged frames										
Insert 1 tag (X): S-C-F → X-S-C-F	8	S	8	C	0	0	15	N/A	Px	X
Insert 1 tag (X), copy external priority: S-C-F → X-S-C-F	8	S	8	C	0	0	15	N/A	9	X

Action type	Filter					Treatment				
	Outer		Inner				Outer		Inner	
	Priority	VID	Priority	VID	EtherType	Tags to remove	Priority	VID	Priority	VID
Insert 2 tags (X,Y): S-C-F → Y-X-S-C-F	8	S	8	C	0	0	Py	Y	Px	X
Insert 2 tags (X,Y), copy external and internal priority: S-C-F → Y-X-S-C-F	8	S	8	C	0	0	9	Y	8	X
Modify external tag: S-C-F → X-C-F	8	S	8	C	0	1	15	N/A	Px	X
Modify external tag, keep original priority: S-C-F → X-C-F	8	S	8	C	0	1	15	N/A	9	X
Modify both tags: S-C-F → Y-X-F	8	S	8	C	0	2	Py	Y	Px	X
Modify both tags, keep original priorities: S-C-F → Y-X-F	8	S	8	C	0	2	9	Y	8	X
Swap both tags: S-C-F → C-S-F	8	S	8	C	0	2	8	4096	9	4097
Remove outer tag: S-C-F → C-F	8	S	8	C	0	1	15	N/A	15	N/A
Remove both tags: S-C-F → F	8	S	8	C	0	2	15	N/A	15	N/A
Default case, do nothing S-C-F → S-C-F	14	4096	14	4096	0	0	15	N/A	15	N/A

Table 4 - Common VLAN tagging operations

Table 5 illustrates the downstream behaviour for common deployment scenarios based on the downstream mode code point and the upstream rule. For brevity, the table omits a column for P-bit only, but the downstream action can be inferred from the VID only column.

In cases when the inner packet tag information is not available (i.e., in cases with more than one VID or VID+PBIT value in "VID-only" and "Both P and VID," such as "X and C" and "Px and Py and X and Y"), only outer tag information is used in the downstream filtering rule.

Upstream action type	Filter					Treatment					Downstream action				
	Outer		Inner				Outer		Inner						
	Priority	VID	Priority	VID	EtherType	Tags to remove	Priority	VID	Priority	VID	Consider only	VID only	Both P and VID	Action	Notes
Untagged frames															
Insert 1 full tag (X): F □ X-F	15	4096	15	4096	0	0	15	N/A	Px	X	Single tagged	X	Px and X	Strip tag	
Default case, do nothing	15	4096	15	4096	0	0	15	N/A	15	N/A	Untagged	–	–	Pass unmodified	
Insert 2 tags (X,Y): F □ Y-X-F	15	4096	15	4096	0	0	Py	Y	Px	X	Double tagged	X and Y	Px and Py and X and Y	Strip two tags	
Single tagged frames															
Insert 1 full tag (X): C-F □ X-C-F	15	4096	8	C	0	0	15	N/A	Px	X	Double tagged	X and C	X and Px and C	Strip outer tag	
Insert 1 tag (X), copy priority: C-F □ X-C-F	15	4096	8	C	0	0	15	N/A	8	X	Double tagged	X and C	X and C	Strip outer tag, copy priority onto remaining tag	
Insert 2 tags (X,Y): C-F □ Y-X-C-F	15	4096	8	C	0	0	Py	Y	Px	X	Triple tagged	X and Y and C	Px and Py and X and Y and C	Strip two outer tags	

Upstream action type	Filter					Treatment					Downstream action				
	Outer		Inner				Outer		Inner						
	Priority	VID	Priority	VID	EtherType	Tags to remove	Priority	VID	Priority	VID	Consider only	VID only	Both P and VID	Action	Notes
Modify tag: C-F □ X-F	15	4096	8	C	0	1	15	N/A	Px	X	Single tagged	X	Px and X	Replace X with C, retain Px	Use treatment specified in downstream mode definition for the set {C} if ambiguous
Modify tag, keep original priority: C-F □ X-F	15	4096	8	C	0	1	15	N/A	8	X	Single tagged	X	Px and X	Replace X with C, retain Px	Use treatment specified in downstream mode definition for the set {C} if ambiguous
Modify and insert tag: C-F □ Y-X-F	15	4096	8	C	0	1	Py	Y	Px	X	Double tagged	X and C	X and Px and C	Strip outer tag	
Remove tag: C-F □ F	15	4096	8	C	0	1	15	N/A	15	N/A	Untagged	C	C	Add tag, VID = C, P = 0	
Insert two tags: C-F □ Y-X-C-F	15	4096	8	C	0	0	Py	Y	Px	X	Triple tagged	X and Y and C	Px and Py and X and Y and C	Strip two outer tags	
Default case, do nothing	15	4096	14	4096	0	0	15	N/A	15	N/A	Single tagged	–	–	Pass unmodified	
Double tagged frames															

Upstream action type	Filter					Treatment					Downstream action				
	Outer		Inner				Outer		Inner						
	Priority	VID	Priority	VID	EtherType	Tags to remove	Priority	VID	Priority	VID	Consider only	VID only	Both P and VID	Action	Notes
Insert 1 tag (X): S-C-F □ X-S-C-F	8	S	8	C	0	0	15	N/A	Px	X	Triple tagged	X and S and C	X and Px and S and C	Strip outer tag	
Insert 1 tag (X), copy external priority: S-C-F □ X-S-C-F	8	S	8	C	0	0	15	N/A	9	X	Triple tagged	X and S and C	X and S and C	Strip outer tag, copy priority onto resulting outer tag	
Insert 2 tags (X,Y): S-C-F □ Y-X-S-C-F	8	S	8	C	0	0	Py	Y	Px	X	Quad tagged	X and Y and S and C	Px and Py and X and Y and S and C	Strip two outer tags	
Insert 2 tags (X,Y), copy external and internal priority: S-C-F □ Y-X-S-C-F	8	S	8	C	0	0	9	Y	8	X	Quad tagged	X and Y and S and C	X and Y and S and C	Strip two outer tags, copy Px, Py onto remaining tags	
Modify external tag: S-C-F □ X-C-F	8	S	8	C	0	1	15	N/A	Px	X	≥ 2 tags	X and C	Px and X and C	Replace X with S in outer tag	
Modify external tag, keep original priority: S-C-F □ X-C-F	8	S	8	C	0	1	15	N/A	9	X	≥ 2 tags	X and C	X and C	Modify outer tag VID = S, retain priority	

Upstream action type	Filter					Treatment					Downstream action				
	Outer		Inner				Outer		Inner						
	Priority	VID	Priority	VID	EtherType	Tags to remove	Priority	VID	Priority	VID	Consider only	VID only	Both P and VID	Action	Notes
Modify both tags: S-C-F □ Y-X-F	8	S	8	C	0	2	Py	Y	Px	X	≥ 2 tags	X and Y	Px and Py and X and Y	Modify tags with S, C, retain priority	Use treatment specified in downstream mode definition for the sets {S} {C} if ambiguous
Modify both tags, keep original priorities: S-C-F □ Y-X-F	8	S	8	C	0	2	9	Y	8	X	≥ 2 tags	X and Y	X and Y	Modify tags with Y, X, retain priority	Use treatment specified in downstream mode definition for the sets {S} {C} if ambiguous
Swap both tags: S-C-F □ C-S-F	8	S	8	C	0	2	8	4096	9	4097	≥ 2 tags	S and C	S and C	Swap tags	
Remove outer tag: S-C-F □ C-F	8	S	8	C	0	1	15	N/A	15	N/A	≥ 2 tags	S and C	S and C	Strip outer tag	
Remove both tags: S-C-F □ F	8	S	8	C	0	2	15	N/A	15	N/A	≥ 2 tags	S and C	S and C	Strip both tags	
Default case, do nothing S-C-F □ S-C-F	14	4096	14	4096	0	0	15	N/A	15	N/A	≥ 2 tags	–	–	Pass unmodified	

Table 5 - Downstream Mode Use Case Examples

5.3.6 Dot1X Port Extension Package (ME #290)

An instance of this managed entity represents a set of attributes that control a port's IEEE 802.1X operation. It is created and deleted autonomously by the ONU upon the creation or deletion of a PPTP that supports [IEEE 802.1X] authentication of CPE.

Application

Controls operation of the PPTP Ethernet UNI port that enables IEEE 802.1X authentication of the Residential Gateway (RG) & controls operation of the PPTP POTS UNI that disables IEEE 802.1X authentication.

Relationships

An instance of this managed entity is associated with a physical path termination point that performs IEEE 802.1X authentication of CPE (e.g., Ethernet or DSL).

Attributes

Managed entity ID: This attribute provides a unique number for each instance of this managed entity. Its value is the same as that of its associated physical path termination point (i.e., slot and port number). (R) (mandatory) (2 bytes)

Dot1x enable: If true, this Boolean attribute forces the associated port to authenticate via [IEEE 802.1X] as a precondition of normal service. The default value false does not impose IEEE 802.1X authentication on the associated port. (R, W) (mandatory) (1 byte)

Action register: This attribute defines a set of actions that can be performed on the associated port. The act of writing to the register causes the specified action.

1 Force re-authentication – this opcode initiates an IEEE 802.1X re-authentication conversation with the associated port. The port remains in its current authorization state until the conversation concludes.
2 Force unauthenticated – this opcode initiates an IEEE 802.1X authentication conversation whose outcome is predestined to fail, thereby disabling normal Ethernet service on the port. The port's provisioning is not changed, such that upon re-initialization, a new IEEE 802.1X conversation may restore service without prejudice.
3 Force authenticated – this opcode initiates an IEEE 802.1X authentication conversation whose outcome is predestined to succeed, thereby unconditionally enabling normal Ethernet service on the port. The port's provisioning is not changed, such that upon re-initialization, a new IEEE 802.1X conversation is required.

(W) (mandatory) (1 byte)

Authenticator PAE state: This attribute returns the value of the port's PAE state. States are further described in [IEEE 802.1X]. Values are coded as shown below:

0 Initialize
1 Disconnected
2 Connecting

3 Authenticating
4 Authenticated
5 Aborting
6 Held
7 Force auth
8 Force unauth
9 Restart

(R) (optional) (1 byte)

Backend authentication state: This attribute returns the value of the port's back-end authentication state. States are further described in [IEEE 802.1X]. Values are coded as shown below:

0 Request
1 Response
2 Success
3 Fail
4 Timeout
5 Idle
6 Initialize
7 Ignore

(R) (optional) (1 byte)

Admin controlled directions: This attribute controls the directionality of the port's authentication requirement. The default value 0 indicates that control is imposed in both directions. The value 1 indicates that control is imposed only on traffic from the subscriber towards the network. (R, W) (optional) (1 byte)

Operational controlled directions: This attribute indicates the directionality of the port's current authentication state. The value 0 indicates that control is imposed in both directions. The value 1 indicates that control is imposed only on traffic from the subscriber towards the network. (R) (optional) (1 byte)

Authenticator controlled port status: This attribute indicates whether the controlled port is currently authorized (1) or unauthorized (2). (R) (optional) (1 byte)

Quiet period: This attribute specifies the interval between EAP request/identity invitations sent to the peer. Other events such as carrier present or EAPOL start frames from the peer may trigger an EAP request/identity frame from the ONU at any time; this attribute controls the ONU's periodic behaviour in the absence of these other inputs. It is expressed in seconds. (R, W) (optional) (2 bytes)

Server timeout period: This attribute specifies the time the ONU will wait for a response from the radius server before timing out. Within this maximum interval, the ONU may initiate several retransmissions with exponentially increasing delay. Upon timeout, the ONU may try another radius server if there is one, or invoke the fallback policy, if no alternate radius servers are available. Server timeout is expressed in seconds, with a default value of 30 and a maximum value of 65535. (R, W) (optional) (2 bytes)

Re-authentication period: This attribute records the re-authentication interval specified by the radius authentication server. It is expressed in seconds. The attribute is only meaningful after a port has been authenticated. (R) (optional) (2 bytes)

Re-authentication enabled: This Boolean attribute records whether the radius authentication server has enabled re-authentication on this service (true) or not (false). The attribute is only meaningful after a port has been authenticated. (R) (optional) (1 byte)

Key transmission enabled: This Boolean attribute indicates whether key transmission is enabled (true) or not (false). This feature is not required; the parameter is listed here for completeness vis-à-vis [IEEE 802.1X]. (R, W) (optional) (1 byte)

Actions

Get, set

Notifications

D1 implementation will not utililize the alarms below.

Alarm

Alarm number	Alarm	Description
0	dot1x local authentication – allowed	No radius authentication server was accessible. In accordance with local policy, the port was allowed access without authentication.
1	dot1x local authentication – denied	No radius authentication server was accessible. In accordance with local policy, the port was denied access.
2..207	Reserved	
208..223	Vendor-specific alarms	Not to be standardized* (to be discussed before implemented)

5.3.7 Dot1ag Maintenance Domain (ME #299)

In [IEEE 802.1ag], a maintenance domain (MD) is a context within which CFM connectivity verification can occur. Individual services (maintenance associations, MAs) exist within an MD. A maintenance domain is created and deleted by the OLT. The MD managed entity is specified by [IEEE 802.1ag] in such a way that the same provisioning can be used for all associated systems in a network; the OMCI definition accordingly avoids ONU-specific information such as pointers.

Application

Used for Ethernet OAM applications.

Relationships

Several MDs may be associated with a given bridge, at various MD levels, and a given MD may be associated with any number of bridges.

Attributes

Managed entity ID: This attribute uniquely identifies an instance of this managed entity. The values 0 and 0xFFFF are reserved. (R, Set-by-create) (mandatory) (2 bytes)

MD level: This attribute ranges from 0..7 and specifies the maintenance level of this MD. Higher numbers have wider geographic scope. (R, W, Set-by-create) (mandatory) (1 byte)

MD name format: This attribute specifies one of several possible formats for the MD name attribute. (R, W, Set-by-create) (mandatory) (1 byte)

Value	MD name format	MD name attribute	Defined in
1	None	No MD name present	[IEEE 802.1ag]
2	DNS-like name	Globally unique text string derived from a DNS name	"
3	MAC addr and UINT	MAC address, followed by a 2-octet unsigned integer, total length 8 bytes	"
4	Character string	String of printable characters. This is recommended to be the default value.	"
32	ICC-based	ITU carrier code followed by locally assigned UMC code, 13 bytes with trailing nulls as needed	[ITU-T Y.1731] Annex A
Others	Reserved		

MD name 1, MD name 2: These two attributes may be regarded as a 50-byte octet string whose value is the left-justified maintenance domain name. The MD name may or may not be a printable character string, so an octet string is the appropriate representation. If the MD name format specifies a DNS-like name or a character string, the string is null-terminated; otherwise, its length is determined by the MD name format. If the MD has no name (MD name format = 0), this attribute is undefined. Note that binary comparisons of the MD name are made in other CFM state machines, so blanks, alphabetic case, etc., are significant. Also, note that the maintenance domain name and the maintenance association name must be packed (with additional bytes) into 48-byte CFM message headers. (R, W) (mandatory if MD name format is not 1) (25 bytes * 2 attributes)

MHF creation: This attribute determines whether an associated bridge creates an MHF for this MD or not, under circumstances defined in clause 22.2.3 of [IEEE 802.1ag]. This attribute is an enumeration with the following values:

1 None
2 Default (IEEE 802.1ag term). The bridge can create MHFs on an associated VID on any port through which the VID can pass, where: i) there are no lower active MD levels or ii) there is an MEP at the next lower active MD level on the port.
3 Explicit. The bridge can create MHFs on an associated VID on any port through which the VID can pass, but only if an MEP exists at some lower maintenance level.

(R, W, Set-by-create) (mandatory) (1 byte)

Sender ID permission: This attribute determines the contents of the sender ID TLV included in CFM messages transmitted by maintenance points controlled by this MD. Chassis ID and management address information is available from the dot1ag chassis-management info managed entity. The attribute is an enumeration with the following values:

1 None: the sender ID TLV is not to be sent.
2 Chassis: the chassis ID length, chassis ID subtype, and chassis ID fields of the sender ID TLV are to be sent, but not the management address fields.
3 Manage: the management address fields of the sender ID TLV are to be sent, but the chassis ID length is to be transmitted with the value 0, and the chassis ID subtype, and chassis ID fields are not to be sent.
4 ChassisManage: all chassis ID and management address fields are to be sent.

(R, W, Set-by-create) (mandatory) (1 byte)

Actions

Create, delete, get, set

Notifications

None.

5.3.8 Dot1ag Maintenance Association (ME #300)

This managed entity models an [IEEE 802.1ag] service defined on a bridge port. A maintenance association (MA) is a set of endpoints on opposite sides of a network, all existing at a defined maintenance level. One of the endpoints resides on the local ONU; the others are understood to be configured in a consistent way on external equipment. [ITU-T Y.1731] refers to the MA as a maintenance entity group (MEG).

A maintenance association is created and deleted by the OLT.

Application

Used for Ethernet OAM applications.

Relationships

Any number of MAs may be associated with a given maintenance domain, or may stand on their own without an MD. One or more MAs may be associated with a MAC bridge or an IEEE 802.1p mapper. An MA exists at one of eight possible maintenance levels.

Attributes

Managed entity ID: This attribute uniquely identifies an instance of this managed entity. The values 0 and 0xFFFF are reserved. (R, Set-by-create) (mandatory) (2 bytes)

MD pointer: This pointer specifies the dot1ag maintenance domain with which this MA is associated. A null pointer specifies that the MA is not associated with an MD. (R, W, Set-by-create) (mandatory) (2 bytes)

Short MA name format: This attribute specifies one of several possible formats for the short MA name attribute. Value 1, the primary VLAN ID, is

recommended to be the default. (R, W, Set-by-create) (mandatory) (1 byte) Short MA name format needs to following [ITU-T G.988 Amendment 1 2.14].

Value	Short MA name format	Short MA name attribute
1	Primary VID	2 octets, 12 LSBs specify primary VID, 0 if none
2	Character string	String of up to 45 printable characters
3	2-octet integer	2 octet unsigned integer
4	VPN ID	7 octets, as defined in [IETF RFC 2685]
Other	Reserved	

Short MA name 1, Short MA name 2: These two attributes may be regarded as an octet string whose value is the left-justified maintenance association name. Because the MA name may or may not be a printable character string, an octet string is the appropriate representation. If the short MA name format specifies a character string, the string is null-terminated; otherwise, its length is determined by the short MA name format. Note that binary comparisons of the short MA name are made in other CFM state machines, so blanks, alphabetic case, etc., are significant. Also, note that the maintenance domain name and the maintenance association short name must be packed (with additional bytes) into 48-byte CFM message headers. (R, W) (mandatory) (25 bytes * 2 attributes)

CCM interval: If CCMs are enabled on an MEP, the CCM interval attribute specifies the rate at which they are generated. The MEP also expects to receive CCMs from each of the other MEPs in its CC database at this rate.

0: CCM transmission disabled
1: 3.33 ms
2: 10 ms
3: 100 ms
4: 1 s
5: 10 s
6: 1 min
7: 10 min

Short intervals should be used judiciously, as they can interfere with the network's ability to handle subscriber traffic. The recommended value is 1 second. (R, W, Set-by-create) (mandatory) (1 byte)

Associated VLANs: This attribute is a list of up to 12 VLAN IDs with which this MA is associated. Once a set of VLANs is defined, the ONU should deny operations to other dot1ag maintenance associations or dot1ag default MD level entries that conflict with the set membership. The all-zeros value indicates that this MA is not associated with any VLANs. Assuming that the attribute is not 0, the first entry is understood to be the primary VLAN. Except forwarded LTMs, CFM messages emitted by maintenance points in this MA are tagged with the primary VLAN ID. (R, W) (mandatory) (2 bytes/entry * 12 entries = 24 bytes)

MHF creation: This attribute determines whether the bridge creates an MHF or not, under circumstances defined in clause 22.2.3 of [IEEE 802.1ag]. This attribute is an enumeration with the following values:

1 None. No MHFs are created on this bridge for this MA.
2 Default (IEEE 802.1ag term). The bridge can create MHFs on this VID on any port through which the VID can pass.
3 Explicit. The bridge can create MHFs on this VID on any port through which the VID can pass, but only if an MEP exists at some lower maintenance level.
4 Defer. This value causes the ONU to use the setting of the parent MD. This is recommended to be the default value.

(R, W, Set-by-create) (mandatory) (1 byte)

Sender ID permission: This attribute determines the contents of the sender ID TLV included in CFM messages transmitted by maintenance points controlled by this MA. This attribute is the same as that defined in the description of the dot1ag maintenance domain managed entity, with the addition of code point 5.

1 None: the sender ID TLV is not to be sent.
2 Chassis: the chassis ID length, chassis ID subtype, and chassis ID fields of the sender ID TLV are to be sent, but not the management address fields.
3 Manage: the management address fields of the sender ID TLV are to be sent, but the chassis ID length is to be transmitted with a 0 value, and the chassis ID subtype, and chassis ID fields are not to be sent.
4 ChassisManage: all chassis ID and management address fields are to be sent.
5 Defer: the contents of the sender ID TLV are determined by the corresponding maintenance domain attribute. This is recommended to be the default value.

(R, W, Set-by-create) (mandatory) (1 byte)

Actions

Create, delete, get, set

Notifications

None.

5.3.9 Dot1ag MEP (ME #302)

This managed entity models a maintenance association end point (MEP) as defined primarily in [IEEE 802.1ag] and secondarily in [ITU-T Y.1731]. It is created and deleted by the OLT. An MEP exists at one of eight possible maintenance levels, and resides at the boundary of a maintenance domain. It inherits a name, and optionally a set of associated VLANs, from its associated MA.

Application

Used for Ethernet OAM applications.

Relationships

One or more MEPs may be associated with a MAC bridge port or an IEEE 802.1p mapper in the absence of a MAC bridge. An MEP is also associated with zero or more VLANs and a maintenance association.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

Layer 2 entity pointer: Depending on the value of the layer 2 type attribute, this pointer specifies the MAC bridge port configuration data ME or the IEEE 802.1p mapper service profile ME with which this MEP is associated. (R, W, Set-by-create) (mandatory) (2 bytes)

Layer 2 type: This attribute specifies whether the MA is associated with a MAC bridge port (value 0) or an IEEE 802.1p mapper (value 1). (R, W, Set-by-create) (mandatory) (1 byte)

MA pointer: This pointer specifies the maintenance association (MA) with which this MEP is associated. (R, W, Set-by-create) (mandatory) (2 bytes)

MEP ID: This attribute specifies the MEP's own identity in the MA. For a given MA, the MEP ID must be unique throughout the network defined by the MD. The MEP ID is defined in the range 1..8191. The value 0 indicates that no MEP ID is (yet) configured. (R, W, Set-by-create) (mandatory) (2 bytes)

MEP control: This attribute specifies some of the overall behavioural aspects of the MEP. It is interpreted as follows.

Bit	Interpretation when bit value = 1
1 (LSB)	Reserved
2	MEP generates continuity check messages, CCMs
3	Enable ITU-T Y.1731 server MEP function
4	Enable generation of Ethernet AIS
5	This is an up MEP, facing toward the core of the bridge. If more than one MEP exists on a given maintenance association and on a given bridge, all such MEPs must face the same direction.
6..8	Reserved

(R, W, Set-by-create) (mandatory) (1 byte)

Primary VLAN: This attribute is a 12-bit VLAN ID. The value 0 indicates that the MEP inherits its primary VLAN from its parent MA. CFM messages, except forwarded LTMs, are tagged with the primary VLAN ID. If explicitly specified, the value of this attribute must be one of the VLANs associated with the parent MA. (R, W, Set-by-create) (mandatory) (2 bytes)

Administrative state: This attribute locks (1) and unlocks (0) the functions performed by this managed entity. Administrative state is further described in [ITU-T G.988] clause A.1.6. (R, W) (mandatory) (1 byte)

CCM and LTM priority: Ranging from 0..7, this attribute permits CCM and LTM frames to be explicitly prioritized, which may be needed if flows are separated, e.g., by 802.1p priority. The priority specified in this attribute is also used in LTR frames originated by this MEP. The value 0xFF selects the IEEE 802.1ag default, whereby CCM and LTM frames are transmitted with the highest Ethernet priority available. (R, W, Set-by-create) (mandatory) (1 byte)

Egress identifier:This attribute comprises 8 bytes to be included in LTMs. They allow received LTRs to be directed to the correct originator. The attribute includes the originator MAC address and a locally-defined identifier. If this field is 0, the ONU uses the MEP's MAC address, with 0 as the locally-defined identifier. (R, W, Set-by-create) (mandatory) (8 bytes)

Peer MEP IDs: This attribute lists the expected peer MEPs for CCMs, 2 bytes per MEP ID. [IEEE 802.1ag] allows for multipoint networks, and therefore a list of peer MEPs. This attribute allows for up to 12 peers for a given MEP, though G-PON applications are expected to need only a single peer. Missing or unexpected messages trigger alarm declaration after a soak interval. Unused peer MEP slots should be set to 0. (R, W) (mandatory) (24 bytes)

ETH AIS control: This attribute controls the generation of Ethernet AIS frames when they are enabled through the MEP control attribute. It is interpreted as follows:

Bit	Interpretation
1 (LSB)	Transmission period 0: once per second 1: once per minute
2..4	P-bit priority of transmitted ETH AIS frames
5..7	The maintenance level at which the client MEP exists
8	Reserved

(R, W, Set-by-create) (mandatory if ETH AIS is enabled) (1 byte)

Fault alarm threshold: This attribute specifies the lowest priority alarm that is allowed to generate a fault alarm. The value 0 specifies that the ONU use its internal default. It is defined as follows:

1 All defects generate alarms after suitable soaking, including AIS and RDICCM.
2 Alarm generated only by one of: MACstatus, RemoteCCM, ErrorCCM, XconCCM. This value is recommended as the default in [IEEE 802.1ag].
3 Alarm generated only by one of: RemoteCCM, ErrorCCM, XconCCM.
4 Alarm generated only by one of: ErrorCCM, XconCCM.
5 Alarm generated only by: XconCCM.
6 No alarms are to be reported. This setting may be useful during configuration of services across the network when spurious alarms could otherwise be generated.

(R, W, Set-by-create) (mandatory) (1 byte)

Alarm declaration soak time: This attribute defines the defect soak time that must elapse before the MEP declares an alarm. It is expressed in ten-millisecond units with a range of 250 to 1000, i.e., 2.5 to 10 seconds. The default is recommended to be 2.5 seconds. (R, W) (mandatory) (2 bytes)

Alarm clear soak time: This attribute defines the defect-free soak time that must elapse before the MEP clears an alarm. It is expressed in ten-millisecond units with a range of 250 to 1000, i.e., 2.5 to 10 seconds. The default is recommended to be 10 seconds. (R, W) (mandatory) (2 bytes)

Actions

Create, delete, get, set

Test: The test operation causes the MEP to originate one or more loopback messages (LBMs) or a linktrace message (LTM) in accordance with the test and test result message formats defined in [ITU-T G.988] clauses A.2 and A.3.

The linktrace test returns its results in a general purpose buffer ME, which must have been created in advance by the OLT. (The general purpose buffer is designated by a pointer in the test message itself.) Upon completion of the linktrace operation, the general purpose buffer contains a sequence of LTR entries in the order they were received:

Length field, 2 bytes	***Length* bytes**
Length of LTR1	LTR: linktrace reply 1 (clause 21.9 of [IEEE 802.1ag])
Length of LTR2	LTR: linktrace reply 2
etc.	

[IEEE 802.1ag] defines the data structure for the linktrace database in detail, but the definition is essentially the same as the LTR PDU itself. The OMCI simply records the messages for parsing and analysis at the OLT or the EMS.

If the ONU cannot allocate enough memory for the entire list, it keeps the most recent responses and discards the older LTRs as necessary (first discarding LTR1, then LTR2, etc.).

Notifications

Alarm

Alarm number	Alarm	Description
0	RDI CCM	RDI received in CCM from peer MEP
1	MAC status	Port or interface status failure at peer MEP
2	Remote CCM	Loss of continuity with peer MEP
3	Error CCM	Invalid CCMs received
4	Xcon CCM	CCMs received from other MAs or a lower MD level
5	Unexpected period	Unexpected period
6	AIS	Ethernet AIS received

Alarm

Alarm number	Alarm	Description
7..207	Reserved	
208..223	Vendor-specific alarms	Not to be standardized* (to be discussed before implemented)

5.3.10 Dot1ag CFM Stack (ME #305)

This managed entity reports the maintenance status of a bridge port at any given time. An ONU that supports [IEEE 802.1ag] functionality automatically creates an instance of the dot1ag CFM stack ME for each MAC bridge or IEEE 802.1p mapper, depending on its provisioning model.

The dot1ag CFM stack also lists any VLANs and bridge ports against which configuration errors are currently identified. The ONU should reject operations that create configuration errors. However, these errors can arise because of operations on other MEs that are not necessarily possible to detect during CFM configuration.

Application

Used for Ethernet OAM applications.

Relationships

An ONU that supports [IEEE 802.1ag] creates one instance of this ME for each MAC bridge or IEEE 802.1p mapper, depending on its provisioning model. It should not create an instance for an IEEE 802.1p mapper that is associated with a MAC bridge.

Attributes

Managed entity ID: This attribute uniquely identifies an instance of this managed entity. Through an identical ID, this managed entity is implicitly linked to an instance of the MAC bridge service profile ME or an IEEE 802.1p mapper ME. It is expected that an ONU will implement CFM on bridges or on IEEE 802.1p mappers, but not both. For precision, the reference is disambiguated by the value of the layer 2 type pointer attribute. (R) (mandatory) (2 bytes)

Layer 2 type: This attribute specifies whether the dot1ag CFM stack is associated with a MAC bridge service profile (value 0) or an IEEE 802.1p mapper (value 1). (R) (mandatory) (1 byte)

MP status table: This attribute is a list of entries, each entry reporting one aspect of the maintenance status of one port. If a port is associated with more than one CFM maintenance entity, each is represented as a separate item in this table attribute; a port that has no current maintenance functions is not represented in the table (so the table may be empty). Each entry is defined as follows:

Port ID: The ME ID of the MAC bridge port config data whose information is reported in this entry. If the layer 2 parent is an IEEE 802.1p mapper, a null pointer. (2 bytes)

Level: The level at which the reported maintenance function exists, 0..7. (1 byte)

Direction: The value 1 (down) or 2 (up). (1 byte)

VLAN ID: If this table entry reports a maintenance function associated with a VLAN, this field contains the value of the primary VLAN ID. If no VLAN is associated with this entry, this field contains the value 0. (2 bytes)

MD: A pointer to the associated dot1ag maintenance domain ME. If no MD is associated with this entry, a null pointer. (2 bytes)

MA: A pointer to the associated dot1ag maintenance association ME. If no MA is associated with this entry, a null pointer. (2 bytes)

MEP ID: If this table entry reports an MEP, this field contains the value of its MEP ID (range 1..8191). If this table entry reports an MHF, this field contains the value 0. (2 bytes)

MAC address: The MAC address of the maintenance point. (6 bytes)

(R) (mandatory) (18N bytes)

Configuration error list table: This attribute is based on the [IEEE 802.1ag] configuration error list. It is a list of entries, each entry reporting a VLAN and a bridge port against which a configuration error has been detected. The table may be empty at any given time. Entries are defined as follows:

VLAN ID: If this table entry reports a maintenance function associated with a VLAN, this field contains the value of the VLAN ID in error. If no VLAN is associated with this entry, this field contains the value 0. (2 bytes)

Port ID: A pointer to the MAC bridge port config data whose information is reported in this entry. If the layer 2 parent is an IEEE 802.1p mapper, a null pointer. (2 bytes)

Detected configuration error: A bit mask with the following meanings. A list entry exists if and only if at least one of these bits is set. Definitions appear in clause 22.2.4 of [IEEE 802.1ag]: (1 byte)

- 0x01 CFM leak. MA x is associated with a specific VID list, one or more of the VIDs in MA x can pass through the bridge port, no up MEP is configured for MA x on the bridge port, no down MEP is configured on any bridge port for MA x, and another MA y, at a higher MD level than MA x, and associated with at least one of the VID(s) also in MA x, does have an MEP configured on the bridge port.
- 0x02 Conflicting VIDs. MA x is associated with a specific VID list, an up MEP is configured on MA x on the bridge port, and another MA y, associated with at least one of the VID(s) also in MA x, and at the same MD level as MA x, also has an up MEP configured on some bridge port.
- 0x04 Excessive levels. The number of different MD levels at which MIPs are to be created on this port exceeds the bridge's capabilities.

0x08 Overlapped levels. An MEP is created for one VID at one MD level, but an MEP is also configured on another VID at that MD level or higher, exceeding the bridge's capabilities.

(R) (mandatory) (5N bytes)

Actions

Get, get next

Notifications

Attribute value change

Number	Attribute value change	Description
1..2	N/A	
3	Config error list table	This AVC indicates that an entry in the configuration error list table has been added or removed. It may be advisable for the OLT to audit the configuration of related MEs.
4..16	Reserved	

5.3.11 Multicast Operations Profile (ME #309)

This managed entity expresses multicast policy. A multi-dwelling unit ONU may have several such policies, which are linked to subscribers as required. Some of the attributes configure IGMP snooping and proxy parameters, in case the defaults do not suffice, as described in [IETF RFC 2236], [IETF RFC 3376], [IETF RFC 3810] and [IETF RFC 5519]. Instances of this managed entity are created and deleted by the OLT.

Application

Represents the Internet Group Management Protocol (IGMP) Multicast Channel parameters associated with the PPTP Ethernet UNI port.

Relationships

An instance of this managed entity may be associated with zero or more instances of the multicast subscriber config info ME.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. The values 0 and 0xFFFF are reserved. (R, Set-by-create) (mandatory) (2 bytes)

IGMP version: This attribute specifies the version of IGMP to be supported. Support of a given version implies compatible support of previous versions. If the ONU cannot support the version requested, it should deny an attempt to set the attribute. (R,W, Set-by-create) (mandatory) (1 byte)

1 IGMP version 1 (deprecated)
2 IGMP version 2
3 IGMP version 3
16 MLD version 1
17 MLD version 2
Other values are reserved.

IGMP function: This attribute enables an IGMP function. The value 0 specifies transparent IGMP snooping only. The value 1 specifies snooping with proxy reporting (SPR); the value 2 specifies IGMP proxy. The function must be consistent with the capabilities specified by the other IGMP configuration attributes. (R,W, Set-by-create) (mandatory) (1 byte)

Immediate leave: This Boolean attribute controls the immediate leave function. The value false disables immediate leave; true enables immediate leave. (R,W, Set-by-create) (mandatory) (1 byte)

Upstream IGMP TCI: Under control of the upstream IGMP tag control attribute, the upstream IGMP TCI attribute defines a VLAN ID and P-bits to add to upstream IGMP messages. (R, W, Set-by-create) (optional) (2 bytes)

Upstream IGMP tag control: This attribute controls the upstream IGMP TCI attribute. If this attribute is non-zero, a possible extended VLAN tagging operation ME is ignored for upstream frames containing IGMP/MLD packets. (R, W, Set-by-create) (optional) (1 byte)

Value	Meaning
0	Pass upstream IGMP/MLD traffic transparently, neither adding, stripping nor modifying tags that may be present.
1	Add a VLAN tag (including P bits) to upstream IGMP/MLD traffic. The tag is specified by the upstream IGMP TCI attribute.
2	Replace the entire TCI (VLAN ID plus P bits) on upstream IGMP/MLD traffic. The new tag is specified by the upstream IGMP/MLD TCI attribute. If the received IGMP/MLD traffic is untagged, an add operation is performed.
3	Replace only the VLAN ID on upstream IGMP/MLD traffic, retaining the original DEI and P bits. The new VLAN ID is specified by the VLAN ID field of the upstream IGMP TCI attribute. If the received IGMP/MLD traffic is untagged, an add operation is performed, with DEI and P bits also taken from the upstream IGMP TCI attribute.

Other values are reserved.

Upstream IGMP rate: This attribute limits the maximum rate of upstream IGMP traffic. Traffic in excess of this limit is silently discarded. The attribute value is specified in messages/second. The recommended default value 0 imposes no rate limit on this traffic. (R, W, Set-by-create) (mandatory) (4 bytes)

Dynamic access control list table: This attribute is a list that specifies one or more multicast group address ranges. Each row in the list comprises up to 3 row parts, where each row part is 24 bytes long. Each entry must include row part 0. The ONU may also support row parts 1-2, thus allowing the table to contain logical rows that exceed the 24-byte definition of row part 0.

Table control (2 bytes)

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Set ctrl		Row part ID			Test	Row key									

The first two bytes of each row part is the table control field, which comprises a key into the row, the row part identifier, and fields to define the result of a set operation and to test whether the ONU supports the extended table format.

It is the responsibility of the OLT to assign and track row keys and content. The ONU should deny set operations that create range overlaps.

Set ctrl

The two MSBs of this field determine the meaning of a set operation. These bits are returned as 00 during get next operations.

Bits 16..15	Meaning
00	Reserved
01	Write this entry into the table. Overwrite any existing entry with the same row part ID and row key.
10	Delete this entry from the table, including all row parts. The remaining fields are not meaningful.
11	Clear all entries from the table. The remaining fields are not meaningful.

Row part ID

The row part ID field distinguishes the row part associated with the current set or get operation.

Row part 0 is backward compatible with earlier versions of this ME definition. Row parts 1-2 are optional on a row by row basis. They can be set by using values 001-010 as the row part ID. Row parts 3-7 are reserved.

Bits 14..12	Meaning
000	The associated row part has format 0.
001	The associated row part has format 1.
010	The associated row part has format 2.
011..111	Reserved

Test

This bit allows the OLT to determine whether an ONU supports the extended format access control list. If the ONU does not support the extended format, it should be possible to set the test bit to 1 and read it back with a get and get next operation. If the ONU does support the extended format, this bit should always return the value 0 under a get next operation.

Row key

The row key distinguishes rows in the table.

Row part definition

<table>
<tr><th>Byte</th><th>Row part 0</th><th>Row part 1</th><th>Row part 2</th></tr>
<tr><td>1
2</td><td>Table control
(2 bytes)</td><td>Table control
(2 bytes)</td><td>Table control
(2 bytes)</td></tr>
<tr><td>3
4</td><td>GEM port ID
(2 bytes)</td><td rowspan="11">Leading bytes of IPv6 source address
(12 bytes)</td><td rowspan="11">Leading bytes of IPv6 destination address
(12 bytes)</td></tr>
<tr><td>5
6</td><td>VLAN ID (ANI)
(2 bytes)</td></tr>
<tr><td>7
8
9
10</td><td>Source IP address
(4 bytes)</td></tr>
<tr><td>11
12
13
14</td><td>Destination IP address, start of range
(4 bytes)</td></tr>
<tr><td>15
16</td><td rowspan="2">Destination IP address, end of range
(4 bytes)</td><td>Preview length
(2 bytes)</td><td rowspan="8">Reserved
(10 bytes)</td></tr>
<tr><td>17
18</td><td>Preview repeat time
(2 bytes)</td></tr>
<tr><td>19
20</td><td rowspan="2">Imputed group bandwidth
(4 bytes)</td><td>Preview repeat count
(2 bytes)</td></tr>
<tr><td>21
22</td><td>Preview reset time (2 bytes)</td></tr>
<tr><td>23
24</td><td>Reserved
(2 bytes)</td><td>Reserved
(2 bytes)</td></tr>
</table>

Table 6 - ACL Row Part Formats

Format of row part 0:

- Table control (2 bytes)
- GEM port-ID (2 bytes)
- VLAN ID (ANI). This field specifies the VLAN carrying the multicast group downstream. The VLAN ID resides in the 12 least significant bits; the remaining bits are set to 0 and not used. The value 0 designates an untagged downstream flow. (2 bytes)
- Source IP address. The value 0.0.0.0 specifies that the source IP address is to be ignored. By default, this is an IPv4 address; it may be an IPv6 address if it is associated with a part 1 row. (4 bytes)
- Destination IP address of the start of the multicast range. By default, this is an IPv4 address; it may be an IPv6 address if it is associated with a part 2 row. (4 bytes)

- Destination IP address of the end of the multicast range. By default, this is an IPv4 address; it may be an IPv6 address if it is associated with a part 2 row. (4 bytes)
- Imputed group bandwidth. Expressed in bytes per second, the imputed group bandwidth is used to decide whether or not to honour a join request in the presence of a max multicast bandwidth limit. The recommended default value 0 effectively allows this table entry to avoid max bandwidth limitations (4 bytes)
- Reserved, set to 0. (2 bytes)

A single multicast group may be specified by setting start and end destination IP addresses to the same value.

Format of row part 1:

- Table control (2 bytes)
- The leading bytes of the IPv6 source address (12 bytes). This field is prepended to the four-byte source IP address field of the corresponding part 0 row. The row part 0 address field is interpreted as an IPv4 address if the first 10 bytes of this row part 1 field are 0 and the last two bytes are either 0 or 0xFFFF [b-IETF RFC 4291]. The latter syntax is preferred.
- Preview length. The maximum duration of each preview in seconds. The value 0 designates a group that is fully authorized by subscription and is not subject to preview restrictions. The remaining preview attributes in this row part are ignored. (2 bytes)
- Preview repeat time. The minimum time in seconds between two previews of a given multicast group. (2 bytes)
- Preview repeat count. The maximum number of times a given multicast group may be previewed. A value of zero allows an unlimited number of previews. (2 bytes)
- Preview reset time. The time at which the ONU resets the preview repeat counter. The value assignments are as follows: (2 bytes)
  0: Do not reset the preview repeat counter automatically. It is cleared only upon explicit action by the OLT.
  1..24: The integer clock time at which the ONU resets the preview repeat counter. For example the value 2 resets the counter at 2:00 AM. If the ONU does not have a time of day clock, the preview repeat counter is reset every 24 hours at an indeterminate time selected by the ONU.
  25…240: Reserved by ITU
  241..254: Reserved for vendor-specific use
  255: Used by the OLT to explicitly reset the preview repeat counter. A set action with this value clears the preview repeat count to zero, but does not alter the pre-existing value of the field in the table row part.
- Reserved (2 bytes)

Format of row part 2:

- Table control (2 bytes)
- The leading bytes of the IPv6 destination addresses (12 bytes). This field is prepended to the four-byte destination IP address field of the corresponding part 0 row. The row part 0 address field is interpreted as an IPv4 address if the first 10 bytes of this row part 2 field are 0 and the last two bytes are either 0 or 0xFFFF [b-IETF RFC 4291]. The latter syntax is preferred.
- Reserved (10 bytes)

(R, W) (mandatory) (each row part: 24 bytes)

Discussion of table size: While theoretically, this table could contain 1024 entries, real-world applications are not expected to require large tables. It is instead anticipated that the table will list a moderate number of contiguous ranges, each of which shares a common GEM port, VLAN, IP source address, imputed bandwidth, and preview characteristics. The ONU maintains preview counters and interval timers on a per-multicast group basis, not collectively for the entire range.

Static access control list table: This attribute is a list that specifies one or more multicast group address ranges. Groups defined in this list are multicast on the associated UNI(s) unconditionally, that is, without the need for an IGMP join. The bandwidth of static multicast groups is not included in the current multicast bandwidth measurement maintained by the multicast subscriber monitor managed entity. If a join message is always expected, this table may be empty. Table entries have the same format as those in the dynamic access control list table. The preview fields are not meaningful. (R, W) (mandatory) (each row part: 24 bytes)

Lost groups list table: This attribute is a list of groups from the dynamic access control list table for which there is an active join, but no downstream flow is present, possibly because of source failure, but also possibly because of misconfiguration somewhere upstream. Be aware of possible ambiguity between overlapping service providers and IPv4/IPv6 addresses. After a join, the ONU should wait a reasonable time for upstream processing before declaring a group to be lost. Each entry is a vector of the following components:

- VLAN ID, 0 if not used (2 bytes)
- Source IP address, 0.0.0.0 if not used. In IPv6, this field captures only the four least significant bytes. (4 bytes)
- Multicast destination IP address. In IPv6, this field captures only the four least significant bytes. (4 bytes)

(R) (mandatory) (10N bytes)

Robustness: This attribute allows tuning for possible packet loss in the network. The recommended default value 0 causes the ONU to follow the IETF recommendation [IETF RFC 3376] to copy the robustness value from query messages originating further upstream. (R, W, Set-by-create) (mandatory) (1 byte)

Querier IP address: This attribute specifies the IP address to be used by a proxy querier. Although it is not a legitimate IP address, the recommended default value 0.0.0.0 is legal in this case (see [b-IETF RFC 4541]). (R, W, Set-by-create) (mandatory) (4 bytes)

Query interval: This attribute specifies the interval between general queries in seconds. The value 0 specifies that the ONU use its own default, which may or may not be the same as the recommended default of 125 seconds. (R, W, Set-by-create) (mandatory) (4 bytes)

Query max response time: This attribute is the max response time added by the proxy into general query messages directed to UNIs. It is expressed in tenths of seconds. The value 0 specifies that the ONU use its own default, which may or may not be the same as the recommended default of 100 (10 seconds). (R, W, Set-by-create) (mandatory) (4 bytes)

Last member query interval: This attribute specifies the max response time inserted into group-specific queries sent to UNIs in response to group leave messages. It is also the repetition rate of [robustness] transmissions of the query. It is specified in tenths of seconds, with a default of 10 (1 second). (R, W) (mandatory) (4 bytes)

Unauthorized join request behaviour: This Boolean attribute specifies the ONU's behaviour when it receives an IGMP join request for a group that is not authorized in the dynamic address control list table, or an IGMPv3 membership report for groups, none of which are authorized in the dynamic ACL. The default value false specifies that the ONU silently discard the IGMP request; the value true specifies that the ONU forwards the request upstream. The ONU does not attempt to honour the request for the unauthorized group(s) in either case. (R, W) (mandatory) (1 byte)

Downstream IGMP and multicast TCI: This attribute controls the downstream tagging of both the IGMP/MLD and multicast frames. If the first byte of this attribute is non-zero, a possible extended VLAN tagging operation ME is ignored for downstream IGMP/MLD and multicast frames. (R, W, Set-by-create) (optional) (3 byte**s**)

The first byte defines the control type:

Value	Meaning
0	Pass the downstream IGMP/MLD and multicast traffic transparently, neither stripping nor modifying tags that may be present.
1	Strip the outer VLAN tag (including P bits) from the downstream IGMP/MLD and multicast traffic.
2	Add a tag onto the downstream IGMP/MLD and multicast traffic. The new tag is specified by the second and third bytes of this attribute.
3	Replace the tag on the downstream IGMP/MLD and multicast traffic. The new tag is specified by the second and third bytes of this attribute.
4	Replace only the VLAN ID on the downstream IGMP/MLD and multicast traffic, retaining the original DEI and P bits. The new VLAN ID is specified by the VLAN ID field of the second and third bytes of this attribute.

5 Add a tag onto the downstream IGMP/MLD and multicast traffic. The new tag is specified by the VID (UNI) field of the multicast service package table row of the multicast subscriber config info ME that is associated with this profile. If the VID (UNI) field is unspecified (0xFFFF) or specifies untagged traffic, the new tag is specified by the second and third bytes of this attribute.

6 Replace the tag on the downstream IGMP/MLD and multicast traffic. The new tag is specified by the VID (UNI) field of the multicast service package table row of the multicast subscriber config info ME that is associated with this profile. If the VID (UNI) field specifies untagged traffic, the outer VLAN tag (including P bits) is stripped from the downstream IGMP/MLD and multicast traffic. If the value of the VID (UNI) is unspecified (0xFFFF), the new tag is specified by the second and third bytes of this attribute.

7 Replace only the VID on the downstream IGMP/MLD and multicast traffic, retaining the original DEI and P bits. The new VLAN ID is specified by the VID (UNI) field of the multicast service package table row of the multicast subscriber config info ME that is associated with this profile. If the VID (UNI) field specifies untagged traffic, the outer VLAN tag (including P bits) is stripped from the downstream IGMP/MLD and multicast traffic. If the value of the VID (UNI) is unspecified (0xFFFF), the new tag is specified by the second and third bytes of this attribute.

Other values are reserved.

The second and third bytes define the TCI (VLAN ID and P bits) to be applied on the downstream IGMP/MLD and multicast streams in case the replace or add option is selected.

Actions

Create, delete, get, get next, set

Set table (optional)

Notifications

Alarm

Alarm number	Alarm	Description
0	Lost multicast group	Indicates that for one or more multicast groups, there is an active join, but no downstream flow is present. This alarm is equivalent to a non-zero number of entries in the lost groups list table attribute. When the alarm is active, the OLT may use the table to retrieve the details of the lost group(s).
1..207	Reserved	
208..223	Vendor-specific alarms	Not to be standardized* (to be discussed before implemented)

5.3.12 Multicast Subscriber Config Info (ME #310)

This managed entity organizes data associated with multicast management at subscriber ports of IEEE 802.1 bridges, including IEEE 802.1p mappers when the provisioning model is mapper-based rather than bridge-based. Instances of this managed entity are created and deleted by the OLT. Because of backward compatibility considerations, a subscriber port without an associated multicast subscriber config info ME would be expected to support unrestricted multicast access; this ME may therefore be viewed as restrictive, rather than permissive.

Through separate attributes, this ME supports either a single multicast operations profile in its backward compatible form, or a list of multicast operations profiles instead (the list may of course contain a single entry). The OLT can determine whether the ONU supports the multiple profile capability by performing a get operation on the multicast service package table attribute, which exists only on ONUs that are prepared to support the feature.

Application

Organizes data associated with multicast management at the PPTP Ethernet UNI port.

Relationships

An instance of this managed entity is associated with one instance of the MAC bridge port configuration data or the IEEE 802.1p mapper service profile.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Through an identical ID, this managed entity is implicitly linked to an instance of the MAC bridge port configuration data or IEEE 802.1p mapper ME. (R, Set-by-create) (mandatory) (2 bytes)

ME type: This attribute indicates the type of the ME implicitly linked by the managed entity ID attribute.

0 MAC bridge port config data
1 IEEE 802.1p mapper service profile

(R, W, Set-by-create) (mandatory) (1 byte)

Multicast operations profile pointer: This attribute points to an instance of the multicast operations profile. This attribute is ignored by the ONU if a non-empty multicast service package table attribute is present. (R,W, Set-by-create) (mandatory) (2 bytes)

Max simultaneous groups: This attribute specifies the maximum number of dynamic multicast groups that may be replicated to the client port at any one time. The recommended default value 0 specifies that no administrative limit is to be imposed. (R, W, Set-by-create) (mandatory) (2 bytes)

Max multicast bandwidth: This attribute specifies the maximum imputed dynamic bandwidth, in bytes per second, that may be delivered to the client port at any one time. The recommended default value 0 specifies that no administrative limit is to be imposed. (R, W, Set-by-create) (mandatory) (4 bytes)

Bandwidth enforcement: The recommended default value of this Boolean attribute is false, and specifies that attempts to exceed the max multicast bandwidth be counted but honoured. The value true specifies that such attempts be

counted and denied. The imputed bandwidth value is taken from the dynamic access control list table, both for a new join request and for pre-existing groups. (R, W, Set-by-create) (mandatory) (1 byte)

Multicast service package table: This attribute is a list that specifies one or more multicast service packages. When the ONU receives an IGMP/MLD join request, it searches the multicast service package table in row key order, matching the VID (UNI) field (several rows can share the same VID). For each VID (UNI) match, the multicast operations profile pointer is used to access the ME that contains the attributes associated with the service package. The search stops when all requested multicast groups have been found and dealt with.

Each list entry is a vector of six components:

- **Table control** (2 bytes)

  The first two bytes of each entry contain a key into the table. It is the responsibility of the OLT to assign and track table keys and content. Since row keys are created by the OLT, they may be densely or sparsely packed.

  The two MSBs of this field determine the meaning of a set operation. These bits are returned as 00 during get next operations.

Bits 16..15	Meaning
00	Reserved
01	Write this entry into the table. Overwrite any existing entry with the same row key.
10	Delete this entry from the table. The remaining fields are not meaningful.
11	Clear all entries from the table. The remaining fields are not meaningful.

  Bits 14..11 are reserved. Bits 10..1 are the row key itself.

- **VID (UNI)**. The value in this field is compared with the VID of upstream IGMP/MLD messages, and is used to decide whether to honour a join request. (2 bytes)

  Values:

  0..4095 – Matched against the VID of the IGMP/MLD message. 0 indicates a priority-tagged message, whose P bits are ignored.

  4096 – Matches untagged IGMP/MLD messages only.

  4097 – Matches tagged messages only, but ignores the value of the VID.

  0xFFFF – Unspecified.

  The VID (UNI) comparison occurs prior to any action defined by the upstream IGMP tag control attribute in an associated multicast

operations profile (or alternatively, before any modification by a possible (extended) VLAN tagging operation configuration data ME).

- **Max simultaneous groups**. This field specifies the maximum number of dynamic multicast groups that may be replicated to the client port at any one time, for the multicast service package that is associated with this row. The value 0 specifies that no administrative limit is to be imposed. (2 bytes)
- **Max multicast bandwidth**. This field specifies the maximum imputed dynamic bandwidth, in bytes per second, that may be delivered to the client port at any one time, for the multicast service package that is associated with this row. The value 0 specifies that no administrative limit is to be imposed. (4 bytes)

  Note: The port is also constrained by the global max simultaneous groups and max multicast bandwidth attributes of the multicast subscriber config info ME.
- **Multicast operations profile pointer**. This field contains the ME ID of the multicast operations profile ME associated with this service package. (2 bytes)
- **Reserved** (8 bytes)

(R, W) (mandatory) (20N bytes, where N is the number of entries in the table)

Allowed preview groups table: This attribute is a list that specifies the preview groups that are currently allowed for the UNI associated with this ME. It is intended to support paid viewing of a multicast group that may or may not have been previewed.

When an IGMP/MLD join request is received, the order of search precedence is as follows:

1. Multicast operations profile(s), fully authorized groups
2. This attribute, the allowed preview groups table
3. Multicast operations profile(s), preview-only groups

If the first match is a group listed in this attribute, the ONU forwards the group to the UNI until the group is removed from this list, or until the subscriber leaves the group.

Each list entry begins with a table control field:

Table control (2 bytes)

16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Set ctrl		Row part			Rsv	Row key									

The first two bytes of each entry contain a key into the table, as well as table management fields. It is the responsibility of the OLT to assign and track row keys and content.

Set ctrl

The two MSBs of this field determine the meaning of a set operation. These bits are returned as 00 during get next operations.

Bits 16..15	Meaning
00	Reserved
01	Write this entry into the table. Overwrite any existing entry with the same row part and row key.
10	Delete this entry from the table, including all row parts. The remaining fields are not meaningful.
11	Clear all entries from the table. The remaining fields are not meaningful.

Row part

The row part field allows the table to contain logical rows that exceed the maximum length of a single row. Table entries with the same row key and different row parts are understood to comprise a single extended row. In this managed entity, an extended row always contains two row parts.

The meaning of extended rows is defined below.

Bits 14..12	Meaning
000	The associated row operation is for part 0.
001	The associated row operation is for part 1.
010..111	Reserved

Rsv

This bit is reserved.

Row key

The row key identifies rows in the table. Row keys may be either densely or sparsely populated.

Row part format definition

Byte	Row part 0	Row part 1
1 2	Table control (2 bytes)	Table control (2 bytes)
3 4 5 6 7 8 9 10 11	Source IP address (16 bytes)	Destination IP address (16 bytes)

12 13 14 15 16 17 18		
19 20	VLAN ID (ANI) (2 bytes)	Duration (2 bytes)
21 22	VLAN ID (UNI) (2 bytes)	Time left (2 bytes)

Table 7 - Allowed Preview Groups Row Part Formats

Row part 0 format:

- Table control (2 bytes)
- Source IP address. This field specifies the source IP address of the allowed preview group. May be either an IPv4 address (first twelve bytes 0) or an IPv6 address. (16 bytes)
- VLAN ID (ANI). This field specifies the VLAN carrying the multicast group downstream. The VLAN ID resides in the 12 least significant bits; the remaining bits are set to 0 and not used. The value 0 designates an untagged downstream flow. (2 bytes)
- VLAN ID (UNI). This field specifies the VLAN carrying IGMP/MLD messages upstream across the UNI. The VLAN ID resides in the 12 least significant bits; the remaining bits are set to 0 and not used. The value 0 designates an untagged upstream flow. (2 bytes)

Row part 1 format:

- Table control (2 bytes)
- Destination IP address. This field specifies the destination IP address of the allowed preview group. May be either an IPv4 address (first twelve bytes 0) or an IPv6 address. (16 bytes)
- Duration – This field indicates the static length of time in minutes for which the group is authorized. The value 0 designates unlimited authorization. (2 bytes)
- Time left – This field is controlled by the ONU (ignored during a set operation from the OLT). It indicates how much time (measured in minutes) remains in the authorization. The ONU counts down; when this field reaches zero, the ONU deletes the entire entry from the table and stops replicating the group to the UNI. If the duration field specifies unlimited authorization, this field is ignored. The OLT may extend (or even truncate) the authorization by writing a new value into the duration field; the

difference between new and old duration values is added to the time left field. (2 bytes)

(R, W) (mandatory) (Each row part: 22 bytes)

Actions

Create, delete, get, get next, set

Set table

Notifications

None.

5.3.13 Ethernet Frame Performance Monitoring History Data Downstream (ME #321)

This managed entity is identical to the ***Ethernet frame performance monitoring history data upstream*** managed entity (see section 5.3.14), with the exception that it monitors downstream traffic.

5.3.14 Ethernet Frame Performance Monitoring History Data Upstream (ME #322)

This managed entity collects performance monitoring data associated with upstream Ethernet frame delivery. It is based on the Etherstats group of [IETF RFC 2819]. Instances of this managed entity are created and deleted by the OLT.

For a complete discussion of generic PM architecture, refer to [ITU-T G.988] clause I.4.

Note 1: Implementers are encouraged to consider the Ethernet frame extended PM ME defined in [ITU-T G.988] clause 9.3.32, which collects the same counters in a more generalized way.

Application

This managed entity collects performance monitoring data associated with upstream Ethernet frame delivery.

Relationships

An instance of this managed entity is associated with an instance of a MAC bridge port configuration data.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Through an identical ID, this managed entity is implicitly linked to an instance of a MAC bridge port configuration data. (R, Set-by-create) (mandatory) (2 bytes)

Interval end time: This attribute identifies the most recently finished 15-minute interval. (R) (mandatory) (1 byte)

Threshold data 1/2 ID: This attribute points to an instance of the threshold data 1 managed entity that contains PM threshold values. Since no threshold value attribute number exceeds 7, a threshold data 2 ME is optional. (R, W, Set-by-create) (mandatory) (2 bytes)

Drop events: The total number of events in which packets were dropped due to a lack of resources. This is not necessarily the number of packets dropped; it is the number of times this event was detected. (R) (mandatory) (4 bytes)

Octets: The total number of upstream octets received, including those in bad packets, excluding framing bits, but including FCS. (R) (mandatory) (4 bytes)

Packets: The total number of upstream packets received, including bad packets, broadcast packets and multicast packets. (R) (mandatory) (4 bytes)

Broadcast packets: The total number of upstream good packets received that were directed to the broadcast address. This does not include multicast packets. (R) (mandatory) (4 bytes)

Multicast packets: The total number of upstream good packets received that were directed to a multicast address. This does not include broadcast packets. (R) (mandatory) (4 bytes)

CRC errored packets: The total number of upstream packets received that had a length (excluding framing bits, but including FCS octets) of between 64 and 1518 octets, inclusive, but had either a bad frame check sequence (FCS) with an integral number of octets (FCS error) or a bad FCS with a non-integral number of octets (alignment error). (R) (mandatory) (4 bytes)

Undersize packets: The total number of upstream packets received that were less than 64 octets long but were otherwise well formed (excluding framing bits, but including FCS). (R) (mandatory) (4 bytes)

Oversize packets: The total number of upstream packets received that were longer than 1518 octets (excluding framing bits, but including FCS) and were otherwise well formed. (R) (mandatory) (4 bytes)

Note 2: If 2000-byte Ethernet frames are supported, counts in this performance parameter are not necessarily errors.

Packets 64 octets: The total number of upstream received packets (including bad packets) that were 64 octets long, excluding framing bits but including FCS. (R) (mandatory) (4 bytes)

Packets 65 to 127 octets: The total number of upstream received packets (including bad packets) that were 65..127 octets long, excluding framing bits but including FCS. (R) (mandatory) (4 bytes)

Packets 128 to 255 octets: The total number of upstream packets (including bad packets) received that were 128..255 octets long, excluding framing bits but including FCS. (R) (mandatory) (4 bytes)

Packets 256 to 511 octets: The total number of upstream packets (including bad packets) received that were 256..511 octets long, excluding framing bits but including FCS. (R) (mandatory) (4 bytes)

Packets 512 to 1023 octets: The total number of upstream packets (including bad packets) received that were 512..1023 octets long, excluding framing bits but including FCS. (R) (mandatory) (4 bytes)

Packets 1024 to 1518 octets: The total number of upstream packets (including bad packets) received that were 1024..1518 octets long, excluding framing bits but including FCS. (R) (mandatory) (4 bytes)

Actions

Create, delete, get, set

Get current data

Notifications

D1 implementation will not set or utililize the TCA value for each alarm number 0-4.

Threshold crossing alert

Alarm number	Threshold crossing alert	Threshold data counter # (Note)
0	Drop events	1
1	CRC errored packets	2
2	Undersize packets	3
3	Oversize packets	4
Note: This number associates the TCA with the specified threshold value attribute of the threshold data 1 managed entity.		

5.4 Layer 3 data services

5.4.1 IP Host Config Data (ME #134)

The IP host config data configures IPv4 based services offered on the ONU. The ONU automatically creates instances of this managed entity if IP host services are available. A possible IPv6 stack is supported through the IPv6 host config data managed entity. In this clause, references to IP addresses are understood to mean IPv4.

Application

Configures IP version 4 (IPv4) protocol based services (H.248 and RTP) offered in the ONU.

Relationships

An instance of this managed entity is associated with the ONU managed entity. Any number of TCP/UDP config data MEs can point to the IP host config data, to model any number of ports and protocols. Performance may be monitored through an implicitly linked IP host PM history data ME.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. The ONU creates as many instances as there are independent IPv4 stacks on the ONU. To facilitate discovery, IP host config data MEs should be numbered from 0 upwards. The ONU should create IP(v4) and IPv6 host config data MEs with separate ME IDs, such that other MEs can use a single TP type attribute to link with either. (R) (mandatory) (2 bytes)

IP options: This attribute is a bit map that enables or disables IP-related options. The value 1 enables the option while 0 disables it. The default value of this attribute is 0.

0x01	Enable DHCP
0x02	Respond to pings
0x04	Respond to traceroute messages
0x08	Enable IP stack
0x10..0x80	Reserved

(R, W) (mandatory) (1 byte)

MAC address: This attribute indicates the MAC address used by the IP node. (R) (mandatory) (6 bytes)

Onu identifier: A unique ONU identifier string. If set to a non-null value, this string is used instead of the MAC address in retrieving DHCP parameters. If the string is shorter than 25 characters, it must be null terminated. Its default value is 25 null bytes. (R, W) (mandatory) (25 bytes)

Several attributes of this managed entity may be paired together into two categories, manual settings and current values.

Manual settings	Current values
IP address	Current address
Mask	Current mask
Gateway	Current gateway
Primary DNS	Current primary DNS
Secondary DNS	Current secondary DNS

While the IP stack is disabled, there is no IP connectivity to the external world from this managed entity instance.

While DHCP is disabled, the current values are always the same as the manual settings. While DHCP is enabled, the current values are those assigned by DHCP, or undefined (0) if DHCP has never assigned values.

IP address: The address used for IP host services; this attribute has the default value 0. (R, W) (mandatory) (4 bytes)

Mask: The subnet mask for IP host services; this attribute has the default value 0. (R, W) (mandatory) (4 bytes)

Gateway: The default gateway address used for IP host services; this attribute has the default value 0. (R, W) (mandatory) (4 bytes)

Primary DNS: The address of the primary DNS server; this attribute has the default value 0. (R, W) (mandatory) (4 bytes)

Secondary DNS: The address of the secondary DNS server; this attribute has the default value 0. (R, W) (mandatory) (4 bytes)

Current address: Current address of the IP host service. (R) (mandatory) (4 bytes)

Current mask: Current subnet mask for the IP host service. (R) (mandatory) (4 bytes)

Current gateway: Current default gateway address for the IP host service. (R) (mandatory) (4 bytes)

Current primary DNS: Current primary DNS server address. (R) (mandatory) (4 bytes)

Current secondary DNS: Current secondary DNS server address. (R) (mandatory) (4 bytes)

Domain name: If DHCP indicates a domain name, it is presented here. If no domain name is indicated, this attribute is set to a null string. If the string is shorter than 25 bytes, it must be null terminated. The default value is 25 null bytes. (R) (mandatory) (25 bytes)

Host name: If DHCP indicates a host name, it is presented here. If no host name is indicated, this attribute is set to a null string. If the string is shorter than 25 bytes, it must be null terminated. The default value is 25 null bytes. (R) (mandatory) (25 bytes)

Relay agent options: This attribute is a pointer to a large string managed entity whose content specifies one or more DHCP relay agent options. (R, W) (optional) (2 bytes)

The contents of the large string are parsed by the ONU and converted into text strings. Variable substitution is based on defined three-character groups, each of which begins with the '%' character. The string '%%' is an escape mechanism whose output is a single '%' character. When the ONU cannot perform variable substitution on a substring of the large string, it generates the specified option as an exact quotation of the provisioned substring value.

Provisioning of the large string is separate from the operation of setting the pointer in this attribute. It is the responsibility of the OLT to ensure that the large string contents are correct and meaningful.

Three-character variable definitions are as follows. The first variable in the large string must specify one of the option types. Both options for a given IP version may be present if desired, each introduced by its option identifier. Terminology is taken from [b-BBF TR-101] clause 3.9.3.

%01, %18
: Specifies that the following string is for option 82 sub-option 1, agent circuit-ID (IPv4) or option 18, interface-ID (IPv6). The equivalence permits the same large string to be used in both IP environments.

%02, %37
: Specifies that the following string is for option 82 sub-option 2, relay agent remote-ID (IPv4) or option 37, relay agent remote-ID (IPv6). The equivalence permits the same large string to be used in both IP environments.

%SL
: In TR-101, this is called a slot. In an ONU, this variable refers to a shelf. It would be meaningful if the ONU has multiple shelves internally or is daisy-chained to multiple equipment modules. The range of this variable is "0".. "99"

%SU
: In TR-101, this is called a sub-slot. In fact, it represents a cardholder. The range of this variable is "0".. "99"

%PO UNI port number. The range of this variable is "0".. "999"
%AE ATM or Ethernet. This variable can take on the values "atm" or "eth".
%SV S-VID for Ethernet UNI, or ATM VPI for ATM UNI, as it exists on the DHCP request received upstream across the UNI. Range "0".. "4096" for S-VID; range "0".. "255" for VPI. The value "4096" indicates no S-VID tag.
%CV C-VID (Q-VID) for Ethernet UNI, or ATM VCI for ATM UNI, as it exists on the DHCP request received upstream across the UNI. Range "0".. "4096" for C-VID; range "0.."65535" for VCI. The value "4096" indicates no C-VID tag.

Spaces in the provisioned string are significant.

Example: if the large string were provisioned with the value

%01%SL/%SU/%PO:%AE/%SV.%CV<null>,

then the ONU would generate the following DHCP option 82 agent circuit-ID string for an Ethernet UNI that sent a DHCP request with no S tag and C tag = 3210 on shelf 2, slot 3, port 4.

2/3/4:eth/4096.3210

With the same provisioning, the ONU would generate the following DHCP option 82 agent circuit-ID string for an ATM UNI that sent a DHCP request on VPI = 123 and VCI = 4567 on shelf 2, slot 3, port 4.

2/3/4:atm/123.4567

Actions

Get, set

Test: Invoke an ICMP message from this IP host. The test message can be configured to generate a ping or traceroute. [ITU-T G.988] Annex A defines the test, test response and test result messages.

Notifications

Attribute value change

Number	Attribute value change	Description
1..8	N/A	
9	Current address	The new value assigned via DHCP
10	Current mask	The new value assigned via DHCP
11	Current gateway	The new value assigned via DHCP
12	Current primary DNS	The new value assigned via DHCP
13	Current secondary DNS	The new value assigned via DHCP
14	Domain name	The new value assigned via DHCP
15	Host name	The new value assigned via DHCP
16	Reserved	

5.4.2 IP Host Performance Monitoring History Data (ME #135)

This managed entity collects performance monitoring data related to an IP host. Instances of this managed entity are created and deleted by the OLT.

For a complete discussion of generic PM architecture, refer to [ITU-T G.988] clause I.4.

Relationships

An instance of this managed entity is associated with an instance of the IP host config data or IPv6 host config data managed entity.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Through an identical ID, this managed entity is implicitly linked to an instance of the IP host configuration data or IPv6 host configuration data ME. (R, Set-by-create) (mandatory) (2 bytes)

Interval end time: This attribute identifies the most recently finished 15-minute interval. (R) (mandatory) (1 byte)

Threshold data 1/2 ID: This attribute points to an instance of the threshold data 1 managed entity that contains PM threshold values. Since no threshold value attribute number exceeds 7, a threshold data 2 ME is optional. (R, W, Set-by-create) (mandatory) (2 bytes)

ICMP errors: This attribute counts ICMP errors received. (R) (mandatory) (4 bytes)

DNS errors: This attribute counts DNS errors received. (R) (mandatory) (4 bytes)

DHCP timeouts: This attribute counts DHCP timeouts. (R) (mandatory) (2 bytes)

IP address conflict: This attribute is incremented whenever the ONU detects a conflicting IP address on the network. A conflicting IP address is one that has the same value as the one currently assigned to the ONU. (R) (mandatory) (2 bytes)

Out of memory: This attribute is incremented whenever the ONU encounters an out of memory condition in the IP stack. (R) (mandatory) (2 bytes)

Internal error: This attribute is incremented whenever the ONU encounters an internal error condition such as a driver interface failure in the IP stack. (R) (mandatory) (2 bytes)

Actions

Create, delete, get, set

Get current data (optional)

Notifications

D1 implementation will not set or utililize the TCA value for each alarm number 1-6.

Threshold crossing alert

Alarm number	Threshold crossing alert	Threshold value attribute # (Note)
1	IPNPM ICMP error	1
2	IPNPM DNS error	2
3	DHCP timeout	3
4	IP address conflict	4
5	Out of memory	5
6	Internal error	6
Note: This number associates the TCA with the specified threshold value attribute of the threshold data 1 managed entity.		

5.4.3 TCP/UDP Config Data (ME #136)

The TCP/UDP config data managed entity configures TCP and UDP-based services that are offered from an IP host. If a non-OMCI interface is used to manage an IP service, this ME is unnecessary; the non-OMCI interface supplies the necessary data.

An instance of this managed entity is created and deleted on request of the OLT.

Application

Configures User Datagram Protocol (UDP) services (for H.248 signaling) offered from an Internet Protocol (IP) host in the ONU.

Relationships

One or more instances of this managed entity may be associated with an instance of an IP host config data or IPv6 host config data managed entity.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. It is recommended that the managed entity ID be the same as the port number. (R, Set-by-create) (mandatory) (2 bytes)

Port ID: This attribute specifies the port number that offers the TCP/UDP service. (R, W, Set-by-create) (mandatory) (2 bytes)

Protocol: This attribute specifies the protocol type as defined by IANA (protocol numbers at www.iana.org), for example UDP (0x11). (R, W, Set-by-create) (mandatory) (1 byte)

TOS/diffserv field: This attribute specifies the value of the TOS/diffserv field of the IPv4 header. The contents of this attribute may contain the type of service per [IETF RFC 2474] or a differentiated services code point (DSCP). Valid values for DSCP are as defined by IANA (differentiated services field code points at www.iana.org). (R, W, Set-by-create) (mandatory) (1 byte)

IP host pointer: This attribute points to the IP host config data or IPv6 host config data ME associated with this TCP/UDP data. Any number of ports and protocols may be associated with an IP host. (R, W, Set-by-create) (mandatory) (2 bytes)

Actions

Create, delete, get, set

Notifications

None.

5.5 Ethernet services

5.5.1 Physical Path Termination Point Ethernet UNI (ME #11)

This managed entity represents the point at an Ethernet UNI where the physical path terminates and Ethernet physical level functions are performed.

The ONU automatically creates an instance of this managed entity per port:

- when the ONU has Ethernet ports built into its factory configuration;
- when a cardholder is provisioned to expect a circuit pack of the Ethernet type;
- when a cardholder provisioned for plug-and-play is equipped with a circuit pack of the Ethernet type. Note that the installation of a plug-and-play card may indicate the presence of Ethernet ports via equipment ID as well as its type, and indeed may cause the ONU to instantiate a port mapping package that specifies Ethernet ports.

The ONU automatically deletes instances of this managed entity when a cardholder is neither provisioned to expect an Ethernet circuit pack, nor is it equipped with an Ethernet circuit pack.

Application

Represents the point at which an Ethernet UNI where the physical path terminates and Ethernet physical level functions are performed.

Relationships

An instance of this managed entity is associated with each instance of a pre-provisioned or real Ethernet port.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. This two-byte number indicates the physical position of the UNI. The first byte is the slot ID (defined in 5.1.5). The second byte is the port ID, with the range 1..255. (R) (mandatory) (2 bytes)

Expected type: This attribute supports pre-provisioning. It is coded as follows:

0 Autosense

1 to 254 One of the values from Table 2 that is compatible with an Ethernet circuit pack

Upon ME instantiation, the ONU sets this attribute to 0. (R, W) (mandatory) (1 byte)

Sensed type: When a circuit pack is present, this attribute represents its type as one of the values from Table 2. If the value of the expected type is not 0, then the value of the sensed type should be the same as the value of the expected type. Upon ME instantiation, the ONU sets this attribute to 0. See also the note in the Attribute value change table below.

(R) (mandatory if the ONU supports circuit packs with configurable interface types, e.g., 10/100 BASE-T card) (1 byte)

Auto detection configuration: This attribute sets the Ethernet port configuration:

Code point	Rate	Duplex
0x00	Auto	Auto
0x01	10 Mbit/s only	Full duplex only
0x02	100 Mbit/s only	Full duplex only
0x03	1000 Mbit/s only	Full duplex only
0x04	Auto	Full duplex only
0x05	10Gb/s only	Full duplex only
0x10	10 Mbit/s only	Auto
0x11	10 Mbit/s only	Half duplex only
0x12	100 Mbit/s only	Half duplex only
0x13	1000 Mbit/s only	Half duplex only
0x14	Auto	Half duplex only
0x20	1000 Mbit/s only	Auto
0x30	100 Mbit/s only	Auto

Upon ME instantiation, the ONU sets this attribute to 0. (R, W) (mandatory for interfaces with autodetection options) (1 byte)

Ethernet loopback configuration: This attribute sets the Ethernet loopback configuration:

0 No loopback

3 Loop 3, loopback of downstream traffic after PHY transceiver. Loop 3 is depicted in Figure 9.

Note that normal bridge behaviour may defeat the loopback signal unless broadcast MAC addresses are used. Although it does not reach the physical interface, [IEEE 802.1ag] loopback is preferred.

Upon ME instantiation, the ONU sets this attribute to 0. (R, W) (mandatory) (1 byte)

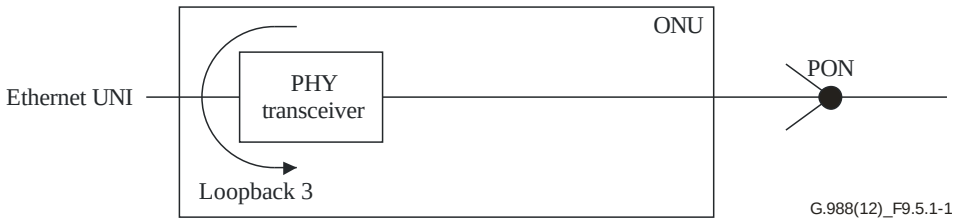

Figure 9 - Ethernet Loopback Configuration

Administrative state: This attribute locks (1) and unlocks (0) the functions performed by this managed entity. Administrative state is further described in [ITU-T G.988] clause A.1.6. (R, W) (mandatory) (1 byte)

Operational state: This attribute indicates whether or not the managed entity is capable of performing its function. Valid values are enabled (0) and disabled (1). (R) (optional) (1 byte)

Configuration ind: This attribute indicates the configuration status of the Ethernet UNI.

0x01 10BASE-T full duplex

0x02 100BASE-T full duplex

0x03 Gigabit Ethernet full duplex

0x04 10G Ethernet full duplex

0x11 10BASE-T half duplex

0x12 100BASE-T half duplex

0x13 Gigabit Ethernet half duplex

The value 0 indicates that the configuration status is unknown (e.g., Ethernet link is not established or the circuit pack is not yet installed). Upon ME instantiation, the ONU sets this attribute to 0. (R) (mandatory) (1 byte)

Max frame size: This attribute denotes the maximum frame size allowed across this interface. Upon ME instantiation, the ONU sets the attribute to 1518. (R, W) (optional) (2 bytes)

DTE or DCE ind: This attribute specifies the Ethernet interface wiring:

0 DCE or MDI-X (default).

1 DTE or MDI.

2 Automatic selection

(R, W) (mandatory) (1 byte)

Pause time: This attribute allows the PPTP to ask the subscriber terminal to temporarily suspend sending data. Units are in pause quanta (1 pause quantum is 512 bit times of the particular implementation). Values: 0..0xFFFF. Upon ME instantiation, the ONU sets this attribute to 0. (R, W) (optional) (2 bytes)

Bridged or IP ind: This attribute specifies whether the Ethernet interface is bridged or derived from an IP router function.

0 Bridged

1 IP router

2 Depends on the parent circuit pack. 2 means that the circuit pack's bridged or IP ind attribute is either 0 or 1.

Upon ME instantiation, the ONU sets this attribute to 2. (R, W) (optional) (1 byte)

ARC: See [ITU-T G.988] clause A.1.4.3. (R, W) (optional) (1 byte)

ARC interval: See [ITU-T G.988] clause A.1.4.3. (R, W) (optional) (1 byte)

PPPoE filter: This attribute controls filtering of PPPoE packets on this Ethernet port. The value 0 allows packets of all types. The value 1 discards everything but PPPoE packets. The default value is 0. (R, W) (optional) (1 byte)

Power control: This attribute controls whether power is provided to an external equipment over the Ethernet PPTP. The value 1 enables power over the Ethernet port. The default value 0 disables power feed. (R, W) (optional) (1 byte)

Note: This attribute is the equivalent of the acPSEAdminControl variable defined in [IEEE 802.3] clause 30.9.1.2.1. Other variables related to power over Ethernet appear in the PoE control ME.

Actions

Get, set

Notifications

Attribute value change

Number	Attribute value change	Description
1	N/A	

2	Sensed type	Sensed type of Ethernet interface. Valid values are: 1 (10BASE-T), 2 (100BASE-T), 3 (Gigabit Ethernet) and 4 (10G Ethernet). (Note)
3..5	N/A	
6	Op state	Operational state
7..11	N/A	
12	ARC	ARC timer expiration
13..15	N/A	
16	Reserved	
Note: These values violate the rules of the AVC message, which require the changed value of the sensed type (in this case) attribute to be reported. Because of existing implementations, pre-existing documentation is retained; however, implementers should regard this attribute and its AVC with caution.		

Alarm

Alarm number	Alarm	Description
0	LAN-LOS	No carrier at the Ethernet UNI
1..207	Reserved	
208..223	Vendor-specific alarms	Not to be standardized* (to be discussed before implemented)

5.5.2 Ethernet Performance Monitoring History Data (ME #24)

This managed entity collects some of the performance monitoring data for a physical Ethernet interface. Instances of this managed entity are created and deleted by the OLT.

For a complete discussion of generic PM architecture, refer to [ITU-T G.988] clause I.4.

Application

For performance monitoring of Ethernet UNI.

Relationships

An instance of this managed entity is associated with an instance of the physical path termination point Ethernet UNI.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Through an identical ID, this managed entity is implicitly linked to an instance of the physical path termination point Ethernet UNI. (R, Set-by-create) (mandatory) (2 bytes)

Interval end time: This attribute identifies the most recently finished 15-minute interval. (R) (mandatory) (1 byte)

Threshold data 1/2 ID: This attribute points to an instance of the threshold data 1 and 2 managed entities that contains PM threshold values. (R, W, Set-by-create) (mandatory) (2 bytes)

FCS errors: This attribute counts frames received on a particular interface that were an integral number of octets in length but failed the frame check sequence (FCS) check. The count is incremented when the MAC service returns the frameCheckError status to the link layer control (LLC) or other MAC user. Received frames for which multiple error conditions are obtained are counted according to the error status presented to the LLC. (R) (mandatory) (4 bytes)

Excessive collision counter: This attribute counts frames whose transmission failed due to excessive collisions. (R) (mandatory) (4 bytes)

Late collision counter: This attribute counts the number of times that a collision was detected later than 512 bit times into the transmission of a packet. (R) (mandatory) (4 bytes)

Frames too long: This attribute counts received frames that exceeded the maximum permitted frame size. The count is incremented when the MAC service returns the frameTooLong status to the LLC. (R) (mandatory) (4 bytes)

Buffer overflows on receive: This attribute counts the number of times that the receive buffer overflowed. (R) (mandatory) (4 bytes)

Buffer overflows on transmit: This attribute counts the number of times that the transmit buffer overflowed. (R) (mandatory) (4 bytes)

Single collision frame counter: This attribute counts successfully transmitted frames whose transmission was delayed by exactly one collision. (R) (mandatory) (4 bytes)

Multiple collisions frame counter: This attribute counts successfully transmitted frames whose transmission was delayed by more than one collision. (R) (mandatory) (4 bytes)

SQE counter: This attribute counts the number of times that the SQE test error message was generated by the PLS sublayer. (R) (mandatory) (4 bytes)

Deferred transmission counter: This attribute counts frames whose first transmission attempt was delayed because the medium was busy. The count does not include frames involved in collisions. (R) (mandatory) (4 bytes)

Internal MAC transmit error counter: This attribute counts frames whose transmission failed due to an internal MAC sublayer transmit error. (R) (mandatory) (4 bytes)

Carrier sense error counter: This attribute counts the number of times that carrier sense was lost or never asserted when attempting to transmit a frame. (R) (mandatory) (4 bytes)

Alignment error counter: This attribute counts received frames that were not an integral number of octets in length and did not pass the FCS check. (R) (mandatory) (4 bytes)

Internal MAC receive error counter: This attribute counts frames whose reception failed due to an internal MAC sublayer receive error. (R) (mandatory) (4 bytes)

Actions

Create, delete, get, set

Get current data

Notifications

D1 implementation will not set or utililize the TCA value for each alarm number 0-13.

Threshold crossing alert

Alarm number	Threshold crossing alert	Threshold value attribute # (Note)
0	FCS errors	1
1	Excessive collision counter	2
2	Late collision counter	3
3	Frames too long	4
4	Buffer overflows on receive	5
5	Buffer overflows on transmit	6
6	Single collision frame counter	7
7	Multiple collisions frame counter	8
8	SQE counter	9
9	Deferred transmission counter	10
10	Internal MAC transmit error counter	11
11	Carrier sense error counter	12
12	Alignment error counter	13
13	Internal MAC receive error counter	14
Note: This number associates the TCA with the specified threshold value attribute of the threshold data 1/2 managed entities.		

5.5.3 Virtual Ethernet Interface Point (ME #329)

This managed entity represents the data plane hand-off point in an ONU to a separate (non-OMCI) management domain. The virtual Ethernet interface point is managed by the OMCI, and is potentially known to the non-OMCI management domain. One or more Ethernet traffic flows are present at this boundary.

Instances of this managed entity are automatically created and deleted by the ONU. This is necessary because the required downstream priority queues are subject to physical implementation constraints. The OLT may use one or more of the virtual Ethernet interface points created by the ONU.

It is expected that the ONU would create one virtual Ethernet interface point for each non-OMCI management domain. At the vendor's discretion, a virtual Ethernet interface point may be created for each traffic class.

Relationships

An instance of this managed entity is associated with an instance of a virtual Ethernet interface between OMCI and non-OMCI management domains.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. When used independently of a cardholder and circuit pack, the ONU should assign IDs in the sequence 1, 2, ... When used in conjunction with a cardholder and circuit pack, this two-byte number

indicates the physical position of the VEIP. The first byte is the slot ID (defined in section 5.1.5). The second byte is the port ID, with the range 1..255. The values 0 and 0xFFFF are reserved. (R) (mandatory) (2 bytes)

Administrative state: This attribute locks (1) and unlocks (0) the functions performed by this managed entity. Administrative state is further described in [ITU-T G.988] clause A.1.6. (R, W) (mandatory) (1 byte)

Operational state: This attribute indicates whether or not the managed entity is capable of performing its function. Valid values are enabled (0) and disabled (1). (R) (mandatory) (1 byte)

Interdomain name: This attribute is a character string that provides an optional way to identify the virtual Ethernet interface point to a non-OMCI management domain. The interface may also be identified by its managed entity ID, IANA assigned port and possibly other ways. If the vendor offers no information in this attribute, it should be set to a sequence of null bytes. (R, W) (optional) (25 bytes)

TCP/UDP pointer: This attribute points to an instance of the TCP/UDP config data managed entity, which provides for OMCI management of the non-OMCI management domain's IP connectivity. If no OMCI management of the non-OMCI domain's IP connectivity is required, this attribute may be omitted or set to its default, a null pointer. (R, W) (optional) (2 bytes)

IANA assigned port: This attribute contains the TCP or UDP port value as assigned by IANA for the management protocol associated with this virtual Ethernet interface. This attribute is to be regarded as a hint, not as a requirement that management communications use this port; the actual port and protocol are specified in the associated TCP/UDP config data managed entity. If no port has been assigned, or if the management protocol is free to be chosen at run-time, this attribute should be set to 0xFFFF. (R) (mandatory) (2 bytes)

Actions

Get, set

Notifications

D1 implementation will not utililize the alarms below.

Attribute value change

Number	Attribute value change	Description
0..1	N/A	
2	Op state	Operational state
3	N/A	
4..16	Reserved	

Alarm

Alarm number	Alarm	Description
0	Connecting function fail	Indicates a failure of the connecting function. May be used to signal faults from the non-OMCI management domain into the OMCI.
1..207	Reserved	
208..223	Vendor-specific alarms	Not to be standardized* (to be discussed before implemented)

5.5.4 Power Over Ethernet (PoE) Control (ME #349)

This managed entity represents the ability to monitor and control the power over Ethernet capability of the ONU as power-sourcing equipment (PSE) as defined in [IEEE 802.3] clauses 30.9 and 33.

An ONU that supports the enhanced PoE control feature automatically creates or deletes an instance of this managed entity whenever it creates or deletes the corresponding PPTP Ethernet UNI.

Administrative control of the PoE feature resides in the power control attribute of the PPTP Ethernet UNI ME.

Application

This managed entity represents the ability to monitor and control the power over Ethernet capability of the ONU as power-sourcing equipment (PSE).

D1 implementation for residential ONUs will not utilize this ME.

Relationships

An instance of this managed entity is associated with each instance of a PPTP Ethernet UNI.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Through an identical ID, this managed entity is implicitly linked to an instance of the physical path Ethernet UNI managed entity. (R) (mandatory) (2 bytes)

PoE capabilities: This attribute is a bit map that identifies the PoE capabilities of the port.

Bits are assigned as follows:

Bit	Meaning
1 (LSB)	When this bit is 1, the PSE pinout alternative may be changed through the power pair pinout control attribute. When the bit is 0, the PSE pinout alternative is fixed, and is described by the power pair pinout control attribute.
2..16	Reserved

(R) (mandatory) (2 bytes)

Power pair pinout control: If the PSE pinout is configurable, according to the PoE capabilities attribute, this attribute is used to configure the pinout. If the

PSE pinout is fixed, this attribute is read-only. In either case, the value returned by a get operation indicates the actual configuration. The value 0 configures/indicates pinout alternative A (signal pairs); the value 1 configures/indicates pinout alternative B (spare pairs). Other values are reserved. This attribute corresponds to the aPSEPowerPairs variable defined in [IEEE 802.3]. (R, W) (mandatory) (1 byte)

Operational state: This attribute indicates whether or not the PPTP is capable of performing its function. Valid values are enabled (0) and disabled (1). (R) (mandatory) (1 byte)

Power detection status: This attribute is an enumeration that returns the current status of the port. It corresponds to the aPSEPowerDetectionStatus variable defined in [IEEE 802.3]. Its values are defined as follows:

0 PSE disabled
1 PSE searching
2 PSE delivering power
3 PSE test mode
4 PSE fault detected
5 PSE implementation specific fault detected

Other values are reserved.

(R) (mandatory) (1 byte)

Power classification status: This attribute is an enumeration that indicates the PD class of a detected PD. It is only valid when the power detection status attribute indicates PSE delivering power. The attribute corresponds to the aPSEPowerClassification variable defined in [IEEE 802.3]. Its values are defined as follows:

0 Undefined or feature not supported
1 Class 0 PD
2 Class 1 PD
3 Class 2 PD
4 Class 3 PD
5 Class 4 PD

Other values are reserved.

(R) (optional) (1 byte)

Power priority: This attribute controls the priority of the port from the point of view of a power management algorithm. The priority that is set by this attribute could be used by a control mechanism that prevents overcurrent situations by first disconnecting ports with lower power priority (higher numerical value). The attribute corresponds to the pethPsePortPowerPriority variable defined in [b-IETF RFC 3621]. Valid values are

1 critical
2 high
3 low

(R, W) (optional) (1 byte)

Invalid signature counter: This attribute increments when the [IEEE 802.3] PoE state machine enters the signature_invalid state, but not more than twice per

second. The counter is never explicitly reset, but its value is not required to persist over ONU initialization. (R) (optional) (2 bytes)

Power denied counter: This attribute increments when the [IEEE 802.3] PoE state machine enters the power_denied state, but not more than twice per second. The counter is never explicitly reset, but its value is not required to persist over ONU initialization. (R) (optional) (2 bytes)

Overload counter: This attribute increments when the [IEEE 802.3] PoE state machine enters the error_delay_over state, but not more than twice per second. The counter is never explicitly reset, but its value is not required to persist over ONU initialization. (R) (mandatory) (2 bytes)

Short counter: This attribute increments when the [IEEE 802.3] PoE state machine enters the error_delay_short state, but not more than twice per second. The counter is never explicitly reset, but its value is not required to persist over ONU initialization. (R) (optional) (2 bytes)

MPS absent counter: This attribute increments when the [IEEE 802.3] PoE state machine goes from the state power_on to the idle state, but not more than twice per second. The counter is never explicitly reset, but its value is not required to persist over ONU initialization. (R) (optional) (2 bytes)

PsE class control: This attribute may be used to place specific limits on the class of power supported by this port. Valid code points for this attribute are:

0 Power feed enabled at the default level for this port
1 Power feed enabled at the class 0 power level
2 Power feed enabled at the class 1 power level
3 Power feed enabled at the class 2 power level
4 Power feed enabled at the class 3 power level
5 Power feed enabled at the class 4 power level

Other values are reserved. (R, W) (optional) (1 byte)

Actions

Get, set

Notifications

Attribute value change

Number	Attribute value change	Description
1..2	N/A	
3	Operational state	
4..12	N/A	
13..16	Reserved	

5.6 This section is intentionally left blank.

5.7 xDSL services

There are no xDSL services related MEs required.

5.8 TDM services

There are no TDM services related MEs required.

5.9 Voice services

5.9.1 Physical Path Termination Point POTS UNI (ME #53)

This managed entity represents a POTS UNI in the ONU, where a physical path terminates and physical path level functions (analogue telephony) are performed.

The ONU automatically creates an instance of this managed entity per port:

- when the ONU has POTS ports built into its factory configuration;
- when a cardholder is provisioned to expect a circuit pack of the POTS type;
- when a cardholder provisioned for plug-and-play is equipped with a circuit pack of the POTS type. Note that the installation of a plug-and-play card may indicate the presence of POTS ports via equipment ID as well as type, and indeed may cause the ONU to instantiate a port mapping package that specifies POTS ports.

The ONU automatically deletes instances of this managed entity when a cardholder is neither provisioned to expect a POTS circuit pack, nor is it equipped with a POTS circuit pack.

Application

Represents the POTS UNI in the ONU where physical path terminates and analog telephony physical level functions are performed.

Relationships

An instance of this managed entity is associated with each real or pre-provisioned POTS port. Either a SIP or a VoIP voice CTP links to the POTS UNI. Status is available from a VoIP line status ME, and RTP and call control PM may be collected on this point.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. This two-byte number indicates the physical position of the UNI. The first byte is the slot ID (defined in section 5.1.5). The second byte is the port ID, with the range 1..255. (R) (mandatory) (2 bytes)

Administrative state: This attribute shuts down (2), locks (1) and unlocks (0) the functions performed by this managed entity. In case the administrative state is set to shut down while the POTS UNI line state is non-idle, no action is taken until the POTS UNI line state changes to idle, whereupon the administrative state changes to locked. In case the administrative state is set to shut down and the POTS UNI line state is already idle, the administrative state is immediately set to locked. In both cases, the transition from shutting down to locked state is signalled with an AVC.

When the administrative state is set to lock, all user functions of this UNI are blocked, and alarms, TCAs and AVCs for this managed entity and all dependent managed entities are no longer generated. Selection of a default value for this attribute is outside the scope of this Recommendation. (R, W) (mandatory) (1 byte)

Deprecated: This attribute is not used and should not be supported. (R, W) (optional) (2 bytes)

ARC: See [ITU-T G.988] clause A.1.4.3. (R, W) (optional) (1 byte)

ARC interval: See [ITU-T G.988] clause A.1.4.3. (R, W) (optional) (1 byte)

Impedance: This attribute specifies the impedance for the POTS UNI. Valid values include:

0 600 Ohms
1 900 Ohms

The following parameter sets from Annex C of [ETSI TS 101 270-1] are also defined:

2 C1=150 nF, R1=750 Ohm, R2=270 Ohm
3 C1=115 nF, R1=820 Ohm, R2=220 Ohm
4 C1=230 nF, R1=1050 Ohm, R2=320 Ohm

where C1, R1, and R2 are related as shown in Figure 10. Upon ME instantiation, the ONU sets this attribute to 0. (R, W) (optional) (1 byte)

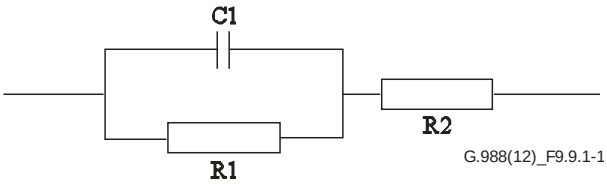

Figure 10 - Impedance Model for POTS UNI

Transmission path: This attribute allows setting the POTS UNI either to full-time on-hook transmission (0) or part-time on-hook transmission (1). Upon ME instantiation, the ONU sets this attribute to 0. (R, W) (optional) (1 byte)

Rx gain: This attribute specifies a gain value for the received signal in the form of a 2s complement number. Valid values are –120 (12.0 dB) to 60 (+6.0 dB). The direction of the affected signal is in the D to A direction, towards the telephone set. Upon ME instantiation, the ONU sets this attribute to 0. (R, W) (optional) (1 byte)

Tx gain: This attribute specifies a gain value for the transmit signal in the form of a 2s complement number. Valid values are –120 (12.0 dB) to 60 (+6.0 dB). The direction of the affected signal is in the A to D direction, away from the telephone set. Upon ME instantiation, the ONU sets this attribute to 0. (R, W) (optional) (1 byte)

Operational state: This attribute indicates whether or not the managed entity is capable of performing its function. Valid values are enabled (0) and disabled (1). (R) (optional) (1 byte)

Hook state: This attribute indicates the current state of the subscriber line: 0 = on hook, 1 = off hook (R) (optional) (1 byte)

POTS holdover time: This attribute determines the time during which the POTS loop voltage is held up when the ONU is not ranged on the PON. After the specified time elapses, the ONU drops the loop voltage, and may thereby cause premises intrusion alarm circuits to go active. When the ONU ranges successfully on the PON, it restores the POTS loop voltage immediately and resets the timer to zero. The attribute is expressed in seconds. The default value 0 selects the vendor's factory policy. (R, W) (optional) (2 bytes)

Nominal feed voltage: This attribute indicates the designed nominal feed voltage of the POTS loop. It is an absolute value with resolution 1 Volt. This attribute does not represent the actual voltage measured on the loop, which is available through the test command. (R, W) (optional) (1 byte)

Actions

Get, set

Test: Request that the ONU perform one or more MLT tests or a dial tone make/break test. Vendor-specific tests are also supported by the test and test result message layouts in [ITU-T G.988] Annex A.

Notifications

Attribute value change

Number	Attribute value change	Description
1	Administrative state	The only change that is signalled with an AVC is the transition from shutting down to locked.
2	N/A	
3	ARC	ARC timer expiration
4..8	N/A	
9	Op state	Operational state
10..11	N/A	
12..16	Reserved	

5.9.2 SIP User Data (ME #153)

The SIP user data defines the user specific configuration attributes associated with a specific VoIP CTP. This entity is conditionally required for ONUs that offer VoIP SIP services. If a non-OMCI interface is used to manage SIP for VoIP, this ME is unnecessary. The non-OMCI interface supplies the necessary data, which may be read back to the OLT via the SIP config portal ME.

An instance of this managed entity is created and deleted by the OLT. A SIP user data instance is required for each POTS UNI port using SIP protocol and configured by the OMCI.

Relationships

An instance of this managed entity is associated with one VoIP voice CTP managed entity and a PPTP POTS UNI.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

SIP agent pointer: This attribute points to the SIP agent config data ME to be used for signalling. (R, W, Set-by-create) (mandatory) (2 bytes)

User part AOR: This attribute points to a large string that contains the user identification part of the address of record. This can take the form of an alphanumeric string or the subscriber's directory number. A null pointer indicates the absence of an AOR. (R, W, Set-by-create) (mandatory) (2 bytes)

SIP display name: This ASCII string attribute defines the customer ID used for the display attribute in outgoing SIP messages. The default value is null (all zero bytes) (R, W) (mandatory) (25 bytes)

Username/password: This attribute points to an authentication security method ME that contains the SIP user name and password used for authentication. A null pointer indicates no username/password. (R, W, Set-by-create) (mandatory) (2)

Voicemail server SIP URI: This attribute points to a network address ME that contains the name (IP address or URI) of the SIP voicemail server for SIP

signalling messages. A null pointer indicates the absence of a SIP voicemail server. (R, W, Set-by-create) (mandatory) (2 bytes)

Voicemail subscription expiration time: This attribute defines the voicemail subscription expiration time in seconds. If this value is 0, the SIP agent uses an implementation-specific value. This attribute is recommended to be set to 3600 seconds by default. (R, W, Set-by-create) (mandatory) (4 bytes)

Network dial plan pointer: This attribute points to a network dial plan table. A null pointer indicates the absence of a network dial plan. (R, W, Set-by-create) (mandatory) (2 bytes)

Application services profile pointer: This attribute points to a VoIP application services profile. (R, W, Set-by-create) (mandatory) (2 bytes)

Feature code pointer: This attribute points to the VoIP feature access codes ME for this subscriber. A null pointer indicates the absence of a VoIP feature access codes ME. (R, W, Set-by-create) (mandatory) (2 bytes)

PPTP pointer: This attribute points to the PPTP POTS UNI managed entity that provides the analogue telephony adaptor (ATA) function. (R, W, Set-by-create) (mandatory) (2 bytes)

Release timer: This attribute contains a release timer defined in seconds. The value 0 specifies that the ONU is to use its internal default. The default value of this attribute is 10 seconds. (R, W) (optional) (1 byte)

ROH timer: This attribute defines the time in seconds for the receiver off hook condition before ROH tone is applied. The value 0 disables ROH timing. The value 0xFF specifies that the ONU is to use its internal default, which may or may not be the same as the 15 second OMCI default value. (R, W) (optional) (1 byte)

Actions

Create, delete, get, set

Notifications

Alarm

Alarm number	Alarm	Description
0	SIPUA register auth	Cannot authenticate a registration session (e.g., missing credentials)
1	SIPUA register timeout	Timeout waiting for response from a registration server
2	SIPUA register fail	Failure response received from a registration server
3..207	Reserved	
208..223	Vendor-specific alarms	Not to be standardized* (to be discussed before implemented)

5.9.3 SIP Agent Config Data (ME #150)

The SIP agent config data managed entity models a SIP signalling agent. It defines the configuration necessary to establish communication for signalling between the SIP user agent and a SIP server.

Note 1: If a non-OMCI interface is used to manage SIP for VoIP, this ME is unnecessary. The non-OMCI interface supplies the necessary data, which may be read back to the OLT via the SIP config portal ME.

Instances of this managed entity are created and deleted by the OLT.

Relationships

An instance of this managed entity serves one or more SIP user data managed entities and points to a TCP/UDP config data that carries signalling messages. Other pointers establish additional agent parameters such as proxy servers.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

Proxy server address pointer: This attribute points to a large string ME that contains the name (IP address or URI) of the SIP proxy server for SIP signalling messages. (R, W, Set-by-create) (mandatory) (2 bytes)

Outbound proxy address pointer: An outbound SIP proxy may or may not be required within a given network. If an outbound SIP proxy is used, the outbound proxy address pointer attribute must be set to point to a valid large string ME that contains the name (IP address or URI) of the outbound proxy server for SIP signalling messages. If an outbound SIP proxy is not used, the outbound proxy address pointer attribute must be set to a null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Primary SIP DNS: This attribute specifies the primary SIP DNS IP address. If the value of this attribute is 0, the primary DNS server is defined in the corresponding IP host config data or IPv6 host config data ME. If the value is non-zero, it takes precedence over the primary DNS server defined in the IP host config data or IPv6 host config data ME. (R, W, Set-by-create) (mandatory) (4 bytes)

Secondary SIP DNS: This attribute specifies the secondary SIP DNS IP address. If the value of this attribute is 0, the secondary DNS server is defined in the corresponding IP host config data or IPv6 host config data ME. If the value is non-zero, it takes precedence over the secondary DNS server defined in the IP host config data or IPv6 host config data ME. (R, W, Set-by-create) (mandatory) (4 bytes)

TCP/UDP pointer: This pointer associates the SIP agent with the TCP/UDP config data ME to be used for communication with the SIP server. The default value is 0xFFFF, a null pointer. (R, W) (mandatory) (2 bytes)

SIP reg exp time: This attribute specifies the SIP registration expiration time in seconds. If its value is 0, the SIP agent does not add an expiration time to the registration requests and does not perform re-registration. The default value is 3600 seconds. (R, W) (mandatory) (4 bytes)

SIP rereg head start time: This attribute specifies the time in seconds prior to timeout that causes the SIP agent to start the re-registration process. The default value is 360 seconds. (R, W) (mandatory) (4 bytes)

Host part URI: This attribute points to a large string ME that contains the host or domain part of the SIP address of record for users connected to this ONU. A null pointer indicates that the current address in the IP host config ME is to be used. (R, W, Set-by-create) (mandatory) (2 bytes)

SIP status: This attribute shows the current status of the SIP agent. Values are as follows:

0 Ok/initial
1 Connected
2 Failed – ICMP error
3 Failed – Malformed response
4 Failed – Inadequate info response
5 Failed – Timeout
6 Redundant, offline: this instance of the SIP agent config data occupies the role of a redundant server, and is not presently in use.

(R) (mandatory) (1 byte)

SIP registrar: This attribute points to a network address ME that contains the name (IP address or resolved name) of the registrar server for SIP signalling messages. Examples: "10.10.10.10" and "proxy.voip.net". (R, W, Set-by-create) (mandatory) (2 bytes)

Softswitch: This attribute identifies the SIP gateway softswitch vendor. The format is four ASCII coded alphabetic characters [A..Z] as defined in [ATIS-0300220]. A value of four null bytes indicates an unknown or unspecified vendor. (R, W, Set-by-create) (mandatory) (4 bytes)

SIP response table: This attribute specifies the tone and text to be presented to the subscriber upon receipt of various SIP messages (normally 4xx, 5xx, 6xx message codes). The table is a sequence of entries, each of which is defined as follows:

SIP response code (2 bytes): This field is the value of the SIP message code. It also serves as the index into the SIP response table. When a set operation is performed with the value 0 in this field, the table is cleared.

Tone (1 byte): This field specifies one of the tones in the tone pattern table of the associated voice service profile. The specified tone is played to the subscriber.

Text message (2 bytes): This field is a pointer to a large string that contains a message to be displayed to the subscriber. If the value of this field is a null pointer, text pre-associated with the tone may be displayed, or no text at all.

(R, W) (optional) (N * 5 bytes)

NOTE 2 – This model assumes that SIP response tones and text are common to all POTS lines that share a given SIP agent.

SIP option transmit control: This Boolean attribute specifies that the ONU is (true) or is not (false) enabled to transmit SIP options. The default value is recommended to be false. (R, W, Set-by-create) (optional) (1 byte)

SIP URI format: This attribute specifies the format of the URI in outgoing SIP messages. The recommended default value 0 specifies TEL URIs; the value 1 specifies SIP URIs. Other values are reserved. (R, W, Set-by-create) (optional) (1 byte)

Redundant SIP agent pointer: This attribute points to another SIP agent config data ME, which is understood to provide redundancy. The initial SIP agent is determined by the pointer from the SIP user data ME. It is the manager's responsibility to provision a group of redundant SIP agents with mutually consistent attributes. (R, W, Set-by-create) (optional) (2 bytes)

Actions

Create, delete, get, set

Set table (optional)

Notifications

Attribute value change

Number	Attribute value change	Description
1..8	N/A	
9	SIP status	Status change
10..11	N/A	
12..16	Reserved	

Alarm

Alarm number	Alarm	Description
0	SIPUA register name	Failed to resolve the registration server name
1	SIPUA register reach	Cannot reach a registration server (the port cannot be reached, ICMP errors)
2	SIPUA register connect	Cannot connect to a registration server (due to bad credentials or other faults after the port has responded)
3	SIPUA register validate	Cannot validate a registration server
4 (Note)	SIPUA register auth	Cannot authenticate a registration session (e.g., missing credentials)
5 (Note)	SIPUA register timeout	Timeout waiting for response from a registration server
6 (Note)	SIPUA register fail	Failure response received from a registration server
7..207	Reserved	
208..223	Vendor-specific alarms	Not to be standardized* (to be discussed before implemented)
Note: These alarms are deprecated, and retained for backward compatibility. It is recommended that the SIP agent config data not declare these alarms, but that they be declared by the SIP user data ME instead. In any event, only one ME should declare the alarm, not both.		

5.9.4 VoIP Voice CTP (ME #139)

The VoIP voice CTP defines the attributes necessary to associate a specified VoIP service (SIP, ITU-T H.248) with a POTS UNI. This entity is conditionally required for ONUs that offer VoIP services. If a non-OMCI interface is used to manage VoIP signalling, this ME is unnecessary.

An instance of this managed entity is created and deleted by the OLT. A VoIP voice CTP managed entity is needed for each PPTP POTS UNI served by VoIP.

Application

This ME defines the attributes necessary to associate the H.248 VoIP service with a POTS UNI.

Relationships

An instance of this managed entity links a PPTP POTS UNI managed entity with a VoIP media profile and a SIP user data or MGC config data ME.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

User protocol pointer: This attribute points to signalling protocol data. If the signalling protocol used attribute of the VoIP config data managed entity specifies that the ONU's signalling protocol is SIP, this attribute points to a SIP user data ME, which in turn points to a SIP agent config data. If the signalling

protocol is ITU-T H.248, this attribute points directly to an MGC config data ME. (R, W, Set-by-create) (mandatory) (2 bytes)

PPTP pointer: This attribute points to the PPTP POTS UNI managed entity that serves the analogue telephone port. (R, W, Set-by-create) (mandatory) (2 bytes)

VOIP media profile pointer: This attribute points to an associated VoIP media profile. (R, W, Set-by-create) (mandatory) (2 bytes)

Signalling code: This attribute specifies the POTS-side signalling:

1 Loop start
2 Ground start
3 Loop reverse battery
4 Coin first
5 Dial tone first
6 Multi-party

(R, W, Set-by-create) (mandatory) (1 byte)

Actions

Create, delete, get, set

Notifications

None.

5.9.5 VoIP Media Profile (ME #142)

The VoIP media profile managed entity contains settings that apply to VoIP voice encoding. This entity is conditionally required for ONUs that offer VoIP services. If a non-OMCI interface is used to manage VoIP signalling, this ME is unnecessary.

An instance of this managed entity is created and deleted by the OLT. A VoIP media profile is needed for each unique set of profile attributes.

Application

This ME contains settings that apply to the H.248 VoIP voice encoding.

Relationships

An instance of this managed entity may be associated with one or more VoIP voice CTP managed entities.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

Fax mode: Selects the fax mode; values are:

0 Passthru
1 ITU-T T.38

(R, W, Set-by-create) (mandatory) (1 byte)

Voice service profile pointer: Pointer to a voice service profile, which defines parameters such as jitter buffering and echo cancellation. (R, W, Set-by-create) (mandatory) (2 bytes)

Codec selection (1st order): This attribute specifies codec selection as defined by [IETF RFC 3551].

Value	Encoding name	Clock rate (Hz)
0	PCMU	8,000
1	reserved	
2	reserved	
3	GSM	8,000
4	ITU-T G.723	8,000
5	DVI4	8,000
6	DVI4	16,000
7	LPC	8,000
8	PCMA	8,000
9	ITU-T G.722	8,000
10	L16, 2 channels	44,100
11	L16, 1 channel	44,100
12	QCELP	8,000
13	CN	8,000
14	MPA	90,000
15	ITU-T G.728	8,000
16	DVI4	11,025
17	DVI4	22,050
18	ITU-T G.729	8,000

(R, W, Set-by-create) (mandatory) (1 byte)

Packet period selection (1st order): This attribute specifies the packet period selection interval in milliseconds. The recommended default value is 10. Valid values are 10..30 ms. (R, W, Set-by-create) (mandatory) (1 byte)

Silence suppression (1st order): This attribute specifies whether silence suppression is on or off. Valid values are 0 = off and 1 = on. (R, W, Set-by-create) (mandatory) (1 byte)

Three more groups of three attributes are defined, with definitions identical to the preceding three:

Codec selection (2nd order): (R, W, Set-by-create) (mandatory) (1 byte)

Packet period selection (2nd order): (R, W, Set-by-create) (mandatory) (1 byte)

Silence suppression (2nd order): (R, W, Set-by-create) (mandatory) (1 byte)

Codec selection (3rd order): (R, W, Set-by-create) (mandatory) (1 byte)

Packet period selection (3rd order): (R, W, Set-by-create) (mandatory) (1 byte)

Silence suppression (3rd order): (R, W, Set-by-create) (mandatory) (1 byte)

Codec selection (4th order): (R, W, Set-by-create) (mandatory) (1 byte)

Packet period selection (4th order): (R, W, Set-by-create) (mandatory) (1 byte)

Silence suppression (4th order): (R, W, Set-by-create) (mandatory) (1 byte)

OOB DTMF: This attribute specifies out-of-band DMTF carriage. When enabled (1), DTMF signals are carried out of band via RTP or the associated signalling protocol. When disabled (0), DTMF tones are carried in the PCM stream. (R, W, Set-by-create) (mandatory) (1 byte)

RTP profile pointer: This attribute points to the associated RTP profile data ME. (R, W, Set-by-create) (mandatory) (2 bytes)

Actions

Create, delete, get, set

Notifications

None.

5.9.6 Voice Service Profile (ME #58)

This managed entity organizes data that describe the voice service functions of the ONU. Instances of this managed entity are created and deleted by the OLT.

Application

Organizes data that describe the voice service functions of the ONU.

Relationships

An instance of this managed entity may be associated with zero or more instances of a VoIP voice CTP by way of a VoIP media profile.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

Announcement type: This attribute specifies the treatment when a subscriber goes off hook but does not attempt a call within the dial-tone timeout interval. Valid values include:

0x01	Silence
0x02	Reorder tone
0x03	Fast busy
0x04	Voice announcement
0xFF	Not specified; ONU is free to make its own choice.

(R, W, Set-by-create) (mandatory) (1 byte)

Jitter target: This attribute specifies the target value of the jitter buffer in milliseconds. The system tries to maintain the jitter buffer at the target value. The value 0 specifies dynamic jitter buffer sizing. (R, W, Set-by-create) (optional) (2 bytes)

Jitter buffer max:This attribute specifies the maximum depth of the jitter buffer associated with this service in milliseconds. The value 0 specifies that the ONU use its internal default. (R, W, Set-by-create) (optional) (2 bytes)

Echo cancel ind: The Boolean value true specifies that echo cancellation is on; false specifies off. (R, W, Set-by-create) (mandatory) (1 byte)

PSTN protocol variant: This attribute controls which variant of POTS signalling is used on the associated UNIs. Its value is equal to the [ITU-T E.164] country code. The value 0 specifies that the ONU use its internal default. (R, W, Set-by-create) (optional) (2 bytes)

DTMF digit levels: This attribute specifies the power level of DTMF digits that may be generated by the ONU towards the subscriber set. It is a 2s complement value referred to 1 mW at the 0 TLP (dBm0), with resolution 1 dB. The default value 0x8000 selects the ONU's internal policy. (R, W, Set-by-create) (optional) (2 bytes)

DTMF digit duration: This attribute specifies the duration of DTMF digits that may be generated by the ONU towards the subscriber set. It is specified in milliseconds. The default value 0 selects the ONU's internal policy. (R, W, Set-by-create) (optional) (2 bytes)

Hook flash minimum time: This attribute defines the minimum duration recognized by the ONU as a switchhook flash. It is expressed in milliseconds; the default value 0 selects the ONU's internal policy. (R, W, Set-by-create) (optional) (2 bytes)

Hook flash maximum time: This attribute defines the maximum duration recognized by the ONU as a switchhook flash. It is expressed in milliseconds; the default value 0 selects the ONU's internal policy. (R, W, Set-by-create) (optional) (2 bytes)

Tone pattern table: This attribute is a table, each of whose entries specifies a complex tone (or silence) and a duration. By linking tones and silence together, possibly cyclically, continuous, varying or interrupted tone sequences, repetitive or not, may be defined. A tone sequence is initiated by pointing to the first tone pattern table entry that defines its parameters. Each entry is a vector comprising the following components:

Index (1 byte): This component is simply an index into the table. It ranges from 1..255. In a set operation, the value 0 in this field clears the table.

Tone on (1 byte): This Boolean component controls whether the tone is on (true) or off. If the tone is off, the frequency and power fields are not meaningful.

Frequency 1 (2 bytes): This component specifies the frequency of one of the tone components in Hz.

Power 1 (1 byte): This component specifies the power level of the corresponding frequency component. It ranges from 0 (coded as 0) to –25.5 (coded as 255) dBm0 with 0.1 dB resolution.

Three additional pairs of frequency-power components may be specified to define a complex tone. If a pair of possibilities is not to be used, its frequency field should be set to 0.

Frequency 2 (2 bytes)
Power 2 (1 byte)
Frequency 3 (2 bytes)
Power 3 (1 byte)
Frequency 4 (2 bytes)
Power 4 (1 byte)

The following pair of frequency-power components allows the composite tone to be modulated (warble effect). If this effect is not to be used, the frequency should be set to 0.

Modulation frequency (2 bytes), Hz
Modulation power (1 byte), 0..25.5 dBm0

Duration (2 bytes): This component specifies the duration of the phase, in milliseconds. The value 0 specifies that the phase endures indefinitely, that is, until terminated by other events such as call abandonment.

Next entry (1 byte): This component is a pointer to another entry in this same table, which permits sequences of tones to be defined, possibly cyclically. A reference to a non-existent table entry, or the value 0, indicates that the sequence should be terminated.

(R, W) (optional) (N * 20 bytes)

Tone event table:This attribute is a table, each of whose entries specifies an event for which a tone is defined. If the tone can be synthesized by a sequence of complex tones and silence, the event refers to an entry in the tone pattern table. Otherwise, the event refers to a file name that is expected to be recognized by the ONU environment. Each entry in the tone event table is a vector comprising the following components:

Event (1 byte): This component is an enumeration of the events for which a tone may be defined. The event component also serves as the index for the table. A set operation to event 0 causes the table to be cleared.

Value	Tone event
0	Not used for get operation; clears table under set operation
1	Busy
2	Confirmation
3	Dial
4	Message waiting
5	Off hook warning (receiver off hook)
6	Ringback (audible ring)
7	Reorder
8	Stutter dial
9	Call waiting 1

Value	Tone event
10	Call waiting 2
11	Call waiting 3
12	Call waiting 4
13	Alerting signal
14	Special dial
15	Special info
16	Release
17	Congestion
18	User defined 1
19	User defined 2
20	User defined 3
21	User defined 4
22..32	Reserved
33	Intrusion
34	Dead tone
35..223	Reserved
224..255	Vendor-specific codes, Not to be standardized* (to be discussed before implemented)

Tone pattern (1 byte): This component specifies an entry point into the tone pattern table attribute, to be invoked when the specified event occurs. The value 0 indicates that no tone from the tone pattern table is to be played.

Tone file (2 bytes): This component points to a large string managed entity that contains the path and name of a file containing a codec sequence to be played out. If no file is found after traversing these links, no tone is played. The behaviour is unspecified if both tone pattern and tone file are specified.

Tone file repetitions (1 byte): This component specifies the number of times the tone file is to be repeated. The value 0 means that the file is to be repeated indefinitely until terminated by some external event such as call abandonment.

Reserved (2 bytes)

(R, W) (optional) (N * 7 bytes).

Ringing pattern table: This attribute is a table, each of whose entries specifies a ringing pattern and a duration. By linking ringing and silence together, possibly cyclically, continuous or interrupted ringing sequences, repetitive or not, may be defined. A ringing sequence is initiated by pointing to the first ringing pattern table entry that defines its parameters. Each entry is a vector comprising the following components:

Index (1 byte): This component is simply an index into the table. It ranges from 1..255. In a set operation, the value 0 in this field clears the table.

Ringing on (1 byte): This Boolean component controls whether ringing is on (true) or off during this interval.

Duration (2 bytes): This component specifies the duration of the ringing phase, in milliseconds. The value 0 specifies that the phase endures indefinitely, that is, until terminated by other events such as call abandonment.

Next entry (1 byte): This component is a pointer to another entry in this same table, which permits sequences of ringing bursts to be defined, possibly cyclically. A reference to a non-existent table entry, or the value 0, indicates that the sequence should be terminated.

(R, W) (optional) (N * 5 bytes).

Ringing event table: This attribute is a table, each of whose entries specifies an event for which a ringing sequence is defined. If the ringing sequence can be generated as a sequence of power ringing and silent intervals, the event refers to an entry in the ringing pattern table. Otherwise, the event refers to a file name that is expected to be recognized by the ONU environment. Each entry is a vector comprising the following components:

Event (1 byte): This component is an enumeration of the events for which a ringing sequence may be defined. The event component also serves as the index for the table. A set operation with the value 0 in this field causes the table to be cleared.

Value	Tone event
0	Not used for get operation; clears table under set operation
1	Default
2	Splash
3..223	Reserved
224..255	Vendor-specific codes, Not to be standardized* (to be discussed before implemented)

Ringing pattern (1 byte): This component specifies an entry point into the ringing pattern table attribute, to be invoked when the specified event occurs. The value 0 indicates that no ringing sequence is defined in the ringing pattern table.

Ringing file (2 bytes): This component points to a large string managed entity that contains the path and name of a file containing a ring tone to be played out. If no file is found after traversing these links, no ringing is played. The behaviour is unspecified if both ringing pattern and ringing file fields are specified.

Ringing file repetitions (1 byte): This component specifies the number of times the ringing file is to be repeated. The value 0 means that the file is to be repeated indefinitely until terminated by some external event such as call abandonment.

Ringing text (2 bytes): This component points to a large string managed entity that contains a text string to be displayed on the CPE device in

conjunction with this event. A null pointer indicates that no text is to be displayed.

(R, W) (optional) (N * 7 bytes).

Network specific extensions pointer: This attribute points to a network address managed entity that contains the path and name of a file containing network specific parameters for the associated UNIs. The default value for this attribute is 0xFFFF, a null pointer. (R, W, Set-by-create) (optional) (2 bytes)

Actions

Create, delete, get, set

Set table (optional)

Notifications

Alarm

Number	Alarm	Description
1	File not found	The voice service profile attempted to access a network specific extensions file that is not available.
2..207	Reserved	

5.9.7 RTP Profile Data (ME #143)

This managed entity configures RTP. It is conditionally required for ONUs that offer VoIP service. If a non-OMCI interface is used to manage VoIP, this ME is unnecessary.

An instance of this managed entity is created and deleted by the OLT. An RTP profile is needed for each unique set of attributes.

Application

This ME configures the Real Time Protocol (RTP) for the H.248 VoIP service.

Relationships

An instance of this managed entity may be associated with one or more VoIP media profile managed entities.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

Local port min: This attribute defines the base UDP port that should be used by RTP for voice traffic. The recommended default is 50 000 (R, W, Set-by-create) (mandatory) (2 bytes)

Local port max: This attribute defines the highest UDP port used by RTP for voice traffic. The value must be greater than local port min. The value 0 specifies that the local port max be equal to the local port min. (R, W, Set-by-create) (optional) (2 bytes)

DSCP mark: Diffserv code point to be used for outgoing RTP packets for this profile. The recommended default value is expedited forwarding (EF) = 0x2E. (R, W, Set-by-create) (mandatory) (1 byte)

Piggyback events: Enables or disables RTP piggyback events.

0 Disabled (recommended default)
1 Enabled

(R, W, Set-by-create) (mandatory) (1 byte)

Tone events: Enables or disables the handling of tones via RTP tone events per [IETF RFC 4733], (see also [IETF RFC 4734]).

0 Disabled (recommended default)
1 Enabled

(R, W, Set-by-create) (mandatory) (1 byte)

DTMF events: Enables or disables the handling of DTMF via RTP DTMF events per [IETF RFC 4733], (see also [IETF RFC 4734]). This attribute is ignored unless the OOB DTMF attribute in the VoIP media profile is enabled.

0 Disabled
1 Enabled

(R, W, Set-by-create) (mandatory) (1 byte)

CAS events: Enables or disables the handling of CAS via RTP CAS events per [IETF RFC 4733], (see also [IETF RFC 4734]).

0 Disabled
1 Enabled

(R, W, Set-by-create) (mandatory) (1 byte)

IP host config pointer: This optional pointer associates the bearer (voice) flow with an IP host config data or IPv6 host config data ME. If this attribute is not present or is not populated with a valid pointer value, the bearer flow uses the same IP stack that is used for signalling, indicated by the TCP/UDP pointer in the associated SIP agent or MGC config data. The default value is 0xFFFF, a null pointer. (R, W) (optional) (2 bytes)

Actions

Create, delete, get, set

Notifications

None.

5.9.8 SIP Agent Performance Monitoring History Data (ME #151)

This managed entity collects performance monitoring data for the associated VoIP SIP agent. Instances of this managed entity are created and deleted by the OLT.

For a complete discussion of generic PM architecture, refer to [ITU-T G.988] clause I.4.

Relationships

An instance of this managed entity is associated with a SIP agent config data or SIP config portal object.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Through an identical ID, this managed entity is implicitly linked to an instance of the corresponding SIP agent config data or to the SIP config portal. If a non-OMCI configuration method is used for VoIP, there can be only one live managed entity instance, associated with the SIP config portal, and with managed entity ID 0. (R, Set-by-create) (mandatory) (2 bytes)

Interval end time: This attribute identifies the most recently finished 15-minute interval. (R) (mandatory) (1 byte)

Threshold data 1/2 ID: This attribute points to an instance of the threshold data 1 managed entity that contains PM threshold values. Since no threshold value attribute number exceeds 7, a threshold data 2 ME is optional. (R, W, Set-by-create) (mandatory) (2 bytes)

Transactions: This attribute counts the number of new transactions that were initiated. (R) (optional) (4 bytes)

Rx invite reqs: This attribute counts received invite messages, including retransmissions. (R) (mandatory) (4 bytes)

Rx invite retrans: This attribute counts received invite retransmission messages. (R) (optional) (4 bytes)

Rx noninvite reqs: This attribute counts received non-invite messages, including retransmissions. (R) (optional) (4 bytes)

Rx noninvite retrans: This attribute counts received non-invite retransmission messages. (R) (optional) (4 bytes)

Rx response: This attribute counts total responses received. (R) (mandatory) (4 bytes)

Rx response retransmissions: This attribute counts total response retransmissions received. (R) (optional) (4 bytes)

Tx invite reqs: This attribute counts transmitted invite messages, including retransmissions. (R) (optional) (4 bytes)

Tx invite retrans: This attribute counts transmitted invite retransmission messages. (R) (optional) (4 bytes)

Tx noninvite reqs: This attribute counts transmitted non-invite messages, including retransmissions. (R) (optional) (4 bytes)

Tx noninvite retrans: This attribute counts transmitted non-invite retransmission messages. (R) (optional) (4 bytes)

Tx response: This attribute counts the total responses sent. (R) (mandatory) (4 bytes)

Tx response retransmissions: This attribute counts total response retransmissions sent. (R) (optional) (4 bytes)

Actions

Create, delete, get, set

Get current data (optional)

Notifications

Threshold crossing alert

Alarm number	Threshold crossing alert	Threshold value attribute # (Note)
0	SIPAMD rx invite req	1
1	SIPAMD rx invite req retransmission	2
2	SIPAMD rx noninvite req	3
3	SIPAMD rx noninvite req retransmission	4
4	SIPAMD rx response	5
5	SIPAMD rx response retransmission	6
Note: This number associates the TCA with the specified threshold value attribute of the threshold data 1 managed entity.		

5.9.9 SIP Call Initiation Performance Monitoring History Data (ME #152)

This managed entity collects performance monitoring data related to call initiations of a VoIP SIP agent. Instances of this managed entity are created and deleted by the OLT.

For a complete discussion of generic PM architecture, refer to [ITU-T G.988] clause I.4.

Relationships

An instance of this managed entity is associated with an instance of the SIP agent config data or SIP config portal ME.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Through an identical ID, this managed entity is implicitly linked to an instance of the SIP agent config data or the SIP config portal ME. If a non-OMCI configuration method is used for VoIP, there can be only one live managed entity instance, associated with the SIP config portal, and with managed entity ID 0. (R, Set-by-create) (mandatory) (2 bytes)

Interval end time: This attribute identifies the most recently finished 15-minute interval. (R) (mandatory) (1 byte)

Threshold data 1/2 ID: This attribute points to an instance of the threshold data 1 managed entity that contains PM threshold values. Since no threshold value attribute number exceeds 7, a threshold data 2 ME is optional. (R, W, Set-by-create) (mandatory) (2 bytes)

Failed to connect counter: This attribute counts the number of times that the SIP UA failed to reach/connect its TCP/UDP peer during SIP call initiations. (R) (mandatory) (4 bytes)

Failed to validate counter: This attribute counts the number of times that the SIP UA failed to validate its peer during SIP call initiations. (R) (mandatory) (4 bytes)

Timeout counter: This attribute counts the number of times that the SIP UA timed out during SIP call initiations. (R) (mandatory) (4 bytes)

Failure received counter: This attribute counts the number of times that the SIP UA received a failure error code during SIP call initiations. (R) (mandatory) (4 bytes)

Failed to authenticate counter: This attribute counts the number of times that the SIP UA failed to authenticate itself during SIP call initiations. (R) (mandatory) (4 bytes)

Actions

Create, delete, get, set

Get current data (optional)

Notifications

Threshold crossing alert

Alarm number	Threshold crossing alert	Threshold value attribute # (Note)
0	SIP call PM failed connect	1
1	SIP call PM failed to validate	2
2	SIP call PM timeout	3
3	SIP call PM failure error code received	4
4	SIP call PM failed to authenticate	5
Note: This number associates the TCA with the specified threshold value attribute of the threshold data 1 managed entity.		

5.9.10 MGC Config Data (ME #155)

The MGC config data ME defines the media gateway controller configuration associated with an MG subscriber. It is conditionally required for ONUs that support ITU-T H.248 VoIP services. If a non-OMCI interface is used to manage VoIP signalling, this ME is unnecessary.

Instances of this managed entity are created and deleted by the OLT.

Application

Defines Media Gateway (MG) Controller (MGC) configuration associated with MG POTS subscriber used to support H.248 VoIP services.

Relationships

An instance of this managed entity may be associated with one or more VoIP voice CTP managed entities.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

Primary MGC: This attribute points to a network address ME that contains the name (IP address or resolved name) of the primary MGC that controls the signalling messages. The port is optional and defaults to 2944 for text message formats and 2955 for binary message formats. (R, W, Set-by-create) (mandatory) (2 bytes)

Secondary MGC: This attribute points to a network address ME that contains the name (IP address or resolved name) of the secondary or backup MGC that controls the signalling messages. The port is optional and defaults to 2944 for text message formats and 2955 for binary message formats. (R, W, Set-by-create) (mandatory) (2 bytes)

TCP/UDP pointer: This attribute points to the TCP/UDP config data ME to be used for communication with the MGC. (R, W, Set-by-create) (mandatory) (2 bytes)

Version: This integer attribute reports the version of the Megaco protocol in use. The ONU should deny an attempt by the OLT to set or create a value that it does not support. The value 0 indicates that no particular version is specified. (R, W, Set-by-create) (mandatory) (1 byte)

Message format: This attribute defines the message format. Valid values are:

0 Text long
1 Text short
2 Binary

The default value is recommended to be 0. (R, W, Set-by-create) (mandatory) (1 byte)

Maximum retry time: This attribute specifies the maximum retry time for MGC transactions, in seconds. The default value 0 specifies vendor-specific implementation. (R, W) (optional) (2 bytes)

Maximum retry attempts: This attribute specifies the maximum number of times a message is retransmitted to the MGC. The recommended default value 0

specifies vendor-specific implementation. (R, W, Set-by-create) (optional) (2 bytes)

Service change delay: This attribute specifies the service status delay time for changes in line service status. This attribute is specified in seconds. The default value 0 specifies no delay. (R, W) (optional) (2 bytes)

Termination ID base: This attribute specifies the base string for the ITU-T H.248 physical termination id(s) for this ONU. This string is intended to uniquely identify an ONU. Vendor-specific termination identifiers (port IDs) are optionally added to this string to uniquely identify a termination on a specific ONU. (R, W) (optional) (25 bytes)

Softswitch: This attribute identifies the gateway softswitch vendor. The format is four ASCII coded alphabetic characters [A..Z] as defined in [ATIS-0300220]. A value of four null bytes indicates an unknown or unspecified vendor. (R, W, Set-by-create) (mandatory) (4 bytes)

Message ID pointer: This attribute points to a large string whose value specifies the message identifier string for ITU-T H.248 messages originated by the ONU. (R, W, Set-by-create) (optional) (2 bytes)

Actions

Create, delete, get, set

Notifications

Alarm

Alarm number	Alarm	Description
0	Timeout	Timeout of association with MG
1..207	Reserved	
208..223	Vendor-specific alarms	Not to be standardized* (to be discussed before implemented)

5.9.11 MGC Performance Monitoring History Data (ME #156)

The MGC monitoring data managed entity provides run-time statistics for an active MGC association. Instances of this managed entity are created and deleted by the OLT.

For a complete discussion of generic PM architecture, refer to [ITU-T G.988] clause I.4.

Relationships

An instance of this managed entity is associated with an instance of the MGC config data or MGC config portal ME.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Through an identical ID, this managed entity is implicitly linked to an instance of the associated MGC config data or to the MGC config portal ME. If a non-OMCI configuration method is used for VoIP, there can be only one live managed entity instance, associated with the MGC

config portal, and with managed entity ID 0. (R, Set-by-create) (mandatory) (2 bytes)

Interval end time: This attribute identifies the most recently finished 15-minute interval. (R) (mandatory) (1 byte)

Threshold data 1/2 ID: This attribute points to an instance of the threshold data 1 managed entity that contains PM threshold values. Since no threshold value attribute number exceeds 7, a threshold data 2 ME is optional. (R, W, Set-by-create) (mandatory) (2 bytes)

Received messages: This attribute counts the number of received Megaco messages on this association, as defined by [ITU-T H.341]. (R) (mandatory) (4 bytes)

Received octets: This attribute counts the total number of octets received on this association, as defined by [ITU-T H.341]. (R) (mandatory) (4 bytes)

Sent messages: This attribute counts the total number of Megaco messages sent over this association, as defined by [ITU-T H.341]. (R) (mandatory) (4 bytes)

Sent octets: This attribute counts the total number of octets sent over this association, as defined by [ITU-T H.341]. (R) (mandatory) (4 bytes)

Protocol errors: This attribute counts the total number of errors detected on this association, as defined by [ITU-T H.341]. This includes:

- syntax errors detected in a given received message;
- outgoing transactions that failed for protocol reasons.

(R) (mandatory) (4 bytes)

Transport losses: This attribute counts the total number of transport losses (for example, socket problems) detected on this association. A link loss is defined as loss of communication with the remote entity due to hardware/transient problems, or problems in related software. (R) (mandatory) (4 bytes)

Last detected event: This attribute reports the last event detected on this association. This includes events such as the link failing or being set up. Under normal circumstances, a get action on this attribute would return 0 to indicate no abnormal activity. This field is an enumeration:

0 No event – No event has yet been detected during this PM interval.
1 Link up – The transport link underpinning the association came up.
2 Link down – The transport link underpinning the association went down.
3 Persistent error – A persistent error was detected on the link (such as the socket/TCP connection to the remote node could not be set up).
4 Local shutdown – The association was brought down intentionally by the local application.
5 Failover down – The association was brought down as part of failover processing.
255 Other event – The latest event does not match any in the list.

(R) (mandatory) (1 byte)

Last detected event time: This attribute reports the time in seconds since the last event on this association was detected, as defined by [ITU-T H.341]. (R) (mandatory) (4 bytes)

Last detected reset time: This attribute reports the time in seconds since these statistics were last reset, as defined by [ITU-T H.341]. Under normal circumstances, a get action on this attribute would return 900 seconds to indicate a completed 15-minute interval. (R) (mandatory) (4 bytes)

Actions

Create, delete, get, set

Get current data (optional)

Notifications

Threshold crossing alert

Alarm number	Threshold crossing alert	Threshold value attribute # (Note)
0	MGCP protocol errors	1
1	MGCP transport losses	2
Note: This number associates the TCA with the specified threshold value attribute of the threshold data 1 managed entity.		

5.9.12 VoIP Config Data (ME #138)

The VoIP configuration data managed entity defines the configuration for VoIP in the ONU. The OLT uses this ME to discover the VoIP signalling protocols and configuration methods supported by this ONU. The OLT then uses this ME to select the desired signalling protocol and configuration method. The entity is conditionally required for ONUs that offer VoIP services.

An ONU that supports VoIP services automatically creates an instance of this managed entity.

Application

Defines configuration for VoIP in ONU and is used by OLT to discover the VoIP signaling protocol type (H.248) and ONU configuration methods.

Relationships

One instance of this managed entity is associated with the ONU.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. There is only one instance, number 0. (R) (mandatory) (2 bytes)

Available signalling protocols: This attribute is a bit map that defines the VoIP signalling protocols supported in the ONU. The bit value 1 specifies that the ONU supports the associated protocol.

1 (LSB) SIP

2 ITU-T H.248
3 MGCP

(R) (mandatory) (1 byte)

Signalling protocol used: This attribute specifies the VoIP signalling protocol to use. Only one type of protocol is allowed at a time. Valid values are:

0 None
1 SIP
2 ITU-T H.248
3 MGCP
0xFF Selected by non-OMCI management interface

(R, W) (mandatory) (1 byte)

Available VoIP configuration methods: This attribute is a bit map that indicates the capabilities of the ONU with regard to VoIP service configuration. The bit value 1 specifies that the ONU supports the associated capability.

1 (LSB) ONU capable of using the OMCI to configure its VoIP services.
2 ONU capable of working with configuration file retrieval to configure its VoIP services.
3 ONU capable of working with [BBF TR-069] to configure its VoIP services.
4 ONU capable of working with IETF sipping config framework to configure its VoIP services.

Bits 5..24 are reserved by ITU-T. Bits 25..32 are reserved for proprietary vendor configuration capabilities. (R) (mandatory) (4 bytes)

VoIP configuration method used: Specifies which method is used to configure the ONU's VoIP service.

0 Do not configure – ONU default
1 OMCI
2 Configuration file retrieval
3 Broadband Forum TR-069
4 IETF sipping config framework
5..240 Reserved by ITU-T
241..255 Reserved for proprietary vendor configuration methods

(R, W) (mandatory) (1 byte)

VoIP configuration address pointer: If this attribute is set to any value other than a null pointer, it points to a network address managed entity, which indicates the address of the server to contact using the method indicated in the VoIP configuration method used attribute. This attribute is only relevant for non-OMCI configuration methods.

If this attribute is set to a null pointer, no address is defined by this attribute. However, the address may be defined by other methods, such as deriving it from the ONU identifier attribute of the IP host config data ME and using a well-known URI schema.

The default value is 0xFFFF (R, W) (mandatory) (2 bytes)

VoIP configuration state: Indicates the status of the ONU VoIP service.

0 Inactive: configuration retrieval has not been attempted
1 Active: configuration was retrieved
2 Initializing: configuration is now being retrieved
3 Fault: configuration retrieval process failed

Other values are reserved. At ME instantiation, the ONU sets this attribute to 0. (R) (mandatory) (1 byte)

Retrieve profile: This attribute provides a means by which the ONU may be notified that a new VoIP profile should be retrieved. By setting this attribute, the OLT triggers the ONU to retrieve a new profile. The actual value in the set action is ignored because it is the action of setting that is important. (W) (mandatory) (1 byte)

Profile version: This attribute is a character string that identifies the version of the last retrieved profile. (R) (mandatory) (25 bytes)

Actions

Get, set

Notifications

Attribute value change

Number	Attribute value change	Description
1..7	N/A	
8	Profile version	Version of last retrieved profile
9..16	Reserved	

Alarm

Alarm number	Alarm	Description
0	VCD config server name	Failed to resolve the configuration server name.
1	VCD config server reach	Cannot reach configuration server (the port cannot be reached, ICMP errors)
2	VCD config server connect	Cannot connect to the configuration server (due to bad credentials or other faults after the port has responded)
3	VCD config server validate	Cannot validate the configuration server
4	VCD config server auth	Cannot authenticate the configuration session (e.g., missing credentials)
5	VCD config server timeout	Timeout waiting for response from configuration server
6	VCD config server fail	Failure response received from configuration server
7	VCD config file error	Configuration file received has an error
8	VCD subscription name	Failed to resolve the subscription server name
9	VCD subscription reach	Cannot reach subscription server (the port cannot be reached, ICMP errors)
10	VCD subscription connect	Cannot connect to subscription server (due to bad credentials or other faults after the port has responded)

11	VCD subscription validate	Cannot validate subscription server
12	VCD subscription auth	Cannot authenticate subscription session (e.g., missing credentials)
13	VCD subscription timeout	Timeout waiting for response from subscription server
14	VCD subscription fail	Failure response received from subscription server
15	VCD reboot request	A non-OMCI management interface has requested a reboot of the ONU. Note: This alarm is used only to indicate the request and not to indicate that a reboot has actually taken place.
16..207	Reserved	
208..223	Vendor-specific alarms	Not to be standardized* (to be discussed before implemented)

5.10 Premises networks

There are no premisis networks related MEs required.

5.11 This section is intentionally left blank.

5.12 General purpose MEs

5.12.1 UNI-G (ME #264)

This managed entity organizes data associated with user network interfaces (UNIs) supported by GEM. One instance of the UNI-G managed entity exists for each UNI supported by the ONU.

The ONU automatically creates or deletes instances of this managed entity upon the creation or deletion of a real or virtual circuit pack managed entity, one per port.

Application

Organizes data associated with Physical path termination point (PPTP) UNI type supported by GEM (XGEM) (Ethernet and POTS UNI).

Relationships

An instance of the UNI-G managed entity exists for each instance of a physical path termination point managed entity.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Through an identical ID, this managed entity is implicitly linked to an instance of a physical path termination point. (R) (mandatory) (2 bytes)

Deprecated: This attribute is not used. It should be set to 0 by the OLT and ignored by the ONU. (R, W) (mandatory) (2 bytes)

Administrative state: This attribute locks (1) and unlocks (0) the functions performed by this managed entity. Administrative state is further described in [ITU-T G.988] clause A.1.6. (R, W) (mandatory) (1 byte)

Note: PPTP MEs also have an administrative state attribute. The user port is unlocked only if both administrative state attributes are set to unlocked. It is recommended that this attribute not be used: that the OLT set it to 0 and that the ONU ignore it.

Management capability: An ONU may support the ability for some or all of its PPTPs to be managed either directly by the OMCI or from a non-OMCI management environment such as [BBF TR-069]. This attribute advertises the ONU's capabilities for each PPTP.

This attribute is an enumeration with the following code points:

0 OMCI only

1 Non-OMCI only. In this case, the PPTP may be visible to the OMCI, but only in a read-only sense, e.g., for PM collection.

2 Both OMCI and non-OMCI

(R) (mandatory) (1 byte)

Non-OMCI management identifier: If a PPTP can be managed either directly by the OMCI or a non-OMCI management environment, this attribute specifies how it is in fact to be managed. This attribute is either 0 (default = OMCI management), or it is a pointer to a virtual Ethernet interface point, which in turn links to a non-OMCI management environment. (R, W) (mandatory) (2 bytes)

Relay agent options: This attribute is a pointer to a large string managed entity whose content specifies one or more DHCP relay agent options. (R, W) (optional) (2 bytes)

The contents of the large string are parsed by the ONU and converted into text strings. Variable substitution is based on defined three-character groups, each of which begins with the '%' character. The string '%%' is an escape mechanism whose output is a single '%' character. When the ONU cannot perform variable substitution on a substring of the large string, it generates the specified option as an exact quotation of the provisioned substring value.

Provisioning of the large string is separate from the operation of setting the pointer in this attribute. It is the responsibility of the OLT to ensure that the large string contents are correct and meaningful.

Three-character variable definitions are as follows. The first variable in the large string must specify one of the option types. Both options for a given IP version may be present if desired, each introduced by its option identifier. Terminology is taken from [b-BBF TR-101] clause 3.9.3.

%01, %18
: Specifies that the following string is for option 82 sub-option 1, agent circuit-ID (IPv4) or option 18, interface-ID (IPv6). The equivalence permits the same large string to be used in both IP environments.

%02, %37
: Specifies that the following string is for option 82 sub-option 2, relay agent remote-ID (IPv4) or option 37, relay agent

remote-ID (IPv6). The equivalence permits the same large string to be used in both IP environments.

%SL In TR-101, this is called a slot. In an ONU, this variable refers to a shelf. It would be meaningful if the ONU has multiple shelves internally or is daisy-chained to multiple equipment modules. The range of this variable is "0".. "99"

%SU In TR-101, this is called a sub-slot. In fact, it represents a cardholder. The range of this variable is "0".. "99"

%PO UNI port number. The range of this variable is "0".. "999"

%AE ATM or Ethernet. This variable can take on the values "atm" or "eth".

%SV S-VID for Ethernet UNI, or ATM VPI for ATM UNI, as it exists on the DHCP request received upstream across the UNI. Range "0".. "4096" for S-VID; range "0".. "255" for VPI. The value "4096" indicates no S-VID tag.

%CV C-VID (Q-VID) for Ethernet UNI, or ATM VCI for ATM UNI, as it exists on the DHCP request received upstream across the UNI. Range "0".. "4096" for C-VID; range "0.."65535" for VCI. The value "4096" indicates no C-VID tag.

Spaces in the provisioned string are significant.

Example: if the large string were provisioned with the value

%01%SL/%SU/%PO:%AE/%SV.%CV<null>,

then the ONU would generate the following DHCP option 82 agent circuit-ID string for an Ethernet UNI that sent a DHCP request with no S tag and C tag = 3210 on shelf 2, slot 3, port 4.

2/3/4:eth/4096.3210

With the same provisioning, the ONU would generate the following DHCP option 82 agent circuit-ID string for an ATM UNI that sent a DHCP request on VPI = 123 and VCI = 4567 on shelf 2, slot 3, port 4.

2/3/4:atm/123.4567

Actions

Get, set

Notifications

None.

5.12.2 OLT-G (ME #131)

This managed entity identifies the OLT to which an ONU is connected. This ME provides a way for the ONU to configure itself for operability with a particular OLT. It also provides a way for the OLT to communicate the time of day to the ONU.

An ONU that supports this managed entity automatically creates an instance of it. Immediately following the start-up phase, the OLT should set the ONU to the desired configuration. Interpretation of the OLT vendor ID, equipment ID and version attributes is a matter for negotiation between the two vendors involved.

Application

Identifies the OLT to which the ONU is connected and provides a way for the ONU to configure itself for operability with a particular OLT.

Relationships

The single instance of this managed entity is associated with the ONU managed entity.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. There is only one instance, number 0. (R) (mandatory) (2 bytes)

OLT vendor ID: This attribute identifies the OLT vendor. It is the same as the four most significant bytes of an ONU serial number specified in [ITU-T G.984.3] and [ITU-T G.987.3]. Upon instantiation, this attribute comprises all spaces. (R, W) (mandatory) (4 bytes)

Equipment ID: This attribute may be used to identify the specific type of OLT. The default value of all spaces indicates that equipment ID information is not available or applicable to the OLT being represented. (R, W) (mandatory) (20 bytes)

Version: This attribute identifies the version of the OLT as defined by the vendor. The default left-justified ASCII string "0" (padded with trailing nulls) indicates that version information is not available or applicable to the OLT being represented. (R, W) (mandatory) (14 bytes)

Time of day information: This attribute provides the information required to achieve time of day synchronization between a reference clock at the OLT and a local clock at the ONU. This attribute comprises two fields: the first field (4 bytes) is the sequence number of the specified GEM superframe. The second field (10 bytes) is TstampN as defined in clause 10.4.6 of [ITU-T G.984.3] and clause 13.2 of [ITU-T G.987.3], using the timestamp format of [IEEE 1588], clause 5.3.3. The value 0 in all bytes is reserved as a null value. (R, W) (optional) (14 bytes)

Note: In ITU-T G.987 systems, the superframe count field of the time of day information attribute contains the 32 least significant bits of the actual counter.

Actions

Get, set

Notifications

None.

5.12.3 Network Address (ME #137)

The network address managed entity associates a network address with security methods required to access a server. It is conditionally required for ONUs that support VoIP services. The address may take the form of a URL, a fully-qualified path or IP address represented as an ACII string.

If a non-OMCI interface is used to manage VoIP signalling, this ME is unnecessary.

Instances of this managed entity are created and deleted by the OLT or the ONU, depending on the method used and case.

Application

Associates a network address required for H.248 VoIP service and contains an IP address.

Relationships

Any managed entity that requires a network address may link to an instance of this ME.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Instances of this managed entity created autonomously by the ONU have IDs in the range 0..0x7FFF. Instances created by the OLT have IDs in the range 0x8000..0xFFFE. The value 0xFFFF is reserved. (R, Set-by-create) (mandatory) (2 bytes)

Security pointer: This attribute points to an authentication security method managed entity. The authentication security method indicates the username and password to be used when retrieving the network address indicated by this ME. A null pointer indicates that security attributes are not defined for this network address. (R, W, Set-by-create) (mandatory) (2 bytes)

Address pointer: This attribute points to the large string ME that contains the network address. It may contain a fully-qualified domain name, URI or IP address. The URI may also contain a port identifier (e.g., "x.y.z.com:5060"). A null pointer indicates that no network address is defined. (R, W, Set-by-create) (mandatory) (2 bytes)

Actions

Create, delete, get, set

Notifications

None.

5.12.4 Authentication security method (ME #148)

The authentication security method defines the user id/password configuration to establish a session between a client and a server. This object may be used in the role of the client or server. An instance of this managed entity is created by the OLT if authenticated communication is necessary.

Relationships

One instance of this management entity may be associated with a network address ME. This ME may also be cited by other MEs that require authentication parameter management.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. The value 0xFFFF is reserved. (R, Set-by-create) (mandatory) (2 bytes)

Validation scheme: This attribute specifies the validation scheme used when the ONU validates a challenge. Validation schemes are defined as follows:

0 Validation disabled

1 Validate using MD5 digest authentication as defined in [IETF RFC 2617] (recommended)

3 Validate using basic authentication as defined in [IETF RFC 2617]

(R, W) (mandatory) (1 byte)

Username 1: This string attribute is the user name. If the string is shorter than 25 bytes, it must be null terminated (Note). (R, W) (mandatory) (25 bytes)

Password: This string attribute is the password. If the string is shorter than 25 bytes, it must be null terminated. (R, W) (mandatory) (25 bytes)

Realm: This string attribute specifies the realm used in digest authentication. If the string is shorter than 25 bytes, it must be null terminated. (R, W) (mandatory) (25 bytes)

Username 2: This string attribute allows for continuation of the user name beyond 25 characters (Note). Its default value is a null string. (R, W) (optional) (25 bytes)

Note: NOTE – The total username is the concatenation of the username 1 and username 2 attributes if and only if a) username 1 comprises 25 non-null characters, b) username 2 is supported by the ONU, and c) username 2 contains a leading non-null character string. Otherwise, the total username is simply the value of the username 1 attribute.

Actions

Create, delete, get, set

Notifications

None.

5.12.5 Large String (ME #157)

The large string managed entity holds character strings longer than 25 bytes, up to 375 bytes. It is maintained in up to 15 parts, each part containing 25 bytes. If the final part contains fewer than 25 bytes, it is terminated by at least one null byte. For example:

Number of parts	3
Part 1	sftp://myusername:mypassw
Part 2	ord@config.telecom.com:12
Part 3	34/path/to/filename<null>

Or

Number of parts	3
Part 1	sftp://myusername:mypassw
Part 2	ord@config.telecom.com:12
Part 3	34/path/to/longfilename<null>

Instances of this managed entity are created and deleted by the OLT. Under some circumstances, they may also be created by the ONU. To use this managed entity, the OLT or ONU instantiates the large string ME and then points to the created ME from other ME instances. Systems that maintain the large string should ensure that the large string ME is not deleted while it is still linked.

Application

Used to hold character strings longer than 25 bytes and up to 375 bytes.

Relationships

An instance of this ME may be cited by any ME that requires a text string longer than 25 bytes.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. The value 0xFFFF is reserved. When the large string is to be used as an IPv6 address, the value 0 is also reserved. The OLT should create large string MEs starting at 1 (or 0), and numbering upwards. The ONU should create large string MEs starting at 65534 (0xFFFE) and numbering downwards. (R, Set-by-create) (mandatory) (2 bytes)

Number of parts: This attribute specifies the number of non-empty parts that form the large string. This attribute defaults to 0 to indicate no large string content is defined.(R, W) (mandatory) (1 byte)

Fifteen additional attributes are defined below; they are identical. The large string is simply divided into as many parts as necessary, starting at part 1. If the end of the string does not lie at a part boundary, it is marked with a null byte.

Part 1, Part 2, Part 3, Part 4, Part 5, Part 6, Part 7, Part 8, Part 9, Part 10, Part 11, Part 12, Part 13, Part 14, Part 15: (R, W) (mandatory) (25 bytes * 15 attributes)

Actions

Create, delete, get, set

Notifications

Attribute value change

Number	Attribute value change	Description
1	Number of parts	
2	Part 1	
3	Part 2	
4	Part 3	
5	Part 4	
6	Part 5	
7	Part 6	
8	Part 7	
9	Part 8	
10	Part 9	
11	Part 10	
12	Part 11	
13	Part 12	
14	Part 13	
15	Part 14	
16	Part 15	
Note: Older implementations of the OMCI may not support this notification, which has been introduced in this version of this Recommendation.		

5.12.6 Threshold Data 1 (ME #273)

Threshold data is partitioned into two MEs for historical reasons. An instance of this managed entity, together with an optional instance of the threshold data 2 ME, contains threshold values for counters in performance monitoring history data managed entities.

For a complete discussion of generic PM architecture, refer to [ITU-T G.988] clause I.4.

Instances of this managed entity are created and deleted by the OLT.

Application

This threshold data value in this managed entity is used for performance monitoring history data ME.

Relationships

An instance of this managed entity may be related to multiple instances of performance monitoring history data type managed entities.

Paired instances of threshold data 1 ME and threshold data 2 ME are implicitly linked together through a common ME ID.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

The following seven attributes specify threshold values for seven thresholded counters in associated PM history data MEs. The definition of each PM history ME includes a table that links each thresholded counter to one of these threshold value attributes.

Threshold value 1: (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold value 2: (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold value 3: (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold value 4: (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold value 5: (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold value 6: (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold value 7: (R, W, Set-by-create) (mandatory) (4 bytes)

Actions

Create, delete, get, set

Notifications

None.

5.12.7 Threshold Data 2 (ME #274)

Together with an instance of the threshold data 1 ME, an instance of this managed entity contains threshold values for counters maintained in one or more instances of performance monitoring history data managed entities.

For a complete discussion of generic PM architecture, refer to [ITU-T G.988] clause I.4.

Instances of this managed entity are created and deleted by the OLT.

Application

This threshold data value in this managed entity is used for performance monitoring history data ME.

Relationships

Refer to the relationships of the threshold data 1 ME.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Its value is the same as that of the paired threshold data 1 instance. (R, Set-by-create) (mandatory) (2 bytes)

The following seven attributes specify threshold values for seven thresholded counters in associated PM history data MEs. The definition of each PM history ME includes a table that links each thresholded counter to one of these threshold value attributes.

Threshold value 8: (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold value 9: (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold value 10: (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold value 11: (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold value 12: (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold value 13: (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold value 14: (R, W, Set-by-create) (mandatory) (4 bytes)

Actions

Create, delete, get, set

Notifications

None.

5.12.8 OMCI (ME #287)

This managed entity describes the ONU's general level of support for OMCI managed entities and messages. This ME is not included in a MIB upload.

Application

Describes general level support by the ONU for OMCI Management Data Model Managed Entity (ME) class types and the OMCI Protocol Model message types visible to the OLT during MIB discovery.

Relationships

One instance exists in the ONU. The ME entities are related to the OMCI entity.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. There is only one instance, number 0. (R) (mandatory) (2 bytes)

ME type table: This attribute lists the ME classes supported by the ONU. Each entry contains the managed entity class value (see Table 1) of a managed entity type. (R) (mandatory) (2 * N bytes, where N is the number of entries in the list.)

Message type table: This attribute is a list of message types supported by the ONU. Each entry contains the message type of an OMCI message (see Appendix A). (R) (mandatory) (M bytes, where M is the number of entries in the list.)

Actions

Get, get next

Notifications

None.

5.12.9 SNMP Configuration Data (ME #335)

The SNMP configuration data managed entity provides a way for the OLT to provision an IP path for an SNMP management agent.

The SNMP configuration data managed entity is created and deleted by the OLT.

Relationships

One instance of this ME is created by the OLT for each SNMP management path termination.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. The ME IDs 0 and 0xFFFF are reserved. (R, Set-by-create) (mandatory) (2 bytes)

SNMP version: This integer attribute is the SNMP protocol version to be supported. (R, W, Set-by-create) (mandatory) (2 bytes)

SNMP agent address: This attribute is a pointer to a TCP/UDP config data managed entity, which provides the SNMP agent. (R, W, Set-by-create) (mandatory) (2 bytes)

SNMP server address: This attribute is the IP address of the SNMP server. (R, W, Set-by-create) (mandatory) (4 bytes)

SNMP server port: This attribute is the UDP port number of the SNMP server. (R, W, Set-by-create) (mandatory) (2 bytes)

Security name pointer: This attribute points to a large string whose content represents the SNMP security name in a human-readable format that is independent of the security model. SecurityName is defined in [b-IETF RFC 2571]. (R, W, Set-by-create) (mandatory) (2 bytes)

Community for read: This attribute is a pointer to a large string that contains the name of the read community. (R, W, Set-by-create) (mandatory) (2 bytes)

Community for write: This attribute is a pointer to a large string that contains the name of the write community. (R, W, Set-by-create) (mandatory) (2 bytes)

Sys name pointer: This attribute points to a large string whose content identifies the SNMP system name. SysName is defined in [b-IETF RFC 3418]. (R, W, Set-by-create) (mandatory) (2 bytes)

Actions

Create, delete, Set, get

Notifications

None.

5.12.10 BBF TR-069 Management Server (ME #340)

If functions within the ONU are managed by [BBF TR-069], this ME allows OMCI configuration of the autoconfiguration server (ACS) URL and related authentication information for an ACS connection initiated by the ONU. [BBF TR-069] supports other means to discover its ACS, so not all BBF TR-069-compatible ONUs necessarily support this ME. Furthermore, even if the ONU does support this ME, some operators may choose not to use it.

An ONU that supports OMCI configuration of ACS information automatically creates instances of this managed entity.

Relationships

An instance of the BBF TR-069 management server managed entity exists for each instance of a BBF TR-069 management domain within the ONU.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. Through an identical ID, this managed entity is implicitly linked to an instance of a virtual Ethernet interface point that links to the BBF TR-069 management domain. (R) (mandatory) (2 bytes)

Administrative state: This attribute locks (1) and unlocks (0) the functions performed by this managed entity. When the administrative state is locked, the functions of this ME are disabled. BBF TR-069 connectivity to an ACS may be possible through means that do not depend on this ME. The default value of this attribute is locked. (R,W) (mandatory) (1 byte)

ACS network address: This attribute points to an instance of a network address managed entity that contains URL and authentication information associated with the ACS URL. (R, W) (mandatory) (2 bytes)

Associated tag: This attribute is a TCI value for BBF TR-069 management traffic passing through the virtual Ethernet interface point. A TCI, comprising user priority, CFI and VID, is represented by 2 bytes. The value 0xFFFF specifies that BBF TR-069 management traffic passes through the virtual Ethernet interface point with neither a VLAN nor a priority tag. (R, W) (mandatory) (2 bytes)

Actions

Get, set

5.13 Miscellaneous services

5.13.1 Enhanced Security Control (ME #332)

This managed entity contains the capabilities, parameters and controls of enhanced G-PON security features when they are negotiated via the OMCI (Note). The attributes in this ME are intended to be used to implement a symmetric-key-based three step authentication process as described in the supplemental information section below.

Note: If an ITU-T G.987 system uses 802.1X authentication as defined in [ITU-T G.987.3], the only applicable attribute of this ME is the broadcast key table.

Note2: This ME only applies to XGS-PON/NG-PON2 at the TC Layer.

Relationships

One instance of this managed entity is associated with the ONU managed entity.

Attributes

Managed entity ID: This attribute uniquely identifies each instance of this managed entity. There is only one instance, number 0. (R) (mandatory) (2 bytes)

OLT crypto capabilities: This attribute specifies the cryptographic mechanisms available at the OLT. It is written by the OLT during authentication step 1. It is formatted as a bit map, where a 1 bit indicates that the particular algorithm is supported, and a 0 bit indicates it is not supported.

Bit position	Algorithm
1 (LSB)	AES-CMAC-128 (support is mandatory)
2	HMAC-SHA-256
3	HMAC-SHA-512
4-128	Reserved

(W) (mandatory) (16 bytes)

OLT random challenge table: This attribute specifies the random challenge OLT_challenge issued by the OLT during authentication step 1. It is structured as a table, with each entry being 17 bytes. The first byte is the table row number, starting at 1, and the remaining 16 bytes are the contents of the entry. OLT_challenge is the concatenation of all 16-byte content fields. In normal use, the OLT will write all the entries in the table, and then trigger the ONU's processing of the entire table using the OLT challenge status attribute. The table size is known by the maximum index set by the OLT. The OLT can clear the table with a set operation to row 0. (R, W) (mandatory) (17 * N bytes)

NOTE – It is assumed that the length of OLT_challenge is always an integer multiple of 16 bytes.

OLT challenge status: This Boolean attribute controls the completion of authentication step 1. This attribute behaves as follows:

When the OLT performs the first of possibly several set operations to the OLT crypto capabilities or the OLT random challenge table attributes, a side effect of the set operation is that the ONU sets the OLT challenge status attribute to false.

When the OLT completes the set operation(s) to the OLT crypto capabilities and the OLT random challenge table attributes, then it sets the OLT challenge status attribute to true. This triggers the ONU to process the OLT random challenge table, using its choice of the OLT's candidate cryptographic hash algorithms.

The ONU initializes this attribute to the value false. (R, W) (mandatory) (1 byte)

ONU selected crypto capabilities: This attribute specifies the cryptographic capability selected by the ONU in authentication step 2. Its value specifies one of the bit positions that has the value 1 in the OLT crypto capabilities attribute. (R) (mandatory) (1 byte)

ONU random challenge table: This attribute specifies the random challenge ONU_challenge issued by the ONU during authentication step 2. It is structured as a table, with each entry being 16 bytes of content. ONU_challenge is the concatenation of all 16-byte content fields in the table. Once the OLT triggers a response to be generated using the OLT challenge status attribute, the ONU generates the response and writes

the table (in a single operation). The AVC generated by this attribute signals to the OLT that the challenge is ready, so that the OLT can commence a get/get-next sequence to obtain the table's contents. (R) (mandatory) (16 * P bytes)

ONU authentication result table: (authentication step 2). This attribute contains the result of the authentication computation from the ONU (ONU_result), according to the ONU's selected crypto capabilities attribute.

ONU_result = SelectedHashFunction (PSK, (ONU_selected_crypto capabilities | OLT_challenge | ONU_challenge | 0x0000 0000 0000 0000)),

where "|" denotes concatenation.

This attribute is structured as a table, with each entry being 16 bytes of content. The number of rows Q is implicit in the choice of hash algorithm.

Once the OLT triggers a response to be generated using the OLT challenge status attribute, the ONU generates ONU_result and writes the table (in a single operation). The AVC generated by this attribute signals to the OLT that the response is ready, so that the OLT can commence a get/get-next sequence to obtain the table's contents. (R) (mandatory) (16 * Q bytes)

OLT authentication result table: This attribute is used in authentication step 3. It contains OLT_result, the result of the authentication computation from the OLT.

OLT_result = SelectedHashFunction (PSK, (ONU_selected_crypto capabilities | ONU_challenge | OLT_challenge | ONU_serial_number)).

The ONU_serial_number is the serial number attribute of the ONU-G managed entity, 8 bytes.

This attribute is structured as a table, with each entry being 17 bytes. The first byte is the table row number, starting at 1; the remaining 16 bytes are content. OLT_result is the concatenation of all 16-byte content fields. The OLT writes all entries into the table, and then triggers the ONU's processing of the table using the OLT result status attribute. The number of rows R is implicit in the choice of hash algorithm. The OLT can clear the table with a set operation to row 0. (W) (mandatory) (17 * R bytes)

OLT result status: (authentication step 3). This Boolean attribute controls and reports the status of the OLT authentication result table attribute. This attribute behaves as follows:

When the OLT performs the first of possibly several set operations to the OLT authentication result table attribute, a side effect of the set operation is that the ONU sets the OLT result status attribute to false.

When the OLT completes the set operation(s) to the OLT authentication result table, then it sets the OLT result status attribute to true. This triggers the ONU to process the OLT authentication result table.

(R, W) (mandatory) (1 byte)

ONU authentication status: This attribute indicates the status of the authentication relationship from the perspective of the ONU. It has the following values:

0 Indeterminate. This initial value indicates that the OMCI authentication process has not yet completed, and may not even have been started.
1 Reserved.
2 Reserved.
3 Authentication success: the procedure has completed at least once and in its most recent execution, the ONU has authenticated the OLT.
4 Authentication failure: the procedure has completed at least once, and either its most recent execution resulted in an error, or the ONU has failed to authenticate the OLT.
5 Reserved.

When the ONU authentication status has the value 3, encryption keys exchanged in the TC layer will be encrypted using the master session key (ITU-T G.984 systems) or the key encryption key (ITU-T G.987 systems). The OLT should check the value of of this attribute before initiating a key switch.

(R) (mandatory) (1 byte)

Master session key name: Following successful authentication, this register contains the "name," or the hash signature, of the current master session key. The master session key is defined as:

MSK = SelectedHashFunction (PSK, (OLT_challenge | ONU_challenge)).

The master session key name is defined as:

MSKname = SelectedHashFunction (PSK, (ONU_challenge | OLT_challenge | 0x 3141 5926 5358 9793 3141 5926 5358 9793)).

If the selected hash function generates more than 128 bits, the result is truncated to the leftmost (most significant) 128 bits.

Upon the invalidation of a master session key (e.g., due to an ONU reset or deactivation, or due to an ONU-local decision that the master session key has expired), the ONU sets the master session key name to all zeros. (R) (mandatory) (16 bytes)

Broadcast key table: This attribute is defined only in ITU-T G.987 systems. It contains the broadcast key generated by the OLT. It is a table, each of whose rows is structured as follows:

Row control (1 byte): The two least significant bits of this byte determine the attribute's behaviour under the set action. They always read back as 0 under the get next action.

00 Set the specified row.
01 Clear the specified row.
10 Clear the entire table.
11 Reserved.

The four most significant bits specify the length of the fragment, which is left-justified in the key fragment field. The value 0 indicates 16 bytes of key fragment.

The other two bits are reserved.

Row identifier (1 byte): The two most significant bits of this field are the key index, which appears in the header of encrypted multicast GEM frames. Key index 0 always indicates cleartext, and should therefore not appear in the identifier. The four least significant bits identify the key fragment number, starting with 0. The other two bits are reserved.

Key fragment (16 bytes): This field contains the specified fragment of the key (encrypted with AES-ECB using the KEK).

(R, W) (mandatory) (18N bytes)

Effective key length: This attribute specifies the maximum effective length, in bits, of keys generated by the ONU. (R) (mandatory) (2 bytes)

Actions

Get, set, get next

Notifications

Attribute value change

Number	Attribute value change	Description
1..4	Reserved	
5	ONU random challenge table	A new ONU challenge has been loaded into the table for the OLT to retrieve
6	ONU authentication result table	A new ONU response has been loaded into the table for the OLT to retrieve
7..8	Reserved	
9	ONU authentication status	The ONU authentication status has changed
10..16	Reserved	

Supplementary information

This managed entity contains the facilities to perform a conventional three step hash-based authentication sequence found in [ISO/IEC 9798-4] (used in DSL systems that employ MS-CHAPv2 and elsewhere) using get and set messages.

The logical structure of the conventional three step sequence is as follows. In the present situation, peer 1 is the OLT and peer 2 is the ONU:

Message 1: (Peer 1 → peer 2) my_cryptographic_capabilities | random_challenge_1

Message 2: (Peer 2 → peer 1): selected_cryptographic_capabilities | random_challenge_2 | MsgHash (PSK, (selected_cryptographic_capabilities | random_challenge_1 | random_challenge_2, peer_1_identity))

Message 3: (Peer 1 → peer 2): MsgHash (PSK, (selected_cryptographic_capabilities | random_challenge_2 | random_challenge_1 | peer_2_identity))

Where:

MsgHash () is a keyed hash function of the message

PSK is the pre-shared key known to the peers of the session

Peer_1_identity is always "0x0000 0000 0000 0000"

Peer_2_identity is the ONU serial number

The prerequisite is the availability of a pre-shared secret PSK. A PSK of 128 bits simplifies the application of security algorithms based on AES-128 (e.g., AES-CMAC-128). A PSK is associated with a particular ONU and is stored at that ONU and at the operator infrastructure. On the operator side, the PSK for a particular ONU might be stored in the physically-connected OLT, or at a central server that the OLT accesses during authentication. Configuration of the PSK into the ONU and into the operator infrastructure may be done in any manner that satisfies these requirements.

In the OMCI, the authentication message sequence follows the steps illustrated in Figure 11.

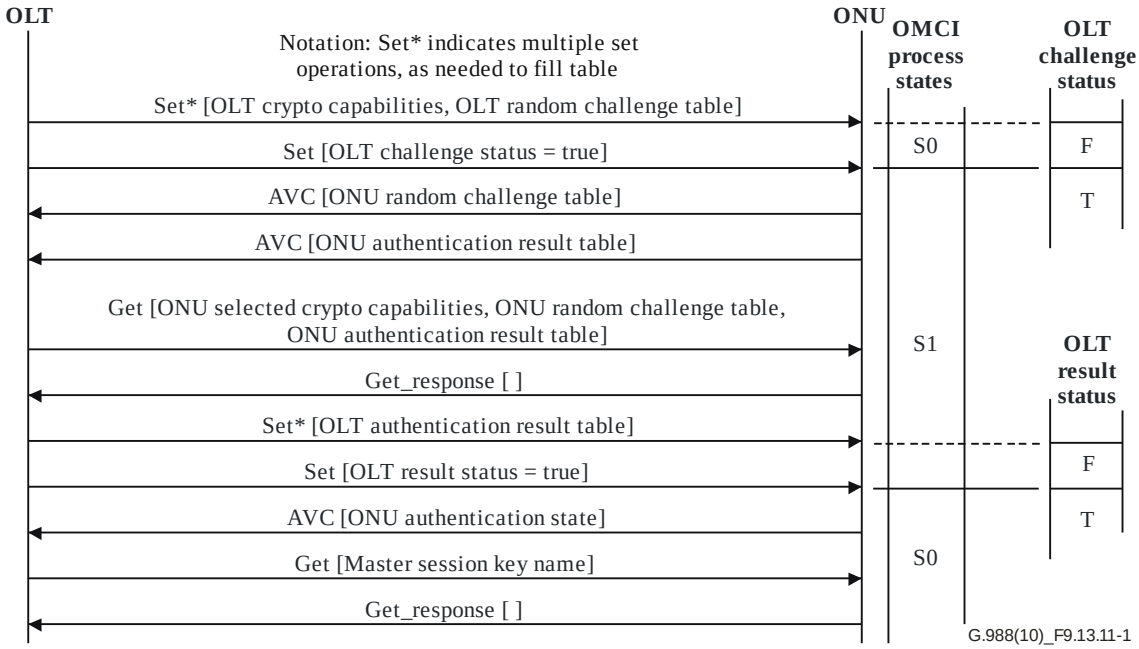

Figure 11 - Authentication Message Exchange Sequence

States of the OMCI authentication process

When an ONU is in operation state O5, as defined in [ITU-T G.984.3] and [ITU-T G.987.3], it maintains an OMCI authentication process state machine that tracks the phase of the authentication-related OMCI message flow exchange. The OMCI authentication process state machine is driven by the OLT challenge and result status indications, and generates output that indicates the ONU authentication status.

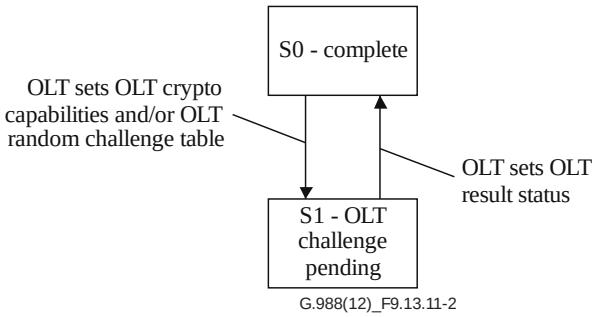

Figure 12 - ONU State Diagram

Synchronization with TC layer and security considerations (ITU-T G.984 systems only)

When the ONU is in authenticated state, it uses its master session key to encrypt the key transmitted in the encryption_key PLOAM message.

The master session key is defined as:

MasterSessionKey = SelectedHashFunction (PSK, (OLT_challenge | ONU_challenge)) where SelectedHashFunction () is the hash function selected by the ONU in the ONU selected crypto capabilities attribute from the list supplied by the OLT.

The encryption of the encryption key is performed using AES-128 in electronic codebook (ECB) mode.

Since the encryption key carried in the encryption key PLOAM message is not protected against forgery, there is the possibility that the key can be forged or replayed by an attacker. Both forged and replayed keys can be detected with key synchronization mechanisms. A replay attack, however, could force the OLT to use an old encryption key, which would violate the security requirements of downstream data encryption. Consequently, an OLT designed to resist a replay attack should ensure that the ONU does not send a previously used encryption key between authentication cycles.

5.14 Mid-span PON reach extender

There are no Mid-span PON reach externder related MEs required.

6. References

1. *ITU-T Recommendation G.984.1, Gigabit-capable Passive Optical Networks (G-PON): General Characteristics* (March 2003)
2. *ITU-T Recommendation G.984.2, Gigabit-capable Passive Optical Networks (G-PON): Physical Media Dependent (PMD) Layer Specification* (March 2003)
3. *ITU-T Recommendation G.984.3, Gigabit-capable Passive Optical Networks (G-PON): Transmission Convergence Layer Specification* (February 2004)
4. *ITU-T Recommendation G.984.3 Amendment 1, Gigabit-capable Passive Optical Networks (G-PON): Transmission Convergence Layer Specification* (May, 2005)
5. *ITU-T Recommendation G.984.4, Gigabit-capable Passive Optical Networks (G-PON): ONT Management and Control Interface Specification* (June 2004)
6. *ITU-T Recommendation G.984.4 Amendment 1, Gigabit-capable Passive Optical Networks (G-PON): ONT Management and Control Interface Specification* (May 2005)
7. [G.988] Recommendation ITU-T G.988 (2010), ONU management and control interface specification (OMCI).
8. *ITU-T Recommendation G.988 Amendment 1, ONU management and control interface (OMCI) specification* (May 2014)
9. *ITU-T Recommendation G.988 Amendment 2, ONU management and control interface (OMCI) specification* (June 2016)
10. [G.989] Recommendation ITU-T G.989 (2015), 40-Gigabit-capable passive optical network systems (NG-PON2): Definitions, abbreviations, and acronyms.
11. [G.989.1] Recommendation ITU-T G.989.1 (2013), 40-Gigabit-capable passive optical networks (NG-PON2): General requirements.
12. [G.989.2] Recommendation ITU-T G.989.2 (2014), 40-Gigabit-capable passive optical networks 2 (NG PON2): Physical media dependent (PMD) layer specification.
13. [G.989.3] Recommendation ITU-T G.989.2 (2015), 40-Gigabit-capable passive optical networks 2 (NG PON2): Transmission convergence layer specification.

7. Appendix A: AT&T OMCI ME Modeling

7.1 General MEs required for ONU

The following sections detail the MEs required for basic ONU function and are not specific to a particular service. The relationships of these MEs are show in the Data ME models, Figure 13 and Figure 14, as well as the H.248 VoIP ME model in Figure 15.

ME Value	ME Type
2	ONU data
5	Cardholder
6	Circuit pack
7	Software image
131	OLT-G
137	Network address
148	Authentication security method
157	Large string
256	ONU-G
257	ONU2-G
262	T-CONT
263	ANI-G
264	UNI-G
266	GEM interworking termination point
268	GEM port network CTP
272	GAL Ethernet profile
277	Priority queue
278	Traffic scheduler
287	OMCI

Table 8 - General MEs

7.1.1 Equipment Management

1. **ONU-G:** Represents the ONU as an equipment.
2. **ONU2-G:** Is an extension of the ONU as an equipment and contains additional attributes (in addition to the ONU-G) associated with the ONU.

3. **ONU data:** Models the ONU Management Information Base (MIB) itself via the "Data Sync" attribute used for MIB synchronization between the Optical Line Terminal (OLT) and the ONU.
4. **Software image:** Models the executable software image stored in the ONU.
5. **Cardholder:** Represents the fixed equipment slot configuration in the ONU for each physical slot.
6. **Circuit pack:** Models a real circuit pack equipped in a real ONU slot (Cardholder).

7.1.2 Access Network Interface (ANI) and Traffic Management

1. **ANI-G:** Represents the Access Network Interface (ANI) supported by the ONU.
2. **T-CONT:** Traffic/Transmission Container (T-CONT) representing a logical connection group associated with an Alloc-Id (Allocation Identifier) assigned by the OLT and used for upstream (US) user traffic.
3. **GEM port network CTP** *(Connection Termination Point)*: Represents the origination/termination of a GEM port on an ONU for US and downstream (DS) Gigabit-capable passive optical network Encapsulated Method (GEM) (also refers generically to XGEM) frames.
4. **GEM interworking termination point:** Represents the point in the ONU where the interworking of an Ethernet service to the GEM layer takes place.
5. **GAL Ethernet Profile:** Describes GEM Adaptation layer (GAL) processing functions of the ONU
6. **Priority queue:** Specifies the priority queue used by a GEM port network CTP related to the T-CONT in the US direction and related to the User Network Interface (UNI) in the DS direction.
7. **Traffic scheduler:** Controls the US GEM frames from a priority queue and transfers them towards a T-CONT when granted bandwidth by the OLT.

7.1.3 General Purpose MEs

1. **UNI-G:** Organizes data associated with Physical path termination point (PPTP) UNI type supported by GEM (XGEM).
2. **OLT-G:** Identifies the OLT to which the ONU is connected and provides a way for the ONU to configure itself for operability with a particular OLT.
3. **OMCI:** Describes general level support by the ONU for OMCI Management Data Model Managed Entity (ME) class types and the OMCI Protocol Model message types visible to the OLT during MIB discovery. The ME class types are identified by the ME Value and ME Type columns in Table 8, Table 9 and Table 10.
4. **Network address:** Associates a network address required for H.248 VoIP service and contains an IP address.
5. **Authentication security method:** Defines the user-id and password configuration required to retrieve the network address indicated by the instance.
6. **Large string:** Used to hold character strings longer than 25 bytes and up to 375 bytes.

7.2 MEs required for Data Services

The following sections detail the MEs required for Data services. The relations ships of these MEs are show in the Data ME models, Figure 13 and Figure 14.

ME Value	ME Type
11	Physical path termination point (PPTP) Ethernet UNI
45	MAC bridge service profile
47	MAC bridge port configuration data
84	VLAN tagging filter data
130	IEEE 802.1p mapper service profile
171	Extended VLAN tagging operation configuration data
281	Multicast GEM interworking termination point
290	Dot1X port extension package
309	Multicast operations profile
310	Multicast subscriber config info
329	Virtual Ethernet Interface Point (VEIP)

Table 9 – Data Service MEs

7.2.1 Ethernet User Network Interface MEs

1. **Physical path termination point (PPTP) Ethernet UNI:** Represents the point at an Ethernet UNI where the physical path terminates and Ethernet physical level functions are performed. Used in Stand-Alone ONUs.
2. **Virtual Ethernet Interface Point (VEIP):** Represents the hand-off point in an Integrated ONU to a non-OMCI management domain. The VEIP is managed by OMCI (for traditional L2 functions etc.) and potentially known to the non-OMCI management domain. Used in Integrated ONUs.

7.2.2 Unicast, IPTV Multicast, and Layer 2 Ethernet MAC Bridge MEs

1. **Extended VLAN tagging operation configuration data (EVTOCD):** Organizes data associated with the Ethernet UNI frame tagging operation rules in the US direction.
2. **Dot1X port extension package:** Controls operation of the PPTP Ethernet UNI port that enables IEEE 802.1X authentication of the Residential Gateway (RG).
3. **Multicast operations profile:** Represents the Internet Group Management Protocol (IGMP) Multicast Channel parameters associated with the PPTP Ethernet UNI port.
4. **Multicast subscriber config info:** Organizes data associated with multicast management at the PPTP Ethernet UNI port.
5. **Multicast GEM interworking termination point:** Represents a point in the ONU where a multicast service interworks with the GEM layer.

6. **MAC bridge service profile:** Models an Ethernet MAC bridge.
7. **MAC bridge port configuration data:** Models a port on an Ethernet MAC bridge.
8. **IEEE 802.1p mapper service profile:** Associates priorities of 802.1p tagged frames (priority p-bit value in a tagged Ethernet frame) to designated GEM ports in the US direction and directs the DS direction GEM ports to PPTP Ethernet UNI fixed queues in ONU (if the priority queue used by the GEM port network CTP in the DS direction is Null).
9. **VLAN tagging filter data:** Organizes data associated with VLAN tag filtering closer to the MAC bridge.

7.2.3 Data Service ME Models

The stand-alone ONU physical Ethernet UNI model used for AT&T Data services on non-integrated SFU ONTs is show below in Figure 13.

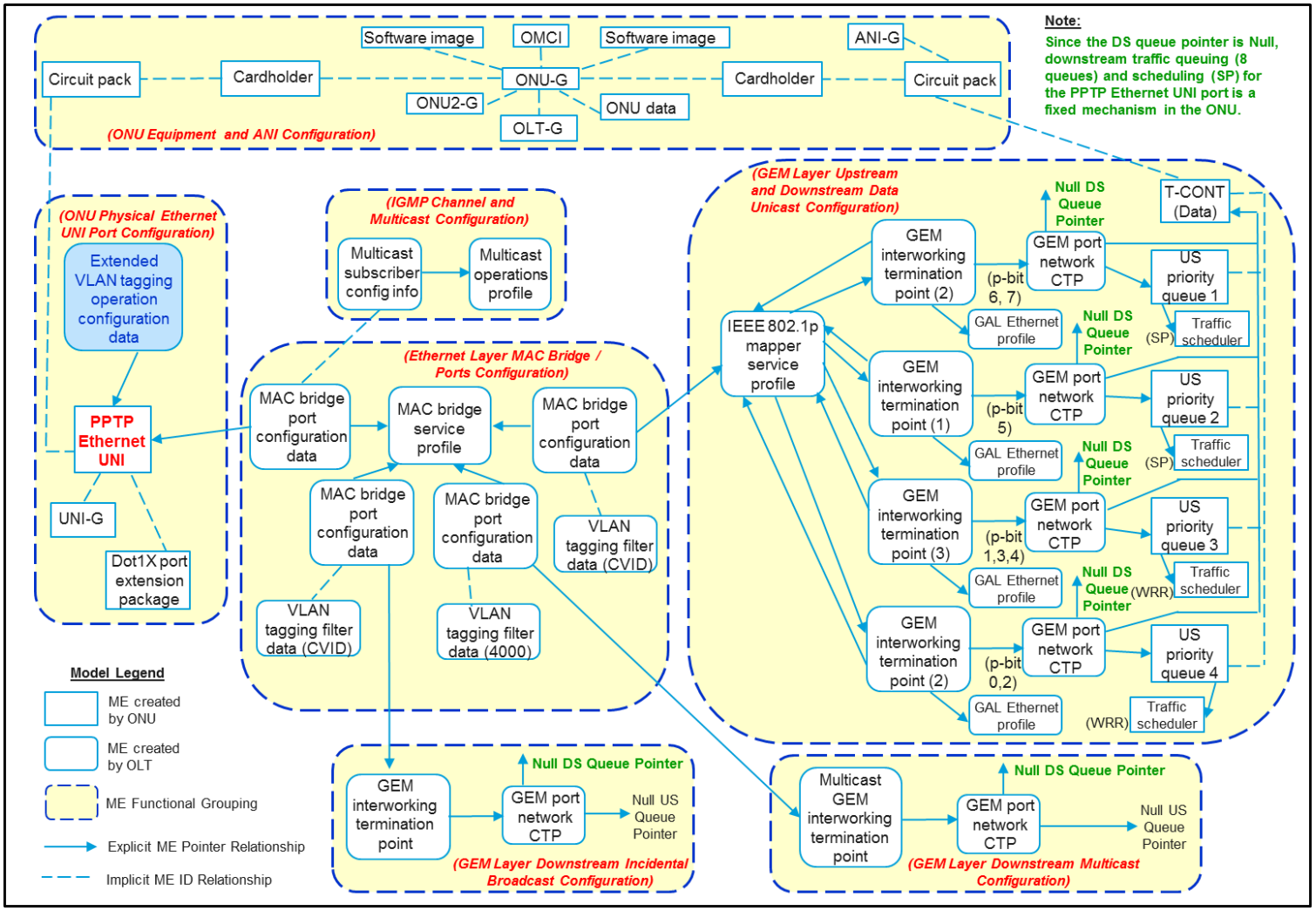

Figure 13 – Physical Ethernet UNI Data Service ME Model

The integrated ONU virtual Ethernet UNI model used for AT&T Data services on CPE devices with integrated ONTs is show below in Figure 14.

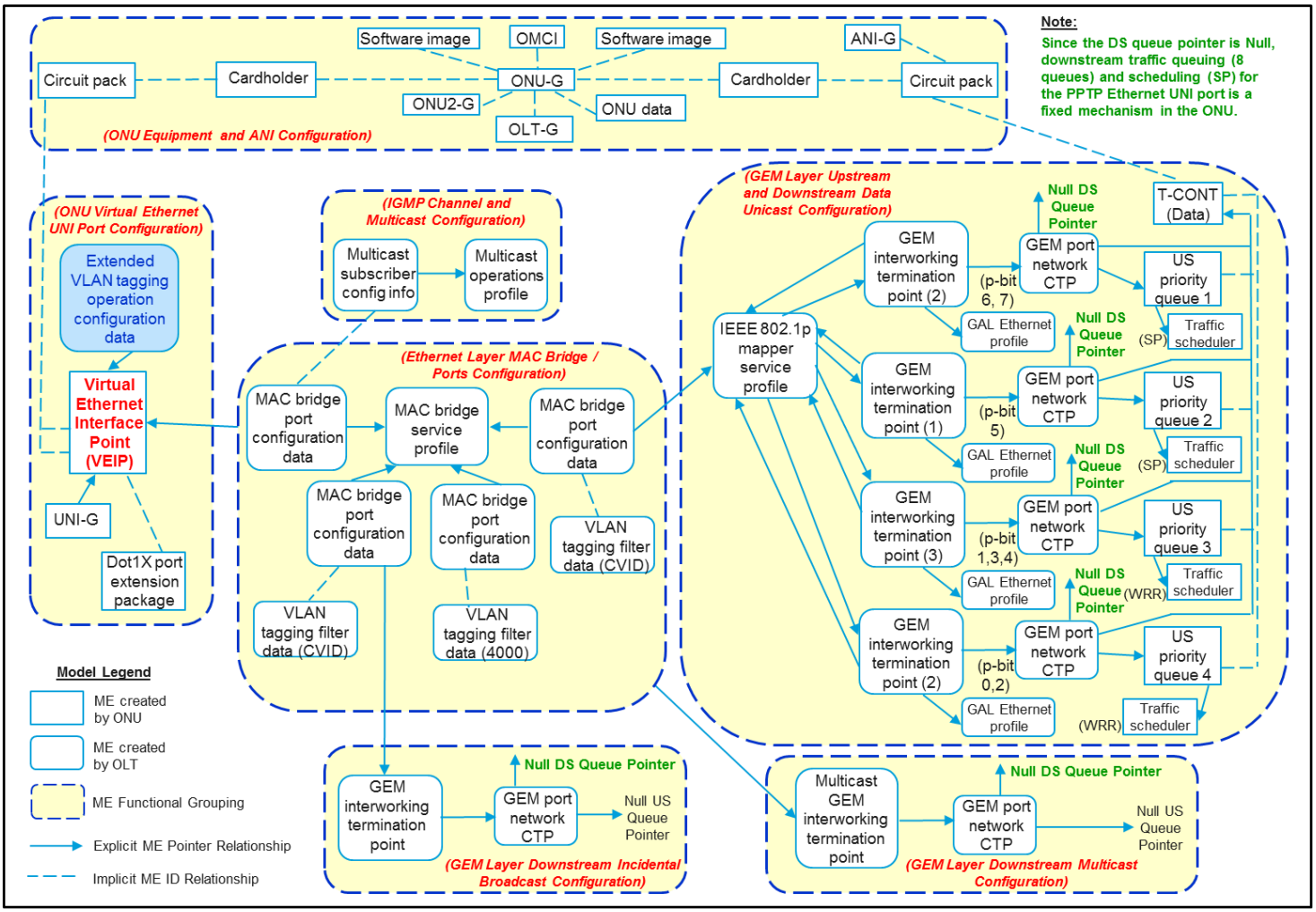

Figure 14 – Virtual Ethernet UNI Data Service ME Model

The following Extended VLAN tagging operation configuration data behavior is expected for both data models.

This ME has rules defining the US/DS Data Service Ethernet frame VLAN tagging for the Ethernet UNI port.

The US and DS rules are defined when the Data Service is provisioned for the Ethernet UNI port.

- In the upstream (US) direction, the RG is expected to only be sending priority tagged frames associated with the Data service. All of the follow behavior should be defined via the service configuration.
    - When a priority tagged Ethernet frame (VID 0, p-bit) is received from the UNI port, the US rule converts the priority tagged Ethernet frame to a single tagged Ethernet frame (CVID assigned to the UNI port, p-bit) before forwarding it to the GEM layer to send over the PON port.

- Although not expected, if an untagged Ethernet frame is received from the UNI port, the US rule converts the untagged Ethernet frame to a single tagged Ethernet frame (CVID assigned to the UNI port, p-bit = 0) before forwarding it to the GEM layer to send over the PON port.
- Although not expected, if single-tagged Ethernet frame is received from the UNI port, the US rule should drop the frame.
- Although not expected, if double-tagged Ethernet frame is received from the UNI port, the US rule should drop the frame.

- In the DS direction, when a single tagged Ethernet frame (CVID assigned to the UNI port, p-bit) is received from the GEM Layer, the DS rule converts the single tagged Ethernet frame to a priority tagged Ethernet frame (VID 0, p-bit) before forwarding it on the UNI port. The p-bit is not modified.

7.3 MEs required for VoIP Services

The following sections detail the MEs required for H.248 VoIP service. The relations ships of these MEs are show in the H.248 VoIP ME model in Figure 15.

ME Value	ME Type
45	MAC bridge service profile
47	MAC bridge port configuration data
53	Physical path termination point POTS UNI
58	Voice service profile
130	IEEE 802.1p mapper service profile
134	IP host config data
136	TCP/UDP config data
138	VoIP config data
139	VoIP voice CTP
142	VoIP media profile
143	RTP profile data
155	MGC config data
171	Extended VLAN tagging operation configuration data
290	Dot1X port extension package

Table 10 – H.248 VoIP Service MEs

7.3.1 POTS User Network Interface (UNI)

1. **Physical path termination point (PPTP) POTS UNI:** Represents the POTS UNI in the ONU where physical path terminates and analog telephony physical level functions are performed.

7.3.2 H.248 VoIP and Layer 2 Ethernet MAC Bridge MEs

1. **VoIP config data:** Defines configuration for VoIP in ONU and is used by OLT to discover the VoIP signaling protocol type (H.248) and ONU configuration methods.
2. **MGC config Data:** Defines Media Gateway (MG) Controller (MGC) configuration associated with MG POTS subscriber used to support H.248 VoIP services.
3. **TCP/UDP config data:** Configures Transmission Control Protocol (TCP) and User Datagram Protocol (UDP) services offered from an Internet Protocol (IP) host in the ONU.
4. **IP host config data:** Configures IP version 4 (IPv4) protocol based services offered in the ONU
5. **VoIP voice CTP:** Defines the attributes necessary to associate the H.248 VoIP service with a POTS UNI.
6. **VoIP media profile:** Contains settings that apply to the H.248 VoIP voice encoding
7. **RTP profile data:** Configures the Real Time Protocol (RTP) for the H.248 VoIP service.
8. **Voice service profile:** Organizes data that describe the voice service functions of the ONU.
9. **Dot1X port extension package:** Controls operation of the PPTP POTS UNI that disables IEEE 802.1X authentication.
10. **MAC bridge service profile:** Models an Ethernet (MAC) bridge.
11. **MAC bridge port configuration data:** Models a port on an Ethernet (MAC) bridge.
12. **IEEE 802.1p mapper service profile:** Associates priorities of 802.1p tagged frames (priority p-bit value in a tagged Ethernet frame) to designated GEM ports in the US direction and directs the DS direction GEM ports to PPTP POTS UNI fixed queues in ONU (if the priority queue used by the GEM port network CTP in the DS direction is Null).
13. **Extended VLAN tagging operation configuration data (EVTOCD):** Organizes data associated with POTS UNI frame tagging operation rules in the US direction.

7.3.3 H.248 VoIP Service ME Model

The H.248 VoIP model used for AT&T POTS services on non-integrated SFU ONTs is show below in Figure 15.

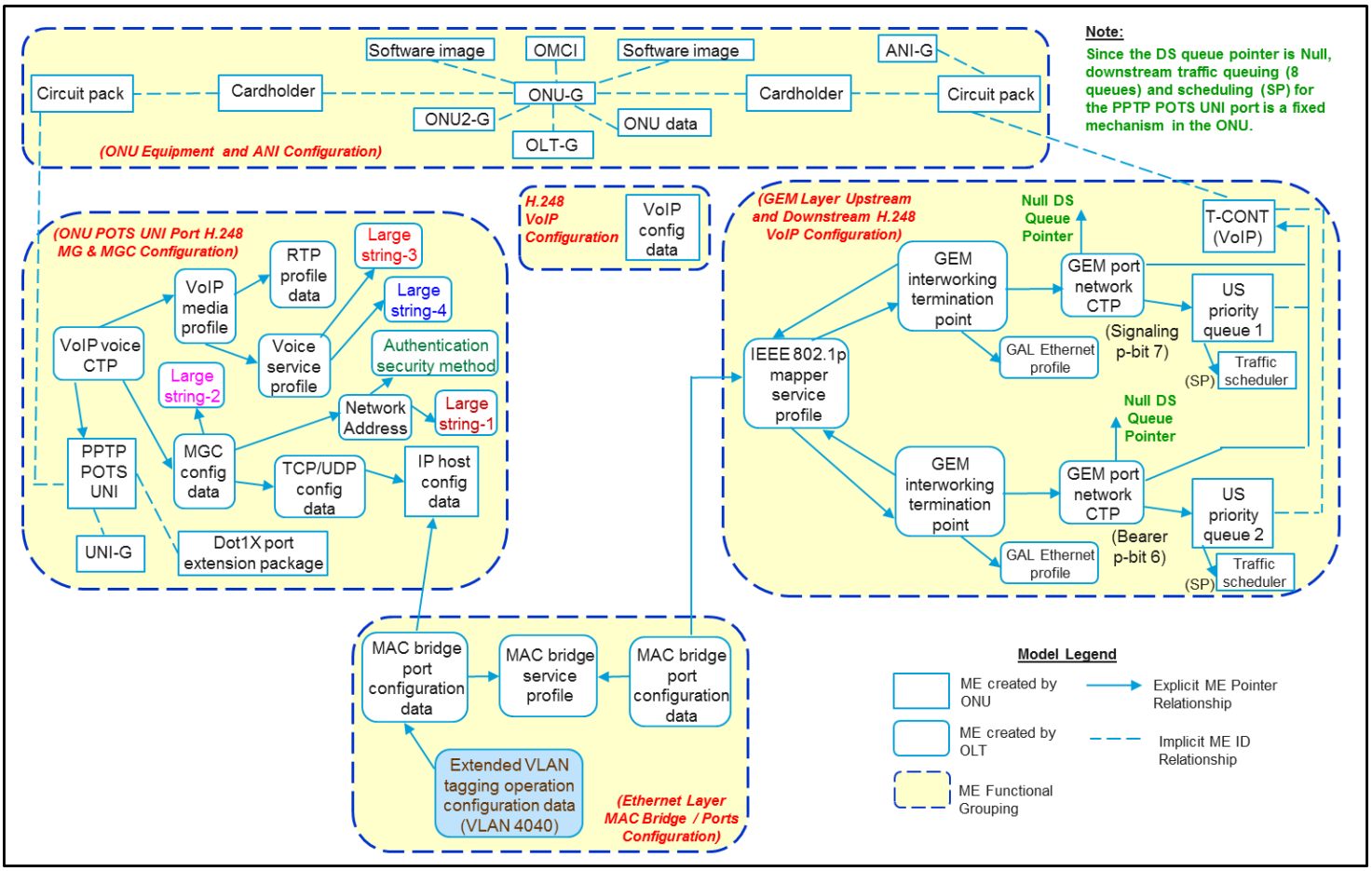

Figure 15 – H.248 VoIP Service ME Model

The following Extended VLAN tagging operation configuration data behavior is expected for the H.248 VoIP service model.

This ME has rules defining the US/DS H.248 VoIP Service Ethernet frame VLAN tagging for the ONU.

The US and DS rules are defined when the H.248 VoIP Service is provisioned for the ONU.

- In the US direction, the H.248 signaling and RTP bearer traffic received from the VoIP client (H.248 MG) via the IP host stack is accepted and encapsulated into a single tagged Ethernet frame with VLAN 4040 and p-bit = 7 for H.248 signaling and p-bit = 6 for RTP bearer before forwarding the Ethernet frame to the GEM layer to send over the PON port.
- In the DS direction, only the single tagged Ethernet frame with VLAN 4040 and p-bit =7 for H.248 signaling and p-bit = 6 for RTP bearer received from the GEM Layer is

accepted and the encapsulated H.248 signaling and RTP bearer traffic is forwarded via the IP host stack to the VoIP client (H.248 MG).

The behavior of additional highlighted MEs from Figure 15 is described below.

- **Large String - 1:** This ME will contain the static IPv4 address of the Genband G6 used as a primary MGC
- **Large String - 2:** This ME will contain the message identifier string for the H.248 messages originated by the ONU
- **Large String - 3:** This ME is used only if the Voice service profile attribute Tone event table does not make use of an entry in the Tone pattern table attribute. The ME contains the name of a file containing a codec sequence to play out a tone.
- **Large String - 4:** This ME is used only if the Voice service profile attribute Ringing event table does not make use of an entry in the Ringing pattern table attribute. The ME contains the name of a file containing a ring tone to be played out.
- **Authentication security method:** This ME is not necessary (and pointer can be set to Null) to retrieve the Genband G6 MGC IPv4 address (since it is statically assigned in Large string), but if ME is used the validation scheme is set to disabled with Username 1, Password, Realm and Username 2 attributes all set to null.

End of Document