TECHNICAL REPORT

TR-167
GPON-fed TR-101 Ethernet Access Node

Issue: 3
Issue Date: September 2017

Notice

The Broadband Forum is a non-profit corporation organized to create guidelines for broadband network system development and deployment. This Technical Report has been approved by members of the Forum. This Technical Report is subject to change. This Technical Report is copyrighted by the Broadband Forum, and all rights are reserved. Portions of this Technical Report may be copyrighted by Broadband Forum members.

Intellectual Property

Recipients of this Technical Report are requested to submit, with their comments, notification of any relevant patent claims or other intellectual property rights of which they may be aware that might be infringed by any implementation of this Technical Report, or use of any software code normatively referenced in this Technical Report, and to provide supporting documentation.

Terms of Use

1. License
Broadband Forum hereby grants you the right, without charge, on a perpetual, non-exclusive and worldwide basis, to utilize the Technical Report for the purpose of developing, making, having made, using, marketing, importing, offering to sell or license, and selling or licensing, and to otherwise distribute, products complying with the Technical Report, in all cases subject to the conditions set forth in this notice and any relevant patent and other intellectual property rights of third parties (which may include members of Broadband Forum). This license grant does not include the right to sublicense, modify or create derivative works based upon the Technical Report except to the extent this Technical Report includes text implementable in computer code, in which case your right under this License to create and modify derivative works is limited to modifying and creating derivative works of such code. For the avoidance of doubt, except as qualified by the preceding sentence, products implementing this Technical Report are not deemed to be derivative works of the Technical Report.

2. NO WARRANTIES
THIS TECHNICAL REPORT IS BEING OFFERED WITHOUT ANY WARRANTY WHATSOEVER, AND IN PARTICULAR, ANY WARRANTY OF NONINFRINGEMENT IS EXPRESSLY DISCLAIMED. ANY USE OF THIS TECHNICAL REPORT SHALL BE MADE ENTIRELY AT THE IMPLEMENTER'S OWN RISK, AND NEITHER THE BROADBAND FORUM, NOR ANY OF ITS MEMBERS OR SUBMITTERS, SHALL HAVE ANY LIABILITY WHATSOEVER TO ANY IMPLEMENTER OR THIRD PARTY FOR ANY DAMAGES OF ANY NATURE WHATSOEVER, DIRECTLY OR INDIRECTLY, ARISING FROM THE USE OF THIS TECHNICAL REPORT.

3. THIRD PARTY RIGHTS
Without limiting the generality of Section 2 above, BROADBAND FORUM ASSUMES NO RESPONSIBILITY TO COMPILE, CONFIRM, UPDATE OR MAKE PUBLIC ANY THIRD PARTY ASSERTIONS OF PATENT OR OTHER INTELLECTUAL PROPERTY RIGHTS THAT MIGHT NOW OR IN THE FUTURE BE INFRINGED BY AN IMPLEMENTATION OF THE TECHNICAL REPORT IN ITS CURRENT, OR IN ANY FUTURE FORM. IF ANY

Issue History

Issue Number	Approval Date	Publication Date	Issue Editor	Changes
1	February 2010	February 2010	Michael Shaffer, Huawei Technologies Co.,Ltd. Dave Hood, Ericsson	Original
2			Michael Hanrahan, Huawei Technologies	Added reference for XG-PON1
3	4 September 2017	25 October 2017	Greg Bathrick Calix	Added reference for XGS-PON

Comments or questions about this Broadband Forum Technical Report should be directed to help@broadband-forum.org.

Editor	Greg Bathrick	Calix
Fiber Access Networks WA Directors	Wei Lin Greg Bathrick	Huawei Technologies Calix

September 2017   4 of 31

Table of Contents

List of Figures

Executive Summary

TR-167 provides architectural and network element requirements to allow the use of GPON to feed an access node as defined in TR-101. TR-101 provides triple play application support in an architecture that migrates from ATM to Ethernet access technology.

TR-167 Issue 2 broadens the applicability to include XG-PON1 support.

TR-167 Issue 3 broadens the applicability of TR-167 to include XG(S)-PON support.

September 2017   7 of 31

1 Purpose and Scope

1.1 Purpose

TR-101 is a popular and successful Broadband Forum architecture that enjoys significant success in the marketplace. Moreover, many of the benefits provided by TR-101 are not associated with DSL or DSLAM network elements, and even some of the benefits and requirements that do apply to DSL access nodes are abstract enough to apply to other types of access – not just DSL.

Note: The remainder of this Technical Report uses the term GPON in a generic manner to refer to any ITU-T TDM PON including GPON, and XG(S)-PON.

Recognizing these benefits, some service providers planning GPON deployments are eager to use elements of the architecture and requirements provided by TR-101, but find that there are some aspects of GPON deployment that require definition and could benefit from standardization. This is especially true of service providers that are planning both GPON deployments as well as DSL deployments, or those that have already deployed DSL in a TR-101-supported approach and intend to add GPON. Similarly, equipment vendors of the network elements and management systems described in TR-101 are highly interested in determining the requirements and approach to make GPON equipment fit into TR-101 applications with minimal variation among service provider deployments.

TR-156 specifies GPON deployment in the access network. A TR-156 ONT/ONU has no switching capabilities, is managed via the OLT, and can serve one or several customers with either Ethernet or DSL last drop.

TR-167 specifies GPON deployment in the aggregation network. In this case, the ONU provides an interface at the V reference point for a TR-101 access node. A TR-167 ONU is managed by the OLT using OMCI while the TR-101 access node is managed in the same manner as an access node with Ethernet as the physical interface at the V reference point.

 TR-156 and TR-167 architectures can co-exist on the same ODN.

1.2 Scope

The intent of this Technical Report is not to specify physical layer requirements for a GPON system, but rather to specify the capabilities of a GPON system in the context of the aggregation of TR-101 access nodes, as well as any higher-layer requirements that are needed but have not been specified elsewhere.

Specifically, this Technical Report:
- is limited to services and architecture as defined by TR-101.
- describes the fundamental architecture and topology for a GPON-fed Ethernet access node in line with TR-101.
- describes functional components of a GPON-fed Ethernet access node.
- defines the service mapping requirements of a GPON-fed Ethernet access node.

- defines the QOS management requirements of a GPON-fed Ethernet access node.
- defines the configuration management requirements of a GPON-fed Ethernet access node, including the option for dual management domains.
- defines the multicast requirements for a GPON-fed Ethernet access node.
- defines an architecture that allows the development of compliant ONU entities that do not need to perform learning of MAC addresses in order to determine how to forward Ethernet frames to the V interface.

1.3   Out of Scope

- RG requirements
- U interface requirements
- Access node management requirements

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.

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 adjective "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 may exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
MAY	This word, or the adjective "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.

RFC 2119	*Keywords for use in RFCs to indicate requirement levels*	IETF	1997
TR-101	*Migration to Ethernet-based DSL aggregation*	Broadband Forum	2006
G.984 series	*Gigabit-capable passive optical networks*	ITU	2006-2009
G.987 series	*10 Gigabit-capable passive optical networks*	ITU	2009-2010
G.988	*ONU management and control interface specification (OMCI)*	ITU	2010

TR-156	*Using GPON in the context of TR-101*	Broadband Forum	2008
Y.1731	*OAM functions and mechanisms for Ethernet based networks*	ITU	2006
802.1ag	*Virtual bridged local area networks, amendment 5: Connectivity fault management*	IEEE	2007
802.1Q	*Virtual bridged local area networks*	IEEE	2005
802.1D	*Media access control (MAC) bridges*	IEEE	2004
802.3ad	*Link aggregation, clause 43 of IEEE 802.3, CSMA/CD access method and physical layer specifications*	IEEE	2005
G.9807.1	*10 Gigabit-capable Symmetric Passive Optical Networks*	ITU-T	2016

2.3   Definitions

The following terminology is used throughout this Technical Report.

GEM	G-PON encapsulation mode is used for encapsulating data over G-PON. It provides both delineation of user data frames and flow identification. Ethernet frames, excluding preamble and SFD bytes, are mapped into GEM frames.
GEM port	An abstraction on the GTC adaptation sublayer representing a logical connection associated with a specific client packet flow.
G-PON interface	The interface at reference points S/R and R/S as specified in ITU-T G.984.1. This is a PON-specific interface that supports all the protocol elements necessary to allow transmission between OLT and ONUs.
GPON network	An OLT connected using an Optical Distribution Network (ODN) to one or more ONUs or ONTs. A GPON network is a subset of the Aggregation Network.
GPON-fed Ethernet access node	A GPON-fed Ethernet access node is a type of access node that provides multiple-user Ethernet access through DSL, 802.3 or other UNI technology. It is a DSLAM or an Ethernet switch with GPON backhaul. A GPON-fed Ethernet access node is usually deployed at a remote site. It collects user traffic near this site and sends this traffic to the OLT by GPON technology.

ONU entity   The GPON ONU function that is associated with a GPON-fed Ethernet access node. This function may be contained in a physically distinct device from the access node or integrated with the TR-101 access node entity.

OLT   A device that terminates the common (root) endpoint of an ODN, implements a PON protocol, such as that defined by G.984, 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 In the context of this Technical Report, the OLT is an Ethernet aggregation node.

ONT   An optical network termination is a single subscriber device that terminates any one of the distributed (leaf) endpoints of an ODN, implements a PON protocol, and adapts PON PDUs to subscriber service interfaces. An ONT is a special case of an ONU. This Technical Report is not concerned with ONTs.

ONU   Optical network unit. A network element in an ODN-based optical access network that terminates a leaf of the ODN. In the context of this Technical Report, the ONU provides an aggregation node interface at the V reference point.

T-CONT   Transmission container. A traffic-bearing object within an ONU that represents a group of logical connections, is managed via the ONU management and control channel (OMCC), and is treated as a single entity for the purpose of upstream bandwidth assignment on the PON.

2.4   Abbreviations

This Technical Report uses the following abbreviations:

AIS	Alarm indication signal
BNG	Border network gateway
BPDU	MAC bridge protocol data unit
CCM	Continuity check message (IEEE 802.1ag)
CFM	Configuration fault management (IEEE 802.1ag)
DEI	Drop eligibility indicator bit
DSCP	Differential services code point
IGMP	Internet group management protocol
LBM	Loopback message (IEEE 802.1ag)
LBR	Loopback reply (IEEE 802.1ag)
LTM	Link trace message (IEEE 802.1ag)
LTR	Link trace reply (IEEE 802.1ag)
MEP	Maintenance endpoint (IEEE 802.1ag)

MIP   Maintenance intermediate point (IEEE 802.1ag)
ODN   Optical Distribution Network
RG   Residential gateway
TR   Technical Report
UNI   User-network interface
VLAN   Virtual local area network
WFQ   Weighted fair queuing

3 Technical Report Impact

3.1   Energy efficiency

TR-167 has no effect on energy efficiency.

3.2   IPv6

TR-167 has no effect on IPv6.

3.3   Security

TR-167 has no effect on security over and above those specific for an Access Node in TR-101

September 2017   14 of 31

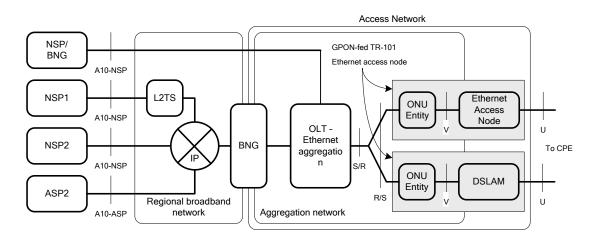# 4 Fundamental Architectural and Topological Aspects

This section describes a GPON system used in an Ethernet aggregation network terminating at a V reference point. Any device that meets TR-101 access node V reference point requirements can be connected on the downstream side of the V reference point.

TR-101 access nodes also include capabilities for converting subscriber ATM to Ethernet for delivery to the aggregation network.

TR-101 defines separate requirements for access nodes and aggregation nodes. The basic difference is that an access node deals with C-Tags in 1:1 VLANs, while an aggregation node acts as an S-VLAN bridge and is not aware of C-Tags.

In TR-101, the interface between the access node and the aggregation network is designated a V reference point. In a GPON-fed access node, the GPON ONU entity transports Ethernet frames on the PON, while a TR-101 access node entity is responsible for switching them to subscriber ports and converting to ATM if necessary. The V reference point therefore appears between the GPON ONU entity and the TR-101 access node. However, this does not imply that the ONU entity and the TR-101 access node must be physically separate devices. In fact, as shown in Figure 1, they may be realized as a single physical device with a virtual V reference point between the two parts. Such an integrated ONU entity combines aggregation node functions and access node functions.

An ONU entity providing a V reference point may coexist on the same ODN as an ONU providing a U reference point as described in TR-156. In this case, aggregation node and access node functions coexist in the OLT.

Figure 1 – Network architecture for Ethernet-based GPON aggregation

4.1   V reference point

In TR-101, the V reference point is the boundary between a DSLAM and the Ethernet aggregation network. In a TR-167 system, the V reference point may be virtual and exist inside a single GPON-fed Ethernet access equipment, or it may be physical between an ONU equipment and a separate Ethernet access equipment. As in TR-101, payload is transferred across the V reference point in Ethernet frames. However, TR-101 describes the V reference point with the expectation that it is a physical boundary between network elements that are separated by some distance. When both functions exist within the same equipment, TR-101 requirements for capabilities such as link aggregation are no longer appropriate.

Figure 2 and Figure 3 illustrate the functions of the TR-101 access node entity and those of the GPON ONU entity. Their respective domains are separated by the V reference point, which may be physical or virtual.
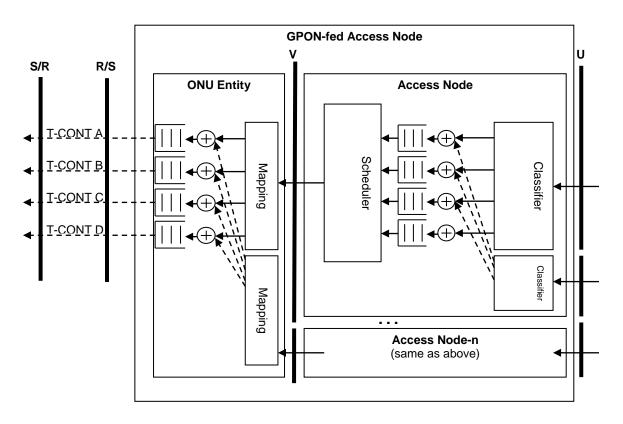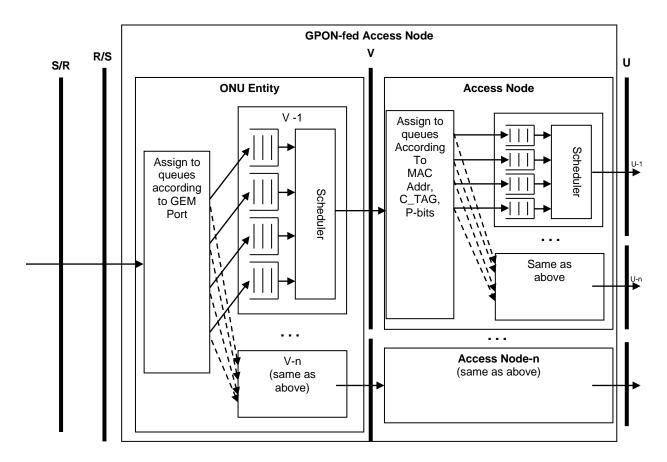
Figure 2 – Separation of functions at the V reference point : Upstream

Figure 3 – Separation of Functions at the V Reference Point : Downstream

4.2   Aggregation network

The GPON ONU entity encapsulates Ethernet frames in GEM frames in the upstream direction. The GPON ONU entity also provides a stage of aggregation when there is more than one V reference point on the ONU entity. The OLT encapsulates Ethernet frames in GEM frames in the downstream direction and provides an Ethernet switching function in both directions.

September 2017   17 of 31

5   VLANs and QoS

Figure 4 – GPON-fed Ethernet access node VLAN and QoS management

5.1   GPON-fed Ethernet Access node VLAN Scope and QoS

The GPON-fed Ethernet access node VLAN scope and QoS mechanism is depicted in Figure 4. The TR-101 access node entity in a GPON-fed Ethernet access node adheres to TR-101 access node VLAN and QoS requirements. In the access node, both C-Tags and S-Tags may be in scope and scheduling is performed at the V interface. In the ONU entity, only S-Tags are in scope and mapping to GEM ports is performed based upon S-Tag (including p-bits) and V interface.

5.2   ONU entity VLAN and QoS

The GPON ONU entity receives frames that have been classified and marked (tagged) by the TR-101 access node. Any combination of VID and P-bit fields of these tags may be used to interwork between Ethernet QoS mechanisms and GPON QoS mechanisms.

Figure 5 – Frame mapping for GPON-fed Ethernet access node

5.2.1   Upstream frame handling

GPON-fed Ethernet access node frame mapping is depicted in Figure 5. The TR-101 access node classifies upstream frames and conveys them to the GPON ONU entity. The ONU entity then maps the frames to GEM ports based on V interface and any combination of S-VID and P bits.

5.2.2   Downstream frame mapping

The OLT maps downstream frames to GEM ports based on any combination of MAC address, S-VID and P bits. The GPON ONU entity maps downstream frames from GEM ports to V reference point interfaces – assuming there is more than one – based on GEM Port

5.3   VLAN and QoS requirements

This section describes aggregation node requirements from TR-101 and how they are mapped to a GPON system used as an Ethernet aggregation node. The text is organized such that each Ethernet aggregation node requirement from TR-101 is identified and the resulting requirements when applied to a GPON are listed.

R-1   The ONT and OLT MUST support frame sizes of 2000 bytes as per IEEE 802.3as

R-2   The OLT and the GPON ONU entity MUST support passing an S-Tag in the upstream
         direction.

R-3   The OLT and the GPON ONU entity MUST support passing an S-Tag in the downstream
         direction.

R-4   The ONU and OLT MUST support all VID values from the range: 1-4094 as specified in
         IEEE 802.1Q, on all ports.

R-5   The OLT MUST support forwarding Ethernet frames received on a GEM port to a
         network facing interface based on S-VID and destination MAC address.

R-6   The OLT MUST support forwarding frames received at a network facing interface to
         GEM ports on the PON based on any combination of destination MAC address, S-VID,
         and P bits.

R-7   A GPON ONU entity MUST support forwarding upstream frames from the V reference
         point to GEM ports based on the ingress V interface and any combination of S-VID and
         P-bits.

R-8   A GPON ONU entity MUST support forwarding downstream Ethernet frames GEM ports
         to a given V reference point interface based on GEM port

R-9   The GPON ONU entity and OLT MUST NOT prevent multiple P-bit values being used in
         the same VLAN.

R-10   The GPON ONU entity and OLT MUST NOT prevent multiple VLANs from using the
         same P bits.

R-11   The GPON ONU entity and the OLT MUST prevent direct layer 2 connectivity between
         users by default configuration. If layer 2 connectivity between users is supported, this
         behaviour MUST be configurable per S-VID.

Note: T-CONT types are purely conceptual. The behaviour of a real-world T-CONT is determined by its
provisioned traffic parameters, which do not include a type parameter.

R-12   The OLT and the GPON ONU entity MUST support at least four traffic classes for
         Ethernet frames, and MUST support configurable mapping to these classes based on an
         arbitrary combination of ingress V interface, S-VID and P-bit value.

R-13   The OLT MUST support T-CONT types 1, 2, 3 and 4, as defined in G.984.3. In the
         absence of higher priority claims on capacity, each T-CONT type MUST be able to use
         the full bandwidth available on the GPON.

September 2017   20 of 31

R-14   The OLT MUST support the extended traffic descriptor parameters P_i and ω_i These parameters MUST be configurable. In the absence of higher priority claims on capacity, each T-CONT MUST be able to use the full bandwidth available on the GPON.

R-15   The OLT and the GPON ONU entity SHOULD support at least six traffic classes for Ethernet frames, and MUST support configurable mapping to these classes based on an arbitrary combination of S-VID and P-bit value..

R-16   The OLT and the GPON ONU entity MUST support drop precedence within at least two upstream traffic classes and MUST support configurable mapping to these classes and drop precedence from the eight possible values of the Ethernet P bits.

R-17   The OLT and the GPON ONU entity MUST support drop precedence within all supported traffic classes based on the DEI bit value of the 802.1ad header.

R-18   The OLT and the GPON ONU entity SHOULD support scheduling of interface queues according to their assigned priority and weight. The number of priorities MUST be at least two; however multiple queues MAY be 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. This mechanism provides support for mapping diffserv per-hop behaviours (e.g. EF, AF, BE, LE) to Ethernet queues.

R-19   In the downstream direction, the GPON ONU entity MUST support at least four queues per V reference point interface, one per traffic class.

R-20   In the upstream direction, the GPON ONU entity MUST support at least four queues, one per traffic class.

R-21   The GPON ONU entity MUST support one queue (traffic class) per T-CONT.

R-22   For unicast traffic, the OLT and the ONU entity MUST support at least one bi-directional GEM port for each T-CONT configured for an ONU entity.

R-23   In the upstream direction, the OLT MUST support at least four queues per network facing port, one per traffic class.

R-24   In the downstream direction, the OLT MUST support at least four queues per PON, one per traffic class.

R-25   In the downstream direction, the GPON ONU entity SHOULD support at least six queues per V reference point interface, one per traffic class.

R-26   In the upstream direction, the GPON ONU entity SHOULD support at least six queues, one per traffic class.

R-27   In the upstream direction, the OLT SHOULD support at least six queues per network facing port, one per traffic class.

September 2017   21 of 31

R-28   In the downstream direction, the OLT SHOULD support at least six queues per PON, one per traffic class.

R-29   The OLT and GPON ONU entity MUST support scheduling of downstream queues according to strict priority between the supported traffic classes.

R-30   The OLT MUST support the scheduling of upstream queues according to strict priority between the supported traffic classes.

R-31   The OLT and ONU entity MUST support setting the maximum depth of all queues.

6 Multicast

6.1 Access node multicast

The TR-101 access node entity in a GPON-fed Ethernet access node adheres to TR-101 access node multicast requirements.

6.2 GPON ONU entity multicast

In a GPON system, downstream frames are visible to all ONU entities on the PON. Therefore, a GPON ONU entity must filter multicast frames arriving on the PON, accepting only multicast traffic that has been joined by that ONU entity's subscribers, as well as possible static (always-on) multicast groups. This means that the GPON ONU entity in a GPON-fed Ethernet access node must perform transparent IGMP snooping to maintain the multicast filtering tables associated with the PON interface.

The TR-101 access node entity replicates the multicast group to subscriber ports that have joined it, and therefore also requires an IGMP snooping function. The TR-101 access node entity may also be required to support snooping with proxy reporting.

6.3 OLT multicast

An OLT used as an Ethernet aggregation node may contain hundreds of ports serving access nodes. Regardless of whether these are Ethernet ports or GPON ports, each constitutes a possible branch for multicast frames. As with any large multicast branching point, the OLT is required to offer a snooping with proxy reporting service to limit IGMP traffic toward the multicast source.

6.4 Multicast requirements

GPON systems can greatly improve the efficiency of downstream bandwidth usage by transmitting a single multicast stream on the PON for all subscribers of that stream that are connected to the PON. To support this capability, the G.984 standards define the use of a single multicast GEM port on the PON.

R-32 The GPON network MUST be able to forward all multicast-VLAN traffic using a single downstream multicast GEM port.

R-33 The GPON ONU entity MUST support IGMP v3 transparent snooping on a per VLAN basis. Note: V3 includes support for previous versions of IGMP.

R-34 The OLT MUST support IGMP v3 snooping with proxy reporting. This feature MUST be configurable on a per VLAN basis.

R-35 The OLT MUST provide the following statistics.

Per VLAN, per multicast group:
   1.   Total number of currently active hosts

September 2017   23 of 31

Per multicast VLAN counters:
1. Current number of active groups (current reading, not a counter)
2. Total number of joins sent
3. Total number of joins received
4. Total number of successful joins
5. Total number of unsuccessful joins

6. Total number of leave messages
7. Total number of general queries sent
8. Total number of general queries received
9. Total number of specific queries sent
10. Total number of specific queries received
11. Total number of invalid IGMP messages received

Per V reference point interface, per multicast VLAN counters:
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
5. Total number of specific queries sent
6. Total number of invalid IGMP messages received

R-36 The IGMP v3 snooping function in the OLT and the GPON ONU entity MUST be able to dynamically create and delete MAC-level group filter entries on a per V reference point interface basis, enabling selective multicast forwarding from network-facing VLANs to user-facing ports.

R-37 Upon detecting topology changes, 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 indicates to the BNG that it needs to immediately send group-specific queries, which will populate the L2 multicast filters in the OLT, in order to speed up network convergence. For reference see RFC-4541.

R-38 The OLT MUST allow selection between transparent snooping and snooping with proxy reporting on a per-VLAN basis.

7   Forwarding information and loop detection (spanning tree)

7.1   GPON forwarding information and loop avoidance/removal

An access node can be used to subtend other access nodes via V interfaces. A ring topology may be used for connecting an arbitrary number or access nodes using two V interfaces of the ONU entity. Therefore, loop avoidance capability is required from OLT, on GEM ports connecting such rings of access nodes.

An OLT serving as an Ethernet aggregation node may contain numerous ports that exchange Ethernet frames with the service provider network. Since the interconnecting networks between the service provider and these ports may be complex, loop avoidance capability is required on network facing ports of the OLT.

In a GPON ONU entity, upstream frames arriving from the V interfaces can be forwarded only toward the PON. Conversely, frames arriving from the PON can be forwarded only toward the V interfaces. The ONU entity never forwards traffic between different V interfaces. Under these conditions loop avoidance is not required on the ONU entity.

7.2   Forwarding Information and Loop Detection Requirements

R-39   An OLT MUST support a minimum of two instances of multiple spanning tree, as per IEEE 802.1Q (2005).

R-40   The OLT MUST forward frames according to 802.1ad. This includes the per VLAN ability to disable MAC address learning and to tunnel customer BPDUs.

R-41   An OLT MUST support interworking with the Common Spanning Tree according to IEEE 802.1Q (2003).

R-42   An OLT MUST support Rapid Spanning Tree as per IEEE 802.1w.

R-43   An OLT MUST support link aggregation on its network facing ports as specified by IEEE 802.3ad to allow link resilience.

R-44   An OLT MUST support load balancing over IEEE 802.3ad aggregated links.

R-45   An OLT MUST be able to prioritize BPDUs in the data plane (by providing dedicated queues) and in the control plane (by providing dedicated CPU queues for BPDUs).

R-46   An OLT MUST be able to drop BPDUs if those BPDUs have a root bridge identifier that is lower (better) than the current spanning tree root. This function MUST be configurable on a per port basis.

R-47   The OLT MUST be able to drop BPDUs regardless of the BPDU content. This function MUST be configurable on a per Ethernet port basis.

September 2017   25 of 31

R-48   The OLT MUST support the disabling of MAC learning on a per VLAN basis. This
       MUST NOT prevent IGMP snooping from installing bridge table entries.

8   OAM

The required CFM entities differ between TR-156 and TR-167 based on the role of the OLT/ONT in the access network. In TR-156, the OLT/ONT is considered the Access Node. In TR-167, the OLT/ONT is considered to be the Aggregation Node.

8.1   Access Node OAM

The TR-101 access node entity in a GPON-fed Ethernet access node adheres to TR-101 defined access node OAM requirements. See Section 7.3.2/ TR-101.

Note: The diagrams in this section follow the IEEE convention of using the direction of MEP triangle objects to indicate if the MEP is an UP or Down MEP.
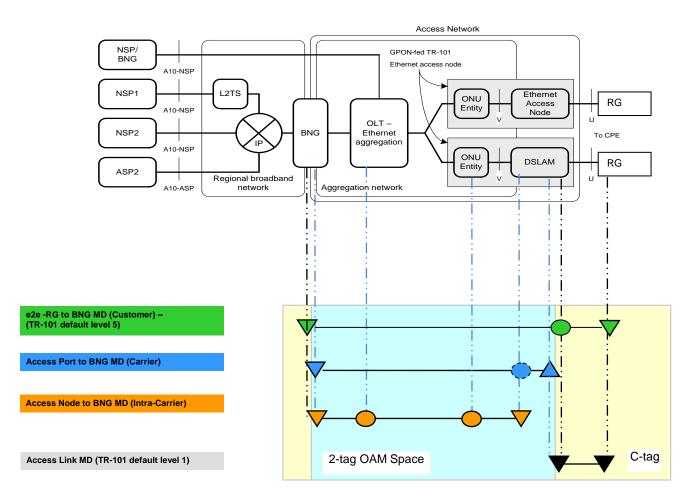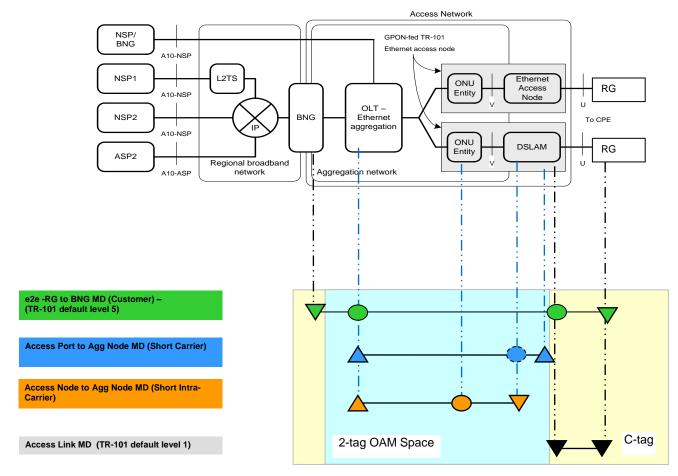

Figure 6 – Ethernet OAM model

Figure 7 – Ethernet OAM model - Wholesale

8.2   GPON ONU entity OAM requirements

The aggregation node can have maintenance points (MPs) at the intra-carrier and carrier levels.

R-49   The OLT SHOULD support rate limiting of received CFM Ethernet OAM messages arriving on all supported maintenance levels

R-50   A GPON ONU entity SHOULD support rate limiting of received CFM Ethernet OAM messages on all supported maintenance levels in the upstream direction.

8.2.1   Intra-carrier maintenance level

R-51   The OLT and the GPON ONU entity MUST support a maintenance association intermediate point (MIP) on a per Ethernet port and per S-VLAN basis.

R-52   The OLT and the GPON ONU entity MUST support a link trace reply (LTR) function for each MIP.

R-53   The OLT and the GPON ONU entity MUST support a loopback reply (LBR) function for each MIP

R-54   The OLT and GPON ONU entity SHOULD support receiving AIS messages from an inferior maintenance level MEP(s), if present, and send out an AIS message at the appropriate MIP level.

R-55   The OLT and GPON ONU entity SHOULD be able to support the use of a server MEP function (defined in Section 5.3.1/Y.1731) to report failure of a server layer and send out an AIS message at the next superior maintenance level.

R-56   The OLT SHOULD trigger the appropriate alarms for loss of continuity.

8.2.2   Short intra-carrier maintenance level (wholesale model)

R-308/TR-101 requires that the aggregation node support an inward-facing maintenance association end point (MEP) on a per network facing port and per S-VLAN basis. 802.1ag does not define or describe the term inward-facing. In TR-101 it is defined as the MEP facing toward the bridge. This would be an Up MEP. Figures in TR-101 all show down MEPs, but probably just were not aware of IEEE convention when TR-101 was written.
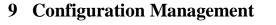
R-57   The OLT MUST support an Up maintenance association end point (MEP) on a per network facing port and per S-VLAN basis.

R-58   The OLT MUST support the function of initiating a loopback message (LBM) towards its peer MEPs and receiving the associated loopback reply (LBR), for the Up MEP on the network facing port.

R-59   The OLT MUST support the function of receiving a loopback message (LBM) from its peer MEPs and initiating the associated loopback reply (LBR), for the Up MEP on the network facing port.

R-60   The OLT MUST support the function of initiating a linktrace message (LTM) towards its peer MEPs and receiving the associated linktrace reply (LTR), for the Up MEP on the network facing port.

R-61   The OLT MUST support the function of receiving a linktrace message (LTM) from its peer MEPs and initiating the associated linktrace reply (LTR), for the Up MEP on the network facing port.

R-62   The OLT SHOULD support generating continuity check messages (CCMs) towards its peer MEPs for the Up MEP on the network facing port.

R-63   The OLT MUST support the ability to disable CCM messages for the MEP on the network facing port, while keeping the associated Up MEP active.

September 2017   29 of 31

R-64   The OLT SHOULD support a means to determine the MAC address of a remote MEP without relying on the reception of CCMs from this remote MEP. One possible way to accomplish the above is via the multicast LBM for point to point segments.

R-65   The OLT MUST support receiving AIS messages on the MEP on the network facing port (at a so-called inferior maintenance level) and sending out an AIS message at the next superior maintenance level across the network facing port.

R-66   The OLT SHOULD trigger the appropriate alarms for loss of continuity.

8.2.3   Short carrier maintenance level (wholesale model)

In addition to the requirements specified in short intra-carrier maintenance level, the following requirements apply to the short carrier maintenance level.

R-67   For 1:1 VLANs, the OLT node MUST support sending a multicast LBM toward its peer MEP.
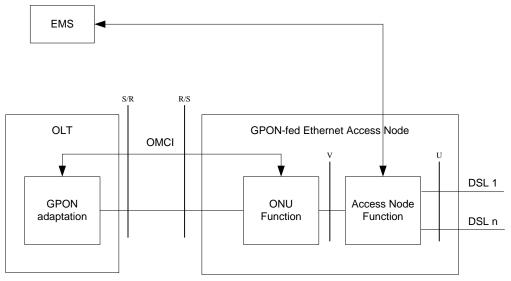
September 2017   30 of 31

9 Configuration Management

Figure 8 – Configuration Management for GPON-fed Ethernet Access Node

GPON-fed Ethernet access node configuration management is depicted by Figure 8. The GPON ONU entity is managed by OMCI, while the TR-101 access node entity, is managed by another protocol such as SNMP.

The data path for communications between the EMS and TR-101 access node entity typically goes in-band through the GPON, but the OLT and GPON ONU entity are not involved in the management of the TR-101 access node entity.

9.1 Configuration management requirements

R-68   All the configurable features of the GPON ONU entity defined in this Technical Report MUST only be managed via the OLT using OMCI and PLOAM as per G. 984

R-69   The GPON ONU entity MUST allow the TR-101 access node entity to be managed by a protocol other than OMCI independent of the OLT.

End of Broadband Forum Technical Report TR-167 Issue 3

September 2017   31 of 31