

TR-309

PON TC Layer Interoperability Test Plan

Issue: 3

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

Editors	Frank Van der Putten	Nokia
	Akiva Sadoski	Broadcom
Fiber Access Networks Work Area Directors	Marta Seda	Calix
Interoperability Test Project Stream Leader	Vincent Buchoux	LAN

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1 Executive Summary

Broadband Forum, after extending the G-PON conformance and interoperability test plans for service architecture to XG-PON and XGS-PON (TR-247 and TR-255), completes the document suite on PON technologies with HSP and 25GS-PON physical layer interoperability test plan. The scope of TR-309, Issue 3 is the verification of XG-PON, XGS-PON, 25GS-PON and HSP OLT and ONU interoperability with respect to the Physical Media Dependent (PMD) sub-layer (ITU-T G.987.2 [9], ITU-T G.9807.1 [12] Annex B, 25GS-PON [1], ITU-T G.9804.3 [15]) and the Transmission Convergence (TC) sub-layer (ITU-T G.987.3 [10], ITU-T G.9807.1 [12] Annex C, 25GS-PON [1], ITU-T G.9804.2 [14]). Note that much of the PMD layer testing is performed indirectly, as a result of testing the TC layer. Specific PMD layer test cases are covered in TR-423 [5].

2 Purpose and Scope

2.1 Purpose

TR-309 Issue 3 defines a set of test cases whose purpose is to verify interoperability between an XG-PON, XGS-PON, 25GS-PON or HSP OLT and an ONU. These test cases address the Physical Media Dependent (PMD) sub-layer (ITU-T G.987.2 [9], ITU-T G.9807.1 [12] Annex B, 25GS-PON [1], ITU-T G.9804.3 [15]) and the Transmission Convergence (TC) sub-layer (ITU-T G.987.3 [10], ITU-T G.9807.1 [12] Annex C, 25GS-PON [1], ITU-T G.9804.2 [14]). Executing these test cases as part of a multi-supplier test event will help OLT and ONU's implementation of the specifications operate as a functional system.

Successfully completing these tests requires that any configurations required will be accomplished through documented EMS interfaces that are typically accessible to provisioning and operations staff and through standards based OLT/ONU communications (i.e., PLOAM, OMCI). This requirement is not enforced for test events focusing on the functionality of the lower layers of the protocol.

The tests are partitioned to two categories:

1. Basic TC layer tests - which focus on the frame structure and isolated TC layer functions
2. Comprehensive TC layer tests - which are oriented towards a more comprehensive TC layer behavior

TR-309 Issue 33 adds tests for the 25GS-PON and HSP TC-layer interoperability.

2.2 Scope

The test cases specified in TR-309, Issue 3 are focused on exploring multi-supplier interoperability at the XG-PON/XGS-PON/25GS-PON/HSP PMD and TC sub-layer level of XG-PON/XGS-PON/25GS-PON/HSP systems or XG-PON/XGS-PON/25GS-PON/HSP test platforms. The test cases are written to allow for the participation of prototype XG-PON/XGS-PON/25GS-PON/HSP implementations, which may not have complete ITU-T G.987.x/ITU-T G.9807.1/25GS-PON/ITU-T G.9804.x functionality. The test cases provided in the body of TR-309, Issue 3 provide a minimum set of PMD and TC sub-layer interoperability tests and are not an exhaustive set of PMD and TC sub-layer test cases. Other supplemental test cases may optionally be executed as part of any interoperability test event. The focus of the tests provided in TR-309, Issue 3 are on interoperability and not conformance, i.e., checking the operation of multiple vendor equipment with each other from PMD and TC layer perspective rather than exhaustive functional test of the behavior of the equipment, as is, or connected to some “golden” opponent device.

TR-309, Issue 3 contains test cases for features and capabilities that are optional according to ITU-T G.987.x/ITU-T G.9807.1/25GS-PON/ITU-T G.9804.x. Test status of such cases is labeled as “conditional”. Only features and capabilities claimed to be supported by both the OLT and the ONU are to be tested.

3 References and Terminology

3.1 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 in RFC 2119 [6].

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.

3.2 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] 25GS-PON	<i>25 Gigabit Symmetric Passive Optical Network (25GS-PON / 25G TDM PON) Specification (11/23)</i>	25GS-PON MSA	2023
[2] OD-247 / [3] IR-247	<i>G-PON ONU Conformance Test Plan</i>	BBF	2011
[4] TR-255	<i>G-PON Interoperability Test Plan</i>	BBF	2011
[5] TR-423	<i>PON PMD Layer Conformance Test Plan</i>	BBF	2018
[6] RFC 2119	<i>Key words for use in RFCs to Indicate Requirement Levels</i>	IETF	1997
[7] G.987	<i>10-Gigabit-capable passive optical network (XG-PON) systems: Definitions, abbreviations and acronyms (06/12)</i>	ITU-T	2012
[8] G.987.1	<i>10-Gigabit-capable passive optical networks (XG-PON): General requirements (01/10)</i>	ITU-T	2010
[9] G.987.2	<i>10-Gigabit-capable passive optical networks (XG-PON): Physical media dependent (PMD) layer specification (02/16)</i>	ITU-T	2016
[10] G.987.3	<i>10-Gigabit-capable passive optical networks (XG-PON): Transmission convergence (TC) layer specification (01/14)</i>	ITU-T	2014
[11] G.988	<i>ONU Management and Control Interface Specification (OMCI) (10/12)</i>	ITU-T	2012
[12] G.9807.1	<i>10-Gigabit-capable symmetric passive optical network (XGS-PON) (06/16)</i>	ITU-T	2016
[13] G.988 Amd.1	<i>Recommendation G.988 (2012) Amendment 1 (05/14)</i>	ITU-T	2014
[14] G.9804.2 Amd. 1	<i>Higher speed passive optical networks – Common transmission convergence layer specification</i>	ITU-T	2023
[15] G.9804.3	<i>50-Gigabit-capable passive optical networks (50G-PON): Physical media dependent (PMD) layer specification</i>	ITU-T	2021

3.3 Definitions

The following terminology is used throughout this Technical Report.

Alien ONU	Alien ONU is an ONU which does not transmit valid PON PSBu pattern. It is a light source transmitting at the same wavelength as regular ONUs connected on the PON causing disturbances. In most cases, it will be a P2P ONU connected to ODN.
Alloc-ID	14-bit number field that indicates the recipient of the bandwidth allocation, i.e., a particular T-CONT or an upstream OMCC within an ONU.
Ethernet Traffic Generator	A device that generates and captures well-formed Ethernet frames as defined by test personnel.
ONU-ID	ONU-ID is a 10-bit identifier that the OLT assigns to an ONU during the ONU's activation using the PLOAM messaging channel. The ONU-ID is unique across the PON.
Optical Distribution Network (ODN)	Optical Distribution Network including the fibers, splitters and connectors.
Optical Line Termination (OLT)	A device that terminates the common (root) endpoint of an ODN, implements a PON protocol, such as that defined by G.987, 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.
Optical Network Unit (ONU)	Optical Network Unit (ONU): A generic term denoting a 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.
Optical test equipment	An external device, which may be included in a non-intrusive manner, between the R/S and S/R-interfaces to capture and/or analyze the signals and the traffic present in the ODN.
PON-TAG	An 8-byte static identity of the OLT PON port that is chosen by the Operator. PON-TAG is recommended to be unique within the operator's domain and fixed for the lifetime of the system.

Port-ID	See XGEM Port-ID
Traffic Flow	A sequence of frames or packets traversing a particular reference point within a network that share a specific frame/packet header pattern. For example, an Ethernet traffic flow can be identified by any combination of specific source MAC address, destination MAC, VLAN ID, 802.1p bits, etc.
Vendor-ID	ONU Vendor-ID code, a four-character combination discovered at SN acquisition.
XGEM	A data frame transport scheme used in XG-PON systems that is connection-oriented and that supports fragmentation of user data frames into variable sized transmission fragments.
XGEM Port	An abstraction on the XGTC adaptation sublayer representing a logical connection associated with a specific client traffic flow.
XGEM Port-ID	A 16-bit number that is assigned by the OLT to an individual logical connection transported over the XG-PON interface and which is carried in the header of all the XGEM frames associated with the given logical connection.
XGTC	The XGTC adaptation sublayer is a sublayer of the XG-PON Transmission Convergence (XGTC) layer that supports the functions of user data fragmentation and de-fragmentation, XGEM encapsulation, XGEM frame delineation, and XGEM Port-ID filtering. Further in the document both ITU-T G.987.x/ITU-T G.9807.1/25GS-PON XGTC sublayer and ITU-T G.9804.x CommTC sublayer will be denoted XGTC.

3.4 Abbreviations

This Technical Report uses the following abbreviations:

25GS-PON	25 Gigabit Symmetric Passive Optical Network [1]
AES	Advanced Encryption Standard
DBA	Dynamic Bandwidth Assignment
DBR	Dynamic Bandwidth Report
DOWi	Drift of Window for ONU i
FEC	Forward Error Correction
FWI	Forced Wakeup Indication
HEC	Hybrid Error Correction
HSP	Higher Speed PON
KEK	Key Encryption Key
LODS	Loss of Downstream Synchronization
MAC	Media Access Control
MDU	Multi-Dwelling Unit
ME	Managed Entity
MIC	Message Integrity Check
MSK	Master Session Key
OAM	Operations, Administration and Maintenance
ODN	Optical Distribution Network – as defined in G.987.1 [8]
OLT	Optical Line Termination – as defined in G.987.1
OMCI	ONU Management and Control Interface – as defined in G.988 [11]
OMCC	ONU Management and Control Channel
ONT	Optical Network Termination – as defined in G.987.1
ONU	Optical Network Unit – as defined in G.987.1
PLOAM	Physical Layer OAM
PLI	Payload Length Indication
PMD	Physical Media Dependent Layer
TDM	Time-Division Multiplexing
TR	Technical Report
TIWi	Transmission Interference Warning for ONU i
ToD	Time of Day
VSSN	Vendor Specific Serial Number
XGEM	XG-PON/XGS-PON/NG-PON2/25GS-PON/HSP Encapsulation Method
XG-PON	10-Gigabit-capable Passive Optical Network, ITU-T G.987.x-series
XGS-PON	10-Gigabit-capable Symmetric Passive Optical Network, ITU-T G.9807.1

XGTC	XG-PON/XGS-PON/NG-PON2/25GS-PON/HSP Transmission Convergence (protocol layer) – as defined in G.987.3 [10]
ρ_0	Fundamental rate of the system, from which any actual line rate in either downstream or upstream direction is obtained as an integer multiple (HSP).
φ_0	Line rate factor used to obtain the full nominal line rate in the system as defined in G.9804.2 [15].

4 Technical Report Impact

4.1 Energy Efficiency

TR-309 has no impact on energy efficiency.

4.2 IPv6

TR-309 has no impact on IPv6.

4.3 Security

TR-309 has no impact on security.

4.4 Privacy

Any issues regarding privacy are not affected by TR-309.

5 Test Configuration and Equipment

5.1 General

This section specifies baseline test setup and parameters, common to all test cases except where noted otherwise.

At early interoperability test stage, verification of MIC for PLOAM and OMCI messages and HEC should be optionally disabled by receivers. Correct values should still be generated by transmitters, if possible.

5.2 Basic TC Layer Test Setup

The following setup is used for single ONU tests:

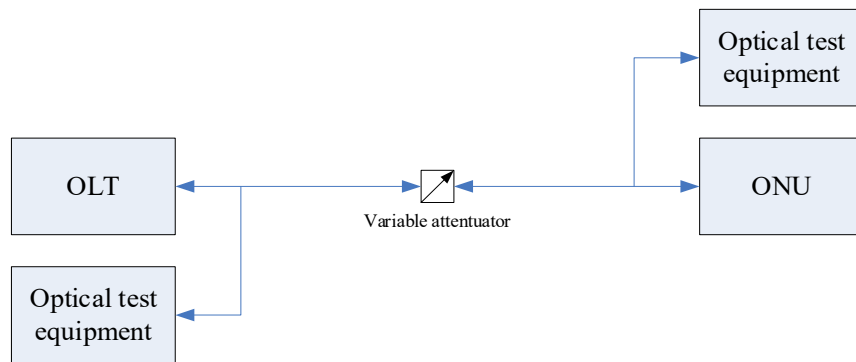


Figure 1 - Basic TC Layer Test Setup

A spool of fiber of 20 km is optionally added between the OLT and ONU.

5.3 Ethernet Traffic Test Setup

The following setup is used for single ONU tests requiring Ethernet traffic:

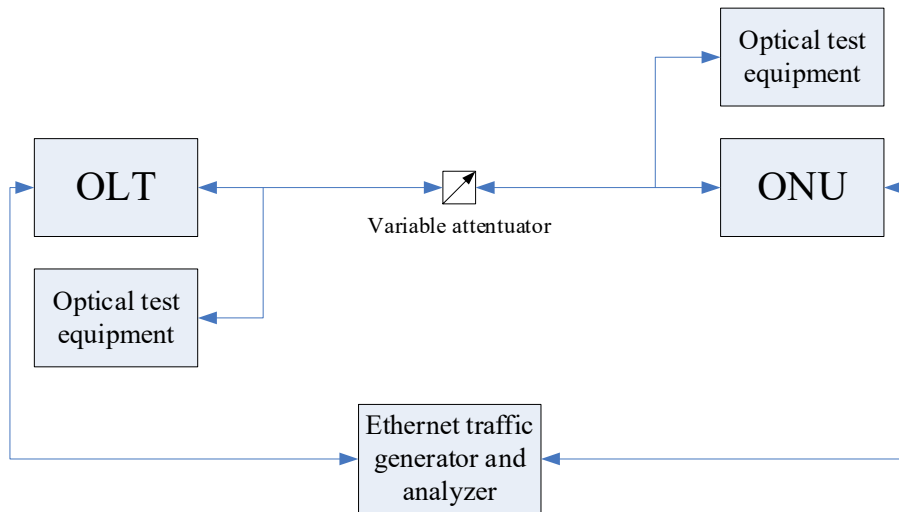


Figure 2 – Ethernet Traffic Test Setup

Both Ethernet traffic generator and analyzer should support 50G/25G/12.5G/10G/1G bitrates.

Exact configuration of the Ethernet interfaces is to be coordinated using the OMCI model below. TP-247 sequences shall be used.

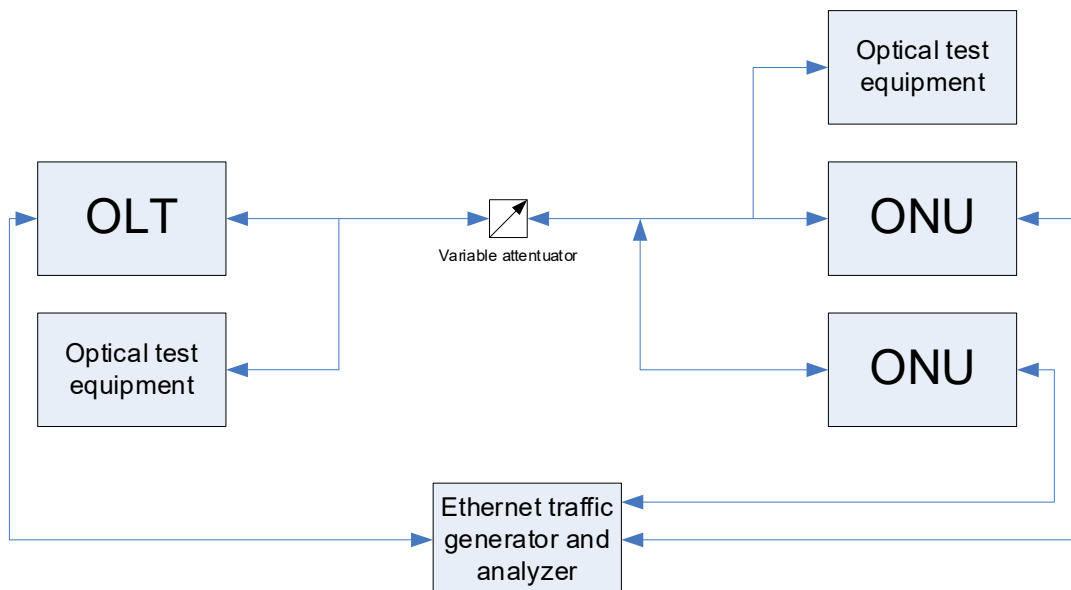


Figure 3 – Multiple ONU Test Setup with Ethernet Traffic

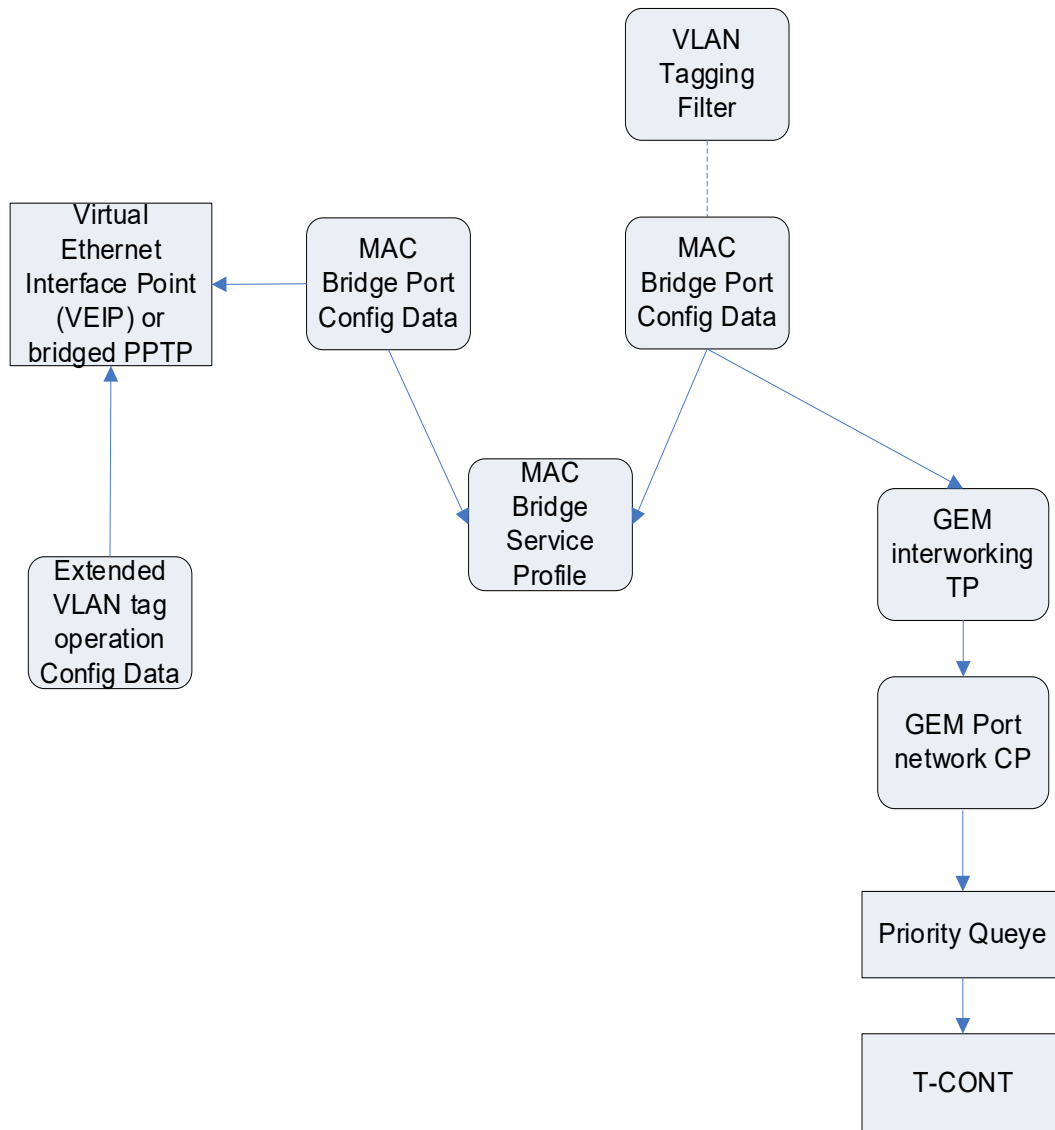


Figure 4 – OMCI Model for Ethernet Traffic Tests

5.4 Multiple ONU Test Setup

This setup is geared to more advanced tests. It is suggested that the basic configuration includes one ONU supplied by the OLT vendor, and another ONU supplied by another vendor. Complex configuration can include several ONUs, possibly at various distances.

During these tests, a spool of fiber of 20 km is optionally used in front of one ONU and none shall be used in front of the other ONU.

Both Ethernet traffic generator and analyzer should support 50G/25G/12.5G/10G/1G bitrates.

5.5 PMD Parameters for TC Layer Tests

The focus of TR-309, Issue 3 is the TC layer and the main role of the PMD layer to is to enable TC layer tests. Transmission power should be within the limits defined in ITU-T G.987.2/ITU-T G.9807.1 Annex B/25GS-PON/ITU-T G.9804.3 and receiver sensitivity can be anywhere within the defined range.

For TC layer tests, optimal parameters shall be implemented by the PMD layer to maintain interoperability. For instance, transceivers must meet the wavelength plans so to be able to work with each other. Sufficient optical budget, extinction ratio and jitter budget to qualify each one of the setups described in this section are required.

For all TC layer tests, the optics should be adjusted via the variable attenuators so that they are in the middle of their operating range, with reasonable differential distance when two ONUs are involved.

5.5.1 Strict Parameter Set

This is a stricter set of parameters, intended to reduce the overhead and allow better utilization of the upstream bandwidth. These parameters are limited by system components such as optical modules, and are at the discretion of the OLT vendor.

5.5.2 Relaxed Parameter Set

This is a set of relaxed parameters, so it would not be stressful for any OLT or ONU to meet. It might be used at initial interoperability test events. The following values are recommended, but can be changed if required by the OLT or the ONU:

Parameters for upstream FEC off:

- Profile index: 0
- Delimiter length: 8 octets
- Delimiter value: 0xCE99 CE5E 5028 B41F
- Preamble length: 8 octets
- Preamble repeat count/Preamble word count (HSP):

- 16 for 2.5G upstream
- 32 for 10G/12.5G/25G upstream
- Preamble value: 0xAAAA AAAA AAAA AAAA
- HSP:
 - Codepoint – as specified in G.9804.2 [14] for corresponding upstream rate
 - ONURssiMin – 0x00
 - ONURssiMax – 0x00

Those parameters are set by the OLT using “profile” PLOAM message and referred within TR-309, Issue 3 as burst profile number 0.

Parameters for upstream FEC on:

- Profile index: 1
- Delimiter length: 8 octets
- Delimiter value: 0xB3BD D310 B2C5 0FA1
- Preamble length: 8 octets
- Preamble repeat count:
 - 16 for 2.5G upstream
 - 32 for 10G/12.5G/25G(HSP) upstream
 - 256 for 25G(25GS-PON) upstream
- Preamble value: 0xAAAA AAAA AAAA AAAA

These parameters are set by the OLT using “profile” PLOAM message and referred within TR-309, Issue 3 as burst profile number 1.

Upstream line rate capability reporting:

- For XG-PON and XGS-PON: a bitmap of the form HL indicating the ONU’s upstream line rate capability, where
 - L - set to 1 if upstream rate 2.5G is supported
 - H - set to 1 if upstream rate 10G is supported
- For HSP: a bitmap of the form ABCL indicating the ONU’s upstream line rate capability, where
 - A - set to 1 if upstream rate $\rho_0\phi_0$ is supported
 - B - set to 1 if upstream rate $\rho_0\phi_1$ is supported
 - C - set to 1 if upstream rate $\rho_0\phi_2$ is supported
 - L - always 0

For the multi-ONU single rate test scenario all ONUs operate using the same upstream rate.

Mixed rate test scenario:

- For XG-PON/XGS-PON/25GS-PON, for mixed rate test scenario at least one ONU operates at 10G upstream rate and at least one ONU operates at 2.5G for XGS-PON, and at least one ONU operates at 10G upstream rate and at least one ONU operates at 25G upstream rate for 25GS-PON. Multiple tests should be performed with different upstream rate for the “first ONU”.
- For HSP, for mixed rate test scenario at least two different rates of either 50G, 25G or 12.5G should be used. Multiple tests should be performed with different upstream rates for the “first ONU”.

For HSP, a non-default cryptographic method will be set via OMCI, by configuring ONU2-G ME, Security mode attribute.

5.5.3 Equipment Requirements

The following equipment is required to execute the test cases in this plan:

- At least one variable attenuator per ODN. The variable attenuators should cover the range of 0-40 dB
- Optical test equipment, including at least one power meter per OLT/ONU
- Ethernet generator and analyzer containing at least two data interfaces

Additional equipment might be included in the test setup:

- 20 km & 40 km spools of fiber
- XG-PON/XGS-PON/25GS-PON/HSP analyzer
- Optical splitter

5.6 Basic Tracing and Troubleshooting Facilities

In order to aid troubleshooting and help efficient testing, it is recommended that the OLT and ONU provide basic tracing information. Examples of such information are:

- OLT and ONU state
- Sent and received PLOAM messages: ONU-ID and contents in hexadecimal format. Ideally, also a parsed version of the message.
- Received XGEM frames: Port-ID and PLI
- Number of sent and received bandwidth allocations
- Number of sent and received XGEM frames and bytes
- Number of sent and received FEC frames and FEC errors
- Number of HEC errors in XGTC/FS header

- Number of HEC errors in bandwidth allocation structures
- Number of HEC errors in XGEM header
- Time of day timestamps
- Count and content of sent and received OMCI messages
- Count and type of errors found in the received stream

5.7 Alien ONU Test Configuration

The following setup is used for the Alien ONU test:

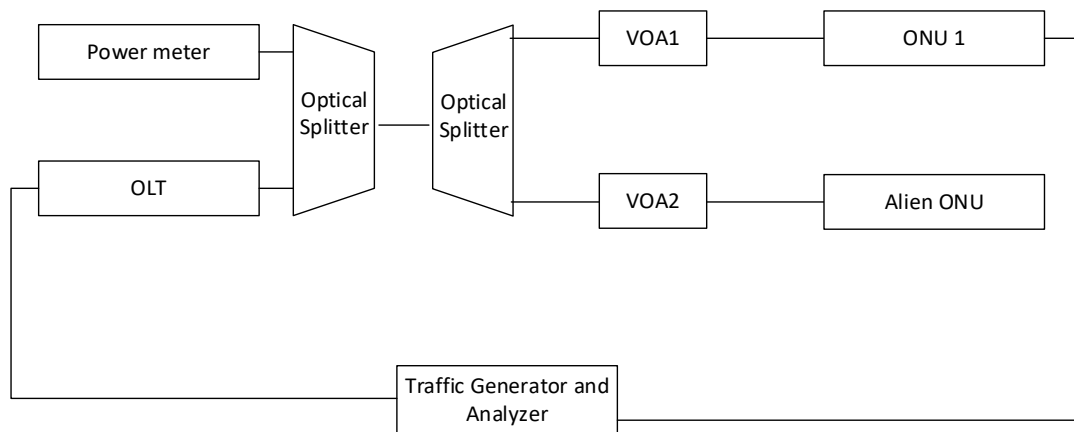


Figure 5 – Alien ONU detection and resilience to alien ONU test set-up

6 Test Case Summary

6.1 General

This section contains a summary of PMD and TC Layer tests, as applicable to different use cases. Tests are partitioned to test sets according to OLT downstream and upstream line rate combinations. XG-PON systems are expected to comply with the 10G/2.5G test set. XGS-PON systems are expected to comply with both 10G/10G and 10G/10G+2.5G TDMA Coexistence test sets. XGS-PON systems in “PON green field” scenarios are only expected to comply with the 10G/10G test set. 25GS-PON systems are expected to comply with the 25G/25G and 25G/10G test sets. HSP systems are expected to comply with the 50G/12.5G, 50G/25G and 50G/50G test sets.

Test cases are labeled:

- **Mandatory** – for features and capabilities that are mandatory according to G.987.x/G.9807.1/25GS-PON /G.9804
- **Conditionally Mandatory** - for features and capabilities that are optional according to G.987.x/G.9807.1/25GS-PON /G.9804.x These cases are to be tested only if claimed to be supported by both the OLT and the ONU.

6.1.1 Test Set Passing Criteria

For the purpose of determining a summary result, such as indicating the OLT and ONU pair is interoperable

- The pair SHALL pass all Mandatory tests for the selected/applicable test sets
- The pair SHALL pass all Conditionally Mandatory tests claimed to be supported by both the OLT and the ONU.

6.2 XG-PON and XGS-PON Basic TC Layer Tests

	Test Set		
Test Name	10G/2.5G	10G/10G	10G/10G+2.5G TDMA Coexistence
ONU Start-up	Test Section		
7.1.1 ONU Discovery - Single ONU (cold OLT, cold ONU)	Mandatory	Mandatory	N/A
7.1.2 ONU Activation – Single ONU	Mandatory	Mandatory	N/A

7.1.3 ONU Discovery – Multiple ONUs (warm PON)	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)
7.1.4 ONU Activation – Multiple ONUs without Data Transmission	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)
7.1.5 ONU Discovery – Multiple ONUs (cold OLT, cold ONUs)	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)
7.1.6 ONU Discovery and Activation during Data Transmission	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)
7.1.7 Differential Reach Operation	Mandatory (DD40)	Mandatory (DD20)	Conditionally Mandatory (DD40+DD20)
7.1.8 ONU Discovery at explicitly assigned Alloc-ID - Single ONU (cold OLT, cold ONU)	N/A	N/A	N/A
7.1.9 ONU Activation at explicitly assigned Alloc-ID – Single ONU	N/A	N/A	N/A
Bandwidth Allocation	Test Section		
7.2.1 Single Allocation	Mandatory	Mandatory	N/A
7.2.2 Repetitive Allocation	Mandatory	Mandatory	N/A
7.2.3 Burst Series	Mandatory	Mandatory	N/A
7.2.4 Maximal Allocation	Mandatory	Mandatory	N/A
7.2.5 Allocations to Different ONUs	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)
7.2.6 Adjacent Allocations to Different ONUs	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)
Embedded OAM Operation	Test Section		
7.3.1 PON-ID / Operation Control	Mandatory	Mandatory	Mandatory
7.3.2 Dying Gasp	Mandatory	Mandatory	Mandatory
7.3.3 PLOAM Queue Status	Mandatory	Mandatory	Mandatory

7.3.4 Dynamic Bandwidth Reporting	Mandatory	Mandatory	Mandatory
PLOAM Channel Operation	Test Section		
7.4.1 Multiple PLOAM Messages per Frame	Conditionally Mandatory for OLT, Mandatory for ONU	Conditionally Mandatory for OLT, Mandatory for ONU	Conditionally Mandatory for OLT, Mandatory for ONU
7.4.2 Burst Profile Version Changes – Single ONU	Mandatory	Mandatory	N/A
7.4.3 Burst Profile Version Changes – Mixed Rate	N/A	N/A	Mandatory
7.4.4 ONU Deactivation and Disable SN	Mandatory	Mandatory	Mandatory
7.4.5 Alloc-ID Allocation and De-allocation	Mandatory	Mandatory	Mandatory
7.4.6 Encryption Key Exchange	Mandatory	Mandatory	Mandatory
Forward error correction	Test Section		
7.5.1 Downstream FEC Operation	Mandatory	Mandatory	Mandatory
7.5.2 Upstream FEC Operation – Integral Multiple of Codeword Size	Mandatory	Mandatory	N/A
7.5.3 Upstream FEC Operation – Non-Integral Multiple of Codeword Size	Mandatory	Mandatory	N/A
7.5.4 Upstream FEC Operation – Burst Series with Shared Parity Words	Mandatory	Mandatory	N/A
7.5.5 Upstream FEC Operation – Mixed FEC and No-FEC Accesses – Multiple ONUs – Single Rate	Mandatory	Mandatory	N/A
7.5.6 Upstream FEC Operation – Multiple Rate	N/A	N/A	Mandatory

Data transmission	Test Section		
7.6.1 OMCI Channel Establishment	Mandatory	Mandatory	N/A
7.6.2 OMCI Channel Establishment – Multiple ONUs	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)
7.6.3 Downstream Encryption Operation	Mandatory	Mandatory	Mandatory
7.6.4 Upstream Encryption Operation	Mandatory	Mandatory	N/A
7.6.5 Downstream Ethernet Traffic Transmission	Mandatory	Mandatory	N/A
7.6.6 Upstream Ethernet Traffic Transmission	Mandatory	Mandatory	N/A
7.6.7 Bidirectional Ethernet Traffic Transmission	Mandatory	Mandatory	N/A
7.6.8 Multiple Port-ID/Alloc-ID Data Transmission – Single ONU	Mandatory	Mandatory	N/A
7.6.9 Bidirectional Ethernet Traffic Transmission – Multiple ONUs	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)
7.6.10 Downstream Interleave State Change during Bidirectional Ethernet Traffic Transmission	N/A	N/A	N/A
7.6.11 Cross Alloc ID busy indication	N/A	N/A	N/A
7.6.12 Contention-based functions – ONU idle support	N/A	N/A	N/A

6.3 25GS-PON Basic TC Layer Tests

	Test Set	
Test Name	25G/10G	25G/25G
ONU Start-up	Test Section	
7.1.1 ONU Discovery - Single ONU (cold OLT, cold ONU)	Mandatory	Mandatory
7.1.2 ONU Activation – Single ONU	Mandatory	Mandatory
7.1.3 ONU Discovery – Multiple ONUs (warm PON)	Mandatory (single rate)	Mandatory (single rate)
7.1.4 ONU Activation – Multiple ONUs without Data Transmission	Mandatory (single rate)	Mandatory (single rate)
7.1.5 ONU Discovery – Multiple ONUs (cold OLT, cold ONUs)	Mandatory (single rate)	Mandatory (single rate)
7.1.6 ONU Discovery and Activation during Data Transmission	Mandatory (single rate)	Mandatory (single rate)
7.1.7 Differential Reach Operation	Mandatory (DD20)	Mandatory (DD20)
7.1.8 ONU Discovery at explicitly assigned Alloc-ID - Single ONU (cold OLT, cold ONU)	N/A	N/A
7.1.9 ONU Activation at explicitly assigned Alloc-ID – Single ONU	N/A	N/A
Bandwidth Allocation	Test Section	
7.2.1 Single Allocation	Mandatory	Mandatory
7.2.2 Repetitive Allocation	Mandatory	Mandatory
7.2.3 Burst Series	Mandatory	Mandatory
7.2.4 Maximal Allocation	Mandatory	Mandatory
7.2.5 Allocations to Different ONUs	Mandatory (single rate)	Mandatory (single rate)
7.2.6 Adjacent Allocations to Different ONUs	Mandatory (single rate)	Mandatory (single rate)
Embedded OAM Operation	Test Section	
7.3.1 PON-ID / Operation Control	Mandatory	Mandatory
7.3.2 Dying Gasp	Mandatory	Mandatory

7.3.3 PLOAM Queue Status	Mandatory	Mandatory
7.3.4 Dynamic Bandwidth Reporting	Mandatory	Mandatory
PLOAM Channel Operation	Test Section	
7.4.1 Multiple PLOAM Messages per Frame	Conditionally Mandatory for OLT, Mandatory for ONU	Conditionally Mandatory for OLT, Mandatory for ONU
7.4.2 Burst Profile Version Changes – Single ONU	Mandatory	Mandatory
7.4.3 Burst Profile Version Changes – Mixed Rate	N/A	N/A
7.4.4 ONU Deactivation and Disable SN	Mandatory	Mandatory
7.4.5 Alloc-ID Allocation and De-allocation	Mandatory	Mandatory
7.4.6 Encryption Key Exchange	Mandatory	Mandatory
Forward error correction	Test Section	
7.5.1 Downstream FEC Operation	Mandatory	Mandatory
7.5.2 Upstream FEC Operation – Integral Multiple of Codeword Size	Mandatory	Mandatory
7.5.3 Upstream FEC Operation – Non-Integral Multiple of Codeword Size	Mandatory	Mandatory
7.5.4 Upstream FEC Operation – Burst Series with Shared Parity Words	Mandatory	Mandatory
7.5.5 Upstream FEC Operation – Mixed FEC and No-FEC Accesses – Multiple ONUs – Single Rate	N/A	N/A
7.5.6 Upstream FEC Operation – Multiple Rate	N/A	N/A
Data transmission	Test Section	
7.6.1 OMCI Channel Establishment	Mandatory	Mandatory
7.6.2 OMCI Channel Establishment – Multiple ONUs	Mandatory (single rate)	Mandatory (single rate)
7.6.3 Downstream Encryption Operation	Mandatory	Mandatory
7.6.4 Upstream Encryption Operation	Mandatory	Mandatory
7.6.5 Downstream Ethernet Traffic Transmission	Mandatory	Mandatory
7.6.6 Upstream Ethernet Traffic Transmission	Mandatory	Mandatory

7.6.7 Bidirectional Ethernet Traffic Transmission	Mandatory	Mandatory
7.6.8 Multiple Port-ID/Alloc-ID Data Transmission – Single ONU	Mandatory	Mandatory
7.6.9 Bidirectional Ethernet Traffic Transmission – Multiple ONUs	Mandatory (single rate)	Mandatory (single rate)
7.6.10 Downstream Interleave State Change during Bidirectional Ethernet Traffic Transmission	N/A	N/A
7.6.11 Cross Alloc ID busy indication	N/A	N/A
7.6.12 Contention-based functions – ONU idle support	N/A	N/A

6.4 HSP Basic TC Layer Tests

	Test Set			
Test Name	50G/12.5G	50G/25G	50G/50G	50G/12.5G+25G+50G Refer to section 5.5.2 for mixed rate tests definition
ONU Start-up	Test Section			
7.1.1 ONU Discovery - Single ONU (cold OLT, cold ONU)	Mandatory	Mandatory	Mandatory	N/A
7.1.2 ONU Activation – Single ONU	Mandatory	Mandatory	Mandatory	N/A
7.1.3 ONU Discovery – Multiple ONUs (warm PON)	Mandatory (single rate)	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)
7.1.4 ONU Activation – Multiple ONUs without Data Transmission	Mandatory (single rate)	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)

7.1.5 ONU Discovery – Multiple ONUs (cold OLT, cold ONUs)	Mandatory (single rate)	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)
7.1.6 ONU Discovery and Activation during Data Transmission	Mandatory (single rate)	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)
7.1.7 Differential Reach Operation	Mandatory (DD40)	Mandatory (DD20)	Mandatory (DD20)	Conditionally Mandatory (DD40+DD20)
7.1.8 ONU Discovery at explicitly assigned Alloc-ID - Single ONU (cold OLT, cold ONU)	Mandatory	Mandatory	Mandatory	N/A
7.1.9 ONU Activation at explicitly assigned Alloc-ID – Single ONU	Mandatory	Mandatory	Mandatory	N/A
Bandwidth Allocation	Test Section			
7.2.1 Single Allocation	Mandatory	Mandatory	Mandatory	N/A
7.2.2 Repetitive Allocation	Mandatory	Mandatory	Mandatory	N/A
7.2.3 Burst Series	Mandatory	Mandatory	Mandatory	N/A
7.2.4 Maximal Allocation	Mandatory	Mandatory	Mandatory	N/A
7.2.5 Allocations to Different ONUs	Mandatory (single rate)	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)
7.2.6 Adjacent Allocations to Different ONUs	Mandatory (single rate)	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)

Embedded OAM Operation	Test Section			
7.3.1 PON-ID / Operation Control	Mandatory	Mandatory	Mandatory	Mandatory
7.3.2 Dying Gasp	Mandatory	Mandatory	Mandatory	Mandatory
7.3.3 PLOAM Queue Status	Mandatory	Mandatory	Mandatory	Mandatory
7.3.4 Dynamic Bandwidth Reporting	Mandatory	Mandatory	Mandatory	Mandatory
PLOAM Channel Operation	Test Section			
7.4.1 Multiple PLOAM Messages per Frame	Conditionally Mandatory for OLT, Mandatory for ONU	Conditionally Mandatory for OLT, Mandatory for ONU	Conditionally Mandatory for OLT, Mandatory for ONU	Conditionally Mandatory for OLT, Mandatory for ONU
7.4.2 Burst Profile Version Changes – Single ONU	Mandatory	Mandatory	Mandatory	N/A
7.4.3 Burst Profile Version Changes – Mixed Rate	N/A	N/A	N/A	Mandatory
7.4.4 ONU Deactivation and Disable SN	Mandatory	Mandatory	Mandatory	Mandatory
7.4.5 Alloc-ID Allocation and De-allocation	Mandatory	Mandatory	Mandatory	Mandatory
7.4.6 Encryption Key Exchange	Mandatory	Mandatory	Mandatory	Mandatory
Forward error correction	Test Section			
7.5.1 Downstream FEC Operation	Mandatory	Mandatory	Mandatory	Mandatory

7.5.2 Upstream FEC Operation – Integral Multiple of Codeword Size	N/A	N/A	N/A	N/A
7.5.3 Upstream FEC Operation – Non-Integral Multiple of Codeword Size	Mandatory	Mandatory	Mandatory	N/A
7.5.4 Upstream FEC Operation – Burst Series with Shared Parity Words	Mandatory	Mandatory	Mandatory	N/A

7.5.5 Upstream FEC Operation – Mixed FEC and No-FEC Accesses – Multiple ONUs – Single Rate	Mandatory	Mandatory	Mandatory	N/A
7.5.6 Upstream FEC Operation – Multiple Rate	N/A	N/A	N/A	Mandatory
Data transmission	Test Section			
7.6.1 OMCI Channel Establishment	Mandatory	Mandatory	Mandatory	N/A
7.6.2 OMCI Channel Establishment – Multiple ONUs	Mandatory (single rate)	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)
7.6.3 Downstream Encryption Operation	Mandatory	Mandatory	Mandatory	Mandatory
7.6.4 Upstream Encryption Operation	Mandatory	Mandatory	Mandatory	N/A
7.6.5 Downstream Ethernet Traffic Transmission	Mandatory	Mandatory	Mandatory	N/A
7.6.6 Upstream Ethernet Traffic Transmission	Mandatory	Mandatory	Mandatory	N/A
7.6.7 Bidirectional Ethernet Traffic Transmission	Mandatory	Mandatory	Mandatory	N/A
7.6.8 Multiple Port-ID/Alloc-ID Data	Mandatory	Mandatory	Mandatory	N/A

Transmission – Single ONU				
7.6.9 Bidirectional Ethernet Traffic Transmission – Multiple ONUs	Mandatory (single rate)	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)
7.6.10 Downstream Interleave State Change during Bidirectional Ethernet Traffic Transmission	Mandatory	Mandatory	Mandatory	N/A
7.6.11 Cross Alloc ID busy indication	Mandatory	Mandatory	Mandatory	N/A
7.6.12 Contention-based functions – ONU idle support	Mandatory	Mandatory	Mandatory	N/A

Test cases 7.5.2 – 7.5.6 can be executed for the following FEC codes. In the test result, record the FEC code used in the test.

FEC encoding scheme	Test status
LDPC(17280, 14592)	Mandatory
High throughput code	Conditionally Mandatory
High margin code parametrized by number of shortened columns (19..35)	Conditionally Mandatory

Test cases 7.6.3 – 7.6.4 must be executed for the applicable cipher algorithms configured via OMCI. In the test result, record the Cipher algorithm(s).

Cipher algorithm	Test case status
AES-128	Mandatory
AES-256	Mandatory
Camellia-128	Conditionally Mandatory
Camellia-256	Conditionally Mandatory
SM4(-128)	Conditionally Mandatory

6.5 XG-PON and XGS-PON Comprehensive TC Layer Tests

	Test Set		
Test Name	10G/2.5G	10G/10G	10G/10G+2.5G TDMA Coexistence
Authentication and Encryption	Test Section		
8.1.1 Registration-ID Based Authentication	Mandatory	Mandatory	N/A
8.1.2 Automatic Encryption Key Exchange and Traffic Transmission	Mandatory	Mandatory	N/A
8.1.3 Encrypted Ethernet Transmission	Mandatory	Mandatory	N/A
8.1.4 Multicast Encryption Operation	Mandatory	Mandatory	Mandatory
8.1.5 ONU Re-Activation After Fiber Disconnection with Registration-ID Based Authentication	Mandatory	Mandatory	N/A
8.1.6 Automatic Encryption Key Exchange during Traffic	Mandatory	Mandatory	N/A
8.1.7 Secure Mutual Authentication – OMCI Based	Conditionally Mandatory	Conditionally Mandatory	N/A
8.1.8 Secure Mutual Authentication – 802.1x	Conditionally Mandatory	Conditionally Mandatory	N/A
8.1.9 ONU Re-Activation after Fiber Disconnection with Secure Mutual Authentication	Conditionally Mandatory	Conditionally Mandatory	N/A
8.1.10 Request Registration after Secure Mutual Authentication	Conditionally Mandatory	Conditionally Mandatory	N/A
ONU Power Management Modes	Test Section		
8.2.1 Doze Mode	Mandatory	N/A	Mandatory
8.2.2 Doze Mode (ONU Wakeup)	Mandatory	N/A	Mandatory
8.2.3 Cyclic Sleep	Conditionally Mandatory	N/A	Conditionally Mandatory
8.2.4 Cyclic Sleep (ONU Wakeup)	Conditionally Mandatory	N/A	Conditionally Mandatory
8.2.5 Watchful Sleep	N/A	Mandatory	Mandatory
8.2.6 Watchful Sleep (ONU Wakeup)	N/A	Mandatory	Mandatory

8.2.7 Contention-based Watchful sleep	N/A	N/A	N/A
Dynamic Bandwidth Allocation	Test Section		
8.3.1 DBA Operation - Single ONU	Mandatory	Mandatory	N/A
8.3.2 DBA Operation - Multiple ONUs	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)
8.3.3 DBA Operation under Different Traffic Loads - Multiple ONUs	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)

Drift Control and Compensation	Test Section		
8.4.1 Acceptable Transmission Drift Boundary	Mandatory	Mandatory	N/A
8.4.2 Adjustable Transmission Drift Boundary (DOW)	Mandatory	Mandatory	N/A
8.4.3 Unacceptable Transmission Drift Boundary (TIW)	Mandatory	Mandatory	N/A
Time of Day Distribution over PON	Test Section		
8.5.1 Time of Day Distribution – Fixed Equalization Delay, Single ONU	Mandatory	Mandatory	N/A
8.5.2 Time of Day Distribution – Equalization Delay Adjustments, Single ONU	Mandatory	Mandatory	N/A
8.5.3 Time of Day Synchronization - Multiple ONUs	Mandatory	Mandatory	Mandatory
Protection Switching	Test Section		
8.6.1 Intermittent LODS	Mandatory	Mandatory	Mandatory
Alien ONU	Test Section		
8.7 Alien ONU Detection and resilience to alien ONU	Mandatory	Mandatory	Mandatory

6.6 25GS-PON Comprehensive TC Layer Tests

	Test Set	
Test Name	25G/10G	25G/25G
Authentication and Encryption	Test Section	
8.1.1 Registration-ID Based Authentication	Mandatory	Mandatory
8.1.2 Automatic Encryption Key Exchange and Traffic Transmission	Mandatory	Mandatory
8.1.3 Encrypted Ethernet Transmission	Mandatory	Mandatory
8.1.4 Multicast Encryption Operation	Mandatory	Mandatory
8.1.5 ONU Re-Activation After Fiber Disconnection with Registration-ID Based Authentication	Mandatory	Mandatory
8.1.6 Automatic Encryption Key Exchange during Traffic	Mandatory	Mandatory

8.1.7 Secure Mutual Authentication – OMCI Based	Conditionally Mandatory	Conditionally Mandatory
8.1.8 Secure Mutual Authentication – 802.1x	Conditionally Mandatory	Conditionally Mandatory
8.1.9 ONU Re-Activation after Fiber Disconnection with Secure Mutual Authentication	Conditionally Mandatory	Conditionally Mandatory
8.1.10 Request Registration after Secure Mutual Authentication	Conditionally Mandatory	Conditionally Mandatory
ONU Power Management Modes	Test Section	
8.2.1 Doze Mode	N/A	N/A
8.2.2 Doze Mode (ONU Wakeup)	N/A	N/A
8.2.3 Cyclic Sleep	N/A	N/A
8.2.4 Cyclic Sleep (ONU Wakeup)	N/A	N/A
8.2.5 Watchful Sleep	Mandatory	Mandatory
8.2.6 Watchful Sleep (ONU Wakeup)	Mandatory	Mandatory
8.2.7 Contention-based Watchful sleep	N/A	N/A
Dynamic Bandwidth Allocation	Test Section	
8.3.1 DBA Operation - Single ONU	Mandatory	Mandatory
8.3.2 DBA Operation - Multiple ONUs	Mandatory (single rate)	Mandatory (single rate)
8.3.3 DBA Operation under Different Traffic Loads - Multiple ONUs	Mandatory (single rate)	Mandatory (single rate)
Drift Control and Compensation	Test Section	
8.4.1 Acceptable Transmission Drift Boundary	Mandatory	Mandatory
8.4.2 Adjustable Transmission Drift Boundary (DOW)	Mandatory	Mandatory
8.4.3 Unacceptable Transmission Drift Boundary (TIW)	Mandatory	Mandatory
Time of Day Distribution over PON	Test Section	
8.5.1 Time of Day Distribution – Fixed Equalization Delay, Single ONU	Mandatory	Mandatory
8.5.2 Time of Day Distribution – Equalization Delay Adjustments, Single ONU	Mandatory	Mandatory
8.5.3 Time of Day Synchronization - Multiple ONUs	Mandatory	Mandatory

Protection Switching	Test Section	
8.6.1 Intermittent LODS	Mandatory	Mandatory
Alien ONU	(test section)	
8.7 Alien ONU Detection and resilience to alien ONU	Mandatory	Mandatory

6.7 HSP Comprehensive TC Layer Tests

	Test Set			
Test Name	50G/12.5G	50G/25G	50G/50G	50G/ 12.5G+25G+50G Refer to section 5.5.2 for mixed rate tests definition
Authentication and Encryption	Test Section			
8.1.1 Registration-ID Based Authentication	Mandatory	Mandatory	Mandatory	N/A
8.1.2 Automatic Encryption Key Exchange and Traffic Transmission	Mandatory	Mandatory	Mandatory	N/A
8.1.3 Encrypted Ethernet Transmission	Mandatory	Mandatory	Mandatory	N/A
8.1.4 Multicast Encryption Operation	Mandatory	Mandatory	Mandatory	Mandatory
8.1.5 ONU Re-Activation After Fiber Disconnection with Registration-ID Based Authentication	Mandatory	Mandatory	Mandatory	N/A
8.1.6 Automatic Encryption Key Exchange during Traffic	Mandatory	Mandatory	Mandatory	N/A

8.1.7 Secure Mutual Authentication – OMCI Based	Conditionally Mandatory	Conditionally Mandatory	Conditionally Mandatory	N/A
8.1.8 Secure Mutual Authentication – 802.1x	Conditionally Mandatory	Conditionally Mandatory	Conditionally Mandatory	N/A
8.1.9 ONU Re-Activation after Fiber Disconnection with Secure Mutual Authentication	Conditionally Mandatory	Conditionally Mandatory	Conditionally Mandatory	N/A
8.1.10 Request Registration after Secure Mutual Authentication	Conditionally Mandatory	Conditionally Mandatory	Conditionally Mandatory	N/A
ONU Power Management Modes	Test Section			
8.2.1 Doze Mode	N/A	N/A	N/A	N/A
8.2.2 Doze Mode (ONU Wakeup)	N/A	N/A	N/A	N/A
8.2.3 Cyclic Sleep	N/A	N/A	N/A	N/A
8.2.4 Cyclic Sleep (ONU Wakeup)	N/A	N/A	N/A	N/A
8.2.5 Watchful Sleep	Mandatory	Mandatory	Mandatory	Mandatory
8.2.6 Watchful Sleep (ONU Wakeup)	Mandatory	Mandatory	Mandatory	Mandatory
8.2.7 Contention-based Watchful sleep	Mandatory	Mandatory	Mandatory	Mandatory
Dynamic Bandwidth Allocation	Test Section			
8.3.1 DBA Operation - Single ONU	Mandatory	Mandatory	Mandatory	N/A
8.3.2 DBA Operation - Multiple ONUs	Mandatory (single rate)	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)
8.3.3 DBA Operation under Different Traffic Loads - Multiple ONUs	Mandatory (single rate)	Mandatory (single rate)	Mandatory (single rate)	Mandatory (mixed rate)
Drift Control and Compensation	Test Section			

8.4.1 Acceptable Transmission Drift Boundary	Mandatory	Mandatory	Mandatory	N/A
8.4.2 Adjustable Transmission Drift Boundary (DOW)	Mandatory	Mandatory	Mandatory	N/A
8.4.3 Unacceptable Transmission Drift Boundary (TIW)	Mandatory	Mandatory	Mandatory	N/A
Time of Day Distribution over PON	Test Section			
8.5.1 Time of Day Distribution – Fixed Equalization Delay, Single ONU	Mandatory	Mandatory	Mandatory	N/A
8.5.2 Time of Day Distribution – Equalization Delay Adjustments, Single ONU	Mandatory	Mandatory	Mandatory	N/A
8.5.3 Time of Day Synchronization - Multiple ONUs	Mandatory	Mandatory	Mandatory	Mandatory
Protection Switching	Test Section			
8.6.1 Intermittent LODS	Mandatory	Mandatory	Mandatory	Mandatory

Test cases 8.1.1 – 8.1.10 must be executed for the applicable cipher algorithms configured via OMCI. In the test result, record the Cipher algorithm(s).

Cipher algorithm	Test case status
AES-128	Mandatory
AES-256	Mandatory
Camellia-128	Conditionally Mandatory
Camellia-256	Conditionally Mandatory
SM4(-128)	Conditionally Mandatory

7 Basic TC Layer Tests

7.1 ONU Start-up

7.1.1 ONU Discovery - Single ONU (cold OLT, cold ONU)

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 6, 8, 10, 11 and 12.
- ITU-T G.9807.1[12], Sections C.6, C.8, C.10, C.11 and C.12.
- 25GS-PON [1].
- ITU-T G.9804.2[14], Sections 6, 8, 10, 11 and 12.

Test Objective:

Verify that the OLT is able to detect ONU. Verify XG-PON/XGS-PON/25GS-PON/HSP framing, synchronization and serial number acquisition.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.

Test Configuration:

Parameters for the profile message #1 (not applicable for 25GS-PON):

- ONU-ID: 0x3FF/0x3FE/0x3FD/0x3FC (broadcast ONU-ID, according to the protocol and upstream rate under test and at the discretion of the OLT)
- XG-PON and XGS-PON (N/A for 25GS-PON):
 - Burst profile applicability flag (F): 0 for 2.5G upstream, 1 for 10G upstream
- HSP:
 - Codepoint – as specified in G.9804.2 [14] for corresponding upstream rate
- Version: 0
- Profile index: 0
- Upstream FEC: off
- PON-TAG: 0x4f 0x4c 0x54 0x23 0x30 0x30 0x30 0x30 (“OLT#0000”)
- Other parameters as specified in Section 5.5.2 for burst profile 0

Parameters for the profile message #2:

- ONU-ID:
 - XG-PON/XGS-PON: 0x3FF/0x3FE (broadcast ONU-ID, according to the protocol and upstream rate under test and at the discretion of the OLT)
 - 25GS-PON: 0x3FB/0x3FC (broadcast ONU-ID, according to the protocol and upstream rate under test and at the discretion of the OLT)
 - HSP: 0x3FF/0x3FE/0x3FD/0x3FC (broadcast ONU-ID, according to the protocol and upstream rate under test and at the discretion of the OLT)
- XG-PON and XGS-PON (N/A for 25GS-PON):
 - Burst profile applicability flag (F): 0 for 2.5G upstream, 1 for 10G upstream
- HSP:
 - Codepoint – as specified in G.9804.2 [14] for corresponding upstream rate
-
- Version: 0
- Profile index: 1
- Upstream FEC: on
- PON-TAG: 0x4f 0x4c 0x54 0x23 0x30 0x30 0x30 0x30 (“OLT#0000”)
- Other parameters as specified in Section 5.5.2 for burst profile 1

Parameters for serial number grant:

- Alloc-ID:
 - 0x03FF for XG-PON 2.5G upstream
 - 0x03FE for XGS-PON 10G upstream
 - 0x03FB for 25GS-PON 10G upstream
 - 0x03FC for 25GS-PON 25G upstream
 - 0x03FC for HSP 50G upstream
 - 0x03FD for HSP 25G upstream
 - 0x03FE for HSP 12.5G upstream
- Flags: 1 (DBRu=0, PLOAMu=1)
- Start time: at the discretion of the OLT. Suggested value: 0x100
- Grant size: 0
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Parameters for serial number ONU message:

- ONU-ID: 0x3FF (unassigned ONU-ID)
- Sequence number: 0
- Vendor ID: at the discretion of the ONU. Suggested value: 0x41 0x42 0x43 0x44 (“ABCD”)
- VSSN: at the discretion of the ONU. Suggested value: 0x31 0x32 0x33 0x34 (“1234”)
- Upstream line rate capability: as defined in Section 5.5.2 (N/A for 25GS-PON)

Test Procedure and message timeline:

1. ONU is at state O1 until downstream frame synchronization is attained. It then transitions to state O2-3.
2. OLT transmits the profile messages. Each message is sent at least twice.
3. OLT sends a serial number grant.
4. ONU responds with a serial number ONU message.
5. OLT prints the received serial number.

Pass/Fail Criteria:

1. Serial number detected by the OLT is correct.
2. ONU has entered serial number state (O2-3).

Remarks:

- PON-TAG can be chosen to a different value at the discretion of the OLT, but must be the same for the two profiles.
- Other profile parameters should be chosen according to Section 5.5.2.
- Only a single ONU should be connected to the ODN for this test. If additional ONUs are connected, they should be not answer the serial number grant.

7.1.2 ONU Activation – Single ONU

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 6, 8, 11 and 12.
- ITU-T G.9807.1 [12], Sections C.6, C.8, C.11 and C.12.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 6, 8, 10, 11 and 12.

Test Objective:

Verify that the OLT is able to detect and activate the ONU and the ranging process. This test follows the ONU discovery test.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The OLT learned the serial number of the ONU.
3. The ONU is in serial number state (O2-3).

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters for Assign ONU-ID message:

- Destination ONU-ID: 0x3FF (broadcast ONU-ID)
- Sequence number: broadcast PLOAM sequence number
- Set ONU-ID: 1
- Vendor ID and VSSN: as learned in the ONU discovery test
- For XG-PON and XGS-PON (N/A for 25GS-PON):
 - Upstream line rate indicator (if applicable): 0 for 2.5G upstream, 1 for 10G upstream
- For HSP:
 - Upstream nominal line rate indicator (if applicable):
 - 00 – 50G
 - 01 – 25G
 - 10 – 12.5G

- Allocation feedback:
 - Continuation flag: 0
 - Major level feedback: 0b10 – successful ONU-ID assignment
 - Detailed feedback on the other events: 0b00 – not evaluated
- Parameters for the ranging grant:
 - Alloc-ID: 1
 - Flags: 1 (DBRu=0, PLOAMu=1)
 - Start time: at the discretion of the OLT. Suggested value: 0x100
 - Grant size: 0
 - FWI: 0
 - Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP
- Parameters for the registration message:
 - ONU-ID: 1
 - Sequence number: 0
 - Registration ID: at the discretion of the ONU. Suggested value:
"0x12345ABDCEF012345ABDCEF0123412345ABDCEF012345ABDCEF01234"
- Parameters for the ranging time message:
 - ONU-ID: 1
 - Sequence number: 1
 - Equalization delay parsing method (octet 5): 0x01 (absolute)
 - For HSP both Downstream PON-ID and Upstream PON-ID should be set to PON-ID of the OC structure.
 - The PLOAM MIC is calculated using the new derived PLOAM- IK (see comment at 5.1)
- Parameters for the acknowledge message:
 - ONU-ID: 1
 - Sequence number: same as ranging time message
 - Completion code: 0 (ok)
 - The PLOAM MIC is calculated using the new derived PLOAM-IK (see comment at 5.1)

Test Procedure and message timeline:

1. The OLT sends an Assign ONU-ID message.
2. The ONU sets up the default Alloc-ID (1) and default OMCC XGEM Port-ID (1) and transitions to state O4.
3. The OLT sends a ranging grant.
4. The ONU responds with a registration message.
5. The OLT sends a ranging time message. It then provides an allocation with PLOAMu enabled.
6. The ONU updates its equalization delay, transitions to state O5 and sends an acknowledge message.

Pass/Fail Criteria:

1. The ONU received ONU-ID (1) and entered state O4
2. The OLT reports an ONU with the expected serial number has been correctly ranged.
3. The ONU has entered regular operational state (O5).
4. OLT received the acknowledge message.

Remarks:

- OLT should count the number of answered allocations and ONU should count the number of granted allocations.

7.1.3 ONU Discovery – Multiple ONUs (warm PON)

Test Status: Refer to Section 5

Reference Documents:

- ITU-T G.987.3 [10], Sections 6, 8, 10, 11 and 12.
- ITU-T G.9807.1 [12], Sections C.6, C.8, C.10, C.11 and C.12.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 6, 8, 10, 11 and 12.

Test Objective:

Verify that the OLT is able to detect additional ONUs, one at a time. This test follows the ONU activation test of the first ONU.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONUs are powered and connected according to the test setup.
2. The first ONU is in operational state (O5).
3. Other ONUs are reset to their initial state (see remarks).

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters for serial number grant:

- Alloc-ID:
 - 0x03FF for XG-PON 2.5G upstream
 - 0x03FE for XGS-PON 10G upstream
 - 0x03FB for 25GS-PON 10G upstream
 - 0x03FC for 25GS-PON 25G upstream
 - 0x03FC for HSP 50G upstream
 - 0x03FD for HSP 25G upstream
 - 0x03FE for HSP 12.5G upstream
- Flags: 1 (DBRu=0, PLOAMu=1)
- Start time: at the discretion of the OLT. Suggested value: 0x100
- Grant size: 0
- FWI: 0

- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Parameters for serial number ONU message:

- ONU-ID: 0x3FF (unassigned ONU-ID)
- Sequence number: 0
- Vendor ID: at the discretion of the ONU.
- VSSN: at the discretion of the ONU, coordinated between participants so serial numbers are unique
- Upstream line rate capability as defined in Section 5.5.2, N/A for 25GS-PON

Test Procedure and message timeline:

1. The ONU (except first ONU) to be detected is at state O1 until downstream frame synchronization is attained. Each ONU (except first ONU) then transitions to state O2-3.
2. The OLT transmits the profile messages. Each message is sent at least twice.
3. The OLT sends a serial number grant.
4. The ONU (except for the first ONU) responds with a serial number ONU message.
5. For HSP:
 - a. The OLT sends Assign_ONU-ID/Collision_Feedback message if collision is detected by the OLT. Allocation feedback field should have set:
 - i. Major level feedback: 0b01 (collision)
 - ii. Detailed feedback: 0b00 (not evaluated)
 - b. The ONUs resolve collisions as explained in ITU-T G.9804.2 section 7.5.3.4 ONU support of the set-splitting collision resolution protocol
6. The OLT displays the received serial number.
7. Steps 1-5 are repeated until all of the serial numbers are learned.

Pass/Fail Criteria:

1. Serial numbers detected by the OLT are correct.
2. The first ONU stays at operational state (O5).
3. All additional ONUs have entered serial number state (O2-3).

Remarks:

- The interoperability between three or more vendors should also be tested. The roles of “first ONU” and “other ONUs” should be rotated.

7.1.4 ONU Activation – Multiple ONUs without Data Transmission

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 6, 8, 11 and 12.
- ITU-T G.9807.1 [12], Sections C.6, C.8, C.11 and C.12.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 6, 8, 10, 11 and 12.

Test Objective:

Verify that the OLT is able to activate additional ONUs. This test follows the ONU discovery – multiple ONUs test.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONUs are powered and connected according to the test setup.
2. The first ONU is in operational state (O5).
3. The OLT learned the serial number of the other ONUs.
4. Other ONUs are in serial number state (O2-3).

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test. Parameters for other messages are defined in test ONU activation – single ONU test (7.1.2). ONU-IDs are at the discretion of the OLT.

Test Procedure and message timeline:

1. The OLT sends an Assign ONU-ID message to an inactive ONU.
2. The ONU sets up the default Alloc-ID and default OMCC XGEM Port-ID and transitions to state O4.
3. The OLT sends a ranging grant to the ONU.
4. The ONU responds with a registration message.
5. The OLT sends a ranging time message. It then provides an allocation with PLOAMu enabled.
6. The ONU updates its equalization delay, transitions to state O5 and sends an acknowledge message.
7. The OLT repeats the procedure for each additional ONU.

Pass/Fail Criteria:

1. All ONUs (except for the first ONU) received an ONU-ID and entered state O4.
2. The OLT reports that all ONUs with the expected serial numbers have been correctly ranged.
3. All ONUs have entered the regular operational state (O5).
4. The OLT received acknowledge messages for all downstream PLOAM messages.

Remarks:

- The OLT should count the number of answered allocations and ONU should count the number of granted allocations.
- Interoperability between three or more vendors should also be tested. The order of activation should be rotated.

7.1.5 ONU Discovery – Multiple ONUs (cold OLT, cold ONUs)

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 6, 8, 10, 11 and 12.
- ITU-T G.9807.1 [12], Sections C.6, C.8, C.10, C.11 and C.12.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 6, 8, 10, 11 and 12.

Test Objective:

Verify that the OLT is able to detect multiple ONUs simultaneously.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONUs are powered and connected according to the test setup.
2. All units are in their initial reset state.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Test Procedure and message timeline:

1. The ONUs are at state O1 until downstream frame synchronization is attained. Each ONU then transitions to state O2-3.
2. The OLT transmits the profile messages. Each message is sent at least twice.
3. The OLT sends a serial number grant.
4. The ONUs respond with a serial number ONU message.
5. The OLT prints the received serial numbers.
6. Steps 3-5 are repeated until all of the serial numbers are learned.

Pass/Fail Criteria:

1. The serial numbers detected by the OLT are correct.
2. All ONUs have entered serial number state (O2-3).

7.1.6 ONU Discovery and Activation during Data Transmission

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 6, 8, 9, 11 and 12.
- ITU-T G.9807.1 [12], Sections C.6, C.8, C.9, C.11 and C.12.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 6, 8, 10, 11 and 12.

Test Objective:

Verify that the OLT is able to discover and activate additional ONUs while data transmission is taking place. Verify that data transmission to the first ONU is not interrupted.

Test Setup:

- As shown in Section 5
- If the specified Port-ID and/or Alloc-ID cannot be provisioned manually, automatic provisioning is allowed. In such case, these parameters will be coordinated after pairing.

Pretest Conditions:

1. The OLT and ONUs are powered and connected according to the test setup.
2. The first ONU is in operational state (O5).
3. Port-ID 1024 is provisioned on both downstream and upstream and assigned to Alloc-ID 1024 for first ONU.
4. Other ONUs are reset to their initial state.

Test Configuration:

Profiles from the “ONU discovery test” (7.1.1) are used in this test. Parameters for other messages are defined in test “ONU activation – single ONU test” (7.1.2). ONU-IDs are at the discretion of the OLT.

Additional parameters (e.g., VLAN tag mapping, order of generator, and analyzer enable) are to be coordinated after pairing.

Parameters for bandwidth allocation structures:

- Alloc-ID: 1024
- Start time: at the discretion of the OLT
- Grant size: at the discretion of the OLT
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Test Procedure and message timeline:

1. The traffic generators are enabled for downstream and upstream traffic.
2. Received data is tested by the Ethernet traffic analyzer for both downstream and upstream.
3. Other ONUs are at state O1 until downstream frame synchronization is attained. Each ONU then transitions to state O2-3.
4. The OLT transmits the profile messages. Each message is sent at least twice.
5. The OLT sends a serial number grant.
6. The ONUs respond with a serial number ONU message.
7. The OLT displays the received serial number.
8. The OLT sends an Assign ONU-ID message to the newly detected ONU.
9. The ONU sets up the default Alloc-ID and default OMCC XGEM Port-ID and transitions to state O4.
10. The OLT sends a ranging grant to an inactive ONU.
11. The ONU responds with a registration message.
12. The OLT sends a ranging time message. It then provides an allocation with PLOAMu enabled.
13. The ONU updates its equalization delay, transitions to state O5 and sends an acknowledge message.
14. The OLT repeats the procedure for each additional ONU.

Pass/Fail Criteria:

1. All serial numbers detected by the OLT are correct.
2. The OLT reports that all ONUs with the expected serial numbers have been correctly ranged.
3. All ONUs have entered the regular operational state (O5).
4. The OLT received acknowledge messages.
5. No errors are detected in downstream and upstream traffic during the whole duration of the test.

Remarks:

- The OLT should count the number of answered allocations and ONU should count the number of granted allocations.
- Interoperability between three or more vendors should also be tested.

7.1.7 Differential Reach Operation

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 6, 8, 10, 11 and 12.
- ITU-T G.9807.1 [12], Sections C.6, C.8, C.10, C.11 and C.12.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 6, 8, 10, 11 and 12.

Test Objective:

Verify that the OLT is able to detect two ONUs with the maximum differential distance.

Test Setup:

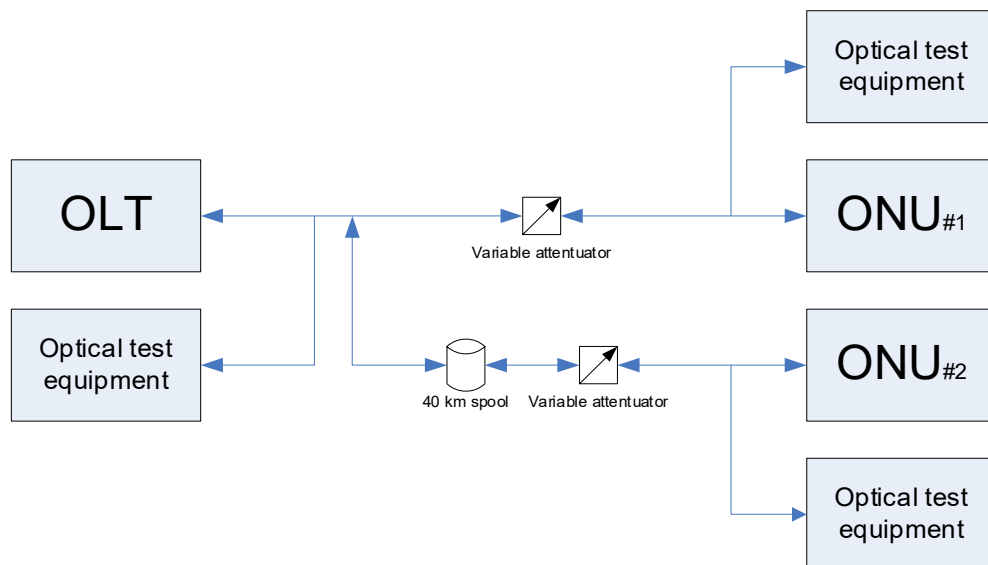


Figure 6 - Test Setup for Differential Reach Test

Pretest Conditions:

1. The OLT and the ONUs are powered and connected according to the test setup.
2. All units are in their initial reset state.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Test Procedure and message timeline:

1. The ONUs are at state O1 until downstream frame synchronization is attained. Each ONU then transitions to state O2-3.

2. The OLT transmits the profile messages. Each message is sent at least twice.
3. The OLT sends a serial number grant.
4. The ONUs respond with a serial number ONU message.
5. The OLT prints the received serial numbers.
6. The OLT sends an Assign ONU-ID message to the detected ONU.
7. The ONU sets up the default Alloc-ID and default OMCC XGEM Port-ID and transitions to state O4.
8. The OLT sends a ranging grant.
9. The ONU responds with a registration message.
10. The OLT sends a ranging time message. It then provides an allocation with PLOAMu enabled.
11. The ONU updates its equalization delay, transitions to state O5 and sends an acknowledge message.
12. Steps 3-11 are repeated for the second ONU.

Pass/Fail Criteria:

1. "PASS (DD40)" when both ONUs are successfully ranged and activated with a spool of 40 km
2. "PASS (DD20)" when both ONUs are successfully ranged and activated with a spool of 20 km and any of ONUs fails to be ranged and activated with a 40 km spool.
3. "FAIL" otherwise

Remarks:

If this test fails with differential distance 40 km, a differential distance of 20 km can be tested.

7.1.8 ONU Discovery at explicitly assigned Alloc-ID - Single ONU (cold OLT, cold ONU)

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.9804.2 [14], Sections 6, 8, 10, 11 and 12.

Test Objective:

Verify that the OLT is able to detect ONU. Verify HSP serial number acquisition.

Test Setup:

- As shown in Section 5

Pretest Conditions:

2. The OLT and ONU are powered and connected according to the test setup.

Test Configuration:

Parameters for broadcast Assign Alloc-ID message:

- ONU-ID: 0x3FF (broadcast message for the contention-based Alloc-ID assignment)
- Alloc-ID-value: 1024
- Alloc-ID-type: 0x01
- Alloc-ID scope: 0x7F (fixed-wavelength TDM system)
- Contention-based function ID: 0x01 (ONU activation)
- Contention-based function parameters:
 - Octet 1: Upstream rate in a form of a bitmap, where the LSB corresponds to the nominal line rate $\rho_0 \phi_0$, the following bit, to the nominal line rate $\rho_0 \phi_1$, etc. Bits corresponding to upstream rates supported for both the ONU and the OLT are set to 1.
 - Octet 2: Maximum random delay as specified in [14] 7.5.2.1 ONU activation
 - Octet 3: Probability used in set-splitting, set to 0xFF ($p=1$) as specified in 7.5.2.1 ONU activation [14]

Parameters for profile message #1:

- ONU-ID: 0x3FF
- Codepoint – as specified in G.9804.2 [14] for corresponding upstream rate
- Version: 0
- Profile index: 1

- Upstream FEC: on
- PON-TAG: 0x4f 0x4c 0x54 0x23 0x30 0x30 0x30 0x30 (“OLT#0000”)
- Other parameters as specified in Section 5.5.2 for burst profile 1

Parameters for serial number grant:

- Alloc-ID: 1024
- Flags: 1 (DBRu=0, PLOAMu=1)
- Start time: at the discretion of the OLT. Suggested value: 0x100
- Grant size: 0
- FWI: 0
- Burst profile: 1

Parameters for serial number ONU message:

- ONU-ID: 0x3FF (unassigned ONU-ID)
- Sequence number: 0
- Vendor ID: at the discretion of the ONU. Suggested value: 0x41 0x42 0x43 0x44 (“ABCD”)
- VSSN: at the discretion of the ONU. Suggested value: 0x31 0x32 0x33 0x34 (“1234”)
- Upstream line rate capability: as defined in Section 5.5.2

Test Procedure and message timeline:

6. The ONU is at state O1 until downstream frame synchronization is attained. It then transitions to state O2-3.
7. The OLT transmits broadcast the Assign Alloc-ID message
8. The OLT transmits the profile message. The message is sent at least twice.
9. The OLT sends a serial number grant.
10. The ONU responds with a serial number ONU message.
11. The OLT prints the received serial number.

Pass/Fail Criteria:

3. The serial number detected by the OLT is correct.
4. The ONU has entered serial number state (O2-3).

Remarks:

- The PON-TAG can be chosen to a different value at the discretion of the OLT, but must be the same for the two profiles.

- Other profile parameters should be chosen according to Section 5.5.2.
- Only a single ONU should be connected to the ODN for this test. If additional ONUs are connected, they should be not answer the serial number grant.

7.1.9 ONU Activation at explicitly assigned Alloc-ID – Single ONU

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.9804.2 [14], Sections 6, 7, 8, 10, 11 and 12.

Test Objective:

Verify that the OLT is able to detect and activate the ONU at explicitly assigned Alloc-ID and the ranging process. This test follows the “ONU discovery at explicitly assigned Alloc-ID” test.

Test Setup:

- As shown in Section 5

Pretest Conditions:

4. The OLT and ONU are powered and connected according to the test setup.
5. The OLT learned the serial number of the ONU.
6. The ONU is in serial number state (O2-3).

Test Configuration:

Profiles from the ONU discovery at explicitly assigned Alloc ID test (7.1.8) are used in this test.

Parameters for Assign ONU-ID message:

- Destination ONU-ID: 0x3FF (broadcast ONU-ID)
- Sequence number: broadcast PLOAM sequence number
- Set ONU-ID: 1
- Vendor ID and VSSN: as learned in the ONU discovery test
- Upstream nominal line rate indicator (if applicable):
 - 00 – 50G
 - 01 – 25G
 - 10 – 12.5G
- Allocation feedback:
 - Continuation flag: 0
 - Major level feedback: 0b10 – successful ONU-ID assignment
 - Detailed feedback on the other events: 0b00 – not evaluated
- Parameters for ranging grant:
 - Alloc-ID: 1

- Flags: 1 (DBRu=0, PLOAMu=1)
- Start time: at the discretion of the OLT. Suggested value: 0x100
- Grant size: 0
- FWI: 0
- Burst profile: 1

- Parameters for registration message:
 - ONU-ID: 1
 - Sequence number: 0
 - Registration ID: at the discretion of the ONU. Suggested value:
"0x12345ABDCEF012345ABDCEF0123412345ABDCEF012345ABDCEF01234"

- Parameters for ranging time message:
 - ONU-ID: 1
 - Sequence number: 1
 - Equalization delay parsing method (octet 5): 0x01 (absolute)
 - Both Downstream PON-ID and Upstream PON-ID should be set to PON-ID of the OC structure

- Parameters for acknowledge message:
 - ONU-ID: 1
 - Sequence number: same as ranging time message
 - Completion code: 0 (ok)
 - PLOAM MIC is calculated using the new derived PLOAM-IK (see comment at 5.1)

Test Procedure and message timeline:

7. The OLT sends an Assign ONU-ID message.
8. The ONU sets up the default Alloc-ID (1) and default OMCC XGEM Port-ID (1) and transitions to state O4.
9. The OLT sends a ranging grant.
10. The ONU responds with a registration message.
11. The OLT sends a ranging time message. It then provides an allocation with PLOAMu enabled.
12. The ONU updates its equalization delay, transitions to state O5 and sends an acknowledge message.

Pass/Fail Criteria:

5. The ONU received ONU-ID (1) and entered state O4
6. The OLT reports that an ONU with the expected serial number has been correctly ranged.
7. ONU has entered regular operational state (O5).
8. The OLT received the acknowledge message.

Remarks:

- The OLT should count the number of answered allocations and the ONU should count the number of granted allocations.

7.2 Bandwidth Allocation

7.2.1 Single Allocation

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 8.1.2.
- ITU-T G.9807.1 [12], Section C.8.1.1.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 8.1.2.

Test Objective:

Verify correct generation and parsing of bandwidth allocation structures.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Downstream FEC parity bits can be ignored (error-free reception is assumed).

Parameters for bandwidth allocation structures:

Table 7-1 – Bandwidth Allocation Parameters for 10G ONU

Alloc-ID	Start time	Grant size	PLOAMu	DBRu	Notes
1	100*	256	0	0	
1	0	256	0	0	Minimal Start time
1	9719	256	0	0	Maximal Start time
1	100*	1	0	0	Minimal XGEM section
1	100*	9719	0	0	Maximal allocation size
1	100*	1	0	1	DBRu only grant
1	100*	1	1	1	PLOAM + DBRu only
1	100*	2	0	1	Minimal XGEM + DBRu
1	100*	2	1	1	Minimal XGEM + PLOAM + DBRu

Table 7-2 – Bandwidth Allocation Parameters for 2.5G ONU

Alloc-ID	Start time	Grant size	PLOAMu	DBRu	Notes
1	100*	256	0	0	
1	0	256	0	0	Minimal Start time
1	9719	256	0	0	Maximal Start time
1	100*	4	0	0	Minimal XGEM section
1	100*	9719	0	0	Maximal allocation size
1	100*	1	0	1	DBRu only grant
1	100*	1	1	1	PLOAM + DBRu only
1	100*	5	0	1	Minimal XGEM + DBRu
1	100*	5	1	1	Minimal XGEM + PLOAM + DBRu

Table 7-3 – Bandwidth Allocation Parameters for a 25GS-PON ONU

Alloc-ID	Start time	Grant size	PLOAMu	DBRu	Notes
1	100*	256	0	0	
1	0	256	0	0	Minimal Start time
1	9719	256	0	0	Maximal Start time
1	100*	1	0	0	Minimal XGEM section
1	100*	9719	0	0	Maximal allocation size
1	100*	1	0	1	DBRu only grant
1	100*	1	1	1	PLOAM + DBRu only
1	100*	1	0	1	Minimal XGEM + DBRu
1	100*	2	1	1	Minimal XGEM + PLOAM + DBRu

Table 7-4 – Bandwidth Allocation Parameters for an HSP ONU

Alloc-ID	Start time	Grant size	PLOAMu	DBRu	Notes
1	100*	256	0	0	
1	0	256	0	0	Minimal Start time
1	9719	256	0	0	Maximal Start time
1	100*	1	0	0	Minimal XGEM section
1	100*	12149	0	0	Maximal allocation size
1	100*	1	0	1	DBRu only grant
1	100*	1	1	1	PLOAM + DBRu only
1	100*	2	0	1	Minimal XGEM + DBRu
1	100*	2	1	1	Minimal XGEM + PLOAM + DBRu

The start time for bandwidth allocation structures marked with (*) are recommended values, and can be changed at the discretion of the OLT as long as grant size is kept as specified. Where not specified, the exact start time is mandatory.

Common parameters:

- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Test Procedure:

1. After ranging succeeds, The OLT sends bandwidth allocation structures with one of the bandwidth allocation structures described above once and idle downstream traffic. Bandwidth allocation structures are sent one at a time, in separate XGTC/FS frames. Test results are recorded separately for each scenario.
2. Upon getting bandwidth grants, ONU responds appropriately and at the correct time:
 - a. XGTC/FS header section: headers and acknowledge PLOAM if PLOAMu is 1, or header alone if PLOAMu is 0.
 - b. Allocation overhead: any valid DBR structure if DBRu is 1 or not present if DBRu is 0.
 - c. XGTC/FS payload section: idle XGEMs.
3. The OLT verifies that idle traffic is received from the ONU in the XGTC/FS payload section.
4. Steps 1-3 are repeated for each additional bandwidth map.

Pass/Fail Criteria:

1. The OLT detects idle traffic from the ONU in the expected windows for each of the scenarios. Alternatively, the OLT should not detect any missing bursts.
2. The OLT should count the number of answered allocations and the ONU should count the number of granted allocations.

Remarks:

- None

7.2.2 Repetitive Allocation

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 8.1.2.
- ITU-T G.9807.1 [12], Section C.8.1.1.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 8.1.2.

Test Objective:

Verify the correct generation and parsing of bandwidth allocation structures.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Downstream FEC parity bits can be ignored (error-free reception is assumed).

Parameters for bandwidth allocation structures:

- Alloc-ID: 1
- Flags: 0
- Start time: at the discretion of the OLT. Recommended value: 100
- Grant size: 256
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Test Procedure:

1. After ranging succeeds, the OLT sends the bandwidth map described above continuously, one bandwidth map at each XGTC/FS frame.
2. Upon getting bandwidth grants, the ONU responds with the XGEM idle upstream traffic at the correct time.
3. The OLT verifies that correct traffic is received from ONU.

Pass/Fail Criteria:

1. The OLT detects idle traffic from ONU in the expected windows. Alternatively, the OLT should not detect any missing bursts.
2. The OLT should count the number of answered allocations and ONU should count the number of granted allocations.

Remarks:

- None

7.2.3 Burst Series

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 8.1.2.
- ITU-T G.9807.1 [12], Section C.8.1.1.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 8.1.2.

Test Objective:

Verify the correct generation and parsing of bandwidth maps containing burst series allocation structures.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. This test can be performed only after the Alloc-ID allocation and de-allocation test has been performed successfully.
2. The OLT and ONU are powered and connected according to the test setup.
3. The ONU has been ranged and activated by the OLT.
4. Alloc-ID 1024 is assigned to the ONU, using assign Alloc-ID PLOAM message. The PLOAM message is acknowledged.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Downstream FEC parity bits can be ignored (error-free reception is assumed).

Parameters for bandwidth allocation structures:

Table 7-5 – Bandwidth Allocation Parameters for Burst Series

Access #	Alloc-ID	Start time	Grant size
1	1	100	256
2	1024 (0x400)	65535 (0xFFFF)	256

Common parameters:

- PLOAMu: 0
- DBRu: 0
- FWI: 0

- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Test Procedure:

1. After ranging succeeds, the OLT sends the bandwidth map described above and idle downstream traffic.
2. Upon getting bandwidth grants, the ONU responds with the XGEM idle upstream traffic at the correct time.
3. The OLT verifies that idle traffic is received from ONU.

Pass/Fail Criteria:

1. The OLT detects idle traffic from the ONU in the expected windows. Alternatively, the OLT should not detect any missing bursts.
2. The OLT should count the number of answered allocations and the ONU should count the number of granted allocations.

Remarks:

- The start time value for the first access is a recommended value only, and can be changed at the discretion of the OLT.

7.2.4 Maximal Allocation

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 8.1.2.
- ITU-T G.9807.1 [12], Section C.8.1.1.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 8.1.2.

Test Objective:

Verify the correct generation and parsing of bandwidth maps containing bandwidth allocation structures with maximal grant sizes.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Downstream FEC parity bits can be ignored (error-free reception is assumed).

Parameters for bandwidth allocation structures:

- Alloc-ID: 1
- Flags: 0
- Start time: at the discretion of the OLT.
- Grant size: set to maximum possible, considering overheads such as PSBu, XGTC/FS header and XGTC/FS trailer.
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Test Procedure:

1. After ranging succeeds, the OLT sends the bandwidth map described above 10 times and idle downstream traffic.
2. Upon getting bandwidth grants, the ONU responds with the XGEM idle upstream traffic at the correct time.

3. The OLT verifies that correct traffic is received from ONU.

Pass/Fail Criteria:

1. The OLT detects idle traffic from ONU in the expected windows. Alternatively, the OLT should not detect any missing bursts.
2. The OLT should count the number of answered allocations and ONU should count the number of granted allocations.

Remarks:

- None

7.2.5 Allocations to Different ONUs

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 8.1.2.
- ITU-T G.9807.1 [12], Section C.8.1.1.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 8.1.2.

Test Objective:

Verify the correct system behavior with bandwidth maps containing allocation structures to different ONUs.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONUs are powered and connected according to the test setup.
2. The ONUs have been ranged and activated by the OLT.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Downstream FEC parity bits can be ignored (error-free reception is assumed).

Parameters for bandwidth allocation structures:

- Alloc-ID: 1, 2
- Flags: 0
- Start time:
 - 100 for Alloc-ID 1
 - 5000 for Alloc-ID 2
- Grant size: 256
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Test Procedure:

1. After ranging succeeds, OLT sends the bandwidth allocation structures described above and idle downstream traffic.

2. Upon getting bandwidth grants, an ONU responds with the XGEM idle upstream traffic at the correct time.
3. OLT verifies that correct traffic is received from ONU.

Pass/Fail Criteria:

1. The OLT detects idle traffic from ONU in the expected windows. Alternatively, the OLT should not detect any missing bursts.
2. The OLT should count the number of answered allocations and ONU should count the number of granted allocations.

Remarks:

- None

7.2.6 Adjacent Allocations to Different ONUs

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 8.1.2.
- ITU-T G.9807.1 [12], Section C.8.1.1.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 8.1.2.

Test Objective:

Verify the correct system behavior with bandwidth maps containing allocation structures with adjacent bursts.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONUs are powered and connected according to the test setup.
2. The ONUs have been ranged and activated by the OLT.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Downstream FEC parity bits can be ignored (error-free reception is assumed).

Parameters for bandwidth allocation structures:

- Alloc-ID: 1, 2
- Flags: 0
- Start time: at the discretion of the OLT.
- Grant size: set to maximum possible, considering overheads such as guard time, PSBu, XGTC/FS header and trailer.
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Test Procedure:

1. After ranging succeeds, the OLT sends the bandwidth allocation structures described above and idle downstream traffic.
2. Upon getting bandwidth grants, each ONU responds with the XGEM idle upstream traffic at the correct time.

3. The OLT verifies that correct traffic is received from ONU.

Pass/Fail Criteria:

1. The OLT detects idle traffic from the ONU in the expected window. Alternatively, the OLT should not detect any missing bursts.
2. The OLT should count the number of answered allocations and the ONU should count the number of granted allocations.

Remarks:

- None

7.3 Embedded OAM Operation

7.3.1 PON-ID / Operation Control

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 10.1.1.
- ITU-T G.9807.1 [12], Section C.10.1.1.1.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 10.1.1.

Test Objective:

Verify that the OLT can generate and the ONU can properly process the PON-ID (XG-PON)/OC (XGS-PON/25GS-PON/HSP) structure in the PSBd.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The value of the PON-ID/OC is set at the OLT.
3. The ONU has been ranged and activated by the OLT.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Value of PON-ID / OC is at the discretion of the OLT.

Test Procedure:

1. The ONU reports the received PON-ID/OC value. This value is compared with the value set at the OLT.

Pass/Fail Criteria:

1. The PON-ID/OC value recognized by the ONU is identical to the value set by the OLT.

Remarks:

- None

7.3.2 Dying Gasp

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 8.2.1.2.
- ITU-T G.9807.1 [12], Section C.8.1.2.1.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 8.2.1.2.

Test Objective:

Verify that the ONU can generate and the OLT can properly process the following upstream embedded OAM indication:

- Dying gasp

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Downstream FEC parity bits can be ignored (error-free reception is assumed).

Parameters of the bandwidth grants are at the discretion of the OLT.

Test Procedure:

1. The OLT sends bandwidth grants.
2. The ONU responds to the grants.
3. Cause ONU to send Dying Gasp by removing power to the ONU.

Pass/Fail Criteria:

1. Dying gasp indication is recognized by OLT.

Remarks:

- None

7.3.3 PLOAM Queue Status

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 8.2.1.2.
- ITU-T G.9807.1 [12], Section C.8.1.2.1.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 8.2.1.2.

Test Objective:

Verify that the ONU can generate and the OLT can properly process the following upstream embedded OAM indication:

- PLOAM queue status

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Downstream FEC parity bits can be ignored (error-free reception is assumed).

Parameters of the bandwidth grants are at the discretion of the OLT.

Test Procedure:

1. The OLT sends two directed profile updates with increasing version numbers. No bandwidth grants are sent.
2. The OLT waits at least 10 ms and then sends a single bandwidth grant without PLOAMu.
3. The ONU responds with the PLOAM queue status bit asserted.
4. The OLT sends a single bandwidth grant with PLOAMu.
5. The ONU responds with an acknowledge message and PLOAM queue status bit asserted.
6. The OLT sends a single bandwidth grant with PLOAMu.
7. The ONU responds with an acknowledge message and the PLOAM queue status bit cleared.

Pass/Fail Criteria:

1. PLOAM status queue bit is correct.

Remarks:

- None

7.3.4 Dynamic Bandwidth Reporting

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 8.2.2.
- ITU-T G.9807.1 [12], Section C.8.1.2.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 8.2.2.

Test Objective:

Verify that the OLT can request and the ONU can generate DBR reports.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. This test can be performed only after the Alloc-ID allocation and de-allocation test has been performed successfully.
2. The OLT and ONU are powered and connected according to the test setup.
3. The ONU has been ranged and activated by the OLT.
4. Alloc-ID 1024 is assigned to the ONU, using the Assign_Alloc-ID PLOAM message. The PLOAM message is acknowledged.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Downstream FEC parity bits can be ignored (error-free reception is assumed).

Parameters for bandwidth allocation structures:

- Alloc-ID: 1024
- Flags: 2 (DBRu=1, PLOAMu=0)
- Start time: at the discretion of the OLT. Recommended value: 100
- Grant size: 1
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Test Procedure:

1. After ranging succeeds, the OLT sends the bandwidth allocation structures as described above.

2. Upon getting bandwidth grants, the ONU responds with a DBRu structure.
3. The OLT tests the CRC field of the DBRu.

Pass/Fail Criteria:

1. The OLT detects a DBRu header with correct CRC field.

Remarks:

- None

7.4 PLOAM Channel Operation

7.4.1 Multiple PLOAM Messages per Frame

Test Status: Refer to Section 6 (conditionally mandatory for the OLT, mandatory for the ONU)

Reference Documents:

- ITU-T G.987.3 [10], Sections 8.1.1, 8.1.4 and 11.
- ITU-T G.9807.1 [12], Sections C.8.1.1.1, C.8.1.1.4 and C.11.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 8.1.1, 8.1.4 and 11.

Test Objective:

Verify that the ONU is able to detect and process a broadcast PLOAM message and a unicast PLOAM message transmitted in the same XGTC/FS frame.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT. The ONU is assigned with ONU-ID=1.

Test Configuration:

Downstream FEC parity bits can be ignored (error-free reception is assumed).

Parameters for broadcast profile message:

- ONU-ID:
 - XG-PON/XGS-PON: 0x3FF/0x3FE (broadcast ONU-ID, according to the protocol and upstream rate under test and at the discretion of the OLT)
 - 25GS-PON: 0x3FB/0x3FC (broadcast ONU-ID, according to the protocol and upstream rate under test and at the discretion of the OLT)
 - HSP: 0x3FF/0x3FE/0x3FD/0x3FC (broadcast ONU-ID, according to the protocol and upstream rate under test and at the discretion of the OLT)
- For XG-PON and XGS-PON, Burst profile applicability flag (F): 0 for 2.5G upstream, 1 for 10G upstream (N/A for 25GS-PON)
- HSP:
 - Codepoint – as specified in G.9804.2 [14] for corresponding upstream rate

- Version: 0
- Profile index: 2
- Delimiter value: at the discretion of the OLT. Recommended value: 0xCE99 CE5E 5028 B41F
- All other parameters are the same as the burst profile number 0 described in Section 5.5.2 for XG-PON/XGS-PON and the burst profile number 1 for 25GS-PON/ HSP.

Parameters for registration request message:

- ONU-ID: 1
- The PLOAM MIC is calculated using the default PLOAM integrity key (see comment at 5.1)

Test Procedure and message timeline:

1. After ranging succeeds, the OLT sends the broadcast profile message and the registration request message in a single XGTC/FS frame. Transmission is done only once.
2. The ONU detects, reports, and counts both messages.

Pass/Fail Criteria:

1. The ONU successfully reports and counts both messages.

Remarks:

- The generation of this test case by the OLT can be non-trivial, as the precise timing of PLOAM message transmission might not be easily controllable due to layering. Hence, this test is conditional for the OLT. An ONU, however, must support such XGTC/FS frames and the test is mandatory for the ONU.

7.4.2 Burst Profile Version Changes – Single ONU

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 11.3.3.1.
- ITU-T G.9807.1 [12], Section C.11.3.3.1.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 11.3.3.1.

Test Objective:

Verify that the OLT can generate and the ONU can properly process the following downstream PLOAM message:

- Burst profile version changes

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT. The ONU is assigned with ONU-ID=1.

Test Configuration:

Downstream FEC parity bytes can be ignored (error-free reception is assumed).

Parameters for broadcast profile message:

- ONU-ID:
 - XG-PON/XGS-PON: 0x3FF/0x3FE (broadcast ONU-ID, according to the protocol and upstream rate under test and at the discretion of the OLT)
 - 25GS-PON: 0x3FB/0x3FC (broadcast ONU-ID, according to the protocol and upstream rate under test and at the discretion of the OLT)
 - HSP: 0x3FF/0x3FE/0x3FD/0x3FC (broadcast ONU-ID, according to the protocol and upstream rate under test and at the discretion of the OLT)
- For XG-PON and XGS-PON, Burst profile applicability flag (F): 0 for 2.5G upstream, 1 for 10G upstream (N/A for 25GS-PON)
- HSP:
 - Codepoint – as specified in G.9804.2 [14] for corresponding upstream rate
- Version: 0
- Profile index: 2

- Delimiter value: at the discretion of the OLT. Recommended value: 0xCE99 CE5E 5028 B41F
- All other parameters are the same as the burst profile number 0 described in Section 5.5.2 for XG-PON/XGS-PON and the burst profile number 1 for 25GS-PON/HSP.

Parameters for directed profile message:

- ONU-ID: 1
- Burst profile applicability flag (F): 0 for 2.5G upstream, 1 for 10G upstream (N/A for 25GS-PON)
- Version: 1
- Profile index: 2
- Delimiter value: at the discretion of the OLT, but different than the broadcast profile message. Recommended value: 0xB752 1F06 48AD E879
- All other parameters are the same as the burst profile number 0 described in Section 5.5.2 for XG-PON/XGS-PON and the burst profile number 1 for 25GS-PON/HSP.

Parameters for bandwidth allocation structures are at the discretion of the OLT. Profile index 2 should be used.

Test Procedure and message timeline:

1. After ranging succeeds, the OLT sends the broadcast profile message at least twice.
2. The OLT sends bandwidth allocation structures with profile index 2.
3. Upon getting bandwidth grants, the ONU responds with idle XGEM frames.
4. The OLT detects idle traffic from the ONU in the expected windows.
5. The OLT stops sending bandwidth grants. It sends the directed profile message as described above, and is configured for the second set of parameters. It then resumes sending bandwidth grants, with PLOAMu allowed at regular intervals.
6. The ONU updates to the new profile and responds with the XGEM frame described above for the granted bandwidth. When PLOAMu is granted, the ONU acknowledges the profile update.
7. The OLT detects idle traffic from the ONU in the expected windows.

Pass/Fail Criteria:

1. The ONU reports a successful profile update.
2. The OLT detects idle traffic from the ONU in the expected windows.
3. The OLT should count the number of answered allocations and the ONU should count the number of granted allocations.

Remarks:

- None

7.4.3 Burst Profile Version Changes – Mixed Rate

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 11.3.3.1.
- ITU-T G.9807.1 [12], Section C.11.3.3.1.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 11.3.3.1.

Test Objective:

Verify that the OLT can generate and the ONU can properly process the following downstream PLOAM message in a mixed rate system:

- Broadcast Burst profile version changes

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and the ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.

Test Configuration:

Downstream FEC parity bits can be ignored (error-free reception is assumed).

Parameters for first set of broadcast profile messages:

- ONU-ID:
 - XG-PON/XGS-PON: 0x3FF/0x3FE (broadcast ONU-ID, according to the protocol and upstream rate under test and at the discretion of the OLT)
 - 25GS-PON: 0x3FB/0x3FC (broadcast ONU-ID, according to the protocol and upstream rate under test and at the discretion of the OLT)
 - HSP: ONU-ID: 0x3FF/0x3FE/0x3FD/0x3FC (broadcast ONU-ID, according to the protocol and upstream rate under test and at the discretion of the OLT)
- For XG-PON and XGS-PON, Burst profile applicability flag (F): 0 for 2.5G upstream, 1 for 10G upstream (N/A for 25GS-PON)
- Version: 0
- Profile index: 2
- Delimiter value: at the discretion of the OLT. Recommended value: 0xCE99 CE5E 5028 B41F

- All other parameters are the same as the burst profile number 0 described in Section 5.5.2 for XG-PON/XGS-PON and the burst profile number 1 for 25GS-PON/HSP.

Parameters for second set of broadcast profile messages:

- ONU-ID:
 - XG-PON/XGS-PON: 0x3FF/0x3FE (broadcast ONU-ID, according to the protocol and upstream rate under test and at the discretion of the OLT)
 - 25GS-PON: 0x3FB/0x3FC (broadcast ONU-ID, according to the protocol and upstream rate under test and at the discretion of the OLT)
 - HSP: ONU-ID: 0x3FF/0x3FE/0x3FD/0x3FC (broadcast ONU-ID, according to the protocol and upstream rate under test and at the discretion of the OLT)
- For XG-PON and XGS-PON, Burst profile applicability flag (F): 0 for 2.5G upstream, 1 for 10G upstream (N/A for 25GS-PON)
- HSP-specific:
 - Codepoint – as specified in G.9804.2 [14] for corresponding upstream rate
- Version: 1
- Profile index: 2
- Delimiter value: at the discretion of the OLT, but different than the broadcast profile message. Recommended value: 0xB752 1F06 48AD E879
- All other parameters are the same as the burst profile number 0 described in Section 5.5.2 for XG-PON/XGS-PON and the burst profile number 1 for 25GS-PON/HSP.

Parameters for bandwidth allocation structures are at the discretion of the OLT. Profile index 2 should be used.

Test Procedure and message timeline:

1. After ranging succeeds, the OLT sends a broadcast profile message from the first set of profile messages. Each message is sent at least twice for each rate.
2. The OLT sends bandwidth allocation structures with profile index 2, containing bandwidth allocation grants for the ONUs of both upstream rates.
3. Upon getting bandwidth grants, the ONUs respond with idle XGEM frames.
4. The OLT detects idle traffic from the ONUs in the expected windows.
5. The OLT stops sending bandwidth grants. It sends broadcast profile messages, from the second set of profile messages, directed only to one of the upstream rates. It then resumes sending bandwidth grants.
6. If targeted (i.e., transmitting at the selected upstream rate), the ONU updates to the new profile. The ONUs respond with the XGEM frame described above for the granted bandwidth.
7. The OLT detects idle traffic from the ONU in the expected windows.

Pass/Fail Criteria:

1. Targeted ONUs (i.e., transmitting at the selected upstream rate) report a successful profile update. Non-targeted ONUs keep their current profiles.
2. The OLT detects idle traffic from the ONU in the expected windows.
3. The OLT should count the number of answered allocations and ONU should count the number of granted allocations.

Remarks:

- Multiple tests should be performed with broadcast profile messages directed to different upstream rates (stage 5 of the test procedure).

7.4.4 ONU Deactivation and Disable SN

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 11.3.3.4, 11.3.3.5.
- ITU-T G.9807.1 [12], Sections C.11.3.3.4, 11.3.3.5.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 11.3.3.4, 11.3.3.5.

Test Objective:

Verify that the OLT can generate and the ONU can properly process the following downstream PLOAM messages:

- ONU deactivation
- Disable serial number

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT. The ONU is assigned with ONU-ID=1.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Downstream FEC parity bits can be ignored (error-free reception is assumed).

Parameters for bandwidth allocation structures are at the discretion of the OLT.

Parameters for Deactivate_ONU-ID message:

- ONU-ID: 1
- SeqNo: unicast PLOAM sequence number
- PLOAM MIC is calculated using the default PLOAM integrity key

Parameters for disable serial number message:

- ONU-ID: 0x03FF
- Disable: 0xFF for disable, 0x00 for enable
- Vendor ID, VSSN: as learned in the ONU discovery test

Test Procedure and message timeline:

1. After ranging succeeds, the OLT sends bandwidth allocation structures with grants to the ONU.
2. Upon getting bandwidth grants, the ONU responds with idle XGEM frames.
3. The OLT detects idle traffic from the ONU in the expected windows.
4. The OLT sends a Deactivate_ONU-ID message. It then sends bandwidth grants.
5. The ONU transitions to state O1 then transitions to state O2-3 and does not respond to the grants.
6. The OLT ranges and activates the ONU.
7. After ranging succeeds, the OLT sends bandwidth allocation structures with grants to the ONU. The ONU responds with idle XGEM frames and OLT detects idle traffic from the ONU in the expected windows.
8. The OLT sends a disable serial number message with the disable setting. It then continues to send bandwidth grants to the ONU.
9. The ONU transitions to state O7 and does not respond to the grants.
10. The OLT sends a Disable_Serial_Number message with the “enable” setting.
11. The ONU transitions to state O1.
12. The OLT ranges and activates the ONU.
13. After ranging succeeds, the OLT sends bandwidth allocation structures with grants to the ONU. The ONU responds with idle XGEM frames and the OLT detects idle traffic from the ONU in the expected windows.

Pass/Fail Criteria:

1. Bandwidth grants sent for a deactivated or disabled ONU are not responded.
2. ONU transitions to state O1 then transitions to state O2-3 when receiving Deactivate_ONU-ID (step 5), to state O7 when receiving Disable_Serial_Number (step 9) and to state O1 when receiving enable serial number (step 11).
3. The ONU returns to regular operational state (O5) after each ranging and correctly responds to bandwidth grants.

Remarks:

- None

7.4.5 Alloc-ID Allocation and De-allocation

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 11.3.3.7.
- ITU-T G.9807.1 [12], Section C.11.3.3.7.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 11.3.3.7.

Test Objective:

Verify that the OLT can generate and the ONU can properly process the Assign_Alloc-ID downstream PLOAM message, with “Alloc-ID-type”:

- 1 – XGEM encapsulated payload
- 255 – de-allocate Alloc-ID

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Downstream FEC parity bits can be ignored (error-free reception is assumed).

Parameters for bandwidth allocation structures:

- Alloc-ID: 1, 2, 1024, 1025
- Start time: at the discretion of the OLT
- Grant size: 256
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Parameters for assign Alloc-ID message:

- ONU-ID: 1
- Alloc-ID value: 1024
- Alloc-ID type: 1 or 255, as described below

Test Procedure and message timeline:

1. After ranging succeeds and ONU-ID 1 is activated, the OLT sends the bandwidth allocation structures with grants to all four specified Alloc-IDs.
2. Upon getting bandwidth grants, the ONU responds with idle XGEM frames only to Alloc-ID 1.
3. The OLT detects idle traffic from the ONU in the expected windows. Only grants to Alloc-ID 1 are responded.
4. The OLT sends an Assign_Alloc-ID with type 1 and Alloc-ID 1024 to ONU-ID 1. It then sends a grant with PLOAMu to Alloc-ID 1
5. The ONU acknowledges the message.
6. The OLT sends bandwidth allocation structures with grants to all four specified Alloc-IDs. Only grants to Alloc-IDs 1 and 1024 are responded to.
7. The OLT sends an Assign_Alloc-ID with type 255 and Alloc-ID 1024 to ONU-ID 1. It then sends a grant with PLOAMu to Alloc-ID 1.
8. The ONU acknowledges the message.
9. The OLT sends bandwidth allocation structures with grants to all four specified Alloc-IDs. Only grants to Alloc-ID 1 are responded to.

Pass/Fail Criteria:

1. OLT detects idle traffic from ONU in the expected windows. Only bandwidth allocation structures to assigned Alloc-IDs are responded - when other Alloc-IDs are granted, there is no reply from ONU.
2. OLT should count the number of answered allocations and ONU should count the number of granted allocations.
3. ONU correctly acknowledges the assign Alloc-ID messages when granted.

Remarks:

- None

7.4.6 Encryption Key Exchange

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 15.5.3.
- ITU-T G.9807.1 [12], Section C.15.5.3.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 15.5.3.

Test Objective:

Verify that the OLT and ONU can correctly perform encryption key exchange. This test is focused on the PLOAM message format and not on the encryption of the data.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. The OLT and ONU are in states KL0 and KN0, respectively (no keys valid).

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Downstream FEC parity bits can be ignored (error-free reception is assumed).

Parameters for the key control message:

- ONU-ID: 1
- Control: 0 (generate a new key) / 1 (confirm existing key)
- Key index: 01
- Key length:
 - 16 bytes for 128 bit cipher
 - 32 bytes for 256 bit cipher

Parameters for the key report message for the new key:

- ONU-ID: 1
- Report type: 0 (new key)
- Key index: 01
- Fragment number: 0

Parameters for the key report message for confirmation:

- ONU-ID: 1
- Report type: 1 (existing key)
- Key index: 01
- Fragment number: 0

Test Procedure and message timeline:

1. The OLT sends a key control message for a new key.
2. The OLT provides a grant with PLOAMu.
3. The ONU responses with key report message for the new key.
4. The OLT prints the received key fragment (KEK encrypted key) and sends a key control message to confirm the key. It then provides a grant with PLOAMu.
5. The ONU sends a key report for the existing key.
6. The OLT displays the received key fragment (key name).

Pass/Fail Criteria:

1. Key fragments are correctly printed by OLT.

Remarks:

- Recommended value of actual encryption key:
 - For 128-bit cipher: 0x112233445566778899AABBCCDDEEFF00
 - For 256-bit cipher:
0x112233445566778899AABBCCDDEEFF00112233445566778899AABBCCDDEEFF00
- Timers TK1-TK5 might have to be relaxed for preliminary implementations

7.5 Forward error correction

7.5.1 Downstream FEC Operation

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 10.3.
- ITU-T G.9807.1 [12], Section C.10.1.3.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 10.3.

Test Objective:

Verify that the OLT and ONU can correctly generate and decode FEC parity bytes in the downstream direction and perform error-free data transmission.

Test Setup:

- As shown in Section 5
- The attenuation should be set to keep the ONU in the correctable range.

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.
Downstream FEC parity bits are processed.

Test Procedure:

1. After ranging succeeds, the OLT sends idle XGEM frames.
2. The ONU checks that idle XGEM frames are correctly received.
3. The variable attenuator is changed to make FEC correction evident.
4. The ONU checks that idle XGEM frames are correctly received.

Pass/Fail Criteria:

1. The ONU detects idle traffic under both conditions.
2. The number of bit errors on the ONU is zero.

Remarks:

- None

7.5.2 Upstream FEC Operation – Integral Multiple of Codeword Size

Test Status: Refer to Section 6

Not applicable to HSP

Reference Documents:

- ITU-T G.987.3 [10], Section 10.3.
- ITU-T G.9807.1 [12], Section C.10.1.3.
- 25GS-PON [1].

Test Objective:

Verify that the OLT and ONU can correctly generate and decode FEC parity bytes in the upstream direction and perform error-free data transmission.

Test Setup:

- As shown in Section 5
- The attenuation should be set to keep the OLT in the correctable range.

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters for bandwidth allocation structures:

- Alloc-ID: 1
- Flags: 0
- Start time: at the discretion of the OLT. Recommended value: 100
- Grant size:
 - 288 for 2.5G upstream
 - 67 for 10G upstream
 - 91 for 25G upstream
- FWI: 0
- Burst profile: 1

Test Procedure:

1. After ranging succeeds, the OLT sends the bandwidth allocation structures as described above.
2. Upon getting bandwidth grants, the ONU responds with the XGEM idle upstream traffic at the correct time.
3. The OLT verifies that idle XGEM frames are received from ONU.
4. The variable attenuator is changed to make FEC correction evident.
5. The OLT verifies that error-free XGEM idle frames are received.

Pass/Fail Criteria:

1. The OLT detects idle traffic from ONU in the expected windows under both conditions.
2. The number of bit errors on the OLT is zero when the OLT operates under optimal conditions.
3. The OLT should count the number of answered allocations and the ONU should count the number of granted allocations.

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Remarks:

- None

7.5.3 Upstream FEC Operation – Non-Integral Multiple of Codeword Size

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 10.3.
- ITU-T G.9807.1 [12], Section C.10.1.3.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 10.3.

Test Objective:

Verify that the OLT and ONU can correctly generate and decode FEC parity bytes in the upstream direction and perform error-free data transmission.

Test Setup:

- As shown in Section 5
- The attenuation should be set to keep the OLT in the correctable range.

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters for bandwidth allocation structures:

- Alloc-ID: 1
- Flags: PLOAMu=0 or PLOAMu=1
- Start time: at the discretion of the OLT. Recommended value: 100
- Grant size:
 - 289 for 2.5G upstream
 - 68 for 10G upstream
 - 92 for 25G upstream
 - HSP:
 - 571 for 12.5 upstream
 - 286 for 25G upstream.
- FWI: 0

- Burst profile: 1

Test Procedure:

1. After ranging succeeds, the OLT sends the bandwidth allocation structures as described above, one at a time.
2. Upon getting bandwidth grants, the ONU responds with the XGEM idle upstream traffic at the correct time.
3. The OLT verifies that idle XGEM frames are received from the ONU.
4. The variable attenuator is changed to make FEC correction evident.
5. The OLT checks for correctly received idle XGEM frames.

Pass/Fail Criteria:

1. The OLT detects idle traffic from the ONU in the expected windows under both conditions.
2. The number of bit errors on the OLT is zero when the OLT operates under optimal conditions.
3. The OLT should count the number of answered allocations and ONU should count the number of granted allocations.

Remarks:

- None

7.5.4 Upstream FEC Operation – Burst Series with Shared Parity Words

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 10.3.
- ITU-T G.9807.1 [12], Section C.10.1.3.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 10.3.

Test Objective:

Verify that the OLT and ONU can correctly generate and decode FEC parity bytes in the upstream direction and perform error-free data transmission.

Test Setup:

- As shown in Section 5
- The attenuation should be set to keep the OLT in the correctable range.

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT, the assigned ONU-ID is 1.
3. Alloc-ID 1024 is assigned to the ONU.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters for bandwidth allocation structures for 2.5G upstream:

Table 7-6 – Bandwidth Allocation for 2.5G Upstream Map #1

Access #	Alloc-ID	Start time	Grant size	PLOAMu	DBRu	FWI	Burst Profile
1	1	100	32	0	0	0	1
2	1024 (0x400)	65535 (0xFFFF)	256	0	0	0	1

Table 7-7 – Bandwidth Allocation for 2.5G Upstream Map #2

Access #	Alloc-ID	Start time	Grant size	PLOAMu	DBRu	FWI	Burst Profile
1	1	100	32	1	0	0	1
2	1024 (0x400)	65535 (0xFFFF)	256	0	0	0	1

Parameters for bandwidth allocation structures for 10G upstream:

Table 7-8 – Bandwidth Allocation for 10G Upstream Map #1

Access #	Alloc-ID	Start time	Grant size	PLOAMu	DBRu	FWI	Burst Profile
1	1	100	8	0	0	0	1
2	1024 (0x400)	65535 (0xFFFF)	59	0	0	0	1

Table 7-9 – Bandwidth Allocation for 10G Upstream Map #2

Access #	Alloc-ID	Start time	Grant size	PLOAMu	DBRu	FWI	Burst Profile
1	1	100	8	1	0	0	1
2	1024 (0x400)	65535 (0xFFFF)	59	0	0	0	1

Parameters for bandwidth allocation structures for 25G upstream:

Table 7-10 – Bandwidth Allocation for 25G Upstream Map #1

Access #	Alloc-ID	Start time	Grant size	PLOAMu	DBRu	FWI	Burst Profile
1	1	100	8	0	0	0	1
2	1024 (0x400)	65535 (0xFFFF)	83	0	0	0	1

Table 7-11 – Bandwidth Allocation for 25G Upstream Map #2

Access #	Alloc-ID	Start time	Grant size	PLOAMu	DBRu	FWI	Burst Profile
1	1	100	8	1	0	0	1
2	1024 (0x400)	65535 (0xFFFF)	83	0	0	0	1

Parameters for bandwidth allocation structures for HSP 12.5G upstream:

Table 7-12 – Bandwidth Allocation for HSP 12.5G Upstream Map #1

Access #	Alloc-ID	Start time	Grant size	PLOAMu	DBRu	FWI	Burst Profile
1	1	100	8	0	0	0	1
2	1024 (0x400)	65535 (0xFFFF)	140	0	0	0	1

Table 7-13 – Bandwidth Allocation for HSP 12.5G Upstream Map #2

Access #	Alloc-ID	Start time	Grant size	PLOAMu	DBRu	FWI	Burst Profile
1	1	100	8	1	0	0	1
2	1024 (0x400)	65535 (0xFFFF)	140	0	0	0	1

Parameters for bandwidth allocation structures for HSP 25G upstream:

Table 7-14 – Bandwidth Allocation for HSP 25G Upstream Map #1

Access #	Alloc-ID	Start time	Grant size	PLOAMu	DBRu	FWI	Burst Profile
1	1	100	8	0	0	0	1
2	1024 (0x400)	65535 (0xFFFF)	70	0	0	0	1

Table 7-15 – Bandwidth Allocation for HSP 25G Upstream Map #2

Access #	Alloc-ID	Start time	Grant size	PLOAMu	DBRu	FWI	Burst Profile
1	1	100	8	1	0	0	1
2	1024 (0x400)	65535 (0xFFFF)	70	0	0	0	1

Test Procedure:

1. After ranging succeeds, the OLT sends the bandwidth maps as described above, one after the other as a burst allocation series. Two burst allocation series are defined for this test, one with PLOAMu=0 and one with PLOAMu=1 that are sent in different XGTC/FS frames.
2. Upon getting bandwidth grants, the ONU responds with the XGEM idle upstream traffic at the correct time.
3. The OLT verifies that correct traffic is received from ONU.

Pass/Fail Criteria:

1. The OLT detects idle traffic from the ONU in the expected windows under both conditions.
2. The number of bit errors at the OLT is zero.
3. The OLT should count the number of answered allocations and the ONU should count the number of granted allocations.

Remarks:

- The start time value for the first allocation structure in each bandwidth map described above is a recommended value only, and can be changed at the discretion of the OLT.

7.5.5 Upstream FEC Operation – Mixed FEC and No-FEC Accesses – Multiple ONUs – Single Rate

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 10.3.
- ITU-T G.9807.1 [12], Section C.10.1.3.
- ITU-T G.9804.2 [14], Section 10.3.

Test Objective:

Verify that the OLT and ONU can correctly generate and decode FEC parity bytes in the upstream direction and perform error-free data transmission.

This test is not applicable to 25GS-PON.

Test Setup:

- As shown in Section 5
- Attenuation should be set for error-free operation.

Pretest Conditions:

1. The OLT and ONUs are powered and connected according to the test setup.
2. The ONUs have been ranged and activated by the OLT, the assigned ONU-IDs are 1 and 2.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters for bandwidth allocation structures:

Table 7-16 – Bandwidth Allocation Parameters for Upstream FEC Operation

Access #	Alloc-ID	Start time	Grant size	PLOAMu	DBRu	FWI	Burst Profile
1	1	100	256	0	0	0	1
2	2	1000	256	0	0	0	0

Test Procedure:

1. After ranging succeeds, the OLT sends the bandwidth maps as described above within the same XGTC/FS frame.
2. Upon getting bandwidth grants, each ONU responds with the XGEM idle upstream traffic at the correct time.
3. The OLT checks for correctly received idle XGEM frames from each of the ONUs.

Pass/Fail Criteria:

1. The number of bit errors on OLT is zero.
2. The OLT detects idle traffic from the ONUs in the expected windows.
3. The OLT should count the number of answered allocations and each ONU should count the number of granted allocations.

Remarks:

- None

7.5.6 Upstream FEC Operation – Multiple Rate

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 10.3.
- ITU-T G.9807.1 [12], Section C.10.1.3.
- ITU-T G.9804.2 [14], Section 10.3.

Test Objective:

Verify that the OLT and ONU can correctly generate and decode FEC parity bytes in the upstream direction and perform error-free data transmission in a multi rate system.
This test is not applicable to 25GS-PON.

Test Setup:

- As shown in Section 5
- Attenuation should be set for error-free operation.

Pretest Conditions:

1. The OLT and ONUs are powered and connected according to the test setup.
2. The ONUs have been ranged and activated by the OLT, the assigned ONU-IDs are 1 and 2.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters for bandwidth allocation structures:

Table 7-17 – Bandwidth Allocation Parameters for Upstream FEC Operation (XG(S)-PON)

Access #	Alloc-ID	Start time	Grant size	PLOAMu	DBRu	FWI	Burst Profile
1	1	100	256	0	0	0	Set by OLT (FEC on, 10G US)
2	2	1000	256	0	0	0	Set by OLT (FEC on, 2.5G US)

Table 7-18 – Bandwidth Allocation Parameters for Upstream FEC Operation (HSP)

Access #	Alloc-ID	Start time	Grant size	PLOAMu	DBRu	FWI	Burst Profile
1	1	100	256	0	0	0	Set by OLT (FEC on, 25G US)
2	2	1000	256	0	0	0	Set by OLT (FEC on, 12.5G US)

Test Procedure:

1. After ranging succeeds, the OLT sends the bandwidth maps described above within the same XGTC/FS frame.

2. Upon getting bandwidth grants, each ONU responds with the XGEM idle upstream traffic at the correct time.
3. The OLT checks for correctly received idle XGEM frames from each of the ONUs.

Pass/Fail Criteria:

1. The number of bit errors in the OLT is zero.
2. The OLT detects idle traffic from the ONUs in the expected windows.
3. The OLT should count the number of answered allocations and each ONU should count the number of granted allocations.

Remarks:

- None

7.6 Data transmission

7.6.1 OMCI Channel Establishment

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 9.
- ITU-T G.9807.1 [12], Section C.9.
- ITU-T G.988 [11], Section 11.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 9.

Test Objective:

- Verify that the OLT can properly detect a data pattern inserted by the ONU into a baseline (48-byte) OMCI SDU.
- Verify that the ONU can properly detect a data pattern inserted by the OLT into a baseline (48-byte) OMCI SDU.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. Default Port-ID 1 is provisioned on both downstream and upstream and assigned to Alloc-ID 1.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters for bandwidth allocation structures:

- Alloc-ID: 1
- Flags: 0
- Start time: at the discretion of the OLT
- Grant size: 14
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

XGEM header parameters for downstream and upstream OMCI messages:

- PLI: 48
- Key index: 0
- Port-ID: 1
- Options: 0
- Last fragment: 1

Downstream OMCI message (MIB reset):

- Transaction correlation identifier: 0x00 0x01
- Message type: 0x4F (acknowledge request, message type: MIB reset)
- Device identifier: 0x0A (baseline OMCI message)
- Managed entity identifier: 0x00 0x02 0x00 0x00 (entity class: ONU data, entity instance: 00)
- Message contents: 0x00 .. 0x00 (zero padding)
- OMCI trailer:
 - CPCS-UU, CPI: 0x00 0x00
 - Length of CPCS-SDU: 0x00 0x28
 - MIC

Upstream OMCI message (MIB reset response):

- Transaction correlation identifier: 0x00 0x01
- Message type: 0x2F (acknowledge, message type = MIB reset)
- Device identifier: 0x0A (baseline OMCI message)
- Managed entity identifier: 0x00 0x02 0x00 0x00 (entity class: ONU data, entity instance: 00)
- Message contents: 0x00 0x00 .. 0x00 (result: success, zero padding)
- OMCI trailer:
 - CPCS-UU, CPI: 0x00 0x00
 - Length of CPCS-SDU: 0x00 0x28
 - MIC

Test Procedure:

1. After ranging succeeds, the OLT sends the bandwidth allocation structures and downstream XGEM frames described above. Only one OMCI XGEM frame should be sent in an XGTC frame.

2. Upon getting bandwidth grants, the ONU responds with the upstream XGEM frame described above or with idle XGEM frames. The ONU should respond at least once with the described frame.
3. Both OLT and ONU display the received data.

Pass/Fail Criteria:

1. The correct OMCI messages are detected on OLT and ONU side at least once. Each MIB reset sent by the OLT shall be answered by a MIB reset response by the ONU.

Remarks:

- None

7.6.2 OMCI Channel Establishment – Multiple ONUs

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 9.
- ITU-T G.9807.1 [12], Section C.9.
- ITU-T G.988 [11], Section 11.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 9.

Test Objective:

- Verify that the OLT can properly detect a data pattern inserted by the ONU into a baseline (48-byte) OMCI SDU.
- Verify that each ONU can properly detect a data pattern inserted by the OLT into a baseline (48-byte) OMCI SDU.

Test Setup:

- As shown in Section 5 (without Ethernet traffic generator and analyzer).

Pretest Conditions:

1. The OLT and ONUs are powered and connected according to the test setup.
2. The ONUs have been ranged and activated by the OLT, with assigned ONU-IDs of 1 and 2.
3. The default Port-ID 1 is provisioned on both downstream and upstream and assigned to Alloc-ID 1 on ONU1.
4. The default Port-ID 2 is provisioned on both downstream and upstream and assigned to Alloc-ID 2 on ONU2.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters for bandwidth allocation structures, XGEM header and OMCI message are the same as the OMCI channel establishment test for a single ONU, with the relevant Alloc-IDs.

Test Procedure:

1. After ranging succeeds, the OLT sends the bandwidth allocation structures and XGEM frames as described above.
2. Upon getting bandwidth grants, the ONU responds with the XGEM frame described above or with idle XGEM frames. Each ONU should respond at least once with the described frame.
3. The OLT and both ONUs display the received data.

Pass/Fail Criteria:

1. The correct OMCI messages are detected on the OLT and on both ONUs at least once. Each MIB reset sent by the OLT shall be answered by a MIB reset response by the addressed ONU.

Remarks:

- None

7.6.3 Downstream Encryption Operation

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 15.4.
- ITU-T G.9807.1 [12], Section C.15.4.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 15.4.

Test Objective:

This test verifies that the encryption process and algorithm itself is correct in downstream direction, using the OMCI GEM port as reference.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. The default Port-ID 1 is provisioned on downstream.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Encryption key:

- For 128-bit cipher: 0x112233445566778899AABBCCDDEEFF00
- For 256-bit cipher:
0x112233445566778899AABBCCDDEEFF00112233445566778899AABBCCDDEEFF00

Downstream XGEM header parameters:

- PLI: 48
- Key index: 1
- Port-ID: 1
- Options: 0
- Last fragment: 1

Parameters for the OMCI messages are the same as in the OMCI channel establishment test for a single ONU.

Test Procedure:

1. After ranging succeeds, the OLT and the ONU are manually configured with the key above as the first key, and that key is made valid.
2. OLT sends at least two downstream XGEM frames per XGTC frame.
3. ONU tests and displays the received data.

Pass/Fail Criteria:

1. Correct downstream OMCI messages are detected in the ONU at least twice. No wrong messages are detected.

Remarks:

- None

7.6.4 Upstream Encryption Operation

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 15.4.
- ITU-T G.9807.1 [12], Section C.15.4.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 15.4.

Test Objective:

This test verifies that the encryption process and algorithm itself is correct in upstream direction, using the OMCI GEM port as reference.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. The default Port-ID 1 is provisioned on upstream and assigned to Alloc-ID 1.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Encryption key:

- For 128-bit cipher: 0x112233445566778899AABBCCDDEEFF00
- For 256-bit cipher:
0x112233445566778899AABBCCDDEEFF00112233445566778899AABBCCDDEEFF00

Parameters for bandwidth allocation structures:

- Alloc-ID: 1
- Flags: 0
- Start time: at the discretion of the OLT. Recommended value: 100
- Grant size: 28
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Upstream XGEM header parameters:

- PLI: 48
- Key index: 1
- Port-ID: 1
- Options: 0
- Last fragment: 1

Parameters for the OMCI messages are the same as in the OMCI channel establishment test for a single ONU.

Test Procedure:

1. After ranging succeeds, OLT and ONU are manually configured with the key above as the first key, and that key is made valid.
2. The OLT sends the bandwidth allocation structures described above.
3. Upon getting bandwidth grants, the ONU responds with two upstream XGEM frames as described above.
4. The OLT tests and displays the received data.

Pass/Fail Criteria:

1. Correct upstream OMCI messages are detected in the OLT. No wrong messages are detected.

Remarks:

- None

7.6.5 Downstream Ethernet Traffic Transmission

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 9.
- ITU-T G.9807.1 [12], Section C.9.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 15.4.

Test Objective:

Verify that the OLT can send and the ONU can properly receive Ethernet frames.

Test Setup:

- As shown in Section 5
- If the specified Port-ID cannot be provisioned manually, automatic provisioning is allowed. In such case, the exact Port-ID value will be coordinated after pairing.

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. Port-ID 1024 is provisioned on downstream.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Traffic is not encrypted.

Additional parameters (e.g., VLAN tag mapping, order of generator and analyzer enable) are to be coordinated after pairing.

Test Procedure:

1. After ranging succeeds, Port-ID 1024 is manually provisioned.
2. Traffic generators are enabled for downstream traffic.
3. Received data is tested by the Ethernet traffic analyzer.

Pass/Fail Criteria:

1. Correct downstream data is received by the Ethernet traffic analyzer connected to the ONU's UNI port.

Remarks:

- None

7.6.6 Upstream Ethernet Traffic Transmission

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 9.
- ITU-T G.9807.1 [12], Section C.9.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 9.

Test Objective:

Verify that the ONU can send and the OLT can properly receive Ethernet frames.

Test Setup:

- As shown in Section 5
- If the specified Port-ID and/or Alloc-ID cannot be provisioned manually, automatic provisioning is allowed. In such case, these parameters will be coordinated after pairing.

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. Port-ID 1024 is provisioned on upstream and assigned to Alloc-ID 1024.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Additional parameters (e.g., VLAN tag mapping, order of generator and analyzer enable) are to be coordinated after pairing.

Parameters for bandwidth allocation structures:

- Alloc-ID: 1024
- Start time: at the discretion of the OLT. Recommended value: 100
- Grant size: 8192 bytes
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Test Procedure:

1. After ranging succeeds, Port-ID 1024 is manually provisioned.

2. Traffic generators are enabled for upstream traffic.
3. Received data is tested by the Ethernet traffic analyzer.

Pass/Fail Criteria:

1. Correct upstream data is detected by the Ethernet traffic analyzer that is connected to the OLT's upstream (WAN-side) port.

Remarks:

- None

7.6.7 Bidirectional Ethernet Traffic Transmission

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 9.
- ITU-T G.9807.1 [12], Section C.9.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 9.

Test Objective:

Verify that the OLT and ONU can properly transfer Ethernet frames.

Test Setup:

- As shown in Section 5
- If the specified Port-ID and/or Alloc-ID cannot be provisioned manually, automatic provisioning is allowed. In such case, these parameters will be coordinated after pairing.

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. Port-ID 1024 is provisioned on both downstream and upstream and assigned to Alloc-ID 1024.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Additional parameters (e.g., VLAN tag mapping, order of generator and analyzer enable) are to be coordinated after pairing.

Parameters for bandwidth allocation structures:

- Alloc-ID: 1024
- Start time: at the discretion of the OLT
- Grant size: at the discretion of the OLT
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Test Procedure:

1. After ranging succeeds, Port-ID 1024 is manually provisioned.
2. Traffic generators are enabled for downstream and upstream traffic.

3. Received data is tested by the Ethernet traffic analyzer.

Pass/Fail Criteria:

1. Frames are received error free by the Ethernet traffic analyzer, both on ONU and on OLT side.

Remarks:

- None

7.6.8 Multiple Port-ID/Alloc-ID Data Transmission – Single ONU

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 9.
- ITU-T G.9807.1 [12], Section C.9.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 9.

Test Objective:

Verify that the OLT and ONU can properly transfer Ethernet frames using multiple Port-IDs and Alloc-IDs.

Test Setup:

- As shown in Section 5
- If the specified Port-IDs and/or Alloc-IDs cannot be provisioned manually, automatic provisioning is allowed. In such case, these parameters will be coordinated after pairing.

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. Port-IDs 1024 and 1025 are provisioned on both downstream and upstream and assigned to Alloc-IDs 1024 and 1025, correspondingly.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Additional parameters (e.g., VLAN tag mapping, order of generator and analyzer enable) are to be coordinated after pairing.

Parameters for bandwidth allocation structures:

- Alloc-ID: 1024, 1025
- Start time: at the discretion of the OLT
- Grant size: at the discretion of the OLT
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Test Procedure:

1. After ranging succeeds, Port-IDs are provisioned manually or automatically, as applicable.

2. Traffic generators are enabled for downstream and upstream traffic.
3. Data is sent on both XGEM ports in upstream and in downstream direction (four traffic flows).
4. Received data is tested by the Ethernet traffic analyzer.

Pass/Fail Criteria:

1. Frames are received error free by the Ethernet traffic analyzer, both on ONU and on OLT side.

Remarks:

- None

7.6.9 Bidirectional Ethernet Traffic Transmission – Multiple ONUs

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 9.
- ITU-T G.9807.1 [12], Section C.9.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 9.

Test Objective:

Verify that the OLT and multiple ONUs can properly transfer Ethernet frames.

Test Setup:

- As shown in Section 5
- If the specified Port-IDs and/or Alloc-IDs cannot be provisioned manually, automatic provisioning is allowed. In such case, these parameters will be coordinated after pairing.

Pretest Conditions:

1. The OLT and the ONUs are powered and connected according to the test setup.
2. The ONUs have been ranged and activated by the OLT.
3. Port-ID 1024 is provisioned on both downstream and upstream and assigned to Alloc-ID 1024 on ONU1.
4. Port-ID 1025 is provisioned on both downstream and upstream and assigned to Alloc-ID 1025 on ONU2.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Additional parameters (e.g., VLAN tag mapping, order of generator and analyzer enable) are to be coordinated after pairing.

Parameters for bandwidth allocation structures:

- Alloc-ID: 1024, 1025
- Start time: at the discretion of the OLT
- Grant size: at the discretion of the OLT
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Test Procedure:

1. After ranging succeeds, Port-IDs 1024 and 1025 are manually provisioned in ONU1 and ONU2, respectively.
2. Traffic generators are enabled for downstream and upstream traffic.
3. Received data is tested by the Ethernet traffic analyzer.

Pass/Fail Criteria:

1. Frames are received error free by the Ethernet traffic analyzer, on both ONUs and on OLT side.

Remarks:

- Additional ONUs can be connected to the test setup.

7.6.10 Downstream Interleave State Change during Bidirectional Ethernet Traffic Transmission

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.9804.2 [14], Section 10.5.

Test Objective:

- Verify that the OLT and ONU can properly transfer Ethernet frames when Downstream Interleaving configuration is changed during transmission

Test Setup:

- As shown in Section 5
- If the specified Port-ID and/or Alloc-ID cannot be provisioned manually, automatic provisioning is allowed. In such case, these parameters will be coordinated after pairing.

Pretest Conditions:

4. The OLT and ONU are powered and connected according to the test setup.
5. The ONU has been ranged and activated by the OLT.
6. Port-ID 1024 is provisioned on both downstream and upstream and assigned to Alloc-ID 1024.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Additional parameters (e.g., VLAN tag mapping, order of generator and analyzer enable) are to be coordinated after pairing.

Parameters for bandwidth allocation structures:

- Alloc-ID: 1024
- Start time: at the discretion of the OLT
- Grant size: at the discretion of the OLT
- FWI: 0
- Burst profile: 1

Test Procedure:

4. At the OLT, the downstream interleaving configuration is set to ONU
5. After ranging succeeds, Port-ID 1024 is manually provisioned.
6. The ONU displays the downstream interleaving state.
7. Traffic generators are enabled for downstream and upstream traffic.

8. Received data is tested by the Ethernet traffic analyzer.
9. The OLT sets interleaving to OFF.
10. The ONU displays the downstream interleaving state.
11. Received data is tested by the Ethernet traffic analyzer.

Pass/Fail Criteria:

1. Frames are received error free by both ONU and OLT at steps 4 and 8.
2. The downstream interleaving state displayed by ONU at steps 3 and 7 matches OLT configuration.

Remarks:

- None

7.6.11 Cross Alloc-ID busy indication

Test Status: Refer to Section 6 (Conditionally Mandatory if the OLT supports the withdrawal of directed allocations under the contention-based operation and the Cross-Alloc-ID busy operation is supported by the devices)

Reference Documents:

- ITU-T G.9804.2 [14], Section 8.2.

Test Objective:

Verify that the ONU transmits and OLT detects the Cross Alloc-ID busy indication in the upstream FS header

Test Setup:

- As shown in Section 5
- If the specified Port-IDs and/or Alloc-IDs cannot be provisioned manually, automatic provisioning is allowed. In such case, these parameters will be coordinated after pairing.

Pretest Conditions:

4. The OLT and ONU are powered and connected according to the test setup.
5. The ONU has been ranged and activated by the OLT.
6. Port-IDs 1024 and 1025 are provisioned on both downstream and upstream and assigned to Alloc-IDs 1024 and 1025, correspondingly.
7. At the OLT Alloc-ID 1024 is assigned to a traffic class that:
 - a. Withdraws bandwidth allocations on T-CONT inactivity
 - b. Uses Cross Alloc-ID busy indication to resume allocations to the T-CONT that previously was idle

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Additional parameters (e.g., VLAN tag mapping, order of generator and analyzer enable) are to be coordinated after pairing.

Parameters for bandwidth allocation structures:

- Alloc-ID: 1024, 1025
- Start time: at the discretion of the OLT
- Grant size: at the discretion of the OLT
- FWI: 0
- Burst profile: 1.

Test Procedure:

1. After ranging succeeds, Port-IDs are provisioned manually or automatically, as applicable.
2. Traffic generators are enabled for downstream and upstream traffic.
3. Received data is tested by the Ethernet traffic analyzer.
4. Stop the upstream traffic flow that is transmitted through T-CONT/Alloc-ID 1024 from traffic generator.
5. The OLT withdraws allocations for Alloc-IDs 1024.
6. Resume the upstream traffic flow for T-CONT/Alloc-ID 1024 from traffic generator.
7. The ONU transmits the Cross Alloc-ID busy indication in the upstream FS header.
8. The OLT resumes allocations for Alloc-IDs 1024.

Pass/Fail Criteria:

1. Frames are received error free by both ONU and OLT at step 3.
2. OLT detects and reports Cross Alloc-ID busy indication at step 7.
3. Frames are received error free by both ONU and OLT at step 8.

Remarks:

- None

7.6.12 Contention-based functions – ONU idle support

Test Status: Refer to Section 6 (Conditionally Mandatory if the OLT supports the withdrawal of directed allocations under the contention-based operation and Busy Alloc-ID field of Acknowledgement PLOAM is supported by the devices)

Reference Documents:

- ITU-T G.9804.2 [14], Section 7.5.2.

Test Objective:

Verify that the ONU transmits and the OLT detects the Busy Alloc-ID flag in the Acknowledgement PLOAM message.

Test Setup:

- As shown in Section 5
- If the specified Port-IDs and/or Alloc-IDs cannot be provisioned manually, automatic provisioning is allowed. In such case, these parameters will be coordinated after pairing.

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup
2. The ONU has been ranged and activated by the OLT
3. Port-IDs 1025 and 1026 are provisioned on both downstream and upstream and assigned to Alloc-IDs 1025 and 1026, correspondingly.
4. At the OLT Alloc-ID 1025 is assigned to traffic class that:
 - a. Withdraws bandwidth allocations on T-CONT inactivity
 - b. Uses Busy Alloc-ID in Acknowledgement PLOAM to resume allocations to T-CONT that previously was idle

Test Configuration:

Parameters for broadcast Assign Alloc-ID message:

- ONU-ID: 0x3FF (broadcast message for the contention-based Alloc-ID assignment)
- Alloc-ID-value: 1024
- Alloc-ID-type: 0x01
- Alloc-ID scope: 0x7F (fixed-wavelength TDM system)
- Contention-based function ID: 0x03 (ONU idle support)
- Contention-based function parameters:
 - Octet 1: Retransmission timeout: 0xFF.

Parameters for Acknowledgement message:

- ONU-ID: ONU-ID assigned to the ONU
- SeqNo: as specified in G.9804.2 [14] Table 11-28
- Completion_code: 0x00 (OK)
- Attenuation: as specified in G.9804.2 [14] clause 11.2.6.7
- Power levelling capability: as specified in G.9804.2 [14] clause 11.2.6.8
- Busy Alloc-ID: Alloc-ID 1025

Parameters for bandwidth allocation structures:

- Alloc-ID: 1024, 1025, 1026
- Start time: at the discretion of the OLT
- Grant size: at the discretion of the OLT
- FWI: 0
- Burst profile: 1.

Test Procedure and message timeline:

1. After ranging succeeds, Port-IDs are provisioned manually or automatically, as applicable.
2. Traffic generators are enabled for downstream and upstream traffic.
3. Received data is tested by the Ethernet traffic analyzer.
4. The OLT transmits the broadcast Assign Alloc-ID message.
5. Stop upstream traffic flow transmitted through T-CONT/Alloc-ID 1025 from traffic generator.
6. The OLT withdraws allocations for Alloc-IDs 1025.
7. Resume upstream traffic flow for T-CONT/Alloc-ID 1025 from the traffic generator.
8. The ONU responds with the Acknowledgement PLOAM message with Busy Alloc-ID set to 1025
9. The OLT resumes allocations for Alloc-IDs 1025.

Pass/Fail Criteria:

10. Frames are received error free by both ONU and OLT at step 3.
11. OLT detects and reports Busy Alloc-ID indication at step 8.
12. Frames are received error free by both ONU and OLT at step 9.

Remarks:

- None

8 Comprehensive TC Layer Tests

8.1 Authentication and Encryption

8.1.1 Registration-ID Based Authentication

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 11.3.3.6, 11.3.4.2.
- ITU-T G.9807.1 [12], Sections C.11.3.3.6, C.11.3.4.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 11.3.3.6, 11.3.4.2.

Test Objective:

Verify that the OLT can generate and the ONU can properly process the following downstream and upstream PLOAM messages:

- Request registration
- Registration (during state O5)

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters for registration request message:

- ONU-ID: 1
- The PLOAM MIC is calculated using the default PLOAM integrity key.

Parameters for registration message:

- ONU-ID: 1
- Registration ID: At the discretion of the ONU. Suggested value:
"0x12345ABDCEF012345ABDCEF0123412345ABDCEF012345ABDCEF01234".

- The PLOAM MIC is calculated using the default PLOAM integrity key.

Test Procedure and message timeline:

1. After ranging succeeds, the OLT sends the registration request message. It then sends a grant with PLOAMu.
2. Upon getting the bandwidth grant, the ONU responds with the registration message.
3. The OLT detects the registration message and displays the registration ID.

Pass/Fail Criteria:

1. The OLT confirms that the registration process has been successfully completed.

Remarks:

- None

8.1.2 Automatic Encryption Key Exchange and Traffic Transmission

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 15.4, 15.5.3.
- ITU-T G.9807.1 [12], Sections C.15.4, C.15.5.3.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 15.4, 15.5.3.

Test Objective:

Verify that the OLT and ONU can correctly perform automatic key exchange and encrypted data transmission.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. The OLT and ONU are in encryption key states KL0 and KN0, respectively (no keys are valid).

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters for key control message:

- ONU-ID: 1
- Control: 0 (generate a new key) / 1 (confirm existing key)
- Key index: 01
- Key length:
 - 16 bytes for 128 bit cipher
 - 32 bytes for 256 bit cipher

Parameters for key report message:

- ONU-ID: 1
- Report type: 0 (new key) / 1 (existing key)
- Key index: 01

- Fragment number: 0
- Key fragment: at the discretion of the ONU

Parameters for bandwidth allocation structures:

- Alloc-ID: 1
- Flags: 0
- Start time: at the discretion of the OLT. Recommended value: 100
- Grant size: 28
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

XGEM header parameters for downstream and upstream messages:

- PLI: 48
- Key index: 1
- Port-ID: 1
- Options: 0
- Last fragment: 1

Parameters for the OMCI messages are the same as in the OMCI channel establishment test for a single ONU (7.6.1).

Test Procedure and message timeline:

1. The OLT transitions to state KL1 and sends a key control message for a new key.
2. The ONU transitions to KN1, generates a new key, and then transitions to KN2. Key values before and after KEK encryption are displayed.
3. The OLT provides a grant with PLOAMu and the ONU responds with a key report message for the new key (containing the new KEK-encrypted key).
4. The OLT transitions to KL2, displays the received key fragment (KEK encrypted key) and its decryption, transitions to KL3, and sends a key control message to confirm the key. It then provides a grant with PLOAMu.
5. The ONU transitions to KN3 and sends a key report for the existing key. It then transitions to KN4.
6. The OLT displays the received key fragment (key name), verifies it and transitions to KL4.
7. The OLT sends the bandwidth allocation structures as described above, and two downstream XGEM frames per XGTC frame, as described above. These messages are sent to the default XGEM port-ID of the ONU (i.e., 1) and are encrypted.

8. Upon getting bandwidth grants, the ONU responds with the upstream XGEM frame described above or with idle XGEM frames. The ONU should respond at least once with the described frame.
9. Both the OLT and the ONU test and display the received data.

Pass/Fail Criteria:

1. Keys are correctly displayed by the OLT at steps 4 and 6. Key decryption and verification succeeds.
2. The OLT and ONU are in states KL4 and KN4, respectively.
3. Correct OMCI messages are detected in both OLT and ONU at least twice. No wrong messages are detected.

Remarks:

- This test assumes some means to verify keys were updated.

8.1.3 Encrypted Ethernet Transmission

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 9, 15.4, 15.5.3.
- ITU-T G.9807.1 [12], Sections C.15.4, C.15.5.3.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 9, 15.4, 15.5.3.

Test Objective:

Verify that the OLT and ONU can correctly perform encrypted Ethernet transmission.

Test Setup:

- As shown in Section 5
- If the specified Port-IDs and/or Alloc-IDs cannot be provisioned manually, automatic provisioning is allowed. In such case, these parameters will be coordinated after pairing.

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. Port-ID 1024 is provisioned on both downstream and upstream and assigned to Alloc-ID 1024. Might be provisioned either by scripts or by OMCI.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Additional parameters (e.g., VLAN tag mapping, order of generator and analyzer enable) are to be coordinated after pairing.

Parameters for bandwidth allocation structures:

- Alloc-ID: 1024
- Start time: at the discretion of the OLT
- Grant size: should be set small enough to cause the encrypted data to require two grants to carry.
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Test Procedure:

1. After ranging succeeds, Port-ID 1024 is manually provisioned.

2. The key exchange process is done.
3. Traffic generators are enabled for downstream and upstream traffic. Generate Ethernet traffic across a range of frame sizes between 64 bytes and the mutually supported maximum frame size. Use at least four different sizes, including the minimum and maximum size.
4. Received data is tested by the Ethernet traffic analyzer.

Pass/Fail Criteria:

1. Frames are received error free by both ONU and OLT.

Remarks:

- None

8.1.4 Multicast Encryption Operation

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 15.4.
- ITU-T G.9807.1 [12], Section C.15.4.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Section 15.4.

Test Objective:

Verify that the OLT can correctly transmit encrypted multicast data to multiple ONUs. Additional parameters (e.g., VLAN tag mapping, order of generator and analyzer enable) are to be coordinated after pairing.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONUs are powered and connected according to the test setup.
2. The ONUs have been ranged and activated by the OLT.
3. Port-ID 1028 is provisioned on downstream as a broadcast Port-ID.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Encryption key:

- For 128 bit cipher: 0x112233445566778899AABBCCDDEEFF00
- For 256 bit cipher:
0x112233445566778899AABBCCDDEEFF00112233445566778899AABBCCDDEEFF00

Test Procedure:

1. After ranging succeeds, Port-ID 1028 is manually provisioned as a broadcast Port-ID in the OLT and ONUs.
2. The OLT and the ONUs are manually configured with the key above as the first broadcast key, and that key is made valid.
3. Traffic generators are enabled for downstream traffic. Generate Ethernet traffic across a range of frame sizes between 64 bytes and the mutually supported maximum frame size. Use at least four different sizes, including the minimum and maximum size.
4. Received data is tested by the Ethernet traffic analyzer.

Pass/Fail Criteria:

1. Downstream multicast frames are received error free by all ONUs.

Remarks:

- If the specified Port-ID cannot be provisioned manually, automatic provisioning is allowed. In such case, these parameters will be coordinated after pairing.

8.1.5 ONU Re-Activation After Fiber Disconnection with Registration-ID Based Authentication

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 9, 15.2, 15.3 and 15.7.
- ITU-T G.9807.1 [12], Sections C.9, C.15.2, C.15.3 and C.15.7.
- ITU-T G.988 [11], Section 11.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 9, 15.2, 15.3 and 15.7.

Test Objective:

- Verify that the OLT can successfully re-activate the ONU after fiber disconnection.
- Verify that session keys are initialized correctly following a re-activation.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. Default Port-ID 1 is provisioned on both downstream and upstream and assigned to Alloc-ID 1.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test. Other parameters for the ranging process are defined in tests 7.1.1 and 7.1.2.

Parameters for bandwidth allocation structures:

- Alloc-ID: 1
- Flags: 0
- Start time: at the discretion of the OLT
- Grant size: 14
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

XGEM header parameters for downstream and upstream OMCI messages:

- PLI: 48
- Key index: 0
- Port-ID: 1
- Options: 0
- Last fragment: 1

Parameters for the OMCI messages are the same as in the OMCI channel establishment test for a single ONU.

Test Procedure:

1. After ranging succeeds, the OLT sends the bandwidth allocation structures and downstream XGEM frames as described above. Only one OMCI XGEM frame should be sent in an XGTC frame.
2. Upon getting bandwidth grants, the ONU responds with the upstream XGEM frame described above or with idle upstream XGEM frames. The ONU should respond at least once with the described frame.
3. Both the OLT and the ONU display the received data and verify that the OMCI MIC is correct.
4. The fiber is disconnected. The ONU transitions to state O1.
5. The master session key (MSK) for the ONU and all the derived keys are discarded.
6. The fiber is reconnected. The ONU transitions to state O2-3.
7. Ranging process is performed as described in tests 7.1.1, 7.1.2.
8. The ONU transitions to state O5. PLOAM MIC results for the ranging time and acknowledge messages are correct. The default Port-ID 1 is provisioned on both downstream and upstream and assigned to Alloc-ID 1.
9. After ranging succeeds, the OLT sends the bandwidth allocation structures and downstream XGEM frames described above. Only one downstream OMCI XGEM frame should be sent in an XGTC frame.
10. Upon getting bandwidth grants, the ONU responds with the upstream XGEM frame described above or with idle XGEM frames. The ONU should respond at least once with the described frame.
11. Both the OLT and the ONU display the received data and verify that the OMCI MIC is correct.

Pass/Fail Criteria:

1. Correct OMCI message with correct OMCI MIC are detected in both OLT and ONU at least once before fiber disconnection (step 3).
2. The ONU has entered regular operational state (O5) after fiber reconnection (step 8).

3. The correct PLOAM MIC is detected for ranging time and acknowledge messages (step 8).
4. Correct OMCI messages with correct OMCI MIC are detected in both OLT and ONU at least once after fiber disconnection (step 11).

Remarks:

- None

8.1.6 Automatic Encryption Key Exchange during Traffic

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 15.4, 15.5.3.
- ITU-T G.9807.1 [12], Sections C.15.4, C.15.5.3.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 15.4, 15.5.3.

Test Objective:

Verify that the OLT and ONU can correctly perform automatic key exchange and encrypted data transmission.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. The OLT and ONU are in states KL4 and KN4, respectively.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters for key control message:

- ONU-ID: 1
- Key length:
 - 16 bytes for 128 bit cipher
 - 32 bytes for 256 bit cipher

Parameters for key report message:

- ONU-ID: 1
- Fragment number: 0
- Key fragment: at the discretion of the ONU

Parameters for the OMCI messages are the same as in the OMCI channel establishment test for a single ONU.

Test Procedure and message timeline:

1. The OLT continuously sends the bandwidth allocation structures with bandwidth allocated to the ONU, and two encrypted downstream XGEM frames per XGTC frame.
2. Upon getting bandwidth grants, the ONU responds with two encrypted upstream XGEM frames as described above and idle XGEMs.
3. Both the OLT and the ONU test and display the received data.
4. A new key exchange is initiated by the OLT: the OLT transitions to state KL1 and sends a key control message for a new key. Downstream and upstream data is not stopped.
5. ONU transitions to KN1, generates a new key and then to KN2. Key values before and after KEK encryption are displayed.
6. The OLT provides a grant with PLOAMu and ONU responses with key report message for the new key (KEK encrypted key).
7. The OLT transitions to KL2, prints the received key fragment (KEK encrypted key) and its decryption, transitions to KL3 and sends a key control message to confirm the key. It then provides a grant with PLOAMu.
8. The ONU transitions to KN3 and sends a key report for the existing key. It then transitions to KN4.
9. The OLT displays the received key fragment (key name), verifies it and transitions to KL4.
10. Both the OLT and the ONU continue to test and display the received data.

Pass/Fail Criteria:

1. Keys are correctly printed by OLT at steps 7 and 9. Key decryption and verification succeeds.
2. At the end of the test, OLT and ONU return to states KL4 and KN4, respectively.
3. Correct OMCI messages detected in both the OLT and the ONU during the whole test. No wrong messages are detected.

Remarks:

- None

8.1.7 Secure Mutual Authentication – OMCI Based

Test Status: Refer to Section 6 (Conditionally Mandatory if Secure Mutual Authentication based on OMCI is supported by the devices)

Reference Documents:

- ITU-T G.987.3 [10], Sections 9, 15.2, 15.3 and 15.7.
- ITU-T G.9807.1 [12], Sections C.9, C.15.2, C.15.3 and C.15.7.
- ITU-T G.988 [11], Section 9.13.11.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 9, 15.2, 15.3 and 15.7.

Test Objective:

Verify that session keys are initialized correctly following a secure mutual authentication and re-activation.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. The default Port-ID 1 is provisioned on both downstream and upstream and assigned to Alloc-ID 1.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters for bandwidth allocation structures:

- Alloc-ID: 1
- Flags: 0
- Start time: at the discretion of the OLT
- Grant size: 14
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

XGEM header parameters for downstream and upstream messages:

- PLI: 48

- Key index: 0
- Port-ID: 1
- Options: 0
- Last fragment: 1

Parameters for the OMCI messages are the same as in the OMCI channel establishment test for a single ONU.

Test Procedure:

1. After ranging succeeds, OMCI based secure mutual authentication takes place.
2. The MSK is updated, based on the results of the secure mutual authentication.
3. Key derivation takes place.
4. The OLT sends the bandwidth allocation structures and downstream XGEM frames described above. Only one OMCI XGEM frame should be sent in an XGTC frame.
5. Upon getting bandwidth grants, the ONU responds with the upstream XGEM frame described above or with idle upstream XGEM frames. ONU should respond at least once with the described frame.
6. Both the OLT and the ONU display the received data and verify that the OMCI MIC is correct. The OMCI MIC is calculated using the keys derived after the secure mutual authentication process.

Pass/Fail Criteria:

1. Correct OMCI message with correct MIC are detected in both the OLT and the ONU at least once at steps 1 and 6. OMCI MIC at step 6 is calculated using the keys derived from secure mutual authentication process.

Remarks:

- None

8.1.8 Secure Mutual Authentication – 802.1x

Test Status: Refer to Section 6 (Conditionally Mandatory if Secure Mutual Authentication based on IEEE 802.1X is supported by the devices)

Reference Documents:

- ITU-T G.987.3 [10], Sections 9, 15.2, 15.3 and 15.7.
- ITU-T G.9807.1 [12], Sections C.9, C.15.2, C.15.3 and C.15.7.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 9, 15.2, 15.3 and 15.7.

Test Objective:

Verify that session keys are initialized correctly following a secure mutual authentication and re-activation.

Test Setup:

- As shown in Section 5
- If the specified Port-ID and/or Alloc-ID cannot be provisioned manually, automatic provisioning is allowed. In such case, these parameters will be coordinated after pairing.

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. The default Port-ID 1 is provisioned on both downstream and upstream and assigned to Alloc-ID 1.
4. Port-ID 1024 is provisioned on both downstream and upstream and assigned to Alloc-ID 1024.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters for bandwidth allocation structures:

- Alloc-ID: 1
- Flags: 0
- Start time: at the discretion of the OLT
- Grant size: 14
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

XGEM header parameters for downstream and upstream messages:

- PLI: 48
- Key index: 0
- Port-ID: 1
- Options: 0
- Last fragment: 1

Parameters for the OMCI messages are the same as in the OMCI channel establishment test for a single ONU.

Test Procedure:

1. After ranging succeeds, IEEE 802.1x-based secure mutual authentication takes place. Port-ID 1024 is provisioned for XGEM frames carrying IEEE 802.1x packets on downstream and upstream. The OLT shall provide appropriate bandwidth grants to Alloc-ID 1024 for 802.1x responses from ONU.
2. The MSK is updated, based on the results of the secure mutual authentication.
3. Key derivation takes place.
4. The OLT sends the bandwidth allocation structures and downstream XGEM frames described in the test configuration. Only one downstream OMCI XGEM frame should be sent in an XGTC frame.
5. Upon getting bandwidth grants, the ONU responds with the upstream XGEM frame described above or with idle upstream XGEM frames. The ONU should respond at least once with the described frame.
6. Both the OLT and the ONU display the received data and verify that the OMCI MIC is correct. The OMCI MIC is calculated using the keys derived after the secure mutual authentication process.

Pass/Fail Criteria:

1. Correct OMCI message with correct OMCI MIC are detected in both the OLT and the ONU at least once at steps 1 and 6. The OMCI MIC at step 6 is calculated using the keys derived from registration ID based authentication.

Remarks:

- None

8.1.9 ONU Re-Activation after Fiber Disconnection with Secure Mutual Authentication

Test Status: Refer to Section 6 (Conditionally Mandatory if Secure Mutual Authentication based on either OMCI or IEEE 802.1X is supported by the devices)

Reference Documents:

- ITU-T G.987.3 [10], Sections 9, 15.2, 15.3 and 15.7.
- ITU-T G.9807.1 [12], Sections C.9, C.15.2, C.15.3 and C.15.7.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 9, 15.2, 15.3 and 15.7.

Test Objective:

- Verify that session keys are initialized correctly following a secure mutual authentication and re-activation.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. Default Port-ID 1 is provisioned on both downstream and upstream and assigned to Alloc-ID 1.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test. Other parameters for the ranging process are defined in tests 7.1.1 and 7.1.2.

Parameters for bandwidth allocation structures:

- Alloc-ID: 1
- Flags: 0
- Start time: at the discretion of the OLT
- Grant size: 14
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

XGEM header parameters for downstream and upstream messages:

- PLI: 48
- Key index: 0
- Port-ID: 1
- Options: 0
- Last fragment: 1

Parameters for the OMCI messages are the same as in the OMCI channel establishment test for a single ONU.

Test Procedure:

1. After ranging succeeds, OMCI or IEEE 802.1x based secure mutual authentication takes place.
2. The MSK is updated, based on the results of the secure mutual authentication.
3. Key derivation takes place.
4. The OLT sends the bandwidth allocation structures and downstream XGEM frames described above. Only one downstream OMCI XGEM frame should be sent in an XGTC frame.
5. Upon getting bandwidth grants, the ONU responds with the upstream XGEM frame as described above or with idle upstream XGEM frames. The ONU should respond at least once with the described frame.
6. Both the OLT and the ONU display the received data and verify that the OMCI MIC is correct. OMCI MIC is calculated using the keys derived after the secure mutual authentication process.
7. The fiber is disconnected. The ONU transitions to state O1.
8. The master session key (MSK) for the ONU and all the derived keys are discarded.
9. The fiber is reconnected. The ONU transitions to state O2-3.
10. The ranging process is performed as described in tests 7.1.1, 7.1.2. A new key derivation takes place, based on the registration ID
11. The ONU transitions to state O5. The PLOAM MIC results for the ranging time and acknowledge messages are correct. The default Port-ID 1 is provisioned on both downstream and upstream and assigned to Alloc-ID 1.
12. After ranging succeeds, the OLT sends the bandwidth allocation structures and XGEM frames described above. Only one OMCI XGEM frame should be sent in an XGTC frame.
13. Upon getting bandwidth grants, the ONU responds with the upstream XGEM frame as described above or with idle upstream XGEM frames. The ONU should respond at least once with the described frame.
14. Both the OLT and the ONU display the received data and verify that the OMCI MIC is correct.

Pass/Fail Criteria:

1. Correct OMCI messages with correct OMCI MIC are detected in both the OLT and the ONU at least once before fiber disconnection (step 6). The OMCI MIC is calculated using the keys derived after the secure mutual authentication process.
2. The ONU has entered regular operational state (O5) after fiber reconnection at step 11.
3. The correct PLOAM MIC is detected for ranging time and acknowledge messages. The PLOAM MIC is calculated using the keys derived from registration ID based authentication (step 11).
4. The correct OMCI messages with correct OMCI MIC are detected in both the OLT and the ONU at least once after fiber disconnection (step 14). The OMCI MIC is calculated using the keys derived from registration ID based authentication.

Remarks:

- None

8.1.10 Request Registration after Secure Mutual Authentication

Test Status: Refer to Section 6 (Conditionally Mandatory if Secure Mutual Authentication is supported by the devices)

Reference Documents:

- ITU-T G.987.3 [10], Sections 11.3.3.6, 11.3.4.2 and 15.3.
- ITU-T G.9807.1 [12], Sections C.11.3.3.6, C.11.3.4.2 and C.15.3.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 11.3.3.6, 11.3.4.2 and 15.3.

Test Objective:

Verify that session keys are not updated on a registration ID report when there is a valid mutual security association between OLT and ONU.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters for registration request message:

- ONU-ID: 1
- MIC is calculated using the default PLOAM integrity key

Parameters for registration message:

- ONU-ID: 1
- Registration ID: At the discretion of the ONU. Suggested value:
0x12345ABDCEF012345ABDCEF0123412345ABDCEF012345ABDCEF01234.
- The PLOAM MIC is calculated using the default PLOAM integrity key.

XGEM header parameters for downstream and upstream messages:

- PLI: 48
- Key index: 0

- Port-ID: 1
- Options: 0
- Last fragment: 1

Parameters for the OMCI messages are the same as in the OMCI channel establishment test for a single ONU.

Test Procedure and message timeline:

1. After ranging succeeds, OMCI or IEEE 802.1x based secure mutual authentication takes place.
2. The MSK is updated, based on the results of the secure mutual authentication.
3. Key derivation takes place.
4. The OLT sends the bandwidth allocation structures and downstream XGEM frames described above. Only one downstream OMCI XGEM frame should be sent in an XGTC frame.
5. Upon getting bandwidth grants, the ONU responds with the upstream XGEM frame as described above or with idle upstream XGEM frames. The ONU should respond at least once with the described frame.
6. Both the OLT and the ONU display the received data and verify that the OMCI MIC is correct. The OMCI MIC is calculated using the keys derived after the secure mutual authentication process.
7. The OLT sends the registration request message. It then sends a grant with PLOAMu.
8. Upon getting the bandwidth grant, the ONU responds with the registration message.
9. The OLT detects the registration message and displays the registration ID.
10. The OLT sends bandwidth allocation structures and XGEM frames described above. Only one OMCI XGEM frame should be sent in an XGTC frame.
11. Upon getting bandwidth grants, the ONU responds with the upstream XGEM frame described above or with idle upstream XGEM frames. The ONU should respond at least once with the described frame.
12. Both the OLT and the ONU display the received data and verify that the OMCI MIC is correct. The OMCI MIC is calculated using the keys derived after the secure mutual authentication process and not from registration ID.

Pass/Fail Criteria:

1. Correct OMCI messages with correct OMCI MIC are detected in both OLT and ONU at least once before registration request (step 6). The OMCI MIC is calculated using the keys derived after the secure mutual authentication process.
2. The OLT detects the registration message from the ONU at step 9.

3. Correct OMCI messages with correct OMCI MIC are detected in both the OLT and the ONU at least once after registration request (step 12). OMCI MIC is calculated using the keys derived from secure mutual authentication and not from the registration ID.

Remarks:

- None

8.2 ONU Power Management Modes

8.2.1 Doze Mode

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 16, 11.3.3.9 and 11.3.4.5.
- ITU-T G.988 [11], Section 9.1.14.

Test Objective:

Verify that the ONU can correctly enter doze mode. Verify that the OLT can send FWI to wake up the ONU.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT, the assigned ONU-ID is 1.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.
Parameters of the bandwidth grants are at the discretion of the OLT.

Parameters for sleep allow message:

- ONU-ID: 1
- SeqNo: unicast PLOAM sequence number
- Sleep_Allow: 1 (on)

Parameters for sleep request message:

- ONU-ID: 1
- SeqNo: 0
- Activity level: 1 - Sleep request (doze)

Parameters for timers:

The parameters for the timers should be manually set at the ONU and the OLT before executing the test procedure.

- Isleep: Recommended value: 200 ms
- Iaware: Recommended value: 20 ms

- lhold: Recommended value: 20 ms

Test Procedure:

1. Ensure that the ONU is activated, supports power reduction management capability, and that doze mode only is enabled (see 9.1.14/G.988).
2. Ensure further that the OLT learns the ONU's power management design parameters: ltransinit, ltxinit, and configures the ONU's dynamic timing parameters: lsleep, laware, lhold (see 9.1.14/G.988).
3. Ensure that any local activity stimuli at the ONU are suppressed.
4. Initiate ONU power reduction at the OLT (by suppressing any remote ONU wakeup stimuli and/or issuing a console command, as appropriate for the OLT implementation).
5. Verify the OLT's actions and the ONU's response.
6. Disconnect the ONU fiber connector, or turn off the ONU power completely.
7. Verify the OLT's actions.
8. Restore ONU power/fiber connectivity and repeat steps 1 through 5.
9. Terminate the ONU power reduction at the OLT (by activating a remote wakeup stimulus or issuing a console command, as appropriate for the OLT implementation).
10. Verify the OLT's actions and the ONU's response.

Pass/Fail Criteria:

The test passes, if all of the following holds:

On Step 5:

- The OLT sends a Sleep_Allow(ON) message to the ONU.
- The OLT continues to provide allocations to the ONU, suppressing the FWI flag.
- The ONU responds with Sleep_Request(Doze) message.
- The ONU alternates between silence periods of duration at most lsleep+Delta1, where Delta1 is a fixed positive value includes ltxinit and tolerances, and periods when it does respond to bandwidth allocations of duration at least laware.
- The OLT detects the missing ONU's bursts, but does not trigger an alarm.

On Step 7:

- The OLT declares the LOBi defect against the ONU within lsleep+Delta2, where Delta2 is a fixed positive value that includes ltxinit, maximum round trip time for the network configuration, and tolerances.

On Step 10:

- The OLT sends a Sleep_Allow(OFF) message to the ONU.
- The OLT continues to provide allocations to the ONU with the FWI flag set.

- Within Delta2 time, the ONU sends a Sleep_Request(Awake) message and subsequently responds to all bandwidth allocations, where Delta2 is a fixed positive value that includes Itxinit, maximum round trip time for the network configuration, and tolerances.

Remarks:

- None

8.2.2 Doze Mode (ONU Wakeup)

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 16, 11.3.3.9 and 11.3.4.5.
- ITU-T G.988 [11], Section 9.1.14.

Test Objective:

Verify that the ONU can correctly enter doze mode. Verify that upon local ONU stimulus it can wake-up from doze mode.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT, the assigned ONU-ID is 1.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters of the bandwidth grants are at the discretion of the OLT.

Parameters for sleep allow message:

- ONU-ID: 1
- SeqNo: unicast PLOAM sequence number
- Sleep_Allow: 1 (on)

Parameters for sleep request message:

- ONU-ID: 1
- SeqNo: 0
- Activity level: 0, 1 - Sleep request (awake, doze)

Parameters for timers:

The parameters for the timers should be manually set at the ONU and the OLT before executing the test procedure.

- Isleep: Recommended value: 200 ms
- Iaware: Recommended value: 20 ms
- Ihold: Recommended value: 20 ms

Test Procedure:

1. Ensure that the ONU is activated, supports power reduction management capability, and that **doze mode only** is enabled (see 9.1.14/G.988).
2. Ensure further that the OLT learns the ONU's power management design parameters: Itransinit, Itxinit, and configures the ONU's dynamic timing parameters: Isleep, Iaware, Ihold (see 9.1.14/G.988).
3. Ensure that any local activity stimuli at the ONU are suppressed.
4. Initiate ONU power reduction at the OLT (by suppressing any remote ONU wakeup stimuli and/or issuing a console command, as appropriate for the OLT implementation).
5. Verify the OLT's actions and the ONU's response.
6. Terminate the ONU power reduction mode by activating an appropriate local activity stimulus at the ONU.
7. Verify the ONU's actions and the OLT's response.

Pass/Fail Criteria:

The test passes, if all of the following holds:

1. On Step 5: see TC 8.2.1
2. On Step 7: within Delta1 time, the ONU sends a Sleep_Request(Awake) message and subsequently responds to all bandwidth allocations, where Delta1 is a fixed positive value that includes Itxinit and tolerances.

Remarks:

- None

8.2.3 Cyclic Sleep

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 16, 11.3.3.9 and 11.3.4.5.
- ITU-T G.988 [11], Section 9.1.14.

Test Objective:

Verify that the ONU can correctly enter cyclic sleep mode. Verify that the OLT can send FWI to wake up the ONU.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT, the assigned ONU-ID is 1.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters of the bandwidth grants are at the discretion of the OLT.

Parameters for sleep allow message:

- ONU-ID: 1
- SeqNo: unicast PLOAM sequence number
- Sleep_Allow: 1 (on)

Parameters for sleep request message:

- ONU-ID: 1
- SeqNo: 0
- Activity level: 2 - Sleep request (sleep)

Parameters for timers:

The parameters for the timers should be manually set at the ONU and the OLT before executing the test procedure.

- Isleep: Recommended value: 200 ms
- Iaware: Recommended value: 20 ms
- Ihold: Recommended value: 20 ms

Test Procedure:

1. Ensure that the ONU is activated, supports power reduction management, and that cyclic sleep mode only is enabled (see 9.1.14/G.988).
2. Ensure further that the OLT learns the ONU's power management design parameters: Itransnit, Itxinit, and configures ONU's dynamic timing parameters: Isleep, Iaware, Ihold (see 9.1.14/G.988).
3. Ensure that any local activity stimuli at the ONU are suppressed.
4. Initiate ONU power reduction at the OLT (by suppressing any remote ONU wakeup stimuli and/or issuing a console command, as appropriate for the OLT implementation).
5. Verify the OLT's actions and the ONU's response.
6. Disconnect the ONU fiber connector, or turn off the ONU power completely.
7. Verify the OLT's actions.
8. Restore the ONU power/fiber connectivity and repeat steps 1 through 5.
9. Terminate the ONU power reduction at the OLT (by activating a remote wakeup stimulus or issuing a console command, as appropriate for the OLT implementation).
10. Verify the OLT's actions and the ONU's response.

Pass/Fail Criteria:

The test passes, if all of the following holds:

On Step 5:

- The OLT sends a Sleep_Allow(ON) message to the ONU.
- The OLT continues to provide allocations to the ONU, suppressing the FWI flag.
- The ONU responds with Sleep_Request(Sleep) message.
- The ONU alternates between silence periods of duration at most Isleep+Delta3, where Delta3 is a fixed positive value includes Itransmit and tolerances, and periods when it does respond to bandwidth allocations of duration at least Iaware.
- The OLT detects the missing ONU's bursts but does not trigger an alarm.

On Step 7:

- The OLT declares the LOBi defect against the ONU within Isleep+Delta4, where Delta4 is a fixed positive value that includes Itransmit, maximum round trip time for the network configuration, and tolerances.

On Step 10:

- The OLT sends a Sleep_Allow(OFF) message to the ONU.
- The OLT continues to provide allocations to the ONU with the FWI flag set,
- Within Isleep+Delta4, the ONU sends a Sleep_Request(Awake) message and subsequently responds to all bandwidth allocations, where Delta4 is a fixed positive value that includes Itransmit, maximum round trip time for the network configuration, and tolerances.

Remarks:

- None

8.2.4 Cyclic Sleep (ONU Wakeup)

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 16, 11.3.3.9 and 11.3.4.5.
- ITU-T G.988 [11], Section 9.1.14.

Test Objective:

Verify that the ONU can correctly enter cyclic sleep mode. Verify that upon local ONU stimulus it can wake-up from cyclic sleep.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT, the assigned ONU-ID is 1.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters of the bandwidth grants are at the discretion of the OLT.

Parameters for sleep allow message:

- ONU-ID: 1
- SeqNo: unicast PLOAM sequence number
- Sleep_Allow: 1 (on)

Parameters for sleep request message:

- ONU-ID: 1
- SeqNo: 0
- Activity level: 0, 2 - Sleep request (awake, sleep)

Parameters for timers:

The parameters for the timers should be manually set at the ONU and the OLT before executing the test procedure.

- Isleep: Recommended value: 200 ms
- Iaware: Recommended value: 20 ms
- Ihold: Recommended value: 20 ms

Test Procedure:

1. Ensure that the ONU is activated, supports power reduction management, and that cyclic sleep mode only is enabled (see 9.1.14/G.988).
2. Ensure further that the OLT learns the ONU's power management design parameters: Itransinit, Itxinit, and configures ONU's dynamic timing parameters: Isleep, Iaware, Ihold (see 9.1.14/G.988).
3. Ensure that any local activity stimuli at the ONU are suppressed.
4. Initiate ONU power reduction at the OLT (by suppressing any remote ONU wakeup stimuli and/or issuing a console command, as appropriate for the OLT implementation).
5. Verify the OLT's actions and the ONU's response.
6. Terminate ONU power reduction by activating an appropriate local activity stimulus at the ONU.
7. Verify the ONU's actions and the OLT's response.

Pass/Fail Criteria:

The test passes, if all of the following holds:

1. On Step 5: see TC 8.2.3
2. On Step 7: within Delta3 time, the ONU sends a Sleep_Request(Awake) message and subsequently responds to all bandwidth allocations, where Delta3 is a fixed positive value that includes Itransmit and tolerances.

Remarks:

- None

8.2.5 Watchful Sleep

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.9807.1 [12], Sections C.16.1, C.11.3.3.9 and C.11.3.4.5.
- ITU-T G.988 [11], Section 9.1.14.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 16.1, 11.3.3.9 and 11.3.4.5.

Test Objective:

Verify that the ONU can correctly enter watchful sleep mode. Verify that the OLT can send FWI to wake up the ONU.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT, the assigned ONU-ID is 1.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.
Parameters of the bandwidth grants are at the discretion of the OLT.

Parameters for sleep allow message:

- ONU-ID: 1
- SeqNo: unicast PLOAM sequence number
- Sleep_Allow: 1 (on)

Parameters for sleep request message:

- ONU-ID: 1
- SeqNo: 0
- Activity level: 3 - Sleep_Request (WSleep)

Parameters for timers:

The parameters for the timers should be manually set at the ONU and the OLT before executing the test procedure.

- Ilowpower: Recommended value: 200ms
- Irxoff: Recommended value: 600ms

- Iaware: Recommended value: 20 ms
- Ihold: Recommended value: 20 ms

Test Procedure:

1. Ensure that the ONU is activated, supports watchful sleep power reduction management, and that only watchful sleep mode is enabled (see 9.1.14/G.988).
2. Ensure further that the OLT learns the ONU's power management design parameter: Itransinit, and configures ONU's dynamic timing parameters: Ilowpower, Irxoff, Iaware, Ihold (see 9.1.14/G.988).
3. Ensure that any local activity stimuli at the ONU are suppressed.
4. Initiate ONU power reduction at the OLT (by suppressing any remote ONU wakeup stimuli and/or issuing a console command, as appropriate for the OLT implementation).
5. Verify the OLT's actions and the ONU's response.
6. Disconnect the ONU fiber connector, or turn off the ONU power completely.
7. Verify the OLT's actions.
8. Restore the ONU power/fiber connectivity and repeat steps 1 through 5.
9. Terminate the ONU power reduction at the OLT (by activating a remote wakeup stimulus or issuing a console command, as appropriate for the OLT implementation).
10. Verify the OLT's actions and the ONU's response.

Pass/Fail Criteria:

The test passes, if all of the following holds:

On Step 5:

- The OLT sends a Sleep_Allow(ON) message to the ONU.
- The OLT continues to provide allocations to the ONU, suppressing the FWI flag.
- The ONU responds with Sleep_Request(WSleep) message.
- The ONU alternates between silence periods of duration at most Ilowpower+Delta5, where Delta5 is a fixed positive value includes Irxoff and tolerances, and periods when it does respond to bandwidth allocations of duration at least Iaware.
- The OLT detects, the missing ONU's bursts, but does not trigger an alarm.

On Step 7:

- The OLT declares the LOBi defect against the ONU within Ilowpower+Delta6, where Delta6 is a fixed positive value that includes Irxoff, maximum round trip time for the network configuration, and tolerances.

On Step 10:

- The OLT sends a Sleep_Allow(OFF) message to the ONU.
- The OLT continues to provide allocations to the ONU with the FWI flag set,

- Within $I_{lowpower} + \Delta t_6$, the ONU sends a Sleep_Request(Awake) message and subsequently responds to all bandwidth allocations, where Δt_6 is a fixed positive value that includes I_{rxoff} , maximum round trip time for the network configuration, and tolerances.

Remarks:

- None

8.2.6 Watchful Sleep (ONU Wakeup)

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.9807.1 [12], Sections C.16.1, C.11.3.3.9 and C.11.3.4.5.
- ITU-T G.988 [11], Section 9.1.14.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 16.1, 11.3.3.9 and 11.3.4.5.

Verify that the ONU can correctly enter watchful sleep mode. Verify that upon local ONU stimulus it can wake-up from watchful sleep.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT, the assigned ONU-ID is 1.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters of the bandwidth grants are at the discretion of the OLT.

Parameters for sleep allow message:

- ONU-ID: 1
- SeqNo: unicast PLOAM sequence number
- Sleep_Allow: 1 (on)

Parameters for sleep request message:

- ONU-ID: 1
- SeqNo: 0
- Activity level: 0, 3 - Sleep_Request (Awake, WSleep)

Parameters for timers:

The parameters for the timers should be manually set at the ONU and the OLT before executing the test procedure.

- Ilowpower: Recommended value: 200ms
- Irxoff: Recommended value: 600ms

- Iaware: Recommended value: 20 ms
- Ihold: Recommended value: 20 ms

Test Procedure:

1. Ensure that the ONU is activated, supports watchful sleep power reduction management, and that only watchful sleep mode is enabled (see 9.1.14/G.988).
2. Ensure further that the OLT learns the ONU's power management design parameter: Itransinit, and configures ONU's dynamic timing parameters: Ilowpower, Irxoff, Iaware, Ihold (see 9.1.14/G.988).
3. Ensure that any local activity stimuli at the ONU are suppressed.
4. Initiate ONU power reduction at the OLT (by suppressing any remote ONU wakeup stimuli and/or issuing a console command, as appropriate for the OLT implementation).
5. Verify the OLT's actions and the ONU's response.
6. Terminate ONU power reduction by activating an appropriate local activity stimulus at the ONU.
7. Verify the ONU's actions and the OLT's response.

Pass/Fail Criteria:

The test passes, if all of the following holds:

1. On Step 5: see TC 8.2.5
2. On Step 7: within Delta7 time, the ONU sends a Sleep_Request(Awake) message and subsequently responds to all bandwidth allocations, where Delta7 is a fixed positive value that includes Irxoff and tolerances.

Remarks:

- None

8.2.7 Contention-based Watchful sleep

Test Status: Refer to Section 0

Reference Documents:

- ITU-T G.988 [11], Section 9.1.14.
- ITU-T G.9804.2 [14], Sections 16.1, 11.3.3.9 and 11.3.4.5.

Test Objective:

Verify that the ONU can correctly enter watchful sleep mode. Verify that the OLT can send FWI to wake up the ONU.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT, the assigned ONU-ID is 1.
3. OLT declares watchful sleep support Alloc ID by sending the broadcast Assign_Alloc-ID message for the Contention-based function ID 0x4 (watchful sleep support)

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.
Parameters of the bandwidth grants are at the discretion of the OLT.

Parameters for sleep allow message:

- ONU-ID: 1
- SeqNo: unicast PLOAM sequence number
- Sleep_Allow: 1 (on)

Parameters for sleep request message:

- ONU-ID: 1
- SeqNo: 0
- Activity level: 3 - Sleep_Request (WSleep)

Parameters for timers:

The parameters for the timers should be manually set at the ONU and the OLT before executing the test procedure.

- Ilowpower: Recommended value: 200ms
- Irxoff: Recommended value: 600ms
- Iaware: Recommended value: 20 ms
- Ihold: Recommended value: 20 ms

Test Procedure:

1. Ensure that the ONU is activated, supports watchful sleep power reduction management capability, and that only watchful sleep mode is enabled (see 9.1.14/G.988).
2. Ensure further that the OLT learns the ONU's power management design parameter: Itransinit, and configures the ONU's dynamic timing parameters: Ilowpower, Irxoff, Iaware, Ihold (see 9.1.14/G.988).
3. Ensure that any local activity stimuli at the ONU are suppressed.
4. Initiate ONU power reduction at the OLT (by suppressing any remote ONU wakeup stimuli and/or issuing a console command, as appropriate for the OLT implementation).
5. Verify the OLT's actions and the ONU's response.
6. Disconnect the ONU fiber connector, or turn off the ONU power completely.
7. Verify the OLT's actions.
8. Restore the ONU power/fiber connectivity and repeat steps 1 through 5.
9. Terminate ONU power reduction at the OLT (by activating a remote wakeup stimulus or issuing a console command, as appropriate for the OLT implementation).
10. Verify the OLT's actions and the ONU's response.

Pass/Fail Criteria:

The test passes, if all of the following holds:

On Step 5:

- The OLT sends a Sleep_Allow(ON) message to the ONU.
- The OLT continues to provide allocations to the ONU, suppressing the FWI flag.
- The ONU responds with Sleep_Request(WSleep) message.
- The ONU alternates between silence periods of duration at most Ilowpower+Delta5, where Delta5 is a fixed positive value includes Irxoff and tolerances, and periods when it does respond to bandwidth allocations of duration at least Iaware.
- The OLT detects, the missing ONU's bursts, but does not trigger an alarm.

On Step 7:

- The OLT declares the LOBi defect against the ONU within Ilowpower+Delta6, where Delta6 is a fixed positive value that includes Irxoff, maximum round trip time for the network configuration, and tolerances.

On Step 10:

- The OLT sends a Sleep_Allow(OFF) message to the ONU.
- The OLT continues to provide allocations to the ONU with the FWI flag set,
- Within $I_{lowpower} + \Delta_6$, the ONU sends a Sleep_Request(Awake) message and subsequently responds to all bandwidth allocations, where Δ_6 is a fixed positive value that includes I_{rxoff} , maximum round trip time for the network configuration, and tolerances.

Remarks:

- None

8.3 Dynamic Bandwidth Allocation

8.3.1 DBA Operation - Single ONU

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 7.2, 7.3 and 8.2.2.
- ITU-T G.9807.1 [12], Sections C.7.2, C.7.3 and C.8.1.2.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 7.2, 7.3 and 8.2.2.

Test Objective:

Verify correct DBA status reporting using allocation overheads in single ONU operation.

Test Setup:

- As shown in Section 5
- If the specified Port-ID and/or Alloc-ID cannot be provisioned manually, automatic provisioning is allowed. In such case, these parameters will be coordinated after pairing.

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. Port-ID 1024 is provisioned on both downstream and upstream and assigned to Alloc-ID 1024.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Additional parameters (e.g., VLAN tag mapping, order of generator and analyzer enable) are to be coordinated after pairing.

Parameters for bandwidth allocation structures:

- Alloc-ID: 1024
- Flags: 2 (DBRu=1, PLOAMu=0)
- Start time: at the discretion of the OLT.
- Grant size: at the discretion of the OLT, according to traffic load.

- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Test Procedure:

1. After ranging succeeds, Port-ID 1024 is manually provisioned.
2. The OLT sends the bandwidth maps as described above.
3. The traffic generator shall be configured to generate downstream and upstream traffic.
4. Upon getting bandwidth grants, the ONU responds with bursts containing a DBRu structure.
5. The OLT tests the CRC field of the DBRu and captures the BufOcc field.
6. The OLT responds to the values present in the BufOcc field by increasing or decreasing the upstream bandwidth allocated to the ONU.
7. Received data is tested by the Ethernet traffic analyzer.

Pass/Fail Criteria:

1. The OLT detects DBRu structures with a correct CRC field. The CRC field is correct for all of the DBRu structures detected.
2. Correct status reporting is transmitted in DBRu according to the amount of upstream SDU traffic – the BuffOcc fields indicate full/empty buffer for heavy/light traffic load.
3. No traffic loss at the upstream and downstream.

Remarks:

- The upstream traffic load shall be changed during the test to observe correct DBA algorithm response.

8.3.2 DBA Operation - Multiple ONUs

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 7.2, 7.3 and 8.2.2.
- ITU-T G.9807.1 [12], Sections C.7.2, C.7.3 and C.8.1.2.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 7.2, 7.3 and 8.2.2.

Test Objective:

Verify correct DBA status reporting using allocation overheads in multiple ONU operation.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. Port-ID 1024 is provisioned on both downstream and upstream and assigned to Alloc-ID 1024 on ONU1.
4. Port-ID 1025 is provisioned on both downstream and upstream and assigned to Alloc-ID 1025 on ONU2.
5. Other ONUs (if exist) are assigned Alloc-IDs accordingly.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Additional parameters (e.g., VLAN tag mapping, order of generator and analyzer enable) are to be coordinated after pairing.

Parameters for bandwidth allocation structures:

- Flags: 2 (DBRu=1, PLOAMu=0)
- Start time: at the discretion of the OLT.
- Grant size: at the discretion of the OLT, according to traffic load.
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Test Procedure:

1. After ranging succeeds, Port-IDs are provisioned manually or automatically, as applicable.
2. The OLT sends the bandwidth allocation structures as described above with bandwidth grants to all ONUs.
3. Traffic generators are enabled for downstream and upstream traffic.
4. Upon getting bandwidth grants, each ONU responds with bursts containing a DBRu structure.
5. The OLT tests the CRC field of the DBRu and captures the BufOcc field.
6. The OLT responds to the values present in the BufOcc field by increasing or decreasing the upstream bandwidth allocated to each of the ONUs.
7. Received data is tested by the Ethernet traffic analyzer.

Pass/Fail Criteria:

1. The OLT detects DBRu structures with correct CRC field for each ONU. The CRC field is correct for all of the DBRu structures detected.
2. Correct status reporting is transmitted in DBRu according to the amount of upstream SDU traffic.
3. Each ONU status reporting allows upstream burst transmission according to the DBA algorithm (as implemented in OLT).
4. No traffic loss at the upstream and downstream.

Remarks:

- None

8.3.3 DBA Operation under Different Traffic Loads - Multiple ONUs

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 7.2, 7.3 and 8.2.2.
- ITU-T G.9807.1 [12], Sections C.7.2, C.7.3 and C.8.1.2.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 7.2, 7.3 and 8.2.2.

Test Objective:

Verify correct DBA status reporting using allocation overheads in multiple ONU operation.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. Port-ID 1024 is provisioned on both downstream and upstream and assigned to Alloc-ID 1024 on ONU1.
4. Port-ID 1025 is provisioned on both downstream and upstream and assigned to Alloc-ID 1025 on ONU2.
5. Other ONUs (if exist) are assigned Alloc-IDs accordingly.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Additional parameters (e.g., VLAN tag mapping, order of generator and analyzer enable) are to be coordinated after pairing.

Parameters for bandwidth allocation structures:

- Flags: 2 (DBRu=1, PLOAMu=0)
- Start time: at the discretion of the OLT.
- Grant size: at the discretion of the OLT, according to traffic load.
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON and HSP

Test Procedure:

1. After ranging succeeds, Port-IDs are provisioned manually or automatically, as applicable.
2. The OLT continuously sends the bandwidth allocation structures as described above with bandwidth grants to all ONUs.
3. Upon getting bandwidth grants, The ONU responds with bursts containing a DBRu structure.
4. The OLT tests the CRC field of the DBRu and captures the BufOcc field.
5. The OLT responds to the values present in the BufOcc field by increasing or decreasing the upstream bandwidth allocated to each of the ONUs.
6. Traffic generators are enabled for downstream and upstream traffic.
7. Traffic load is changed per ONU:
 - a. Equal traffic load per ONU.
 - b. Different traffic load for each ONU.
8. Received data is tested by the Ethernet traffic analyzer.

Pass/Fail Criteria:

1. The OLT detects DBRu structures with correct CRC field for each ONU. CRC field is correct for all of the DBRu structures detected.
2. Correct status reporting is transmitted in DBRu according to the amount of upstream SDU traffic.
3. Upstream bandwidth is granted to each ONU according to status reporting and DBA algorithm (as implemented in OLT).
4. No traffic loss at the upstream and downstream.

Remarks:

- None

8.4 Drift Control and Compensation

8.4.1 Acceptable Transmission Drift Boundary

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 13.1.6 and 14.2.1.
- ITU-T G.9807.1 [12], Sections C.13.1.6 and C.14.2.1.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 13.1.6 and 14.2.1.

Test Objective:

Verify errorless upstream transmission within the safe (acceptable) transmission drift boundary.

Test Setup:

- As shown in Section 5
- If the ONU is not capable of artificially changing its equalization delay in the required resolution, the required drift can be generated using a spool of fiber in a temperature controlled oven.

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. Default Port-ID 1 is provisioned on both downstream and upstream and assigned to Alloc-ID 1.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Equalization delay is initially set by the OLT during ranging.

Test Procedure:

1. After ranging succeeds, OLT continuously grants bandwidth to ONU.
2. The ONU is forced to change its equalization delay in order to create an upstream PHY burst drift within the safe margin in two different scenarios:
 - a. Early PHY burst:
 - i. XG-PON: $0 > \text{drift} \geq -7$ bits
 - ii. XGS-PON and 25GS-PON: $0 > \text{drift} \geq -31$ bits
 - iii. HSP:

1. $0 > \text{drift} \geq -127$ bits for 50G
 2. $0 > \text{drift} \geq -63$ bits for 25G
 3. $0 > \text{drift} \geq -31$ bits for 12.5G
- b. Late PHY burst:
- i. XG-PON: 7 bits $\geq \text{drift} > 0$
 - ii. XGS-PON: 31 bits $\geq \text{drift} > 0$
 - iii. HSP:
 1. 127 bits $\geq \text{drift} > 0$ for 50G
 2. 63 bits $\geq \text{drift} > 0$ for 25G
 3. 31 bits $\geq \text{drift} > 0$ for 12.5G

Pass/Fail Criteria:

1. DOWi and TIWi alarms are not raised by the OLT.
2. No EqD adjustment is made by the OLT.
3. Upstream PHY bursts are detected correctly during the test.

Remarks:

- Due to inaccuracies in the ONU transmission or the OLT timing measurement, the OLT might respond to ONU drift earlier than expected. It is the responsibility of the pairing parties to state their inaccuracies and adjust the thresholds accordingly.

8.4.2 Adjustable Transmission Drift Boundary (DOW)

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 13.1.6 and 14.2.1.
- ITU-T G.9807.1 [12], Sections C.13.1.6 and C.14.2.1.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 13.1.6 and 14.2.1.

Test Objective:

Verify correct in-service equalization delay adjustments in drift of window (DOW) transmission boundary.

Test Setup:

- As shown in Section 5
- If the ONU is not capable of artificially changing its equalization delay in the required resolution, the required drift can be generated using a spool of fiber in a temperature controlled oven.

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. Default Port-ID 1 is provisioned on both downstream and upstream and assigned to Alloc-ID 1.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.
Equalization delay is initially set by the OLT during ranging.

Test Procedure:

1. After ranging succeeds, the OLT continuously grants bandwidth to ONU.
2. The ONU is forced to change its equalization delay in order to create an upstream PHY burst drift in the drift of window (DOW) boundary in two different scenarios:

2.5G upstream line-rate

- a. Early PHY burst: $-9 \text{ bits} \geq \text{drift} \geq -15 \text{ bits}$
- b. Late PHY burst: $15 \text{ bits} \geq \text{drift} \geq 9 \text{ bits}$

10G and 25G(25GS-PON) upstream line-rate

- a. Early PHY burst: $-33 \text{ bits} \geq \text{drift} \geq -63 \text{ bits}$

- b. Late PHY burst: $63 \text{ bits} \geq \text{drift} \geq 33 \text{ bits}$

HSP

- a. Early PHY burst

- i. $-129 \text{ bits} > \text{drift} \geq -255 \text{ bits}$ for 50G
- ii. $-63 \text{ bits} > \text{drift} \geq -127 \text{ bits}$ for 25G
- iii. $-33 \text{ bits} > \text{drift} \geq -63 \text{ bits}$ for 12.5G

- b. Late PHY burst:

- i. $255 \text{ bits} \geq \text{drift} > 127$ for 50G
- ii. $127 \text{ bits} \geq \text{drift} > 63$ for 25G
- iii. $63 \text{ bits} \geq \text{drift} > 33$ for 12.5G

3. For each scenario, the OLT recognizes a drift of window event for ONU (DOWi).
4. The OLT calculates a new equalization delay value and transmits it to the ONU using a ranging time PLOAM message.
5. The ONU displays the received ranging time PLOAM message and adjusts its equalization delay according to the message.
6. The drift of window event for the ONU (DOWi) is not detected anymore.

Pass/Fail Criteria:

1. Upstream PHY bursts are detected correctly during the test.
2. For each scenario, the OLT recognizes a drift of window event for ONU (DOWi).
3. Ranging time PLOAM messages are correctly detected by the ONU.
4. After processing of each ranging time PLOAM message, the drift of window event for the ONU (DOWi) is not detected anymore.
5. The ONU stays in regular operational state (O5) for the whole duration of the test.

Remarks:

- Due to inaccuracies in the ONU transmission or the OLT timing measurement, the OLT might respond to ONU drift earlier than expected. It is the responsibility of the pairing parties to state their inaccuracies and adjust the thresholds accordingly.

8.4.3 Unacceptable Transmission Drift Boundary (TIW)

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Sections 13.1.6 and 14.2.1.
- ITU-T G.9807.1 [12], Sections C.13.1.6 and C.14.2.1.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 13.1.6 and 14.2.1.

Test Objective:

Verify correct OLT-ONU behavior in transmission interference warning (TIW) state – unacceptable transmission drift.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. Default Port-ID 1 is provisioned on both downstream and upstream and assigned to Alloc-ID 1.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.
Equalization delay is initially set by the OLT during ranging.

Test Procedure:

1. After ranging succeeds, the OLT continuously grants bandwidth to ONU.
2. The ONU is forced to change its equalization delay in order to create an upstream PHY burst drift in the transmission interference warning (TIW) boundary in two different scenarios:

2.5G upstream line-rate

- a. Early PHY burst: -16 bits > drift
- b. Late PHY burst: drift > 16 bits

10G and 25G upstream line-rate

- a. Early PHY burst: -64 bits > drift
- b. Late PHY burst: drift > 64 bits

HSP

- a. Early PHY burst
 - i. -256 bits > drift for 50G
 - ii. -128 bits > drift for 25G
 - iii. -64 bits > drift for 12.5G
 - b. Late PHY burst
 - i. drift > 256 bits for 50G
 - ii. drift > 128 bits for 25G
 - iii. drift > 64 bits for 12.5G
3. For each scenario, OLT raises a TIWi alarm for ONU.

Pass/Fail Criteria:

- a. For each scenario, the OLT raises a transmission interference warning alarm for ONU (TIWi).
- b. After appropriate corrective measures have been taken, upstream PHY bursts are detected correctly and the TIWi alarm is cancelled.

Remarks:

- Due to inaccuracies in the ONU transmission or the OLT timing measurement, the OLT might respond to ONU drift earlier than expected. It is the responsibility of the pairing parties to state their inaccuracies and adjust the thresholds accordingly.
- If the ONU is not capable of artificially changing its equalization delay in the required resolution, the required drift can be generated using a spool of fiber in a temperature controlled oven.
- Depending on the mitigation actions taken by the OLT in response to a TIWi alarm, additional actions such as a new discovery and activation process might be performed between the two scenarios at the discretion of the OLT.

8.5 Time of Day Distribution over PON

8.5.1 Time of Day Distribution – Fixed Equalization Delay, Single ONU

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 13.
- ITU-T G.9807.1 [12], Section C.13.
- ITU-T G.988 [11], Section 9.12.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 13

Test Objective:

Verify the correct time of day synchronization using the OMCI channel in a single ONU link when the equalization delay of the ONU is fixed throughout the test.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. The default Port-ID 1 is provisioned on both downstream and upstream and assigned to Alloc-ID 1.
4. The OMCI message channel is established between OLT and ONU.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

The equalization delay is initially set by the OLT during ranging and stays constant for the duration of the test.

Test Procedure:

1. After ranging succeeds, OLT and ONU ToD clock synchronization process is manually initialized.
2. The OLT selects a downstream XGTC/FS frame to be used as timing reference. This frame is identified as superframe counter #N. The OLT generates the pair N, TstampN and sends it to the ONU using the relevant OMCI ME (OLT-G).
3. The ONU calculates the time of day based on the information communicated using the OMCI ME, its equalization delay, and its response time.

4. 1PPS outputs from ONU and OLT are compared using a scope.
5. The OLT and the ONU periodically display their ToD with corresponding values of the superframe counter.

Pass/Fail Criteria:

1. 1PPS outputs from the ONU and the OLT are accurate within $\pm 1\mu\text{s}$.
2. ToD values printed with the values of the superframe counter match between ONU and OLT.
3. The ONU ToD synchronization was completed within up to 10 sec from the communication of the downstream frame parameters over the OMCI channel.

Remarks:

- None

8.5.2 Time of Day Distribution – Equalization Delay Adjustments, Single ONU

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 13.
- ITU-T G.9807.1 [12], Section C.13.
- ITU-T G.988 [11], Section 9.12.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 13

Test Objective:

Verify the correct time of day synchronization using the OMCI channel in a single ONU link when the equalization delay of the ONU is adjusted throughout the test.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONU has been ranged and activated by the OLT.
3. The default Port-ID 1 is provisioned on both downstream and upstream and assigned to Alloc-ID 1.
4. The OMCI message channel is established between the OLT and the ONU.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.
Equalization delay is initially set by the OLT during ranging.

Test Procedure:

1. After ranging succeeds, the OLT continuously grants bandwidth to the ONU.
2. The OLT and the ONU ToD clock synchronization process is manually initialized.
3. The OLT selects a downstream XGTC/FS frame to be used as timing reference. This frame is identified as superframe counter #N. The OLT generates the pair N, TstampN and sends it to the ONU using the relevant OMCI ME (OLT-G).
4. The ONU calculates the time of day based on the information communicated using the OMCI ME, its equalization delay, and its response time.
5. The 1PPS output signal from the ONU and the OLT are compared using a scope.
6. The OLT and the ONU periodically display their ToD with corresponding values of superframe counter.

7. Controlled upstream PHY burst drift in the drift of window (DOW) boundary is generated, for example using a spool of fiber in a temperature controlled oven.
8. The OLT recognizes a drift of window event for the ONU (DOWi). The OLT calculates a new equalization delay value and transmits it to the ONU using a ranging time PLOAM message.
9. The ONU displays the received ranging time PLOAM message and adjusts its equalization delay according to the message.
10. The ONU fixes the ToD calculation according to the new equalization delay.
11. The 1PPS output from the ONU and the OLT are compared using a scope.
12. The OLT and the ONU periodically print their ToD with corresponding values of superframe counter.

Pass/Fail Criteria:

1. The 1PPS outputs from the ONU and the OLT are accurate within ± 1 us in steps 5 and 11.
2. The ToD values printed with values of superframe counter match between the ONU and the OLT in steps 6 and 12.
3. The ONU ToD synchronization was completed within up to 10 s from the communication of the downstream frame parameters over the OMCI channel.
4. Ranging time PLOAM messages are correctly detected by ONU.
5. The ONU stays in regular operational state (O5) for the whole duration of the test.

Remarks:

- None

8.5.3 Time of Day Synchronization - Multiple ONUs

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 13.
- ITU-T G.9807.1 [12], Section C.13.
- ITU-T G.988 [11], Section 9.12.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 13

Test Objective:

Verify correct time of day synchronization using the OMCI channel with multiple ONUs.

Test Setup:

- As shown in Section 5

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. The ONUs have been ranged and activated by the OLT.
3. The default Port-ID 1 is provisioned on both downstream and upstream and assigned to Alloc-ID 1 on ONU1.
4. The default Port-ID 2 is provisioned on both downstream and upstream and assigned to Alloc-ID 2 on ONU2.
5. Other ONUs (if exist) are assigned Alloc-IDs accordingly.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Parameters for bandwidth maps, XGEM header and OMCI message are the same as the OMCI channel establishment test for a single ONU, with the relevant Alloc-IDs.

Equalization delay is initially set by the OLT during ranging.

Test Procedure:

1. After ranging succeeds, the OLT and the ONU ToD clock synchronization process is manually initialized.
2. The OLT selects a downstream XGTC/FS frame to be used as timing reference. This frame is identified as superframe counter #N. OLT generates the pair N, TstampN and sends it to each ONU using separate OMCI channels.
3. Each ONU calculates the time of day based on the information communicated using the OMCI ME, its equalization delay and its response time.

4. The 1PPS outputs from all ONUs and the OLT are compared using a scope.
5. The OLT and the ONUs periodically print their ToD with corresponding values of superframe counter.

Pass/Fail Criteria:

1. The 1PPS outputs from all ONUs and the OLT are accurate within $\pm 1\mu\text{s}$.
2. The ToD values displayed with the values of the superframe counter match between all ONUs and OLT.
3. The ONU ToD synchronization for each ONU was completed within up to 10 s from the communication of the downstream frame parameters over the OMCI channel.

Remarks:

- None

8.6 Protection Switching

8.6.1 Intermittent LODS

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.987.3 [10], Section 12.2.
- ITU-T G.9807.1 [12], Section C.12.1.2.
- 25GS-PON [1].
- ITU-T G.9804.2 [14], Sections 12.4

Test Objective:

Verify correct ONU response to an intermittent loss of downstream synchronization.

Test Setup:

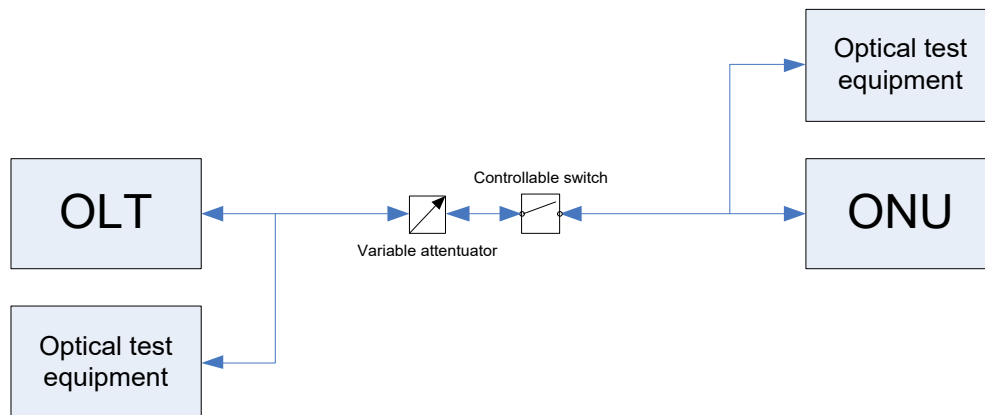


Figure 7 - Test Setup for Intermittent LODS

Pretest Conditions:

1. The OLT and ONU are powered and connected according to the test setup.
2. Switch is initially set to closed (connected) position.
3. The ONU has been ranged and activated by the OLT.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

TO2 timer is increased according to the properties of the controllable switch.

Test Procedure:

1. After ranging succeeds, TO2 timer is increased from the recommended initial value of 100 ms to a higher value according to the properties of the controllable switch (e.g., 1 s).

2. The switch is briefly (for a time $< T_{O2}$) set to the open position and back to the closed position.
3. The ONU transitions to intermittent LODS state (O6) while the switch is open and transitions back to regular operational state (O5) once the switch is closed.

Pass/Fail Criteria:

1. The ONU transitions to intermittent LODS state (O6) while the switch is open and transitions back to regular operational state (O5) once the switch is closed.
2. The ONU does not transition to the initial state (O1) or the serial number state (O2-3).

Remarks:

- Bandwidth grants to the ONU should be disabled for the duration of the test in order to prevent LOBi alarms at the OLT, leading to a deactivation or disable for the ONU.
- The controllable switch can be replaced by a simulation of a brief disconnection by the OLT or ONU, if such a procedure is available.

8.7 Alien ONU Detection and resilience to alien ONU

Test Status: Refer to Section 6

Reference Documents:

- ITU-T G.9807.1 [12] C.19.4, C.19.5
- 25GS-PON [1].
- ITU-T G.9804.2 [14]

Test Objective:

The test case verifies how the OLT deals with an Alien ONU. The requirement is that the Alien ONU shall be detected and proper alarm/event shall be displayed.

Test Setup:

Please refer to Figure 5.

Pretest Conditions:

1. ONU1 is powered and connected to ODN.
2. The ONU1 has been created at the OLT.
3. Only one user traffic class should be configured per ONU (via the OMCI messages defined below), requiring one GEM port and one Alloc-ID/T-CONT/Port-ID.
4. Enable FEC in upstream and downstream direction.
5. Enable the OLT for Alien detection if necessary.
6. The Ethernet Traffic Generator should be configured to transmit Ethernet frames (maximization of the traffic load in upstream, and 1 Mbit/s in downstream).
7. Four types of alien ONUs should be prepared: GbE Tx 1310 nm, 10GbE Tx 1270 nm, 10GbE Tx 1310 nm, 10GbE Tx 1330 nm
8. The Alien ONUs shall be disconnected from the set-up.

Test Configuration:

Profiles from the ONU discovery test (7.1.1) are used in this test.

Additional parameters (e.g., VLAN tag mapping, order of generator and analyzer enable) are to be coordinated after pairing.

Parameters for bandwidth allocation structures:

- Alloc-ID: 1024
- Start time: at the discretion of the OLT
- Grant size: at the discretion of the OLT
- FWI: 0
- Burst profile: 0 for XG-PON and XGS-PON, 1 for 25GS-PON

If the specified Port-ID and/or Alloc-ID cannot be provisioned manually, automatic provisioning is allowed. In such case, these parameters will be coordinated after pairing.

Test Procedure:

1. Power on ONU1
2. Using VOA1 set the OLT Rx Power at the sensitivity level according to:
 - a. ITU-T G.9807.1 Table: B.9 for XGS-PON
 - b. ITU-T G.9804.3 Table 9-5 for HSP
3. Run the traffic and confirm that no packet loss in upstream is observed. Stop the traffic.
4. Power off ONU1.
5. Disconnect the fiber from the OLT.
6. Connect the GbE Tx 1310 nm as Alien ONU. Power on the Alien ONU.
7. Using VOA2, set the OLT Rx Power of the Alien ONU to level equal to: $Rx_{alien} = Rx_{ONU1} - \text{Extinction ratio} - 1$ (for N1 transceiver it will be $Rx_{alien} = -26 - 6 - 1 = -33$ dBm)
8. Turn off the Alien ONU.
9. Power on the ONU1.
10. Connect the fiber to the OLT.
11. Wait for the ONU1 ranging.
12. Clear all counters and run the traffic.
13. Turn on the Alien ONU.
14. Check whether the OLT discovered the Alien ONU.
15. Observe for frame loss in upstream for 60 s.
16. Reset ONU1, check whether ONU1 is able to range.
17. Power off ONU1.
18. Disconnect fiber from OLT
19. Reduce VOA2 attenuation by 1 dB.
20. Repeat 8-19 until the Alien ONU causes that no upstream traffic is transmitted in 15.
21. Repeat 2-20 for $Rx_{ONU1} = \text{Sensitivity} - 4$ dB, Sensitivity - 8 dB and Overload.
22. Repeat 2-21 for Alien ONUs: 10GbE Tx 1270 nm, 10GbE Tx 1310 nm, 10GbE Tx 1330 nm
23. Fill in the table:

Alien ONU type	GbE 1310 nm			
Level Rx_{ONU1}	Sensitivity	Sensitivity + 4	Sensitivity + 8	Overload
Alien detected	True/False	True/False	True/False	True/False
Rx_{alien} at which OLT discovers alien [dBm]				
Rx_{alien} at which ONU1 was unable to range [dBm]				
Rx_{alien} at which packet loss started for upstream [dBm]				
Rx_{alien} at which upstream transmission was stopped [dBm]				
Alien ONU type	GbE 1270 nm			
Level Rx_{ONU1}	Sensitivity	Sensitivity + 4	Sensitivity + 8	Overload
Alien detected	True/False	True/False	True/False	True/False

Rxalien at which OLT discovers alien [dBm]				
Rxalien at which ONU1 was unable to range [dBm]				
Rxalien at which packet loss started for upstream [dBm]				
Rxalien at which upstream transmission was stopped [dBm]				
Alien ONU type	10GbE 1310 nm			
Level RxONU1	Sensitivity	Sensitivity + 4	Sensitivity + 8	Overload
Alien detected	True/False	True/False	True/False	True/False
Rxalien at which OLT discovers alien [dBm]				
Rxalien at which ONU1 was unable to range [dBm]				
Rxalien at which packet loss started for upstream [dBm]				
Rxalien at which upstream transmission was stopped [dBm]				
Alien ONU type	10GbE 1330 nm			
Level RxONU1	Sensitivity	Sensitivity + 4	Sensitivity + 8	Overload
Alien detected	True/False	True/False	True/False	True/False
Rxalien at which OLT discovers alien [dBm]				
Rxalien at which ONU1 was unable to range [dBm]				
Rxalien at which packet loss started for upstream [dBm]				
Rxalien at which upstream transmission was stopped [dBm]				

Pass/Fail Criteria:

1. The OLT is able to detect Alien ONU at Rxalien \leq sensitivity level

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