Common Provisioning and Management of PON
Cable OpenOMCI

Cable OpenOMCI Specification

CPMP-SP-Cable-OpenOMCI-I03-251211

ISSUED

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Key to Document Status Codes

Work in Progress	An incomplete document designed to guide discussion and generate feedback; may include several alternative requirements for consideration.
Draft	A document that is considered largely complete but is undergoing review by members and vendors. Drafts are susceptible to substantial change during the review process.
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Closed	A static document that has been reviewed, tested, validated, and closed to further Engineering Change requests to the specification through CableLabs.

Trademarks

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1 SCOPE

1.1 Introduction and Purpose

Cable operators have traditionally deployed ITU-T PON systems in which both the OLT and ONUs are supplied by the same vendor, often because of a lack of cross-vendor interoperability, i.e., the ONUs of one vendor are not fully compatible with the OLT of another vendor.

This Cable OpenOMCI specification addresses those shortcomings and supports network operator deployment of OMCI-managed XGS-PON (ITU-T [G.9807.1]), MSA-based 25GS-PON ([25GS-PON]), and HSP ([G.9804.2]) via industry-wide best-practice standardization for consistent interoperability between OLTs and ONUs of any vendor.

This specification focuses on common cable operator service configurations and incorporates ideas similar to those of OpenOMCI documents written by non-cable operators, which were created to promote interoperability. These documents include the [AT&T OpenOMCI] and [Verizon OpenOMCI] specifications.

The target audience for this specification includes suppliers of OLT and ONU equipment compliant with the aforementioned ITU-T standards. This specification assumes the reader is familiar with the contents and format of the ITU-T G.988 specification [G.988].

1.2 Requirements Conformance Notation

Throughout this document, the words that are used to define the significance of particular requirements are capitalized.

"MUST"	This word means that the item is an absolute requirement of this specification.
"MUST NOT"	This phrase means that the item is an absolute prohibition of this specification.
"SHOULD"	This word means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighed before choosing a different course.
"SHOULD NOT"	This phrase means that there may exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
"MAY"	This word means that this item is truly optional. One vendor may choose to include the item because, for example, a particular marketplace requires it or because it enhances the product; another vendor may omit the same item.

2 REFERENCES

2.1 Normative References

To claim compliance with this specification, it is necessary to conform to the following standards and other works as indicated, in addition to the other requirements of this specification. Notwithstanding, intellectual property rights may be required to use or implement such normative references.

All references are subject to revision, and parties to agreement based on this specification are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

[25GS-PON] 25GS-PON MSA Group, 25GS-PON Specification—25 Gigabit Symmetric Passive Optical Network, Version 3.0, November 3, 2023

[G.988] ITU-T Recommendation G.988 (2022)–Amendment 2 (05/2025), ONU Management and Control Interface (OMCI) Specification

[G.9804.2] ITU-T Recommendation G.9804.2–Amendment 1 (02/2023), Higher Speed Passive Optical Networks—Common Transmission Convergence Layer Specification

[G.9807.1] ITU-T Recommendation G.9807.1–Amendment 2 (10/2020), 10-Gigabit-Capable Symmetric Passive Optical Network (XGS-PON)

[IEEE 802.1Q] IEEE 802.1Q-2018, IEEE Standard for Local and Metropolitan Area Networks—Bridges and Bridged Networks

[RFC 5234] IETF RFC 5234, D. Crocker, P. Overell, Augmented BNF for Syntax Specifications: ABNF, January 2008

2.2 Informative References

This specification uses the following informative references.

[AT&T OpenOMCI] AT&T, Open OMCI Specification, Edition 3.0, June 2017, https://wiki-archive.opencord.org/attachments/1966449/2557137.pdf

[eDOCSIS] eDOCSIS Specification, CM-SP-eDOCSIS-I31-220831, August 31, 2022, Cable Television Laboratories, Inc.

[eRouter] IPv4 and IPv6 eRouter Specification, CM-SP-eRouter-I22-240503, May 3, 2024, Cable Television Laboratories, Inc.

[G.984.3] ITU-T Recommendation G.984.3 (02/2004), Gigabit-Capable Passive Optical Networks (G-PON): Transmission Convergence Layer Specification—Includes Amendment 1 (07/2005), Amendment 2 (03/2006), and Amendment 3 (12/2006)

[G.984.4] ITU-T Recommendation G.984.4 (02/2008), Gigabit-Capable Passive Optical Networks (G-PON): ONT Management and Control Interface Specification—Includes Amendment 1 (06/2009), Amendment 2 (11/2009), and Amendment 3 (07/2010)

[G.987] ITU-T Recommendation G.987 (02/2012), 10-Gigabit-Capable Passive Optical Network (XG-PON) Systems: Definitions, Abbreviations and Acronyms

[G.9804.1] ITU-T Recommendation G.9804.1–Amendment 2 (01/2024), Optical Line Systems for Local and Access Networks

[IEEE 802.3at] IEEE 802.3at-2009, IEEE Standard for Information Technology—Part 3: CSMA/CD Access Method and Physical Layer Specifications, Amendment 3: Data Terminal Equipment (DTE) Power via the Media Dependent Interface (MDI) Enhancements

[RFC 3261] IETF RFC 3261, J. Rosenberg et al., SIP: Session Initiation Protocol, June 2002

[TR-069] Broadband Forum TR-069, CPE WAN Management Protocol (Amendment 6, Corrigendum 1), June 2020

[TR-369] Broadband Forum TR-369, Amendment 4: User Services Platform (USP), July 2024

[TR-471] Broadband Forum TR-471, Issue 3: Maximum IP-Layer Capacity Metric, Related Metrics, and Measurements, December 2022

[Verizon OpenOMCI] Verizon, OpenOMCI, Version 2.3, March 2024, https://github.com/vz-etech/verizon-openomci/tree/main/

2.3 Reference Acquisition

- Broadband Forum, https://www.broadband-forum.org/technical-reports
- Cable Television Laboratories, Inc., 858 Coal Creek Circle, Louisville, CO 80027;
  Phone: +1-303-661-9100; Fax: +1-303-661-9199; http://www.cablelabs.com
- Institute of Electrical and Electronics Engineers (IEEE), Phone: +1-800-422-4633 (USA and Canada);
  http://www.ieee.org
- International Telecommunication Union (ITU), Place des Nations, CH-1211, Geneva 20, Switzerland;
  Phone: +41-22-730-51-11; Fax: +41-22-733-7256; http://www.itu.int
- Internet Engineering Task Force (IETF), https://www.rfc-editor.org/
- 25GS-PON MSA Group, https://www.25gspon-msa.org/resources

3 TERMS AND DEFINITIONS

This specification uses the following terms.

802.1p	An IEEE task group and specification that defines a mechanism for quality of service (QoS) at the Ethernet media access control (MAC) layer. Note that though [G.988] refers to "802.1p," the IEEE has replaced the 802.1p specification with the [IEEE 802.1Q] specification.
802.1Q	An IEEE task group and specification that defines virtual local area networks (VLANs) on an Ethernet network. Sometimes referred to as "Dot1q."
25GS-PON	25Gbps symmetric PON as defined in [25GS-PON].
alloc-ID	allocation ID—A 14-bit number that an optical line terminal (OLT) assigns to an ONU to identify a traffic-bearing entity (T-CONT) that receives upstream bandwidth allocations as defined in [G.9807.1].
cardholder	A managed entity defined in [G.988] that represents the fixed equipment slot configuration of an ONU. Each cardholder can contain 0 or 1 circuit packs.
circuit pack	A managed entity defined in [G.988] that models equipment information that can change over the lifetime of an ONU, e.g., through replacement. A circuit pack is associated with a cardholder.
CPE	customer premise equipment—Examples include an ONU, a residential gateway, and an IP-STB.
eDOCSIS	The embedded DOCSIS specification [eDOCSIS] that defines the interface between the eCM and an eSAFE.
eDVA	embedded digital voice adapter—Contains the interface to a physical voice device, a network interface, CODECs, and all signaling and encapsulation functions required for VoIP transport, class features signaling, and QoS signaling. It generally refers to a SIP-based voice adapter.
eMTA	embedded multimedia terminal adaptor—Generally refers to a PacketCable 1.x-compliant voice adapter. See *eDVA*.
ePTA	embedded performance test agent—As described in [eDOCSIS].
eRouter	An embedded router eSAFE that is compliant with [eRouter], providing IPv4 and/or IPv6 data forwarding, address configuration, and domain name services to Internet Protocol (IP) host devices connected to the residential gateway in a customer's premises. If a given device includes an eRouter entity, that eRouter controls the Ethernet and Wi-Fi LAN interfaces. See *residential gateway*.
eSAFE	embedded service/application functional entity (eSAFE)—Examples include an eRouter or an eDVA.
functional set	A grouping of managed entities organized in this document to support specific operator-defined service use cases.
GEM	GPON Encapsulation Method—As defined in [G.984.3]. Unless explicitly stated otherwise, this term also refers generically to XGEM encapsulation.
GEM port	A virtual port for performing GEM encapsulation for transmitting frames between the ONU and the OLT. Each GEM port is referenced via a GEM port ID.
GPON	gigabit-capable passive optical network—2.5 Gbps/1.25 Gbps PON as defined in [G.984.3] and [G.984.4].
HSP	higher-speed PON—As defined in [G.9804.1].
ITU-T PON	A family of PON standards developed by ITU-T Study Group 15 Transport Access and Home—Question 2, "Optical systems for fibre access networks," that share a common TDM/TDMA channel-pair architecture and are managed by ONU management and control interface (OMCI) services [G.988]. For this specification, this term encompasses GPON, XG(S)-PON, 25GS-PON, and HSP.
LCI	logical CPE interface—A bi-directional or uni-directional data-only logical 802.3/Ethernet MAC frame interface between an ONU and an eSAFE. For the purposes of this specification, it is equivalent to a [G.988] VEIP.
managed entity	An OMCI-layer data element used to communicate control plane information between the ONU and OLT.
managed entity class value	A unique numerical identifier assigned to each managed entity as per table 11.2.4-1 of [G.988].

ONU	optical network unit—The passive optical network (PON) CPE. The ONU transmits upstream optical signals across the PON. The term optical network terminal (ONT) is often used interchangeably with ONU or with the particular semantics of an ONU that is used for fiber to the premise and includes the user port function. (See clause 5.9 of [G.9807.1].) The present specification will consistently use the term ONU.
OLT	optical line terminal—The network operator equipment typically installed in an operator's facility or as part of the outside fiber plant. The OLT transmits downstream signals across a point-to-multipoint PON to one or more ONUs.
OTT management	over-the-top management—A protocol that is outside the scope of this specification. An OTT Management protocol is assumed to be IP-based, requiring an ONU-provided physical termination point Ethernet UNI or a virtual Ethernet interface point. Example OTT Management protocols include the BBF CPE WAN Management Protocol ([TR-069] and BBF User Services Platform (USP) [TR-369]) as well as RDK Broadband management protocols such as WebPA (https://github.com/xmidt-org/webpa) and WebConfig (https://github.com/rdkcentral/webconfig).
PoE	power over Ethernet—As defined in [IEEE 802.3at].
PPTP	physical path termination point—As defined in [G.988].
residential gateway	A Layer 3 forwarding device in the customer's premises that may include Ethernet and Wi-Fi LAN interfaces and may or may not include an embedded ONU.
service flow	A unidirectional flow of packets from the OLT or the ONU to the ODN with pre-defined QoS traffic parameters. Also see *GEM port*.
SIP	Session Initiation Protocol—As defined in [RFC 3261].
T-CONT	transmission container or traffic container—A traffic-bearing object within an ONU that represents a group of logical connections that are treated as a single entity for the purpose of upstream bandwidth assignment. One or more GEM ports are mapped into a T-CONT, representing a service flow in the upstream direction.
XGEM	XG-PON Encapsulation Method—As defined in [G.987].
XGS-PON	10Gbps symmetric PON as defined in [G.9807.1]. Also referred to as XG(S)-PON.

4 ABBREVIATIONS

This specification uses the following abbreviations.

ABNF	augmented Backus-Naur form
AC	alternating current
AIS	alarm indication signal
alloc-ID	allocation ID
ANI	access node interface
ARC	alarm reporting control
AVC	Attribute Value Change
BER	bit error rate
CCM	continuity check message
CODEC	coder decoder
CPE	customer premise equipment
DC	direct current
DHCP	Dynamic Host Configuration Protocol
DSCP	DiffServ code point
eCM	embedded cable modem
ECN	engineering change notice
eDVA	embedded digital voice adapter
eMTA	embedded multimedia terminal adaptor
ePTA	embedded performance test agent
eSAFE	embedded service/application functional entity
GEM	GPON Encapsulation Method
GPON	gigabit-capable passive optical network
HSP	higher-speed PON
IANA	Internet Assigned Numbers Authority
ICMP	Internet Control Message Protocol
IEEE	Institute of Electrical and Electronics Engineers
IP-STB	Internet Protocol– set-top box
LAN	local area network
LCI	logical CPE interface
LSB	least significant bit
MAC	media access control
ME	managed entity
ODN	optical distribution network
OLT	optical line terminal
OMCC	ONU Management and Control Channel
OMCI	ONU management and control interface
ONT	optical network terminal
ONU	optical network unit
OTT	over the top
PD	powered device
PEN	Private Enterprise Number

PLOAM	Physical Layer Operations, Administration and Maintenance
PoE	power over Ethernet
PON	passive optical network
POTS	plain old telephone service
PPTP	physical path termination point
PSE	power sourcing equipment
QoS	quality of service
RF	radio frequency
RMON	remote network monitoring
SIP	Session Initiation Protocol
SNMP	Simple Network Management Protocol
T-CONT	transmission container, traffic container
TCA	Threshold Crossing Alert
TCI	tag control information
TCP	Transmission Control Protocol
TDM/TDMA	time division multiplexing/time division multiple access
UNI	user to network interface
VEIP	virtual Ethernet interface point
VID	VLAN identifier
VLAN	virtual local area network
VoIP	Voice Over Internet Protocol
WAN	wide area network
XGEM	XG-PON Encapsulated Method
XML	Extensible Markup Language

5 OVERVIEW

The majority of this specification references a subset of managed entities (MEs) published in [G.988]. It also includes a limited number of supplemental MEs, defined for functionality not already provided. This OpenOMCI document primarily focuses on XGS-PON deployments, but it also includes forward compatibility statements for 25GS-PON [25GS-PON] and HSP [G.9804.2] as needed.

Required (mandatory) MEs are grouped into functional sets that are organized to support common operator-defined service use cases. The functional sets begin with a common building block—a core set. Follow-on functional sets layer on additional functionality.

Both ITU-T GPON (G.984 series) and XGS-PON [G.9807.1] are currently being deployed by cable operators. It is not the intent of this specification to dictate hardware-impacting changes to PON equipment. Rather, the requirements in this specification serve as a basis for future software implementations that use a common set of MEs defined herein.

This document assumes Physical Layer Operations, Administration and Maintenance (PLOAM) operations as per the relevant recommendation: [G.9807.1], [25GS-PON], or [G.9804.2].

5.1 Conventions

Minimal content from [G.988] will be included in this document to add needed clarity. Otherwise, refer to complete and official content in [G.988].

5.1.1 G.988 ME and Attribute Naming Correspondence

For any reference to a [G.988] ME, the ME name will be followed by the clause number in parentheses, e.g., ANI-G (9.2.1), ONU2-G (9.1.2). For MEs newly defined for this specification, the word "New" will appear in parentheses, e.g., OpenOMCI Version (New).

Each [G.988] ME description specifies associated attributes, referenced by name. Note that attribute names are unique within the context of the associated ME, not across the entirety of the [G.988] specification.

5.1.2 OpenOMCI Organization Name and Version Identifier Reported by the ONU

This document is expected to be updated over time both as [G.988] is amended and as cable operators and CableLabs implement changes. CableLabs establishes a unique document identifier for each specification (SP) that includes a version number (Ixx) and a publication date (YYMMDD), which are updated for each version release, e.g., CPMP-SP-Cable-OpenOMCI-I01-241212.

An ONU conformant with the present specification MUST implement and support the OpenOMCI Version (New) ME. For more details, see Section 6.1.16, "OpenOMCI Version (New) Managed Entity."

5.1.3 ONU Functional Set and Release Notes Reporting

This specification organizes ONU service offerings by functional set. Each functional set is uniquely numbered. In using the OpenOMCI Version (New) ME, the ONU MUST report implementation status of each functional set documented in the reported OpenOMCI document version. Implementation status includes one of the following:

- not supported—ONU provides no support for this functional set, or
- supported—ONU supports all mandatory items.

In addition, an ONU MAY indicate a functional set availability for evaluation purposes (non-production use) only.

ONU vendors are expected to provide cable operators with release notes detailing any OMCI implementation differences from the present specification document. The release notes are expected to describe any partial support details, information pertaining to any evaluation status items, and any supported engineering change notices (ECNs). Note that ECNs are applicable to the specification but have not yet been incorporated into a new specification version.

5.1.4 Mandatory vs Optional MEs and Attributes

Each functional set provides a list of mandatory MEs required for implementation compliance.

ME attributes follow the mandatory vs optional designation used in [G.988]. Where needed, this specification will update an optional attribute to mandatory status, specify one or more attribute values that are required for compliance, etc. Any per-ME attribute requirements will individually follow the mandatory managed entities table for each functional set.

Vendor implementation of optional [G.988] MEs, propriety MEs, and ME attributes beyond what is indicated as mandatory is accommodated by this specification.

The ONU MUST include all supported [G.988] MEs and New MEs in the OMCI (9.12.8) ME, ME type table attribute. Listing of other vendor-specific MEs is optional, but if any are supported in the ONU firmware, the ONU vendor is expected to provide the operator with complete documentation of each ME including items (a) through (e) as per [G.988] clause 9, "MIB description."

5.1.5 ME Creation: Automatically Created by ONU

The [G.988] standard uses the directive "The ONU automatically creates an instance of this ME" for various conditions where the ONU firmware is responsible for providing ME support for installed options, configurations, presence of card packs, etc. In some cases, the ONU is required to create an ME based on ME creation by the OLT. This specification focuses on specifying the mandatory MEs required for ONU functionality that meets specific operator use cases. It is the responsibility of the ONU vendor to implement all MEs required by [G.988].

5.1.6 ME Sequencing

The OLT controls sequencing of ME creation. The ONU SHOULD accept ME creation in any sequence without impact to service creation or existing services. Information on ME sequences is provided in [G.988] appendix II, "G-PON Mechanisms and Services."

5.1.7 ONU Devices with Dual Management Domains

ONU devices compliant with this specification can be dual-managed in which the ONU is managed by OMCI and one or more instances of an embedded service/application functional entity (eSAFE) (e.g., an embedded router (eRouter) or an embedded digital voice adapter (eDVA)) are managed by an OTT Management system.

Dual-managed devices follow the two-management domain architecture as specified in [G.988] section II.2, "Dual-managed ONUs," with the Virtual Ethernet interface point (9.5.5) (also known as VEIP) providing the demarcation point between the OMCI and non-OMCI management domains. OMCI is not used to manage the IP connectivity of the non-OMCI management domain.

5.2 Cable Common PON CPE Architecture

Cable operators deploy a variety of CPE configurations into customer homes. The set of CPE deployed to a given customer includes an ONU that may or may not be integrated with one or more eSAFEs. For the purposes of this specification, eSAFE entities are managed by OTT Management.

5.2.1 Layer 2 Bridge ONU

The Layer 2 bridge ONU configuration supports the MEs for Functional Set 1: . It often exists as a single chassis device that contains only an ONU. A characteristic of this configuration is that only PLOAM and OMCI are required for management.

5.2.1.1 Limited Case—Layer 2 Bridge ONU + PPTP POTS UNI

A limited case of the Layer 2 bridge ONU includes one or more Physical path termination point POTS UNI (9.9.1) interfaces (e.g., RJ11) for voice/telephone, where the configuration is managed entirely by OMCI using SIP configuration options. See Functional Set 4: Embedded OMCI-Managed SIP VoIP Services. This configuration has some historical presence and is included in this document in case it is needed by an operator. Note that the preferred method for adding voice support in an ONU is via eSAFE, with configuration via OTT Management.

5.2.2 Integrated CPE

An integrated CPE configuration is a single chassis device that includes the Layer 2 Bridge ONU and one or more of the following eSAFE entities:

- eRouter,
- eDVA, or
- ePTA.

An example of an integrated CPE with an eRouter is depicted in Figure 1.

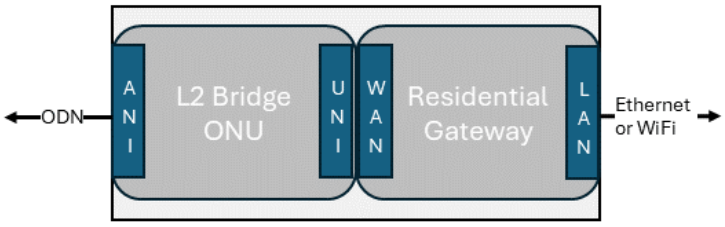

Figure 1 - Example of an Integrated CPE with an eRouter

An example of an integrated CPE with an eDVA is depicted in Figure 2.

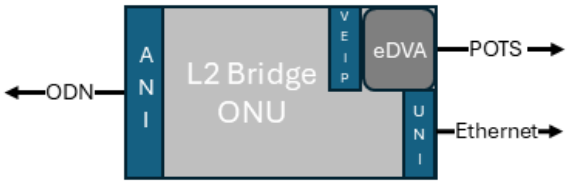

Figure 2 - Example of an Integrated CPE with an eDVA

OMCI management connectivity is provided via a Virtual Ethernet Interface Point (VEIP) ME separately for each eSAFE entity present. OMCI configures each VEIP in order to enable DHCP use by the eSAFE, which creates a demarcation point between OMCI management of the ONU and OTT Management of the eSAFE to support a dual-managed ONU. See Functional Set 3: Dual-Managed ONU.

Any physical Ethernet interface ports present on the integrated CPE chassis MUST be managed by the eRouter eSAFE following [eRouter] Section 5.1, "eDOCSIS eRouter and CPE Management Architecture," and Section 9.2, "System Description."

Any eRouter-embedded functions in the integrated CPE chassis, such as 802.11 Wi-Fi radio interfaces, eRouter performance monitoring agents, and eRouter-embedded speed test agents, MUST be managed by the eRouter via its VEIP using OTT Management.

5.2.3 Disintegrated CPE

A disintegrated CPE configuration consists of two chassis: a Layer 2 Bridge ONU chassis and a separate residential gateway chassis. An ONU PPTP Ethernet UNI port is connected to the residential gateway's WAN port. An example of a disintegrated CPE is depicted in Figure 3.

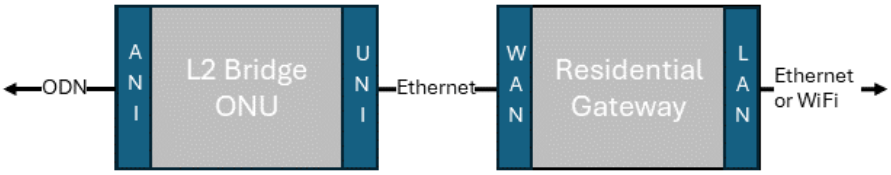

Figure 3 - Example of a Disintegrated CPE

OMCI is used to configure this UNI port sufficient to permit the residential gateway to use DHCP. The residential gateway is managed by the operator via OTT Management.

In the case of an ONU chassis with multiple PPTP Ethernet UNI ports, it is expected that the lowest numbered UNI port on the ONU is used to connect to the residential gateway. Any additional ONU Ethernet UNI ports are managed and monitored via OMCI for potential subscriber access needs.

In the case where the set of CPE in the subscriber home includes a separate IP-STB, that IP-STB is assumed to be connected to the LAN side of the residential gateway and managed by the operator via OTT Management.

6 CABLE OPENOMCI MANAGED ENTITY FUNCTIONAL SETS

Related managed entity definitions in this specification are grouped into a functional set. Multiple functional sets are defined in this section of the specification.

ONU implementation of the functional sets in this specification are dependent on each vendor's choice to meet various operator use cases. Each functional set should be implemented in its entirety.

Functional sets may relate to one or more managed entity relation diagrams in [G.988] clause 8, "Protocol-independent MIB for the OMCI." An ME shown in any relation diagram in [G.988] that is not specifically listed in any functional set in this section is considered optional.

6.1 Functional Set 1: Base

This functional set is the fundamental base set of MEs common to all ONU configurations for functional Layer 2 Bridge ONU services. Specific bridge functionality comes from the summary of connectivities from [G.988] clause 8.2.2, "Layer 2 functions," and the specific OLT-directed configuration of the management model in the ONU.

This functional set is used primarily for configuration management and provides ME relationship configuration flexibility ranging from

- a single service flow (Alloc-ID + T-CONT + GEM port) to
- several service flows and use of 802.1p mapping, VLAN mapping, and DSCP-to-priority mapping.

The ONU MUST support the OMCI managed entities listed in Table 1 - Mandatory Managed Entities: Functional Set 1: Base, as well as any per-attribute requirements listed in this section.

Table 1 - Mandatory Managed Entities: Functional Set 1: Base

G.988 Clause	Managed Entity Class Value	Mandatory Managed Entities
9.1.1	256	ONU-G
9.1.2	257	ONU2-G
9.1.3	2	ONU data
9.1.4	7	Software image
9.1.5	5	Cardholder
9.1.6	6	Circuit pack
9.1.16	456	ONU manufacturing data
9.1.17	457	ONU time configuration
9.2.1	263	ANI-G
9.2.2	262	T-CONT
9.2.3	268	GEM port network CTP
9.2.4	266	GEM interworking termination point
9.2.7	272	GAL Ethernet profile
9.2.10	277	Priority queue
9.3.1	45	MAC bridge service profile
9.3.4	47	MAC bridge port configuration data
9.3.10	130	IEEE 802.1p mapper service profile
9.3.11	84	VLAN tagging filter data
9.3.13	171	Extended VLAN tagging operation configuration data
9.5.1[1]	11	Physical path termination point (PPTP) Ethernet UNI
9.12.1[2]	264	UNI-G
9.12.2	131	OLT-G
9.12.8	287	OMCI

G.988 Clause	Managed Entity Class Value	Mandatory Managed Entities
New	65450	OpenOMCI Version
NOTES: 1. An ONU in an integrated device need not report the Physical Path Termination Point Ethernet UNI (9.5.1) ME in the MIB upload. 2. An ONU in an integrated device need not report the UNI-G (9.12.1) ME in the MIB upload.		

The ONU SHOULD support the OMCI managed entities listed in Table 2 - Optional Managed Entities: Functional Set 1: Base, as well as any per-attribute requirements listed in this section.

Table 2 - Optional Managed Entities: Functional Set 1: Base

G.988 Clause	Managed Entity Class Value	Mandatory Managed Entities
9.1.15	441	ONU3-G

Only those MEs and attributes impacted are listed in the above two tables. Otherwise, the ONU is expected to follow the mandatory and optional requirements in [G.988].

6.1.1 ONU-G (9.1.1)

The [G.988] ONU-G (9.1.1) ME defines a set of actions. In addition to Get and Set, these actions include Reboot, Test, and Synchronize Time. ONUs are expected to make use of the Synchronize Time action as their primary means to learn the time-of-day from the OLT. Though [G.988] defines additional MEs and methods for time synchronization, the present specification is silent on whether an ONU needs to support them.

6.1.2 ONU2-G (9.1.2)

The attributes in Table 3 have fixed operational parameters as reported for the ONU2-G (9.1.2) ME.

The OMCI Extended Message Set supports variable length PDUs, up to a maximum of 1980 bytes, which allow for message segment sizes many times that of the fixed 48 byte Baseline Message Set PDUs. As such, the use of the Extended Message Set greatly improves the efficiency of OMCI messaging. There are several use cases where Extended Message Set provides a significant positive OMCI messaging efficiency impact. These include MIB Upload and ONU Software Download, where the use of Extended Message Set allows for significantly faster MIB Uploads and ONU Software downloads.

The ONU SHOULD support both OMCI Baseline and Extended Message Sets as defined in clause 11 of [G.988]. If the ONU supports Extended Message Sets, it MUST indicate this support via the ONU2-G (9.1.2) OMCC version attribute.

The ONU SHOULD support the use of the extended message format for Message Type 13 - MIB upload response ([G.988] clause A.2.14) and Message Type 14 - MIB upload next response ([G.988] clause A.2.16).

The ONU SHOULD support the OLT's use of the extended message format for Message Type 19 – Start download ([G.988] clause A.2.23) and Message Type 20 - Download section ([G.988] clause A.2.25).

The ONU MUST support a number of bidirectional GEM port-IDs that is equal to or greater than the number of supported T-CONTs. In addition, the ONU MUST support a downstream-only GEM port-ID for broadcast traffic and a downstream-only GEM port-ID for multicast traffic. The total number of supported GEM port-IDs does not include the GEM port-ID for the ONU Management and Control Channel (OMCC).

The ONU MUST support a total of at least 8 Priority Queue ME instances for upstream traffic and a total of at least 8 Priority Queue ME instances for downstream traffic.

Table 3 - ONU2-G (9.1.2)

Item	Value, Comment
OMCC version[1]	Baseline message set is the minimum requirement. Baseline and extended message set is strongly encouraged.
Security capability[2]	0x1, Advanced encryption standard-128 (AES-128)
Security mode[2]	0x1, AES-128 algorithm
Total GEM port number	<vendor specific value>
Total priority queue number	<vendor specific value>
Connectivity capability[3]	0x14, 1:P and 1:MP
Quality of service (QoS) configuration flexibility	<vendor specific value>, if this attribute is supported
Priority queue scale factor[4]	1000

NOTES:

1. The OLT cares about the higher order 4 bits of this attribute. The ONU uses the B value range to indicate support for baseline and extended message set.
2. AES-128 is always supported for downstream and upstream encryption; other code points (payload encryption methods) are optional. Use of upstream encryption is at operator discretion.
3. Minimum required Ethernet connectivity models; others optional.
4. Suggested default. Otherwise, vendor optional.

6.1.3 Cardholder (9.1.5)

The attributes in Table 4 have fixed operational parameters as reported for the Cardholder (9.1.5) ME.

Table 4 - Cardholder (9.1.5)

Item	Value, Comment
Actual plug-in unit type	See Table 5 and Table 6 below.

In the context of plug-in unit types, the present specification supports XGS-PON, 25GS-PON, and HSP PON. The ONU MUST support at least one of the coding values listed in Table 5 - Plug-in Unit Types.

Table 5 - Plug-in Unit Types
From [G.988] table 9.1.5-1 and [25GS-PON] section 7, "OMCI Specification."

Coding	Content	Description
222[1]	25G-PON25G10	25G-PON interface, 25 Gbps downstream and 10 Gbps upstream
223[1]	25G-PON25G25	25G-PON interface, 25 Gbps downstream and 25 Gbps upstream
227	HSP50G50	HSP interface with 49.7664 Gbps downstream, 49.7664 Gbps upstream
228	HSP50G25	HSP interface with 49.7664 Gbps downstream, 24.8832 Gbps upstream
229	HSP50G12	HSP interface with 49.7664 Gbps downstream, 12.4416 Gbps upstream
238	XG-PON10G10	XG-PON interface, 10 Gbps downstream and 10 Gbps upstream

NOTE:

1. From the [25GS-PON] specification: "25GS-PON equipment vendors shall not use the coding values for other purposes."

6.1.4 Circuit Pack (9.1.6)

When an ONU includes a circuit pack with an Ethernet interface, the ONU MUST support the attributes and values defined in Table 6 - Circuit Pack (9.1.6).

Table 6 - Circuit Pack (9.1.6)

Item	Value, Comment
Bridged or IP ind	0, Bridged (only)

6.1.5 ONU3-G (9.1.15)

The ONU SHOULD support the attributes and values defined in Table 7 - ONU3-G (9.1.15).

Table 7 - ONU3-G (9.1.15)

Item	Value, Comment
Latest restart reason	as reported by ONU

6.1.6 ONU Manufacturing Data (9.1.16)

The current release of [G.988] is ITU-T G.988 (2022) Amd. 2. This latest release adds an additional optional attribute to the ONU manufacturing data (9.1.16) ME. The following requirement is a result of this addition and is intended to make support for this attribute mandatory in the present specification.

The ONU MUST support the ONU manufacturing data (9.1.16) MAC address attribute, representing the unique IEEE 802 MAC address of the physical ONU. The ONU MUST return a value in the MAC address attribute that matches the MAC address printed on its chassis exterior. In the case where the ONU is embedded in a gateway, where the overall integrated device may have many MAC addresses, the intended MAC address for this ME attribute is that of the ONU itself and not a MAC address associated with the eRouter entity.

6.1.7 ANI-G (9.2.1)

An ONU MUST support the attributes and values defined in Table 8 - ANI-G (9.2.1). An ONU MUST support at least 8 T-CONTs.

Table 8 - ANI-G (9.2.1)

Item	Value, Comment
SR indication	1 (True)
Total T-CONT number	<vendor specific value>
Optical signal level	as reported by ONU
Lower optical threshold	254..0 (default 0xFF selects the ONU's internal policy)
Upper optical threshold	254..0 (default 0xFF selects the ONU's internal policy)
Transmit optical level	as reported by ONU
Lower transmit power threshold	(default 0x81 selects the ONU's internal policy)
Upper transmit power threshold	(default 0x81 selects the ONU's internal policy)

6.1.8 GEM Port Network CTP (9.2.3)

An ONU MUST support the attributes and values defined in Table 9 - GEM Port Network CTP (9.2.3).

Table 9 - GEM Port Network CTP (9.2.3)

Item	Value, Comment
Direction[1]	3 or 2
Encryption key ring[2]	0, 1, 2, and 3
NOTES: 1. Direction is 3 (bidirectional) for unicast traffic. Direction is 2 (ANI-to-UNI) for the GEM port supporting multicast or broadcast downstream. 2. This attribute is not supported in GPON equipment.	

6.1.9 GEM Interworking Termination Point (9.2.4)

An ONU MUST support the attributes and values defined in Table 10 - GEM Interworking Termination Point (9.2.4).

Table 10 - GEM Interworking Termination Point (9.2.4)

Item	Value, Comment
Interworking option[1]	1 (MAC bridged LAN), 5 (IEEE 802.1p mapper), or 6 (downstream broadcast)
NOTE: 1. Use 1 for 1:P, 5 for 1:MP, and 6 for a multicast/broadcast link, e.g., "flooding link."	

6.1.10 MAC Bridge Service Profile (9.3.1)

An ONU MUST support the attributes and values defined in Table 11 - MAC Bridge Service Profile (9.3.1).

Table 11 - MAC Bridge Service Profile (9.3.1)

Item	Value, Comment
MAC learning depth	0 (default, no imposed limit)
Dynamic filtering ageing time	0 (default, ONU uses internal ageing time)

When the OLT creates the MAC bridge service profile (9.3.1) ME, [G.988] requires the ONU to automatically create

- MAC bridge configuration data (9.3.2).

6.1.11 MAC Bridge Port Configuration Data (9.3.4)

When the OLT creates the MAC bridge port configuration data (9.3.4) ME, [G.988] requires the ONU to automatically create

- MAC bridge port filter table data (9.3.6),
- MAC bridge port filter pre-assign table (9.3.7),
- MAC bridge port bridge table data (9.3.8), and
- MAC bridge port ICMPv6 process pre-assign table (9.3.33) (only if the ONU supports ICMPv6 awareness).

6.1.12 VLAN Tagging Filter Data (9.3.11)

An ONU MUST support the attributes and values defined in Table 12 - VLAN Tagging Filter Data (9.3.11).

Table 12 - VLAN Tagging Filter Data (9.3.11)

Item	Value, Comment
Forward operation[1]	0x10 required
VLAN filter list[2]	12 VLAN entries supported
NOTES: 1. 0x10: untagged frames are discarded. Tagged frames are discarded if the outer VID is not present in the VLAN filter list. Other forward operations listed in [G.988] table 9.3.11-1, "Forward operation attribute values," are optional. 2. Only the outer VID is used for matching, regardless of the number of tags a frame has.	

6.1.13 Extended VLAN Tagging Operation Configuration Data (9.3.13)

An ONU MUST support the attributes and values defined in Table 13 - Extended VLAN Tagging Operation Configuration Data (9.3.13).

Table 13 - Extended VLAN Tagging Operation Configuration Data (9.3.13)

Item	Value, Comment
Association type[1]	2 (PPTP Ethernet UNI) or 10 (VEIP)
Received frame VLAN tagging operation table max size	at least 5
Downstream mode[1]	0, 3, and 6
DSCP to P-bit mapping	(see note 2)
NOTES: 1. Support is required for the listed values. Other values are optional. 2. The DSCP to P-bit mapping attribute is Read/Write Mandatory.	

An ONU MUST support a Received frame VLAN tagging operation table max size of at least 5.

An ONU SHOULD support a Received frame VLAN tagging operation table max size of at least 32.

6.1.14 Physical Path Termination Point Ethernet UNI (9.5.1)

The attributes in Table 14 have fixed operational parameters as reported for the Physical path termination point Ethernet UNI (9.5.1) ME. The ONU automatically creates an instance of this ME for each PPTP Ethernet UNI port as per the requirements in [G.988] clause 9.5.1.

Table 14 - Physical Path Termination Point Ethernet UNI (9.5.1)

Item	Value, Comment
Bridged or IP ind	0 (Bridged) or 2 (Depends on the parent circuit pack)
Max frame size	(see below)

An XGS-PON or newer ONU MUST support a Max Frame Size of at least 9000 bytes. A GPON ONU supports a Max Frame Size of at least 2000 bytes.

When the ONU automatically creates the Physical path termination point Ethernet UNI (9.5.1) ME and the ONU supports the enhanced PoE control feature, the ONU automatically creates

- Power over Ethernet Control (9.5.6) for the corresponding PPTP Ethernet UNI.

XGS-PON and higher-rate ONUs can include various LAN-side Ethernet UNIs. In the trivial case, the service configuration of a single UNI on an ONU is straightforward, but if multiple UNIs are presented, this can be more complex—especially if the UNIs have differing capabilities (e.g. IEEE 802.3 1000 BASE-T vs. IEEE 802.3 2.5G BASE-T vs. IEEE 802.3 10G BASE-T).

In the case of an ONU in an integrated device, with an active eSAFE, the ONU need not report the Physical Path Termination Point Ethernet UNI (9.5.1) ME in the MIB upload. An ONU in an integrated device, with an active eSAFE, SHOULD reject an OLT's attempt to perform a Set to the Physical Path Termination Point Ethernet UNI (9.5.1) ME.

6.1.14.1 Multiple Ethernet UNI Ports of the Same Rate Capability

When the ONU includes multiple Ethernet UNI ports of the same rate capability, the ONU MUST populate a value for the physical path termination point Ethernet UNI [G.988] clause 9.5.1, Managed Entity ID Attribute, for each of these UNIs, that aligns numerically with the ONU chassis face plate numbering associated with each of these ports.

When the ONU includes multiple UNI ports of the same rate capability, the ONU SHOULD populate a value for the physical path termination point Ethernet UNI [G.988] clause 9.5.1, Managed Entity ID Attribute, for each of these UNIs, in a monotonically incrementing sequential order.

If an ONU has only four 1000 BASE-T UNIs, the ONU SHOULD populate a value for the physical path termination point Ethernet UNI [G.988] clause 9.5.1, Managed Entity ID Attribute, for these interfaces as 0x<slotA>01, 0x<slotA>02, 0x<slotA>03, 0x<slotA>04, where the hexadecimal value of <slotA> is vendor implementation dependent.

6.1.14.2 Multiple Ethernet UNI Ports of Differing Rate Capabilities

When the ONU includes UNI ports of differing rate capabilities, the ONU SHOULD populate a value for the physical path termination point Ethernet UNI [G.988] clause 9.5.1, Managed Entity ID Attribute, whereby higher rate-capable interfaces have a lower numerical value than lower rate-capable interfaces.

If an ONU has one 10G BASE-T UNI and one 1000 BASE-T UNI, the ONU SHOULD populate a value for the physical path termination point Ethernet UNI [G.988] clause 9.5.1, Managed Entity ID Attribute, for these interfaces as 0x<slotA>01, 0x<slotB>01, where the hexadecimal value of <slotA> is less than that of <slotB>. The specific values used for <slotA> and <slotB> are vendor implementation dependent.

If an ONU has one 10G BASE-T UNI and four 1000 BASE-T UNIs, the ONU SHOULD populate a value for the physical path termination point Ethernet UNI [G.988] clause 9.5.1, Managed Entity ID Attribute, for these interfaces as 0x<slotA>01, 0x<slotB>01, 0x<slotB>02, 0x<slotB>03, 0x<slotB>04, where the hexadecimal value of <slotA> is less than that of <slotB>. The specific values used for <slotA> and <slotB> are vendor implementation dependent.

If an ONU has one 25G Optical UNI, two 10G BASE-T UNIs, and one 1000 BASE-T UNI, the ONU SHOULD populate a value for the physical path termination point Ethernet UNI [G.988] clause 9.5.1, Managed Entity ID Attribute, for these interfaces as 0x<slotA>01, 0x<slotB>01, 0x<slotB>02, 0x<slotC>01, where the hexadecimal value of <slotA> is less than that of <slotB>, and the hexadecimal value of <slotB> is less than that of <slotC>. The specific values used for <slotA>, <slotB>, and <slotC> are vendor implementation dependent.

6.1.14.3 Ethernet UNI Pluggable Modules

[G.988] includes support for pluggable circuit packs, described in clauses Cardholder (9.1.5) and Circuit Pack (9.1.6), which cover the case where the entire circuit pack is pluggable; however, a more typical use case for ONU Ethernet ports is where one or more physical path termination point Ethernet UNIs (9.5.1) are some form of modular slot with an SFP/SFP+ pluggable module. In this case, the hosting circuit pack may contain pluggable and non-pluggable ports.

The ONU is expected to populate values for the physical path termination point Ethernet UNI [G.988] clause 9.5.1, Expected Type and Sensed Type Attributes, using a coding value from [G.988] Table 9.1.5-1, Plug-In Unit Types, that most accurately reflects the capabilities of the UNI.

The ONU MUST represent the physical path termination point Ethernet UNI (9.5.1) sensed type attribute value as 0 (no line interface module) when no pluggable module is sensed in the modular slot.

The ONU MUST represent the physical path termination point Ethernet UNI (9.5.1) sensed type attribute value based on [G.988] Table 9.1.5-1, Plug-In Unit Types, when a pluggable module is sensed. The ONU SHOULD use the most accurate value from this table.

The ONU SHOULD represent the physical path termination point Ethernet UNI [G.988] clause 9.5.1, Managed Entity ID Attribute, value of a pluggable LAN interface based on the maximum capability of the modular slot. For example, a QSFP28 modular slot can often support code point 72 (25G optical) or lower rate pluggables. Therefore, the ONU will populate a QSFP28 modular interface with a managed entity ID attribute value that is lower than that of an SFP+ modular interface even if the QSFP28 modular slot has a 10G BASE-T pluggable module inserted. A change in the rate capability of a pluggable module SHOULD NOT cause a change in the MEID value of this PPTP instance.

6.1.15 UNI-G (9.12.1)

An ONU MUST support the attributes and values defined in Table 15 - UNI-G (9.12.1).

Table 15 - UNI-G (9.12.1)

Item	Value, Comment
Non-OMCI management identifier[1]	0 (OMCI only) or <VEIP pointer>
NOTE: 1. <VEIP pointer> for VEIP.	

6.1.16 OpenOMCI Version (New) Managed Entity

This managed entity provides the means for the ONU to indicate support for elements of this OpenOMCI specification. The ONU MUST autonomously instantiate an instance of the OpenOMCI Version (New) ME. The ONU MUST support the Managed Entity ID, Organization Identifier, Version Identifier, and Implementation Status attributes of this ME. The ONU MAY support the Evaluation Status attribute of this ME.

The ONU MUST include the OpenOMCI Version (New) ME in the MIB upload.

Relationships

The instance of this managed entity is implicitly associated with an ONU-G (9.1.1) ME.

Attributes

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

Organization Identifier: This unsigned integer attribute provides the value of an IANA Private Enterprise Number (PEN) of the organization that published the OpenOMCI specification. For Cable OpenOMCI specification compliance, the value of this attribute is the Cable Television Laboratories PEN decimal value of 4491. (R) (mandatory) (4 bytes)

Version Identifier: This unsigned integer attribute identifies the version of the OpenOMCI specification the ONU supports. For Cable OpenOMCI specification compliance, the value of this attribute is the specification issued version number. For example, for CPMP-SP-Cable-OpenOMCI-I02-250701, the decimal value of this attribute is 2. (R) (mandatory) (2 bytes)

Implementation Status: This attribute is meaningful in the context of the OpenOMCI specification referenced by the Organization Identifier and the Version Identifier. It is a bit map that defines whether the ONU supports (1) or does not support (0) specific implementation items (e.g., a functional set) as detailed in the referenced specification. Bits that are not applicable to the referenced specification should be designated as not supported (0). Table 16 represents bit assignment for a specific organization.

Table 16 - OpenOMCI Version (New) Managed Entity—Implementation Status

Organization Name: CableLabs	
Bit	**Meaning**
1 (LSB)	Functional Set 1
2	Functional Set 2
3	Functional Set 3
4	Functional Set 4
5..32	Reserved

(R) (mandatory) (4 bytes)

NOTE: It is the responsibility of the named organization to maintain consistency of implementation status reporting across all versions of their OpenOMCI specifications.

Evaluation Status: This attribute is meaningful in the context of the OpenOMCI specification referenced by the Organization Identifier and the Version Identifier and provides a secondary (lower priority) indication of implementation status for evaluation purposes only. It is a bit map that defines whether the ONU provides an evaluation implementation (1) of a designated item or does not (0). Bits that are not applicable to the referenced specification should be designated as not supported (0). If the evaluation status attribute is present and if an implementation status bit is set as supported (1), the corresponding evaluation status bit is ignored. Bits are assigned as shown in Table 17.

Table 17 - OpenOMCI Version (New) Managed Entity—Evaluation Status

Organization Name: CableLabs	
Bit	**Meaning**
1 (LSB)	Functional Set 1
2	Functional Set 2
3	Functional Set 3
4	Functional Set 4
5..32	Reserved

(R) (optional) (4 bytes)

Actions

Get.

Notifications

None

Through the use of the Version Identifier attribute, the ONU advertises the OpenOMCI specification version its running firmware was built to support. The expectation is that the OLT will handle any Version Identifier value as best as it can.

The OLT is expected to gracefully handle the case where the OLT is running code that is complaint to a newer OpenOMCI version than the ONU. The expectation is that the OLT will not attempt to perform a MIB Set for an ME that is not supported by the OpenOMCI specification version indicated via the ONU's Version Identifier.

In addition, the OLT is expected to gracefully handle the case where the ONU is compliant to a newer version of the OpenOMCI specification than the OLT. Here, the expectation is that the OLT can log an error when it sees an unknown ME in the MIB upload, but the OLT does not reject the ONU for this reason alone.

6.1.17 IP 5-Tuple Traffic Classifier Managed Entity (Future)

Many cable operators support unique, per-service service flows on their DPoE (EPON) networks today via the use of IP 5-tuple traffic classifiers. Just as in DOCSIS, DPoE supports the ability to classify a given traffic flow into a specific service flow via any of source IP address, destination IP address, source port, destination port, or protocol. This is in addition to traffic classification based on DSCP value.

In order to support a more seamless migration by cable operators from DPoE to ITU-T PON technologies, a future version of the present specification may define a new IP 5-tuple classifier ME. Though not all current ITU-T PON ONU hardware designs support this feature, it is our hope that future ITU-T PON ONU hardware will.

6.2 Functional Set 2: Performance Monitoring (PM)

The ONU MUST support Functional Set 2: Performance Monitoring (PM).

This functional set represents performance and status monitoring MEs supporting optical operations and management of the PON system as viewed by the ONU. This functional set should be regarded as a companion to Functional Set 1: ONU Core + Layer 2 Bridge ONU. Functional Set 2: Performance Monitoring (PM) currently supports XGS-PON and 25GS-PON. It is anticipated that a later version of this specification will update this functional set to add support for 50G HSP. This section defines a distinct functional set in order to permit incremental growth independent from Functional Set 1: .

The ONU MUST support the OMCI MEs listed in Table 18 - Mandatory Managed Entities: Functional Set 2: Performance Monitoring as well as any per-attribute requirements listed in this section.

Table 18 - Mandatory Managed Entities: Functional Set 2: Performance Monitoring

G.988 Clause	Managed Entity Class Value	Mandatory Managed Entities
9.2.13	341	GEM port network CTP performance monitoring history data
9.2.14	343	Energy consumption performance monitoring data
9.2.16	345	XG-PON downstream management performance monitoring history data
9.2.17	346	XG-PON upstream management performance monitoring history data
9.2.22	453	Enhanced FEC performance monitoring history data
9.2.23	454	Enhanced TC performance monitoring history data (XGS-PON & 25GS-PON only)
9.3.3	51	MAC bridge performance monitoring history data
9.3.34	425	Ethernet frame extended PM 64-bit
9.5.2[1]	24	Ethernet performance monitoring history data
9.12.6	273	Threshold data 1
9.12.7	274	Threshold data 2
9.12.17	426	Threshold data 64 bit

NOTE:
1. An ONU in an integrated device SHOULD reject an attempt by the OLT to create the Ethernet performance monitoring history data (9.5.2) ME if the Physical Path Termination Point Ethernet UNI (9.5.1) is not present in the MIB upload.

6.2.1 Ethernet Frame Extended PM 64-Bit (9.3.34)

The ONU MUST support the following counter methods for the Ethernet frame extended PM 64-bit (9.3.34) ME.

- Binned PM
  - One instance each for upstream and downstream counters per physical path termination point Ethernet UNI or virtual Ethernet interface point as specified in the control block attribute's parent ME class and parent ME instance fields. Upstream or downstream is indicated by the control block control fields bit 2 value.
  - 15-minute accumulators (like classical PM)—Control block control fields bit 1 has value 0.
  - Interface level counters—Control block control fields bit 15 and bit 16 are set to 0, and the control block TCI field is set to 0.
  - Clear operation—Control block accumulation disable bit 16 is supported for counter clearing.

- Continuous accumulation (similar to SNMP RMON gauged counters)
  - One instance each for upstream and downstream counters per physical path termination point Ethernet UNI or virtual Ethernet interface point as specified in the control block attribute's parent ME class and parent ME instance fields. Upstream or downstream is indicated by the control block control fields bit 2 value.
  - Continuous accumulation—Control block control fields bit 1 has value 1.
  - Interface level counters—Control block control fields bit 15 and bit 16 are set to 0, and the control block TCI field is set to 0.
  - Clear operation—Control block accumulation disable bit 16 is supported for counter clearing.

6.3 Functional Set 3: Dual-Managed ONU

If the ONU supports one or more eSAFE entities, it MUST support Functional Set 3: Dual-Managed ONU.

When implementing Functional Set 3: Dual-Managed ONU, the ONU MUST support the OMCI managed entities listed in Table 19 - Mandatory Managed Entities: Functional Set 3: Dual-Managed ONU, as well as any per-attribute requirements listed in this section.

Table 19 - Mandatory Managed Entities: Functional Set 3: Dual-Managed ONU

G.988 Clause	Managed Entity Class Value	Mandatory Managed Entities
9.5.5	329	Virtual Ethernet interface point

Note the optional status of the TCP/UDP configuration data (9.4.3) ME, quoted from [G.988] clause 9.4.3.

> If a non-OMCI interface is used to manage an IP service, this ME is unnecessary; the non-OMCI interface supplies the necessary data.

6.3.1 Virtual Ethernet Interface Point (9.5.5)

When implementing Functional Set 3: Dual-Managed ONU, the ONU MUST support the attributes and values defined in Table 20 - Virtual Ethernet Interface Point (9.5.5).

Table 20 - Virtual Ethernet Interface Point (9.5.5)

Item	Value, Comment
Interdomain name	<hex-private-enterprise-number>","<domain-type-id>
TCP/UDP pointer	No OMCI management, this attribute may be omitted or set to its default, a null pointer
IANA assigned port	0xFFFF

The ONU MUST instantiate an instance of the Virtual Ethernet Interface Point (9.5.5) ME for each active eSAFE in the ONU. When instantiating the Virtual Ethernet Interface Point (9.5.5) ME, the ONU MUST indicate the type of non-OMCI managed domain associated with the Virtual Ethernet Interface Point via the Interdomain name attribute. The value of the Interdomain name attribute MUST be formatted as follows (using ABNF notation as defined in [RFC 5234]):

Interdomain name = hex-private-enterprise-number "," domain-type-id

where

hex-private-enterprise-number = "0x" 8HEXDIGIT

and

domain-type-id = %s"EROUTER" | %s"EDVA" | %s"EPTA".

The ONU MUST provide a value of hex-private-enterprise-number 0x0000118B to be compliant with this specification.

Use of the above format allows other organizations to use this ME for similar purposes and avoid a conflict in the domain-type-id name space.

Note that the value 0x0000118B is the hexadecimal representation of the Cable Television Laboratories (CableLabs) IANA-assigned PEN of 4491. It is formatted as hexadecimal to allow a fixed-length string representation of the value where such a representation of the decimal value would be awkward for some possible PEN values.

Based on the above requirements, the three possible string values for the interdomain name attribute are the following:

0x0000118B,EROUTER

0x0000118B,EDVA

0x0000118B,EPTA

The virtual Ethernet interface point (9.5.5) ME is considered the primary UNI interface if an eRouter entity is active in the ONU chassis.

An ONU with an active eRouter entity MUST represent the virtual Ethernet interface point (9.5.5) managed entity ID attribute value based on the ONU's interface to the eRouter WAN interface, as 0x<slotA>01, where the hexadecimal value of <slotA> is vendor implementation dependent. If the eRouter supports multiple logical WAN interfaces, e.g., distinct data and TR-069 management service interfaces, all of the eRouter logical interfaces are expected to communicate with this 0x<slotA>01 virtual Ethernet interface point instance on the ONU.

6.4 Functional Set 4: Embedded OMCI-Managed SIP VoIP Services

The ONU MUST support Functional Set 4: Embedded OMCI-Managed SIP VoIP Services if it is used to support embedded VoIP that requires OMCI management and SIP. More details of this use case can be found in Section 5.2.1.1, "Limited Case—Layer 2 Bridge ONU + PPTP POTS UNI."

There are ONUs on the market that directly support native voice services and provide one or more PPTP POTS UNI interfaces in which the provisioning and management is directly by OMCI and not by OTT Management. For these configurations of ONU, the voice services are Voice Over Internet Protocol (VoIP), and the supported management protocol is the Session Initiation Protocol (SIP). Implementations that provide this style of voice support should generally follow [G.988] clause 6.4, "Voice over Internet protocol management," and [G.988] appendix II.4, "Voice Services."

When implementing this functional set, the ONU MUST support the OMCI Managed Entities listed in Table 21 - Mandatory Managed Entities: Functional Set 4: OMCI-Managed SIP VoIP Services, as well as any per-attribute requirements listed in this section.

Table 21 - Mandatory Managed Entities: Functional Set 4: OMCI-Managed SIP VoIP Services

G.988 Clause	Managed Entity Class Value	Mandatory Managed Entities
9.4.1	134	IP host config data
9.4.2	458	IP host performance monitoring (PM) history data
9.4.3	136	TCP/UDP config data
9.9.1	53	Physical path termination point POTS UNI
9.9.2	153	SIP user data
9.9.3	150	SIP agent config data
9.9.4	139	VoIP voice CTP
9.9.5	142	VoIP media profile
9.9.6	58	Voice service profile
9.9.7	143	RTP profile data
9.9.8	146	VoIP application service profile
9.9.18	138	VoIP config data

The following general notes apply to Table 21.

1. Several of the above mandatory MEs for SIP VoIP services have mandatory attributes that reference other MEs for support: Large string, Authentication security method, Network address, etc.
2. Optional voice service-related MEs for consideration are
    a. VoIP feature access codes (9.9.9),
    b. Network dial plan table (9.9.10), and
    c. SIP agent config data 2 (9.9.21).
3. Optional voice service-related PM MEs for consideration are
    a. Call control performance monitoring history data (9.9.12),
    b. IP host performance monitoring history data (9.4.2),
    c. TCP/UDP performance monitoring data (9.4.4),
    d. IP host performance monitoring history data part 2 (9.4.6),
    e. RTP performance monitoring history data (9.9.13),
    f. SIP agent performance monitoring history data (9.9.14), and
    g. SIP call initiation performance monitoring history data (9.9.15).

6.4.1 Physical Path Termination Point POTS UNI (9.9.1)

The following guidance is taken from [G.988]. The ONU automatically creates an instance of the Physical path termination point POTS UNI (9.9.1) ME per port as follows.

- 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.

When the ONU automatically creates the Physical path termination point POTS UNI (9.9.1) ME, the ONU automatically creates the following:

- VoIP line status (9.9.11).

6.4.2 VoIP Config Data (9.9.18)

When implementing Functional Set 4: Embedded OMCI-Managed SIP VoIP Services, the ONU MUST support the OMCI managed entities listed in Table 22 - VoIP Config Data (9.9.18).

Table 22 - VoIP Config Data (9.9.18)

Item	Value, Comment
Available signaling protocols	1 (SIP only)
Signaling protocol used	1 (SIP only)
Available VoIP configurations methods	1 (OMCI only)
VoIP configuration method used	1 (OMCI only)

Annex A Notifications (Normative)

Annex A defines the notifications for each mandatory ME in the functional sets defined in this specification. This annex currently supports XGS-PON and 25GS-PON. It is anticipated that a later version of this specification will update this annex to add support for 50G HSP. The tables in this annex are sourced from the ITU-T Recommendation G.988—Amendment 1 (03/2024), "ONU Management and Control Interface (OMCI) Specification." They are reproduced with the permission of the ITU-T.

Notifications can be zero or more of the following types: Test Result, Attribute Value Change (AVC), Alarm, or Threshold Crossing Alert (TCA).

TCAs make use of the Threshold data 1 (9.12.6) ME, Threshold data 2 (9.12.7) ME, and Threshold data 64 bit (9.12.17) ME, which contain threshold values for counters in PM history data MEs.

In the tables in this annex, the leftmost column indicates whether the row entry is required. An "M" indicates a mandatory status, and a "C" indicates a conditionally mandatory status.

If [G.988] defines a given ME attribute as optional and the ONU implements that attribute, then the corresponding notifications for that attribute are considered conditionally mandatory.

The ONU MUST support all row entries marked as "M", mandatory, in the notification tables in Annex A, "Notifications (Normative)." The ONU MUST support all row entries marked as "C", conditionally mandatory, in the notification tables in Annex A, "Notifications (Normative)," if the specified condition is true.

Notifications are included for MEs that may be automatically created by the ONU as a result of implementing the mandatory MEs for a given functional set.

A.1 Notifications for Functional Set 1: Base

This section defines the notifications for each mandatory ME in Functional Set 1.

A.1.1 ONU-G (9.1.1)

The ONU-G (9.1.1) ME definition includes notifications of the types Test Result, AVC, and Alarm. The present specification is silent on requirements for this ME for Test Results and AVCs but includes the Alarm requirements defined in Table 23.

Table 23 - ONU-G (9.1.1): Alarms

Req	Number	Alarm	Description
M	0	Equipment alarm	Functional failure on an internal interface
C	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. Mandatory if the ONU hardware has battery backup support.
C	2	Battery missing	Battery is provisioned but missing. Mandatory if the ONU hardware has battery backup support.
C	3	Battery failure	Battery is provisioned and present but cannot recharge. Mandatory if the ONU hardware has battery backup support.
C	4	Battery low	Battery is provisioned and present, but its voltage is too low. Mandatory if the ONU hardware has battery backup support.
C	5	Physical intrusion	Applies if the ONU supports detection such as door or box open. Mandatory if the ONU is an MDU ONU with this hardware capability.
C	12	ONU manual power off	The ONU is shutting down because the subscriber has turned off its power switch. Mandatory if the ONU has an internally monitored power switch.
C	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. Mandatory if the ONU provides PoE power.
C	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. Mandatory if the ONU provides PoE power.

Note that though the ONU-G (9.1.1) Alarm number 7 "Dying gasp" has not been explicitly mandated in the present specification, it is assumed that the ONU supports a more reliable method to indicate a loss of power. This method is defined in [G.9807.1] and [G.9804.2] as the "Ind Field" bit 0, known as the dying gasp bit.

A.1.2 ONU2-G (9.1.2)

No specified notifications.

A.1.3 ONU Data (9.1.3)

No specified notifications.

A.1.4 Software Image (9.1.4)

No specified notifications.

A.1.5 Cardholder (9.1.5)

Table 24 - Cardholder (9.1.5): Attribute Value Change

Req	Number	Attribute Value Change	Description
C	1	Actual type	Actual type of circuit pack in cardholder. Mandatory if the ONU hardware supports pluggable circuit packs.
C	5	Actual equipment id	Actual equipment ID of circuit pack in cardholder. Mandatory if the ONU hardware supports pluggable circuit packs.

Table 25 - Cardholder (9.1.5): Alarms

Req	Number	Alarm	Description
C	0	Plug-in circuit pack missing	Configured circuit pack is not present. If this alarm is active, none of the mismatch alarms are declared. Mandatory if the ONU hardware supports pluggable circuit packs.
C	1	Plug-in type mismatch alarm	Inserted circuit pack is wrong type. Mandatory if the ONU hardware supports pluggable circuit packs.
C	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 ([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. Mandatory if the ONU hardware supports pluggable circuit packs.
C	3	Plug-in equipment ID mismatch alarm	Inserted circuit pack has the wrong equipment ID. Mandatory if the ONU hardware supports pluggable circuit packs.
C	4	Protection switch	An autonomous equipment protection switch has occurred. This notification is reported by the protected cardholder. Mandatory if the ONU hardware supports pluggable circuit packs.

A.1.6 Circuit Pack (9.1.6)

The Circuit pack (9.1.6) ME definition includes notifications of types AVC and Alarm. The present specification is silent on requirements for AVCs for this ME but includes the Alarm requirements defined in Table 26.

Table 26 - Circuit Pack (9.1.6): Alarms

Req	Number	Alarm	Description
C	0	Equipment alarm	A failure on an internal interface or failed self-test. Mandatory if the ONU hardware supports pluggable circuit packs.
C	1	Powering alarm	Fuse failure or failure of DC/DC converter. Mandatory if the ONU hardware supports pluggable circuit packs.

Req	Number	Alarm	Description
C	2	Self-test failure	Failure of circuit pack autonomous self-test. Mandatory if the ONU hardware supports pluggable circuit packs.
C	3	Laser end of life	Failure of transmit laser imminent. Mandatory if the ONU hardware supports pluggable circuit packs.
C	4	Temperature yellow	No service shutdown at present, but the circuit pack is operating beyond its recommended range. Mandatory if the ONU hardware supports pluggable circuit packs.
C	5	Temperature red	Service has been shut down to avoid equipment damage. The operational state of the affected PPTPs indicates the affected services. Mandatory if the ONU hardware supports pluggable circuit packs.

A.1.7 ONU3-G (9.1.15)

No specified notifications.

A.1.8 ONU Manufacturing Data (9.1.16)

No specified notifications.

A.1.9 ONU Time Configuration (9.1.17)

No specified notifications.

A.1.10 ANI-G (9.2.1)

Table 27 - ANI-G (9.2.1): Test

Req	Test	Description
M	Test the ANI-G	The test action can be used to perform optical line supervision tests. Refer to [G.988] annex A.

Note that the ONU is expected to support the test response and test result messages per [G.988], annex A. In particular, the ONU is expected to support the ANI-G optical line supervision test message contents including power feed voltage, received optical power, mean optical launch power, laser bias current, and temperature in degrees Celsius.

The ANI-G (9.2.1) ME definition includes notifications of types AVC and Alarm. The present specification is silent on requirements for AVCs for this ME but includes the Alarm requirements defined in Table 28.

Table 28 - ANI-G (9.2.1): Alarms

Req	Number	Alarm	Description
M	0	Low received optical power	Received downstream optical power below threshold
M	1	High received optical power	Received downstream optical power above threshold
M	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.
M	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.
M	4	Low transmit optical power	Transmit optical power below lower threshold
M	5	High transmit optical power	Transmit optical power above upper threshold
M	6	Laser bias current	Laser bias current above threshold determined by vendor; laser end of life pending

A.1.11 T-CONT (9.2.2)

No specified notifications.

A.1.12 GEM Port Network CTP (9.2.3)

No specified notifications.

A.1.13 GAL Ethernet Profile (9.2.7)

No specified notifications.

A.1.14 Priority Queue (9.2.10)

No specified notifications.

A.1.15 MAC Bridge Service Profile (9.3.1)

No specified notifications.

A.1.16 MAC Bridge Configuration Data (9.3.2)

No specified notifications.

A.1.17 MAC Bridge Port Configuration Data (9.3.4)

No specified notifications.

A.1.18 MAC Bridge Port Filter Table Data (9.3.6)

No specified notifications.

A.1.19 MAC Bridge Port Filter Pre-Assign Table (9.3.7)

No specified notifications.

A.1.20 MAC Bridge Port Bridge Table Data (9.3.8)

No specified notifications.

A.1.21 IEEE 802.1p Mapper Service Profile (9.3.10)

No specified notifications.

A.1.22 VLAN Tagging Filter Data (9.3.11)

No specified notifications.

A.1.23 Extended VLAN Tagging Operation Configuration Data (9.3.13)

No specified notifications.

A.1.24 MAC Bridge Port ICMPv6 Process Pre-Assign Table (9.3.33)

No specified notifications.

A.1.25 Physical Path Termination Point (PPTP) Ethernet UNI (9.5.1)

Table 29 - Physical Path Termination Point (PPTP) Ethernet UNI (9.5.1): Attribute Value Change

Req	Number	Attribute Value Change	Description
M	2	Sensed type	Sensed type of Ethernet interface. Valid values are as follows. 1 (10BASE-T), 2 (100BASE-T) 3 (Gigabit Ethernet), 4 (10G Ethernet).
M	6	Op state	Operational state

The insertion and removal of a pluggable module causes the ONU to trigger an attribute value change (AVC) notification for the sensed type. For historical reasons, the value in the AVC may not be useful, so it is typical for the OLT to retrieve the current sensed type value after processing the AVC in order to update the current sensed type.

The ONU MUST send an AVC Number 2, sensed type, when the physical path termination point Ethernet UNI (9.5.1) sensed type attribute value changes.

The expected behavior of an ONU with regard to pluggable module sensed type reporting and AVC generation is described in Table 30.

Table 30 - ONU Sensed Type Reporting and AVC Generation

Condition	Reported Sensed Type	AVC Generated?
Slot empty at MIB upload	0 – No line interface module (LIM)	-
Module present at MIB upload	Applicable [G.988] Table 9.1.5-1 coding value	-
Module inserted	Applicable [G.988] Table 9.1.5-1 coding value	Yes
Module removed	0 – No line interface module (LIM)	Yes

Table 31 - Physical Path Termination Point (PPTP) Ethernet UNI (9.5.1): Alarms

Req	Number	Alarm	Description
M	0	LAN-LOS	No carrier at the Ethernet UNI

A.1.26 Power over Ethernet Control (9.5.6)

Table 32 - Power Over Ethernet Control (9.5.6): Attribute Value Change

Req	Number	Attribute Value Change	Description
C	3	Operational state	Mandatory in the case where the ONU supports PoE

A.1.27 UNI-G (9.12.1)

No specified notifications.

A.1.28 OLT-G (9.12.2)

No specified notifications.

A.1.29 OMCI (9.12.8)

No specified notifications.

A.1.30 OpenOMCI Version (New)

No specified notifications.

A.2 Notifications for Functional Set 2: Performance Monitoring (PM)

This section defines the notifications for each mandatory ME in Functional Set 2.

A.2.1 GEM Port Network CTP Performance Monitoring History Data (9.2.13)

Table 33 - GEM Port Network CTP Performance Monitoring History Data (9.2.13): Threshold Crossing Alert

Req	Number	Threshold Crossing Alert	Threshold Value Attribute No.
M	1	Encryption key errors	1

A.2.2 Energy Consumption Performance Monitoring Data (9.2.14)

No specified notifications.

A.2.3 XG-PON Downstream Management Performance Monitoring History Data (9.2.16)

Table 34 - XG-PON Downstream Management Performance Monitoring History Data (9.2.16): Threshold Crossing Alert

Req	Number	Threshold Crossing Alert	Threshold Value Attribute No.
M	1	PLOAM MIC error count	1
M	2	OMCI MIC error count	2

A.2.4 XG-PON Upstream Management Performance Monitoring History Data (9.2.17)

No specified notifications.

A.2.5 Enhanced FEC Performance Monitoring History Data (9.2.22)

Table 35 - Enhanced FEC Performance Monitoring History Data (9.2.22): Threshold Crossing Alert

Req	Number	Threshold Crossing Alert	Threshold Value Attribute No.
M	0	Corrected bits/bytes	1
M	1	Corrected code words	2
M	2	Uncorrectable code words	3
M	4	FEC seconds	4

A.2.6 Enhanced TC Performance Monitoring History Data (XGS-PON and 25GS-PON Only) (9.2.23)

No specified notifications.

A.2.7 MAC Bridge Performance Monitoring History Data (9.3.3)

Table 36 - MAC Bridge Performance Monitoring History Data (9.3.3): Threshold Crossing Alert

Req	Number	Threshold Crossing Alert	Threshold Value Attribute No.
M	0	Bridge learning entry discard	1

A.2.8 Ethernet Frame Extended PM 64-Bit (9.3.34)

Table 37 - Ethernet Frame Extended PM 64-Bit (9.3.34): Threshold Crossing Alert

Req	Number	Threshold Crossing Alert	Threshold Value Attribute No.
M	1	Drop events	1
M	2	CRC errored packets	2
M	3	Undersize packets	3
M	4	Oversize packets	4 (**Note:** [G.988] indicates that any frame over 1518 bytes is oversize.)

A.3 Notifications for Functional Set 3: Dual-Managed ONU

This section defines the notifications for each mandatory ME in Functional Set 3.

A.3.1 Virtual Ethernet Interface Point (9.5.5)

No specified notifications.

A.3.2 UNI-G (9.12.1)

No specified notifications.

A.4 Notifications for Functional Set 4: Embedded OMCI-Managed SIP VoIP Services

This section defines the notifications for each mandatory ME in Functional Set 4.

A.4.1 IP Host Config Data (9.4.1)

No specified notifications.

A.4.2 IP Host Performance Monitoring (PM) History Data (9.4.2)

Table 38 - IP Host Performance Monitoring (PM) History Data (9.4.2): Threshold Crossing Alert

Req	Number	Threshold Crossing Alert	Threshold Value Attribute No.
M	3	DHCP timeout	3

A.4.3 TCP/UDP Config Data (9.4.3)

No specified notifications.

A.4.4 Physical Path Termination Point POTS UNI (9.9.1)

No specified notifications.

A.4.5 SIP User Data (9.9.2)

Table 39 - SIP User Data (9.9.2): Alarms

Req	Number	Alarm	Description
M	0	SIP UA register auth	Cannot authenticate a registration session (e.g., missing credentials)
M	1	SIP UA register timeout	Timeout waiting for response from a registration server
M	2	SIP UA register fail	Failure response received from a registration server
M	3	SIP UA missing dial plan	Missing dial plan
M	4	SIP UA invalid dial plan	Invalid dial plan

A.4.6 SIP Agent Config Data (9.9.3)

The SIP Agent Config Data (9.9.3) ME definition includes notifications of types AVC and Alarm. The present specification is silent on requirements for AVCs for this ME but includes the Alarm requirements defined in Table 40.

Table 40 - SIP Agent Config Data (9.9.3): Alarms

Req	Number	Alarm	Description
M	0	SIP UA register name	Failed to resolve the registration server name
M	1	SIP UA register reach	Cannot reach a registration server (the port cannot be reached, ICMP errors)
M	2	SIP UA register connect	Cannot connect to a registration server (due to bad credentials or other faults after the port has responded)
M	3	SIP UA register validate	Cannot validate a registration server

A.4.7 VoIP Voice CTP (9.9.4)

No specified notifications.

A.4.8 VoIP Media Profile (9.9.5)

No specified notifications.

A.4.9 Voice Service Profile (9.9.6)

No specified notifications.

A.4.10 RTP Profile Data (9.9.7)

No specified notifications.

A.4.11 VoIP Application Service Profile (9.9.8)

No specified notifications.

A.4.12 VoIP Line Status (9.9.11)

No specified notifications.

A.4.13 VoIP Config Data (9.9.18)

No specified notifications.

Appendix I Acknowledgements

We wish to thank the following participants contributing directly to this document.

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Samuel Chen	Broadcom
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