TECHNICAL REPORT

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

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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 XGPON1 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.

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, XGPON1, XGS-PON and NG-PON2 in the context of a TR-178 architecture.

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-PON1, 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.

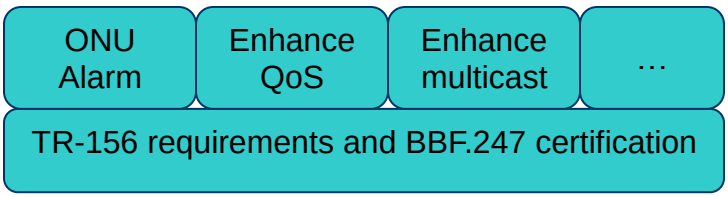

Figure 1 – Functional modules & requirements

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*	ETF	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	ITU-T	2015

		networks (NG-PON2): Transmission Convergence Layer Specification		
[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.

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.

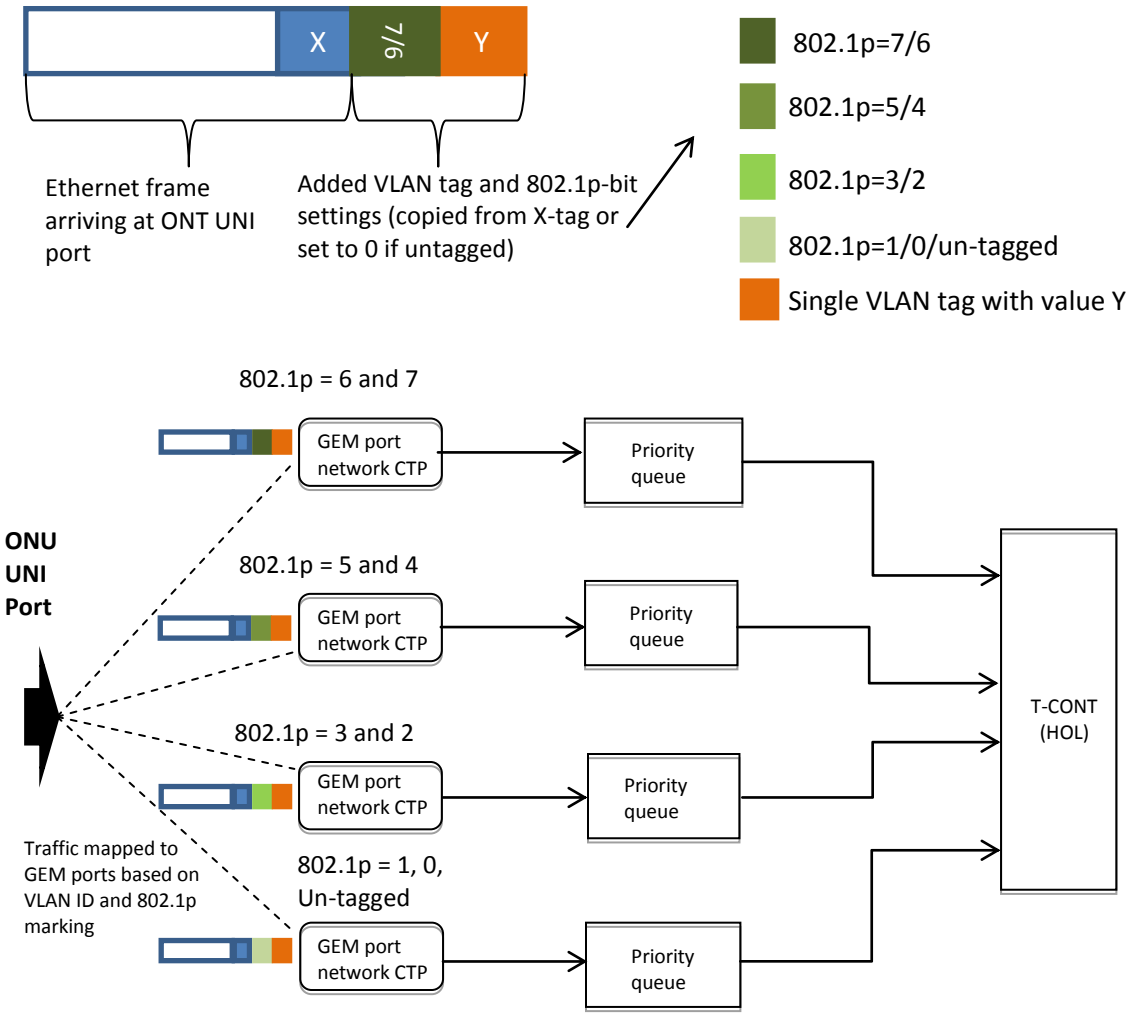

Figure 2 – Upstream strict priority scheduling with four queues per T-CONT

[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 be able to identify an Ethernet frame with a VLAN ID of 0 on ingress to the UNI port and strip this VLAN tag but still copy the 802.1p bits to the added VLAN tag with the payload remaining unchanged.

[R-4] The ONU MUST support the fixed method of queues and fixed priority scheduling shown in Figure 2 as the upstream default QoS architecture, in accordance with the fixed methods specified in G.988.

[R-5] The OLT MUST support one traffic stream under the single assigned VLAN ID and comprising 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.

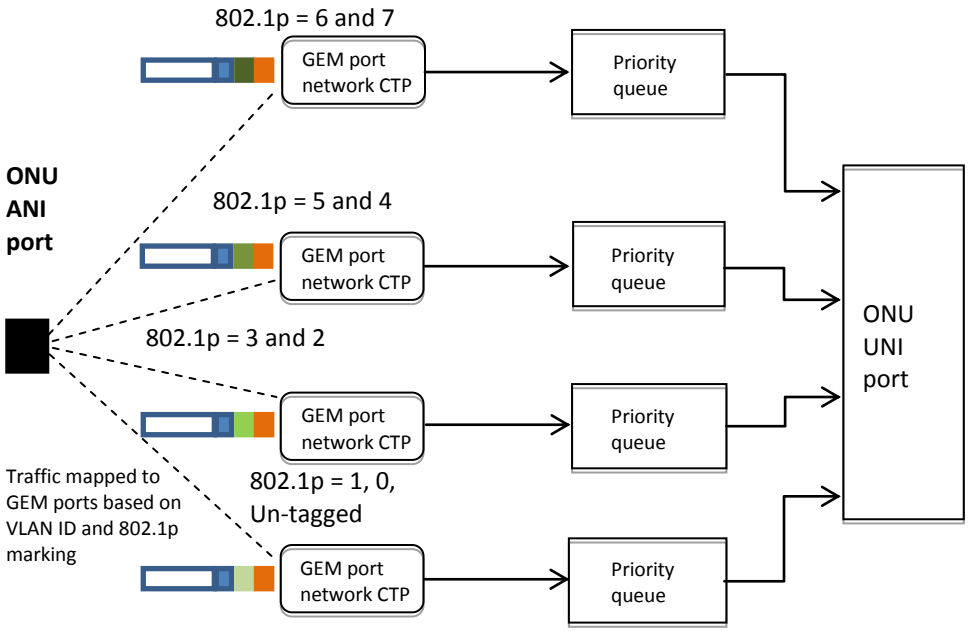

Figure 3 – Downstream strict priority scheduling with four queues

[R-6] The ONU MUST support the downstream strict priority scheduling with four queues application shown in Figure 3. Note that the traffic mapping can be based on one or more 802.1 priority levels per GEM port (two are shown in Figure 3).

[R-7] The ONU MUST support the fixed method of queues and strict priority scheduling shown in Figure 3 as the downstream default QoS architecture in accordance with the fixed methods specified in G.988.

[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 detect invalid p-bit settings for each inner VLAN and overwrite these with valid values 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 B indicates the mapping for two 802.1p priority levels per GEM port applied by the OLT.

These 3 below requirements refer to the following ME 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 Pbit 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 TCI 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 these attribute

[R-18] The OLT MUST support and send configuration to the ONU of the following attributes of multicast TCI 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 these attribute

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

[R-20] The maximum multicast bandwidth must be configurable as defined in G.988.

[R-21] The ONU MUST support to transfer 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] The OLT and ONU MUST use OMCI in the configuration and reporting of Alarms and counters

[R-26] The OLT and ONU MUST use PLOAM for reporting PLOAM specific alarms e.g. SD/SF, Dying Gasp.

[R-27] Ethernet counters (32 bit) MUST report
- received frames
- received bits
- sent frames
- sent bits
- dropped frames
- multicast frames

[R-28] Ethernet counters (64 bit) SHOULD report
- received frames
- received bits
- sent frames
- sent bits
- dropped frames
- multicast frames

[R-29] Ethernet counters MUST allow configurations of threshold for dropped frames (ME threshold 1 and Threshold 2)

[R-30] Ethernet counters MUST send/report alarms when threshold is reached

[R-31] The OLT and the ONU MUST support Ethernet frame extended PM ME for the following:
- Physical path termination point Ethernet UNI ME
- GEM interworking termination point ME
- Multicast GEM interworking termination point ME

and based on any arbitrary combination of:
- Upstream direction
- Downstream direction
- VID
- Pbit

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

[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
- GEMport
- T-CONT
- VID
- Pbit
- VID+Pbit

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

- Total traffic
- VID
- Pbit
- VID+Pbit

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

- Total traffic
- GEMport
- T-CONT
- VID
- Pbit
- VID+Pbit

[R-36] The OLT/ONU MUST be able to configure and report on the counters specified in [R-32] to [R-35], [R-37] to [R-40] and [R-55] to [R-56].

[R-37] The ONU MUST have Ethernet counters per R/S interface for upstream traffic based on:

- GEMport
- VID
- Pbit
- VID+Pbit

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

- Total traffic
- VID
- Pbit
- VID+Pbit

[R-39] The ONU MUST have Ethernet counters per R/S interface for downstream based on :

- GEMport
- VID
- Pbit
- VID+Pbit

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

- total traffic
- VID
- Pbit
- VID+Pbit

[R-41] The ONU/OLT MUST measure and report :

- ONU temperature
- ONU Voltage
- ONU bias Current
- ONU Tx power
- ONU received port

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

- SF
- SD

[R-43] The OLT MUST be able to configure optical threshold via OMCI (ME ANI-G G.988) at the ONU. The ONU MUST be able to configure optical threshold and send alarms (via OMCI) when threshold 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 OLT MUST report it

[R-45] The ONU MUST detect and send PLOAM messages, as defined in ITU-T G.984.3, of the following list:

- LOS
- LOF
- SF
- SD
- LCDG
- TF
- SUF
- MEM
- DACT
- DIS
- PEE
- RDI

[R-46] The OLT MUST detect and send PLOAM messages as defined in ITU-T G.984.3 of the following list:

- LOSi
- LOS
- LOFi
- DOWi
- SFi
- SDi
- LCDGi
- RDIi
- TF
- SUFi
- DFi
- LOAi
- DGi
- LOAMi
- PEEi

[R-47] The OLT MUST be able to read the type and status of the UNI

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

[R-49] The ONU MUST send an alarm for operational status changes on the U interface

[R-50] The OLT MUST receive and report the type and status of each U interface for each ONU.

[R-51] If U interface Type is Ethernet, the U interface MUST report:

- Ethernet synchronization mode
- Ethernet synchronization speed

[R-52] The ONU and OLT Counters MUST support 15-minute accumulation mode (see ITU-T G.988 for the definition)

[R-53] The ONU and OLT counters SHOULD continuous accumulation mode (see ITU-T G.988 for the definition)

[R-54] The OLT and/or EMS MUST support Archival and analysis along with accumulation into 24-hour statistics of the ONU counters (e. g.: counters of the Ethernet frame extended PM ME)

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

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

[R-57] The ONU MUST support remote debug ME ITU-T G.988

[R-58] The ONU MUST support standard implementation as described in appendix I section I.2.8 [5]

[R-59] The OLT MUST support the ability to create the Remote debug ME and to send command to the ONU via OMCI as described in appendix I section I.2.8 [5]

[R-60] When applicable, the ONU MUST implement at least the following parameters obtained via the Remote Debug ME:

- Multicast IP address and mac address learnt by ONU
- Multicast frames sent/received at ONU
- Unicast IP address and mac address learnt by ONU
- Unicast frames sent/received at ONU
- Broadcast IP address and mac address learnt by ONU
- Broadcast frames received at ONU
- Traffic/packets that the ONU discards
- Traces (DHCP, ARP, IGMP and OMCI channel) / logs

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 [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

[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 provide supports 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 perform MAC filtering or learning unless 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 product MUST implements either a Virtual Ethernet Interface Point (VEIP) interface or a Physical Path Termination Point (PPTP) UNI interfaces 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

End of Broadband Forum Technical Report TR-280