International Telecommunication Union

ITU-T

ITU-T G.9801 Implementers' Guide

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

(5 December 2014)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Access networks – Optical line systems for local and access networks

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Implementers' Guide for ITU-T G.9801 (Ethernet passive optical networks using OMCI)

Summary

This Implementers' Guide includes both conformance and interoperability test plans for OMCI-EPON defined by Recommendation ITU-T G.9801 with respect to the requirements defined by BBF TR-156.

The conformance test plan for OMCI-EPON consists of test configurations and a limited set of key test cases to verify conformance regarding both the required OMCI-EPON ONU functionality and the implementation of the OMCI protocol.

The interoperability test plan for OMCI-EPON consists of test configuration and a limited set of key test cases to verify interoperability of an OMCI-EPON OLT and OMCI-EPON ONU pairing. The OMCI-EPON ONU must be satisfied with the conformance test plan in this Recommendation. The test cases verify interoperability regarding the functionality of OMCI-EPON systems where each test is applied and measured at the edges of the system, SNI and UNI defined in Recommendation ITU T G.9801.

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ITU-T G.9801 Implementers' Guide

Conformance and interoperability test plans for OMCI-EPON

1 Scope

This document includes both conformance and interoperability test plans for OMCI-EPON defined by ITU-T Recommendation G.9801 with respect to the requirements defined by BBF TR-156.

The conformance test plan for OMCI-EPON consists of test configurations and a limited set of key test cases to verify conformance regarding both the required OMCI-EPON ONU functionality and the implementation of the OMCI protocol.

The interoperability test plan for OMCI-EPON consists of test configuration and a limited set of key test cases to verify interoperability of an OMCI-EPON OLT and OMCI-EPON ONU pairing. The OMCI-EPON ONU must be satisfied with the conformance test plan in this Recommendation. The test cases verify interoperability regarding the functionality of OMCI-EPON systems where each test is applied and measured at the edges of the system, SNI and UNI defined in ITU-T Recommendation G.9801.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this document. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this document are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

[ITU-T G.988] ITU-T Recommendation G.988 (2010), *ONU management and control interface (OMCI) specification*

[ITU-T G.9801] ITU-T Recommendation G.9801 (2013), *Ethernet passive optical networks using OMCI*

[IEEE 1904.1] IEEE standard 1904.1-2013, *Service Interoperability in Ethernet Passive Optical Networks (SIEPON)*

[IEEE 1904.1-Conformance 02] IEEE standard 1904.1-Conformance02-2014, *Standard for Conformance Test Procedures for Service Interoperability in Ethernet Passive Optical Networks, IEEE Std 1904.1 Package B*

[IEEE 802.3] IEEE standard 802.3-2012, *IEEE Standard for Ethernet*

[BBF TR-156] BBF Technical Report 156 issue-01 (2008), Using GPON Access in the context of TR-101

[BBF TR-255] BBF Technical Report 255 issue-01 (2013), GPON Interoperability Test Plan

[BBF ATP-247] BBF Abstract Test Plan 247 issue-02 (2013), GPON ONU Conformance Abstract Test Plan

3 Definitions

3.1 Terms defined elsewhere

This document uses the following terms defined elsewhere:

3.1.1 access network (AN) [b-ITU-T G.902]: An implementation comprising those entities (such as cable plant, transmission facilities, etc.) which provide the required transport bearer capabilities for the provision of telecommunications services between a service node interface (SNI) and each of the associated user-network interfaces (UNI).

3.1.2 Ethernet Passive Optical Network (EPON) [ITU-T G.9801]: a general name for PON systems that are based on the [IEEE 802.3] standard and the [IEEE 1904.1] standard.

3.1.3 OMCI-EPON [ITU-T G.9801]: An EPON system that applies the ONU Management and Control Interface (OMCI) defined by [ITU-T G.988].

3.1.4 optical access network (OAN) [ITU-T G.9801]: A part of an access network whose network elements are interconnected by optical communication channels.

NOTE – An OAN may or may not extend all the way to the UNI, so that the user-side interface of the OAN does not necessarily coincide with the UNIs of the AN.

3.1.5 optical distribution network (ODN) [ITU-T G.9801]: A point-to-multipoint optical fibre infrastructure. A *simple* ODN is entirely passive and is represented by a single-rooted point-to-multipoint tree of optical fibres with splitters, combiners, filters, and possibly other passive optical components. A *composite* ODN consists of two or more passive *segments* interconnected by active devices, each of the segments being either an optical trunk line segment or an optical distribution segment. A passive optical distribution segment is a simple ODN itself. Two ODNs with distinct roots can share a common subtree.

3.1.6 optical line termination (OLT) [ITU-T G.9801]: A network element in an ODN-based optical access network that terminates the root of at least one ODN and provides an OAN SNI.

3.1.7 optical network terminal (ONT) [ITU-T G.9801]: An ONU supporting a single subscriber.

3.1.8 optical network unit (ONU) [ITU-T G.9801]: A network element in an ODN-based optical access network that terminates a leaf of the ODN and provides an OAN UNI.

3.1.9 ONU management and control interface (OMCI) [ITU-T G.9801]: An operation and management channel between the OLT and an ONU that is message-based and employs an extendable management information base.

3.1.10 passive optical network (PON) system [ITU-T G.9801]: A combination of network elements in an ODN-based optical access network that includes an OLT and multiple ONUs and implements a particular coordinated suite of physical medium dependent layer, transmission convergence layer, and management protocols.

3.1.11 physical layer OAM (PLOAM) [ITU-T G.9801]: An operation and management channel between the OLT and the ONUs that is close to real time and is based on a fixed set of messages.

3.1.12 ranging [ITU-T G.9801]: A procedure of measuring the logical distance between the OLT and any of its subtending ONUs with the objective to determine and assign the appropriate equalization delay, which is necessary to align the ONU's upstream transmissions on a common OLT-based upstream frame reference. Ranging is performed during ONU activation and may be performed while the ONU is in service.

3.1.13 service node (SN) [b-ITU-T G.902]: A network element that provides access to various switched and/or permanent telecommunication services.

3.1.14 service node interface (SNI) [b-ITU-T G.902]: An interface which provides customer access to a service node.

3.1.15 user-network interface (UNI) [b-ITU-T I.112]: The interface between the terminal equipment and a network termination at which interface the access protocols apply.

3.2 Terms defined in this document

Terms for test plans are defined in the section 5.

4 Abbreviations

This document uses the following abbreviations and acronyms:

AN	Access Network
ARP	Address Resolution Protocol
BBF	Broadband Forum
BE	Best Effort (service category)
BNG	Broadband Network Gateway
BW	Bandwidth
CRC	Cyclic Redundancy Check
DEI	Drop Eligible Indication
EPON	Ethernet Passive Optical Network
DSCP	DiffServ Code Point
G-PON (GPON)	Gigabit-capable Passive Optical Network
GEM	Generic Encapsulation Method
ID	Identifier
IGMP	Internet Group Management Protocol
IP	Internet Protocol
IPoE	IP over Ethernet
LAN	Local Area Network
LLID	Logical Link Identifier
MAC	Media Access Control
MD	Maintenance Domain
ME	Managed Entity
MEP	Maintenance association End Point
MIB	Management Information Base
MIP	Maintenance association Intermediate Point
MPCPDU	Multi Point Control Protocol Data Unit
OAM	Operation, Administration, and Management
OAN	Optical Access Network
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
PLOAM	Physical Layer Operations, Administration and Maintenance
PON	Passive Optical Network
PPPoE	Point-to-point protocol over Ethernet
QoS	Quality of Service
R/S	Reference point at the interface of the ONU to the ODN
RG	Residential Gateway
S/R	Reference point at the interface of the OLT to the ODN
SNI	Service Node Interface
TC	Transmission Convergence
T-CONT	Transmission Container
TR	Technical Report
UNI	User Network Interface
VBES	VLANs for Business Ethernet Services
VID	Virtual Identifier
VLAN	Virtual Local Area Network

5 Conventions

5.1 Test equipment

5.1.1 ONU Conformance test

Reference OLT

The Reference OLT is required to perform conformance tests of ONU devices. The Reference OLT must add the following minimum requirements on the OLT functions defined in [ITU-T G.9801].

1. The Reference OLT MUST provide a user interface that allows the tester to monitor OMCI messages and Ethernet frames and their content. This interface MUST provide a log capability of the executed test case.
2. The Reference OLT MUST support generation of MPCP and MAC control extension messages to activate and configure the L2 flow for OMCC, and provide ONU with an active upstream timeslot for any activated unit of bandwidth assignment (including the one used for the OMCC).

ODN

The test uses ODN architecture described in 6.3 of [ITU-T G.9801].

EPON analyzer

The EPON analyser is an optional piece of equipment, which may be included in the ODN during conformance tests to capture and analyze the traffic present on that network.

Ethernet traffic analyzer

The Ethernet traffic analyzer generates and captures Ethernet frames, and measure traffic parameters of the Ethernet frames such as frame rate, the number of lost frames.

5.1.2 OLT and ONU pairing interoperability test

ODN

The test uses ODN architecture described in 6.3 of [ITU-T G.9801].

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The EPON analyser is an optional piece of equipment, which may be included in the ODN during interoperability tests to capture and analyze the traffic present on that network.

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The Ethernet traffic analyser generates and captures Ethernet frames, and measure traffic parameters of the Ethernet frames such as frame rate, the number of lost frames.

5.2 Test setup

5.2.1 ONU conformance test

Figure 1shows the basic test setup for ONU conformance test. A specific test case may include an additional figure to refine the test setup by including additional information and parameters.

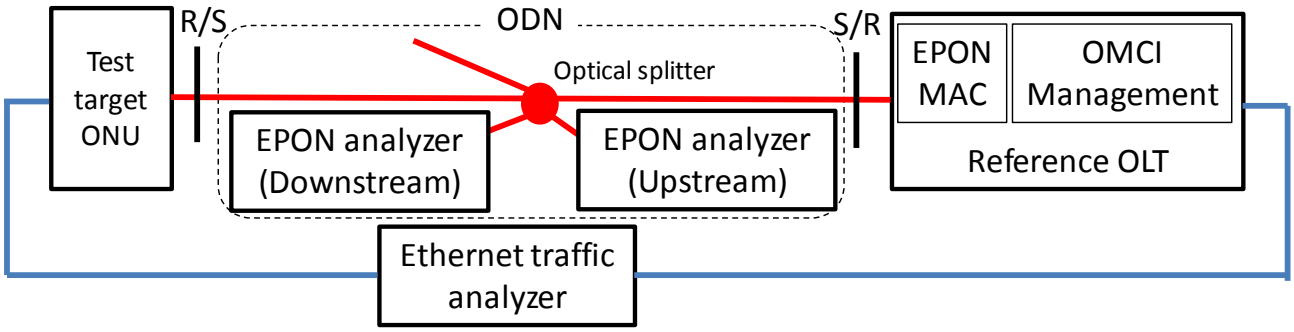

Figure 1: Basic setup for ONU conformance test

5.2.2 OLT and ONU pairing interoperability test

Figure 2 shows the basic test setup for OLT and ONU pairing interoperability test. The test target ONU has completed conformance tests described in Section 8 of this document. A specific test case may include an additional figure to refine the test setup by including additional information and parameters.

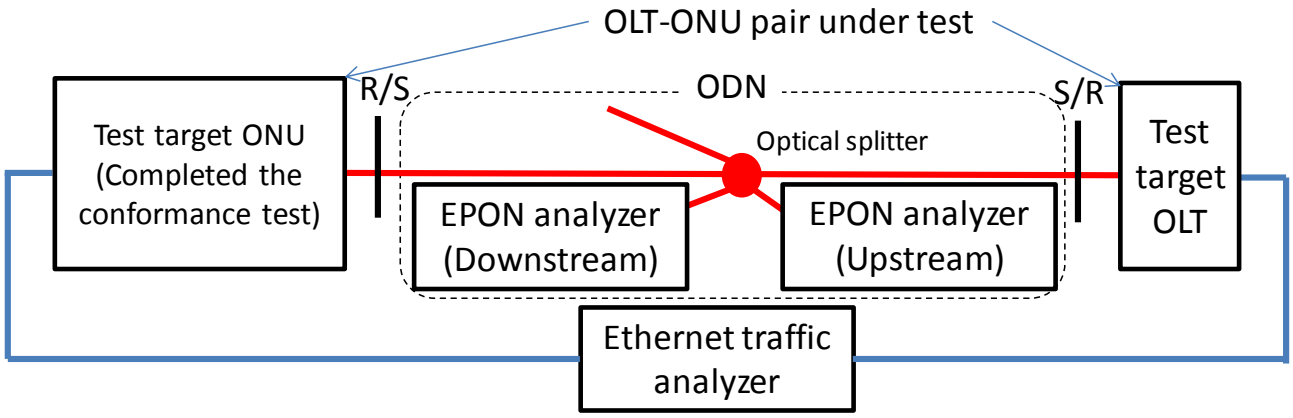

Figure 2: Basic setup for OLT and ONU pairing interoperability test

6 Service scenarios

All service scenarios described in [ITU-T G.9801] can be supported.

7 Service requirements

Service requirements for [ITU-T G.9801] are derived from [BBF TR-156]. But some service requirements defined in [BBF TR-156] are not applicable to [ITU-T G.9801] because [BBF TR-156] are based on G-PON system not OMCI-EPON system. Table 1 summarizes the service requirements for EPON system defined in [BBF TR-156] and their applicability to [ITU-T G.9801]. R-1 and R-2 in [BBF TR-156] are not included in Table 1 because these are requirements for RG. R-5, R-6 and R-7 are not included in Table 1 because these are G-PON specific requirements. In Table 1, G-PON interface are interpreted as EPON interface, GEM ports are interpreted as L2 flows in EPON and T-CONTs are interpreted as logical links in EPON.

Table 1: Service requirements

C: Verified by conformance tests in Section 8, I: Verified by interoperability tests in Section 9
M: Mandatory tests, O: Optional tests

Category	Service requirements defined in [BBF TR-156]		C/I	M/O
Fundamental Architectural and Topological Aspects	R-3	The OLT MUST support user isolation as defined in TR-101.	I	O
	R-4	The ONT and OLT MUST support frame sizes of 2000 bytes as per IEEE 802.3as.	C	M
VLANs	R-8	The ONU and OLT MUST support all VID values from the range: 1-4094 as specified in IEEE 802.1Q, on all ports3.	I	M
	R-9	The ONU MUST support setting VID for untagged and priority-tagged frames in the upstream direction based on EtherType, except on VLANs used for Business Ethernet Services.	C,I	M
	R-10	The ONU MUST support adding an S-Tag to upstream untagged traffic received from the U interface.	C,I	M
	R-11	The ONU MUST support removing an S-Tag from downstream traffic received from the OLT.	C,I	M
	R-12	The ONU MUST support unique, symmetric translation of Q-Tag VIDs received from the U interface into S-Tag VIDs .	C,I	M
	R-13	The ONU MUST support unique, symmetric translation of the S-Tag VIDs used in the downstream-tagged traffic into the Q-Tag VIDs sent to the U interface.	C,I	M
	R-14	The unique symmetric translation among tag VIDs MUST be done by means of a single provisioned table per U interface.	C	O
	R-15	The OLT MUST support passing an S-Tag in the upstream direction.	I	M
	R-16	The OLT MUST support passing an S-Tag in the downstream direction.	I	M

Category	Service requirements defined in [BBF TR-156]		C/I	M/O
	R-17	The OLT MUST support forwarding traffic received at the V interface (i.e. downstream direction) to GEM Ports on the PON based on S-Tag, including P-bits if needed, and destination MAC address.	I	O
	R-18	The OLT MUST be able to prevent forwarding traffic between user ports (user isolation). This behavior MUST be configurable per S-VID.	I	M
	R-19	The ONU MUST support mapping traffic from one or more GEM Ports to a U interface in the downstream direction.	C	M
	R-20	The ONU MUST support adding a C-Tag or S-Tag to upstream untagged traffic.	C,I	M
	R-21	The ONU MUST support removing the tag from downstream traffic.	C,I	M
	R-22	The ONU MUST support VID translation of the Q-Tag received from the U interface into the CTag or S-Tag for upstream-tagged traffic.	C,I	M
	R-23	The ONU MUST support VID translation of the tag used in the downstream-tagged traffic into the Q-Tag sent to the U interface.	C,I	M
	R-24	The OLT MUST support adding an S-Tag in the upstream direction for C-tagged traffic.	I	M
	R-25	The OLT MUST support passing an S-Tag in the upstream direction.	I	M
	R-26	The OLT MUST support passing an S-Tag in the downstream direction.	I	M
	R-27	The OLT MUST support forwarding traffic to the V interface (i.e. upstream direction) based on SVID.	I	O
	R-28	The OLT SHOULD support forwarding traffic to the V interface (i.e. upstream direction) based on S-VID and C-VID.	I	O
	R-29	The OLT MUST support forwarding traffic received at the V interface (i.e. downstream direction) to GEM Ports on the PON based on S-VID or (S-VID & C-VID), including P-bits, where needed, in the S-Tag.	I	M
	R-30	The OLT MUST support removal of an S-Tag in the downstream direction when traffic is doubletagged.	I	O
	R-31	The ONU MUST support mapping traffic from one or more GEM Ports to a U interface in the downstream direction.	C,I	M
	R-32	The OLT MUST support deactivating MAC learning, for 1:1 VLANs	I	M
	R-33	The Access Node MUST configure 1:1 VLANs so that the C-Tags are assigned to be unique across the U interfaces and across the entries in the 1:1 VLAN membership list.	I	M

Category	Service requirements defined in [BBF TR-156]		C/I	M/O
	R-34	The ONU MUST support adding an S-Tag in the upstream direction for Q-tagged, untagged, and priority-tagged frames.	C,I	M
	R-35	The ONU MUST support validating and translating an S-Tag in the upstream direction for Stagged frames.	C,I	M
	R-36	The ONU MUST support removing an S-Tag in the downstream direction.	C,I	M
	R-37	The OLT MUST support forwarding traffic to the V interface (i.e. upstream direction) based on STag.	I	O
	R-38	The OLT MUST support passing an S-Tag in the upstream direction.	I	M
	R-39	The OLT MUST support forwarding traffic in the downstream direction to GEM Ports based on the S-Tag, including P-bits, when needed, and destination MAC address.	I	M
	R-40	The OLT MUST support passing an S-Tag in the downstream direction.	I	M
	R-41	The ONU MUST support mapping traffic from one or more GEM Ports to a U interface in the downstream direction.	C	M
	R-42	The ONU MUST support VID translation of the S-Tag received from the U interface into a new STag for upstream double-tagged traffic.	C,I	M
	R-43	The ONU MUST support VID translation of the S-Tag received from the GPON interface into a new S-Tag for downstream double-tagged traffic sent to the U interface.	C,I	M
QoS	R-44	The OLT MUST support the basic traffic descriptor parameters as specified in G.984.3 (7.4.4.3 Fixed, Assured, Max BW and type NA or BE). These parameters MUST be configurable.	I	M
	R-45	The OLT MUST support the extended traffic descriptor parameters Pi and ωi as specified in G.984.3. These parameters MUST be configurable.	I	O
	R-46	The OLT and ONU MUST support at least 4 traffic classes for Ethernet frames.	I	M
	R-47	The OLT and ONU SHOULD support at least 6 traffic classes for Ethernet frames.	I	O
	R-48	The ONU MUST support deriving P-bit markings in the upstream direction based on an arbitrary combination of: user port, VID, received P-bit markings, and EtherType.	C,I	M
	R-49	The ONU SHOULD support deriving the P-bit markings in the upstream direction based on an arbitrary combination of: user port, VID and received DSCP value.	C	O
	R-50	The ONU MUST perform any necessary VID and P-bit manipulations before performing the mapping into GEM ports.	C	O

Category	Service requirements defined in [BBF TR-156]		C/I	M/O
	R-51	The ONU MUST support mapping traffic into GEM Ports based on arbitrary combination of user port, VID and P-bit values in the upstream direction.	C,I	M
	R-52	The ONU MUST NOT prevent multiple P-bit values being used in the same VLAN.	C,I	M
	R-53	The ONU MUST NOT prevent multiple VLANs from using the same P-bits.	C,I	M
	R-54	The OLT and ONU MUST support drop precedence within at least 2 traffic classes and MUST support configurable mapping to these classes and drop precedence from the 8 possible values of the Ethernet P-bits.	C,I	M
	R-55	The OLT and ONU MUST support drop precedence within all supported traffic classes based on the DEI bit value of the 802.1ad header.	C,I	M
	R-56	In the downstream direction, the ONU MUST support at least 4 queues per user port, one per traffic class.	C,I	M
	R-57	In the upstream direction, the ONU MUST support at least 4 queues, one per traffic class.	I	M
	R-58	In the downstream direction, the OLT MUST support at least 4 queues per PON, one per traffic class.	I	O
	R-59	The OLT MUST support T-CONT types 1, 2, 3 and 4. Each T-CONT type MUST be able to use the full bandwidth available on the GPON.	I	M
	R-60	In the downstream direction, the ONU SHOULD support at least 6 queues per user port, one per traffic class.	C	O
	R-61	In the upstream direction, the ONU SHOULD support at least 6 queues, one per traffic class.	C	O
	R-62	In the downstream direction, the OLT SHOULD support at least 6 queues per PON, one per traffic class.	I	O
	R-63	The OLT and ONU MUST support scheduling of downstream queues according to strict priority among at least 4 TCs.	C,I	M
	R-64	The OLT and ONU MUST support assigning an individual TC to a downstream queue.	C,I	M
	R-65	The OLT and ONU SHOULD support assigning multiple downstream queues to the same priority. If multiple downstream queues are assigned to the same priority, queues assigned to the same priority MUST be scheduled according to a weighted algorithm (like WFQ) with weights assigned through provisioning.	C	O
	R-66	In the upstream direction, the OLT MUST support at least 4 queues per network facing port, one per traffic class.	I	O
	R-67	In the upstream direction, the ONU MUST support at least 4 T-CONTs, one per traffic class.	I	O

Category	Service requirements defined in [BBF TR-156]		C/I	M/O
	R-68	In the upstream direction, the OLT SHOULD support at least 6 queues per network facing port, one per traffic class.	I	O
	R-69	In the upstream direction, the ONU SHOULD support at least 6 T-CONTs, one per traffic class.	C	O
	R-70	The OLT MUST support strict priority scheduling of upstream queues among at least 4 priorities.	I	O
	R-71	The OLT MUST support assigning a TC to an upstream queue.	I	M
	R-72	The OLT SHOULD support assigning multiple upstream queues to the same priority. If multiple upstream queues are assigned to the same priority, queues assigned to the same priority MUST be scheduled according to a weighted algorithm (like WFQ) with weights assigned through provisioning.	I	O
	R-73	The OLT MUST and ONU SHOULD support setting the maximum depth of all queues.	C	O
IGMP Controlled Multicast	R-74	The GPON network MUST be able to forward all multicast-VLAN traffic using a single downstream multicast GEM port.	C	M
	R-75	The OLT SHOULD be able to forward all multicast-VLAN traffic and act on IGMP on an N:1 VLAN using only bidirectional unicast GEM ports.	I	O
	R-76	The ONU MUST allow the configuration of the IP multicast groups that are acceptable per user port based on: • Source address matching • Group address matching • VLAN membership	C	M
	R-77	The OLT MUST allow the configuration of the IP multicast groups that are associated with a multicast-VLAN based on: • Source address matching • Group address matching	I	O
	R-78	The OLT MUST allow the configuration of the IP multicast groups described in R-76 and R-77 using ranges based on: • Source address matching • Group address matching	I	O
	R-79	The GPON network MUST use a bi-directional GEM port for upstream IGMP messages. This GEM Port can be shared by other VLANs from the same U interface that share the same TC.	C,I	M
	R-80	The OLT SHOULD send downstream multicast IGMP messages (e.g. Global Query messages) using the same GEM port that is used to carry the multicast content.	I	M
	R-81	The ONU MUST support receiving downstream multicast IGMP messages (e.g. Global Query messages) on either a unicast GEM port, or the multicast GEM port that is used to carry the multicast content.	C,I	M
	R-82	The ONU and OLT MUST support the identification and processing of upstream IGMP messages. When this function is disabled on a port and/or VLAN, these messages are transparently forwarded.	C,I	M

Category	Service requirements defined in [BBF TR-156]		C/I	M/O
	R-83	The OLT MUST support configurable silent discard of all IGMP messages received on an ONU user port and/or VLAN.	I	M
	R-84	The OLT and ONU MUST support matching groups conveyed by IGMP messages on a user port to the list of groups (R-76) associated with this port. When there is no match, the copy of IGMP message directed toward the multicast-VLAN MUST be silently discarded. When there is a match, the IGMP message SHOULD be forwarded within a multicast-VLAN, and enter the IGMP snooping function.	C,I	M
	R-85	The OLT MUST support mechanisms to stop user ports injecting multicast traffic to the aggregation network. This behaviour MUST be configurable per ONU user port and/or VLAN.	I	M
	R-86	The OLT MUST be able to discard IGMP messages received from user-facing ports on a multicast-VLAN	I	O
	R-87	The ONU and OLT MUST be able to rate-limit IGMP messages received from user-facing ports on a multicast-VLAN.	C,I	M
	R-88	The ONU and OLT MUST support an IGMP v3 (as per RFC 3376) transparent snooping function. This MUST be configurable on a per VLAN basis.	C,I	M
	R-89	The ONU and OLT IGMP v3 transparent snooping function MUST support the capability to snoop the multicast source IP address and destination IP group address in IGMP messages and to set the corresponding MAC group address filters as specified in R-90.	C	M
	R-90	The ONU and OLT IGMP v3 transparent snooping function MUST be able to dynamically create and delete MAC-level Group Filter entries, enabling in turn, selective multicast forwarding from network-facing VLANs to user-facing ports.	C,I	M
	R-91	The ONU MUST support IGMP immediate leave as part of the IGMP transparent snooping function.	C,I	M
	R-92	Upon detecting topology changes (e.g. VLAN membership change, port being disabled by STP and network port changing state) the OLT MUST be able to issue an IGMP proxy query solicitation, i.e. an IGMP Group Leave with group address '0.0.0.0'. This will indicate to the BNG to immediately send Group Specific queries, which will populate the L2 multicast filters in the Access Node, in order to speed up network convergence. For reference see RFC 4541, chapter 2.1.1 section 4.	I	M
	R-93	For security purposes, the ONU SHOULD and OLT MUST silently discard any user-initiated IGMP Leave messages for group '0.0.0.0'.	I	M
	R-94	The ONU MUST support marking, in the upstream direction, user-initiated IGMP messages with Ethernet P-bits.	C,I	M

Category	Service requirements defined in [BBF TR-156]		C/I	M/O
	R-95	The OLT SHOULD provide the following statistics. Per VLAN, per multicast group: 1. Total number of currently active hosts Per U interface, per multicast-VLAN: 1. Total number of successful joins 2. Total number of unsuccessful joins 3. Total number of leave messages 4. Total number of general queries sent to users 5. Total number of specific queries sent to users 6. Total number of invalid IGMP messages received Per multicast-VLAN: 1. Current number of active groups 2. Total number of sent joins 3. Total number of joins received from users 4. Total number of successful joins from users 5. Total number of unsuccessful joins from users 6. Total number of leave messages 7. Total number of leave messages received from users 8. Total number of general queries sent 9. Total number of general queries received from network 10. Total number of specific queries sent to users 11. Total number of specific queries received from network 12. Total number of invalid IGMP messages received	I	O
	R-96	The ONU MUST support configuring which user ports are members of a given multicast-VLAN	C	O
	R-97	The ONU and OLT MUST be able to configure per U interface the maximum number of simultaneous multicast groups allowed.	C,I	M
	R-98	The ONU MUST silently discard IGMP v1 messages.	C,I	M
	R-99	The ONU SHOULD support an IGMP/PPPoE transparent snooping function. This capability will use the methods described for classification and establishment of group address filters based on the baseline requirements (See section 6.2.2/TR-101).	C	O
	R-100	If R-99 is supported, then for those IGMP messages observed within PPPoE, the ONU MUST be able to trigger a local IGMP Host function (aka “echo client”) when a group is joined or left by a user-facing port. The IGMP Host function MUST then locally generate IGMP/IPoE messages (e.g. membership report/leave) and locally reply to IGMP membership queries to reflect the groups whose delivery to the ONU is needed. The IGMP Host function MUST be triggered in the context of the multicast-VLAN.	C	O
	R-101	If R-99 is supported, then the instantiation of the local IGMP Host at the ONU MUST be configurable per multicast-VLAN and user port.	C	O
	R-102	The OLT MUST support IGMP v3 snooping with proxy reporting configurable on a per VLAN basis.	I	O
	R-103	The OLT MUST allow selection between transparent snooping and snooping with proxy reporting on a per-VLAN basis.	I	O
	R-104	The IGMP snooping with proxy reporting function MUST support IGMP proxy query functions.	I	O
	R-105	The OLT proxy-reporting function MUST support marking IGMP messages it initiates with Ethernet (VLAN) P-bits.	I	O

Category	Service requirements defined in [BBF TR-156]		C/I	M/O
Non-IGMP Controlled Multicast and Broadcast	R-106	The OLT SHOULD be able to create MAC multicast filter entries for VLANs and multicast groups that MUST be forwarded downstream using the bidirectional GEM ports – i.e. VLANs and groups that will not be multicast to all ONUs using a multicast GEM port.	I	O
	R-107	If R-106 is supported, then the OLT MUST NOT forward any multicast traffic provisioned to use a bidirectional GEM port to GEM ports for ONUs that are not associated with the multicast-VLAN and group or have not joined the group.	I	O
	R-108	If R-106 is supported, then upon receipt of an IGMP message to join a multicast group provisioned to be delivered using bidirectional GEM ports, the OLT MUST forward the associated multicast traffic to the unicast GEM port(s) through which it received the IGMP message.	I	O
	R-109	It MUST be possible to configure each N:1 VLAN so that the OLT either silently discards or floods frames with MAC addresses that are not in the AN forwarding table.	I	M
	R-110	For N:1 VLANs where flooding is enabled, when the OLT receives a tagged frame with an unknown unicast MAC address then it MUST be flooded by forwarding to a downstream GEM port.	I	M
	R-111	It MUST be possible to configure each VLAN so that it silently discards broadcast frames.	I	M
	R-112	For N:1 VLANs, when the OLT receives a broadcast frame, and if it is not otherwise filtered, then it MUST be forwarded using a downstream GEM port.	I	M
	R-113	If the ONU receives a tagged frame on a downstream GEM Port, it MUST forward it to all U interfaces that are members of that VLAN.	C	O
Security Considerations	R-114	The OLT SHOULD be able to provide service to users with duplicate MAC addresses.	I	O
	R-115	The OLT SHOULD be able to deny service to users with duplicate MAC addresses.	I	O
	R-116	The OLT SHOULD provide a mechanism to prevent Broadband Network Gateway MAC address spoofing.	I	O
	R-117	The OLT SHOULD inspect upstream and downstream DHCP packets in order to discover the mapping of IP address to MAC address and populate an ARP table associating these addresses with their respective U-interface and VLAN.	I	O
	R-118	The OLT SHOULD ensure that downstream broadcast ARP requests are not sent on U-interfaces that do not have the requested IP address.	I	O
	R-119	The OLT SHOULD provide mechanisms to prevent user IP address spoofing, by discarding upstream IP packets received from U-interfaces that do not match the configured or DHCPdiscovered source IP address.	I	O
	R-120	The OLT SHOULD be configurable with a list of IP address associated with user port and VLAN, to be used for users having static IP configuration.	I	O

Category	Service requirements defined in [BBF TR-156]		C/I	M/O
	R-121	In order to prevent source MAC flooding attacks, the OLT MUST be able to limit the number of source MAC addresses learned and forwarded from each user port. This limit MUST be configurable per user port.	I	O
Filtering	R-122	The OLT and ONU SHOULD allow configuring and applying the following filters. The OLT MUST apply any configured filters in the downstream direction, and the ONU MUST apply any configured filters in the upstream direction. 1. Source MAC address filter. This filter may be used in one of the following ways: i. Allowing access from a specific MAC address. ii. Denying access from a specific MAC address. 2. Destination MAC address filter. This filter may be used in one of the following ways: i. Allowing access to specific destinations. ii. Denying access to specific destinations.	I	O
	R-123	The ONU SHOULD allow configuration of an EtherType filter, and applying it per U-interface in the upstream direction. This filter may be used in one of the following ways: i. Allowing a specific EtherType frame access (e.g. IPoE, PPPoE). ii. Denying a specific EtherType frame access (e.g. IPoE, PPPoE).	I	O
	R-124	The OLT and ONU SHOULD be able to filter reserved group MAC destination addresses (in the 01:80:C2 range – See TR-101/R-95)	I	O
Port Identification and Characterization	R-125	The OLT MUST create the Agent Circuit ID and Remote ID as described in TR-101.	I	O
	R-126	The OLT MUST use a static identifier, ONUID, for each ONU device in a PON interface. This identifier MUST remain the same across re-initialization, software and firmware updates, adds, moves, and other changes that do not involve that ONU.	I	O
	R-127	The Access Node DHCP Relay Agent and PPPoE Intermediate Agent MUST use the following default syntax to automatically generate the Agent Circuit ID field, identifying access loop logical ports as follows: Access-Node-Identifier atm Slot/Port/ONUID/Slot/Port:VPI.VCI (when ATM/DSL is used) Access-Node-Identifier eth Slot/Port/ONUID/Slot/Port[:VLAN-ID] (when Ethernet[/DSL] is used) In this syntax, Access-Node-Identifier MUST be a unique ASCII string (not using character spaces). The Access-Node-Identifier, L2 type (ATM, ETH) field and the slot/port fields are separated using a single space character. The Slot identifier MUST NOT exceed 6 characters in length and the Port identifier MUST NOT exceed 3 characters in length, using a '/' as a delimiter. The VPI, VCI and VLAN-ID fields (when applicable) are related to a given access loop (Uinterface).	I	O
	R-128	The OLT MUST be able to perform the Layer 2 DHCP relay agent function as specified in Section 3.9.1/TR-101.	I	O

Category	Service requirements defined in [BBF TR-156]		C/I	M/O
	R-129	The OLT MUST be able to perform the PPPoE Intermediate Agent function as specified in Section 3.9.2/TR-101.	I	O
OAM	R-130	For the 1:1 VLAN case, for an Access Node to BNG MD (Intra-Carrier), the Down MEP in the Access Node MUST be created on the OLT at the interface facing the BNG.	I	O
	R-131	For the 1:1 VLAN case, for an Access Port to BNG MD (Carrier), the Up MEP in the Access node MUST be created on the user port on the ONU.	C	O
	R-132	For the 1:1 VLAN case, for an Access Port to BNG Carrier MD, a MIP MUST be created on the OLT at the interface facing the BNG.	I	O
	R-133	For the 1:1 VLAN case, for an Access Port to BNG Carrier MD, an MIP SHOULD be created on the OLT at the interface facing the ONU.	I	O
	R-134	For the 1:1 VLAN case, for end-to-end RG to BNG MD (Customer), a MIP MUST be created on the ONU at the interface facing the user.	C	O
	R-135	For the 1:1 VLAN case, for the Access Node to BNG MD, Access Port to BNG Carrier MD, and the end-to-end RG to BNG Customer MD, the BNG MUST support MEP functionality at all 3 levels at the same time.	I	O
	R-136	For the N:1 VLAN case, for an Access Node to BNG Intra-Carrier Maintenance Domain (MD), the Down MEP in the Access Node MUST be created on the OLT at the interface facing the BNG.	I	O
	R-137	For the N:1 VLAN case, for an Access Port to BNG Carrier MD, the Up MEP in the Access node MUST be created on the user port on the ONU.	C	O
	R-138	For the N:1 VLAN case, for an Access Port to BNG Carrier MD, a MIP MUST be created on the OLT at the interface facing the BNG.	I	O
	R-140	For the N:1 VLAN case, for end-to-end RG to BNG Customer MD, a MIP MUST be created on the ONU interface facing the user.	C	O
	R-141	For the N:1 VLAN case, for the Access Node to BNG Intra-Carrier MD, the Access Port to BNG Carrier MD, and the end-to-end RG to BNG Customer MD, the BNG MUST support MEP functionality at all 3 levels at the same time.	I	O
	R-142	For the TLS VLAN case, for an Access Node to BNG MD (Intra-Carrier), a Down MEP in the Access Node MUST be created on the OLT at the interface facing the BNG.	I	O
	R-143	For the TLS VLAN case, for an Access Port to Carrier Edge MD (Carrier), an Up MEP in the Access node MUST be created on the user port on the ONU.	C	O
	R-144	For the TLS VLAN case, for an Access Port to Carrier Edge MD, a MIP MUST be created on the OLT at the interface facing the BNG.	I	O

Category	Service requirements defined in [BBF TR-156]		C/I	M/O
	R-145	For the TLS VLAN case, for an Access Port to Carrier Edge MD, a MIP MUST be created on the BNG at the interface facing the OLT.	I	O
	R-146	For the TLS VLAN case, for an Access Port to Carrier Edge MD, a MIP SHOULD be created on the OLT at the interface facing the ONU.	I	O
	R-147	For the TLS VLAN case, for end-to-end RG to far endpoint (Customer) MD, a MIP MUST be created on the ONU at the interface facing the user.	C	O
	R-148	For the TLS VLAN case, for the Access Node to BNG Intra-Carrier MD the BNG MUST support MEP functionality.	I	O
Network Management	R-149	All the configurable features of the ONU that are covered by explicit requirements in this Technical Report MUST only be managed via the OLT using OMCI and PLOAM as per G.984.	C	O
	R-150	The OLT MUST support the pre-provisioning of ONU serial numbers and their associated ONUIDs.	I	O
	R-151	The OLT MUST support the pre-provisioning of registration IDs and their associated ONUIDs.	I	O
	R-152	ONUs that support the registration ID approach MUST support the local setting of a registration ID.	C	M
	R-153	ONUs that support the registration ID approach MUST retain the registration ID indefinitely.	C	M
	R-154	When the OLT receives a serial number from an ONU during ranging, the OLT MUST determine whether the serial number is recognized either from a previous registration or from its set of provisioned values.	I	O
	R-155	In the case where a serial number is not recognized, an OLT MUST determine whether the registration ID is recognized from its set of provisioned values.	I	O
	R-156	When an ONU registers successfully [per R-154/R-155] the OLT MUST add that ONUs serialnumber to the set of recognized serial numbers and assign an ONUID.	I	O

8 Conformance test cases for ONU

Service requirements for OMCI-EPON ONU are verified by performing the conformance test cases in [BBF ATP-247], however EPON specific requirements for OMCI EPON ONU are verified by performing the conformance test cases in [IEEE 1904.1 Conformance 02].

8.1 Test cases for verifying EPON specific requirements.

EPON specific requirements for OMCI EPON ONU are verified by performing the conformance test cases in [IEEE 1904.1 Conformance 02]. These test cases are listed in Table 2.

Table 2 ONU conformance test cases for verifying the EPON specific requirements

M: Mandatory tests, O: Optional tests

Category	Test cases defined in [IEEE 1904.1 Conformance 02]		Requirements	M/O
Authentication	BU-AU1a-01	Test case for ONU authentication for 1G-EPON ONU	[IEEE Std 1904.1, 9 11.3.4]	M
	BU-AU1b-01	Test case for ONU authentication for 10G-EPON ONU	[IEEE Std 1904.1, 9 11.3.4]	M
Device and capability discovery	BU-DCD1-01	Test case for OAM extension and capability discovery process, successful discovery	[IEEE Std 1904.1, 5 12.2.2]	M
Data encryption	BU-DE1-01	Test case for data encryption, successful IEEE Std 802.1ae-2006 encryption	[IEEE Std 1904.1, 11.2.3]	M
REPORT MPCPDU Format	BU-RF1-01	Test case for REPORT MPCPDU Format for ONU	[IEEE Std 1904.1, 8.4.3.3]	M
ONU VLAN Modes	BU-UVM2-01	Test case for Transparent VLAN mode, upstream and downstream direction	[IEEE Std 1904.1, 7.2.2.1.2]	M
	BU-UVM3-01	Test case for Tagging VLAN mode, upstream and downstream direction	[IEEE Std 1904.1, 7.2.2.1.4], R-20, R-21	M
	BU-UVM4-01	Test case for ToS/CoS Conversion VLAN mode, upstream and downstream direction	[IEEE Std 1904.1, 7.2.2.1.6], R-20, R-21	M

8.2 Test cases for verifying service requirements in BBF TR-156

Service requirements for OMCI-EPON ONU are verified by performing the conformance test cases in [BBF ATP-247]. These test listed in Table 3. In these test cases, G-PON interface are interpreted as EPON interface, GEM ports are interpreted as L2 flows in EPON and T-CONTs are interpreted as logical links in EPON.

Table 3 ONU conformance test cases for service requirements in BBF TR-156

M: Mandatory tests, O: Optional tests, -: Verified by performing the test cases in [IEEE 1904.1 Conformance 02]

Category	Test cases defined in [BBF ATP-247]		Requirements	M/O
N:1 VLAN Architecture	ONU.6.1.1	Single Untagged U-Interface	R-10, R-11, R-19	M
	ONU.6.1.2	Single U-interface with symmetric VLAN tag translation	R-12, R-13, R-19	M
	ONU.6.1.3	Deriving P-bits as a function of received P-bits (single user port)	R-48	M
	ONU.6.1.13	VID Support for Untagged Frames (N:1 VLAN or 1:1 VLAN Single Tagged at the V Interface)	R-9	M

Category	Test cases defined in [BBF ATP-247]		Requirements	M/O
	ONU.6.1.15	VID Support for Priority Tagged Frames with Priority Preservation (N:1 VLAN or 1:1 VLAN Single-Tagged at V Interface)	R-9	M
	ONU.6.1.16	VID Support for Priority Tagged Frames without Priority Preservation (N:1 VLAN or 1:1 VLAN Single-Tagged at V Interface)	R-9	M
	ONU 6.1.25	Deriving P-bits as a function of received VID for a 1:1 or N:1 architecture (single user port)	R-48	M
	ONU 6.1.26	Deriving P-bits as a function of received Ethertype for a 1:1 or N:1 architecture (single user port).	R-48	M
	ONU 6.1.27	Deriving P-bits as a function of received user port for a 1:1 or N:1 architecture (multiple user ports).	R-48	O
1:1 VLAN Architecture	ONU.6.1.1	Single Untagged U-Interface	R-20, R-21, R-31	-
	ONU.6.1.2	Single U-interface with symmetric VLAN tag translation	R-22, R-23, R-31	M
	ONU.6.1.3	Deriving P-bits as a function of received P-bits (single user port)	R-48	M
	ONU.6.1.13	VID Support for Untagged Frames (N:1 VLAN or 1:1 VLAN Single Tagged at the V Interface)	R-9	M
	ONU.6.1.14	VID Support for Untagged Frames (1:1 VLAN Architecture Double Tagged at the V-Interface)	R-9	M
	ONU.6.1.15	VID Support for Priority Tagged Frames with Priority Preservation (N:1 VLAN or 1:1 VLAN Single-Tagged at V Interface)	R-9	M
	ONU.6.1.16	VID Support for Priority Tagged Frames without Priority Preservation (N:1 VLAN or 1:1 VLAN Single-Tagged at V Interface)	R-9	M
	ONU.6.1.17	VID Support for Priority Tagged Frames with Priority Preservation (1:1 VLAN Architecture Double-Tagged at the V Interface)	R-9	M
	ONU.6.1.18	VID Support for Priority Tagged Frames without Priority Preservation (1:1 VLAN Architecture Double-Tagged at the V Interface)	R-9	M
	ONU.6.1.19	ONU addition and removal of C-Tag for 1:1 VLANs	R-20, R-21	-
	ONU.6.1.20	ONU addition and removal of S-Tag for 1:1 VLANs	R-20, R-21	O
	ONU.6.1.21	ONU translation between Q-Tag and C-Tag for 1:1 VLANs	R-22, R-23	M
	ONU.6.1.22	ONU translation between Q-Tag and S-Tag for 1:1 VLANs	R-22, R-23	M
	ONU 6.1.25	Deriving P-bits as a function of received VID for a 1:1 or N:1 architecture (single user port)	R-48	M

Category	Test cases defined in [BBF ATP-247]		Requirements	M/O
	ONU 6.1.26	Deriving P-bits as a function of received Ethertype for a 1:1 or N:1 architecture (single user port).	R-48	M
	ONU 6.1.27	Deriving P-bits as a function of received user port for a 1:1 or N:1 architecture (multiple user ports).	R-48	O
VBES VLAN Architecture	ONU.6.1.4	Addition of an S-Tag in the Upstream Direction in a VBES Architecture	R-34	O
	ONU.6.1.5	Validation of an S-Tag in the Upstream Direction in a VBES Architecture	R-35	O
	ONU.6.1.6	Translation of an S-Tag in the Upstream Direction in a VBES Architecture	R-35, R-42	O
	ONU.6.1.7	Removal of an S-Tag in the Downstream Direction in a VBES Architecture	R-36	O
	ONU.6.1.8	Translation of an S-Tag in the Downstream Direction in a VBES Architecture	R-43	O
	ONU-6.1.10	Deriving P-bits as a function of received VID (single user port)	R-48	O
	ONU.6.1.11	Deriving P-bits as a function of received Ethertype (single user port)	R-48	O
	ONU.6.1.12	Deriving P-bits as a function of received user port (multiple user ports)	R-48	O
	ONU 6.1.24	Deriving P-bits as a function of received P-bits for a VBES architecture (single user port)	R-48	O
	ONU 6.2.3	Mapping Traffic from GEM Ports to U Interface in Downstream Direction in a VBES Architecture	R-41	O
Multicast Operations	ONU.6.3.1	ONU passing of downstream IGMP messages	R-81	M
	ONU.6.3.3	ONU silent discarding of IGMPv1 messages	R-98	M
	ONU.6.3.5	Marking Upstream IGMP Messages with Ethernet P-Bits	R-94	M
	ONU.6.3.6	IGMP controlled Multicast	R-74, R-79	M
	ONU.6.3.7	Multicast While List	R-76, R-84	M
	ONU.6.3.8	IGMP rate limit	R-8	M
	ONU.6.3.9	IGMP Immediate leave	R-91	M
	ONU.6.3.10	Maximum number of multicast flows	R-97	M
	ONU.6.3.11	IGMP transparent Snooping	R-88, R-89, R-90	M
	ONU.6.3.12	Multicast VLAN membership based on user ports (Multiple User ports)	R-96	O
	ONU.6.3.13	IGMP transparent Snooping (Multiple User ports)	R-88, R-89, R-90	O
	ONU 6.3.14	IGMP Transparent forwarding	R-10, R-19, R-82	M
Baseline Test Cases	ONU.6.4.1	Downstream Broadcast Handling, Single U-interface	R-113	M
	ONU.6.4.2	Downstream Broadcast Handling, Multiple U-interfaces	R-113	O
	ONU.6.6.1	2000-Byte Frames Supported by the ONU	R-4	M

Category	Test cases defined in [BBF ATP-247]		Requirements	M/O
	ONU.6.7.1	Local setting of a registration ID at the ONU (ONU retains the Registration ID indefinitely)	R-152, R-153	-
	ONU.6.8.1	New ONU Bring-up method on new ONU	G.988 Appendix I	M
	ONU.6.8.2	New ONU Bring-up method for old ONU	G.988 Appendix I	M
	ONU.6.8.3	Old ONU Bring-up method for ONU	G.988 Appendix I	M
	ONU.6.8.4	New ONU Bring-up method for new ONU with encrypted OMCC	G.988 Appendix I	M
	ONU.6.9.1	Alarm synchronization	G.988 Appendix I	M
	ONU.6.9.2	MIB synchronization: Correct Data Sync	G.988 Appendix I	M
	ONU.6.9.3	MIB synchronization: MIB Upload	G.988 Appendix I	M
	ONU.6.10.1	Software Image Download, multiple window sizes, padded final window	G.988 Appendix I	M
	ONU.6.10.2	Software Image Download, shortened final window final window	G.988 Appendix I	M
	ONU.6.10.3	Failed Software Image Download, missing section	G.988 Appendix I	M
	ONU.6.10.4	Failed Software Image Download, incorrect section CRC	G.988 Appendix I	M
	ONU.6.10.5	Failed Software Image Download, incorrect software image CRC	G.988 Appendix I	M
	ONU.6.10.7	Failed Software Image Download, incorrect software image CRC	G.988 Appendix I	M
	ONU.6.10.7	Activate uncommitted software image	G.988 Appendix I	M
	ONU.6.10.8	Commit software image	G.988 Appendix I	M
	ONU.6.11.3	Cardholder or port mapping package for integrated ONU	G.988 Appendix I	O
	ONU.6.2.1	Single U-interface with multiple downstream GEM ports	R-19, R31, R-41	M
	ONU.6.2.2	User Isolation on ONU Devices with Multiple U-Interfaces	R-3 (TR-101 R-40)	O
	ONU.6.2.4	Mapping traffic into GEM Ports based on P-bit values in the upstream direction (single user port)	R-51, R-52, R-53	M
	ONU.6.2.5	Mapping traffic into GEM Ports based on VID values in the upstream direction (single user port)	R-51, R-52, R-53	M
	ONU.6.2.6	Mapping traffic into GEM Ports based on VID & P-bit values in the upstream direction (single user port)	R-51, R-52, R-53	M
	ONU.6.2.7	Mapping traffic into GEM Ports based on P-bit values in the upstream direction (multiple user port)	R-51, R-52, R-53	O
	ONU.6.2.8	Mapping traffic into GEM Ports based on VID values in the upstream direction (multiple user port)	R-51, R-52, R-53	O
	ONU.6.2.9	Mapping traffic into GEM Ports based on VID & P-bit values in the upstream direction (multiple user port)	R-51, R-52, R-53	O
	ONU.6.2.10	Mapping multiple P-bit values to the same GEM port (single user port)	R-51	M

Category	Test cases defined in [BBF ATP-247]		Requirements	M/O
	ONU.6.2.12	Strict priority downstream scheduling among 4 queues on ONU	R-56, R-63, R-64	M
	ONU.6.2.13	Indicating drop precedence using P-bits upstream	R-54	M
	ONU.6.2.14	Indicating drop precedence using DEI bit upstream	R-55	M
	ONU.6.2.15	Indicating drop precedence using P-bits downstream	R-54	M
	ONU.6.2.16	Indicating drop precedence using DEI bit downstream	R-55	M
	ONU.6.2.19	Mapping Traffic from GEM Ports to Multiple U Interfaces in the Downstream Direction	R-19, R-31, R-41	O
	ONU.6.2.21	Mapping Traffic from GEM Ports to Multiple U Interfaces in the Downstream Direction	R-19, R-31, R-41	O

9 Interoperability test cases for OLT and ONU pairing.

Service requirements for OMCI-EPON are verified by performing the interoperability test cases in [BBF WT-255], however EPON specific requirements for OMCI EPON are verified by performing the interoperabolity test cases in [IEEE 1904.1 Conformance 02].

9.1 Test cases for verifying EPON specific requirements

EPON specific requirements for OMCI EPON are verified by performing the interoperability test cases in [IEEE 1904.1 Conformance 02]. These test cases are listed in Table 4.

Table 4 Interoperability test cases for EPON specific requirements

M: Mandatory tests, O: Optional tests

Category	Test cases defined in [IEEE 1904.1 Conformance 02]		Requirements	M/O
Authentication	BT-AU4b-01	Test case for ONU authentication for 1G-EPON ONU	[IEEE Std 1904.1, 11.3.4]	M
	BT-AU6b-01	Test case for ONU authentication for 10G-EPON ONU	[IEEE Std 1904.1, 11.3.4]	M
Device and capability discovery	BT-DCD1-01	Test case for OAM extension and capability discovery process, successful discovery	[IEEE Std 1904.1, 12.2.2]	M
	BT-DCD1-02	Test case for OAM discovery process, discovery failure due to unacceptable version	[IEEE Std 1904.1, 12.2.2]	M
Data encryption	BT-DE1-01	Test case for data encryption, successful IEEE Std 802.1ae-2006 encryption	[IEEE Std 1904.1, 11.2.3]	M
OLT VLAN Modes	BT-TVM2-01	Test case for Transparent VLAN mode, upstream and downstream direction	[IEEE Std 1904.1, 7.2.2.1], R-25, R-26	M

Category	Test cases defined in [IEEE 1904.1 Conformance 02]		Requirements	M/O
	BT-TVM3-01	Test case for Tagging VLAN mode, upstream and downstream direction	[IEEE Std 1904.1, 7.2.2.1], R-24	M
	BT-TVM4-01	Test case for Translation VLAN mode, upstream and downstream direction	[IEEE Std 1904.1, 7.2.2.1.5]	M

9.2 Test cases for verifying the service requirements

Service requirements for OMCI-EPON are verified by performing the interoperability test cases in [BBF TR-255]. These test listed in Table 5. In these test cases, G-PON interface are interpreted as EPON interface, GEM ports are interpreted as L2 flows in EPON and T-CONTs are interpreted as logical links in EPON.

Table 5 Interoperability test cases for verifying the service requirements in BBF TR-156

M: Mandatory tests, O: Optional tests, -: Verified by performing the test cases in [IEEE 1904.1 Conformance 02]

Category	Test cases defined in [BBF TR-255]		Requirements	M/O
VLAN Manipulation	6.1.1.1	Untagged U-interface Test Case	R-9, R-10, R-11, R-15, R-16	M
	6.1.1.2	Priority-tagged U-interface Test Case	R-9, R-10, R-11, R-15, R-16	M
	6.1.1.3	Q-tagged U-interface Test Case	R-12, R-13, R-15, R-16	M
	6.1.1.4	User Isolation Test Case	R-18	M
	6.1.1.5	Configurable Value of the S-tag TPID Value Test Case	R-8	M
	6.1.2.1	Untagged U-interface, Single Tagged V-interface Test Case	R-20, R-21, R-25, R-26	-
	6.1.2.2	Untagged U-interface, Double Tagged V-interface Test Case	R-20, R-21, R-24, R-30	-
	6.1.2.3	Tagged U-interface, Single Tagged V-interface Test Case	R-22, R-23, R-25, R-26	M
	6.1.2.4	Tagged U-interface, Double Tagged V-interface Test Case	R-22, R-23, R-24, R-30	M
	6.1.2.5	Deactivate MAC learning for 1:1 VLANs Test Case	R-32	M
	6.1.3.1	Untagged U-interface, Single Tagged V-interface Test Case	R-34, R-36, R-38, R-40	M
	6.1.3.2	Priority-tagged U-interface, Singled Tagged Vinterface Test Case	R-34, R-36, R-38, R-40	M
	6.1.3.3	Q-tagged U-interface, Double Tagged V-interface Test Case	R-34, R-36, R-38, R-40	M
	6.1.3.4	S-tagged U-interface, Singled Tagged V-interface Test Case	R-35, R-38, R-40	M

Category	Test cases defined in [BBF TR-255]		Requirements	M/O
	6.1.3.5	Double Tagged U-interface, Double Tagged Vinterface Test Case	R-42, R-43, R-38, R-40	M
	6.1.3.6	Hairpin Turn for VBES at OLT Test Case	R-39	M
QoS	6.2.1.1	Setting of P-bit value based on received VID	R-48	M
	6.2.1.2	Setting of p-bit value based on received p-bit	R-48	M
	6.2.1.3	Setting of p-bit value based on received Ethertype	R-48	M
	6.2.1.4	Setting of p-bit value based on UNI port	R-48	M
	6.2.1.5	Setting of p-bit value based on received DSCP value	R-48	O
	6.2.2.1	Strict priority upstream scheduling among 4 queues on ONU and OLT based on pbit values (1:1 VLAN, single user port)	R-44, R-46, R-51, R-52, R-53, R-57, R-59, R-71, R-67	M
	6.2.2.2	Strict priority upstream scheduling among 4 queues on ONU and OLT based on VID values (1:1 VLAN, single user port)	R-44, R-46, R-51, R-52, R-53, R-57, R-59, R-71, R-67	M
	6.2.2.3	Strict priority upstream scheduling among 4 queues on ONU and OLT based on VID & pbit values (1:1 VLAN, single user port)	R-44, R-46, R-51, R-52, R-53, R-57, R-59, R-71, R-67	M
	6.2.2.4	Strict priority upstream scheduling among 4 queues on ONU and OLT based on VID, pbit & U-interface values (1:1 VLAN, multiple user port)	R-33, R-44, R-46, R-51, R-52, R-53, R-57, R-59, R-71, R-67	M
	6.2.2.5	Strict priority downstream scheduling among 4 queues on ONU and OLT based on pbit values (1:1 VLAN, single user port)	R-29, R-46, R-56, R-63, R-64	M
	6.2.2.6	Strict priority downstream scheduling among 4 queues on ONU and OLT based on VID values (1:1 VLAN, single user port)	R-29, R-46, R-56, R-63, R-64	M
	6.2.2.7	Strict priority downstream scheduling among 4 queues on ONU and OLT based on VID & pbit values (1:1 VLAN, single user port)	R-29, R-46, R-56, R-63, R-64	M
	6.2.2.8	Strict priority downstream scheduling among 4 queues on ONU and OLT based on SVID, CVID & pbit values (1:1 VLAN, single user port)	R-29, R-46, R-56, R-63, R-64	M
	6.2.2.9	Strict priority downstream scheduling among 4 queues on ONU and OLT based on VID, pbit values & MAC DA (VBES, single user port)	R-39, R-46, R-56, R-63, R-64	M
	6.2.2.10	Strict priority downstream scheduling among 4 queues on ONU and OLT based on SVID, CVID & pbit values (1:1 VLAN, multiple user port)	R-29, R-31, R-33, R-46, R-56, R-63, R-64	M

Category	Test cases defined in [BBF TR-255]		Requirements	M/O
	6.2.2.11	Strict priority downstream scheduling among 4 queues on ONU and OLT based on VID, pbit values & MAC DA (VBES, multiple user port)	R-39, R-41, R-46, R-56, R-63, R-64	M
	6.2.3.1	Indicating drop precedence using p-bit upstream	R-54, R-59	M
	6.2.3.2	Indicating drop precedence using DEI bit upstream	R-55, R-59	M
	6.2.3.3	Indicating drop precedence using p-bits downstream	R-54	M
	6.2.3.4	Indicating drop precedence using DEI bits downstream	R-55	M
IGMP Controlled Multicast	6.3.1	Downstream Transport of IGMP messages	R-80, R-81, R-82	M
	6.3.2	Upstream Transport of IGMP messages	R-79, R-82	M
	6.3.3	Configurable discard of upstream IGMP messages	R-83	M
	6.3.4	White and black listing of multicast channels	R-76, R-84	M
	6.3.5	Blocking of user generated multicast traffic	R-85	M
	6.3.6	Rate-limiting of user generated IGMP messages	R-87	M
	6.3.7	IGMPv3 transparent snooping functions	R-88, R-90	M
	6.3.8	IGMP immediate leave	R-91	M
	6.3.9	Discard of user generated proxy query solicitations	R-93	M
	6.3.10	Marking of upstream IGMP messages with Ethernet Pbits	R-94	M
	6.3.11	Configurable maximum number of simultaneous multicast groups	R-97	M
	6.3.12	Silent discard of upstream IGMPv1 messages	R-98	M
Non-IGMP Controlled Multicast and Broadcast	6.4.1	Silent discard of frames with unknown MAC addresses	R-109	M
	6.4.2	Flooding of frames with unknown MAC addresses	R-110	M
	6.4.3	Silent discard of downstream broadcast frames	R-111	M
	6.4.4	Flooding of downstream broadcast frames	R-112	M
Security	6.5.1	Test for Providing service to users with duplicate MAC addresses	R-114	O
	6.5.2	Test for denying service to users with duplicate MAC addresses	R-115	O
	6.5.3	Test for mechanism to prevent Broadband Network Gateway MAC address spoofing	R-116	O

Category	Test cases defined in [BBF TR-255]		Requirements	M/O
	6.5.4	Test for mechanism to handle ARP broadcasts	R-118	O
	6.5.5	Test for mechanism to prevent IP address spoofing	R-119	O
	6.5.6	Test for mechanism to prevent MAC flooding attacks	R-121	O
Filtering	6.6.1	MAC source address allowing filter	R-122	O
	6.6.2	MAC source address denying filter	R-122	O
	6.6.3	MAC destination address allowing filter	R-122	O
	6.6.4	MAC destination address denying filter	R-124	O
	6.6.5	Group MAC destination address filter	R-124	O
	6.6.6	EtherType allowing filter (IPoE)	R-123	O
	6.6.7	EtherType allowing filter (PPPoE)	R-123	O
	6.6.8	EtherType denying filter (IPoE)	R-123	O
	6.6.9	EtherType denying filter (PPPoE)	R-123	O
Port Identification and Characterization	6.7.1	Basic PPPoE Intermediate Function	R-125, R-129	O
	6.7.2	PPPoE Intermediate Function Option 82 Overwriting	R-125, R-129	O
	6.7.3	PPPoE Intermediate Function with Multiple Clients	R-125, R-129	O
	6.7.4	PPPoE Intermediate Function with Unicast PADI message	R-125, R-129	O
	6.7.5	Basic DHCP Relay Agent Functions	R-125, R-128	O
	6.7.6	DHCP Relay Agent Functions Option 82 Overwriting	R-125, R-128	O
	6.7.7	DHCP Relay Agent Functions with Multiple Clients	R-125, R-128	O
	6.7.8	DHCP Relay Agent Functions with Unicast DHCP Discover Message	R-125, R-128	O
Initial provisioning of ONU	6.8.1	ONU provisioning according to serial number test case	R-150, R-154	-
	6.8.2	ONU Provisioning according to the registration-ID test case	R-151, R-155	-
ONU Bring-up	6.9.1	ONU Bring-up for New ONU	G.988 Appendix I	M
	6.9.2	ONU Bring-up method for Old ONU	G.988 Appendix I	M
	6.9.3	ONU Bring-up method with encrypted OMCC	G.988 Appendix I	M
	6.9.4	MIB synchronization	G.988 Appendix I	M
Alarms	6.10.1	Alarms synchronization Mandatory	G.988 Appendix I	M
Software download	6.11.1	Software Download, Valid Image	G.988 Appendix I	M
	6.11.2	Software Download, Corrupt Image	G.988 Appendix I	M
	6.11.3	Switch Active Software Instance	G.988 Appendix I	M

Category	Test cases defined in [BBF TR-255]		Requirements	M/O
	6.11.4	Switch Committed Software Instance	G.988 Appendix I	M

Appendix: Interpretation of G-PON specific items to EPON

GEM ports and T-CONTs are G-PON specific items and are not used in EPON because EPON conveys Ethernet frames transparently in the PON section. However, these G-PON specific items can be applied to EPON by the interpretation shown in Table 1.

Table 1 – Interpretation of G-PON specific items

#	Items	Interpretation in EPON system
1	GEM port	The concept of GEM port is interpreted as a layer 2 flow such as VLAN, CoS, etc. In an EPON system, GEM port network CTP and GEM interworking termination point MEs exist for binding the layer 2 flows and priority queue MEs and the MAC bridge ME.
2	T-CONT	The T-CONT is the unit of bandwidth assignment. In any EPON systems, the unit of bandwidth assignment is the logical link.

For providing Ethernet services to users in a PON system,

- G-PON/XG-PON1: Ethernet flows are encapsulated by GEM/XGEM in the PON section.
- EPON/10G-EPON: Ethernet flows are transparently conveyed in the PON section.

Both G-PON and EPON require QoS configuration, cross connection, filtering, VLAN operation, etc. for each layer 2 service flow. There is no difference between G-PON and EPON for providing Ethernet services except for GEM encapsulation.

Figure 1 shows layer2 flows in G-PON ONU, and Figure 2 shows virtual GEM ports in EPON ONU based on the interpretation shown in Table 1.

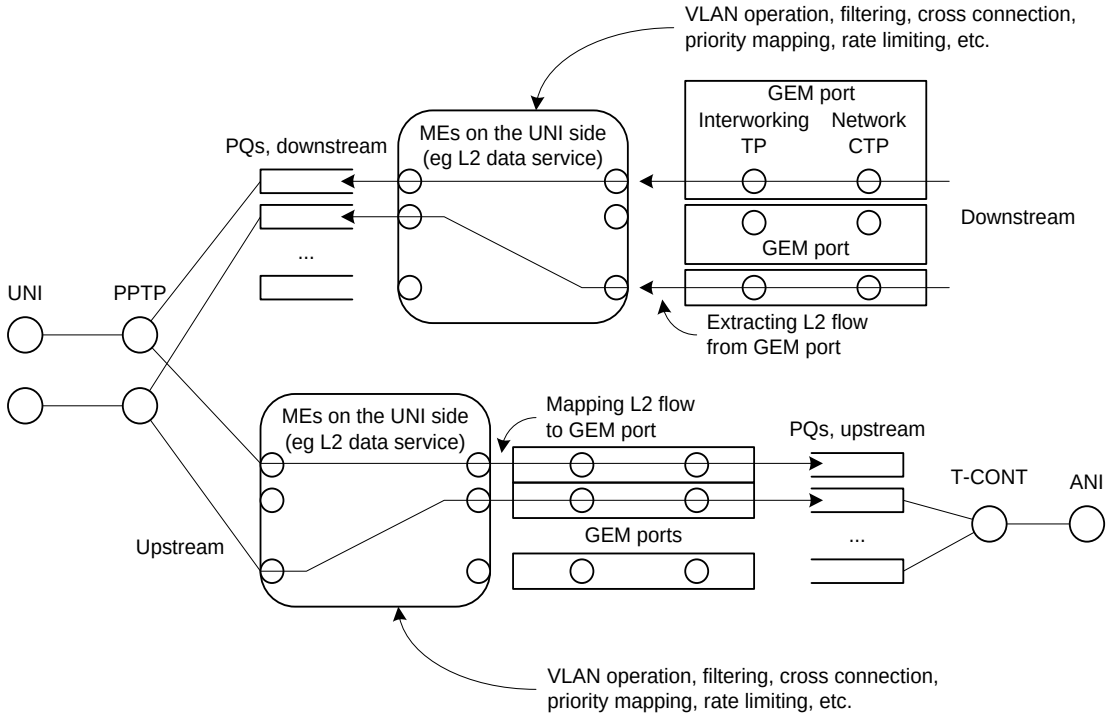

Figure 1 Layer 2 flows in G-PON ONU

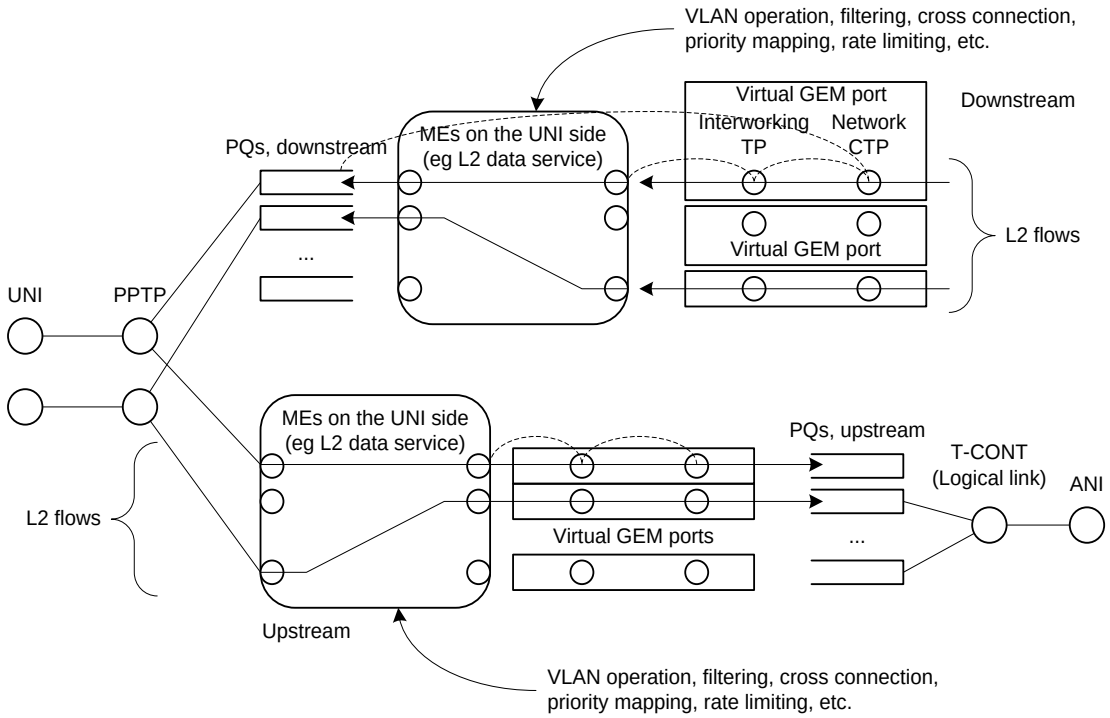

Figure 2 Virtual GEM ports in EPON ONU

By introducing the concept of virtual GEM port into OMCI, the MEs in Rec. ITU-T G.988 can be re-used for EPON.

In G-PON, a GEM port is defined to convey each layer 2 flow. The GEM port network CTP connects the MAC bridge port and upstream/downstream priority queues in the ONU for Ethernet service. EPON also requires the same configuration of connectivity between the MAC bridge port and upstream/downstream priority queues. By configuring the GEM ports virtually in EPON, both G-PON and EPON are compatible in management of Ethernet services. A virtual GEM port exists for the purpose of connecting the MAC bridge port and priority queue. GEM port network CTP and GEM interworking termination point MEs are created for the ME pointer relationship.

What this means is that the GEM port network CTP can be re-used in EPON, but the value of the GEM port attribute is not used. It is suggested that it be set to 0 by the OLT, and it must be ignored by the ONU in EPON.

The details are described in Section C.4 of ITU-T Recommendation G.988 Annex C.

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