Technical Report

TR-280
ITU-T PON in the context of TR-178

Issue: 1 Corrigendum 1
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Issue History

Issue Number	Approval Date	Release Date	Issue Editor	Changes
1	17 October 2016	14 December 2016	Vincent Buchoux, LAN Gilles Samson, LAN Hugues Le Bras, ORANGE	Original
1 Corrigendum 1	9 March 2021	9 March 2021	Hugues Le Bras, ORANGE Samuel Chen, BROADCOM	Issue 1 Corrigendum 1

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Executive Summary

TR-178 [4] introduces access capabilities for a broadband multiservice network beyond the layer 2 architecture described in TR-101 [1] and the associated TR-156 [2] document “Using GPON access in the context of TR-101”.

This Technical Report strengthens the TR-178 requirements as applied to GPON and XG-PON by providing more detailed and additional requirements.

This first issue of TR-280 focuses on requirements for enhanced QoS, enhanced multicast, alarms and counters, vlan tagging, filtering and learning, and enhanced security, Multi-managed ONU.

This enables an update to IR-247 “GPON & XG-PON1 ONU Conformance Test Plan” [19] and the next phase of BBF.247 certification testing to commence.

Corrigendum 1 of this Technical Report updates the following requirements:

- Enhanced QoS: R-3, R-4, R-5, R-6, R-7, R-10, R-11.
- Enhanced multicast: R-17, R-18, R-20, R-21.
- Alarms and counters: R-25, R-26, R-27, R-28, R-29, R-30, R-31, R-32, R-33, R-34, R-37, R-39, R-41, R-42, R-43, R-45, R-46, R-47, R-48, R-49, R-50, R-51, R-52, R-53, R-54, R-55, R-56, R-57, R-58, R-59, R-60.
- VLAN tagging: R-63.
- Filtering and learning: R-65.
- Multi-managed ONU: R-68.

The text of this Corrigendum represents the original text of TR-280 Issue 1 with all the above updates implemented.[1]

[1] Implementers of TR-280 are encouraged to refer to both TR-280 Issue 1 Corrigendum 1 and TR-280 Issue 1 Amendment 1.

1 Purpose and Scope

1.1 Purpose

TR-178 documents a set of architectures for a broadband multi-service network, addressing typical infrastructures, topologies and deployment scenarios, and specifies associated nodal requirements. These include copper and fibre access architectures to support business and residential, fixed and mobile, wholesale and retail markets.

TR-178 specifies multiservice capabilities beyond the layer 2 based architecture of TR-101 and the associated TR-156, which specifies the requirements for deploying GPON within a TR-101 architecture.

Taking a similar approach to TR-101 and its TR-156 derivative, the purpose of this document is to specify the requirements for deploying GPON, XG-PON, XGS-PON and NG-PON2 in the context of a TR-178 architecture.

TR-280 follows the architectural/topological models and reference points as defined in Section 4 of TR-156.

1.2 Scope

This document builds on the service layer and access node features described in TR-178 and specifies PON requirements for the following:

- ENHANCED QOS
- ENHANCED MULTICAST
- ALARMS AND COUNTERS
- VLAN TAGGING
- FILTERING AND LEARNING
- ENHANCED SECURITY
- MULTI-MANAGED ONU
- VOICE OVER IP

Hence, it will give a reference in the BBF framework for new GPON, XG-PON, XGS-PON and NG-PON2 functionalities which are already supported in the ITU-T OMCI related standards.

Requirements are specified under functional modules with each module being independent from the others.

The “wholesale service” module describes support for data, voice and video services delivered by multiple Network Service Providers over a PON infrastructure provided by a single Access Network Provider. Multicast video service delivery using the OMCI enhancements specified in G.988 Amd1 is described.

The “enhanced QoS” module will address QoS related functionalities described in the ITU-T G.988 [5] not covered by TR-156.

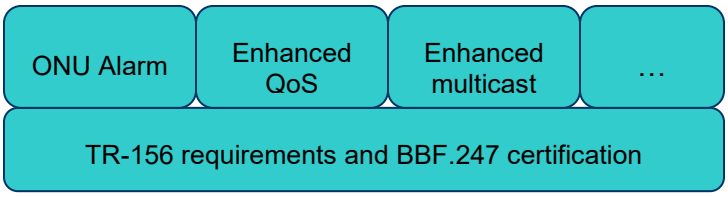

Figure 1 – Functional modules & requirements

This first issue of TR-280 focuses on requirements for enhanced multicast and QoS, as well as ONU alarms and counters. This enables an update to IR-247 “GPON & XG-PON1 ONU Conformance Test Plan” and the next phase of BBF.247 certification testing to commence.

2 References and Terminology

2.1 Conventions

In this Technical Report, several words are used to signify the requirements of the specification. These words are always capitalized. More information can be found be in RFC 2119 [8].

MUST	This word, or the term “REQUIRED”, means that the definition is an absolute requirement of the specification.
MUST NOT	This phrase means that the definition is an absolute prohibition of the specification.
SHOULD	This word, or the term “RECOMMENDED”, means that there could exist valid reasons in particular circumstances to ignore this item, but the full implications need to be understood and carefully weighed before choosing a different course.
SHOULD NOT	This phrase, or the phrase "NOT RECOMMENDED" means that there could exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications need to be understood and the case carefully weighed before implementing any behavior described with this label.
MAY	This word, or the term “OPTIONAL”, means that this item is one of an allowed set of alternatives. An implementation that does not include this option MUST be prepared to inter-operate with another implementation that does include the option.

2.2 References

The following references are of relevance to this Technical Report. At the time of publication, the editions indicated were valid. All references are subject to revision; users of this Technical Report are therefore encouraged to investigate the possibility of applying the most recent edition of the references listed below.

A list of currently valid Broadband Forum Technical Reports is published at www.broadband-forum.org.

Document		Title	Source	Year
[1]	TR-101	Migration to Ethernet-Based DSL Aggregation	Broadband-Forum	2006
[2]	TR-156 Issue 3	Using GPON Access in the context of TR-101	Broadband-Forum	2012
[3]	TR-167 Issue 2	GPON-fed TR-101 Ethernet Access Node	Broadband-Forum	2010
[4]	TR-178	Multi-service Broadband Network Architecture and Nodal Requirements	Broadband-Forum	2014
[5]	G.988	ONU management and control interface (OMCI) specification	ITU-T	2012

[6]	G.988 Amd1	ONU management and control interface (OMCI) specification Amendment 1	ITU-T	2014
[7]	G.988 Amd2	ONU management and control interface (OMCI) specification Amendment 2	ITU-T	2016
[8]	RFC 2119	Key words for use in RFCs to Indicate Requirement Levels	IETF	1997
[9]	G.984.2	Gigabit-capable Passive Optical Networks (G-PON): Physical Media Dependent (PMD) layer specification	ITU-T	2003
[10]	G.984.2 Amd1	Gigabit-capable Passive Optical Networks (G-PON): Physical Media Dependent (PMD) layer specification Amendment 1	ITU-T	2006
[11]	G.984.2 Amd2	Gigabit-capable Passive Optical Networks (G-PON): Physical Media Dependent (PMD) layer specification Amendment 2	ITU-T	2008
[12]	G.984.3	Gigabit-capable Passive Optical Networks (G-PON): Transmission convergence layer specification	ITU-T	2014
[13]	G.987.2	10-Gigabit-capable passive optical networks (XG-PON): Physical media dependent (PMD) layer specification	ITU-T	2010
[14]	G.987.2	10-Gigabit-capable passive optical networks (XG-PON): Physical media dependent (PMD) layer specification	ITU-T	2016
[15]	G.987.3	10-Gigabit-capable passive optical networks (XG-PON): Transmission convergence (TC) layer specification	ITU-T	2014
[16]	G.989.2	40-Gigabit-capable passive optical networks 2 (NG PON2): Physical media dependent (PMD) layer specification	ITU-T	2014
[17]	G.989.3	40-Gigabit-capable passive optical networks (NG-PON2): Transmission Convergence Layer Specification	ITU-T	2015
[18]	G.9807.1	10-Gigabit-capable symmetric passive optical network (XGS-PON)	ITU-T	2016
[19]	IR-247 Issue 3	GPON& XG-PON1 ONU Conformance Test Plan	Broadband-Forum	2014

2.3 Definitions

The following terminology is used throughout this Technical Report. TR-280 follows the definitions in Section 2.3 of TR-156.

ODN	Optical Distribution Network: The physical medium that connects an OLT to its subtended ONUs. The ODN is comprised of various passive components, including the optical fiber, splitter or splitters, and optical connectors.
OLT	Optical Line Terminal (OLT): A device that terminates the common (root) endpoint of an ODN, implements a PON protocol, and adapts PON PDUs for uplink communications over the provider service interface. The OLT provides management and maintenance functions for the subtended ODN and ONUs.
ONU	Optical Network Unit (ONU): A generic term denoting a functional element that terminates any one of the distributed (leaf) endpoints of an ODN, implements a PON protocol, and adapts PON PDUs to subscriber service interfaces. In some contexts an ONU supports interfaces for multiple subscribers.
PON	Passive Optical Network. A PON includes the OLT, ONU, and Optical Distribution Network (ODN).

2.4 Abbreviations

This Technical Report uses the following abbreviations:

AES	Advanced Encryption Standard
AN	Access Node
ASP	Application Service Provider
BTS	Base Transceiver Station
CB	Cellular Backhaul
CPE	Customer Premises Equipment
CPN	Customer Premises Network
DSCP	DiffServ Code Point
DSL	Digital Subscriber Line
FE	Fast Ethernet (100Mbps)
FITH	Fiber Into the Home
FTTC	Fiber to the Curb
FTTH	Fiber to the Home
FTTO	Fiber to the Office
FTTP	Fiber to the Premises, including buildings
GE	Gigabit Ethernet
GEM	Generic Encapsulation Method
GPM	GPON Physical Media Layer
GPON	Gigabit-capable Passive Optical Network
GTC	GPON Transmission Convergence layer – as defined in G.984.3
MAC	Media Access Control

MDU	Multi-Dwelling Unit
MLD	Multicast Listener Discovery
MTU	Multi-Tenant Unit – or Maximum Transmission Unit
NSP	Network Service Provider
ODN	Optical Distribution Network – as defined in G.984.1
OLT	Optical Line Termination – as defined in G.984.1
OMCI	ONU Management and Control Interface
ONT	Optical Network Termination – as defined in G.984.1
ONU	Optical Network Unit – as defined in G.984.1
PD	Proposed Draft
POTS	Plain Old Telephone Service
RBN	Regional Broadband Network
RG	Residential Gateway
RNC	Radio Network Controller
SFU	Single Family Unit – a type of residence
SNI	Service Node Interface
TDM	Time-Division Multiplexing
TLS	Transparent LAN Service – a common synonym for Business Ethernet Services
TR	Technical Report
VDSL	Very high speed Digital Subscriber Line
xDSL	Any variety of DSL

3 Technical Report Impact

3.1 Energy Efficiency

TR-280 does not cover specific requirements related to energy efficiency.

3.2 IPv6

TR-280 does not cover specific requirements related to IPv6.

3.3 Security

TR-280 describes a number of ONU and OLT security requirements that are designed to protect the PON access network from malicious users. Security impacts can be found in Section 4.6.

3.4 Privacy

TR-280 builds upon the principles and requirements defined in TR-178. Hence, it maintains the mechanisms that ensure privacy of end-users. This includes mechanisms that avoid malicious users from intercepting traffic from other users in the access network.

4 Functional Modules and Requirements

4.1 Enhanced QoS

TR-156 specifies only one priority queue for each T-CONT. There are applications where it is desirable to have multiple queues per T-CONT and to have scheduling between those queues. ITU-T G.988 specifies the best practice for implementing solutions for such applications. This section describes the requirements for the application where the service provider assigns a VLAN to a T-CONT, but wishes to give different priority to different flows within that T-CONT. This is achieved by mapping specific P-bit values within that VLAN to different queues, then using strict priority to schedule traffic from the queues into the T-CONT for that VLAN. Figure 2 illustrates the application, which is based on the default fixed method with strict priority scheduling specified in G.988.

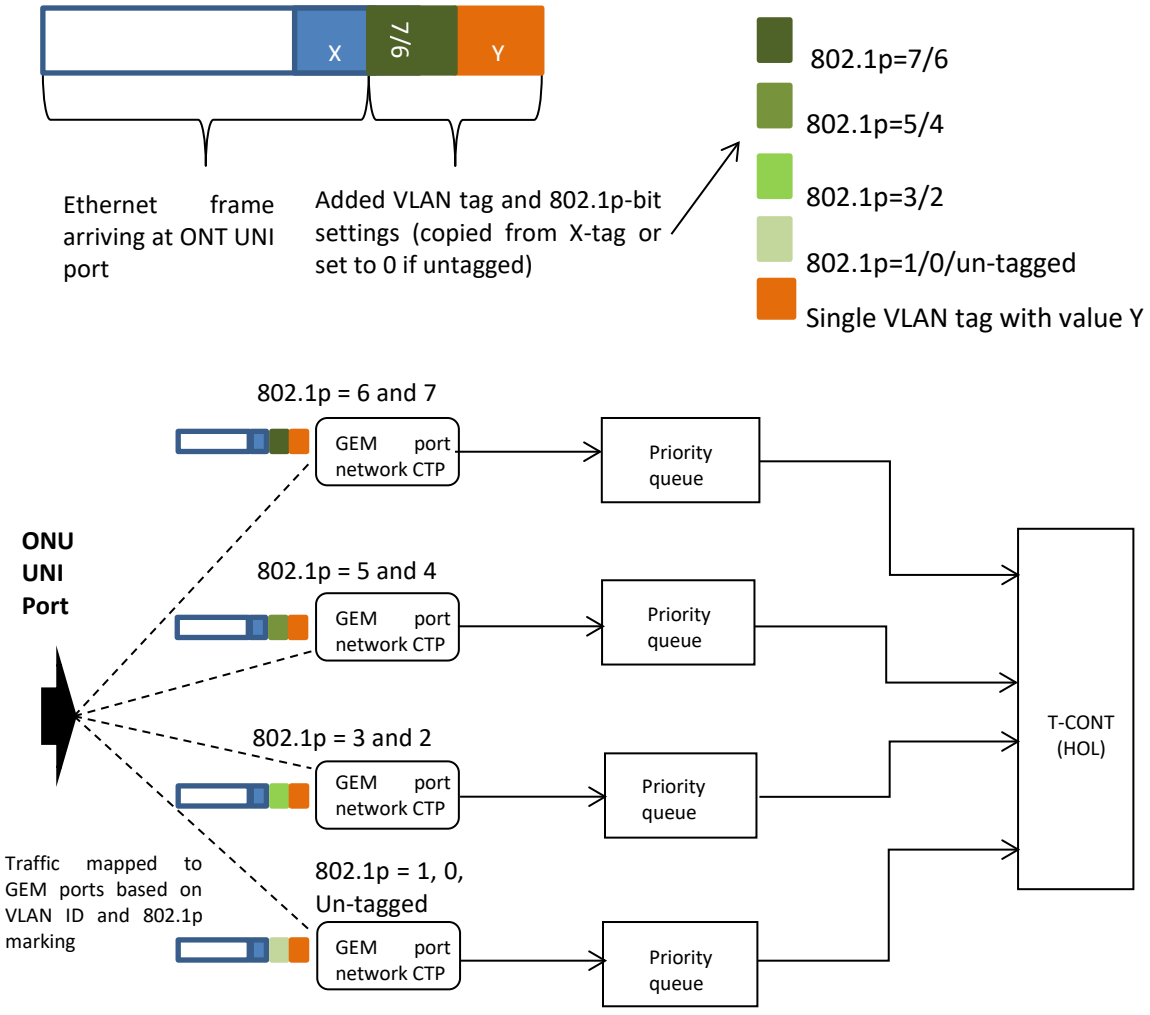

Figure 2 – Upstream strict priority scheduling with four queues per T-CONT

[R-1] The ONU MUST support the recommendations defined in TR-156.

[R-2] The ONU MUST support the upstream strict priority scheduling with four queues per T-CONT application shown in Figure 2. Note that the traffic mapping can be based on one or more 802.1 priority levels per GEM port (two are shown in Figure 2).

[R-3] The ONU MUST support VID translation and P-bit copying in the upstream direction for priority-tagged (VID = 0) frames.

[R-4] The ONU MUST support the fixed method of queue configuration and strict priority scheduling shown in Figure 2 as the upstream default QoS architecture in accordance with the fixed method specified in clause II.3.3.1.1/ITU-T G.988.

Note that the number of queues and their assignment to T-CONTs are pre-configured and not changed (see clause 9.1.2/ITU-T G.988, Quality of service (QoS) configuration flexibility attribute, all bits are set to 0 if the attribute is reported by the ONU).

[R-5] The OLT MUST support upstream traffic flows under a single assigned VLAN ID and comprising upstream traffic from the four GEM ports, which can be sent to the L2 switch in the OLT for switching based on the VLAN ID.

Downstream priority queues are managed via the GEM port network CTP ME, as shown in Figure 3.

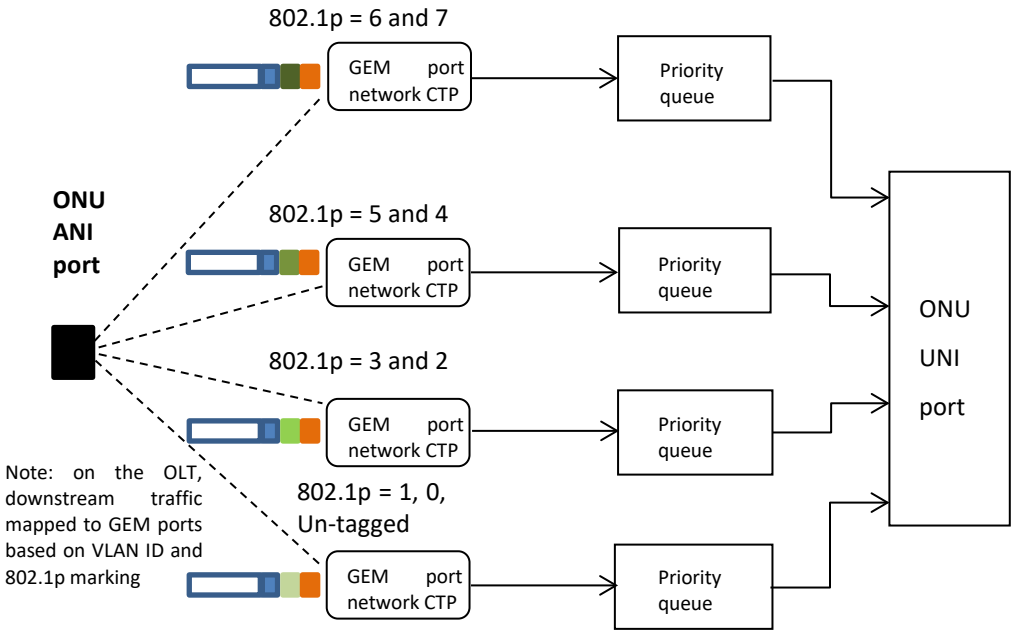

Figure 3 – Downstream strict priority scheduling with four queues

[R-6] The ONU MUST support strict priority scheduling in downstream with four queues per U interface shown in Figure 3. Note that the traffic mapping can be based on one or more P-bits per GEM port (two are shown in Figure 3).

[R-7] The ONU MUST support the fixed method of queue configuration and strict priority scheduling shown in Figure 3 as the downstream default QoS architecture in accordance with the fixed method specified in clause II.3.3.1.1/ITU-T G.988.

Note that the number of priority queues and their priorities are pre-configured and not changed.

[R-8] The OLT MUST support the recommendations defined in TR-156.

[R-9] The OLT MUST be able to strip the outer VLAN, swap the inner VLAN tag and copy the P-bit settings from the ingress inner VLAN tag to the new inner VLAN tag.

[R-10] The OLT MUST be able to overwrite the P-bit values in the outer VLAN tag for each VLAN in the upstream direction in accordance with the service profiles in the OLT.

[R-11] The OLT MUST support mapping of traffic from the physical SNI port to four logical GEM ports based on the assigned VLAN ID and the 802.1p priority. The mapping is based on one or more 802.1p priority levels per GEM port.

Figure 3 indicates the ONU-side mapping for two 802.1p priority levels per GEM port applied by the OLT.

These 3 below requirements refer to the following MEs in ITU-T G.988:

- Priority queue ME
  - Attribute: Maximum queue size and allocated queue size
- ONU-2G ME
  - Attribute: Priority queue scale factor

[R-12] The ONU MUST support the setting of the allocated queue size for each queue.

[R-13] The OLT MUST support via OMCI the ability to "read" max queue size of each queue.

[R-14] The OLT MUST support via OMCI the setting at the ONU of the allocated queue size for each queue.

[R-15] The OLT MUST support shaping per ONU and per queue per ONU.

4.2 Enhanced Multicast

[R-16] The ONU MUST support all combinations of VID and P-bit translation in the upstream direction for IGMP/MLD packets, and IGMP/MLD and multicast frames in the downstream direction.

[R-17] The ONU MUST support the following attributes of Multicast Operations Profile ME:

- Upstream IGMP TCI
- Upstream IGMP tag control
  - All code points defined in this attribute
- Downstream IGMP and multicast TCI
  - All code points defined in this attribute

[R-18] The OLT MUST support and send configuration to the ONU of the following attributes of Multicast Operations Profile ME:

- Upstream IGMP TCI
- Upstream IGMP tag control
  - All code points defined in this attribute
- Downstream IGMP and multicast TCI
  - All code points defined in this attribute

[R-19] The OLT and the ONU MUST be capable of supporting a maximum multicast bandwidth per U interface.

[R-20] The ONU MUST support the configuration of the maximum multicast bandwidth as defined in clause 9.3.28/ITU-T G.988.

[R-21] The ONU MUST support to forward or discard IGMP/MLD packets based on the permissions of multicast group in the upstream.

[R-22] The OLT MUST support to send permissions of multicast group to the ONU.

[R-23] The ONU MUST support the following attributes of Multicast Operations Profile ME:

- Dynamic access control list table

[R-24] The OLT MUST support and send configuration to the ONU of the following attributes of Multicast Operations Profile ME:

- Dynamic access control list table

4.3 Alarms and counters

TR-156 does not specify the alarm and counter functionalities used by service providers in their network deployments. This section specifies these for the optical and Ethernet layers.

[R-25] *Obsoleted. It has been replaced by [R-25a] to [R-25f].*

[R-25a] The OLT MUST support the configuration and retrieval of OMCI-based performance monitoring counters on the ONU.

[R-25b] The ONU MUST support the configuration and reporting of OMCI-based performance monitoring counters on the request of the OLT.

[R-25c] The OLT MUST support receiving alarm notifications sent by the ONU.

[R-25d] The OLT MUST support alarm audit and resynchronization, as described in clause A.1.4.2/ITU-T G.988.

[R-25e] The ONU MUST support generating and sending alarms to the OLT.

[R-25f] The ONU MUST support alarm audit and resynchronization, as described in clause A.1.4.2/ITU-T G.988, requested by the OLT.

[R-26] *Obsoleted. It has been replaced by [R-26a] to [R-26b].*

[R-26a] The ONU MUST use Embedded OAM or PLOAM channel for reporting specific upstream alarm messages when applicable e.g., Dying Gasp (embedded OAM for XG(S)-PON/NG-PON2, PLOAM for G-PON), REI for G-PON.

[R-26b] The OLT MUST use Embedded OAM or PLOAM channel for detecting specific upstream alarm messages sending by the ONU e.g., Dying Gasp (embedded OAM for XG(S)-PON/NG-PON2, PLOAM for G-PON), REI for G-PON.

[R-27] The ONU MUST collect and report the following Ethernet frame extended PM ME (32 bit) (clause 9.3.32/ITU-T G.988) information:

- Received frames
- Sent frames
- Dropped received upstream frames due to MAC layer CRC errors
- Received multicast frames
- Sent multicast frames

[R-28] The ONU SHOULD collect and report the following Ethernet frame extended PM ME (64 bit) (clause 9.3.34/ITU-T G.988) information:

- Received frames
- Sent frames
- Dropped received upstream frames due to MAC layer CRC errors
- Received multicast frames
- Sent multicast frames

Note:

- Received frames and received multicast frames are counted at the UNI in upstream direction and at the GEM port level in downstream direction.
- Dropped frames due to MAC layer CRC errors are reported only on the UNI in upstream direction and not per VID or P-bit. Counting dropped frames is not applicable in the downstream direction.

[R-29] *Obsoleted. It has been replaced by [R-29a] to [R-29b].*

[R-29a] The ONU MUST support the threshold configuration for drop events (Threshold 1 and Threshold 2 ME) associated to the Ethernet frame extended PM ME.

[R-29b] The OLT MUST support the threshold configuration for drop events (Threshold 1 and Threshold 2 ME) associated to the Ethernet frame extended PM ME at the ONU.

[R-30] *Obsoleted. It has been replaced by [R-30a] to [R-30b].*

[R-30a] The ONU MUST support generating and sending of a Threshold Crossing Alert (TCA) when threshold is reached for drop events associated to the Ethernet frame extended PM ME.

[R-30b] The OLT MUST support retrieving of a Threshold Crossing Alert (TCA) when threshold is reached for drop events associated to the Ethernet frame extended PM ME at the ONU.

Note: Drop events are the total number of events in which frames were dropped due to lack of resources. This is not necessarily the number of frames dropped; it is the number of times this event was detected as defined in clause 9.3.32/ITU-T G.988.

[R-31] *Obsoleted. It has been replaced by [R-31a] to [R-31c].*

[R-31a] The OLT and the ONU MUST support Ethernet frame extended PM ME for the following:

- Physical path termination point Ethernet UNI ME (when it represents an actual physical interface, not a virtual interface as defined in [R-68])
- GEM interworking termination point ME
- Multicast GEM interworking termination point ME

and in upstream and downstream direction for the monitored point:

- All frames received
- Frames matching on arbitrary combination of VID+P-bit
- Frames matching VID
- Frames matching P-bit

[R-31b] The OLT and the ONU MUST support Ethernet frame extended PM ME for the following:

- VEIP ME
- Physical path termination point Ethernet UNI ME (when it represents a virtual interface as defined in [R-68])

and in upstream and downstream direction for the monitored point:

- All frames received

[R-31c] The OLT and the ONU SHOULD support Ethernet frame extended PM ME for the following:

- VEIP ME
- Physical path termination point Ethernet UNI ME (when it represents a virtual interface as defined in [R-68])

and in upstream and downstream direction for:

- Frames matching on arbitrary combination of VID+P-bit
- Frames matching VID
- Frames matching P-bit

[R-32] The OLT MUST have Ethernet counters at the V interface for upstream traffic based on:

- Total traffic
- VID
- P-bit
- VID+P-bit

[R-33] The OLT MUST have Ethernet counters at the S/R and R/S interface for upstream traffic per ONU based on:

- Total traffic
- GEM port
- T-CONT
- VID
- P-bit
- VID+P-bit

[R-34] The OLT MUST have Ethernet counters per V interface for downstream traffic based on:

- Total traffic
- VID
- P-bit
- VID+P-bit

[R-35] The OLT MUST have Ethernet counters per S/R and R/S interface for downstream traffic per ONU based on:

- Total traffic
- GEM port
- T-CONT
- VID
- P-bit
- VID+P-bit

[R-36] The OLT/ONU MUST be able to configure, collect, and report on the counters specified in [R-37] to [R-40] and [R-54] to [R-56].

[R-37] The ONU MUST collect and report in the following Ethernet frame extended PM ME (32 bit) (clause 9.3.32/ITU-T G.988) information per GEM port for upstream traffic based on:

- All frames received
- Frames matching an arbitrary combination of VID+P-bit
- Frames matching P-bit
- Frames matching VID

[R-38] The ONU MUST have Ethernet counters per U interface for upstream traffic based on:

- Total traffic
- VID
- P-bit
- VID+P-bit

[R-39] The ONU MUST collect and report in the following Ethernet frame extended PM ME (32 bit) (clause 9.3.32/ITU-T G.988) information per GEM port for downstream traffic based on:

- All frames received
- Frames matching an arbitrary combination of VID+P-bit
- Frames matching P-bit
- Frames matching VID

[R-40] The ONU MUST have Ethernet counters per U interface for downstream based on:

- Total traffic
- VID
- P-bit
- VID+P-bit

[R-41] The ONU/OLT MUST measure, collect, and report the following information in ANI-G ME in clause 9.2.1/ITU-T G.988:

- ONU temperature
- ONU Voltage
- ONU bias Current
- ONU transmitted optical power
- ONU received optical power

[R-42] The OLT MUST be able to configure SF and SD thresholds via OMCI (ANI-G ME in clause 9.2.1/ITU-T G.988) at the ONU, the ONU MUST support the configuration and detect/report alarms (via OMCI) when thresholds are reached for:

- SF (Signal failed)
- SD (Signal degraded)

[R-43] The OLT MUST be able to configure optical threshold via OMCI (ANI-G ME in clause 9.2.1/ITU-T G.988) at the ONU. The ONU MUST be able to configure optical threshold and send alarms (via OMCI) when thresholds are reached for:

- Low received optical power
- High received optical power
- Low transmit optical power
- High transmit optical power

[R-44] The ONU MUST send a Dying Gasp alarm in response to electrical disconnection and the OLT MUST report it.

[R-45] The ONU MUST detect the following events:

In ITU-T G.984.3 operation mode:

- LOS (Loss of signal) - local status notification
- LOF (Loss of frame) - local status notification
- SF (Signal failed) reported via OMCI - ONU generates a notification to the OLT according to ITU-T G.984.4/G.988 (see [R-42])
- SD (Signal degraded) reported via OMCI - ONU generates a notification to the OLT according to ITU-T G.984.4/G.988 (see [R-42])
- LCDG (Loss of GEM channel delineation) - local status notification
- TF (Transmission failure) - local status notification
- SUF (Start-up failure) - local status notification

- MEM (Message Error message) - local status notification
- DACT (Deactivate ONU-ID) - local status notification
- DIS (Disabled ONU) - local status notification
- MIS (Link mismatching) - local status notification
- PEE at ONU (Physical equipment error, locally detected at ONU) - ONU generates a notification to the OLT according to ITU-T G.984.3
- PEE at OLT (Physical equipment error, remotely detected at OLT) - local status notification (PEE is reported to the ONU via a downstream PLOAM message)
- RDI (Remote defect indication in ONU) - ONU generates a notification to the OLT according to ITU-T G.984.3 (RDI is reported to OLT via Ind field of the upstream PON frame (Embedded OAM)

In ITU-T G.987.3/ITU-T G.9807.1 operation mode:

- SF (Signal failed) reported via OMCI - ONU generates a notification to the OLT according to ITU-T G.988 (see [R-42])
- SD (Signal degraded) reported via OMCI - ONU generates a notification to the OLT according to ITU-T G.988 (see [R-42])
- LODS (Loss of downstream synchronization) - local status notification

Note: The implementation of local status notifications is vendor specific.

[R-46] The OLT MUST detect the following events, and generate notification if the OLT is required to perform such action by the clauses listed below.

In ITU-T G.984.3 operation mode (refer to clause 11.1.1/ITU-T G.984.3):

- LOSi (Loss of signal for ONUi)
- LOS (Loss of signal)
- LOFi (Loss of frame of ONUi)
- DOWi (Drift of window of ONUi)
- SFi (Signal fail of ONUi)
- SDi (Signal degraded of ONUi)
- LCDGi (Loss of GEM channel delineation)
- RDIi (Remote defect indication of ONUi)
- TF (Transmitter failure)
- SUFi (Start-up failure of ONUi
- DFi (Deactivate failure of ONUi)
- LOAi (Loss of acknowledge with ONUi)
- DGi (Receive dying gasp of ONUi)
- LOAMi (Loss of PLOAM for ONUi)
- PEEi (Physical equipment error of ONUi)

In ITU-T G.987.3/ITU-T G.9807.1 operation mode (refer to clause 14.2.1/ITU-T G.987.3, and clause C.14.2.1/ ITU-T G.9807.1):

- LOBi (Loss of burst for ONUi)
- LOS (Loss of signal)
- TIWi (Transmission interference warning for ONUi)
- SUFi (Start-up failure of ONUi)
- DFi (Disable failure of ONUi)

- LOPCi (Loss of PLOAM channel with ONUi)
- LOOCi (Loss of OMCC channel with ONUi)

Note: The implementation of the notification is vendor specific.

[R-47] The OLT MUST be able to read the type and port status of the U interface.

[R-48] The ONU MUST allow reading of the type and port status for each U interface.

[R-49] The ONU MUST send an OMCI alarm and/or Attribute Value Change (AVC) for port status changes on the U interface when applicable.

[R-50] When the OLT receives port type and port status changes from the ONU, the OLT MUST report to the operators/EMS the port type and status changes of each U interface for each ONU.

[R-51] *Omitted*.

[R-52] The ONU and OLT MUST support 15-minute accumulation mode of the Performance Monitoring ME instances (see Appendix I.4 of ITU-T G.988 for 15-minutes accumulation mode definition).

[R-53] The ONU and OLT SHOULD support continuous accumulation mode of the Extended Performance Monitoring instances (see Appendix I.4 of ITU-T G.988 for continuous accumulation mode definition).

[R-54] The OLT and/or EMS MUST support Archival of 24-hour statistics of the ONU.

[R-55] ONU MUST support the following attributes of the Multicast subscriber monitor ME defined in clause 9.3.29/ITU-T G.988:

- Current multicast bandwidth
- Join messages counter
- Bandwidth exceeded counter

[R-56] The ONU MUST support the following attributes of the FEC performance monitoring history data ME defined in clause 9.2.9/ITU-T G.988:

- Corrected bytes
- Corrected code words
- Uncorrectable code words
- Total code words
- FEC seconds

[R-57] The ONU MUST support the Remote Debug ME as defined in clause 9.1.12 and Appendix I.2.8 of ITU-T G.988.

It is recommended that the ONU vendor provides a list of valid vendor specific commands and their responses to the OLT operator and that the ASCII command “help” is provided by the ONU as the default command.

It is recommended that any command sent to the ONU in the “Command” attribute is responded to in the “Reply table” attribute and that a self-explaining error message is returned to the OLT, if an invalid command is sent to the ONU.

[R-58] *Omitted*.

[R-59] The OLT MUST support the Remote Debug ME as defined in clause 9.1.12 and Appendix I.2.8 of ITU-T G.988 [5].

[R-60] The ONU SHOULD implement at least the following parameters obtained via the Remote Debug ME (see [R-57]):

- List of multicast IP addresses or related MAC addresses learned by the ONU through the IGMP or MLD protocol, if IGMP/MLD controlled multicast is supported
- Total number of multicast frames forwarded by the ONU between UNI and ANI interfaces per direction (upstream and downstream)
- Unicast MAC addresses learned by the ONU, if MAC bridge learning is used
- Total number of unicast frames forwarded by the ONU between UNI and ANI interfaces per direction (upstream and downstream)
- Total number of broadcast frames forwarded by the ONU between UNI and ANI interfaces per direction (upstream and downstream)
- Total number of data packets discarded by the ONU
- Traces of received protocol frames (e.g., DHCP, ARP, IGMP/MLD, OMCI)

4.4 VLAN Tagging

[R-61] The ONU MUST support all actual code points (0 to 8) for the downstream mode attribute of the Extended VLAN tagging operation configuration data ME as defined in ITU-T G.988.

[R-62] The OLT MUST support and send configuration to the ONU of all actual code points (0 to 8) for the downstream mode attribute of the Extended VLAN tagging operation configuration data ME.

[R-63] The ONU MUST support at least 8 simultaneously active VLAN per U interface.

Note: This requirement allows the ONU to classify the ingress traffic with 8 distinct VIDs with all P-bit values per U interface in the upstream direction. Also refer to [R-64] for the requirement on the OMCI configuration.

[R-64] The ONU MUST support at least 67 entries in the Extended VLAN tagging operation table including the auto created default entries.

Note: This provides the support for 8 VLANs, each with 8 P-bit values plus the 3 default rules defined in ITU-T G.988.

4.5 Filtering and Learning

[R-65] The ONU MUST not use MAC address as a classification criterion for the VLAN translation or traffic class mapping if not requested by the OLT.

4.6 Enhanced Security

[R-66] The ONU MUST support GEM port encryption for all unicast GEM ports.

Point to point ONUs that do not support 'silent start mode' can disrupt PON operation by preventing other ONUs from performing activation or ranging refresh operations. A rogue ONU may cause a similar effect.

[R-67] After the opening of a quiet window, the OLT MUST process additional steps of the ranging process only upon detection of a valid PSBu structure from an ONU.

4.7 Multi-Managed ONU

[R-68] Multi-managed ONU MUST implement either a Virtual Ethernet Interface Point (VEIP) interface or a Physical Path Termination Point (PPTP) UNI interface as the interface to the non OMCI management domain.

[R-69] The OLT MUST support Multi-managed ONU implementations based on Physical Path Termination Point as the interface to the non-OMCI management domain.

[R-70] The OLT MUST support Multi-managed ONU implementations based on Virtual Ethernet Interface Point as the interface to the non-OMCI management domain.

4.8 Voice over IP

The VoIP service offered by ONUs can be configured by one or more methods including OMCI, TR-069, and configuration file, etc. The OLT may discover the abilities of VoIP configuration methods supported by ONUs. And then, if applicable, it may select one of the supported methods. The VoIP config data ME defined in ITU-T G.988 will help the OLT to perform this.

[R-71] The ONU offering VoIP services MUST support the following attribute of VoIP config data ME:

- Available VoIP configuration methods

[R-72] The OLT MUST support the reading of the following attribute of VoIP config data ME:

- Available VoIP configuration methods

[R-73] The ONU offering VoIP services MUST support the following attribute of VoIP config data ME:

- VoIP configuration method used

[R-74] The OLT MUST support the configuration of the following attribute of VoIP config data ME on the ONU:

- VoIP configuration method used

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