वर्गीय आवश्यकताएँ

सं:टीईसी/जीआर/एफए/पीओएन-००२/०२/नवंबर-१८

(सं: टीईसी/जीआर/टीएक्स/पीओएन-०२/०१.मई २०१३ को अधिक्रमित करता है)

GENERIC REQUIREMENTS

No. : TEC/GR/FA/PON-002/02/NOV-18

(Supersedes No. TEC/GR/TX/PON-02/01.MAY 2013)

एफटीटीएक्स बेस्ड ब्रॉडबैंड एक्सेस एप्लिकेशन युसिंग गीगाबिट पैसिव ऑप्टिकल नेटवर्क (जीपीओएन) टेक्नालजी विथ मिनी-ओएलटी

FTTx based Broadband Access Applications using Gigabit Passive Optical Network (GPON) Technology with Mini-OLT

दूरसंचार अभियांत्रिकी केंद्र

खुर्शीदलाल भवन, जनपथ, नई दिल्ली-110001, भारत

TELECOMMUNICATION ENGINEERING CENTRE

KHURSHIDLAL BHAWAN, JANPATH, NEW DELHI–110001, INDIA

www.tec.gov.in

Release 2: November, 2018

Price: ₹ 800/-

FOREWORD

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

- Issue of Generic Requirements (GR), Interface Requirements (IR), Service Requirements (SR) and Standards for Telecom Products and Services
- 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/Building/Curb/Cab/cell (FTTH/FTTB/ FTTC/FTTCab/FTTcell) commonly called FTTx architectures, using Gigabit-capable Passive Optical Network (GPON) technology, as per ITU-T G.984.x series Recommendations, for use in Indian telecom network. The GR also includes the specifications of various equipment constituents and management system to deploy these architectures

CONTENTS

HISTORY

Sl. No.	GR No.	Particulars	Remarks
1.	TEC/GR/TX/PON-02/01. MAY.2013	Generic Requirements for FTTx based Broadband Access Applications using Gigabit Passive Optical Network (GPON) Technology with Mini-OLT	First release
2	TEC/GR/FA/PON-002/02/NOV-18	FTTx based Broadband Access Applications using Gigabit Passive Optical Network (GPON) Technology with Mini-OLT	Second release

REFERENCE

Sl No	Reference	Particulars
1.	ITU-T Rec.G.652(11/2009)	Characteristics of a Single Mode Optical Fibre and Cable
2.	ITU-T Rec. G.656(07/2010)	Characteristics of a fibre and cable with non-zero dispersion for wideband optical transport
3.	ITU-T Rec. G.657 (10/2012)	Characteristics of a bending-loss insensitive single-mode optical fibre and cable for the access network
4.	ITU-T Rec.G.984.1(3/2008)	Gigabit-capable Passive Optical Networks (GPON): General Characteristics.
5.		Amendment 1 – 10/2009, Amendment 2 – 04/2012
6.	ITU-T Rec.G.984.2 (03/2003)	Gigabit-capable Passive Optical Networks (GPON): Physical Media Dependent (PMD) layer specification
7.		Amendment 1 -2/2006, Amendment 2 - 3/2008
8.	ITU-T Rec.G.984.3(03/2008)	Gigabit-capable Passive Optical Networks (GPON): Transmission convergence layer specification.
9.		Amendment 1 – 02/2009, Amendment 2 – 11/2009, Amendment 3-04/2012
10.	ITU-T Rec.G.984.4(02/2008)	Gigabit-capable Passive Optical Networks (GPON): ONT management and control interface specification

11.		Amendment 1 – 06/2009, Erratum-08/2009,Amd 2 – 11/2009 , corrigendum 1-03/2010 & Amendment 3 – 07/2010
12.	G.987.1(01/2010)	10-Gigabit-capable passive optical networks (XG-PON): General requirements, Amendment 1 (04/2012)
13.	G.988 (10/2012)	ONU management and control interface (OMCI) specification
14.	ITU-T Rec.G.993.2	Very high speed digital subscriber line transceivers 2 (VDSL2)
15.		Amendment 1(4/2012),Amendment 2(12/2012), Amendment 3(4/2013)
16.	ITU-T Rec.H.248.3(3/2013)	Gateway control protocol: User interface elements and actions packages
17.	IEEE 802.3	Ethernet standards
18.	IEEE 802.3ad	Ethernet link aggregation standards
19.	IEEE 802.3ae	Media Access Control (MAC)Parameters, Physical Layers, and Management Parameters for 10 Gbps Operation
20.	IEEE 802.1d/p/q	Ethernet bridging standards
21.	IEEE 802.11 b/g/n	Standards for wireless networking related to Wi-Fi.
22.	IEEE 1588 v2	Precision Time Protocol (PTP):Defines time synchronization for many spatially distributed real-time clocks through a multicast-capable network such as Ethernet
23.	QM-333	Specification for environmental testing of electronic equipment for transmission and switching use

24.	QM-115	Reliability Methods and Predictions
25.	RFC 2544	Benchmarking Methodology for Network Interconnect Devices
26.	RFC 3046	DHCP Relay Agent Information option
27.	RFC 3261	SIP- Session Initiation Protocol
28.	IS 8437 (1993)	Guide on the effects of current passing through the human body
29.	IEC 61010	Safety Requirements for Electrical Equipment for Measurement, Control and laboratory use
30.	CISPR-11	Radio-frequency disturbance characteristics - Limits and methods of measurement
31.	CISPR-22	Limits and methods of measurement of radio disturbance characteristics of Information Technology Equipment
32.	IEC Publication 61000-4-2	Testing and measurement techniques of Electrostatic discharge immunity test
33.	IEC Publication 61000-4-3	Radiated RF electromagnetic field immunity test
34.	IEC Publication 61000-4-4	Testing and measurement techniques of electrical fast transients/burst immunity test
35.	IEC Publication 61000-4-5	Testing and measurement techniques - Surge immunity test
36.	IEC Publication 61000-4-6	Immunity to conducted disturbances
37.	IEC Publication 61000-4-11	Testing and measurement techniques- Voltage dips, short interruptions and voltage variations immunity tests
38.	TEC Standard No. SD/EMI-02/03 MAY 2006	Electromagnetic Compatibility Standard for Telecommunication Equipment

	with Amendment No. 1 dated 01.01.2008	
39.	TEC/GR/TX/EMC-001/02/SEP-12	Ethernet Media Converter
40.	GR No GR/PON-01/02.Apr2008)	TEC GR on G-PON
41.	GR No. TEC/GR/TX/OPT-001/APR 2012.	TEC GR on optical splitter

Note:

1. 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/Building/Curb/Cab/cell (FTTH/FTTB/ FTTC/FTTCab/FTTcell) commonly called FTTx architectures, using Gigabit-capable Passive Optical Network (GPON) technology, as per ITU-T G.984.x series Recommendations, for use in Indian telecom network. The GR also includes the specifications of various equipment constituents and management system to deploy these architectures.

1.2 A Passive Optical Network (PON), in general, consists of Optical Line Termination (OLT) which is named as Mini-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 Mini-OLT may be centralised or distributed to a Remote Office (RO), building basement etc. In such a manner, the Service providers may extend the PON services beyond the reach possible with existing CO.

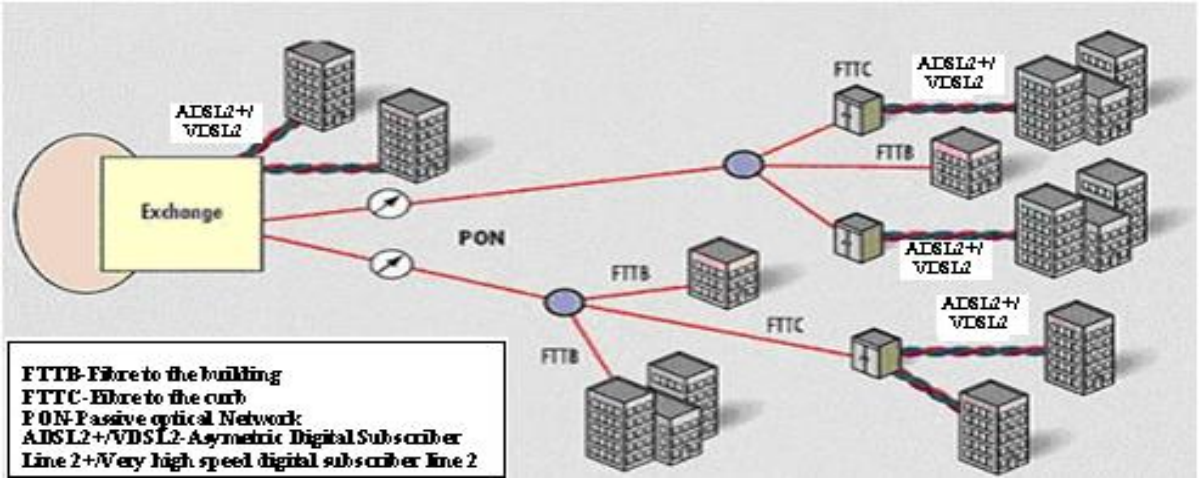


Figure.1: General schematic of passive optical network applications

1.3 The general characteristics and architecture of GPON shall be complaint to ITU-T RecG.984.1 as specified in the GR. The transmission convergence (TC) layer specifications for Gigabit-capable Passive Optical Network shall be as per ITU-T Rec. G.984.3 (2014 version). Physical Media Dependent (PMD) layer specifications shall be as per ITU-T Rec.G.984.2 (2003 version including amendment 1 dated February 2006 and amendment 2 dated March 2008).The ONT management and control interface (OMCI) and other management requirements shall be per ITU-T G.988 (2017 version) and ITU-T G.984.4(2008 version with all subsequent amendments i.e. Amendment 1, Amendment 2 and Amendment3) for those features that are not covered in G.988.

1.4 The GR outlines general characteristics of GPON systems including network services, User Network Interfaces (UNI) and Service Node Interfaces (SNI). In addition, the GR outlines the basic deployment configurations; however, specific implementation shall be subject to networking requirements of the Service Providers.

2.0 An introduction to GPON constituents.

A GPON shall consist of Mini-OLT in Central Office and distributed Optical Network Unit (ONU)/Optical Network Termination (ONT) to terminate customer traffic at various remote locations. The access node in FTTH 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, are termed as ONU. A single-fibre shall connect Mini-OLT to an ONU or ONT in point to multipoint {p2mp} configuration through optical splitter/coupler. Such splitters/couplers shall be installed at various outdoor as well as indoor locations (at Central Office and remote nodes) dependent on the number of customers to be served and consequently on the FTTX architecture chosen for the deployment. Depending upon the customer

density and speed requirements in the serving area, single or multi-stage splitting shall be used by Service Providers as shown in Figure.2.

There are also cases where GPON system might be deployed in a point-to-point (p2p) architecture where a separate fibre is terminated for each user. Such a configuration is used to cater to higher customer bandwidth requirements in specific cases, as per requirements. Another application for such point-to-point connectivity is to provide backbone connectivity to the existing infrastructure. Various ONU/ONTs are terminated at Mini-OLT.

The GR envisages the use of the industry best practice with reference to optical budgets etc., for 2.448Gb/s downstream and 1.244Gb/s Upstream bit rate GPON system.

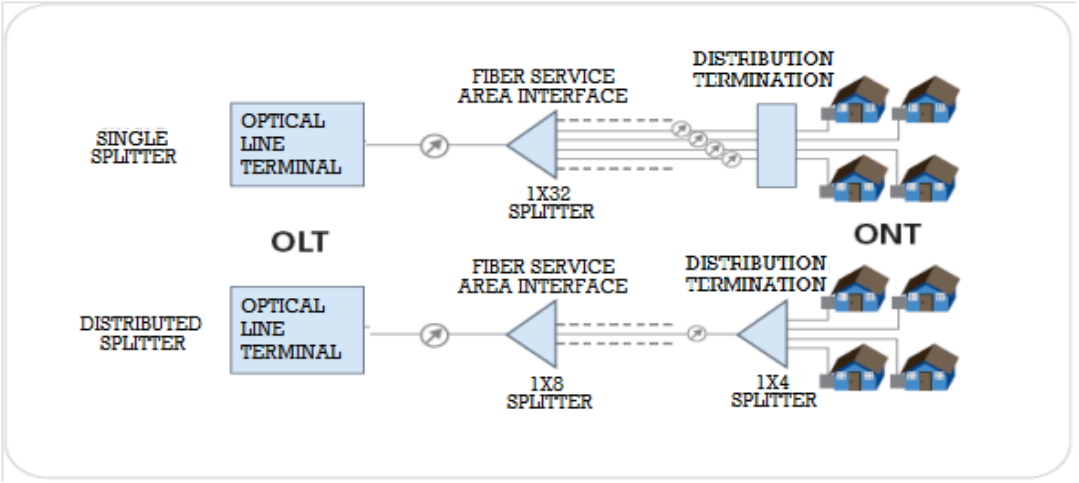


Figure.2: Schematic showing single or multi-stage splitting

2.1 Functional components of GPON:

This GR envisages FTTX deployments using GPON technology. Depending upon the deployed architecture, there shall be variations in placement of various PON constituents, as described in clause 2.3.1 detailing various FTTX architectures.

2.1.1 ONU/ONT

ONU and ONT are the system blocks to provide access to the users. The access node in FTTH architecture for network termination installed within user premises is termed as ONT. Whereas the access nodes in FTTB/FTTC/FTTCab architectures, installed at locations such as Curb/Cabinet/MDU (or MTU) basement, are termed as ONU.

In FTTC/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. Whereas, in FTTB scenario, the user can access the ONU installed in the MTU/MDU over Ethernet or ADSL2+/VDSL2/G.fast interfaces. The VDSL2 card shall be backward compatible with ADSL2+.

The ONU/ONTs shall provide 1) User-interfaces **(UNI)** towards the customers and 2) Uplink **(IF_{PON})** interfaces to uplink local traffic towards an Mini-OLT. Adaptation function for specified UNIs shall also be an integral part of the ONU/ONT blocks.

ONTs are deployed in Fibre to the Home (FTTH) and Fibre to the Business (FTTB) architectures, where the fibre termination shall take place at the premises. The UNI are integrated in the ONT box to provide data, voice, RF video (optional to purchaser) and WiFi interfaces.

ONUs are deployed in MDU, cabinet and at curb site. ONU shall provide PON interface towards the Mini-OLT to connect IP backhaul to the additional network termination (NT) and UNI interface towards the customer of high density living or working areas and as such it may comprise of two separate devices. Both of them may be provided as an integrated solution or the NT device such as DSLAM

(ADSL2+/VDSL2/G.fast) may be implemented as a separate box in case it is a third party item.

Note: In the case of ONUs providing separate box solution, the management of different boxes shall be possible through the TR69 or any other management standard. However, there are cases where the ONT and the UNI equipment are physically integrated into the same device (e.g., an integrated ONT / RG or an integrated ONT / DSLAM) and there may not be a physical interface connecting the two. Even in this case, the Virtual Ethernet Interface Point (VEIP) demarcates the point between the two management domains, with OMCI managing from the Virtual Ethernet Interface Point to the ANI

Service support by ONU and ONT:

- High speed data/Internet,
- Voice through in-built VoIP gateway in case of ONT and through in-built/external VoIP gateway as per requirement in the case of ONU for large no. of POTS.
- E1 through TDM over IP External Gateway,
- IP Video.
- Wi Fi support as per IEEE 802.11b/g/n/ac(Note: Exact requirement for WiFi support as per IEEE 802.11b/IEEE 802.11g/ IEEE 802.11n/ IEEE 802.11 ac will be specified by the purchaser. However, higher standard shall be backward compatible with lower version of standard).

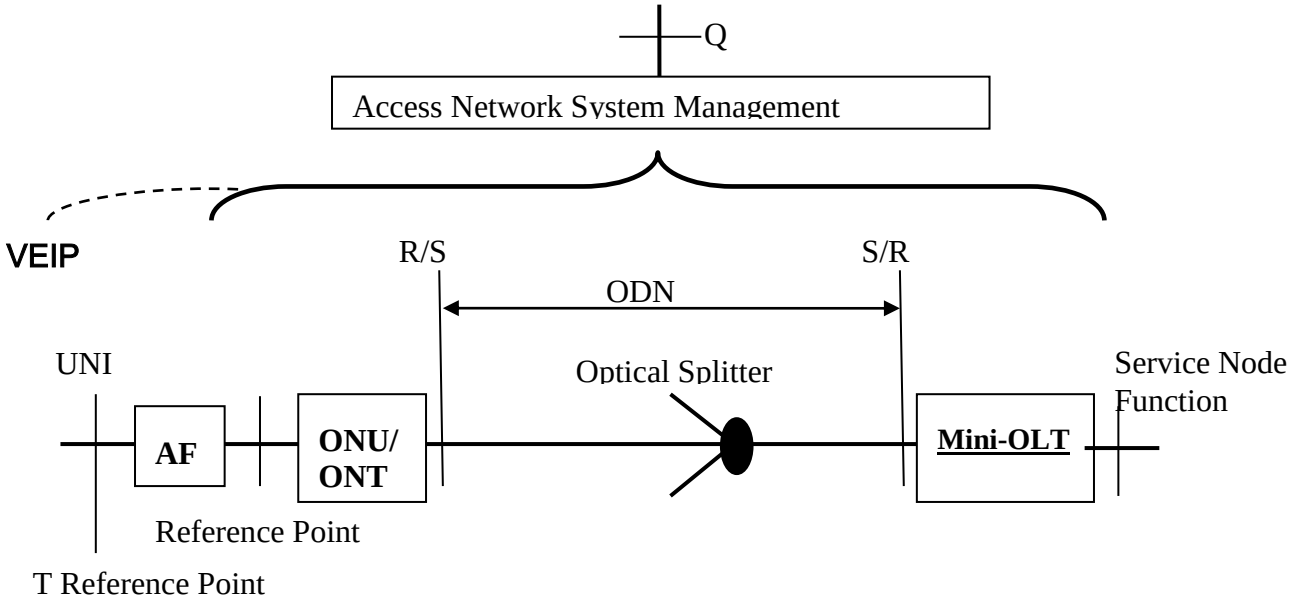
Note: - The different type of interfaces/services discussed in this document is indicative only. Purchaser may decide type of interface/service and number of interfaces as per its implementation strategy.

2.1.2 Mini-OLT:

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

2.1.3 Optical splitters.

Optical splitters capable of providing up to 1: 128 optical split, on end-to-end basis, per PON interface on OLT, are envisaged. There shall be various options provided to purchaser such as m: N where m = 1 or 2 and N = 4, 8, 16, 32, 64 or may be more. The purchaser may use a combination of these split options. The purchaser shall communicate the exact requirements.



ONU/ONT	:	Optical Network Unit / Optical Network Terminal
ODN	:	Optical Distribution Network
OLT	:	Optical Line Termination
SNI	:	Service Node Interface
UNI	:	User Node Interface
AF	:	Adaptation Function (May be included in ONU/ONT)
S	:	Point on the Optical fibre just after the OLT (Downstream) /ONU (Upstream)

R : Point on the Optical fibre just before the ONU (Downstream) /OLT (Upstream)

Reference Point :Reference point in case AF outside ONU

T Reference Point :The user services reference point

Figure 3. Configuration for a Passive Optical Network

2.1.4 Fibre plant for PON

ITU-T Rec. G.652 fibre shall primarily be used between Mini-OLT and ONUs/ONTs. Special access fibre e.g. ITU-T Rec. G.657 fibre may also be used for FTTB/FTTH intra-building, campus etc. applications.

2.2 TDM lines and voice transport options.

The layer-2 control protocol between ONU/ONT and Mini-OLT shall be Ethernet over GEM. TDM support shall be provided through TDM over Packet (TDMoP) option. TDMoP support shall be relevant to E1 lines. The Mini- OLT shall interface the core network at various Ethernet interfaces, as detailed later in the GR.Transport of voice services shall be supported as Voice over Packet between ONT/ONU and Mini-OLT. The voice traffic shall be terminated at Mini-OLT across IP over Ethernet interfaces (with SIP signalling and ITU-T Rec. G.711 framing), thus creating a simple evolution path to an all IP network with soft-switches, as needed. An external SIP/H.248 ↔ Media gateway may be used for interfacing PSTN switches subject to purchaser's requirements and is optional

2.3 Topological requirements.

The optical section of a local access network system shall be passive and its architecture shall be capable of simultaneously supporting a mix of p2p or p2mp applications. Figure 4 shows the architectures for Fibre-to-the-Home (FTTH), Fibre-to-the-Building/Curb (FTTB/FTTC) and also Fibre to

the Cabinet (FTTCab). Actual architecture required shall be decided and conveyed by the purchaser. The Optical Access Network (OAN) is common to all architectures as shown in the figure 4.

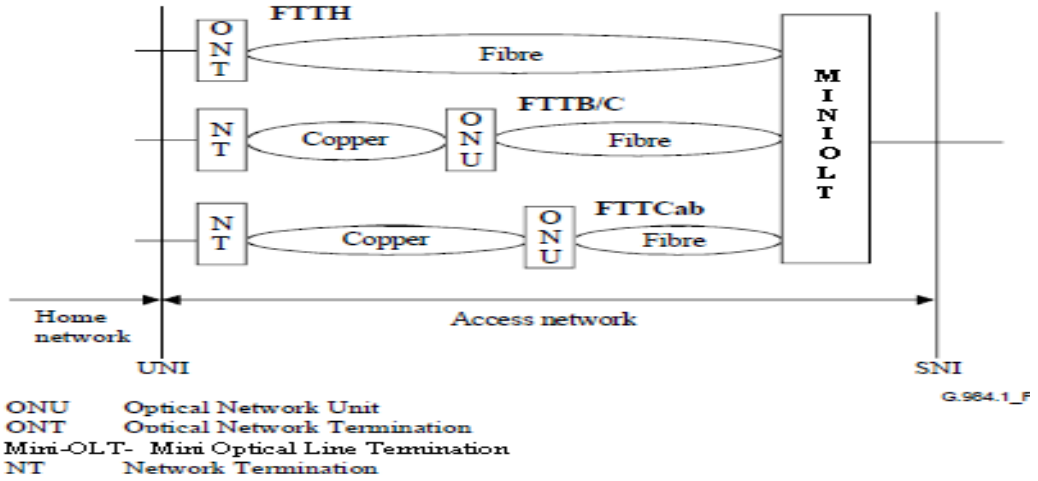


Figure4: Network architecture

Note: Direct Ethernet access to ONU (upto 100Mb/s) over copper-pairs can be used, if user location is within ~100 meter reach of ONU in an MDU/MTU in FTTB architecture. DSL based access may be used for longer distances in FTTB/FTTC/FTTCab architectures.

2.3.1 FTTX architectures: An introduction & discussion.

The 'X' in FTTX stands for a lot of things, often not very different, but for practical purposes they can all be grouped under any of the three basic approaches:

1) **Fibre all the way to residential or business customer by using PON or Ethernet:**

These are-

- Fibre to the Home (FTTH)
- Fibre to the Building (FTTB).
- Fibre to the Cell(FTTcell)

The distinction is basically between single homes or apartments and business or multi-tenant buildings and Mobile backhaul applications.

2) **Fibre all the way to the customer by using PON only**

- Fibre to the Premises (FTTP).

3) **Fibre partial**

These all use copper from the partial point to the user:

- Fibre to the Curb (FTTC)
- Fibre to the Cabinet (FTTCab).

Fibre partial means that fibre goes to some point near to the customer, and then another mechanism usually copper-pairs supporting ADSL2+/VDSL2/G.fast takes over for the final link to the customer. Specific to Indian context, in FTTCab architecture, the fibre is brought upto a point close to the customers, where a cabinet is installed in the existing network (approximately 1000-2000m from users). To a rough approximation, this node may serve ~500-1000 customers or households. Whereas, in FTTC, the fibre is brought even closer, upto a roadside telephone pole in the distance range of 200-400 m from end users. Usually, this architecture may serve ~ 8-32 customer drops (copper).

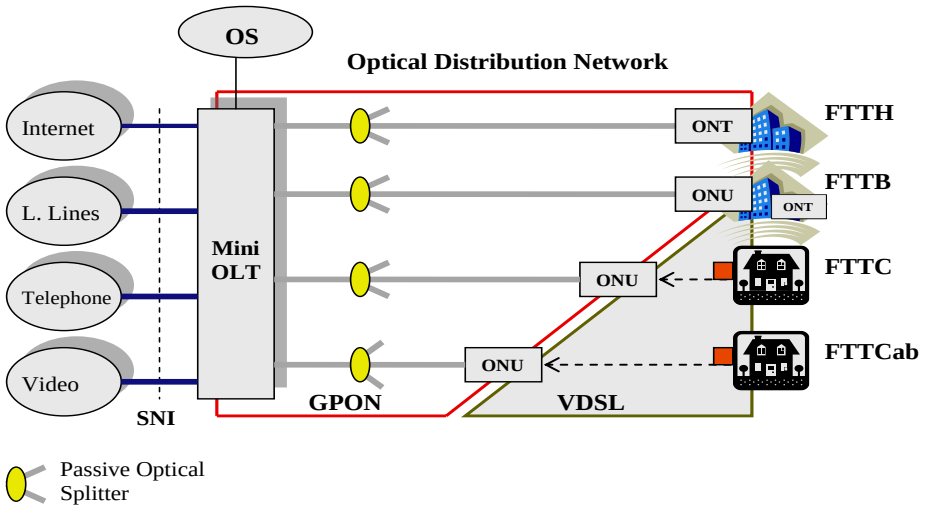


Figure 4a. Schematic showing various FTTX architectures

In FTTH architecture, fibre termination takes place right up to individual home. The user installs an ONT and connects to Mini-OLT in CO directly or through cascaded splitter stages.

In FTTB architecture, fibre is extended right upto the building. Based on home and business applications, there are two possible scenarios in this architecture.

1. FTTB for residential applications in MDU.
2. FTTB for business applications.
3. A mix of these applications in MDU/MTU.

The main difference for the afore-mentioned scenarios is based on the user access to ONU. The users in Scenario #1 shall mainly access the ONU through use of in-building copper runs, through ADSL2+/VDSL2/G.fast. Whereas in Scenario #2, users might prefer to avail direct fibre access to ONU over Ethernet interface. To support such flexible options, the ONU shall provide options for direct Ethernet access as well as DSL based access. The ATM encapsulation, if any, shall be terminated right at the ONU.

In FTTC and FTTCab architectures, fibre penetration takes place up to the curb (200-400m) or cabinet (1000-2000m) from user locations. These architectures are suitable for densely populated residential areas comprising of mainly individual households. The access to the users shall be provided mainly through ADSL2+/VDSL2/G.fast as the NT device over copper pairs. There shall be provision for POTS and ADSL2+/VDSL2/G.fast interfaces towards users at ONUs.

Note: The VDSL2 specifications shall be as per ITU-T Rec. G.993.2. The G.fast specifications shall be as per ITU-T Rec. G.9700 & 9701.

2.4 Equipment interfaces in FTTB/FTTH/FTTC/FTTCab architectures.

The GPON equipment shall provide three types of interfaces, namely:

1. User-Network Interface (UNI)
2. Service-Node Interface (SNI)
3. PON interface (IF_{PON})

2.4.1 User-network interface (UNI) and service-node interface (SNI).

a. User-network interface (UNI)

The ONU/ONT provides various application interfaces towards users, as shown in figure 3, called UNI. UNIs shall be supported for various services as envisaged for different Categories/Types of ONU/ONTs. The possible examples of UNI are described in clause I.2, detailing with examples of UNI in Appendix II.

b. Service-node interface (SNI)

Mini-OLT shall support SNI towards core network, as described in Figure.3. SNI depends on the services provided by the service provider. The examples of SNI are described in clause I.3 detailing examples of SNI in Appendix II.

The SNI at Mini-OLT is envisaged to provide various Gigabit Ethernet and/or 10G Ethernet interfaces. The actual number of interfaces are optional to the purchaser's requirement.

c. PON interfaces (IF_{PON})

The ONUs shall provide (IF_{PON}) interfaces towards Mini-OLT for GPON transport. In a similar manner, Mini-OLT also provides (IF_{PON}) interfaces towards ONUs for GPON transport.

2.4.2 A broad overview of services in various FTTX architectures.

The service support for various FTTX deployment architectures are summarized below. The details of the service support are also available in Appendix II/Clause I.1.

a. FTTB architecture.

The scenarios identified in Clause 2.3.1 shall support the following service categories:

FTTB for residential applications.

-Asymmetric broadband services (e.g., Internet, digital broadcast TV services, Video-on-

demand, file download, etc.) over direct Ethernet over copper or through ADSL2+/VDSL2/G.fast.

-Symmetric broadband services (e.g., content broadcast, e-mail, file exchange, distance

learning, telemedicine, online-gaming, etc.) over direct Ethernet over copper or through

ADSL2+/VDSL2/G.fast.

- POTS through VoIP.

FTTCell wireless scenario

Within this scenario, the ONU/ONT will be called a cell-site backhauling unit (CBU) and will have to offer connectivity to wireless base stations:

Symmetric TDM services (e.g., 2G cell site backhaul);

Symmetric/asymmetric packet-based broadband services (e.g., 3G/4G cell-site backhaul). The system shall support 1588v2 protocol for synchronization.

FTTB for business applications.

-Asymmetric broadband services (e.g., Internet, digital broadcast TV services, Video-on-demand, file download, etc.) over direct Ethernet over copper or through ADSL2+/VDSL2/G.fast.

-Symmetric broadband services (e.g., group software, content broadcast, e-mail, file exchange, etc.) over direct Ethernet over copper or through ADSL2+/VDSL2/G.fast.

-POTS through VoIP.

-TDMoIP services.

b. FTTC and FTTCab applications

In this architecture, the following service categories are envisaged:

-Asymmetric broadband services (e.g., Internet, digital broadcast TV services, VoD, file download, online-gaming, etc.) over ADSL2+/VDSL2/G.fast.

-Symmetric broadband services (e.g., content broadcast, e-mail, file exchange, distance learning, telemedicine, etc.) over ADSL2+/VDSL2/G.fast.

-POTS through VoIP.

Note: ATM encapsulation of DSL, if any, shall be terminated in the ONU node in all deployment architectures.

c. FTTH applications

In this scenario, the following service categories are envisaged:

- Asymmetric broadband services (e.g., Internet, digital broadcast TV services, VOD, file download, etc.) over fibre.

-Symmetric broadband services (e.g., content broadcast, e-mail, file exchange, distance learning, telemedicine, online-game, etc.) over fibre.

- POTS through VoIP.

Note 1. The above service descriptions are indicative of possibilities and not for exact specification. The purchaser shall indicate the requirement of the interfaces.

Note 2. The service interface shall be TDM over packet.

2.4.3 PON interface (IF_{PON}) at the reference points S/R and R/S.

The interface at reference points S/R and R/S in figure 3 is designated as IF_{PON}. This is a PON-specific interface that shall support all the protocol

elements necessary to allow transmission between Mini-OLT and ONU/ONTs.

2.5 Important parametric definitions & functional requirements of GPON systems.

a. **Logical reach:** The maximum logical reach is defined as the maximum length between ONU/ONT and Mini-OLT that can be achieved for a particular transmission system independently from optical budget. It is measured in km and it is not limited by PMD parameters, but rather TC layer and implementation issues.

The GPON system shall support a logical reach up to 60 km. At least a physical reach of 20 kms shall be demonstrated.

Specific requirements may be suitably planned and conveyed by purchaser.

b. **Maximum differential logical reach:** The differential logical reach is the maximum difference in logical reach among all ONTs/ONUs. It is measured in km and it is not limited by PMD parameters but rather TC layer and implementation issues. The maximum differential logical reach shall be 20 kms as per GPON standards G.984.x.

c. The power-supply failure/EMS server break-down/bugs in the software shall not affect the current tributary-connection map.

2.5.1 Bit-rate options

a. The GPON system shall support a bit rate of 2488.32 Mb/s in the downstream MINI OLT – ONT/ONU and 1244.16 Mb/s in the upstream ONT/ONU – Mini-OLT directions.

b. The GPON parameters to be defined are categorized by the downstream and upstream, and nominal bit-rates are as follows-

Table-1

Tx -Direction	Nominal Bit Rate	Table in ITU-T Rec. G.984.2(03/2003)
Downstream	2488.32 Mbit/s	Table 2c (downstream, 2488 Mbit/s)
Upstream	1244.16 Mbit/s	Table 2f-1 (upstream, 1244 Mbit/s)

Note: All parameter values specified are worst-case values, assumed to be met over the range of standard operating conditions (i.e., temperature and humidity ranges), and they include ageing effects. The parameters are specified relative to an optical section design objective of a Bit Error Ratio (BER) not worse than 1×10^{-10} for the extreme case of optical path attenuation and dispersion conditions.

3.0 Specifications for GPON system constituents for various topologies

3.1 Equipment categorization

Two broad categories of ONU/ONTs are envisaged in the GR:

1. **Category-I:** ONT with one optical input will support Type-B protection and
2. **Category-II:** ONT with two optical inputs will support Type-C protections. However, the purchaser may permit separate such ONU/ONTs for each application. This type of

ONU/ONT shall be suitable for business applications.

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

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

Type 2. Cabinet/Curb-ONU **(C-ONU)** for FTTCab/FTTC applications.

Type 3. MDU-ONU **(M-ONU)** for FTTB applications in MDU.

Type 4. Business-ONT **(B-ONT)** for FTTH business applications.

Type 5. ONT for cell-site backhauling unit (CBU) / fronthauling to offer connectivity to wireless base

Protection requirements due to fibre cuts:

1. No support for protection (used mainly for residential applications), and
2. For Business as well as high-density residential applications, the purchaser may opt for configurable protection as fully protected, partially protected or unprotected. This requires separate such ONT/ONUs for each application with diversified fibre routes.

3.2 Physical interface requirements at UNI[1].

3.2.1 Type 1: H-ONT for residential broadband service delivery[1].

H-ONT shall provide the following residential broadband services. Service support shall be there for voice, video & data.

i. POTS - Minimum One.
ii. 10/100/1000 BaseT Ethernet interface (to inter-connect IP phones, STB, PC etc., through a home Ethernet bridge or Router mode with inbuilt Residential Gate Way functionality) -Minimum one.
iii. Dying gasp feature (If required by purchaser).
iv. Inbuilt IEEE 802.11b/g/n/ac WiFi interface in the home(Optional)
v. USB 2.0/3.0 Interface(optional).

3.2.2 Type 2: Residential-ONU (R-ONU) for FTTCab/FTTC applications[1].

The ONU for FTTC/FTTCab architectures shall provide ADSL2+/VDSL2 interfaces in addition to other interfaces as mentioned below. The number of homes/users to be served shall be high in these deployments. A typical distance from target users may be 500m-1000m. The interface support shall be provided for:

i. 10/100/1000 Ethernet Interface– Minimum 16.
ii. ADSL2+/VDSL2 interface –Minimum 16
iii. G.Fast (ITU-T rec G.9700 & G.9701) / G.hn(ITU-T rec G.9960 & G.9961) interface. (If required by purchaser)

iv. Dying gasp feature (If required by purchaser).

v. The users shall install an appropriate NT at their premises.

3.2.3 Type 3: MDU-ONU (M-ONU) for FTTB applications in MDU[1].

The M-ONU for FTTB architectures shall provide interfaces to cater to residential as well as business requirements in Multi-Dwelling Unit (MDU). M-ONU is usually installed in the basement of the MDU.

Direct Ethernet access to ONU (up to 100Mb/s) over copper-pairs can be used, if user location is within ~100 meter reach of ONU in an MDU/MTU. ADSL2+/VDSL2 based access may be used for longer distances.

A typical distance from target users may be 100-150m. The interface support shall be provided for:

i. POTS-minimum 24

ii. 10/100/1000BaseT Ethernet interfaces – Minimum 24

iii. Inbuilt IEEE 802.11b/g/n/ac WiFi interface in the home(Optional)

iv. ADSL2+/VDSL2 interfaces- Minimum 24.

v. G.Fast (ITU-T rec G.9700 & G.9701) / G.hn(ITU-T rec G.9960 & G.9961) interface. (If required by purchaser)

vi. Dying gasp feature (If required by purchaser).

vii. The users shall install an appropriate NT at their premises.

3.2.4 Type 4: Business-ONT (B-ONT) for FTTH applications[1].

i. POTS – Minimum One

ii. E1 line (for PBX interconnection etc.). The support for E1 shall be meant for transportapplications of TDM to Mini-OLT. The system shall support E1 Interface – Minimum One

iii. 10/100/1000 BaseT Ethernet interface (to inter-connect IP phones, STB, PC etc., through a home Ethernet bridge or Router mode with inbuilt Residential Gate Way functionality) – Minimum Two

iv. IEEE 802.11b/g/n/ac WiFi interface (inbuilt implementation) in the home – Minimum One

v. Dying gasp feature (If required by purchaser).

vi. USB 2.0/3.0 Interface(Optional)

3.2.5 Type 5: Cell- Site backhauling/fronthauling (M-ONT) for FTTM applications[1]

i. 10/100/1000BaseT Ethernet interfaces – Minimum Four Port

ii. PON ports for Uplink- Two

iii. Dying gasp feature (If required by purchaser)

iv. USB 2.0/3.0 Interface(optional).

v. The system shall support 1588v2 protocol for synchronisation.

3.3 ONU & 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 various 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 ONU/ONT at UNI

1. Isolation of subscriber traffic to ensure user privacy for ONU.

---

[1]**Note 1** Purchaser shall specify exact number of ports required and also the no. of access to WiFi users.

Note 2 In all types of ONTs/ONUs mentioned above, the purchaser may specify different number of ports required.

Note 3 All types of ONTs/ONUs shall be IPv6 compliant.

Note 4 The system shall be designed considering 400 Mbps up/down for 10/100/1000 BaseT Ethernet UNI port.

Note 5 The PON access shall support Set Top Boxes (STB) in the home network offering different video channels of IPTV, on different TV sets.

- 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.

-There shall be no layer 2 connectivity between users at ONU. Subscriber (peer to peer-P2P) communication shall be allowed only through Mini-OLT.

2. Layer 2 bridging support for various ONU/ONTs.

- Type 1. Home-ONT (H-ONT) for FTTH applications.
  64 MAC addresses, 16 VLAN.
- Type 2. Residential-ONU (R-ONU) for FTTCab/FTTC applications.
  1K MAC addresses, 4096 VLAN[2].
- Type 3. MDU-ONU (M-ONU) for FTTB applications in MDU.
  1K MAC addresses, 4096 VLAN[2].
- Type 4. Business-ONT (B-ONT) for FTTH applications.
  256 MAC addresses, 64 VLAN.

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

i. Flow control per 802.3x
ii. IGMPv2/3 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.

3. Bandwidth management, congestion control and QoS.

i. For ONU, there shall be robust and programmable buffer management, congestion control, and traffic scheduling at a per-user flow level. This is required to ensure appropriate levels of service on premium or time-sensitive content. Sufficient buffer capacity shall be as per ITU-T G984.3.

[2]Available VLAN may be lesser than 4096 depending upon implementation

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 at UNI ports shall be controllable through EMS of the bidder.

4. Dynamic bandwidth adjustment (DBA).

i. Piggy-back DBRu report mode 0 shall be supported.

ii. Idle GEM DBA shall be supported

- By 'Idle GEM' support, it is implied that Mini- OLT will proactively monitor US frame for these and reassign BW-MAP as needed to other ONT/ONUs reporting back-pressure in its queues via DBRu.

iii. Concurrent support of idle GEM and piggy-back DBRu mode 0 shall be supported

iv. T-CONT Type 1 to T-CONT type 4 shall be supported.

5. 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. Bandwidth control can be done by per-VLAN or per-class policing and shaping 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.

6. Security

i. user name and password based authentication,

ii. optional support of 802.1x authenticator functionality (MAC based)

iii. MAC address limitation per-port

iv. >100 ACL support (based on switch port, MAC address, Ether-type)

v. DOS prevention, SSH v1/2 for CLI for ONU.

vi. AES (key-size of 128 bit) support (optional) per port-id with operator disable/enable capability.- Operator disable/enable shall be done in-band PLOAM message (Encrypt Port-Id) and there is only one AES key per ONT/ONU. Also for higher security, ONT/ONU must support run-time regeneration of the AES key and encryption using the new key, while carrying the live traffic.

Note: The above mentioned security capabilities shall be supported by ONU.

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.

7. ONU shall support DHCP relay agent with DHCP option 82 for DHCP based broadband access and shall support DHCP-based authentication for access.

8. There shall be support for RS (255,239) FEC with operator enable/disable capability in both upstream and downstream directions.

9. **Line testing**

In FTTC/FTTCab and FTTB architectures, the ONU shall allow pre-qualification testing of the 2-wire 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.

10. **Local management port**

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).

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 6 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 of 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 Mini- 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.

3.4 Mini-OLT specifications

a. **Hardware capability**

1. Number of PON interfaces in the box:

   Mini-OLT shall support single PON/IF card which may be integrated with network side interface card.

2. Number of PON interfaces supported in the box:

The Mini-OLT shall support 4/8/16 PON interfaces.

3. Number of interfaces towards the Core network:

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

(i) **For 4 PON interface configuration:** A minimum of 2 x GigE and 1 x 10GE LAN interfaces shall be supported towards the core network to cater to the different service providers links. Ratio of uplink access should be 1:1.

(ii) **For 8 PON interface configuration:** A minimum of 4 x GigE and 2 x 10GE LAN interfaces shall be supported towards the core network to cater to the different service providers links. Ratio of uplink access should be 1:1.

(iii) For 16 PON interface configuration: A minimum of 4 x GigE and 4 x 10GE LAN interfaces shall be supported towards the core network to cater to the different service providers links. Ratio of uplink access should be 1:1.

b. Functional and architectural requirements

Mini-OLT shall transparently support SIP/H.248 signaling.

Protection requirements

-The protection mechanism for the PON line should be mandatorily provided.

-1+1 or 1:1 redundancy may also be provisioned for uplink connectivity. The redundancy shall be as per Purchaser's requirements.

c. Features and capabilities.

- The Mini-OLT shall have local status monitoring
- The Mini-OLT shall supports LED status indication per Mini-OLT port
- **Power:** Indicates power on status
- **Fail:** Indicates internal device failure status
- **Alarm:** Indicate alarm status

d. Dynamic Bandwidth Allocation (DBA).

- Maximum bandwidth limiting
- Minimum guaranteed bandwidth
- Two or more level (preferred four) classes of classification
- Piggy-back DBRu report mode 0
- Idle GEM DBA
- Concurrent support of idle GEM and piggy-back DBRu mode 0 support
- T-CONT Type 1 to Type 4.

e. Layer 2 management and QoS support

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

f. Support for MAC address limiting.

- The operator shall be able to set the maximum number of MAC addresses from an ONT/ONU UNI through Mini-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 Mini-OLT.

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

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

h. VLAN function.

The Mini-OLT shall support the following VLAN operation

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

i. Filtering functions at Mini-OLT.

- Filtering by destination MAC address
- Filtering by source MAC address
- Filtering of 802.1x packets (optional)
- Support of Ethernet port authentication mandatory for ONU and optional for ONT."

j. Support for packet classification functions.

- Support of IGMP proxy for ONU.
- Classification based on VLAN ID
- Classification based on 802.1p bit
- The OLT chassis should be able to configure up to 4K VLAN. However VLAN 0, 1, 2, 3 and 4095 are reserved and not used in the OLT system.
- VLAN forwarding /filtering database should be based on IVL (Independent VLAN Learning)".

Note: Purchaser shall communicate Number of Port-Id/Alloc.-Id per ONT/ONU to be supported by GPON link.

4.0 Network requirements

4.1 Passive optical network

a. The transmission methodology should be bidirectional on a single fibre compliant with ITU-T Rec. G.652.

b. Bidirectional transmission shall be accomplished on a single fibre.

c. The wavelength in the range 1260-1360nm shall be used for upstream.

d The PON system shall support mxN architecture. A 1:128, 1:64, 1:32, 1:16, 1:8, 1:4 split options per PON interface on Mini-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.

4.1.1 **Optical splitter specifications:** Optical Splitter shall comply Optical splitter specifications as per GR No. TEC/GR/TX/OPT-001/APR 2012.

4.1.2 **Ethernet user interfaces at SNI of Mini-OLT: Specifications**

The following Ethernet interface options shall be supported. Actual interface type shall be communicated by purchaser. In the case of p2p application, the SNI interface of the Mini- OLT may be GbE as mentioned below and the purchaser shall indicate the exact interface requirement.

1. 1000BaseSX (50µ multi-mode) interface
2. 1000BaseLX (10µ single-mode @1310nm) interface
3. 1000Base ZX (10µ single-mode @ 1550) interfaces.
4. 10GBase LAN interface as per IEEE 802.3ae.

- The specifications for these interfaces shall comply with relevant IEEE standard.
- The different GbE interfaces and 10GBaseLAN interfaces may be implemented through the use of SFP/SFP+/XFP.

5.0 Configuration schemes

From the viewpoint of administration of the access network, the protection architecture of GPON 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 following configuration schemes are given as examples for implementation of various protection mechanisms in GPON network such

as unprotected, partially protected and fully protected. These protection schemes shall be optional to purchaser's requirements.

Type A: A deprecated configuration that duplicated only the optical fibres.

Type B: The second configuration (Figure 4b) doubles the PON ports and the optical fibres between the Mini-OLTs and the optical splitter, and the splitter has two input/output ports on the Mini-OLT side. This configuration reduces the cost of duplexing the ONUs, although only the Mini-OLT side can be recovered.

Type C: The third configuration (Figure 4c) doubles not only the Mini-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. The ONTs in Type C protection should support dual parenting.

Type D: A deprecated configuration that allowed the mixing of duplicated and non-duplicated ONUs, essentially providing a combination of types B and C protection.

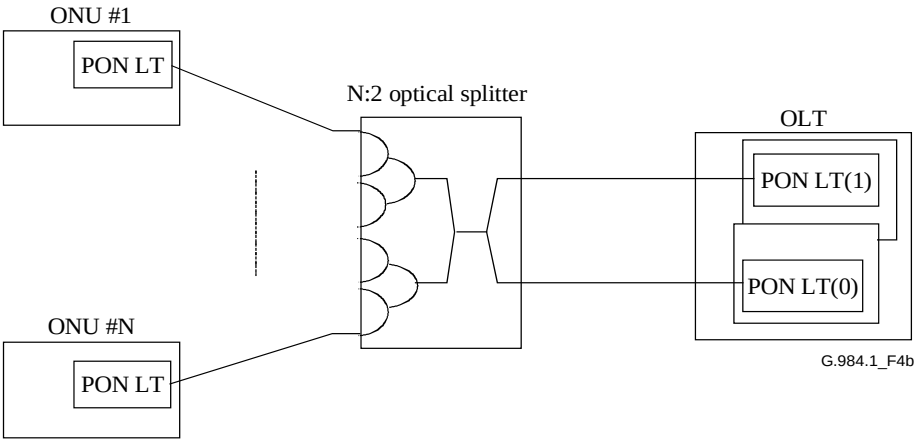


Figure 4b Duplex GPON system: Mini-OLT-only duplex system

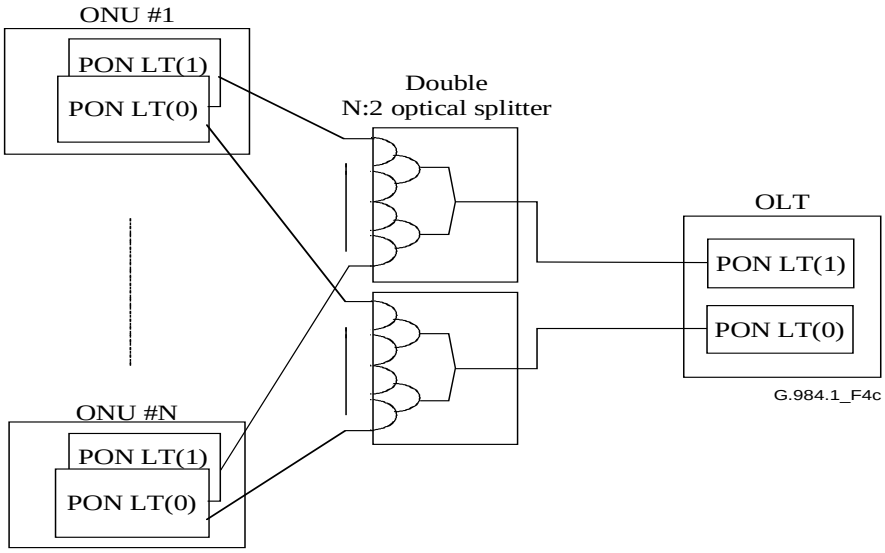


Figure 4c Duplex GPON system: Full duplex system

5.1 **Protection on the Mini-OLT SNI section**

There shall be support of multiple Ethernet service node interfaces (SNI) from each Mini-OLT. For redundancy, the Mini-OLT shall support IEEE 802.3ad Ethernet link aggregation and RSTP as per IEEE 802.1w on those interfaces.

5.2 **Possible switching types for PON protection**

In case the purchaser asks for protection in the PON section as detailed in Clause 5.0 (Type-B/C), the following two types of protection switching shall be provisioned

i) Automatic switching and

ii) Forced switching.

The first one is triggered by fault detection of loss of signalThe second one is activated by administrative events, such as fibre rerouting, fibre replacement, etc. Both types should be possible in the GPON 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.

5.3 Synchronization requirements are required for Mobile Backhaul applications. To deliver high bandwidth to mobile operators, accurate

synchronization and timing is required in the G-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 IEEE1588v2 precisionTime Protocol (PTP).

Synchronizing the ONTs: All ONU/ONTs shall operate synchronously with the PON clocktransmitted by the OLT. Mini-OLT shall serve as the master timing source.

The following interfaces shall be optionally available as specified by the purchaser at the Mini-OLT for synchronization. :

- IEEE1588v2 Transparent Clock Over PON or- SyncE

6.0 Performance requirements

The equipment shall be tested for error performance as follows.

In laboratory: In the case E1 service is offered, BER performance over simulated hop shall be tested better than 1x10-10 for 24 hours over an emulated E1 (TDMoP) in an end-to-end configuration. IETF RFC 2544 conformance/performance shall be tested for end-to-end Ethernet service.

In field: In the case E1 service is offered, BER performance over simulated hop shall be tested better than 1x10-10 for 24 hours over an emulated E1 (TDMoP) in an end-to-end configuration. IETF RFC 2544 conformance/performance shall be tested for end-to-end Ethernet service.

7.0 Maintenance, performance monitoring & supervisory signals

The maintenance signals philosophy shall be as per ITU-T Rec. G.984.x.

7.1 Alarms

The alarms and consequent actions shall be possible to monitor via EMS& LCT of the equipment be as per ITU-T G.984 series Recs.

8.0 Mechanical standards

a. As the ONT is located in customer premises, it should be designed to support wall-mounting installation. For Rack type of installation, the Mini–OLT shall be housed in standard 19” racks with 600 mm depth or ETSI racks. The purchaser may specify specific requirements.

b. The Mini-OLT equipment shall be housed in the standard mechanical ETSI upto 2U size.

c. There shall be proper arrangements to avoid the ingress of dust

9.0 Minimum equipment required for Type Approval

Fully loaded Mini-OLT equipment with input and output ports as specified in this GR shall be offered during the Type Approval testing. EMS and LCT shall also be offered. All test jigs, test instruments etc., shall be arranged by the manufacturer.

ONT/ONU : 4 nos.
Mini-OLT : 1 no.
EMS/LCT : 1 no.

10.0 Field trial

The equipment shall be subjected to field trial for a minimum of 4 weeks with working traffic. The equipment shall be loaded with maximum possible live-traffic & the balance may be loaded with simulated traffic to assess the performance of the equipment. The manufacturer/supplier shall ensure that the equipment meets the field requirements of the purchaser.

CHAPTER 2

General Requirements

1.0 Reference documents

1.1 Whatever that has not been specifically stated in this document, shall deem to be as per relevant latest ITU-T Recommendations.

1.2 Relevant ITU-T 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 provide natural cooling arrangements. But the purchaser may allow use of fans if the natural cooling arrangement is not found adequate provided:

-Fans are DC operated.In case of fan failure, the reporting of the same is desirable on LCT/EMS

-MTBF is better than 80,000 hours.

2.6 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 the requirements for environment as specified in TEC document No. SD: QM-333. Issue: March 2010 – "Standard For Environmental Testing of Telecommunication Equipment".

2.7 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.

2.8 Each terminal block and individual tags shall be numbered suitably with clear identification code and shall correspond to the associated wiring drawings.

2.9 All controls, switches, indicators etc., shall be clearly marked to show their circuit diagrams and functions.

2.10 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 self-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 be IPV6 compliant.

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".

4.2 The equipment shall be manufactured in accordance with international quality management system ISO 9001:2000 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 QM 301{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 GPON constituents.

a. ONU/ONT/Mini-OLT

Environmental requirements for various ONUs shall be as follows:

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

-QM-333 ‘B2’ category

Type 2. Cabinet/Curb-ONU **(C-ONU)** for FTTCab/FTTC applications:

-QM-333 ‘D’ category

Type 3. MDU-ONU **(M-ONU)** for FTTB applications in MDU:

-QM-333 ‘B2’ category

Type 4. Business-ONT **(B-ONT)** for FTTH applications:

-QM-333 ‘B2’ category

Mini-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/sub-systems.

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 GPON constituents:

a. Powering requirements: ONT

The primary power source shall be 160-270Vac, 50±2Hz for the following:

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

Type 4. Business-ONT **(B-ONT)** for FTTH applications.

Type 3. MDU-ONU **(M-ONU)** for FTTB applications in MDU.

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 conversion shall be provided. The adaptor can be either internal or external to the device.

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 –48V DC with a variation in the range from -40V to -60V for R-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 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 provided. The adaptor can be external or 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 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.
    - Battery present or not (assessed by voltage of the battery)
    - Battery useful or not (assessed by a short periodic discharge/charge test)
    - Low capacity (means going to shutdown soon).

d. Powering requirements: Mini-OLT and related equipment in CO

Nominal power supply is –48V DC 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 Mini-OLT shall have the option of power feed through DC power source and/or AC power sourceusing AC/DC Adapter and operatingat nominal 230 volts AC with voltage variation of -15% to +10% at 50 Hz ± 2 Hz.The Mini-OLT shall be designed to have protection of power transient, power-surge and power blowouts.

v. The power rating shall be clearly marked on the Mini-OLT.

vi. The power redundancy requirement for Mini-OLT is left to the purchaser's discretion

vii. The power backup requirement for Mini-OLT is left to the purchaser's discretion. The Mini-OLT shall provide external 4-6 hours battery backup (to be specified by purchaser for the exact backup duration) to withstand commercial power outages.

viii. 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.

ix. The Mini-OLT should also be provided with the feature of power monitoring and automatic shutdown to safe guard the system, before the power backup goes below the cutoff level. The system shall also be equipped to test, monitor and report (through EMS and LCT) the following:

- Battery present or not (assessed by voltage of the battery)
- Battery useful or not (assessed by a short periodic discharge/charge test)
- Low capacity (means going to shutdown soon).

7.0 Accessories

The supplier shall provide complete set of:

i. 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

ii. Software and the arrangement to load the software at site.

Note. The quantity shall be as ordered by purchaser.

iii. 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.

Installation spares, 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.

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-assemblyreplacement 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 Optical access port

The optical access ports should be designed to protect themselves against the entry of dust when they are not occupied by an external fibre-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.

CHAPTER 3

Safety Requirements

1.0 Operating personnel safety requirements

1.1 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.

1.2 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.

1.3 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.

1.4 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. There shall be a provision for the terminal for grounding the equipment.

1.5 The optical access ports should be designed to protect themselves against the entry of dust when they are not occupied by an external fibre-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.

1.6 If the fiber is broken or an optical connector is opened, the laser shall be automatically shut down or the optical power to be decreased to a value less than -10 dBm. Optical connectors, if used in the system, shall be self protective against entry of dust when not occupied by external patch cord.

CHAPTER 4
EMC REQUIREMENTS

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 perIEC 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

CHAPTER 5

Part-I: Element Management System Requirements

(EMS Requirements are common for GPON OLT and Mini-OLT)

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).

1. The management system shall comply with the latest ITU G.984.x series Recommendations on GPON.
2. The access network management system shall be able to execute and configure the following.
3. The management menu selections should include the following functionality:
   - Alarm monitoring
   - Customized functions (To be mentioned by the purchaser)
   - Remote view on ONT/ONU
   - PON management
   - IP management
   - Alarm management
   - Equipment management
   - Log management
   - Loop back Management in case of ONU
   - Operational state
   - Profile Management
   - Performance monitoring
   - User security

4. Configuration of overall equipment with modules (ONU/ONTs, Mini-OLT and all related equipment modules).
   - EMS shall be able to display Graphical network topology

- All alarms and messages of the entire network to be displayed by EMS and for the local node by the LCT also.
- EMS/LCT shall be able to display Color coded graphical fault display
- Each individual site shall have the facility to be managed by Local craft terminal in the remote sites.
- 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.

5. The EMS shall provide:
   - Security management (EMS security control, and management privilege control)
   - Configuration management (NE equipment provisioning, connection provisioning, and NE software download)
   - Database management (system data, software version, and database backup).

6. It should be possible to generate 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.

7. 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.
8. 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.
9. 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.

10. 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 colour like green for healthy, red for non-operational, yellow for degraded mode of operation etc.
11. 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.
12. 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.
13. The configuration of the various network elements like creating, 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.
14. Manufacturer shall provide soft copy of EMS on DVD as per management domain basis (or as per purchaser requirement)
15. The setup/procedure to download the software shall be clearly mentioned in the system manual of the equipment.

16. 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.

17. Messaging system

The EMS shall have a messaging system which will generate and send alert messages on e-mail as well as sms to the designated personnel depending upon the location of NE, on generation of alarms..

18. It is recommended that the response time for query/command on any operator terminal, local or remote shall be 10 seconds or better.
19. 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).
20. 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.
21. All critical components and units of the EMS i.e. – LAN interfaces, hard-disk, processor etc., shall be fault resilient.
22. Installation & commissioning of the EMS shall include supply & installation of cables, distribution frames, electrical switches etc.
23. 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 & server hardware specifications

2.1 Architecture

1. In case of loss of EMS connectivity, the LCT privilege shall remain for monitoring and for local configurations, as privileged by EMS administrator.
2. The centralized EMS may consist of standalone application server and database 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 bidde
3. 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.

2.2 Scalability aspects

1. The EMS should be able to support at least 500 OLTs/Mini-OLTs. The EMS application shall also be scalable to minimum no. 10000 ONT/ONUs. Any more requirements may be communicated by purchaser.
2. 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.

   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 Intel processor based, preferably PC i3 or above latest versions with minimum of 1TB HDD, and a minimum 21" LCD/TFT video display. Ethernet interface (10/100M) with industry standard operating system UNIX/Linux/Windows but having GUI.
3. The EMS shall provide SNMPv2 (or later versions), for southbound interfaces. The options for northbound interface shall be SOAP, XML, SNMP or CORBA.

2.3 EMS server specifications

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

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. The operating system shall be Windows 2000 or XP, Linux or Unix. The specifications are given in clause 2.7 of Appendix I.

2.4 Application server specifications

The EMS application server shall be multi-server based (with at least 1+1), 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 any suitable back-up device(with purchaser consent), multiple Ethernet LAN interfaces and the server shall operate in high availability cluster mode.

N.B. However, the purchaser may also choose for single server instead of Server in 1+ 1 redundancy as per network needs. Exact specifications may be issued by purchaser as per network/equipment requirements.

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. support RDBMS and 40/80 GB DLT drives shall be provided as back up devices

N.B.: However, the purchaser may choose single server as per network needs. Exact specifications may be issued by purchaser as per network/equipment requirements.

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. Any alternate specifications may be issued by purchaser.

1. 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.
2. 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.
3. Industry standard relational database (RDBMS) for storing all the data related to the network and the system shall be used.
4. 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.
5. The memory of the Database server shall be sufficient to store the data of 500 full loaded Mini- 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]**

- 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 10/100BaseT expandable to 12 ports.

- 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.
- 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-

- I7 processor or better
- 21” TFT/ LCD monitor
- 1TB HDD/ 8GB RAM
- Any suitable back-up device(with purchaser consent)
- Dual Ethernet LAN port
- Min 2 nos. USB ports
- Mouse port
- USB Keyboard port
- 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. No QM-333 environmental tests shall be conducted on the EMS server/LCT PC.

CHAPTER 5
PART II: FCAPS REQUIREMENTS FOR GPON SYSTEM

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.984.x series for GPON. 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 Recs. G.984x series. 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:

1. Network Element creation in the NE management domain.
2. Programming of a multiple interface units.
3. Assigning the equipment protection to a unit/interface.
4. Error detection thresholds.
5. Network Element configuration.
6. Software download (local & remote).
7. Protection switching.
8. Ethernet interface bandwidth.
9. The layer-2 control protocol between ONU/ONT and Mini-OLT shall be Ethernet over GEM. 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.984.x series. 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.984.x series. Each failure and clearance, thereof, shall be time-stamped. The atomic functions associated with the failure shall be as per ITU-T Rec. G.984.x series.

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:

- Path alarm notification to be generated and recorded, the alarm notification shall include:type, occurrence, severity, probable cause and clearing.
- Path alarm shall be graphically shown by the EMS/LCT.
- Alarm and status display.
- Fault localization.
- Storing and processing of current alarm information, up to module/unit level.

- 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.
- FCS errors for Ethernet clients.
- 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.984.x. 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:

i. Configuration of threshold concerning the error counters.
ii. FCS error check for Ethernet clients
iii. Frame/Packets dropped in case of Ethernet frames
iv. Configuration of threshold concerning the error counters
v. 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 –

vi. The collection of the performance counters shall be performed at pre-assigned rate as per ITU-T Rec. G.984.x.

vii. 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.

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. 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.

vii. 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.

viii. Back up for programs and data.

ix. The EMS shall be able to back up and restore the data base to and from external storage media.

x. **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-

1. Firewalls
2. Access control servers
3. Data encryption devices/use of PKI keys

4. Anti-virus packages.
5. In the data communication network (DCN) for management system, VLAN tags/MPLS labels may be used for security to information flows fromNEs 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 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, 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:

- Protocol details at all layers of TCP/IP stack.
- PHY I/F at each layer.
- Database structures.
- Number formats.
- Node addressing system.
- Complete application software details etc.
- 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.984.x.The system shall provide an SNMP version2c [or later interface] with standard MIBs Browzer. It shall be implemented on UDP/IP stack.Or else ITU-T specified Qx 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 either TL1, SNMP, TMF 814 CORBA [version 3.0] or XML. And the southbound interface towards Nes shall be SNMPv2c [or later interface] implemented on UDP/IP stack or XML/SOAP. 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 RS232/RS-485/RJ-45/USB 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 with in 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 ONUs 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. UNI access port link status
iv. Loop back test status in case of ONU
v. Loop-back time-out status in case of ONU

vi. Power supply status

vii. Vendor code

viii. Model number.

1.2.3 **ONT 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. UNI 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? Can also be defined as ONT sees off-hook signal from one phone.

- **Voice-signaling: ONT has registered with soft-switch**

c. LEDs to E1 services for B-ONT

d. Operation. Indicates PON fiber link is normal and OAM channel is operational

e. Signal that voice/data NW is received

f. Test. Indicates ONT is in loopback test status by one or a combination of LEDs

g. UNI connection. Indicates ONT UNI access port link is normal

h. Data. Indicates ONT UNI access port activity

i. Full duplex. Indicates ONTUNI access port at full-duplex mode

j. Speed. Indicates 10/100/1000M speed selection (as applicable)

The system shall support OMCI as per ITU-T Rec. G.984x GPON standard for all OAM features between ONT/ONU and Mini-OLT for interoperability.

1.3. **Mini-OLT requirements.**

1. The Mini-OLT shall provide one craft port for local configuration access.

2. The Mini-OLT shall provide in-band management connection to the EMS through GigE from the network.
3. The Mini-OLT shall provide out-band management connection to the EMS through 100BaseT Ethernet interface.
4. The Mini-OLT shall support alarm output and control

- Critical alarm output
- Major alarm output
- Minor alarm output

5. Line rate, security, and performance requirements
6. The PON system shall support 2.488Gbps line-rate downstream and 1.244Gbps line-rate upstream.
7. AES (key size of 128 bit) support per port-id with operator disable/enable capability
8. RS(248,216) FEC shall be supported with operator enable/disable capability in both upstream and downstream
9. Network diagnostic and healthy check:

CHAPTER 6
GPON SERVICE SUPPORT

1.1 Examples of services

The examples of services that GPON may support are shown in Table 2, along with relevant remarks.

Table2 – Examples of services and related remarks

Service category(Note 1)	Service	Remarks
Data service	Ethernet (Note 2)	Standardized in IEEE 802.3. Comply with IEEE 802.1D.
PSTN	POTS	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. Synchronize with the network's 8 kHz clock. Signal on the T reference point and V reference point must be continuous.
Private Line	E1 (Optional)	Bearer rate is 2.048 Mbit/s.
Video	Digital video	Deliver with same quality as class.1 specified in ITU-T I.356 or rt-VBR/CBR specified in ATM-Forum.
NOTE 1 – Service category is merely an index. It is not meaningful in itself, but it is useful in visualizing the services. NOTE 2 – Ethernet service is mainly to transmit the data such as IP, which includes VoIP, video streams coded by MPEG-2 or MPEG-4, and so on.		

1.2 Examples of UNI

In this Appendix, UNIis defined as the interface thatincludes the following conditions:

- described by a well-known standard
- includes a physical layer aspect.

Some UNIs are provided via an AF, so it is not mandatory that the ONU/ONT support those interfaces.

Examples of UNIs, physical interfaces and services that they provide are shown in Table 3

Table 3 – Examples of UNI and services

UNI (Note 1)	Physical interface (Note 2)	Service (Note 3)
10 BASE-T (IEEE802.3)	–	Ethernet
100BASE-TX (IEEE802.3)	–	Ethernet
1000BASE-T (IEEE802.3)	–	Ethernet
ITU-T Rec. G.703	PDH	E1
	-	POTS
ITU-T Rec. G993.2	-	VDSL2
Note-1: There are many other services accommodated in GPON, 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.		

1.3 Examples of SNI

In this appendix, SNIis defined as the interface thatincludes the following conditions:

- 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 4

Table 4 – Examples of SNI and services

SNI (Note 1)	Physical interface (Note 2)	Service (Note 3)
1000BASE- X (IEEE802.3)	–	Ethernet
10GE LAN (802.1ae)	-	Ethernet
NOTE 1 – There are many other services accommodated in GPON, 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.		

1.4 QoS details for GPON.

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.

HSI content differentiation based on 802.1p**& DSCP.** Each queue shall have individual CIR/PIR and shaping.**"**

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/ONT end

- Per-subscriber queuing and PIR/CIR policing/shaping for HSI.
- 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 Mini-OLT end

- VoIP and Video queued and prioritized as per VLAN QoS policy.
- HSI content differentiation based on 802.1p. Each queue shall have individual CIR/PIR and shaping.
- Optional overall subscriber rate limiting on VLAN (H-QoS).

Upstream QoS enablementAt 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 Mini-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. 802.1p marked.

Mini-OLT shall **optionally** provide DSCP marking and re-marking QoS per packet, per application based on-

1. Port of arrival
2. TCP/UDP source/destination port
3. Time of day
4. Based on service/application
5. Based on MAC (SA/DA) address
6. Based on S-VLAN tags
7. Based on Source/Destination IP address
8. Based on IGMP
9. Based on ICMP
10. Based on IP-TOS/DSCP bits etc.

CHAPTER 7

Industry Best Practice

(Informative: Optional to purchaser's requirements)

This annexure establishes the industry best practice optical budgets for the G-PON system operating at 2.488 Gbit/s downstream, 1.244 Gbit/s upstream.

1.0 Introduction

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

The notable variations from the loss budgets found elsewhere in ITU-T Rec. G.984.2 include:

-Overall loss budget supporting class B+ and Class C+ shall be on a PON port basis as required
by the purchaser.
-Different value of optical path penalties
-The Mini-OLT must support FEC in the downstream

These variations can provide increased capabilities for operation of G-PON systems. Therefore, the budgets contained in this annexure are recommended over and above all others in this Recommendation for the 2.4/1.2 Gbit/s rate PON.

2.0 System Applications

There are currently two major applications for the G-PON system. The first is a full-service system with a video overlay. The second digital-only system that is specified in this GR is shown in Figure 5

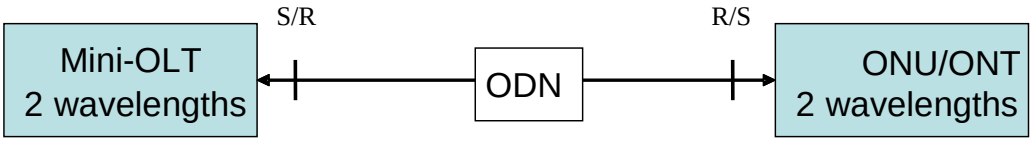


Figure 5– G-PON applications digital only.

3.0 Optical specifications

The optical specifications for the Mini-OLT and ONU optics are given in Table 5. This table refers to power levels measured at the interface points shown in Figure 5 Digital-only systems; specifically, any WDM filters external to the Mini-OLT or ONU equipment are considered part of the ODN. These specifications are meant to augment similar specifications found in Table 2 in the main body of the Recommendation. All other specifications found elsewhere in the table still apply.

The ONU sensitivity can be achieved either using an APD without FEC, or a PIN with FEC. The choice is a matter of ONU implementation. The APD solution is seen as an immediately available option, while the PIN with FEC solution is a longer-term option that depends on the introduction of higher performance receiver circuitry. The Mini-OLT must support FEC in the downstream by having the capability of calculating and transmitting the FEC parity bytes in the downstream signal. The Mini-OLT equipment must also have the ability to activate or deactivate the downstream FEC feature by operations system command. The ONU can optionally support FEC decoding in the downstream, and in any specific instance the ONU can use the FEC parity at its own discretion.

The optical penalty does not include any Raman impairment in the downstream wavelength. Any penalty due to this effect must be accounted for out of the link budget. However, in any system with

appreciable Raman effect will also have a significant length of fibre. Because of the loss differential between 1490 nm and 1310 nm, it is anticipated that the Raman impairment will be compensated by the lower fibre loss at 1490 nm.

Table 5 - Optical power levels for the 2.4 Gbit/s downstream, 1.2 Gbit/s upstream system

Items	Unit	Single fibre (Class B+)	Single fibre (Class C+)
MINI OLT:		**Mini-OLT**	**Mini-OLT**
Mean launched power MIN	dBm	+1.5	+3
Mean launched power MAX	dBm	+5	+7
Minimum sensitivity	dBm	-28	-32
Minimum overload	dBm	-8	-12
Downstream optical penalty	dB	0.5	1.0
ONU/ONT:		**ONU/ONT**	**ONU/ONT**
Mean launched power MIN	dBm	+0.5	+0.5
Mean launched power MAX	dBm	+5	+5
Minimum sensitivity	dBm	-27	-30
Minimum overload	dBm	-8	-8
Upstream optical penalty	dB	0.5	0.5

4.0 Link Budget

The link budget is given in Table 6. This budget covers all optical components between the Mini-OLT and ONU, including non-integrated WDM filters for the multiplex of video overlays and other enhancement band services, and must include any Raman impairment from the overlay signal.

Table 6 - Loss Budgets for the G-PON system

Items	Unit	Single fibre (class B+)	Single fibre (class c+)
Minimum optical loss at 1490 nm	dB	13	17
Minimum optical loss at 1310 nm	dB	13	17
Maximum optical loss at 1490 nm	dB	28	32
Maximum optical loss at 1310 nm	dB	28	32

CHAPTER 8

Purchaser Guidelines

Part I: Technical Requirements

2.1.3 & Selection of splitters from m: N where m = 1 or 2 and N = 2, 4, 8, 16, 32,64,128 or up to 256.

2.2 Requirements of external SIP/H.248 ↔ Media gateway for interfacing PSTN switches to be indicated.

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 (FTTCab).

2.3.2 Requirements of IPTV and RF-broadcast modes for residential deployment to be indicated.

3.1 Selection of protection as fully protected, partially protected, or unprotected.

3.2 **Note: -** 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.

3.2.1 Indicate -

i. Provisioning of dying gasp
ii. Provisioning of USB
iii. - Provisioning of inbuilt IEEE 802.11b/g/n/ac WiFi interface

3.2.2 - Specify exact number of POTS.

i. Provisioning of dying gasp
ii. Provisioning of G.Fast

3.2.3 Indicate -

i. Provisioning of dying gasp

ii. Provisioning of G.fast

iii. - Provisioning of inbuilt IEEE 802.11b/g/n/ac WiFi interface

3.2.4 Indicate –

i. Provisioning of dying gasp

ii. Provisioning of USB

iii. - Provisioning of inbuilt IEEE 802.11b/g/n/ac WiFi interface

3.2.5 Indicate –

i. Provisioning of dying gasp

ii. Provisioning of USB

3.4 Indicate the number of Port-Id/Alloc.-Id per ONT/ONU to be supported by GPON link.

4.1.2 Indicate the requirements of GbE interfaces.

Note: - 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.

5.0 Indicate the requirements of protection scheme.

10.0 Specify racks

Part II: General Requirements

2.5 Indicate the use of fans.

5.8 Supply of spares by the vendor.

ABBREVIATIONS

ACL	Access Control List
AES	Advanced Encryption Standard
ADSL2+	Asymmetric Digital Subscribers Line 2+
AIS	Alarm Indication Signal
APC	Angle Polished Connector
BITE	Built-In Test Equipment
BSNL	Bharat Sanchar Nigam Limited
CATV	Cable Television
CD	Compact Disc
CISPR	Special International Committee on Radio Interference
CO	Central Office
CORBA	Common Object Request Broker Architecture
CPU	Computer Processing Unit
DBA	Dynamic Bandwidth Allocation
DBRu	Dynamic Bandwidth Report - upstream
DHCP	Dynamic Host Control Protocol
DOS	Denial of Service
DSCP	Differential services code point
DSLAM	Digital Subs Line Access Multiplexer
EEPROM	Electrically Erasable Programmable Read-Only Memory
EMC	Electro Magnetic Compatibility
EMS	Element Management System
FEC	Forward Error Correction
FTTB	Fibre To The Building
FTTC	Fibre To The Curb
FTTCab	Fibre To The Cabinet
FTTCell	Fiber To The Cell
FTTH	Fibre To The Home
FWS	Firewall Server

GEM	GPON Encapsulation Method
GPON	Gigabit capable Passive Optical Network
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 Organization
LCT	Local Craft Terminal
LED	Light Emitting Diode
LMI	Local Management Interface
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
NE	Network Element
NMS	Network Management System
NNI	Network Node Interface
OAN	Optical Access Network
ODN	Optical Distribution Network
OLT	Optical Line Terminal
Mini-OLT	Scale down version of OLT
OMCI	ONT Management and Control Interface
ONU	Optical Network Unit
ONT	Optical Network Termination

OSI	Open System Interconnection
P2P	Point to Point
PBX	Private Branch Exchange
PC	Personal Computer
PCM	Pulse Code Modulation
PMD	Physical Media Dependent
PON	Passive Optical Network
POP	Point of presence
POTS	Plain Old Telephone System
PRC	Primary Reference Clock
PVC	Permanent Virtual Circuit
QA	Quality Assurance
QM	Quality Manual
QoS	Quality of Service
RDBMS	Relational Database Management System
RISC	Reduced Instruction Set Computer
RO	Remote Office
ROM	Read Only Memory
RSTP	Rapid Spanning Tree Protocol
SDH	Synchronous Digital Hierarchy
SFP	Small Form Factor Pluggable Transceiver
SIP	Session Initiation Protocol
SNI	Service Node Interface
SNMP	Simple Network Management Protocol
SOAP	Simple Object Access Protocol
STB	Set Top Box
TC	Transmission Convergence
T-CONT	Traffic Containers
TCP	Transmission Control Protocol
TDM	Time Division Multiplexing

TDMoP	Time Division Multiplexing over Packet
TMN	Telecommunication Management Network
UNI	User Network Interface
USB	Universal serial Bus
VDSL	Very High-speed Digital Subscriber Line
VEIP	Virtual Ethernet Interface Protocol
VLAN	Virtual LAN
VoD	Video on Demand
VoIP	Voice over Internet Protocol
WiFi	Wireless Fidelity
XML	Extensible Markup Language