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सं:टीईसी/जीआर/एफए/एक्सजीएस-001/01/अक्टूबर-18

GENERIC REQUIREMENTS

No. : TEC/GR/FA/XGS-001/01/OCT-18

**10-जिगाबिट सक्षम सममित निष्क्रिय ऑप्टिकल नेटवर्क
(एक्सजीएस-पीओएन) प्रौद्योगिकी पर आधारित
एफटीटीएक्स ब्रॉडबैंड अनुप्रयोग**

**10-Gigabit-capable symmetric passive optical network
(XGS-PON) technology for FTTX based broadband
applications**

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FOREWORD

Telecommunication Engineering Centre(TEC) functions under Department of Telecommunications (DOT), Government of India. Its activities include:

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- Field evaluation of products and Systems
- National Fundamental Plans
- Support to DOT on technology issues
- Testing & Certification of Telecom products

For the purpose of testing, four Regional Telecom Engineering Centers (RTECs) have been established which are located at New Delhi, Bangalore, Mumbai, and Kolkata.

ABSTRACT

This document describes the generic requirements and specifications for broadband access network architectures based on Fibre-to-the-Home/Office/Cell/Building/Curb/ Cab (FTTH/ FTTO/ FTTCe// FTTB/ FTTC/ FTTCab) commonly called FTTx architectures, using 10-Gigabit-capable symmetric passive optical network (XGS-PON) technology, as per, ITU-T G.9807.1 Recommendations for use in Indian telecom network.

CONTENTS

<i>Sl. No.</i>	<i>Particulars</i>	<i>Page No.</i>
	History Sheet	8
	References	9
Chapter 1:- Technical Requirements		12
1.0	Introduction	12
2.0	XGS-PON Network Architecture and Requirements	13
2.1	Constituents of XGS-PON deployment	15
2.1.1	ONT/ONU	15
2.1.2	OLT	16
2.1.3	Optical Splitters	17
2.1.4	Wavelength Blocking Filter	17
2.1.5	WDM1r Coupler	17
2.1.6	Fibre plant: Passive Optical Network	19
2.1.7	Reach Extenders	20
2.2	Co-existence requirements of XGS-PON	21
2.3	FTTX architectures: in XGS-PON	21
2.4	Equipment interfaces and service support	23
2.4.1	XGS-PON equipment interfaces	23
2.4.2	A broad overview of the services in various FTTX architectures.	23
2.5	Physical layer requirements for XGS-PON system	25
2.5.1	Optical wavelengths of XGS-PON	25
2.5.2	Bit rates	25
2.5.3	Optical power budget	25
2.5.4	Fibre characteristics	25
2.5.5	Split Ratio	26
2.5.6	Fibre Distance	26
3.0	Specifications for XGS-PON system constituents for various topologies	26
3.1	Types of equipment	26

3.2	Physical interface requirements at UNI	27
3.2.1	Type 1: H-ONT for residential broadband delivery	27
3.2.2	Type 2: B-ONT for FTTO applications	27
3.2.3	Type 3: Cell- Site Backhaul (M-ONT) for FTTM applications	28
3.2.4	Type 4: Cabinet/Curb ONU (C-ONU) for FTTC/Cab applications	28
3.2.5	Type 5: Residential-ONU for FTTB applications in MDU	29
3.2.6	Type 6: Business-ONU for FTTB applications in MTU	29
3.2.7	Type 7: Optical-ONU for FTTH applications	30
3.3	ONT equipment architecture	31
3.3.1	Functional requirements of ONT/ONU at UNI	31
3.3.2	'Triple-play' related requirements for ONU	35
3.4	OLT specifications	35
4.0	Network requirements	39
4.1	Passive optical network	39
4.1.1	Optical Splitter specifications	40
4.1.2	Optical WDM1r coupler specification	40
5.0	Ethernet interfaces at UNI of ONT/ONU and SNI of OLT: Specifications	42
6.0	Protection on the PON section	42
6.1	Possible protection switching types	43
6.2	Possible duplex XGS-PON configurations and characteristics	44
7.0	Equipment redundancy	46
8.0	Performance requirements	47
9.0	Synchronization requirements	47
9.1	The Synchronizing references	48
9.2	Timing output interface	48
10.0	Maintenance, performance monitoring & supervisory signals	48
10.1	Alarms	49

Chapter 2:- General Requirements		50
1.0	Reference documents	50
2.0	Engineering requirements	50
3.0	Operational requirements	51
4.0	Quality requirements	52
5.0	Maintenance requirements	53
6.0	Power supply	54
7.0	Accessories	57
8.0	Documentation	57
9.0	Mechanical standards	58
10.0	Operating personnel safety requirements	59
11.0	Minimum equipment requirements	60
12.0	Field trial	61
13.0	Applicable tests(for TAC purpose):	61
Chapter 3:- EMC Requirements		63
1.0	Electromagnetic Interference	63
Chapter 4 (Part-I):- EMS Requirements		70
1.0	General operational and functional requirements	70
2.0	EMS Architecture and Server Hardware Specifications	74
2.1	Architecture	74
2.2	Scalability aspects	75
2.3	EMS server specifications	76
2.4	Application server specifications	76
2.5	Database server specifications	77
2.6	Firewall server [optional to purchaser's requirements]	78
2.7	Specifications for local craft terminal/work station	78
Chapter 4 (Part-II):- FCAPS Requirements		80
1.0	Network management functions	80
1.1	General functions	80
1.1.1	Configuration management	80
1.1.2	Fault management	81
1.1.3	Performance management	82

1.1.4	Security management	83
1.1.5	Inventory management	85
1.1.6	Software management	86
1.1.7	Software download	87
1.1.8	Management interface details	87
1.1.9	Southbound management interface	87
1.1.10	Northbound management interface	88
1.1.11	Local management interface	88
1.1.12	User interface	88
1.2	Additional functional requirements	89
Chapter 5:- Industry Best Practice		92
1.0	Introduction	92
2.0	System applications	92
3.0	Optical specifications	93
4.0	Optical link budget	96
Chapter 6:- Purchase Guidelines		98
Appendix-I: - XGS-PON Service Support		104
Abbreviations		111

HISTORY SHEET

S. No.	Name of the Generic Requirements	No. of the Generic Requirements	Remarks
1)	10-Gigabit-capable symmetric passive optical network (XGS-PON)Technology for FTTx based Broadband Applications	TEC/GR/FA/XGS-001/01/OCT-18	First Issue : Note: GR on 10-Gigabit-capable passive optical network (XG-PON)Technology for FTTx based Broadband Applications. No: TEC/GR/TX/XG-PON-01/01/March.2013 already exist.

REFERENCES

S. No.	Standard No.	Designation
1.	ITU-T G.652	Characteristics of a single-mode optical fiber and cable.
2.	ITU-T G.657	Characteristics of a bending-loss insensitive single-mode optical fiber and cable for the access network
3.	ITU-T G.709	Interfaces for the optical transport network.
4.	ITU-T G.9807.1	10-Gigabit-capable symmetric passive optical Network (XGS-PON)
5.	ITU-T G.984.1	Gigabit-capable passive optical networks (GPON): General characteristics.
6.	ITU-T G.984.5	Gigabit-capable passive optical networks (GPON): Enhancement Band.
7.	ITU-T G.984.6	Gigabit-capable passive optical networks (GPON): Reach extension.
8.	ITU-T G.987	10-Gigabit-capable passive optical network (XG-PON) systems: Definitions, abbreviations, and acronyms.
9.	ITU-T G.987.1	10 Gigabit-capable passive optical networks (XG-PON): General requirements
10.	ITU-T G.987.2	10-Gigabit-capable passive optical networks (XG-PON): Physical media dependent (PMD) layer specification
11.	ITU-T G.987.3	10-Gigabit-capable passive optical networks (XG-PON): Transmission convergence (TC) layer specification.
12.	ITU-T G.987.4	10-Gigabit-capable passive optical networks (XG-PON): Reach extension.
13.	ITU-T G.989	40-Gigabit-capable passive optical networks (NG-PON2): Definitions, abbreviations and

		acronyms
14.	ITU-T G.989.3	40-Gigabit-capable passive optical networks (NG PON2): Transmission Convergence Layer Specification
15.	ITU-T G.993.2	Very high speed digital subscriber line transceivers 2 (VDSL2).
16.	ITU-T rec G.9700	Fast access to subscriber terminals (G.fast) - Power spectral density specification
17.	ITU-T rec G.9701	Fast access to subscriber terminals (G.fast) - Physical layer specification
18.	ITU-T rec G.9960	Unified high-speed wireline-based home networking transceivers - System architecture and physical layer specification
19.	ITU-T rec G.9960	Unified high-speed wireline-based home networking transceivers - Data link layer specification
20.	ITU-T G.664	Optical safety procedures and requirements for optical transmission systems
21.	IEEE 802.3	IEEE Standard for Ethernet
22.	QM-333	Specification for environment testing of electronic equipment for transmission and switching use.
23.	RFC-2544	Bench marking methodology for Network inter connected devices
24.	IS 13252 part 1	Information Technology Equipment -- Safety, Part 1: General Requirements
25	IS 10437	Safety requirements for radio transmitting equipment
26	IEC 60950-1	Information technology equipment –Safety –Part 1:General requirements
27	IEC 60215	Safety Requirements for Radio Transmitting Equipment
28	IEC-60825-1	Safety of laser products – Part 1: Equipment

		classification, requirements and user's guide
29	IEC Publication 61000-4-2	Testing and measurement techniques of Electrostatic discharge immunity test
30	IEC Publication 61000-4-3	Radiated RF electromagnetic field immunity test
31	IEC Publication 61000-4-4	Testing and measurement techniques of electrical fast transients/burst immunity test
32	IEC Publication 61000-4-5	Test & Measurement techniques for surge immunity tests
33	IEC Publication 61000-4-6	Immunity to conducted disturbances
34	TEC/SD/DD/EMC-221/05/OCT-16	Electromagnetic compatibility standard for Telecommunication equipment.

Note:

Unless otherwise explicitly stated, the latest approved issue of the standard/GR/IR, with all amendments in force, listed in references, on the issuance date of this GR/IR applicable”

CHAPTER-1

Technical Requirements

1.0. Introduction

- 1.1. This document describes the generic requirements and specifications for broadband access network architectures based on Fibre-to-the-Home/Office/Cell/Building/Curb/ Cab (FTTH/ FTTO/ FTTCcell/ FTTB/ FTTC/ FTTCab) commonly called FTTx architectures, using 10-Gigabit-capable symmetric passive optical network (XGS-PON) technology, as per, ITU-T G.9807.1 Recommendations for use in Indian telecom network.
- 1.2. A Passive Optical Network (PON), in general, consists of Optical Line Termination (OLT) system installed generally at the Central Office (CO) and a set of associated Optical Network Units (ONU)/Optical Network Terminations (ONT) installed at various locations in the network (as detailed later) with a passive Optical Distribution Network (ODN) comprised of optical fibres and passive splitters/couplers interconnecting them. The placement of OLT may be centralized i.e. collocated with the Central Office (CO) or distributed to a Remote Office (RO), building basement etc. In such a manner, the distributed architecture shall provide flexibility and may thus extend the services as well as reach offered by the centralized architecture (Refer fig1).

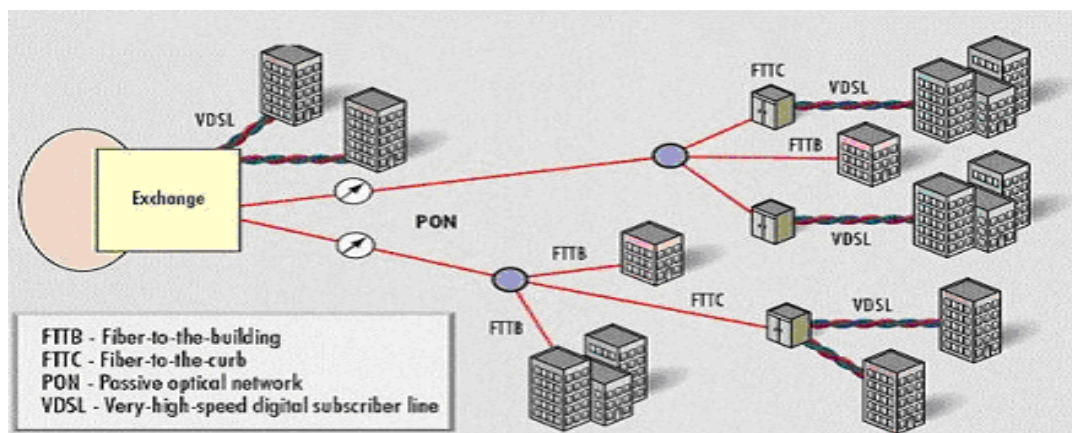


Fig.1: General schematic passive optical network applications

- 1.3. The operations, administration and management (OAM) and other management requirements shall be as per implementation philosophy of technology developer.
- 1.4. The general characteristics and architecture of XGS-PON shall be compliant to ITU-T G.9807.1 as specified in the GR.
- 1.5. The GR outlines the general characteristics of XGS-PON systems including network services, User Network Interfaces (UNI) and Service Network Interfaces (SNI). Also, it outlines the basic deployment configurations. However, specific implementation shall be subject to networking requirements of the Service Providers.

2.0. XGS-PON Network Architecture and Requirements

A XGS-PON access network system includes an OLT in the Central Office and distributed Optical Network Units (ONUs)/Optical Network Terminations (ONTs) to terminate customer traffic through an optical distribution network (ODN) between them. The access node in FTTH /FTTO/FTTCell architecture for network termination installed within user premises is called as ONT. Whereas the access nodes in FTTB/FTTC/FTTCab architectures, installed at other locations i.e. Curb/Cabinet/MDU (or MTU) basement in a building, are termed as ONU. An Optical distribution network (ODN) connects the OLT and ONTs/ONUs in point to multipoint configuration (Ref. Figure 2.) through single mode fibre. The ODN can be either a simple ODN or a composite ODN. The composite ODN comprises of optical splitters, combiners, filters interconnected by active devices.

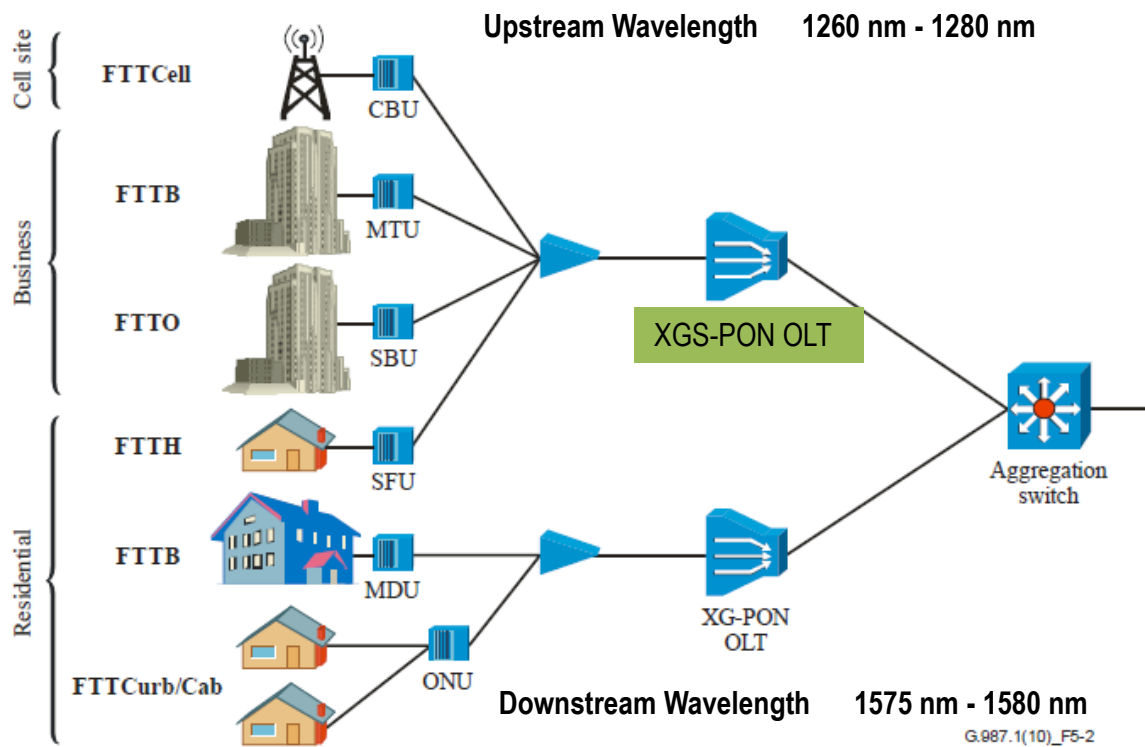


Fig 2: Schematic showing various FTTX Architectures

An XGS-PON ODN may consist of a single passive optical distribution (ODS) or a group of ODSs interconnected with active reach extenders or coexistence elements as shown in figure 3.

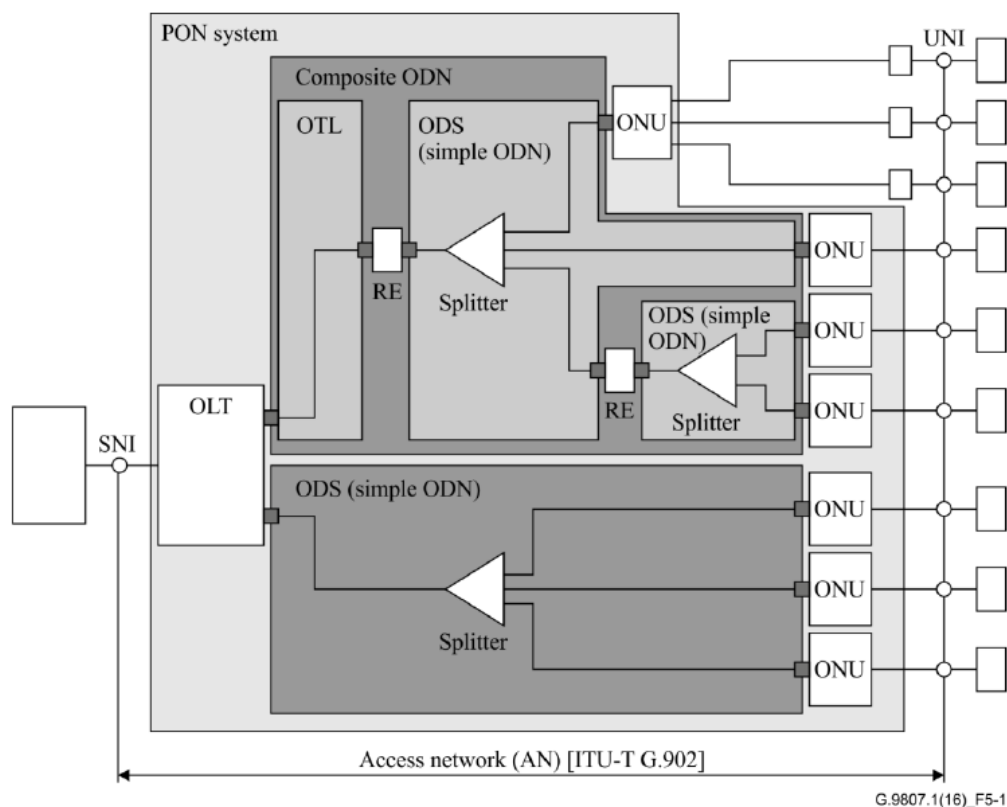


Figure 3: Reference Access Network Architecture

2.1. Constituents of XGS-PON deployment

This GR envisages deploying FTTX deployments using XGS-PON technology. Depending upon the deployed architecture, there shall be variations in placement of various PON constituents, as described in clause 3 detailing various FTTX architectures.

2.1.1. ONT/ONU

The Network Terminations in FTTH/FTTCell/FTTO architecture installed within user premises is termed as ONT. Whereas the network terminations in FTTB/FTTC/FTTCab architectures, installed at other locations i.e. Curb/Cabinet/MDU (or MTU) basement of building, is termed as ONU.

In FTTB/C/Cab architecture, the users generally need to install additional network termination (NT) device to access the ONU at a typical distance of 500m-1000m. The possible choices of NT for households shall be

ADSL2+/VDSL2/G.fast/G.hn. Whereas, in FTTB scenario, the user can access the ONU installed in the MTU/MDU over Ethernet or ADSL2+/VDSL2/G.fast/G.hn interfaces.

The ONTs/ONUs shall provide:

- 1) User-interfaces (**UNI**) towards the customers and
- 2) Uplink (**IF_{XGS-PON}**) interfaces to uplink local traffic towards an OLT.

Adaptation function for specified UNIs shall also be an integral part of the ONT/ONU blocks. Following service support options at ONT and ONU may be:

- High speed internet
- WiFi support as per 802.11b/g/n/ac (exact requirement for Wi Fi support as per IEEE 802.11g, IEEE 802.11n and IEEE 802.11ac will be specified by the Purchaser/ Manufacture.)
- IP phone
- POTS
- IPTV
- RF TV using RF-video Overlay
- E1 lines
- Mobile Backhaul for 2G/3G/4G.
- Layer 2 VPN
- Layer 3 VPN
- CPRI
- OBSAI (Open Base Station Architecture Initiative)

Note: - The above service support are optional and decided by purchaser.

2.1.2. OLT

An OLT shall provide aggregation and switching functionality between the core network and PON interfaces. It shall offer PON interfaces (towards ONU/ONTs) & Service interfaces (towards core network). The interfaces

towards ONTs are called PON interfaces (**IF_{XGS-PON}**) and the interfaces towards core network are called Uplink interfaces (**SNI**).

2.1.3. Optical Splitters

Optical splitters capable of providing upto 1:128 optical split, on end to end basis, per PON interface on OLT are envisaged as per TEC GR No. TEC/GR/TX/OPT-001/01/APR 2012. There shall be various options provided to the purchaser such as m: N where m=1 or 2 and N= 4, 8, 16, 32, 64 or 128. Optical splitters capable of 1:256 optical splits shall be optional. The purchaser may use a combination of these split options. The purchaser shall communicate the exact requirement.

2.1.4. Wavelength Blocking Filter

Wavelength Blocking Filters (WBF): WBF are to be used when NGPON2, XGS-PON, XG-PON, G-PON and RF video are combined within the same optical distribution network as shown in figure 4A & 4B. To minimize the effect of interference of signals, XGS-PON ONU/ONTs need to isolate themselves using an appropriate WBF and WDM filter. The WBF shall be used with ONT/ONU to block the unwanted wavelengths.

ITU-T G.9807.1 recommendation does not specify the isolation characteristics of the WBF and WDM filters directly, but specifies the X/S tolerance of the XGS-PON ONU/ONT. Implementers need to specify the isolation characteristics of the WBF and WDM filters to obtain enough isolation of the interference signal(s).

2.1.5. WDM1r Coupler

To allow co-existence of G-PON, XG-PON and XGS-PON, multiple dedicated wavelengths may be used, as per ITU-T Recs. G.984.5, G.987.x and G.9807.1, for various applications and enabling combined optical transport through a single fibre. For example, for G-PON two dedicated wavelengths may be used for downstream and upstream (~1490nm & 1310nm respectively)

and the other one (1550nm) may be used for downstream video. Similarly, the wavelength range of XGS-PON downstream wavelength signal is from 1575-1580nm and the range of upstream signal is from 1260-1280nm.

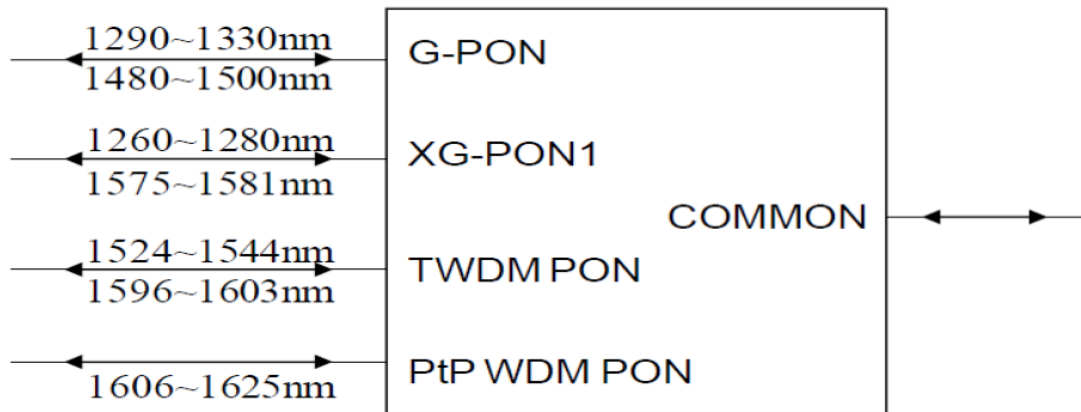
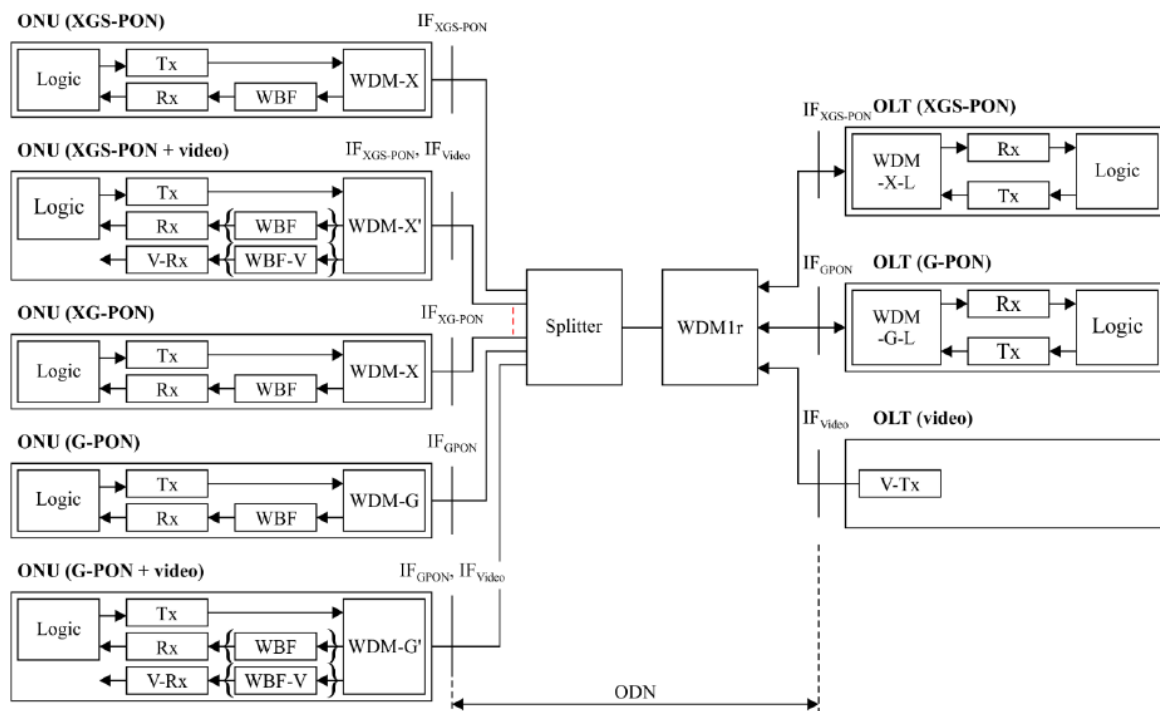


Fig. 4A: Reference diagram of a WDM1r coupler with G-PON, XG-PON, TWDM PON and PtP WDM PON support

The characteristics of the Wavelength Blocking Filter shall be compliant to ITU-T Rec. G.984.5 and G.987.1.



Tx	Optical transmitter
Rx	Optical receiver
V-Tx	Video transmitter
V-Rx	Video receiver
WBF	Wavelength blocking filter for blocking interference signals to Rx.
WBF-V	Wavelength blocking filter for blocking interference signals to V-Rx.
WDM-X	WDM filter in the XG-PON ONU to combine/isolate the wavelengths of the XG-PON upstream and downstream.
WDM-X'	WDM filter in the XG-PON ONU to combine/isolate the wavelengths of the XG-PON upstream and downstream and isolate the video signal(s).

Fig. 4B: Schematic showing XGS-PON architecture

2.1.6. Fibre plant: Passive Optical Network

Already existing ITU-T Rec. G.652 fibre shall primarily be used between OLT and ONUs/ONTs. Newer fibre types exhibiting low-bend radius characteristics defined by ITU-T G.657 shall also be supported.

The user shall access the Ethernet over copper wires from the ONU.

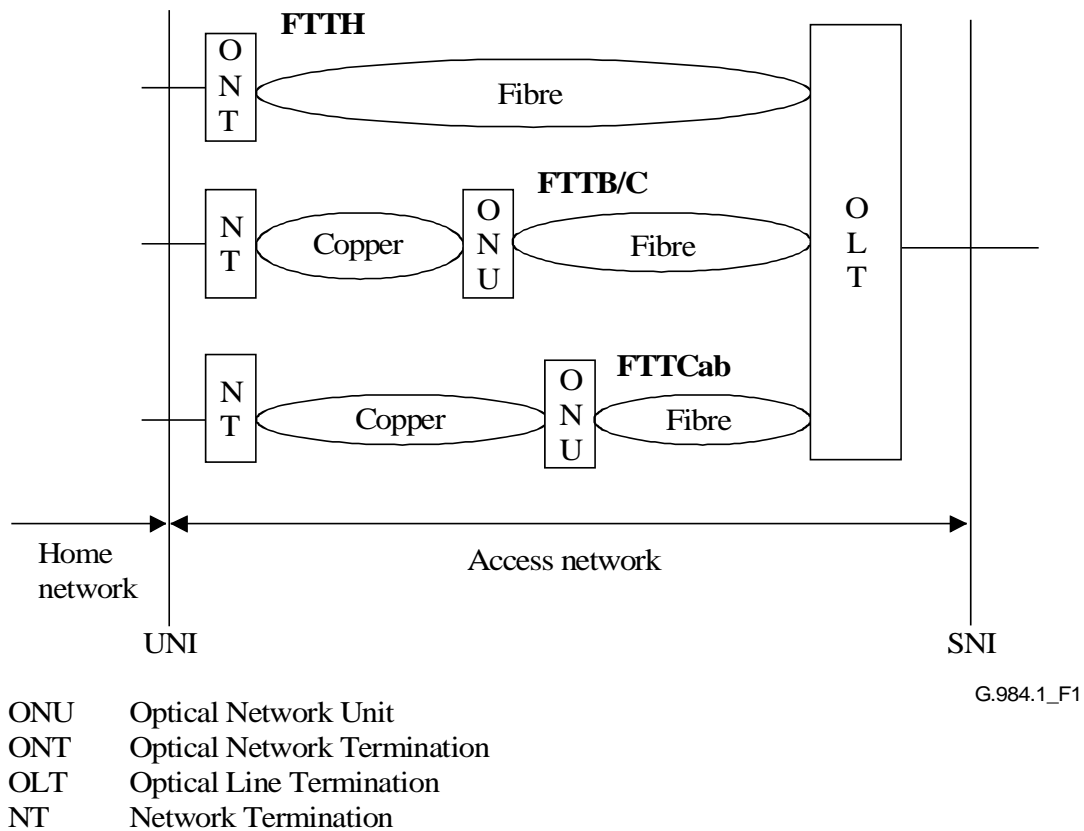
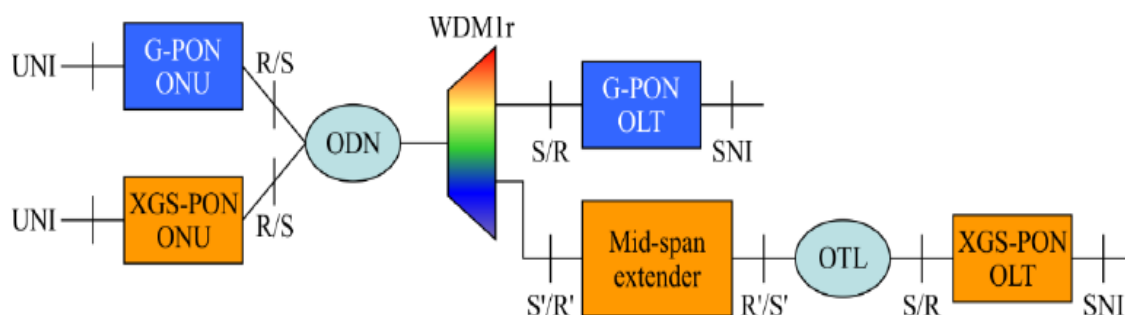


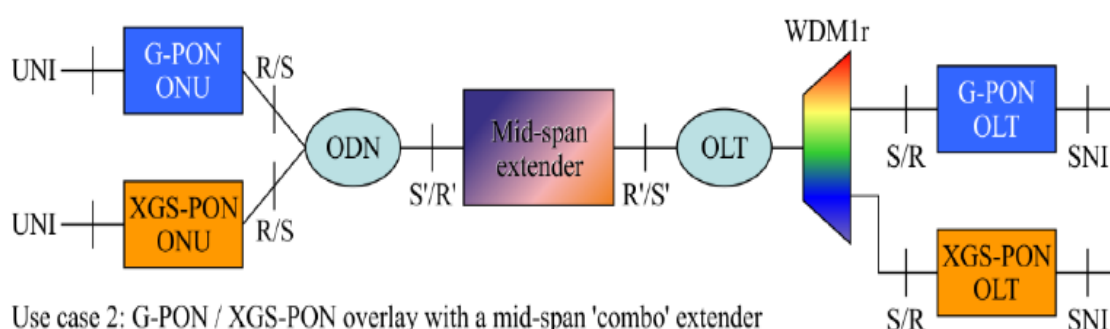
Fig. 5: FTTx ODN options

2.1.7 Reach Extenders

Two configurations using RE are possible as shown in Fig. 6. In the XGS-PON world, two main architectures involving reach extenders are envisioned, as described in Figure 6: One for deployments in which network consolidation will take place when migrating from G-PON to XGS-PON and the other for deployments in which REs have already been deployed for the G-PON systems, in which case two situations will occur depending on the early RE technology deployed: Either the RE had from the start the capability to cover G-PON and XGS-PON requirements; or the early RE has to be replaced by what will onwards be called a "combo" RE.



Use case 1: G-PON / XGS-PON overlay with mid-span XGS-PON only extender



Use case 2: G-PON / XGS-PON overlay with a mid-span 'combo' extender

G.9807.1(16)_FA.6-5

Fig. 6 Reach Extender Configurations

The testing of XGS-PON with Reach Extender options shall be done only when the purchaser has asked for it. A certificate/undertaking regarding the additional optical budget available through a Reach Extender shall be sufficient during TAC/TSEC.

2.2 Co-existence requirements of XGS-PON

To ensure co-existence of GPON, XG-PON and XGS-PON, co-existence elements like WDM1r and Wavelength Blocking Filter may be used in the network.

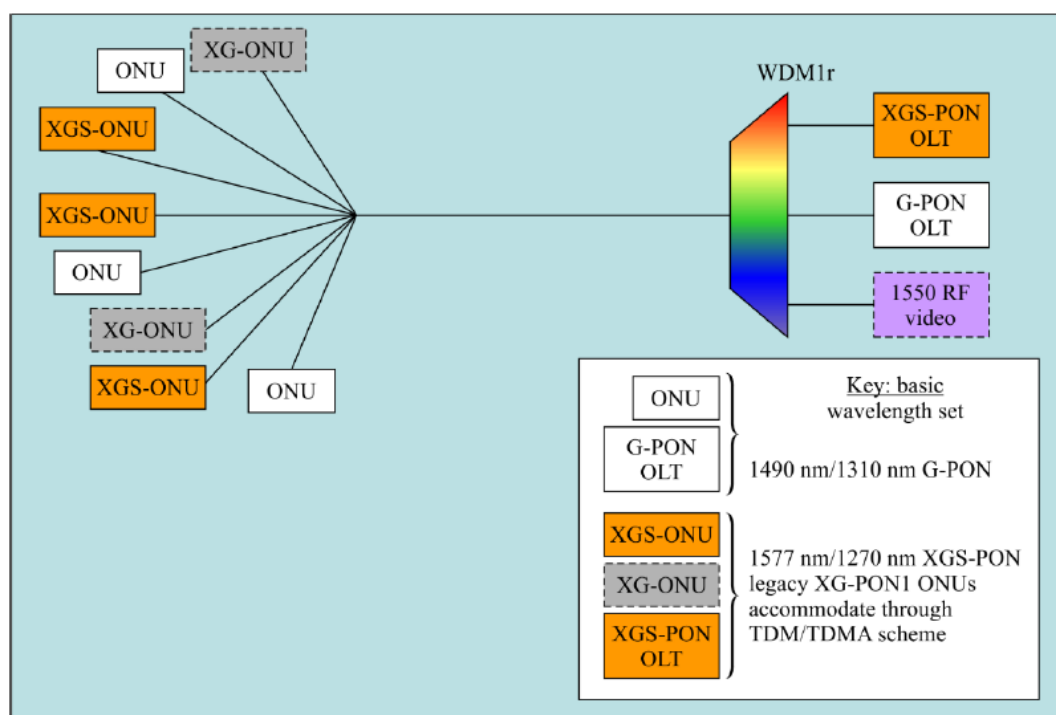


Figure. 7: Coexistence of XGS-PON with G-PON through WDM1r

2.3. FTTX architectures: in XGS-PON

The 'X' in FTTX stands for a lot of things, often not very different, but for practical purposes, they can all be grouped as under.

- 1) Fibre all the way to the customer residential premises/office/cell-site back hauling unit: These are:
 - Fibre to the Home (FTTH)
 - Fibre to the Office (FTTO)
 - Fibre to the Cell (FTT Cell)
- 2) Fibre all the way to the multi dwelling units, business, and multi-tenant unit: Here the fibre reaches to a particular point in the building, further

connectivity to each residence and office is provided by copper wires which carry Ethernet data.

- Fibre to building/business (FTTB)
- Fibre to the curb/cab (FTTC/FTTCab)

3) Fibre partial: Here fibre reaches to a point far from the actual user. Further connectivity to each customer is provided by copper pairs using ADSL2+/VDSL2/G.fast/G.hn.

- Fibre to the cabinet (FTTCab)
- Fibre to the curb (FTTC)

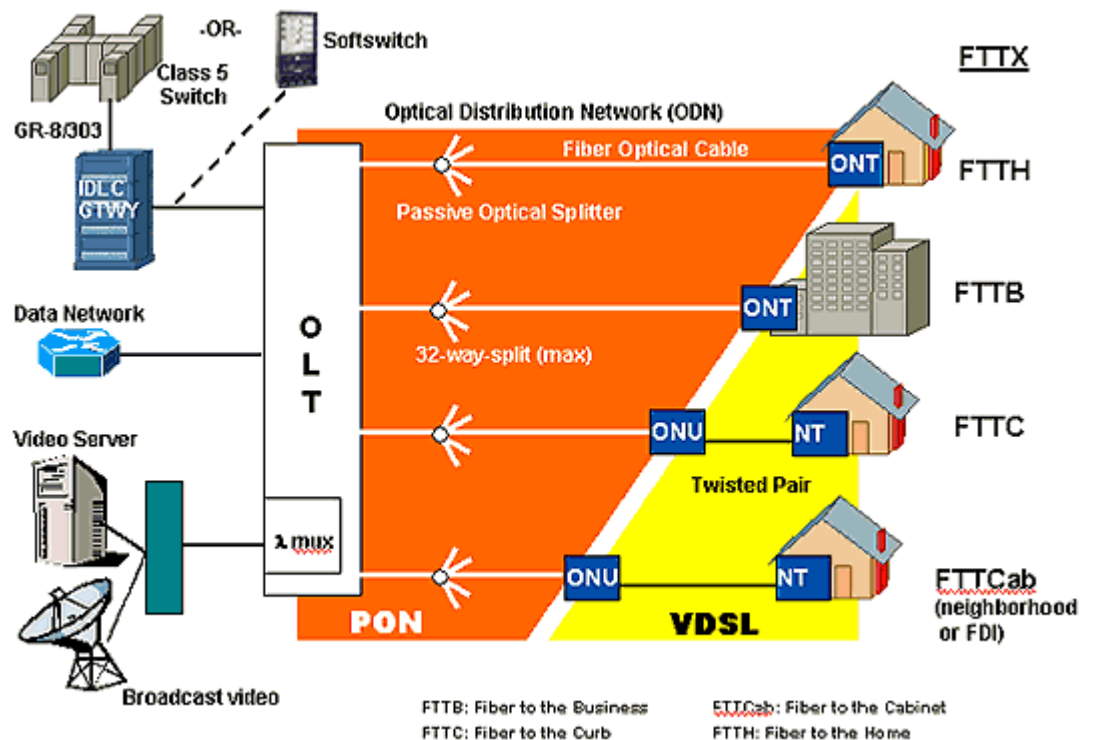


Figure 7a: Schematic showing various FTTX architectures

In FTTC/FTTCab architectures, fibre penetration takes place up to the curb (200-400m) and cabinet (1000-2000m) from user locations. These architectures are useful for densely populated areas.

2.4 Equipment interfaces and service support

2.4.1 XGS-PON equipment interfaces

As depicted in the figure 8 below, the XGS-PON equipment shall provide three types of interfaces, namely

- User Network interface (UNI)
- Service Node interface (SNI)
- PON interface (IFXGS-PON) – The interface at reference point S/R and R/S at OLT and ONU optical ports. This is a PON specific interface that supports all protocol elements necessary to allow transmission between OLT and ONUs.

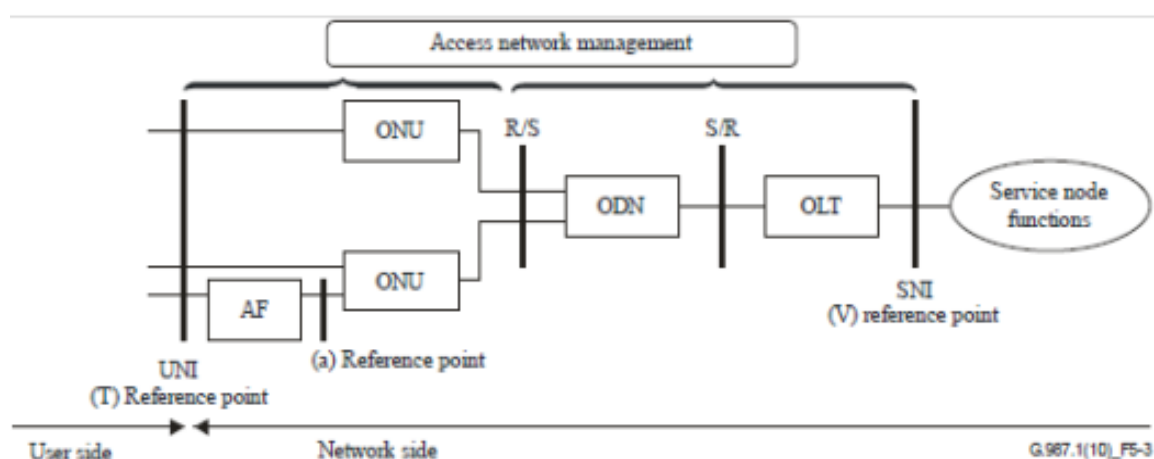


Figure.8: Interfaces of an optical access network

2.4.2 A broad overview of the services in various FTTX architectures.

The optical section of the local access system shall have point-to point architecture. The differences among the various architectures are due to variation in the services supported and the location of the ONU.

2.4.2.1 FTTB scenario

FTTB scenario is possible for Multi Dwelling units (MDU) as well as Multi-tenant units (MTU).

2.4.2.1.1 FTTB for MDU

- Asymmetric broadband services (like IPTV, video on demand etc.)

- Symmetric broadband services (like e-mail, distance learning, telemedicine)
- POTS

2.4.2.1.2 FTTB for MTU

- Symmetric broadband services (like e-mail, distance learning, telemedicine)
- POTS
- E1 lines

2.4.2.2 FTTC and FTTCab scenario

- Asymmetric broadband services (like IPTV, video on demand, file download, online games etc.) shall be supported.
- Symmetric broadband services (like e-mail, distance learning, telemedicine etc.)
- POTS
- ADSL2+/ VDSL2/G.fast/G.hn.

2.4.2.3 FTTH scenario

- Asymmetric broadband services (like IPTV, video on demand etc.)
- Symmetric broadband services (like e-mail, distance learning, telemedicine, online games etc.)
- POTS
- Wi-Fi

2.4.2.4 FTTO scenario

- Symmetric broadband services (like e-mail, distance learning, telemedicine)
- POTS
- E1 lines

2.4.2.5 FTT Cell (Wireless Scenario)

In this scenario, the ONU shall be called Mobile Backhaul Unit (MBU) and shall offer connectivity to wireless base stations:

- Symmetric E1 services (e.g. 2G cell site backhaul).
- Symmetric/ asymmetric packet based broadband services (e.g. 3G/4G cell site backhaul).
- WiFi Hot spots for wireless connectivity.

2.5. Physical layer requirements for XGS-PON system

2.5.1 Optical wavelengths of XGS-PON

Optical wavelengths for XGS-PON upstream shall be “O” band, ranging from 1260 to 1280nm. The typical wavelength for upstream shall be 1270nm. The optical wavelength for downstream shall be from 1575 to 1580nm. The typical wavelength shall be 1577nm.

2.5.2 Bit rates

The XGS-PON system shall support symmetrical bit rates of 9.95328Gbps in the upstream and downstream directions.

2.5.3 Optical power budget

XGS-PON must be able to operate on nominally 28/29 dB loss ODNs, depending on the wavelength set plan used. The Basic wavelength set aligns with the N1 class of XG-PON for 29 dB, considering the extra loss in the WDM1r for this band. The Optional wavelength set aligns with the B+ class of G-PON for 28 dB, considering the lower loss in the WDM1r for this band. In addition to these loss budgets, provision is also made to accommodate the N2 (31 dB), E1 (33 dB) and E2 (35 dB) power budgets from XG-PON and C+ (32 dB) power budget from G-PON.

When reusing the G-PON wavelength is adopted, since the G-PON port of the WDM1r will be reused, legacy B+ or C+ power budget classes are to be considered.

2.5.4 Fibre characteristics

The fibre between OLT and ONT shall comply with ITU-T G.652, which is used in other PON systems. This is to ensure co-existence of the XGS-PON and other PON systems, and to utilise the existing ODN for XGS-PON systems.

Newer fibre types exhibiting low-bend radius characteristics defined by ITU-T G.657 shall also be supported.

2.5.5 Split Ratio

1:32 to 1:64 split for Gigabit PONs, 1:64 split (subject to the overall loss budget) shall be the minimum requirement for XGS-PON to allow the coexistence of G-PON, XG-PON and XGS-PON and can go up to 1:128 split with different class optics. Support for 1:256 split shall be optional to allow extension of PON in the backhaul section and/or to extend PON towards the end users to provide flexible splitter configurations and efficiently support a variety of deployment scenarios.

2.5.6 Fibre Distance

XGS-PON must support the maximum fibre distance of at least 20 km.

In addition, XGS-PON TC layer needs to support the same requirements as XG-PON, starting with the maximum fibre distance of 60 km. XGS-PON TC layer also needs to support the maximum differential fibre distance of up to 40 km. XGS-PON TC layer also needs to be able to configure the maximum differential fibre distance with a 20 km step.

3.0. Specifications for XGS-PON system constituents for various topologies

3.1. Types of equipment

On the basis of target applications, there shall be the following types of ONU/ONTs

Type 1: Home-ONT (H-ONT) for FTTH applications

Type 2: Business-ONT (B-ONT) for FTTH applications

Type 3: Cell- Site Fronthauling/Backhauling (M-ONT) for FTTM applications

Type 4: Cabinet/Curb ONU (C-ONU) for FTTC/Cab applications

Type 5: MDU-ONU (M-ONU) for FTTB applications in Multi Dwelling unit (MDU)

Type 6: Business-ONU (B-ONU) for FTTB applications in Multi-Tenant Unit (MTU)

Type 7: Optical-ONT (O-ONT) for FTTH applications

3.2 Physical interface requirements at UNI

Ethernet interface shall be provisioned for Residential ONT and both types of interfaces, Ethernet and ADSL2+/VDSL2/G.fast/G.hn shall be provisioned in case of ONUs.

3.2.1 Type 1: H-ONT for residential broadband delivery

H-ONT shall provide the following residential broadband services. Service support shall be there for voice, video and data. Exact number of ports for each interface shall be indicated by the user.

- POTS
- 10/100/1000 Base T Ethernet interfaces (to inter-connect IP phones, Set top box for IPTV, PC etc. through a home Ethernet Bridge or Router)
- WiFi support as per IEEE 802.11g/n/ac in the home(if required by the purchaser).
- USB 2.0/3.0 Interface (If required by the purchaser)
- Dying gasp feature (If required by the purchaser)
- 10G port(if required by purchaser)
- RF video interface over coaxial F connector (if required by the purchaser)

3.2.2 Type 2: B-ONT for FTTO applications

B-ONT shall provide the following broadband services. Service support shall be there for voice video and data. Exact number of ports for each interface shall be indicated by the user.

- 10/100/1000 Base T Ethernet interfaces (to inter-connect IP phones, Set top box for IPTV, PC etc. through a home Ethernet bridge or Router).
- E1 line (For PBX interconnection). The support for E1 shall be meant for transport applications of TDM to OLT.
- POTS (purchaser shall specify exact number of ports)

- RF interfaces over coaxial female 'F' connector (If required by the purchaser)
- WiFi support as per IEEE 802.11g/n/ac(if required by the purchaser).
- Dying gasp feature (If required by the purchaser)
- USB 2.0/3.0 Interface (If required by the purchaser)
- 10G port(if required by purchaser)

3.2.3 Type 3: Cell- Site Fronthaul/Backhaul (M-ONT) for FTTM applications

M-ONT shall provide the following broadband services. Service support shall be there for voice video and data. Exact number of ports for each interface shall be indicated by the user.

- POTS (If required by the purchaser)
- 10/100/1000 Base T Ethernet interfaces (for interconnection to 2G/3G/4G BTS).
- PON ports for Uplink.
- USB 2.0/3.0 Interface (If required by the purchaser)
- E1 line (for interconnection to 2G/3G/4G BTS) (Optional, to be specified by the purchaser).
- Synchronization interface supporting IEEE 1588v2 (Optional, to be specified by the purchaser).
- WiFi support as per IEEE 802.11g/n/ac(if required by the purchaser).
- 10G port(if required by purchaser)
- CPRI(Optional, to be specified by the purchaser).
- OBSAI(Optional, to be specified by the purchaser).

ONT shall have SFP at least for one of the UNI so that the BTS connectivity can be extended through fibre.

3.2.4 Type 4: Cabinet/Curb ONU (C-ONU) for FTTC/Cab applications

C-ONU shall provide the following residential broadband services. Service support shall be there for voice video and data. Exact number of ports for each interface shall be indicated by the user

- POTS (Upto 16 ports, exact number to be specified by the purchaser)
- ADSL2+/VDSL2 lines

- G.fast/G.hn(if required by purchaser)
- Dying gasp feature (If required by the purchaser)
- USB 2.0/3.0 Interface (If required by the purchaser)
- 10/100/1000 Base T Ethernet interfaces (to inter-connect IP phones, Set top box for IPTV, PC etc. through a home Ethernet bridge)
- WiFi support as per IEEE 802.11g/n/ac(if required by the purchaser).
- 10G port(if required by purchaser)

3.2.5 Type 5: Residential-ONU for FTTB applications in MDU

Residential-ONU shall provide the following residential broadband services. Service support shall be there for voice video and data. Exact number of ports for each interface shall be indicated by the user. For distances less than 100 meter from the ONU direct Ethernet access over copper lines can be done. For greater distances, ADSL2+/VDSL2/G.fast/G.hn based access shall be used.

- POTS
- 10/100/1000 Base T Ethernet interfaces (to inter-connect IP phones, Set top box for IPTV, PC etc. through a home Ethernet bridge)
- RF interfaces over coaxial female 'F' connector (If required by the purchaser)
- WiFi support as per IEEE 802.11g/n/ac(if required by the purchaser).
- Dying gasp feature (If required by the purchaser)
- USB 2.0/3.0 Interface (If required by the purchaser)
- ADSL2+/VDSL2 lines
- G.fast/G.hn(if required by purchaser)
- 10G port(if required by purchaser)

3.2.6 Type 6: Business-ONU for FTTB applications in MTU

Business-ONU shall provide the following broadband services. Service support shall be there for voice video and data. Exact number of ports for each interface shall be indicated by the user.

- POTS
- 10/100/1000 Base T Ethernet interfaces (to inter-connect IP phones, Set top box for IPTV, PC etc. through a home Ethernet bridge)

- ADSL2+/VDSL2 lines
- G.fast/G.hn(if required by purchaser)
- WiFi support as per IEEE 802.11g/n/ac(if required by the purchaser).
- 10G port(if required by purchaser)

3.2.7 Type 7: Optical-ONU for FTTH applications

Business-ONU shall provide the following broadband services. Service support shall be there for voice video and data. Exact number of ports for each interface shall be indicated by the user.

- POTS (Purchaser shall specify the exact number of ports)
- 10/100/1000 Base T Ethernet interfaces (to inter-connect IP phones, Set top box for IPTV, PC etc. through a home Ethernet bridge)
- PON ports for Uplink-one
- Dying gasp feature (If required by the purchaser)
- USB 2.0/3.0 Interface (If required by the purchaser)
- WiFi support as per IEEE 802.11g/n/ac(if required by the purchaser).
- 10G port(if required by purchaser)

¹ **Note 1:** Purchaser shall specify the exact number of ports required and also the number of access to WiFi users.

Note 2: The system shall be designed considering 100Mbps throughput per 10/100BaseX Ethernet UNI port and 400Mbps up/down for 10/100/1000BaseX Ethernet UNI port.

Note 3: The PON access shall support Set Top Boxes (STB) in the home network offering different video channels of IPTV, on different TV sets.

Note 4: All types of ONTs/ONU shall support Dual stack IP addresses (IPv4 & IPv6) for management and services.

Note 5: Any ONT to be utilized for meeting Type C Protection shall be provided with two PON ports.

Note 6: Every 10G port shall support SFP+.

3.3. ONT equipment architecture

The equipment architecture of ONU as well as ONT is kept out of the scope of the GR and as such the implementation is entirely left open to the equipment manufacturer/supplier. Thus, a complete ONU/ONT may comprise of the basic module providing optical interface on the PON side and some sub-modules providing UNI interfaces on the user side through DSLAM etc. This basic module and the sub-modules may be implemented in the same mechanical package or implemented on different box.

3.3.1. Functional requirements of ONT/ONU at UNI

a) Isolation of subscriber traffic to ensure user privacy for ONU

- i. ONU shall have capability to prevent MAC address spoofing. It shall be possible to limit the number of MAC/IP addresses per port and to bind the MAC/IP addresses to a port.
- ii. There shall be no layer 2 connectivity between users at ONU. Subscriber (peer-to-peer P2P) communication shall be allowed only through OLT.

b) Support for Layer 3 functionalities

- i. ONU shall have the capability to support layer 3 features like routing, NAT and firewall functionality
- ii. There shall be no layer 2 connectivity between users at ONU for Layer 2 UNIs that is the ONU/ONT operating in Switched Bridge mode. Subscriber (peer to peer-P2P) communication shall be allowed only through OLT for ONU/ONT operating in Switched Bridge mode.

c) Layer 2 bridging support for various ONU/ONTs

Type 1. Home-ONT (H-ONT) for FTTH applications.

32 MAC addresses, 16 VLAN.

Type 2. Business-ONT (**B-ONT**) for FTTH applications.

256MAC addresses, 64 VLAN.

Type 3. Cell- Site fronthauling/Backhauling -ONT (M-ONT) for FTTM applications

64MAC addresses, 16 VLAN.

Type 4. Cabinet/curb-ONU (**C-ONU**) for FTTCab/FTTC applications.

1K MAC addresses, 4096 VLAN.

Type 5. Residential-ONU (**R-ONU**) for FTTB applications in MDU.

1K MAC addresses, 4K VLAN.

Type 6. Business-ONU (**B-ONU**) for FTTB applications in MTU.

1K MAC addresses, 4K VLAN.

Type 7. Optical-ONT (O-ONT) for FTTH applications.

64 MAC addresses, 16 VLAN.

The following capabilities shall be supported at UNI for all above types:

- i. Flow control per 802.3x
- ii. IGMPv2/v3 snooping – applicable for ONU only, optional for ONT
- iii. IGMP filtering – applicable for ONU only, optional for ONT
- iv. 128 multicast groups – applicable for ONU only, optional for ONT.

Note: Flow control shall be supported by both ONU and ONT. The others shall be as per the requirements of the purchaser.

d) Bandwidth management, congestion control and QoS.

- i. For ONU, there shall be robust and programmable buffer management, congestion control, and traffic scheduling. This is required to ensure appropriate levels of service on premium or time-

sensitive content. Sufficient buffer capacity shall be as per ITU-T G.9807.1

- ii. For better quality of service support, the ONT/ONU is required to support 802.1p bridging. This function maps 802.1p priorities into priority queues in the upstream direction.
- iii. Different scheduling methods can be applied, e.g., strict priority and weighted round robin. When p-bits are combined with VLAN ID for indicating QoS classes, the network elements should have the ability to queue in function of the VLAN ID.
- iv. For ONU, the rate in the downstream and upstream directions shall be controllable through LCT/EMS.

e) Dynamic Bandwidth Adjustment (DBA)

- i. DBRu shall be supported.
- ii. Idle XGEM DBA shall be supported.
 - For each Alloc-ID logical buffer, the DBA functional module of the OLT infers its occupancy by collecting in-band status reports, or by observing the upstream idle pattern, or both. The DBA function then provides input to the OLT upstream scheduler, which is responsible for generating the bandwidth maps (BWmaps). The BWmap specifies the size and timing of upstream transmission opportunities for each Alloc-ID, and is communicated to the ONUs in-band with the downstream traffic.
- iii. XGS-PON must provide at least four classes of services to map UNI flows.

f) Traffic policing functions

These functions shall include traffic shaping. Policing of upstream traffic shall be done at ONU/ONT. To ensure strict QoS guarantees, the ONU/ONT shall need to perform bandwidth control at the ingress of the Ethernet network. Stricter guarantees can be provided with policing at

the ingress port of each Ethernet switch. The service edge and the ONU must also implement policers and shapers for downstream traffic.

g) Security

- i. User name and password based authentication
- ii. Support of 802.1x authenticator functionality (MAC based) for ONU
- iii. MAC address limitation per-ONT & in case of ONU per port
- iv. >100 ACL support (based on switch port, MAC address, Ether-type) on ONU
- v. DOS prevention (optional SSH v1/2 for CLI)
- vi. AES (key-size of 128 bit) support (*mandatory*) per port id.

h) ONT Ethernet port shall be configurable to accept the following frames

- i. Customer VLAN tagged frames
- ii. Priority tagged frames
- iii. Untagged frames
- iv. 802.1p mode

i) ONU shall support DHCP relay agent. ONU shall support DHCP option 82 for DHCP-based broadband access.

j) There shall be support for FEC for downstream and upstream directions which shall be dynamically controlled by the operator (enable/disable).

k) Line testing: In FTTC/FTTCab and FTTB architectures, the ONU shall allow pre-qualification testing of the 2-wire (DSL) line from the central location through software. The output of the pre-qualification testing shall at least be the maximum downstream and upstream bit rate possible over the line (DSL).

l) Local management port

There shall be provision for a local management port on Ethernet interface ports for local trouble-shooting at ONU.

3.3.2. 'Triple-play' related requirements for ONU

a. Channel zapping time

The GR envisages distributed channel-change activation at ONU by means of IGMPv2/3 messages. The GR assumes an average 2 seconds time between channel swapping by a user as a design measure. To achieve the same, the ONU shall be able to scale up to $@N*10$ swaps/minute (where N = No. of users at ONU). Besides, it shall keep the time taken for the multicast join low enough to enable the customer to perceive a channel change time of less than a second.

b. Channel-change activation

Channel change decision shall be taken at ONU to achieve the targets as at sub-clause a) above. Further, ONU shall support two-stage multicasting for Broadcast TV. Normally, the ONU shall be downloading a group of channels commonly seen in the served-area. Other 'niche' channels shall be available in Metro Core. For a 'niche' channel, ONU shall send an IGMP join to OLT, if demanded by at least one user.

c. DHCP option 82 (IETF RFC 3046)

For DHCP based access for entertainment & gaming services, the ONU shall support DHCP option 82 for line identification (Applicable for ONU).

3.4 OLT specifications

The OLT shall be modular architecture, which shall support PON interfaces, Switch fabric and controller functionalities.

a) Hardware capability

i. Number of XGS-PON interfaces in a chassis:

- A. An OLT shall support PON Interface Cards, network side interface cards, switch fabric cards and controller cards.

B. Number of interfaces supported:

Each sub-rack shall support minimum 16 XGS-PON interfaces.

However, exact number of interface per sub-rack shall be as per the Purchaser's Requirement.

ii. Number of interfaces towards the Core network:

An OLT shall have the provision to terminate the following interfaces:

- A. 4 x 10GbE LAN Interface
- B. 2 x 1GbE / 10GbE LAN Interface
- C. 1 x 100GbE / 40GbE LAN Interface (Optional)
- D. CPRI/OBSAI interface can be supported towards the core network(Optional).

The actual number of the Interfaces shall be as per the Purchaser's Requirement.

b) Functional and architectural requirements

- i. OLT shall support universal application card-slots for either PON or may be utilized for any other application.

ii. Protection requirements

- A. There shall be 1:1 protections for PON line cards.
- B. The fibre protection scheme at the individual PON line card granularity shall be mandatory.
- C. 1+1 redundancy for uplink, system controller, Switch fabric cards. The two uplink ports shall reside on two different cards in case of 1+1 redundancy for uplink port.
- D. The OLT provide a 1:1 network-side uplink protection for uplinks of the same type located on the same card using link aggregation.

c) Features and capabilities

- i. The OLT shall have local status monitoring
- ii. The OLT shall supports LED status indication per OLT port

- iii. **Power:** Indicates power on/off status
- iv. **Fail:** Indicates internal device failure status
- v. **Alarm:** Indicate alarm status
- vi. OLT shall support the following PON link diagnostics measurement:
 - A. Measurement of received optical power per ONT.
 - B. BER measurement per ONT/ONU (applicable in case of E1 interfaces only).

d) DBA

- i. Maximum bandwidth limiting
- ii. Minimum guaranteed bandwidth
- iii. Two or more level (preferred four) classes of classification
- iv. DBRu report
- v. Idle GEM DBA
- vi. To provide access to a variety of packet-based services, such as IPTV, VoIP, L2/L3 VPNs and high-speed Internet access, XGS-PON must provide at least four classes of services to map UNI flows.

e) Layer 2 management

- i. Switch fabric in OLT shall be able to handle full wired speed throughputs.
- ii. MAC learning shall be supported at OLT
- iii. Port-id-based VLAN shall be supported at OLT
- iv. VLAN stacking towards the network at the OLT shall be supported

f) Support for MAC addresses limiting

- i. The operator shall be able to set the maximum number of MAC addresses from an ONT UNI at the OLT. The number shall be operator programmable. When MAC address limit is reached, subsequent MAC addresses from that specific ONT UNI will not be learned.

g) Supports learning and aging time configuration at OLT

The operator shall be able to enable/disable MAC address learning function and configure the MAC learning aging time.

- i. VLAN and Port-id mapping
- ii. The OLT shall have a function to store the corresponding relationship of user ID, VLAN tag value and port-id number.

h) VLAN function

The OLT shall support the following VLAN operation

- i. VLAN insertion in ingress process
- ii. VLAN removal in egress process
- iii. VLAN stacking per 802.1ad.

i) Filtering functions at OLT

- i. Filtering by destination MAC address
- ii. Filtering by source MAC address
- iii. Filtering of 802.1x packets (Optional)

j) QoS and Security Support for packet classification functions.

- i. Classification based on VLAN ID
- ii. Classification based on 802.1p bit
- iii. DSCP to 802.1p mapping
- iv. The XGS-PON OLT chassis should be able to configure up to 4094 (1-4094) VLAN. VLAN 0 and 4095 are reserved and not used in the XGS-PON OLT system.
- v. The database of learning should be based on IVL (Independent VLAN Learning)
- vi. Support of RSTP or RPF or MSTP(support of any)
- vii. Support of IGMP proxy
- viii. 802.1x port based security (optional)
- ix. DHCP relay and relay agent with option 82 for RADIUS authentication

k) Security

- i. >100 ACL support (based on switch port, MAC address, Ether Type)
- ii. DOS prevention, SSH v1/2 for CLI

l) Duplicity Check

- i. ONT with duplicate serial number/ Duplicate MAC address should not be allowed in the network and it shall be possible to check this from the OLT.

4.0. Network requirements

4.1. Passive optical network

- a) The transmission methodology should be bidirectional on a single fibre or unidirectional over two fibre compliant with ITU-T Rec. G.652.
- b) Bidirectional transmission shall be accomplished using WDM technique on a single-fibre.
- c) The wavelength in the range 1575-1580nm (1575-1581nm for outdoor deployment) shall be used for downstream. There shall be option to purchaser for use of 1550nm for overlay RF video applications.
- d) The wavelength in the range 1260-1280nm shall be used for upstream.
- e) The PON system shall support m x N architecture. A 1:256, 1:128, 1:64 split options per PON interface on OLT shall be supported. The exact requirement of optical interfaces for 1xN and 2xN splitters shall be specified by the purchaser based on the optical power-budget calculation.

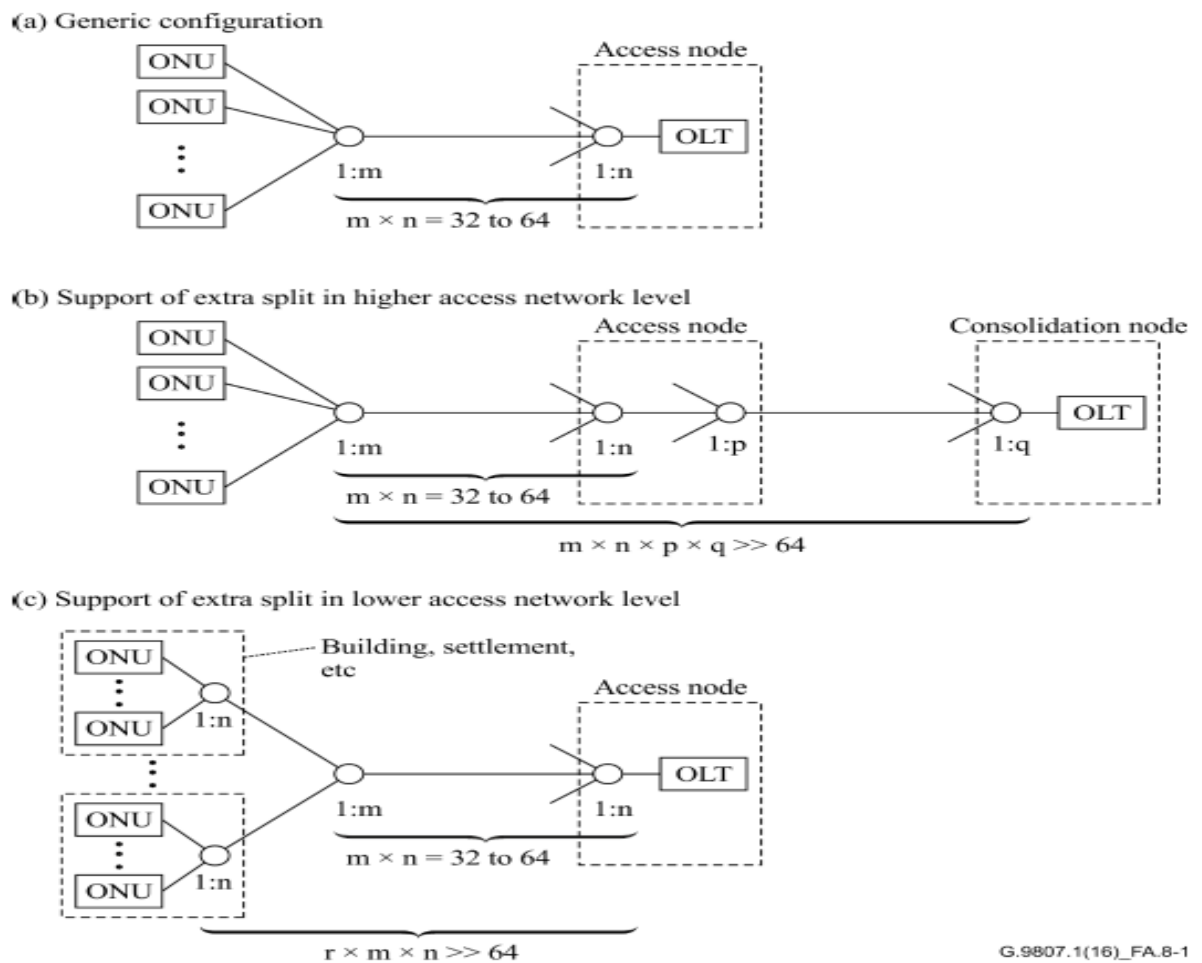


Figure 9: Various splitter configurations of XGS-PON

4.1.1. Optical Splitter specifications

For optical splitter specifications, GR No. TEC/GR/TX/OPT-01/APR-2012 shall be referred.

4.1.2. Optical WDM1r coupler specifications

Table 4.1: Optical WDM1r coupler specifications

Performance Specification		Unit	Value
G-PON	Wavelength range	nm	1290 to 1330 & 1480 to 1500

	Insertion loss	dB	0.8
	Isolation @ XG-PON1 & NG-PON2 & PtP WDM PON	dB	>30
XG-PON bands	Wavelength range	nm	1260 to 1280 & 1575 to 1581
	Insertion loss	dB	1.3
	Isolation @ G-PON & NG-PON2 & PtP WDM PON	dB	>30
NG-PON2 bands	Wavelength range	nm	1524 to 1544 & 1596 to 1603
	Insertion loss	dB	1.4
	Isolation @ G-PON & XG-PON1 & PtP WDM PON	dB	>30
Ptp WDM PON band	Wavelength range	nm	1606 to 1625
	Insertion loss	dB	1.6
	Isolation @ G-PON & NG-PON2 & XG-PON1 PON	dB	>30
Ripple		dB	<0.3
Directivity		dB	>50
Optical Return loss		dB	>45
Polarization dependent loss		dB	<0.2
Polarization Mode dispersion		ps	<0.1
Operating temperature		°C	-40 to 85
Storage temperature		°C	-40 to 85
Max optical power		mW	500
Package size (Lxhxd)		mm	80*58*8
Fiber type		N/A	G657.A1 or SMF-28

“Note- connector loss is not included for insertion loss in above specification.”

5.0 Ethernet interfaces at UNI of ONT/ONU and SNI of OLT: Specifications

The following Ethernet interface options shall be supported. Actual interface type and number shall be communicated by purchaser.

- a) 1000Base-SX (50 μ multi-mode) interface
- b) 1000Base-LX (10 μ single-mode @1310nm) interface
- c) 1000Base-ZX (10 μ single-mode @ 1550) interfaces.
- d) 10Gb Ethernet interfaces as per IEEE 802.3ae.
- e) 40/100Gb Ethernet interfaces as per IEEE 802.3ba and IEEE 802.3bg.

The specifications for 1Gb interfaces shall comply with TEC GR No.: TEC/GR/TX/EMC-001/02/SEP-12 on Ethernet Media Converter and 10/40/100Gb interface shall comply IEEE standards. The different GbE interfaces, 10GbE interfaces and 40/100GbE interfaces may be implemented through the use of SFP, XFP and CFP respectively. For higher data rates, Support of 10GbE and 40GbE/100GbE through SFP+ and QSFP+/QSFP28 respectively may be implemented.

For redundancy, the OLT shall support IEEE 802.3ad Ethernet link aggregation and RSTP IEEE 802.1w on those interfaces.

6.0. Protection on the PON section

From the viewpoint of administration of the access network, the protection architecture of XGS-PON is considered to enhance the reliability of the access networks. However, protection shall be considered as an optional mechanism because its implementation depends on the realization of economical systems.

The best resilience architecture needs to be defined by operator/purchaser. It should include duplex and dual parented duplex system configuration as defined in clause 14 of G.984.1 as well as Appendix II and III of the same recommendation.

This clause presents some possible duplex configurations and related requirements as examples of protected XGS-PON systems. In addition, the required OAM message for protection is mentioned.

There are some basic elements that can be protected in a PON network:

- a) The OLT PON ports
- b) The PON section between OLT and optical splitter.
- c) The passive optical splitter.
- d) The PON section between optical splitter and ONU/ONT.
- e) The ONU/ONT PON port.

There shall be two categories of ONU/ONTs:

Category 1: ONU/ONT with one XGS-PON interface

Category 2: ONU/ONT with two XGS-PON interfaces

6.1. Possible protection switching types

There are two types of protection switching both of which are analogous to those of SDH systems.

- a) Automatic switching; and
- b) Forced switching.

The first one (Automatic Switching) is triggered by fault detection, such as loss of signal, loss of frame, signal degrade (BER becomes worse than the predetermined threshold), and so on in Type C protection.

The second one (Forced switching) is activated by administrative events, such as fiber rerouting, fiber replacement, etc. Both types should be possible in the XGS-PON system, if required, even though they are optional functions. The switching mechanism is generally realized by the OAM function; therefore, the required OAM information field should be reserved in the OAM frame.

The switching between working PON port and standby PON port should be reported as an alarm, when the port status changes from active to standby. LCT/EMS/NMS should report the port change status.

Figure 10 shows the duplex system model for the access network. The relevant part of the protection in the XGS-PON system should be a part of the protection between the ODN interface in the OLT and the ODN interface in the ONU via the ODN, excluding the SNI redundancy in the OLT.

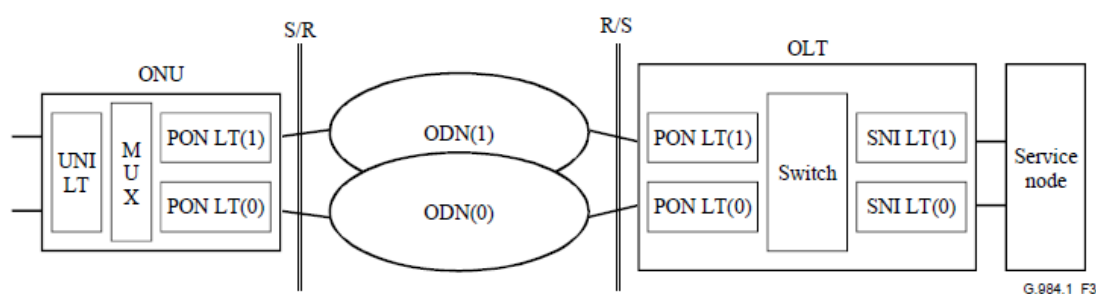


Figure 10: Duplex system Model

6.2 Possible duplex XGS-PON configurations and characteristics

There can be several types of duplex XGS-PON systems, as shown in figures 11-a) to b). The control protocols for each configuration should be specified independently from one another. The purchaser has the option to procure any of the configurations depending upon the reliability of services.

For example, no switching protocol is required for the OLT/ONU in the figure 11a) and 11b) since the switching is only applied for the optical fibres.

Type B protection shall be supported, whereas other schemes shall be optional to purchaser's requirements.

Type B: The second configuration (Figure 11a) doubles the PON ports and the optical fibres between the OLTs and the optical splitter, and the splitter has two

input/output ports on the OLT side. This configuration reduces the cost of duplexing the ONUs, although only the OLT side can be recovered.

Type C: The third configuration (Figure 11b) doubles not only the OLT side facilities but also the ONU side. In this configuration, recovery from failure at any point is possible by switching to the standby facilities. Therefore, the full duplex cost enables a high reliability.

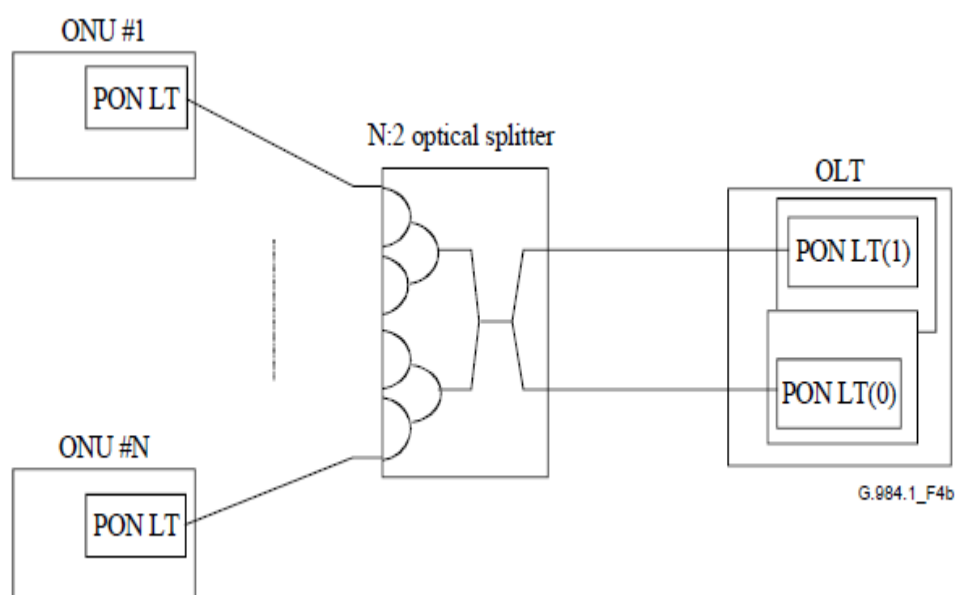


Figure 11a– Duplex XGS-PON system: OLT-only duplex system Type B

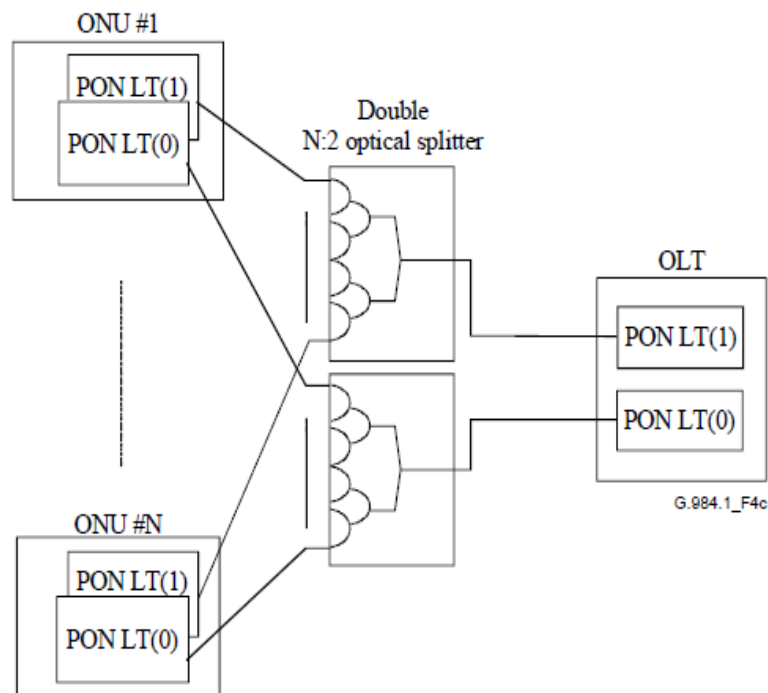


Figure 11b– Duplex XGS-PON system: Full duplex system-Type C

7.0. Equipment redundancy

The equipment shall provide complete redundancy for:

a) Control/Processor

If the Control/Processor unit failure does not affect the working traffic, no redundancy of Control/Processor unit shall be required.

However, if the Control/Processor unit failure does result in traffic failure, then (1+1) hot-standby mode redundancy of Control/Processor shall be provided in the equipment. Immediate upon insertion of a healthy card, the system shall revert to its pre-failure NMS/EMS configuration.

Note. The performance data as envisaged above shall be ensured all clients at UNI/NNI/SNI.

b) Switch/Matrix

There shall be provision for a parallel hot-standby MAC switch fabric at the OLT to take-over traffic during failure of the working card.

The switching-over time from working switch matrix card to standby card shall be completed within 50 ms. (Optional)

c) Power supply

If the power-supply is provided through a centralized power-supply unit at chassis-level, a hot-standby power-supply shall be provided at chassis-level, to ensure smooth working of the equipment during failures. Further, there shall be provision for dual-feed arrangement to the chassis power-supply, such that in case of failure of one feed, the system shall be able to function in a healthy manner without traffic interruption.

d) The redundancy in the OLT equipment may be provided for the Timing Circuitry.

8.0. Performance requirements

The equipment shall be tested for error performance.

In laboratory: IETF RFC 2544 conformance/performance shall be tested for end-to-end Ethernet service. In the case E1 service is offered, BER performance over simulated hop shall be tested better than 1×10^{-10} for 24 hours over an emulated E1 (TDMoP) in an end-to-end configuration.

In field: IETF RFC 2544 conformance/performance shall be tested for end-to-end Ethernet service. In the case E1 service is offered, BER performance over simulated hop shall be tested better than 1×10^{-10} for 24 hours over an emulated E1 (TDMoP) in an end-to-end configuration.

9.0. Synchronization requirements

To deliver high bandwidth to mobile operators, accurate synchronization and timing is required in the XGS-PON network. For 2G operators, E1 interfaces have been used for synchronization. However, for 3G/4G wireless additional synchronization schemes need to be provided through IEEE 1588v2 Precision Time Protocol (PTP).

Synchronising the ONTs: All ONTs shall operate with the PON clock transmitted by the OLT. The round trip delay of each ONT is known with high accuracy. If an accurate timing source is available at the OLT, its is possible to accurately recover the clock at ONT by tracking the phase and the frequency relation between the reference and the PON clock at the ONT.

Synchronising the OLT: XGS-PON OLT shall serve as the master timing source for ONUs. The following interfaces shall be available at the OLT for synchronisation. :

- a. BITS (E1 clock)(Optional) or
- b. GPS based source for high accuracy clock input (Optional)
- c. IEEE 1588v2 over PON (Optional)

Note: For packet synchronization, GR No. TEC/GR/TX/PTP-002/01/MAR-12 and TEC/GR/TX/PTP-003/01/MAR-12 may be referred.

9.1. The Synchronizing references:

The synchronization timing reference shall be an external timing reference source at 2048 KHz (Optional) OR IEEE1588v2 enabled Ethernet packet.

- 9.1.1. Frequency accuracy, hold-over mode accuracy, clock bandwidth and frequency pull- in and pull-out range shall be as per ITU-T Rec. G.987.x series of Recommendations.

9.2 Timing output interface

The XGS-PON OLT shall provide a timing-output interface at 2048 KHz for external synchronization. The output specifications shall conform to ITU-T Rec. G.812, as applicable. (Optional)

10.0 Maintenance, performance monitoring & supervisory signals

The maintenance signals philosophy shall be as per ITU-T Rec. G.987.x.

10.1 Alarms

The alarms and consequent actions shall be possible to monitor via EMS & LCT of the equipment be as per ITU-T G.987 series Recs

---End of Chapter I---

CHAPTER 2

General Requirements

1.0 Reference documents

- 1.1 Whatever that has not been specifically stated in this document, shall be deemed to be as per relevant latest ITU-T Recommendations.
- 1.2 Relevant ITU-T/IEEE Recommendations & other specifications are given in the GR.
- 1.3 All references to TEC GRs & other Recommendations imply for their latest issues.

2.0 Engineering requirements

- 2.1 The equipment shall be fully solid state and adopt state-of-the-art technology.
- 2.2 The equipment shall be compact and composite in construction and light-weight. The manufacturers shall furnish the actual dimensions and weight of the equipment.
- 2.3 All connectors shall be reliable and of standard type (CACT approved) to ensure failure free operation over long periods and under specified environmental conditions.
- 2.4 All connectors and the cable used shall be of low loss type and suitably shielded (CACT approved).
- 2.5 The equipment shall be housed in standard 19" rack, 600 mm rack or slim rack with front/back access. **The purchaser may specify specific requirements.**
- 2.6 The equipment shall provide natural cooling arrangements. But the purchaser may allow use of fans if the natural cooling arrangement is not found adequate provided:
 - a. Fan failure is reported through LCT/EMS.
 - b. Multiple fans are there in one tray.
 - c. Fans are DC operated.

d. MTBF is better than 80,000 hours.

- 2.7 The plug-in units shall be of suitable type to allow their removal/insertion while the equipment is in energized condition.
- 2.8 The mechanical design and construction of each card/unit shall be inherently robust and rigid under all conditions of operation, adjustment, replacement, storage and transport and conforming to TEC document No. SD: QM-333. Issue: March 2010 – “Standard For Environmental Testing of Telecommunication Equipment”.
- 2.9 The plug-in units shall be of suitable type to allow their removal/insertion while the equipment is in energized condition.
- 2.10 Each sub-assembly shall be clearly marked with schematic reference to show its function, so that it is identifiable from the layout diagram in the handbook.
- 2.11 Each terminal block and individual tags shall be numbered suitably with clear identification code and shall correspond to the associated wiring drawings.
- 2.12 All controls, switches, indicators etc., shall be clearly marked to show their circuit diagrams and functions.
- 2.13 Facility to mount fixed-attenuator, if required, shall be provided in the receive-chain of the system.

3.0 Operational requirements

- 3.1 The equipment shall be designed for continuous operation.
- 3.2 The equipment shall be able to perform satisfactorily without any degradation at an altitude up to 4000 meters above mean-sea-level. A test certificate from the manufacturer will be acceptable.
- 3.3 The equipment shall be able to work without any degradation in saline atmosphere near coastal areas and should be protected against corrosion.
- 3.4 Visual indication to show power ON/OFF status shall be provided.
- 3.5 Wherever the visual indications are provided, Green colour for healthy and Red colour unhealthy conditions would be provided. Some colour may be used for non-urgent alarms.

3.6 The equipment shall support Dual stack IP addresses (IPv4 & IPv6) for management and services.

4.0 Quality requirements

4.1 The manufacturer shall furnish the MTBF/MTTR values. The calculations shall be based on the guidelines as in BSNL-QA document: QM-115 - “Reliability Methods and Predictions” or any other international standard.

4.2 The equipment shall be manufactured in accordance with international quality management system ISO 9001:2008 for which the manufacturer should be duly accredited. A quality plan describing the quality assurance system followed by the manufacturer would be required to be submitted. And the equipment shall meet the latest BSNL QA Guidelines indicated in Manuals QM 118 {Quality and Reliability in product Design.}, QM 205 {Guidelines for Standard of Workmanship for Printed Boards}, QM 206 {Guidelines for Standard of Workmanship for Printed Board Assemblies}, QM 210 {Guidelines for Standard of Workmanship for Surface Mounted Devices} and QM301{Transmission Equipment General Documentation}.

4.3 The equipment shall conform to the requirements for environment as specified in TEC document No. SD: QM-333. Issue: March 2010 – “Standard For Environmental Testing of Telecommunication Equipment”. The applicable tests shall be conducted for respective environmental categories as follows:

4.4 Environmental requirements for various XGS-PON constituents.

a. ONU/ONT/OLT

i. Environmental requirements for various ONUs shall be as follows:

Type 1. Home-ONT (H-ONT) for FTTH applications:

✓ QM-333 ‘B2’ category

Type 2. Business-ONT (B-ONT) for FTTH applications:

✓ QM-333 ‘B2’ category

Type 3. Cell- Site Backhauling -ONT (M-ONT) for FTTM applications:

✓ QM-333 'B2' category

Type 4. Cabinet/Curb-ONU (C-ONU) for FTTCab/FTTC applications:

✓ QM-333 'B2' category

Type 5. Residential-ONU (R-ONU) for FTTB applications in MDU:

✓ QM-333 'D' category

Type 6. Business-ONU (B-ONU) for FTTB applications in MTU:

✓ QM-333 'B2' category

Type 7. Optical-ONT (O-ONT) for FTTH applications:

✓ QM-333 'B2' category

ii. OLT shall provide compliance to QM-333 'B2' category.

b. 1xN Symmetrical Splitters

At Cabinet: QM-333 'D' category.

At MDU/MTU: QM-333 'B2' category

At Central/Remote Office: QM-333 'B2' category.

c. 2xN Symmetrical Splitters

At Cabinet: QM-333 'D' category.

At MDU/MTU: QM-333 'B2' category

At Central/Remote Office: QM-333 'B2' category.

d. Connectors

At Cabinet: QM-333 'D' category.

At MDU/MTU: QM-333 'B2' category

At Central/Remote Office: QM-333 'B2' category.

5.0 Maintenance requirements

- 5.1 Maintenance philosophy is to replace faulty units/subsystems after quick on-line analysis through monitoring sockets, alarm indications and Built-in Test Equipment. The actual repair will be undertaken at centralized repair centers. The corrective measures at site shall involve replacement of faulty units/subsystems.
- 5.2 The equipment shall have easy access for servicing and maintenance.
- 5.3 Suitable alarms shall be provided for identification of faults in the system and faulty units.
- 5.4 Suitable potential-free contacts (preferably)/or any other suitable method shall be provided for extension of audio/visual alarms.
- 5.5 Ratings and types of fuses used are to be indicated by the supplier.
- 5.6 The manufacturer/supplier shall furnish the list of recommended spares for three years maintenance.
- 5.7 The supplier shall have maintenance/repair facility in India.
- 5.8 Supplier should guarantee the spares so long as the equipment is in service, at least for 10 years from the date of supply. The purchaser would like to stock spares as and when the supplier decides to close down the production of the offered equipment. In such an event, supplier shall give a two years notice to the purchaser so as to stock the life-time spares.

6.0 Power supply

6.1 Power supply requirements for various XGS-PON constituents:

a. Powering requirements: ONT

The primary power source shall be 160-270Vac, 50+/-5Hz for the following:

Type 1. Home-ONT (**H-ONT**) for FTTH applications:

Type 2. Business-ONT (**B-ONT**) for FTTH applications:

Type 3. Cell- Site fronthaul/Backhauling -ONT (**M-ONT**) for FTTM applications:

Type 5. Residential-ONU (**R-ONU**) for FTTB applications in MDU:

Type 6. Business-ONU (**B-ONU**) for FTTB applications in MTU:

Type 7. Optical-ONT (O-ONT) for FTTH applications:

The ONT shall be designed to have protection of power transient, power-surge and power blowouts. However,

- i. In case of DC operation, the adaptor for AC↔DC may be external to ONT.
- ii. The power rating shall be clearly marked on the device.
- iii. The power backup requirement for ONT is left to the purchaser's discretion.

b. Powering requirements: Cabinet/Curb ONU (C-ONU) at Remote Office

The nominal power supply shall be uninterrupted –48V DC with a variation in the range from -40V to -60V for C-ONU for FTTCab applications (when installed at Remote Office e.g. DLC/RSU/RLU locations). The equipment shall operate over this range without any degradation in performance.

- i. The equipment shall be adequately protected in case of voltage variation beyond the range as specified above and also against input reverse polarity.
- ii. The power consumption shall be minimal. The actual power rating/ consumption to be furnished by the manufacturer on the equipment.
- iii. The derived DC voltages in the equipment shall have protection against over-voltage, short-circuit and overload.

c. Powering requirements: Cabinet/Curb ONU (C-ONU) at Curb (installed at street-cabinets etc.)

The primary power source shall be 160-270Vac, 50+/-5Hz for this case. The ONU shall be designed to have protection of power transient, power-surge and power blowouts. However,

- i. In case of DC operation, the adaptor for AC↔DC conversion shall be internal to the device.
- ii. The power rating shall be clearly marked on the device.

- iii. The power backup requirement for R-ONU is left to the purchaser's discretion.
- iv. The ONU shall provide external 4-6 hours 12V battery backup (to be specified by purchaser for the exact backup duration) to withstand commercial power outages. This assumes 0.5 average traffic in erlangs for POTS and 4-6 hours average usage time for 10/100/1000Base interface with 30% activity factor.
- v. The battery shall have a minimum life of 2 years. The replacement of the battery shall not cause any service interruption. The backup system should have a low voltage cut-off at battery voltage below 10.5V to prevent overdraw.
- vi. The system shall be equipped to test, monitor and report (through EMS and LCT) the following:
 - A. Battery present or not (assessed by voltage of the battery)
 - B. Battery useful or not (assessed by a short periodic discharge/charge test)
 - C. Battery voltage
 - D. Charging current
 - E. Low capacity (means going to shut down soon).

d. Powering requirements: OLT and related equipment in CO/RO

Nominal power supply is -48V DC or 220V with AC/DC adapter (Optional) with a variation in the range from -40V to -60V. The equipment shall operate over this range without any degradation in performance.

- i. The equipment shall be adequately protected in case of voltage variation beyond the range as specified above and also against input reverse polarity.
- ii. The derived DC voltages in the equipment shall have protection against over-voltage, short-circuit and overload.
- iii. The power consumption shall be minimal. The actual power rating/ consumption to be furnished by the manufacturer on the equipment.
- iv. The OLT system shall be provided with atleast two power feeds
 - A. centralized power supply with 1+1 redundancy, and

- B. Distributed on-board power supply
- C. Under voltage (-42V) alarm and over-voltage (-56V) alarm at EMS

7.0 Accessories

7.1 The supplier shall provide complete set of:

- a) All the necessary connectors, connecting cables and accessories required for satisfactory and convenient operation of the equipment. Types of connectors, adopters to be used and the accessories of the approved quality shall be clearly indicated in the operating manuals which should be in conformity with the detailed list in the GR

- b) Software and the arrangement to load the software at site.

Note. *The quantity shall be as ordered by purchaser.*

- c) Special tools, extender-boards, extender-cables and accessories essential for installation, operation and maintenance of the equipment shall be clearly indicated and supplied along with the equipment.

8.0 Documentation

Technical literature in English language only shall be accepted.

a) Installation, operation and maintenance manual

It should cover the following:

- i. Safety measures to be observed in handling the equipment;
- ii. Precautions for installation, operation and maintenance;
- iii. Test jigs and fixtures required and procedures for routine maintenance, preventive maintenance, troubleshooting and sub-assembly replacement;
- iv. Illustration of internal and external mechanical parts.

b) Repair manual

It should cover the following:

- i. List of replaceable parts used including their sources and the approving authority.

- ii. Detailed ordering information for all the replaceable parts shall be listed in the manual to facilitate recording of spares.
- iii. Procedure for trouble-shooting and sub-assembly replacement shall be provided. Test fixture and accessories required for repair shall also be indicated. Systematic trouble shooting chart (fault-tree) shall be given for the probable faults with their remedial actions.

9.0 Mechanical standards

- a) As the ONT is located in customer premises, it should be designed to support wall-mounting as primary mounting.
- b) The OLT and ONU shall be housed in the standard sub-racks preferably 19" width. The OLT Line Card shall be fitted with motherboard duly masked to avoid short-circuiting. The sub-rack shall have protruded impressions on the top and base-plate of sub-rack assembly to act as built-in guides known as "CNC guide forming" for holding the PCBs in the sub-rack. The back and forth movement of PCBs shall be very smooth without any significant play towards the sideways.
- c) The guides in the sub-rack shall be made with CNC machines/tools. In case of CNC tool being used to make guides, in order to maintain the accuracy, the technique adopted shall use a single DIE punching. The plastic guides shall not be permitted.
- d) In order to avoid bending/sagging of top and base-plates during transportation, installation and maintenance process, the metal-sheet used for these plates shall be minimum 1.2 mm in thickness for mild-steel material, 1.5 mm for Aluminum material and in case of stainless-steel material; the thickness of metal-sheet shall be 1.0 mm.
- e) The connectors used on the PCB and their mating connectors on the mother-board shall have tight grip to avoid jacking problems. The connectors used shall be professional grade telecom connectors of international industry standards. (Euro-type or better).
- f) The slots for interfaces in the sub-rack shall be universal, supporting any type of PCBs in any position except for common control, matrix and line cards. No damage shall take place to PCBs when loaded in the wrong

slot except in power-supply unit slots. The PCBs shall have the provision of locking/screwing to the sub-rack.

- g) The input/output terminations of tributary signals shall either follow extended mother-board using connectorised connections or directly from proper connectors at the mother-board.
- h) The height of main-rack shall be strictly as per this document till specified otherwise. The main-rack shall be made from metal-sheet of minimum 2.0 mm thickness and shall be covered from three-side minimum, with top and base covers. The thickness of the back-covers shall be 1.0 mm minimum. The base-plate of the main-rack shall be 2.0 mm minimum.
- i) The main-rack shall have adequate provision of holding/fixing the sub-racks in their positions. It shall be ensured that there is no lateral movement of sub-racks when fitted in main-rack. The main-rack shall have the proper fixing arrangements on floor, preferably with a base-plate and expansion-bolts etc. The thickness of base-plate shall be minimum 2.0 mm. The main-rack supplied with equipment shall be uniform in size irrespective of the loading of the equipment for all consignments by the manufacturer.
- j) The manufacturer shall specify the mechanical standard of racks and sub-racks in their manual and shall maintain the size and standard of racks, sub-racks, connectors etc., during supply of the equipment. The main-rack shall have sufficient space preferably in the sideways for running the input out cabling etc. This shall specifically be ensured during the testing, field trial and QA of the equipment.
- k) The permanent wiring such as distribution of power-supply etc. shall be pre-wired. During the testing and supply of the equipment the racks and sub-racks quality supplied by the manufacturer shall be ensured.
- l) The front/back opening of the sub-rack/main-rack is envisaged. No side-way opening shall be permitted. The access to data terminations shall be from the front/back side. However, with both the options available, the purchaser may specify specific requirements.

10.0 Operating personnel safety requirements

- 10.1 The equipment shall conform to IS 13252 part 1: 2010+Amd 2013+Amd 2015 “Information Technology Equipment – Safety- Part 1: General Requirements” [equivalent to IEC 60950-1:2005+A1:2009+A2:2013 “Information Technology Equipment –Safety- Part 1: General Requirements”]. The manufacturer/supplier shall submit a certificate in respect of compliance to these requirements.
- 10.2 The laser product shall meet the optical safety requirement as per IEC-60825-1. The equipment shall meet the optical safety requirement as per ALSD/ APR procedure of ITU-T Rec. G.664 (latest edition) on Class B laser. The equipment shall have visual warning and controls ensuring danger-free operation.
- 10.3 The equipment shall follow proper construction practice to minimize unintended radiation due to leakage from any gap or monitoring points. All unused ports and monitoring points should be terminated. The power flux density shall not exceed 1 mW/cm² at a distance of 2.5 cms.
- 10.4 Protection against short circuit/open circuit in the accessible points shall be provided. All switches/controls on front panel shall have suitable safeguards against accidental operations.
- 10.5 The optical access ports should be designed to protect themselves against the entry of dust when they are not occupied by an external fiber-optic connection. The optical access port shall be so positioned on the card as to be easy- to- clean by the user as well as for operation/handling purposes.
- 10.6 The equipment shall conform to the EMC requirements as per the standards and limits indicated therein. A test Certificate and the test report shall be furnished from the agency.

11.0 Minimum equipment requirements

Fully loaded pre-wired equipment for specific ‘category/type’ with input and output ports as specified in this GR. EMS and LCT shall also be offered. All test jigs, test instruments etc., shall be arranged by the manufacturer.

ONT/ONU	4 nos.
OLT	1 no.
EMS/LCT	1 no.

12.0 Field trial

The purchaser may conduct field trial for a minimum of 4 weeks. The manufacturer shall ensure that the equipment meets the field requirements of the purchaser.

13.0 Applicable tests(for TAC purpose):

For OLT:

- a) **Mandatory interface and services:**
 - i. POTS
 - ii. IPTV
 - iii. Ethernet interface & service
 - iv. PON Port
- b) **Additional test, if such configurations offered in OLT:**
 - i. E1 lines
 - ii. CIPRI/OBSAI
 - iii. RF video overlay

For ONT/ONU:

- a) **Mandatory interface and services:**
 - i. Ethernet interface & service
 - ii. IPTV
 - iii. PON Port
- b) **Additional test, if such configurations offered in ONU/ONT:**
 - i. RF video overlay
 - ii. E1 lines

- iii. CIPRI/OBSAI
- iv. POTS
- v. IPTV
- vi. Wifi
- vii. ADSL2+
- viii. VDSL2
- ix. G.fast
- x. G.hn
- xi. USB
- xii. Synchronization interface supporting IEEE 1588v2

---End of Chapter 2---

Chapter 3

EMC Requirements

1.0 Electromagnetic Interference

The equipment shall conform to the following EMC requirements for Class B:

General Electromagnetic Compatibility (EMC) Requirements: - The equipment shall conform to the EMC requirements as per the following standards and limits indicated therein. A test certificate and test report shall be furnished from an accredited test agency.

a) Conducted and radiated emission (applicable to telecom equipment):

Name of EMC Standard: "As per CISPR 22 (2008) - Limits and methods of measurement of radio disturbance characteristics of Information Technology Equipment" for the following

Limits:-

- i. To comply with **Class B** of CISPR 22 (2008).
- ii. The values of limits shall be as per TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16.
- iii. For Radiated Emission tests, limits below 1 GHz shall be as per Table 4 (a) or 5 (a) for measuring distance of 10m **OR** Table 4 (a1) or 5 (a1) for measuring distance of 3m.

OR

Conducted and radiated emission (applicable to telecom equipment):

Name of EMC Standard: "CISPR 32 (2015) - Electromagnetic compatibility of multimedia equipment - Emission requirements"

- i. To comply with Class B of CISPR 32 (2015).
- ii. For Radiated Emission tests, limits below 1 GHz shall be for measuring distance of 3m.

Note: Test Reports as per limits of CISPR 22 (2008) mentioned above shall be acceptable only upto March 31, 2019.

OR

Conducted and radiated emission (applicable to instruments such as power meter, frequency counter etc.):

Name of EMC Standard: "As per CISPR 11 {2015} - Industrial, scientific and medical (ISM) radio- frequency equipment -Electromagnetic disturbance characteristics- Limits and methods of measurement" for the following

Limits :-

- i. To comply with the category of Group 1 of Class B of CISPR 11 {2015}
- ii. The values of limits shall be as per clause No. 8.5.2 of TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16.

b) Immunity to Electrostatic discharge:

Name of EMC Standard: As per IEC 61000-4-2 {2008} "Testing and measurement techniques of Electrostatic discharge immunity test" for the following.

Limits: -

- i. Contact discharge level 2 { ± 4 kV} or higher voltage;
- ii. Air discharge level 3 { ± 8 kV} or higher voltage;

Performance Criteria shall be as per Table 1 under Clause 6 of TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16.

Applicable Performance Criteria shall be as per Table 3 under Clause 7.2 of TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16

c) Immunity to radiated RF:

Name of EMC Standard: As per IEC 61000-4-3 (2010) "Testing and measurement techniques-Radiated RF Electromagnetic Field Immunity test" for the following

Limits:-

For Telecom Equipment and Telecom Terminal Equipment with Voice interface (s)

- i. Under test level 2 {Test field strength of 3 V/m} for general purposes in frequency range 80 MHz to 1000 MHz and
- ii. Under test level 3 (10 V/m) for protection against digital radio telephones and other RF devices in frequency ranges 800 MHz to 960 MHz and 1.4 GHz to 6.0 GHz.

For Telecom Terminal Equipment without Voice interface (s)

Under test level 2 {Test field strength of 3 V/m} for general purposes in frequency range 80 MHz to 1000 MHz and for protection against digital radio telephones and other RF devices in frequency ranges 800 MHz to 960 MHz and 1.4 GHz to 6.0 GHz.

Performance Criteria shall be as per Table 1 under Clause 6 of TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16.

Applicable Performance Criteria shall be as per Table 3 under Clause 7.2 of TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16.

d) Immunity to fast transients (burst):

Name of EMC Standard: As per IEC 61000- 4- 4 {2012) "Testing and measurement techniques of electrical fast transients / burst immunity test" for the following.

Limits:-

Test Level 2 i.e. a) 1 kV for AC/DC power lines; b) 0.5 kV for signal / control / data / telecom lines;

Performance Criteria shall be as per Table 1 under Clause 6 of TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16.

Applicable Performance Criteria shall be as per Table 3 under Clause 7.2 of TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16.

e) Immunity to surges:

Name of EMC Standard: As per IEC 61000-4-5 (2014) "Testing & Measurement techniques for Surge immunity test" for the following.

Limits:-

i) For mains power input ports:

- (a) 1.0 kV peak open circuit voltage for line to ground coupling
- (b) 0.5 kV peak open circuit voltage for line to line coupling
- (c) 4.0 kV peak open circuit voltage for line to ground coupling
- (d) 2.0 kV peak open circuit voltage for line to line coupling

ii) For telecom ports:

- (a) 1.0 kV peak open circuit voltage for line to ground
- (b) 0.5 kV peak open circuit voltage for line to line coupling.
- (c) 4.0 kV peak open circuit voltage for line to ground
- (d) 2.0 kV peak open circuit voltage for line to line coupling.

Performance Criteria shall be as per Table 1 under Clause 6 of TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16.

Applicable Performance Criteria shall be as per Table 3 under Clause 7.2 of TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16.

f) Immunity to conducted disturbance induced by Radio frequency fields:

Name of EMC Standard: As per IEC 61000-4-6 (2013) "Testing & measurement techniques-Immunity to conducted disturbances induced by radio- frequency fields" for the following.

Limits:-

Under the test level 2 {3 V r.m.s.}in the frequency range 150 kHz-80 MHz for AC / DC lines and Signal /Control/telecom lines.

Performance Criteria shall be as per Table 1 under Clause 6 of TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16.

Applicable Performance Criteria shall be as per Table 3 under Clause 7.2 of TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16.

g) Immunity to voltage dips & short interruptions (applicable to only ac mains power input ports, if any):

Name of EMC Standard: As per IEC 61000-4-11 (2004) "Testing & measurement techniques- voltage dips, short interruptions and voltage variations immunity tests" for the following.

Limits:-

- i. a voltage dip corresponding to a reduction of the supply voltage of 30% for 500ms (i.e. 70 % supply voltage for 500ms)
- ii. a voltage dip corresponding to a reduction of the supply voltage of 60% for 200ms; (i.e. 40% supply voltage for 200ms)
- iii. a voltage interruption corresponding to a reduction of supply voltage of > 95% for 5s.
- iv. a voltage interruption corresponding to a reduction of supply voltage of >95% for 10ms.

Performance Criteria shall be as per Table 1 under Clause 6 of TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16.

Applicable Performance Criteria shall be as per Table 3 under Clause 7.2 of TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16.

h) Immunity to voltage dips & short interruptions (applicable to only DC power input ports, if any):

Name of EMC Standard: IEC 61000-4-29:2000: Electromagnetic compatibility (EMC) - Part 4-29: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations on d.c. input power port immunity tests

Limits:

- i. Voltage Interruption with 0% of supply for 10ms. Applicable Performance Criteria shall be B.
- ii. Voltage Interruption with 0% of supply for 30ms, 100ms, 300ms and 1000ms. Applicable Performance Criteria shall be C.
- iii. Voltage dip corresponding to 40% & 70% of supply for 10ms, 30 ms. Applicable Performance Criteria shall be B
- iv. Voltage dip corresponding to 40% & 70% of supply for 100ms, 300 ms and 1000 ms. Applicable Performance Criteria shall be C
- v. Voltage variations corresponding to 80% and 120% of supply for 100 ms to 10s as per Table 1c of IEC 61000-4-29. Applicable Performance Criteria shall be B.

Note 1: Classification of the equipment:

Class B: Class B is a category of apparatus which satisfies the class B disturbance limits. Class B is intended primarily for use in the domestic environment and may include:

- Equipment with no fixed place of use; for example, portable equipment powered by built in batteries;
- Telecommunication terminal equipment powered by the telecommunication networks
- Personal computers and auxiliary connected equipment.

Please note that the domestic environment is an environment where the use of broadcast radio and television receivers may be expected within a distance of 10 m of the apparatus connected.

Class A: Class A is a category of all other equipment, which satisfies the class A limits but not the class B limits.

Note 2: The test agency for EMC tests shall be an accredited agency and details of accreditation shall be submitted.

Note 3: For checking compliance with the above EMC requirements, the method of measurements shall be in accordance with TEC Standard No. TEC/SD/DD/EMC-221/05/OCT-16 and the references mentioned therein unless otherwise specified specifically. Alternatively, corresponding relevant Euro Norms of the above IEC/CISPR standards are also acceptable subject to the condition that frequency range and test level are met as per above mentioned sub clauses (a) to (g). The details of IEC/CISPR and their corresponding Euro Norms are as follows:

IEC/CISPR	Euro Norm
CISPR 11	EN 55011
CISPR 22	EN 55022
IEC 61000-4-2	EN 61000-4-2
IEC 61000-4-3	EN 61000-4-3
IEC 61000-4-4	EN 61000-4-4
IEC 61000-4-5	EN 61000-4-5
IEC 61000-4-6	EN 61000-4-6
IEC 61000-4-11	EN 61000-4-11

---End of Chapter 3---

Chapter 4

Element Management System and Local Craft Terminal

Part I: EMS Requirements

1.0. General operational and functional requirements

An EMS shall be provided along with the FTTX solution for centralized management and control of the access network. The EMS shall be multi-user system and based on Graphical User Interface (GUI).

- a. The management system shall comply with the latest ITU-T G.9807.1 Recommendations on XGS-PON.
- b. The access network management system shall be able to execute and configure the following.
- c. The management menu selections should include the following functionality:
 - i. Alarm monitoring
 - ii. Customized functions as per the purchaser's requirement
 - iii. Remote view on ONT/ONU
 - iv. PON Management
 - v. IP management
 - vi. Alarm management
 - vii. Equipment management
 - viii. Service management
 - ix. Log management
 - x. Loopback Management
 - xi. Operational state
 - xii. Profile management
 - xiii. Performance monitoring
 - xiv. User security
- d. Configuration of overall equipment with modules (ONU/ONTs, OLT and all related equipment modules).

- i. EMS shall be able to display Graphical network topology
 - ii. All alarms and messages of the entire network to be displayed by EMS and for the local node by the LCT
 - iii. EMS/LCT shall be able to display Color coded graphical fault display
 - iv. Each individual site shall have the facility to be managed by Local craft terminal in the remote sites.
 - v. The operator should be able to check system status, alarm information, alarm logging, performance data and performance system diagnostic from GUI. The EMS shall access and security control for multiple classes access.
- e. The EMS shall provide:
 - i. Security management (NE access control, EMS security control, and management privilege control)
 - ii. Configuration management (NE equipment provisioning, connection provisioning, and NE software download)
 - iii. Database management (system data, software version, and database backup).
- f. It should be possible to generate customized reports for various types of faults, performance history, security management etc. It should also be possible to generate up time-reports to facilitate monitoring of performance statistics in a pre-defined/customized format. It shall be possible to generate and define the formats at any time, based on network needs.
- g. It should be possible to have a view of selected FTTx network controlled by the Element Management System as per requirement. By zooming-in, it shall be possible to drill-down up to module-level in each NE for configuration and fault management. The same shall be provided through user-friendly GUI commands.
- h. The EMS shall be able to diagnose its own faults by running diagnostic software.
- i. The Element Manager shall provide the complete view of the network elements and the interconnecting links. The EMS shall have the ability to include the

network elements and the links in the visual/graphical map of the domain. The visual maps shall display the elements and the links in different color depending upon the status of the links. It is preferable that green color for healthy and amber/yellow color for degraded condition and red for unhealthy condition is used.

- j. It shall provide the ability to drill down to the individual element, then to subsystem, then to card and then to port level configuration template from the domain-map by clicking on the icon of the network element.
- k. The Element Manager shall have suitable system level backup mechanism for taking backup of EMS data of at least one month. There shall be no magnetic tapes used for the objective, only DVD, CD-ROM, SSDs or any other suitable backup device with purchaser consent shall be provided.
- l. The information model shall be as per specified standards. The EMS shall support correlation (filtering and suppression) to avoid multiple alarms from a single source of failure within the sub-network. Single Alarm shall be provided for the events that are correlated and are due to a common cause.
- m. The EMS shall provide the visual presentation of the Network Element's status and the alarms. It shall also present the complete map of the network domain with suitable icons and in suitable color like green for healthy, red for non-operational, yellow for degraded mode of operation etc.
- n. It shall be possible to take any Network Element out-of-service & in-service from the EMS. It shall be possible to restart the Network Element from EMS.
- o. The EMS shall carry out the systematic Health Monitoring of the elements of the Network. Check on the health of the card of any element of the Network shall be possible through command with settable periodicity - @ 24 hrs, 1 week, and 1 month.
- p. It shall be possible to log recent commands and be re-displayed, and re-issued on request through GUI if the southbound interface supported is TL.
- q. The configuration of the various network elements like creating or discovering, viewing, and editing shall be possible from the EMS. The configurations of the network elements shall also be stored at suitable place in EMS from where it can be retrieved in case of failure.

- r. It shall provide the graphical layout of the network elements with modules drawn using different colors to indicate their status. Manufacturer shall provide soft copy of EMS on a CD on per-ink or per-ring basis (or as asked for by the purchaser). The setup/procedure to download the software shall be clearly mentioned in the system manual of the equipment.
- s. Manufacturer shall provide soft copy of EMS on a CD on per-ink or per-ring basis (or as asked for by the purchaser). The setup/procedure to download the software shall be clearly mentioned in the system manual of the equipment
- t. **Calendar Management:** It shall be possible to execute any schedulable administrative command i.e.- NE backup, software download, performance, operator log-in/ log-out etc., at any time by attaching a time tag to the command and it shall be executed when the Network real time matches the time tag. It shall be possible to define both time and date. If no date is mentioned, the command shall be executed daily at the time indicated.
- u. **Messaging system:** The EMS shall have a messaging system which will generate and send alert messages on telephone (fixed & mobile), e-mail or SMS to the designated personnel depending upon the location of NE, on generation of alarms.
- v. It is recommended that the response time for query/command on any operator terminal, local or remote shall be 10 seconds or better. For updation on topological information on the terminals, the response time shall be better than 20 seconds under all conditions. The response time shall however, be reviewed depending upon total NE load and topology by purchaser during testing of EMS.
- w. The supplier shall provide all necessary interface details (with the documents) for integration of its EMS with existing or proposed NMS (irrespective of its brand/make) and also provide time bound support for its integration, under obligation of a Non-Disclosure Agreement (NDA).
- x. The supplier shall provide infrastructure requirements to the purchasers for setting up the EMS. The items of infrastructure include A/C power, Air conditioning load, space etc.
- y. All critical components and units of the EMS i.e. – LAN interfaces, hard-disk, processor etc., shall be fault resilient.

- z. It shall be possible to produce customized reports. The purchaser shall be free to ask for customization of reports based on the data available in the database from time to time.
- aa. It shall be desirable to interconnect a Disaster Recovery EMS with an existing EMS, in future, with possible manual switchover between them. The issues regarding hardware and software compatibility with regards to existing server platform shall be subject to a mutual understanding on the issue between purchaser and manufacturer.
- bb. Installation & commissioning of the EMS shall include supply & installation of cables, distribution frames, electrical switches etc.
- cc. Format for creation of database of network elements, circuits, ODN/OLT etc., and their numbering scheme, details of built up points across various rings other commissioning details, supplementary information, order reference, dates etc. shall be prescribed by purchaser at the time of validation of EMS.
- dd. The purchaser shall validate all the components of EMS and features of EMS. All the instruments necessary for carrying out validation test shall be arranged by supplier.

2.0 EMS Architecture and Server Hardware Specifications

2.1 Architecture

1. It shall be ensured that EMS connectivity to sub-network is not disrupted and there is no loss of EMS performance and fault data from the sub-network. To ensure EMS connectivity to the sub-network under control-card failure, there shall be provision to support control card redundancy. In case of total loss of EMS connectivity, the sub-network shall continue to provide the services without any deterioration.
2. In case of total loss of EMS connectivity, it is recommended that the performance data of the NE shall be stored in the controller card, and shall be sent to central EMS server upon restoration of EMS connectivity. It is recommended that 6400 performance and fault data messages containing a minimum of 100 alarms shall be stored by the system. The response time

- shall however, be reviewed depending upon total NE load and topology by purchaser during testing of EMS.
3. In case of loss of EMS connectivity, the LCT privilege shall remain for managing the local equipment, as privileged by EMS administrator.
 4. The centralized EMS may consist of standalone application server, database server and firewall server or it can be a standalone EMS server subject to scaling requirements. Any other server required for meeting the purchase requirements shall be quoted separately by the bidder.
 5. Local Client connectivity to EMS for privileged operation shall be through a log-in password.
 6. As a cost effective measure, two display units are adequate for all the servers (application, database, and firewall servers). Purchaser is at discretion to convey any additional requirements. It shall be possible to access any server from any of the display.
 7. The purchaser shall communicate requirements for (1+1) server backup or internal constituents of server.

2.2 Scalability aspects

- a. The EMS should be able to support at least 500 OLTs. The EMS application shall also be scalable to 15000 ONT/ONUs. Any more requirements may be communicated by purchaser.
- b. The operating system and applications for EMS including database server shall be multi-user with minimum 25 concurrent users (including local terminals at EMS site and remote terminals i.e. LCTs). Any more requirements may be communicated by purchaser.
- c. A minimum of four operator terminals will be provided at the EMS site. The EMS shall be equipped to connect to at least 5 local terminals at EMS site. It shall be upgradeable to 15 local terminals. The operator terminals at the EMS site are recommended to be PC i3, 1TB HDD, 21" LCD/TFT video display, DVD or better configuration , Ethernet interface (10/100M) with industry standard operating system UNIX/Linux/Windows but having GUI.

- d. The EMS shall provide SNMP or TL1 options for southbound interfaces. The options for northbound interface shall be SOAP, or XML or CORBA or better configuration.

2.3. EMS server specifications

A 'Telecom Grade Enterprise Server' from a reputed national/international vendor with broad specifications, as below, shall be provided.

The multi-process EMS design is recommended which shall enable distribution of functions over multiple processors. In addition, the RMI inter-process communication enables distribution of functions over multiple servers. Consequently, increasing system capability can be achieved by upgrading the existing platform (e.g. adding CPUs) or adding new servers into the cluster. The manufacturer shall indicate limitations regarding processing requests, notifications, updates, Network-map view refreshing etc., in the supplied system.

Both Application and Database servers shall have UNIX based operating system.

The EMS shall be supplied with a Work Station offering Graphical User Interface (GUI) using 17" colour screen with key board and mouse etc. the Work Station shall be of latest type of machine with very high processing speed as available on the date of procurement of equipment. The Work Station shall support Ethernet ports as 10BaseT, 100BaseT and 1000BaseT. The operating system shall be Windows 7/8/10, Linux or Unix. The specifications are given in clause 2.7 of Chapter-4 (Part-I).

2.4. Application server specifications

The EMS application server shall be multi-processor with minimum 4 processor with each processor having at least 8 cores, RISC/CISC based 64 bit system with at least 1.9 GHz clock, 32GB RAM, 1GB cache memory, 160GB HDD with CD-ROM/DVD-ROM or any suitable back-up device(with purchaser consent),

multiple Ethernet LAN interfaces and the server shall operate in high availability cluster mode.

2.5. Database server specifications

The database server shall be multi-processor with minimum 4 processor with each processor having at least 8 cores, RISC/CISC based 64 bit system with at least 1.9 GHz clock, 32GB RAM, 1GB cache memory. However, the purchaser may choose single server as per network needs. The system shall support at least 6xDVD for loading of software configuration. The system shall have Hard-disk storage implemented on RAID 0, RAID 1, T+RAID 0+1 and RAID 5 architecture of disk storage which shall be configurable. The RAID system shall be hardware based and shall have redundant fibre based RAID controller. The hard-disk storage shall provide for no single point of failure. The server will operate in high availability cluster mode, on load sharing basis. Exact specifications may be issued by purchaser.

- a. Database hard-disk memory shall be sufficient to store all the information as indicated in the document and any other necessary system for at least one month duration.
- b. Each of the server i.e. EMS server and database server as well as firewall server shall have redundancy for control module, disk, power supply and LAN interface.
- c. Industry standard relational database (RDBMS) for storing all the data related to the network and the system shall be used.
- d. The database interface shall be open so that a centralized EMS at a future date is able to retrieve information from the EMS database using TCP/IP stack and do post processing. The data base structure for all the databases used in the system shall be provided.
- e. The memory of the Database server shall be sufficient to store the data of 500 full loaded OLTs and 10000 ONT/ONUs (as per respective type/category of equipment) at a minimum. It shall be capable of storing performance/fault

history of 30 days of the network under its domain. This shall be ensured during the testing of the equipment.

2.6. Firewall server [optional to purchaser's requirements]

- a. In order to provide security to EMS from public networks, a dual redundant hardware based Firewall system may be provided at each of the NMS locations for providing security to the various servers at the EMS. The Firewall system shall be as per TEC GR No.: GR/FWS-01. The Firewall System (FWS) shall have a capability of handling a concurrent sessions of around 20,000. The Firewall system shall support 4 ports of 10/100/1000BaseT expandable to 12 ports.
- b. There shall be a common Firewall system. The Firewall system shall be used for providing the security cover to the Web-based Customer-care system from the internet. The same Firewall system shall also provide the security to the EMS database from the Internet and the Web-based Customer-care users & the systems.
- c. The Firewall shall be based on stateful connection-oriented fire-walling and shall be appliance/hardware based. The Firewall shall track the following parameters of each packet-source and destination address, Transmission Control Protocol (TCP) sequence numbers, port numbers and TCP flags.)

2.7. Specifications for local craft terminal/work station

The LCT desktop configuration as a PC or laptop shall be as given below at a minimum-

- i. i7 processor or better
- ii. 21" TFT/ LCD monitor
- iii. 1TB HDD/ 8GB RAM
- iv. DVD Drive or any suitable back-up device(with purchaser consent)
- v. Dual Ethernet LAN port
- vi. Min 2 nos. USB ports

- vii. USB Keyboard port
- viii. Licensed operating software preloaded/recovery CDs.

The Desktop/Laptop shall be supplied with the LCT software installed in it. The PC shall be from a reputed international/national PC manufacturer.

Note 1: No QM-333 environmental tests shall be conducted on the EMS server/LCT PC.

Note 2: Actual server sizing defined should be left to purchaser requirements.

--End

Chapter 4

Part II: FCAPS requirements

1.0. Network management functions

1.1. General functions

The equipment shall provide a centralized element management system (EMS) as well as shall provide local management capability through an LCT, which shall be capable of managing the required functions and shall also be used for carrying out supervisory, maintenance, fault localization & performance functions (FCAPS) as outlined in ITU-T Rec. G.9807.1 for XGS-PON. It shall be possible to manage various constituent of the system through local management interface) as well as through remote management interface.

The equipment EMS shall provide general management functions described in ITU-T Rec. G.784. The filters for performance and fault management shall also be as per ITU-T Rec. G.784. The other management functions as defined in ITU-T Rec. G.784 shall be as under:

1. Configuration management
2. Fault management
3. Performance management
4. Security management
5. Software management
6. Inventory management.

1.1.1. Configuration management

The equipment EMS shall support configuration and provisioning capabilities as per ITU-T Rec. G.9807.1. The system shall support 'point & click'

provisioning in a vendor's sub-network, subject to clearance by Inventory management, shall be supported as per the following configuration provisioning:

- a. Network Element creation in the NE management domain.
- b. Programming of a multiple interface units.
- c. To create, update, delete and retrieve the managed network topology data.
- d. Assigning the equipment protection to a unit/interface.
- e. Error detection thresholds.
- f. Network Element configuration.
- g. Software download (local & remote).
- h. Protection switching.
- i. Ethernet interface bandwidth.
- j. The layer-2 control protocol between ONU/ONT and OLT shall be Ethernet over XGEM. TDM support shall be provided through TDM over Packet (TDMoP) option. The same shall be configurable through EMS/LCT. Such TDMoP support shall be relevant to E1 lines

1.1.2. Fault management

The equipment management system shall support 'Fault management functions' as described in the ITU-T Rec. G.9807.1. The EMS Network Element shall perform a persistency check on the fault-cause, before it declares a fault causing failure. The time taken to declare the fault shall be as per ITU-T Rec. G.9807.1. Each failure and clearance, thereof, shall be time-stamped. The atomic functions associated with the failure shall be as per ITU-T Rec. G.9807.1.

The equipment shall do surveillance of alarms & their detection, reporting of relevant events and conditions that lead to the generation of alarm after filtering. Further, the element management system shall support the following:

- a. Path alarm notification to be generated and recorded, the alarm notification shall include: type, occurrence, severity, probable cause and clearing.

- b. Path alarm shall be graphically shown by the EMS/LCT.
- c. Alarm and status display.
- d. Fault localization.
- e. Fault correlation control.
- f. Storing and processing of current alarm information, up to module/unit level.
- g. Storing and processing of historical alarm information for 30 days minimum. The EMS/LCT shall provide on-line logging capability for historical alarms and events with sufficient information such as managed resources, alarm/event type, alarm severity, day and time of occurrence etc. The retrieving functions with filtering capabilities for historical alarms and events shall be provided as well.
- h. FCS errors for Ethernet clients.
- i. Assigning alarm severity i.e., Critical, Major, Minor & Deferred.

1.1.3. Performance management

The equipment shall support the 'Performance Management' functions in accordance with ITU-T Rec. G.9807.1. The performance management shall consist of set of functions that evaluate and report on the behavior of network element and their effectiveness relating to the communication taking place on the network. The performance management shall deal with definitions, evaluation and reporting of equipment performance.

It shall be possible to store all the performance and traffic statistics for a month. It shall also be possible to generate daily, weekly, monthly reports for the individual element as well as complete domain. The report generation shall be supported for text and graphic reports.

The performance monitoring shall conform to IETF RFC 2544 for Ethernet clients. If the management protocol is based on SNMP then the performance monitoring will be based on RFC 2558. Performance history for minimum 30 days shall be supported with configurable launch-time and performance evaluation/integration period. The main performance functionality to be provided shall be as under:

- a. Configuration of threshold concerning the error counters.
- b. FCS error check for Ethernet clients
- c. Frame/Packets dropped in case of Ethernet frames
- d. Configuration of threshold concerning the error counters
- e. Performance history (data logging).

The EMS shall store the performance data of the sub-network in terms of configured circuits. In addition to, the following shall also be some of the different parameters that shall be stored

- f. The collection of the performance counters shall be performed at pre-assigned rate.
- g. The EMS shall support configurable scheduling of the performance measurement, collection, storage and transfer of the performance statistics. It shall also support presentation of the performance statistics in graphical and text mode as and when requested and at repeated interval automatically.

1.1.4. Security management

The management system shall provide adequate security to the data and for the access to the management system as per the following details:

- i. The EMS shall have the capability of supporting the management of Network through local and remote operators. The authorizations and the privileges of the operators (remote and local) shall depend upon the Login and Password.
 - a. Low-level protection for read only access to faults and performance information.
 - b. Medium-level protection for access to configuration status and features.
 - c. High-level protection for control of access to change in the configuration and control parameters.

- ii. Network management security features shall include operator authentication, command, menu-restriction and operator privileges. The EMS shall support multi-level passwords as below-
 - a. EMS shall allow the System Administrator to define the level of access to the network capabilities or feature for each assigned password. It shall be desirable that the EMS shall block the access to the operator in case of unauthorized commands being tried for five consecutive times. Also it is desirable that the EMS shall also not allow the entry into the EMS in case wrong password is provided more than five consecutive times during the login.
 - b. The system administrator shall be able to monitor and log all operator activities in the EMS and Local Craft Terminal.
 - c. The dynamic password facility shall be provided in which the operator may change his password at any time.
- iii. All log-in and log-out attempts shall be logged in the security log file of the EMS system.
- iv. The network and the management system shall be protected against intentional or accidental abuse, unauthorized access and loss of communication.
- v. The man-machine communication programs shall have the facility of restricting the use of certain commands or procedures to certain passwords and terminals.
- vi. The Equipment shall normally operate through the centralized EMS. Only in case of failure of link between the Equipment location and the EMS, the LCT should be able to manage the local assigned to it.
- vii. It should be mandatory for the system to have a record of all log-ins for a period of at least six months after which a back up should be possible under system administrator command.
- viii. It shall be possible to connect EMS and the network elements to the IP-MPLS network. The EMS and components of the existing/proposed Network Management Layer (NML)/Service Management Layer (SML) of a purchaser shall be part of the common MPLS-VPN providing the inherent security required for the management information in addition to

the login and password based authorization for the operators of the Network Manager.

- ix. Back up for programmes and data.
- x. The EMS shall be able to back up and restore the data base to and from external storage media.
- xi. **External security measures (optional to purchaser's requirements)**

Network security may require deployment of external devices/machines/firm-ware at the network operation centre [NOC], like-

- a. Firewalls
- b. Access control servers
- c. Data encryption devices/use of PKI keys
- d. Anti-virus packages.
- e. In the data communication network (DCN) for management system, VLAN tags/MPLS labels may be used for security to information flows from NEs to DCN Gateways with IPSec, PKI security options.

The purchaser may communicate requirements as per his network security needs.

1.1.5. Inventory management

- i. It shall indicate the absence or presence of any physical module in hardware elements. It shall also indicate the usage of module i.e., how many ports are in use, which interface is in use and which are free to be used etc.
- ii. The EMS shall be able to discover and keep the device information
- iii. The EMS shall be able to keep track on any change in the network inventory reported chronologically.
- iv. The EMS shall provide the inventory information to the Network Management Layer (NML)/Service Management Layer (SML) so that SML is able to create and activate a service to the customer automatically. This shall also assist SML in providing the network inventory to which the SML

shall add the customer identification and maintain this information in its database.

- v. The EML shall be able to show inventory based on the available device inventory in terms of circuits' utilization.
- vi. The EMS shall provide the complete view of the network elements and the interconnecting links.

1.1.6. Software management

It shall be possible to carry out the following tasks under the software management function

- i. Loading of new system software.
- ii. Manage different versions of software.
- iii. Shall have the capability of managing multiple versions of software for individual elements. In this case, one software version shall remain active and other versions shall be passive.
- iv. Installation of software patches.
- v. At the time of downloading the software, the message shall be displayed that the software has been downloaded successfully or failed and at what stage.
- vi. The EMS shall support FTP/TFTP for downloading of Software, configuration, patches etc., to the Network Element.
- vii. The operator terminals (local & remote) shall not allow loading of any software without the terminal administrator's authorization.
- viii. The EMS shall enable operations like changing the system configuration, reconfiguration of input and output devices, loading a new software package, etc. Both automatic and manual reconfiguration capabilities shall be available.
- ix. It shall be possible through a single man-machine command to obtain a list and the total number of equipment of a particular domain in a state (e.g. in-service, blocked etc.).

1.1.7. Software download

Local & remote software download via management system to NEs and LCT shall be possible, including the means of identification of software module versions. No loss of data/traffic & connection-map shall take place during the software down-loading process.

1.1.8. Management interface details

The complete details of the management interface and the protocols, as pertaining to each layer of the protocol-stack implemented in the management system, shall be made available, for the purpose of integrating the local management capabilities with the centralized NMS at a later date. The requirements, in brief, shall be:

- i. Protocol details at all layers of TCP/IP stack.
- ii. PHY I/F at each layer.
- iii. Database structures.
- iv. Number formats.
- v. Node addressing system.
- vi. Complete application software details etc.
- vii. EMS software check-sum.

1.1.9. Southbound management interface

The system shall provide at least one remote management interface and one Local Management Interface (LMI) at each Network Element as conforming to ITU-T Rec. G.9807.1.

The system shall provide an SNMP version2c [or later interface] with standard MIBs Browser. It shall be implemented on UDP/IP stack at all Gateway NEs (GNEs) to interact with a centralized Element Management System (EMS). Or else ITU-T specified Qx or Bellcore specified TL1 interface implemented on TCP/IP, remote management interface shall also be acceptable.

Note 1. The equipment shall provide an Ethernet port for Work Station/Network Server connectivity with standard RJ-45 connector.

Note 2. The purchaser may validate vendor's claim for management functions as well as protocol compliance for Qx or SNMPv2c interface (or later interface) through NMS Protocol Analyzer etc.

1.1.10. Northbound management interface

For remote management purposes, the equipment shall provide remote and local management interfaces at NEs as outlined in the GR. The northbound interface of the EMS towards NMS layer shall be TMF 814 CORBA [version 3.0] or SOAP or XML. And the southbound interface towards NEs shall be SNMPv2c [or later interface] implemented on UDP/IP stack. The purchaser may verify SNMP MIBs and CORBA IDLs during their testing.

1.1.11. Local management interface

The manufacturer shall provide a Work Station/Network Server, which shall act as a manager of management activities, i.e. monitoring and controlling NEs within its management domain. The Local Craft Terminal i.e., a Personal Computer shall support the local management of NEs. The Local Craft Terminal and Network Server shall be operating simultaneously.

The inter-office communication shall be facilitated through in-band management channels or dedicated data-link. The equipment shall provide V.24/V.28/RS232/RS-485/RJ-45 for connecting a PC-server as a Local Craft Terminal.

1.1.12. User interface

The management system shall be provided with user-friendly interfaces based on Windows/UNIX icons & menus and mouse to accomplish management function that needs user interventions. The EMS start-up and shut-down shall

be user friendly, and shall provide on-line help. The EMS shall be able to provide an on-screen nested geographical view of the managed network in the management domain of the manufacturer. It shall be possible to access any managed node within the whole network in the managed domain. The EMS shall be able to depict the failure state of each link and node in the displayed network.

Further, it shall also be possible from the EMS system to get the details of status of an individual managed NE, such as equipment presence, settings, alarm status etc.

1.2. Additional functional requirements.

a. ONT/ONU requirements

1.2.1. ONU shall perform following tests/monitor relative to the battery to be reported through EMS and LCT:

- i. Battery present or not (assessed by voltage of the battery)
- ii. Low capacity (means going to shutdown soon).

1.2.2. Status reporting

- i. ONU/ONT ID
- ii. PON port link status
- iii. UTP access port link status
- iv. Loop back test status
- v. Loop-back time-out status
- vi. Power supply status
- vii. Vendor code
- viii. Model number.

1.2.3 ONT/ONU shall also support the following:

- i. Vendor code and model number in EEPROM.
- ii. Remote download firmware upgrade.

- iii. Auto negotiation or manual configuration of 10M/100Mbps and half-duplex or full-duplex on ONT's user port.
- iv. UTP port MDI-MDIX auto-detection.
- v. Maximum frame size 1522 bytes
- vi. **LED status indication**
 - A. **Power.** Indicates power on/off status
 - B. **Voice.** To show that there is at least 1 call active on the ONT, and prevent service interruption.
- vii. **Voice-signaling:** ONT has registered with soft-switch
- viii. **LEDs to E1 services for B-ONT**
- ix. **Operation.** Indicates PON fiber link is normal and OAM channel is operational
- x. Signal that voice/data NW is received
- xi. Report that video overlay is received
- xii. **Test** Indicates ONT is in loopback test status
- xiii. **UTP connection.** Indicates ONT UTP access port link is normal
- xiv. **Data.** Indicates ONT UTP access port activity
- xv. **Full duplex.** Indicates ONT UTP access port at full-duplex mode
- xvi. **Speed.** Indicates 10/100/1000M speed selection (as applicable)

The system shall support OMCI for all OAM features between ONT/ONU and OLT for interoperability.

b. OLT requirements.

- i. The OLT shall provide one craft port for local configuration access.
- ii. The OLT shall provide in-band management connection to the EMS through GigE from the network.
- iii. The OLT shall provide out-band management connection to the EMS through 10/100/1000BaseT Ethernet interface.
- iv. The OLT shall support alarm output and control

- A. Critical alarm output
 - B. Major alarm output
 - C. Minor alarm output
- v. Line rate, security, and performance requirements
- vi. The PON system shall support symmetrical 10 Gbps line-rate for both downstream and upstream.
- vii. AES (key size of 128 bit) support per port-id.
- viii. RS (248,216) FEC shall be supported at rates of 9.95328 Gbit/s with operator enable/disable capability in both upstream and downstream.
- ix. Network diagnostic and healthy check.
- x. Perform logical loopback test on specified ONT. This shall be relevant to an all-frames loopback on the Ethernet port of the ONT, towards the network.

---End of Chapter 4 (Part-II)---

CHAPTER 5

Industry Best Practice

Industry best practice for 9.95328 Gbit/s downstream, 9.95328 Gbit/s upstream XGS-PON (As per ITU-T Rec. G.9807.1)

(Informative: Optional to purchaser's requirements)

This Chapter establishes the industry best practice optical budgets for the XGS-PON system operating at 9.95328 Gbit/s downstream, 9.95328 Gbit/s upstream.

1.0 Introduction

These power budgets are optional extensions of the GR, and reflect the observed practical values for this particular system. Purchaser may specify these requirements if needed.

Depending on the wavelength set plan (Basic wavelength set or Optional wavelength set) used, The Notable Variations from the loss budgets found elsewhere in ITU-T Rec 9807.1

These variations can provide increased capabilities of operations of XGS-PON system. Therefore, the budget contained in this chapter are recommended over and above all other recommendations for 9.95328 Gbit/s symmetric PON system.

2.0 System Applications

Recommendation ITU-T G.9807.1 describes a 10-Gigabit-capable symmetric passive optical network (XGS-PON) system in an optical access network for

residential, business, mobile backhaul (examples will use the radio network controller (RNC) and Node B network elements) and other applications.

This system operates over a point-to-multipoint optical access infrastructure at the nominal data rate of 10 Gbit/s both in the downstream and the upstream directions.

XGS-PON systems are able to operate on the same optical distribution network (ODN) as XG-PON systems. The XGS-PON systems are capable of operating at the same wavelengths as an existing XG-PON system or operating at the gigabit-capable passive optical network (G-PON) wavelengths. Co-existence of XGS-PON with G-PON, 10-gigabit passive optical network (XG-PON) and next generation passive optical network 2 (NG-PON2) is supported.

3.0 Optical Specifications

The optical specifications for OLT and ONU optics are described below in the given table:-

Table: Optical line supervision-related measurement specifications

	Typical range (Note 1)	Resolution	Accuracy	Repeatability	Typical response time
Temperature – OLT and ONT	–45° to +90° C	0.25° C	±6° C	±1° C	1 s
Voltage – OLT and ONT (Note 4)	0 to 6.55 V	0.5% of nominal	±3% of nominal	±1% of nominal	1 s

Bias current – OLT and ONT (Note 4)	0 to 819 mA	1% of nominal	±10% of nominal	±5% of nominal	1 s
ONT transmit power	–28 to +20 dBm	0.1 dB	±3 dB	±0.5 dB (Note 2)	300 ns
ONT receive power	–53 to –4.9 dBm	0.1 dB	±3 dB (Note 5)	±0.5 dB (Notes 2, 6)	300 ns
OLT transmit power	–28 to +20 dBm	0.1 dB	±2 dB	±0.5 dB (Note 2)	300 ns
OLT receive power (Note 3)	–32 to –4.9 dBm	0.1 dB	±2 dB (Note 5)	±0.5 dB (Notes 2, 6)	300 ns

NOTE 1 – The typical range attempts to capture the most common range of parameters of an operational optical module. If a module has a different operational range, then the measurement range follows that range, augmented by the measurement inaccuracy on either end.

NOTE 2 – ONT and OLT optical repeatability refers to multiple measurements taken when the true values of the ONT or OLT temperature and voltage are the same at the time of measurement. However, the normal range of those parameters is exercised in between tests as a means to gauge their aging effects.

NOTE 3 – The OLT's measurement reflects the average power received during a burst. This requires the OLT to perform the measurement at the proper time with respect to the incoming burst, and that said burst is long enough to support the response time of the detector. The deviation due to non-50% duty cycle in the upstream data pattern is not to be charged against the measurement accuracy or repeatability specifications.

NOTE 4 – Nominal refers to the design value of the quantity being measured (i.e., voltage or bias current) for the particular device implementation.

NOTE 5 – Absolute accuracy is +/- 3 dB down to -35 dBm received optical power, and +/- 5 dB beyond -35 dBm.

NOTE 6 – Repeatability < 0.5 dB down to -35 dBm optical power over 1-10 second measurement time

Table: Optical interface parameters of 9.95328 Gbit/s downstream direction

Item	Unit	value			
OLT transmitter (optical interface Old)					
Nominal line rate	Gbit/s	9.95328			
Operating wavelength	nm	1575 - 1580			
ODN class		N1	N2	E1	E2
Mean launched power MIN	dBm	+2.0	+4.0	+6.0	FFS
Mean launched power MAX	dBm	+5.0	+7.0	+9.0	FFS
Minimum extinction ratio	dB	8.2			
OLT transmitter (optical interface Old)					
Minimum side mode suppression ratio	dB	30			
Maximum differential optical path loss	dB	15			
ONU receiver (optical interface Ord)					
ODN class		N1	N2	E1	E2
Minimum Sensitivity at BER reference level	dBm	-28.0	-28.0	-28.0	FFS
Minimum overload at BER reference level	dBm	-9.0	-9.0	-9.0	FFS

Table: Optical interface parameters of 9.95328 Gbit/s upstream direction

Item	Unit	value			
ONU transmitter (optical interface Oru)					
Nominal line rate	Gbit/s	9.95328			
Operating wavelength	nm	1260 - 1280			
ODN class		N1	N2	E1	E2
Mean launched power MIN	dBm	+4.0	+4.0	+4.0	FFS
Mean launched power MAX	dBm	+9.0	+9.0	+9.0	FFS
Minimum extinction ratio	dB	6.0			
OLT receiver (optical interface Olu)					
ODN class		N1	N2	E1	E2
Sensitivity	dBm	-26.0	-28.0	-30.0	FFS
Overload	dBm	-5.0	-7.0	-9.0	FFS

4.0 Optical Link Budget

XGS-PON must be able to operate on nominally 28/29 dB loss ODNs, depending on the wavelength set plan used. The Basic wavelength set aligns with the N1 class of XG-PON for 29 dB, considering the extra loss in the WDM1r for this band. The Optional wavelength set aligns with the B+ class of G-PON for 28 dB, considering the lower loss in the WDM1r for this band. In addition to these loss budgets, provision is also made to accommodate the N2 (31 dB), E1 (33 dB) and E2 (35 dB) power budgets from XG-PON and C+ (32 dB) power budget from G-PON.

When reusing the G-PON wavelength is adopted, since the G-PON port of the WDM1r will be reused, legacy B+ or C+ power budget classes are to be considered.

Recommended classes for optical path loss are shown in Table below:-

Table: Recommended Classes for optical path loss

	Optional wavelength set		Basic wavelength set			
OPL class	B+ class	C+ class	Nominal1 class (N1 class)	Nominal2 class (N2 class)	Extended1 class (E1 class)	Extended2 class (E2 class)
Minimum loss	13 dB	17 dB	14 dB	16 dB	18 dB	20 dB
Maximum loss	28 dB	32 dB	29 dB	31 dB	33 dB	35 dB

Certain architectures may result in optical path losses with less than the minimum loss specified in Table above. In such a case, the ODN must contain additional optical attenuators guaranteeing minimum channel insertion loss for the given class to prevent potential damage to receivers.

---End of Chapter 5---

CHAPTER 6

Purchase Guidelines

Following are the guidelines, which the purchaser may follow while deciding for the procurement or maintenance of the XGS-PON system including Element Management System. However the purchaser needs to make decision on various aspects/parameters of this GR.

Chapter 1: Technical Requirements

Clause 2.1.1

Selection of Network Termination (NT) i.e. Type of ONT/ONU depending upon the reach and the network need.

Provisioning of Wi Fi support as per 802.11b/g/n/ac

The different type of interfaces/services discussed in this document is indicative only. Purchaser may decide type of interface/service and number of interfaces as per its implementation strategy.

Clause 2.1.3 & 4.1.1

Selection of Optical Splitter from m: N where m = 1 or 2 and N = 2, 4, 8, 16, 32, 64, 128, 256. The purchaser may specify his requirements.

Clause 2.3

Selection of architecture which ranging from Fibre-to-the-Home (FTTH), through Fibre-to-the-Building/Curb (FTTB/FTTC) to Fibre to the Cabinet (FTT Cab) Actual architecture required shall be decided and conveyed by the purchaser.

Clause 2.5.6

Support of fiber distance.

Specific requirements may be suitably planned and conveyed by purchaser.

Clause 3.2

Exact requirement of Ports at ONU defined in Clause no 3.2 shall be communicated by the Purchaser.

Clause 3.2.1

Indicate:

- POTS
- 10/100/1000 Base T Ethernet interfaces (to inter-connect IP phones, Set top box for IPTV, PC etc. through a home Ethernet Bridge or Router)
- WiFi support as per IEEE 802.11g/n/ac in the home(if required by the purchaser).
- USB 2.0/3.0 Interface (If required by the purchaser)
- Dying gasp feature (If required by the purchaser)
- 10G port(if required by purchaser)
- RF video interface over coaxial F connector (if required by the purchaser)

Clause 3.2.2

Indicate:

- 10/100/1000 Base T Ethernet interfaces (to inter-connect IP phones, Set top box for IPTV, PC etc. through a home Ethernet bridge or Router).
- E1 line (For PBX interconnection). The support for E1 shall be meant for transport applications of TDM to OLT.
- POTS (purchaser shall specify exact number of ports)
- RF interfaces over coaxial female 'F' connector (If required by the purchaser)

- WiFi support as per IEEE 802.11g/n/ac(if required by the purchaser).
- Dying gasp feature (If required by the purchaser)
- USB 2.0/3.0 Interface (If required by the purchaser)
- 10G port(if required by purchaser)

Clause 3.2.3

Indicate:

- POTS (If required by the purchaser)
- 10/100/1000 Base T Ethernet interfaces (for interconnection to 2G/3G/4G BTS).
- PON ports for Uplink.
- USB 2.0/3.0 Interface (If required by the purchaser)
- E1 line (for interconnection to 2G/3G/4G BTS) (Optional, to be specified by the purchaser).
- Synchronization interface supporting IEEE 1588v2 (Optional, to be specified by the purchaser).
- WiFi support as per IEEE 802.11g/n/ac(if required by the purchaser).
- 10G port(if required by purchaser)
- CPRI(Optional, to be specified by the purchaser).
- OBSAI(Optional, to be specified by the purchaser).

Clause 3.2.4

Indicate:

- POTS (Upto 16 ports, exact number to be specified by the purchaser)
- ADSL2+/VDSL2 lines
- G.fast/G.hn(if required by purchaser)
- Dying gasp feature (If required by the purchaser)
- USB 2.0/3.0 Interface (If required by the purchaser)
- 10/100/1000 Base T Ethernet interfaces (to inter-connect IP phones, Set top box for IPTV, PC etc. through a home Ethernet bridge)
- WiFi support as per IEEE 802.11g/n/ac(if required by the purchaser).
- 10G port(if required by purchaser)

Clause 3.2.5

Indicate:

- POTS
- 10/100/1000 Base T Ethernet interfaces (to inter-connect IP phones, Set top box for IPTV, PC etc. through a home Ethernet bridge)
- RF interfaces over coaxial female 'F' connector (If required by the purchaser)
- WiFi support as per IEEE 802.11g/n/ac(if required by the purchaser).
- Dying gasp feature (If required by the purchaser)
- USB 2.0/3.0 Interface (If required by the purchaser)
- ADSL2+/VDSL2 lines
- G.fast/G.hn(if required by purchaser)
- 10G port(if required by purchaser)

Clause 3.2.6

Indicate:

- POTS
- 10/100/1000 Base T Ethernet interfaces (to inter-connect IP phones, Set top box for IPTV, PC etc. through a home Ethernet bridge)
- ADSL2+/VDSL2 lines
- G.fast/G.hn(if required by purchaser)
- WiFi support as per IEEE 802.11g/n/ac(if required by the purchaser).
- 10G port(if required by purchaser)

Clause 3.2.7

Indicate:

- POTS (Purchaser shall specify the exact number of ports)
- 10/100/1000 Base T Ethernet interfaces (to inter-connect IP phones, Set top box for IPTV, PC etc. through a home Ethernet bridge)
- PON ports for Uplink-one
- Dying gasp feature (If required by the purchaser)
- USB 2.0/3.0 Interface (If required by the purchaser)
- WiFi support as per IEEE 802.11g/n/ac(if required by the purchaser).

- 10G port(if required by purchaser)

Clause 3.4a

The purchaser may specify exact number of XGS-PON interface per sub-rack.

The purchaser may specify the exact requirement of interfaces GigE, 10GigE and 40/100GigE interfaces.

The different type of interfaces discussed in this document is indicative only. Purchaser may decide type of interface and number of interfaces as per its implementation strategy.

Clause 5.0

Support for 1000Base-T, 1000BaseSX, 1000BaseLX, 1000BaseZX, 10GbE and 40/100Gb interfaces at SNI. The purchaser may convey specific interface requirements as well as quantity of such interfaces.

Clause 6.0, 6.2

Indicate the requirements of protection scheme.

Clause 9.2

Specify provision of external clock port.

Chapter 2: General Requirements

Clause 2.6

Indicate the use of fans.

Clause 5.8

Supply of spares by the vendor.

Chapter 5 Part I: EMS Requirements

1.0 General operational and functional requirements:

Clause 1.0 point 22

Review of response time depending upon total NE load and topology

Clause 1.0 point 19

Supply of EMS software over CDs by the vender on per link/per ring basis.

Clause 1.0 point 29

Specifications of format for creation of database of network elements, circuits, ODN/OLT etc.

Clause 2.6

Supply of Firewall server [optional to purchaser's requirements] validation of all the components of EMS and features of EMS.

Clause 2.3, 2.4, 2.5, 2.7

Configuration details.

---End of Chapter 6---

APPENDIX-I

XGS-PON Service Support

I.1 Examples of services

The examples of services that XGS-PON is required to support are shown in Table I.1, along with relevant remarks.

Table I.1 – Examples XGS-PON services

No.	Service		Remark
1	Telephony	VoIP	
2		POTS	<p>Mean signal transfer delay time between T-V (or (a)-V) should be less than 1.5 ms. If echo cancellation is used in the network, the mean signal transfer delay time between T-V (or (a)-V) on the PON-based system may be longer, provided end-to-end transfer delay requirements are met.</p> <p>8 kHz reference has to be provided. (see Note)</p> <p>Signal on the T reference point and V reference point must be continuous.</p> <p>Emulation and/or simulation, as defined in [ITU-T Y.2201], is assumed.</p> <p>e.g., packetized voice at ONU</p>
3	TV (real-time)	IPTV	To be transported using IP multicast/unicast
		Digital TV broadcasting	Transported using RF-video overlay (see [ITU-T G.983.3], [ITU-T J.185] and [ITU-T J.186])
4	Leased Line	T1	<p>Bearer rate is 1.544 Mbit/s.</p> <p>Mean signal transfer delay time between T-V (or (a)-V) should be less than 1.5 ms.</p>

No.	Service		Remark
			Emulation is assumed primarily.
5		E1	Bearer rate is 2.048 Mbit/s. Mean signal transfer delay time between T-V (or (a)-V) should be less than 1.5 ms. Emulation is assumed primarily.
6	High speed Internet access		UNI is typically Gigabit Ethernet
7	Mobile backhaul		Accurate frequency/phase/time synchronization should be supported.
8	L2 VPN Services		such as Ethernet services, etc.
9	IP Services		such as L3 VPN, and VoIP, etc.

NOTE 1 – Reference points (a), (T) and (V) are shown in Figure A.5.3.

NOTE 2 – See [ITU-T G.703], [ITU-T G.810], [ITU-T G.813], [ITU-T G.8261] and [ITU-T G.8262].

I.2 Examples of UNI

In this Appendix, UNI is defined as the interface that includes the following conditions:

- Interconnection between the access network and the customer
- described by a well-known standard
- includes a physical layer aspect.

Some UNIs are provided via an adaptation function, so it is not mandatory that the ONU support those interfaces.

Note that some FTTdp configurations require reverse power feeding of distribution point unit (DPU) from the copper UNI interface.

Examples of UNIs, physical interfaces and connectivity to be provided are shown in Table I.2.

Table I.2 – Examples of UNI and services

UNI (Note 1)	Physical interface (Note 2)	Service (Note 3)
10 Mbit/s/100 Mbit/s/1 Gbit/s Ethernet [IEEE 802.3]	10/100/1000BASE	Ethernet
MoCA 2.0	–	MoCA 2.0
1 Gbit/s fibre UNI	–	Ethernet
10 Gbit/s fibre UNI	10BASE	Ethernet
[ITU-T G.8261]; [ITU-T G.8262]	–	Synchronous Ethernet
[b-ITU-T Q.552]	–	POTS
ISDN [ITU-T I.430]	–	ISDN
V.35	–	–
G.hn [ITU-T G.9960] and [ITU-T 9961]	G.hn	G.hn
VDSL2 [ITU-T G.993.2], ADSL2+ [ITU-T G.992.5]	xDSL	xDSL
G.fast [ITU-T G.9701]	G.fast	G.fast
[ITU-T G.703]	STM-1e	DS3 , E1, E3
CPRI/OBSAI (Open Base Station Architecture Initiative)		
1PPS	Synchronizing interface	

NOTE 1 – There are many other services accommodated in XGS-PON, but those services do not have specified UNIs.

NOTE 2 – Each item in the "Physical interface" column is illustrated by the corresponding entry in the "UNI" column.

NOTE 3 – The column labelled "Service" shows which services can be supported by the physical interface.

I.3 Examples of SNI

In this appendix, SNI is defined as the interface that includes the following conditions:

- interconnection between the access network and the service node
- described by a well-known standard;
- includes a physical layer aspect.

Examples of SNIs, physical interfaces and services that they provide are shown in Table I.3.

Table I.3 – Examples of SNI and services

SNI (Note 1)	Physical interface (Note 2)	Service (Note 3)
1000BASE ([b-IEEE 802.3]) 10000BASE ([b-IEEE 802.3])	–	Ethernet
1 GigE [IEEE 802.3]	1000BASE	Ethernet
10 GigE [IEEE 802.3]	10GBASE	Ethernet
40 GigE [IEEE 802.3]	40GBASE	Ethernet
100 GigE [IEEE 802.3]	100GBASE	Ethernet
[ITU-T G.8261], [ITU-T G.8262]	–	SyncE
[b-ITU-T G.965]	V5.2	POTS
[ITU-T G.703]	STM-1e	DS3, E1, E3, STM-1, DS1, DS0
[ITU-T G.957]	STM-1, 4, 16, 64	E1, E3, DS1, DS3, GFP, E4, STM-n, DS0
CPRI/OBSAI (Open Base Station Architecture Initiative)		

NOTE 1 – There are many other services accommodated in XGS-PON, but those services do not have specified SNIs.

NOTE 2 – Each item in the "physical interface" column is illustrated by the corresponding entry in the "SNI" column.

NOTE 3 – The column labelled "service" shows which services can be supported by the physical interface.

I.4 QoS details for XGS-PON

Peak Information Rate (PIR). PIR is the rate of the maximum transmitting bytes of GEM packets. Its unit is “Bytes/s”. This parameter is analogous to Peak Cell Rate in ATM.

Sustained Information Rate (SIR). SIR is the rate of committed transmitting bytes of GEM packets on the long-term range. Its unit is “Bytes/s”. This parameter is analogous to Sustained Cell Rate (SCR) in ATM.

Per customer, per application CIR/EIR/CIR+EIR policing on all interfaces for packet data

- per UNI port basis
- per UNI port + per customer VLAN
- per UNI port + 802.1p bits (optional)
- per UNI port + per customer VLAN + 802.1p bits.

There shall be per-customer service queuing, scheduling, accounting and filtering.

There shall be classification of high-speed Internet (HSI) based on source network address or IEEE 802.1p marking that shall allow QoS information to be propagated to upstream or downstream nodes.

The ONU nodes shall be capable of scheduling and queuing functions on per-service, per-subscriber basis, in addition to performing packet classification and filtering based on layer 2 fields.

Each subscriber interface shall provide at least three dedicated queues. In addition to per-service rate limiting for HSI services, each subscriber's traffic can be rate-limited as an aggregate using a "bundled" service policy. This shall allow different subscribers to receive different service levels independently and simultaneously. It shall also be necessary for the combined bandwidth of all the services to be scheduled to an overall rate limit to allow multicast traffic to be delivered to subscribers further downstream, and thus avoid further complex queuing and scheduling of traffic in the ONU.

Downstream QoS enablement

At ONU end

- Per-subscriber queuing and PIR/CIR policing/shaping for HSI. HSI service classify on Source IP range.
- Per-service prioritization for VoIP and Video. VoIP prioritized over Video. Destination IP and/or DSCP classification. 802.1p marking for prioritization in the access rings and Residential Gateway (RG).

At OLT end

- VoIP and Video queued and prioritized as per VLAN QoS policy.
- HSI content differentiation based on DSCP. Each queue shall have individual CIR/PIR and shaping.
- Optional overall subscriber rate limiting on VLAN (H-QoS).

Upstream QoS enablement

At ONU end

- Per-subscriber queuing and PIR/CIR policing/shaping for HSI.
- Shared queuing for prioritization of real-time traffic over HSI.
- Per-subscriber QoS/content classification for content differentiation.

At OLT end

- For VoIP and video, policy shall define priority aggregate CIR/PIR.
- For HSI, QoS policy shall define priority and aggregate CIR/PIR. Content differentiation based on ingress classification. DSCP marked.

If required by purchaser, OLT shall **optionally** provide DSCP marking and re-marking QoS per packet, per application based on-

- i. Port of arrival
- ii. TCP/UDP source/destination port
- iii. Time of day
- iv. Based on service/application
- v. Based on MAC (SA/DA) address
- vi. Based on S-VLAN tags
- vii. Based on PVC (for FTTC/FTTCab)
- viii. Based on Source/Destination IP address
- ix. Based on IGMP
- x. Based on IP-TOS/DSCP bits etc.

ABBREVIATIONS

ACL	Access Control List
AES	Advanced Encryption Standard
AIS	Alarm Indicating Signal
APC	Angle Polished Connector
BITE	Built-In Test Equipment
BLS	Broadband Light Source
BSNL	Bharat Sanchar Nigam Limited
CATV	Cable Television
CISPR	Special International Committee on Radio Interference
CO	Central Office
CORBA	Common Object Request Broker Architecture
CPU	Computer Processing Unit
DEMUX	Demultiplexer
DHCP	Dynamic Host Control Protocol
DOS	Denial of Service
DSCP	Differential Services Code Point
DSLAM	Digital Subscriber Line Access Multiplexer
EMC	Electro Magnetic Compatibility
EMS	Element Management System
FTTH	Fibre To The Home
FTTC	Fibre To The Curb
FTTCab	Fibre To The Cabinet
FTTB	Fibre To The Building
FWS	Firewall Server
ICMP	Internet Control Message Protocol
IEEE	International electronic and Electrical Engineering

IETF	Internet Engineering Task Force
IGMP	Internet Group Multicast protocol
IP	Internet Protocol
ISO	international Standard Organisation
LCT	Local Craft Terminal
LED	Light Emitting Diode
LOS	Loss of Signal
MAC	Media access Control
MDI	Media dependent interface
MDIX	Media dependent interface crossover
MDU	Multi-Dwelling Unit
MTBF	Mean Time Between Failure
MTTR	Mean Time To Restore
MTU	Multi-Tenant Unit
MUX	Multiplexer
NE	Network Element
NMS	Network Management System
NNI	Network Node Interface
OAN	Optical Access Network
ODN	Optical Distribution Network
OLT	Optical Line Terminal
ONU	Optical Network Unit
ONT	Optical Network Termination
OSI	Open System Interconnection
OTL	Optical trunk line
P2P	Point to Point
PCM	Pulse Code Modulation
PON	Passive Optical Network
POP	Point of presence
POTS	Plain Old Telephone System
PRC	Primary Reference Clock
PVC	Permanent Virtual Circuit
QA	Quality Assurance

RN	Remote Node
RO	Remote Office
RSTP	Rapid Spanning Tree Protocol
SDH	Synchronous Digital Hierarchy
SFP	Small Form Factor Pluggable Transceiver
SIP	Session Initiation Protocol
SNI	Service Network Interface
SNMP	Simple Network Management Protocol
TCP	Transmission Control Protocol
TMN	Telecommunication Management Network
UNI	User Network Interface
VDSL	Very High-speed Digital Subscriber Line
VLAN	Virtual LAN
VoIP	Voice over Internet Protocol
WDM	Wavelength Division Multiplexing
XGS-PON	10Gigabit-capable Symmetric-Passive Optical Network
Wi-Fi	Wireless Fidelity
XML	Extensible Markup Language

----End of the document----