

# ALTICE LABS MANUAL

## XGS-PON FGW User Manual

XSR150DX

Document Version V2.3.0 | March 2022



Copyright © AlticeLabs, S.A.

All rights reserved. This document contains proprietary information belonging to Altice Labs which is legally protected by copyright and industrial property rights and, as such, may not be copied, photocopied, reproduced, translated or converted into electronic format, either partially or in its entirety, without prior written permission from Altice Labs. Nothing in this document shall be construed or interpreted as the granting of a license to make use of any software, information or products referred to in the document.

This document is for information purposes only and does not constitute a legally binding offer. The communication of the information contained in this document shall not oblige Altice Labs to supply the products and services identified and described herein. Altice Labs reserves the right to effect changes to this document, at any time and without prior notice, and may not be held responsible for any inaccuracy in, or obsolescence of, the information, or for any losses or damage that may be incurred as a result of the use of the information.

Altice Labs  
Rua Eng. José Ferreira Pinto Basto  
3810-106 Aveiro – Portugal  
<http://www.alticelabs.com>  
Tel: +351 234 403 200  
Fax: +351 234 424 723

# Contents

|  |    |
|--|----|
| List of figures.....                           | 6  |
| List of tables.....                            | 7  |
| Glossary.....                                  | 8  |
| 1 Summary.....                                 | 15 |
| 2 Technical Description.....                   | 16 |
| 2.1 Main Functionalities.....                  | 16 |
| 2.2 Application Scenario.....                  | 16 |
| 2.3 Interoperability.....                      | 17 |
| 2.4 Interfaces.....                            | 19 |
| 2.5 General Features.....                      | 19 |
| 2.6 General Architecture.....                  | 21 |
| 2.7 PON.....                                   | 22 |
| 2.8 Ethernet.....                              | 22 |
| 2.9 Voice.....                                 | 23 |
| 2.9.1 VoIP specifications:.....                | 23 |
| 2.9.2 Voice interfaces.....                    | 23 |
| 2.10 Wi-Fi.....                                | 24 |
| 2.10.1 Compliance.....                         | 24 |
| 2.10.2 Features.....                           | 24 |
| 2.10.3 Interfaces.....                         | 24 |
| 2.10.4 Antennas.....                           | 25 |
| 2.11 Wi-Fi Easy Mesh.....                      | 25 |
| 2.12 Multiple QoS per VLAN.....                | 25 |
| 2.13 Policing/Rate Limiting.....               | 26 |
| 2.13.1 Downstream QoS.....                     | 26 |
| 2.13.2 Upstream QoS.....                       | 27 |
| 2.13.3 Dynamic Bandwidth Allocation (DBA)..... | 27 |
| 2.13.4 Upstream QoS scenarios.....             | 28 |
| 3 General Specifications.....                  | 31 |
| 3.1 Optical Interfaces.....                    | 31 |
| 3.1.1 10GE BASE-X interfaces.....              | 31 |
| 3.1.2 XGS-PON optical interfaces.....          | 31 |
| 3.2 Ethernet Interfaces.....                   | 33 |
| 3.2.1 10/100/1000BASE-T.....                   | 33 |

|        |   |    |
|--------|---|----|
| 3.2.2  | 10GE interfaces .....   | 33 |
| 3.3    | FXS Interfaces .....  | 33 |
| 3.4    | Wi-Fi interfaces .....  | 34 |
| 3.5    | General Features .....  | 34 |
| 3.6    | General Service Description .....   | 35 |
| 3.7    | Optical metering.....   | 37 |
| 3.8    | Wavelength filtering.....   | 37 |
| 3.9    | XGS-PON characteristics support .....   | 37 |
| 3.10   | Standards .....   | 37 |
| 4      | Setup .....   | 39 |
| 4.1    | Equipment Connectivity .....  | 39 |
| 4.2    | Equipment buttons .....   | 40 |
| 4.3    | Fiber Gateway Status LEDs.....  | 41 |
| 4.4    | Typical Fiber Gateway usage scenario.....   | 43 |
| 4.5    | Figure 16 bellow shows a Fiber Gateway Typical usage scenario showing Home Network connections for triple play service provisioning. Fiber Gateway connectors' description can be found in section 4.1 Equipment Connectivity ..... | 43 |
| 4.6    | Equipment buttons .....   | 44 |
| 4.7    | Before installing the Fiber Gateway equipment .....   | 45 |
| 4.7.1  | Safety Warnings.....  | 45 |
| 4.7.2  | Enviromental conditions.....  | 45 |
| 4.7.3  | Powering .....  | 45 |
| 4.7.4  | Wireless network installation best practices .....  | 45 |
| 4.8    | Connections .....   | 46 |
| 4.9    | Fiber Gateway ports are located at the back side of the equipment. For information on the available ports and its description please refer to section 4.1-Equipment Connectivity.....   | 46 |
| 4.10   | Equipment buttons .....   | 47 |
| 4.11   | Fiber Gateway Setup.....  | 48 |
| 4.11.1 | Network Provider Connection .....   | 48 |
| 4.11.2 | Mains connection and power up .....   | 49 |
| 5      | Configuration .....   | 50 |
| 5.1    | Fiber Gateway Activation .....  | 50 |
| 5.2    | Costumization .....   | 50 |
| 5.2.1  | Software download from the OLT .....  | 50 |
| 6      | Troubleshooting.....  | 52 |

## List of figures

|  |    |
|--|----|
| Figure 1: FTTx architecture – In home Networking.....  | 16 |
| Figure 2: Link Layer Configuration and Management .....  | 17 |
| Figure 3: FGW (ONU/ONT) equipment configuration .....  | 17 |
| Figure 4: IP Based services-TR069 configuration.....   | 18 |
| Figure 5: Optical fiber multi-service user access .....  | 20 |
| Figure 6: Stack of protocols for PON architecture.....   | 20 |
| Figure 7: TR-142 Framework .....   | 21 |
| Figure 8: Fiber Gateway system architecture.....   | 22 |
| Figure 9: XGS-PON Fiber Gateway as the Smart Mesh Wi-Fi network controller.....                        | 25 |
| Figure 10: Downstream QoS diagram .....  | 26 |
| Figure 11: Upstream QoS diagram .....  | 27 |
| Figure 12: Traffic distribution by service/client .....  | 28 |
| Figure 13: Fiber Gateway Status LEDs.....  | 41 |
| Figure 14: Fiber Gateway Typical usage scenario - Home network connections (XSR151DX<br>example) ..... | 44 |
| Figure 15: Network provider connection.....  | 49 |

## List of tables

|   |    |
|---|----|
| Table 1: Equipment interfaces.....  | 19 |
| Table 2: T-CONT types definition.....   | 28 |
| Table 3: Alloc-ID's distribution by T-CONT type.....                                | 28 |
| Table 3-1 - Optical 10Gbase interfaces characteristics .....                        | 31 |
| Table 2: XGS-PON Interfaces Specification: XGS –PON Fiber Gateway transceivers..... | 31 |
| Table 3: FXS interface specifications .....   | 33 |
| Table 4: Wi-Fi specification .....  | 34 |
| Table 5: General Features.....  | 34 |
| Table 6: General Service Description.....   | 35 |
| Table 7: Standards compliance.....  | 37 |
| Table 8: Fiber Gateway connections description .....                                | 39 |
| Table 9: Status LEDs information.....   | 41 |
| Table 10: Connection cables.....  | 45 |
| Table 11: Material required for instalation .....                                   | 48 |
| Table 12: Troubleshooting Procedures .....  | 52 |

# Glossary

## Acronyms and abbreviations

|                  |  |
|------------------|--|
| <b>3G</b>        | Third generation mobile telecommunications                                   |
| <b>AAA</b>       | Authentication, Authorization, and Accounting                                |
| <b>AC</b>        | Alternating Current  |
| <b>AC</b>        | Access Concentrator  |
| <b>ACL</b>       | Access Control List  |
| <b>ACS</b>       | Auto Configuration Server  |
| <b>AES</b>       | Advanced Encryption Standard   |
| <b>ARP</b>       | Address Resolution Protocol  |
| <b>AS</b>        | Autonomous System  |
| <b>AUTO-MDIX</b> | Medium Dependent Interface Crossover Automatic Choice                        |
| <b>BBF</b>       | Broadband Forum  |
| <b>BGP</b>       | Border Gateway Protocol  |
| <b>CAT5E</b>     | Category 5 Cable   |
| <b>CATV</b>      | Cable TV   |
| <b>CIFS</b>      | Common Internet File System  |
| <b>CLI</b>       | Command-line interface   |
| <b>CO</b>        | Central Office   |
| <b>CPE</b>       | Customer-Premises Equipment  |
| <b>CRC</b>       | Cyclic Redundancy Check  |
| <b>DC</b>        | Direct Current   |
| <b>DDNS</b>      | Dynamic DNS  |
| <b>DHCP</b>      | Dynamic Host Configuration Protocol  |
| <b>DNS</b>       | Domain Name System   |
| <b>DSCP</b>      | Differentiated Services Code Point   |
| <b>DSL</b>       | Digital Subscriber Line  |
| <b>EAP-SIM</b>   | Extensible Authentication Protocol Method for GSM Subscriber Identity Module |
| <b>FTP</b>       | File Transfer Protocol   |
| <b>FTTH</b>      | Fiber-To-The-Home  |
| <b>FXS</b>       | Foreign eXchange Station   |
| <b>GbE</b>       | Gigabit Ethernet   |
| <b>GEM</b>       | GPON Encapsulation Module  |
| <b>GEPON</b>     | Gigabit Ethernet Passive Optical Network                                     |
| <b>GPON</b>      | Gigabit-capable Passive Optical Network                                      |
| <b>GSM</b>       | Global System for Mobile Communications                                      |
| <b>GW</b>        | Gateway  |
| <b>HG</b>        | Home Gateway   |
| <b>HSI</b>       | High Speed Internet  |
| <b>ID</b>        | Identification   |



|                |  |
|----------------|--|
| <b>IEEE</b>    | Institute of Electrical and Electronics Engineers        |
| <b>IGMP</b>    | Internet Group Management Protocol                       |
| <b>IMS</b>     | IP Multimedia Subsystem                                  |
| <b>IP</b>      | Internet Protocol  |
| <b>IPTV</b>    | Internet Protocol Television                             |
| <b>IPv4</b>    | Internet Protocol version 4                              |
| <b>IPv6</b>    | Internet Protocol version 6                              |
| <b>ISP</b>     | Internet Service Provider                                |
| <b>ITU-T</b>   | Telecommunications International Telecommunication Union |
| <b>L2</b>      | OSI Layer 2  |
| <b>L3</b>      | OSI Layer 3  |
| <b>LAN</b>     | Local Area Network                                       |
| <b>LED</b>     | Light Emitting Diode                                     |
| <b>MAC</b>     | Media Access Control                                     |
| <b>MAN</b>     | Metropolitan Area Network                                |
| <b>MAP</b>     | Mobile Application Part                                  |
| <b>ME</b>      | Managed Entity   |
| <b>MEGACO</b>  | Media Gateway Control Protocol                           |
| <b>MRU</b>     | Maximum Receive Unit                                     |
| <b>MTBF</b>    | Mean Time Between Failures                               |
| <b>NAS</b>     | Network Access Server                                    |
| <b>NAT</b>     | Network Address Translation                              |
| <b>NGN</b>     | Next Generation Network                                  |
| <b>NG-PON2</b> | 40-Gigabit-capable passive optical networks              |
| <b>NMS</b>     | Network Management System                                |
| <b>OLT</b>     | Optical Line Terminal                                    |
| <b>OMCI</b>    | ONT Management Control Interface                         |
| <b>ONT</b>     | Optical Network Terminal                                 |
| <b>ONU</b>     | Optical Network Unit                                     |
| <b>OOB</b>     | Out-Of-Band  |
| <b>OOB-PSD</b> | Out-Of-Band Power Spectral Density                       |
| <b>OOC</b>     | Out-Of-Channel   |
| <b>OOC-PSD</b> | Out-Of-Channel Power Spectral Density                    |
| <b>OPEX</b>    | Operational Expenditure                                  |
| <b>OPP</b>     | Optical Path Penalty                                     |
| <b>ORL</b>     | Optical Return Loss                                      |
| <b>OSI</b>     | Open Systems Interconnection                             |
| <b>PC</b>      | Personal Computer  |
| <b>PMD</b>     | Physical Media Dependent                                 |
| <b>PON</b>     | Passive Optical Network                                  |
| <b>PPP</b>     | Point-to-Point Protocol                                  |
| <b>PPPoE</b>   | Point-to-Point Protocol over Ethernet                    |
| <b>PSD</b>     | Power Spectral Density                                   |
| <b>PSK</b>     | Phase-Shift Keying                                       |
| <b>PWLAN</b>   | Public Wireless LAN                                      |

|               |  |
|---------------|--|
| <b>QoS</b>    | Quality of Service                         |
| <b>RADIUS</b> | Remote Authentication Dial In User Service |
| <b>RF</b>     | Radio Frequency                            |
| <b>RGW</b>    | Residential Gateway                        |
| <b>RIP</b>    | Routing Information Protocol               |
| <b>RJ11</b>   | Registered Jack model 11                   |
| <b>RJ45</b>   | Registered Jack model 45                   |
| <b>SAMBA</b>  | SMB/CIFS implementation                    |
| <b>SC/APC</b> | SC/APC optical connector                   |
| <b>SIM</b>    | Subscriber Identity Module                 |
| <b>SIP</b>    | Session Initiation Protocol                |
| <b>SIP</b>    | Session Initiation Protocol                |
| <b>SMB</b>    | Server Message Block                       |
| <b>SMSR</b>   | Side Mode Suppression Ratio                |
| <b>SNTP</b>   | Simple Network Time Protocol               |
| <b>SS7</b>    | Signalling System No. 7                    |
| <b>SSID</b>   | Service Set IDentifier                     |
| <b>STB</b>    | Set Top Box                                |
| <b>SW</b>     | Software                                   |
| <b>T-CONT</b> | Transmission Container                     |
| <b>TCP</b>    | Transmission Control Protocol              |
| <b>TDM</b>    | Time Division Multiplexing                 |
| <b>TDMA</b>   | Time Division Multiple Access              |
| <b>TKIP</b>   | Temporal Key Integrity Protocol            |
| <b>TR-069</b> | Technical Report 069                       |
| <b>TTL</b>    | Time to Live                               |
| <b>TV</b>     | Television                                 |
| <b>TWDM</b>   | Time and Wavelength Division Multiplexing  |
| <b>UDP</b>    | User Datagram Protocol                     |
| <b>URL</b>    | Uniform Resource Locator                   |
| <b>USB</b>    | Universal Serial Bus                       |
| <b>UTP</b>    | Unshielded Twisted Pair                    |
| <b>VAD</b>    | Voice Activity Detection                   |
| <b>VAP</b>    | Virtual Access Point                       |
| <b>VID</b>    | VLAN Identifier                            |
| <b>VLAN</b>   | Virtual Local Area Networks                |
| <b>VoIP</b>   | Voice over Internet Protocol               |
| <b>VPN</b>    | Virtual Private Network                    |
| <b>WAN</b>    | Wide Area Network                          |
| <b>WDM</b>    | Wavelength Division Multiplexing           |
| <b>WEP</b>    | Wired Equivalent Privacy                   |
| <b>Wi-Fi</b>  | Wireless Fidelity                          |
| <b>WLAN</b>   | Wireless Local Area Network                |
| <b>WM</b>     | Wavelength Multiplexer                     |
| <b>WNE</b>    | When Not Enabled                           |

|                |  |
|----------------|--|
| <b>WNE-PSD</b> | optical Power Spectral Density When Not Enabled      |
| <b>WPA</b>     | Wi-Fi Protected Access                               |
| <b>WPS</b>     | Wi-Fi Protected Setup                                |
| <b>xBASE-T</b> | Ethernet over twisted pair technologies              |
| <b>XGEM</b>    | 10-Gigabit-capable PON Encapsulation Method          |
| <b>XGS-PON</b> | 10-Gigabit-capable symmetric passive optical network |



## This User Manual is applicable to the equipment Fiber Gateway Altice XSR150DX with the FCC ID: 2ACJF-FGW-XSR150DX

### FCC NOTICE

This device complies with FCC part 15 rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference and
2. This device must accept any interference, including interference that may cause undesired operation of the device

**Caution:**

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

**Note:** This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to

Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

Reorient or relocate the receiving antenna.

Increase the separation between the equipment and receiver.

Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

Consult the dealer or an experienced radio/TV technician for help.

This device meets the FCC requirements for RF exposure in public or uncontrolled environments.

### RF Exposure Statement

**Note:** This transmitter must not be co-located or operated in conjunction with any other antenna or transmitter.

This equipment should be installed and operated with a minimum distance of 8.3 inches (21 cm) between the radiator and your body.

This system has been evaluated for RF exposure for humans in reference to ANSI C 95.1 (American National Standards Institute) limits.

The evaluation was based in accordance with FCC OET Bulletin 65C rev 01.01 in compliance with Part 2.1091 and Part 15.27.

The minimum separation distance from the antenna to general bystander is 8.3 inches (21 cm) to maintain compliance.

### Compliance with FCC requirement 15.407(c)

Data transmission is always initiated by software, which is then passed down through the MAC, through the digital and analog baseband, and finally to the RF chip. Several special packets are initiated by the MAC. These are the only ways the digital baseband portion will turn on the RF transmitter, which it then turns off at the end of the packet. Therefore, the transmitter will be ON only while one of the aforementioned packets is being transmitted. This device automatically discontinues transmission in case of either absence of information to transmit or operational failure.



# 1 Summary

Targeted to the PON FTTH deployment scenario, compact Multiplay XGS-PON Fiber Gateway feature High Speed Internet, VoIP and TV (IPTV or IPTV and RF depending on the specific model) services, being the right choice for Operators and Service Providers who are willing to deliver multiple and advanced services to residential clients.

XGS-PON Fiber Gateway equipment's architecture is based on the Rec.ITU G.9807.1. and supports full in-house multi-play services enabling Data, Voice and Video services through Ethernet, Wi-Fi, FXS and USB standard interfaces. Four built-in RJ45 10/100/1000 BASE-T ports allow for the connection of devices via cable. Ultrafast device is possible via Wi-Fi access or via a LAN GbE/10GbE SFP/SFP+ port, for Internet application such as video, email, web surfing, files upload/download and online gaming. Furthermore, an RJ11FXS port permits the connection of fax or voice devices featuring the SIP protocol. An useful set of LEDs, built-in in the equipment's case, provide fast and pertinent information either to the user or the installer. This ultimate and low consumption apparatus simplifies the technicians' life during the installation process while in the clients' premises via built-in routing features that avoids the need for an external third party gateway.

XGS-PON Fiber Gateway include a high performance 4x4:4 Wi-Fi 6, dual band concurrent spanning 802.11 a/b/g/n/ax standards, operating simultaneously on the 2.4 and 5 GHz UNII-1 and UNII-3 frequency bands, allowing for an air interface throughput and range increase by mitigating the multi-user interference and the utilization of frequency bands allocated to weather radars, using dynamic frequency selection.

XGS-PON Fiber Gateway are EasyMesh™ Wi-Fi compliant, acting as a WLAN controller to the Altice Labs Smart Mesh extenders, allow full Wi-Fi coverage of all areas of the home enabling changing network conditions to deliver a consistent, high quality user experience.

Altice Labs XGS-PON Fiber Gateway equipment is straightforward and remotely managed/configured, allowing for the optimization of Operators OPEX and the scale up deployment by starring auto provisioning mechanisms (e.g. TR-069, OMCI and DHCP).

## 2 Technical Description

### 2.1 Main Functionalities

XGS-PON Fiber Gateway equipment is aimed for customer premises and complies with the ITU-T G.9807.1(XGS-PON) recommendation in order to transport (over FTTH PON architectures) and deliver (to premises domain) the full broadband service pack.

Broadband service applications are commonly referred as below:

- High speed internet (HSI);
- Voice (VoIP) services (SIP/MEGACO H.248);
- TV (IPTV or IPTV and RF TV, specific model dependent);
- Wi-Fi 6
- EasyMesh™ (Wi-Fi Alliance® multiple AP specification)

The multiplay environment is thus reinforced when combining the upper referred services

### 2.2 Application Scenario

Next figure shows a possible In-home networking scenario for XGS-PON Fiber Gateway equipments when in an FTTH-PON architecture.

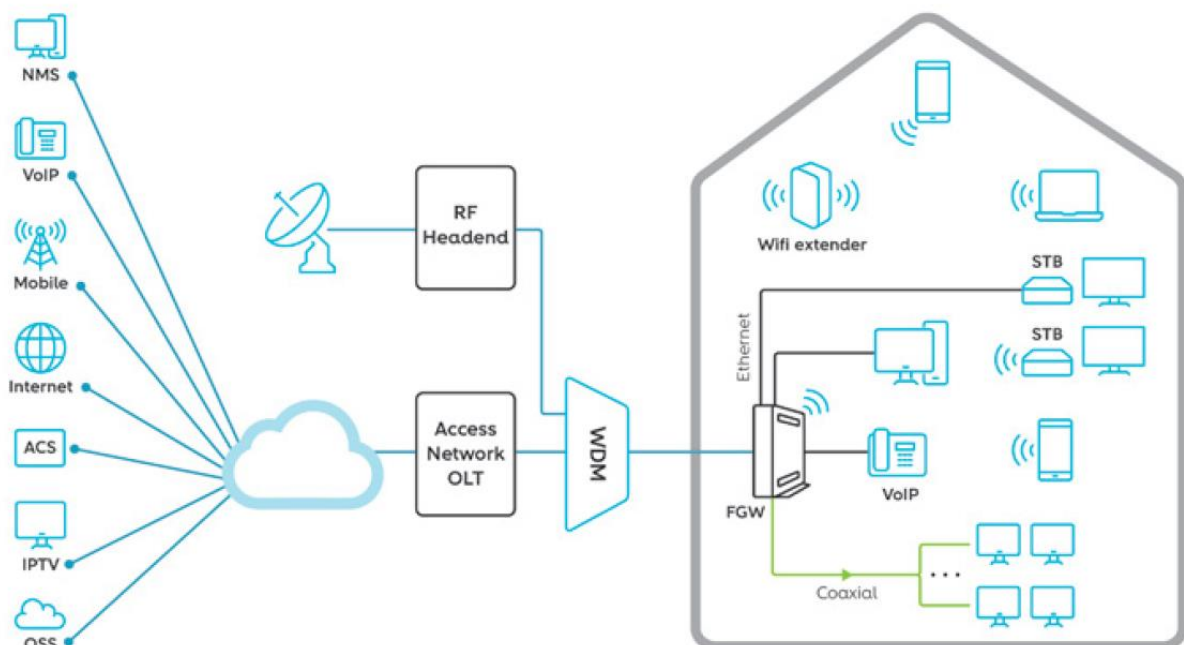


Figure 1: FTTH architecture – In home Networking



## 2.3 Interoperability

XGS-PON Fiber Gateway equipment complies with ITU-T G.9807.1 recommendation and G.988 (OMCI) ensuring multi-vendor OLT interoperability with major OLT vendors, as defined in BBF.247 ONU certification program.

BBF.247 ONU certification program certifies OLT link layer configuration and management protocol, OMCI, Figure 2, as defined by ITU-T G.988.

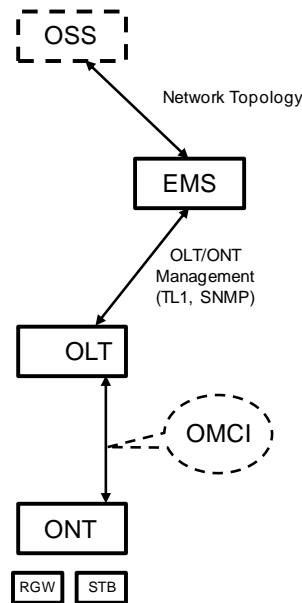


Figure 2: Link Layer Configuration and Management

IP-based services configuration and management is achieved by means of the TR-069 protocol as defined by Broadband Forum. This procedure takes for granted that previously the link layer connectivity has been achieved.

TR-069 is then transparent to the OLT, since the TR-069 connections are established between the ACS and the ONTs, Figure 4.

Fiber Gateway equipments integrate gateway functionalities. Link layer configuration and management is achieved by the use of OMCI, while IP-based services (RG functionality and Voice over IP) are configured and managed by TR-069, Figure 3.

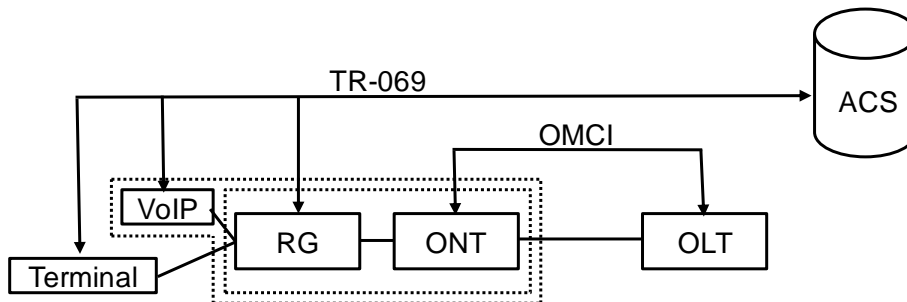


Figure 3: FGW (ONU/ONT) equipment configuration

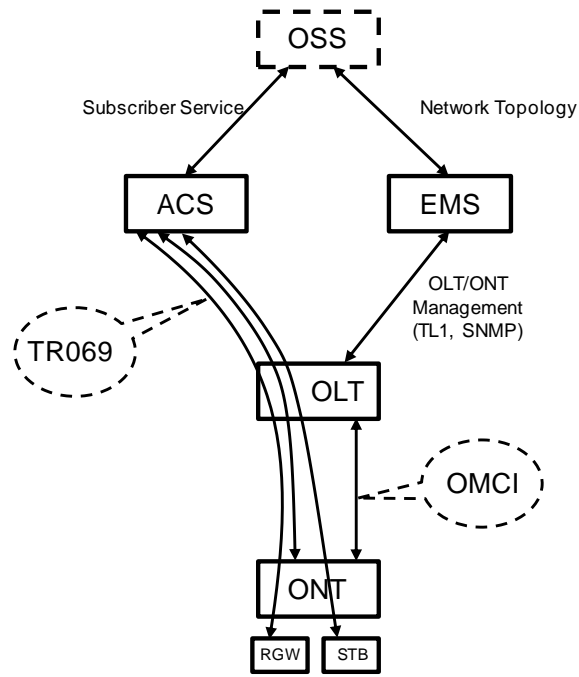


Figure 4: IP Based services-TR069 configuration

## 2.4 Interfaces

Equipment Network interface type as well as number and type of equipment Client interfaces are model dependent, Table 1.

**Table 1: Equipment interfaces**

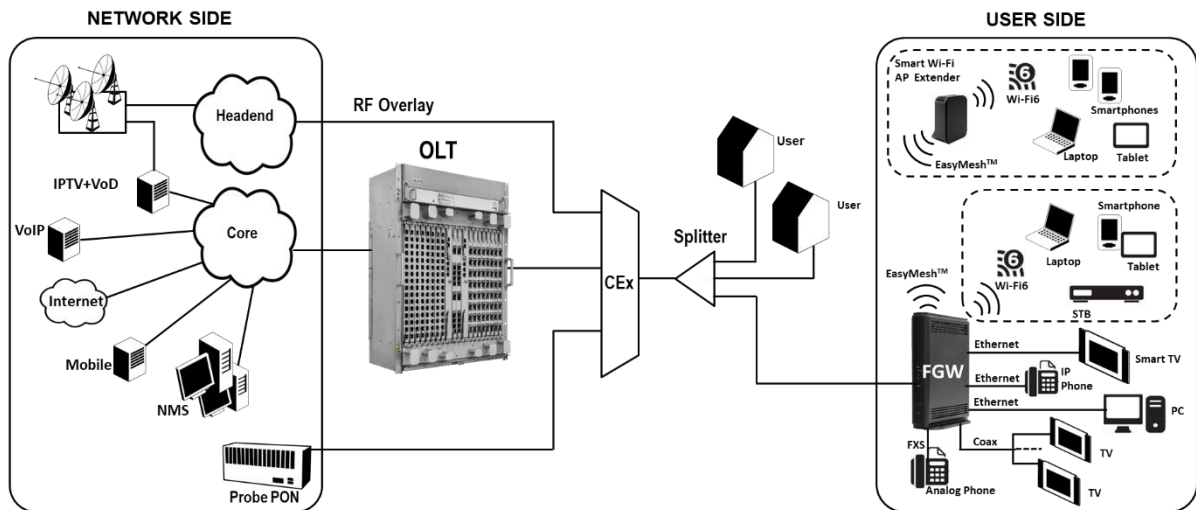
| Interfaces |                          |                      | Models        |
|------------|--------------------------|----------------------|---------------|
|            |                          |                      | XSR150DX      |
| PON        | Type                     |                      | XGS-PON       |
|            | Class                    |                      | N1,N2,E1,DD20 |
|            | Tx/Rx Type               |                      | Fixed         |
|            | Wavelength (nm)          | DS                   | 1575 - 1580   |
|            |                          | UP                   | 1260 - 1280   |
|            | Bitrate (Gbps)           | DS                   | 9.95328       |
| UP         |                          | 9.95328              |               |
| FXS ports  |                          |                      | 1x            |
| LAN ports  | GbE (10/100/1000 BASE-T) |                      | 4x            |
|            | 1/10GE                   | BASE-X/-T (SFP/SFP+) | 1x-           |
| USB        | 3.1 GEN1                 |                      | 1x            |

## 2.5 General Features

FTTH PON is a point-to-multipoint passive optical network, in which unpowered optical splitters are used to enable a single optical fiber to serve multiple premises, up to 1:128 (typically 1:64).

A PON consists of an optical line terminal (OLT) at the central office and a number of optical network units/terminals (ONU/ONT) at the customer premises. Downstream signals are broadcasted to all premises sharing multiple fibers. Encryption can prevent eavesdropping. Upstream signals are combined using a multiple access protocol (Time Division Multiple Access - TDMA). The OLT queues data to the various ONU/ONT in order to provide time slot assignments for upstream communication.

In Figure 5 it is shown a scenario for a multi-service user domain basic architecture through an ISP network.



**Figure 5: Optical fiber multi-service user access**

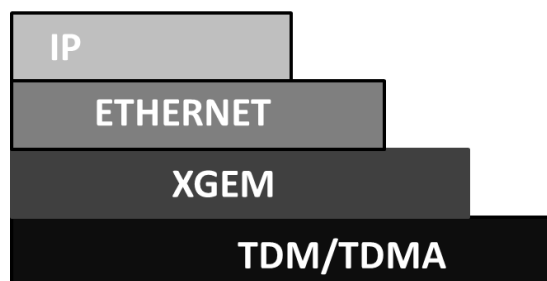
In the upstream direction, the XGS-PON Fiber Gateway equipment is connected to the optical splitter and respectively to the an OLT XGS-PON port through the CEx element to provide integrated access services through the service headend.

In the downstream direction, the XGS-PON Fiber Gateway equipment is connected to various terminals through the following LAN-side ports to implement multi-play services:

- Four 10/100/1000M Base-T Ethernet ports, which can be connected to terminals such as PCs, STBs, and video phones to provide the high-speed data and video services;
- One 1/10GE BASE-X/T
- One/two FXS port, which can be connected to telephone sets to provide VoIP services;
- Four Wi-Fi antennas, which can connect to Wi-Fi terminals wirelessly to provide a secure and reliable high-speed wireless network;
- One USB port, which can be connected to a USB storage device to provide convenient storage and file sharing services within a home network;

The communication between client Fiber Gateway equipment (ONU/ONT) and the ISP access routers (MAN edge) is made by an optical fiber-based passive architecture (ITU-T G.9807.1). The PON network acts as a Layer 2 Ethernet metropolitan network. Access network assures and controls the media (MAC) communication through a TDMA scheme, introducing XGEM (XGS-PON Encapsulation Method) in between to adapt TDM layer to Ethernet.

The used protocol stack is shown in Figure 6.



**Figure 6: Stack of protocols for PON architecture**

Several transmission containers (T-CONT) are assigned to each user. Each T-CONT has an associated XGEM port and each XGEM port has a VLAN identifier and an 802.1p priority level.

The XG\_PON Fiber Gateway classifies the traffic depending on the VLAN and the marked priority, and routes it over the corresponding T-CONT/XGEM port. Thus for frame multiplexing, XGEM and T-CONT ports are used for uplink while the downlink only use the XGEM ports feature.

XGS-PON Fiber Gateway equipment complies with Broadband Forum TR-142 Technical Report, which defines a framework for the remote configuration and management of IP-based services over PON (Passive Optical Network) and fiber access technology.

TR-142 framework uses TR-069 which is the protocol of choice for the remote management and configuration of IP services over PON and fiber access networks. TR-069 is intended to be used for the remote configuration and management of IP services running over XGS-PON Fiber Gateway (ONU/ONT) , as well as for some aspects of its management.

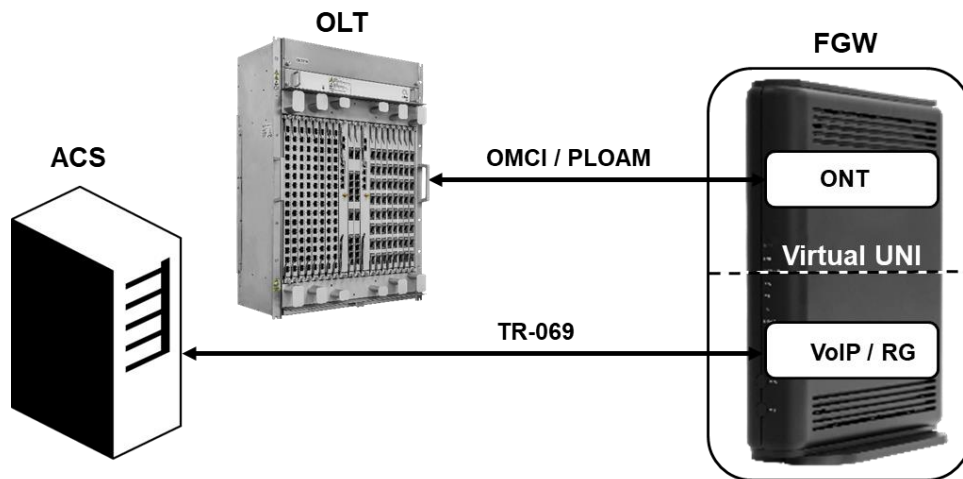


Figure 7: TR-142 Framework

TR-142 framework defines a virtual UNI between the OMCI (ONT Management Control Interface) and TR-069 management domains.

This framework allows PON CPE with L3 layer capabilities to be mass remotely configured, troubleshoot and managed by an ACS (Auto Configuration Server) using TR-069 CPE WAN Management Protocol.

## 2.6 General Architecture

Fiber Gateway basic system architecture is hereafter presented.

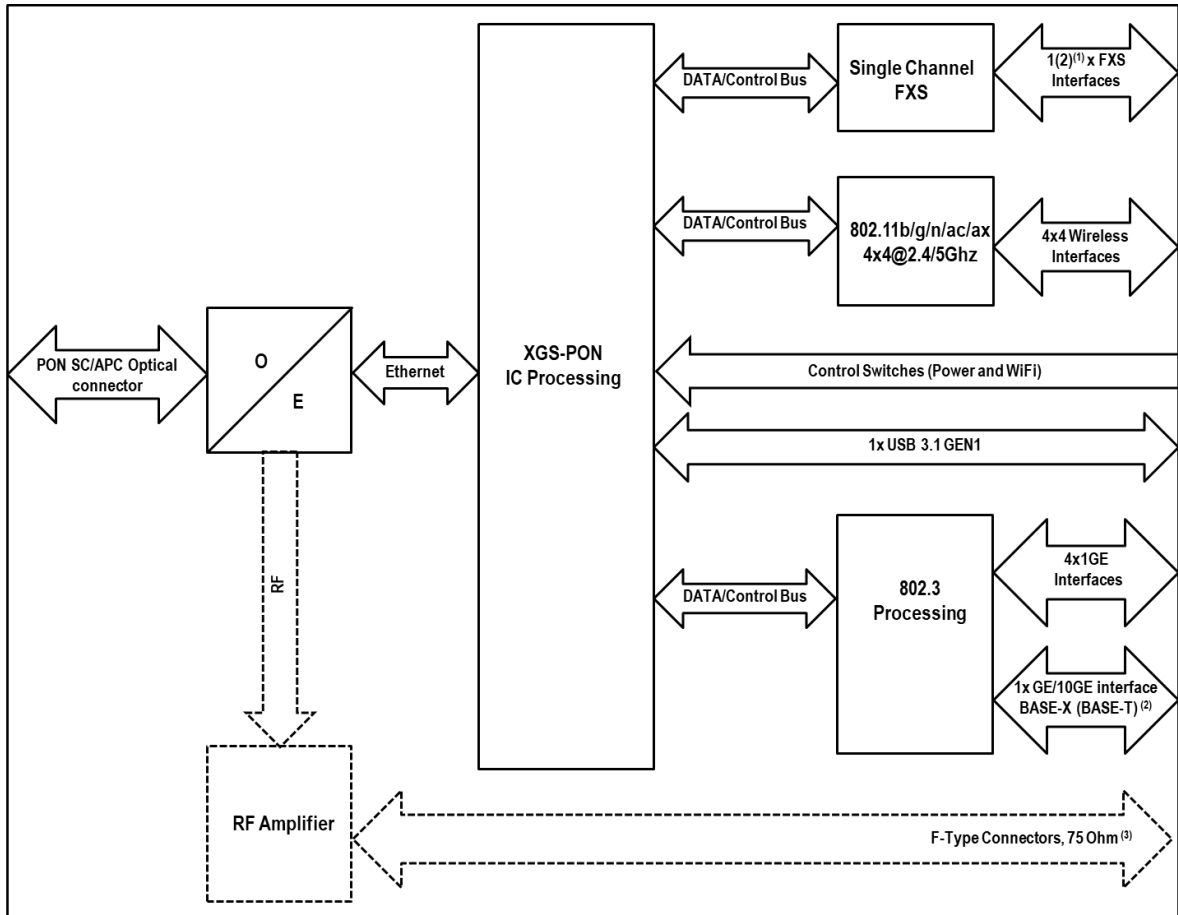


Figure 8: Fiber Gateway system architecture

The XGS-PON IC Processing unit is the core component inside XGS-PON Fiber Gateway. It is responsible for the interconnection and processing between client side interfacing and optical XGS-PON Uplink interface.

## 2.7 PON

Fiber Gateway PON port type is XGS-PON, and uses an optical connector SC/APC.

The XGS-PON Fiber Gateway XGS-PON layer as G.9807.1 uses optical wavelengths in the range of 1575 to 1580 nm downstream and in the range of 1260 to nm upstream, with a bit rate of 9.95328Gbps both downstream and upstream by using an SC/APC protected optical connector.

## 2.8 Ethernet

Ethernet is the wired LAN technology and is revised in the IEEE 802.3 standard. At the OSI reference system, Ethernet is at the Data Link layer. In the XGS-PON Fiber Gateway equipment LAN type of physical interfaces are 10/100/1000BASE-T AUTO-MIX Ethernet type over RJ45 connectors; 1/10GE interface is of type 1/10GBASE-X via an SFP/SFP+ module.

For the IPTV service the XGS-PON Fiber Gateway also behaves like a Layer 2 bridging device. For this service, the XGS-PON Fiber Gateway has a specific XGEM PORT for Multicast. This same XGEM PORT is requested by the user in order to have access to the various IPTV channels. Every time a user requests a new channel, the XGS-PON Fiber Gateway will send to OLT a IGMP packet requesting that Channel. The XGS-PON Fiber Gateway is also responsible for implementing the snooping for the channels that the user requests.

## 2.9 Voice

### 2.9.1 VoIP specifications:

- Call control: SIPv1/v2;
- T.38 Fax relay;
- Fax/Data bypass;
- Echo canceller;
- Echo canceller length;
- Jitter buffer;
- Caller ID generation;
- G.711 PCMU;
- G.711 PCMA;
- G.723.1;
- G.726;
- G.729;
- VAD and CNG;
- Caller ID and call waiting;
- RTP/RTCP packet encapsulation;
- RFC 2833 Support;
- In-band signaling detection and generation (DTMF, call progress tones).
- Automatic Tone generation (dial, busy, ring back, stutter, distinctive ring);
- 3-Way conferencing.

### 2.9.2 Voice interfaces

XGS-PON Fiber Gateway voice service provisioning could be made through OLT configurations over OMCI messages or could be downloaded (FTP) from the OLT up to the XGS-PON Fiber Gateway after its registration on the PON network. XGS-PON Fiber Gateway equipments have the ability to deliver the Voice service over two types of interface:

#### 2.9.2.1 Physical interface (FXS ports)

The XGS-PON Fiber Gateway has physical RJ11 FXS interfaces terminated in the equipment by means of FXS (RJ11) connections. The RJ11 analog terminals adapter function is auto/self-configured, integrated (analog/VoIP) and associated with a defined SIP or Megaco (H.248) user.

The XGS-PON Fiber Gateway will allow VoIP or NGN (Next Generation Network) traffic from devices connected to the RJ11 or RJ45 interfaces, towards the same internal VLAN.

Apart of the SIP and Megaco (H.248) self-configuration, it is also possible to make modifications in the voice service configurations by updating the XGS-PON Fiber Gateway SW through download from the OLT via OMCI.

The XGS-PON Fiber Gateway equipment has a DHCP client to get an IP address, alternatively the XGS-PON/NG-PON2 ONT Gateway could be configured with a static IP. The configuration of the static IP or DHCP client is related to the WAN side and is enabled by the OLT.

### 2.9.2.2 Logical interface (VLAN encapsulation)

If the XGS-PON Fiber Gateway has no FXS ports and the VoIP service is transparently forwarded from the OLT up to the Home Gateway (and vice versa) within a previously defined voice VLAN. XGS-PON Fiber Gateway respects the defined priority and implements the traffic encapsulation from its own Ethernet interface into a specific T-CONT/XGEM-Port over the PON interface and up to the OLT equipment.

## 2.10 Wi-Fi

The XGS-PON Fiber Gateway supports Wi-Fi 6, with Wi-Fi interfaces operating in the 2.4GHz and 5GHz UNII-1 and UNII-3 frequencies

### 2.10.1 Compliance

- IEEE 802.11a (5GHz, 6,9,12,18,24,36,48,54 Mbps)
- IEEE 802.11b (2.4GHz, 1, 2, 5.5, 11 Mbps)
- IEEE 802.11g (2.4GHz, 6,9,12,18,24,36,48,54 Mbps)
- IEEE 802.11n (2.4GHz and 5 GHz, up to 600 Mbps)
- IEEE 802.11ac (5GHz, up to 3400 Mbps)
- IEEE 802.11ax (2.4 GHz): up to 1200 Mbps
- IEEE 802.11ax (5 GHz): up to 4800 Mbps

### 2.10.2 Features

The XGS-PON Fiber Gateway supports the following features:

- 802.1x Authentication;
- External RADIUS Authentication;
- WPA/WPA2 Protected access;
- 64/128 Bits WEP;
- AES and TKIP Encryption;
- Wi-Fi multimedia support: WMM and WMM-PS;
- Multiple SSIDs Profiles;
- MAC Address filtering integrated;
- WPS (Pushbutton and PIN entry);
- Hotspot 2.0;
- Band steering.

### 2.10.3 Interfaces

- Dual-band, concurrent mode 2.4GHz plus 5GHz (UNII-1 and UNII-3),
- Compliant with IEEE 802.11 a/b/g/n/ac/ax
- Channel Bandwidth: 20, 40, 80



## 2.10.4 Antennas

- 4x4 Dual-Band antennas

## 2.11 Wi-Fi Easy Mesh

XGS-PON Fiber Gateway complies with Wi-Fi @Alliance Multi-AP specification, acting as a WLAN controller to the Altice Labs Smart Mesh Wi-Fi extenders.

Wi-Fi EasyMesh™ networks utilize multiple APs that work together to ensure all areas of the home have complete Wi-Fi coverage and enable changing network conditions to deliver a consistent, high quality user experience.

Altice Labs has dedicated major attention to the in-house Wi-Fi coverage scenarios and has developed a Smart Mesh Wi-Fi certified solution based on Wi-Fi EasyMesh™ from Wi-Fi Alliance®. The solution incorporate hardware (FGW and Smart Mesh Wi-Fi AP extenders), a mobile user APP (Android &iOS) and a unified portal cloud based to configure, manage and report the Wi-Fi mesh ecosystem. Both FGW and Smart Mesh Wi-Fi APs will run local software (local Controller, local Agent and a SmartMesh Wi-Fi Management agent) supported on high performance state of the art Wi-Fi interfacing.

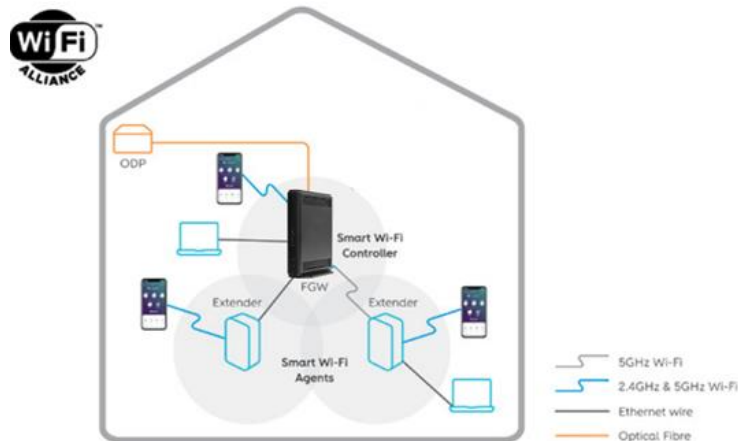


Figure 9: XGS-PON Fiber Gateway as the Smart Mesh Wi-Fi network controller

## 2.12 Multiple QoS per VLAN

The XGS-PON Fiber Gateway supports 802.1p QoS per VLAN services in which several flows (one per allowed pbit) are embedded in the same VLAN. According to the applied configuration, the ONT Gateway performs a per-flow QoS policy: dropping traffic marked with not allowed pbits and limiting to the configured value the data rate of the allowed flows.

The XGS-PON Fiber ONT Gateway performs transparent VLAN translation. It is transparent to upper layer protocols, such as ARP, RIP, DHCP, IGMP, PPP, etc.

## 2.13 Policing/Rate Limiting

### 2.13.1 Downstream QoS

The OLT system supports traffic classification at the ingress ports (ETH, LAGs, PON, etc) based on P-Bits, IP DSCP and IP.

The OLT system provides several QoS mechanisms, that can be targeted to the flow characterized by one or two VLAN according with the type of service, or can be targeted to the packets priority, where each p-bit/DSCP is mapped in one of eight queues of each port.

For each OLT PON ports are associated eight queues, for each of these queues is possible to configure the p-bit mapping in one of the queues, the scheduler type (Strict Priority or Weighted Fair Queuing) and the minimum and maximum bandwidth of each queue.

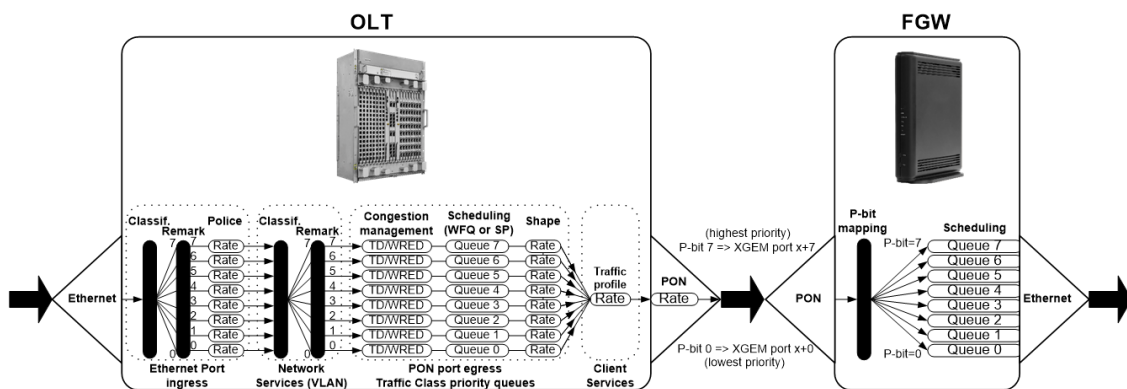


Figure 10: Downstream QoS diagram

In the downstream direction, Figure 10, the ingress traffic can be firstly classified. It passes by a policer and is configured to each FGW service, which is defined by one or two tags. It is remarked and policed per-CoS rate (port profile).

After this, Network services (per VLAN) classification determine the PON port queue where packets will wait for a transmission opportunity, and can remark the CoS (P-bits in VLAN PCP). The traffic is put in a queue according with the p-bit/DSCP->Traffic Class mapping.

Each of these Traffic Classes is associated with a scheduler (WRR or SP) and a policer.

Queue congestion management is used to prevent the queue from overflowing and is performed based on Tail Drop or WRED.

Each queue is served by either a priority or weighted scheduler and rate controlled.

Then Traffic Classes to P-bit remarking is done and the traffic flows to the PON interface.

Destination FGW client service downstream profile defines traffic classless policing. The overall PON port may be limited to a percentage of its capacity.

Traffic arriving to the FGW it will pass by a mapping block which will map the traffic in one of the eight queues according with the p-bits; these queues have a Strict Priority scheduler in order to guarantee that the most prioritized traffic passes first, Figure 10.

## 2.13.2 Upstream QoS

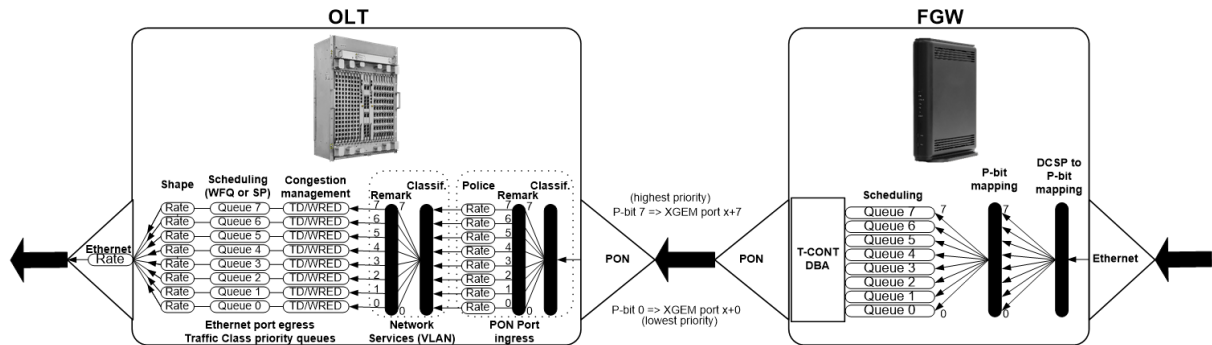


Figure 11: Upstream QoS diagram

In the upstream, Figure 11, for each T-CONT DBA the ingress traffic in the FGW passes by a mapping block that maps the traffic in one of the eight queues according with the p-bit, (in case the ingress traffic is untagged a DSCP->p-bit mapping is performed).

These queues have a Strict Priority Scheduler. Packets are stored at the intended T-CONT priority queue, which is scheduled according to FGW configuration.

The ONT “waits” until the OLT assigns a transmission timeslot for that T-CONT, according to DBA, so that the most prioritized queues are the ones that transmit first.

In the OLT PON ingress port, traffic is remarked and can be policed per-CoS. The traffic is put into a Traffic Class according with what is defined in the p-bit/DSCP->queue mapping.

Each of these Traffic Classes has an associated scheduler and policer. Queue management is performed based on Tail Drop or WRED. Then Traffic Classes to P-bit remarking is done and the traffic is sent to the uplink, Figure 11.

## 2.13.3 Dynamic Bandwidth Allocation (DBA)

The DBA (Dynamic Bandwidth Allocation) is available in order to optimize the upstream bandwidth. This mechanism consists in defining an adequate T-CONT to the service traffic in question. There are five types of T-CONT, defined by the Fixed, Assured and Maximum Parameters:

- Type 1: Only fixed Bandwidth;
- Type 2: Only Assured Bandwidth;
- Type 3: Assured+Maximum Bandwidth;
- Type 4: Only Maximum Bandwidth (Best Effort);
- Type 5: Fixed+Assured+Maximum Bandwidth.

Table 2: T-CONT types definition

| T-CONT                | Type 1            | Type 2            | Type 3                    | Type 4                 | Type 5                     | Units |
|-----------------------|-------------------|-------------------|---------------------------|------------------------|----------------------------|-------|
| Fixed BW- $R_F$       | $R_{F1}$          | 0                 | 0                         | 0                      | $R_{F5}$                   | [b/s] |
| Assured BW- $R_A$     | 0                 | $R_{A2}$          | $R_{A3}$                  | 0                      | $R_{A5}$                   | [b/s] |
| Max Bw - $R_M$        | $R_{M1} = R_{F1}$ | $R_{M2} = R_{A2}$ | $R_{M3} > R_{A3}$         | $R_{M4}$               | $R_{M5} > R_{F5} + R_{A5}$ | [b/s] |
| Bandwidth Eligibility | 0                 | 0                 | Non-Assured BW - $R_{NA}$ | Best-Effort - $R_{BE}$ | $R_{NA} / R_{BE}$          |       |

In each PON interface there are 1024 Alloc-ID (T-CONT identifiers) available, provided to manage FGW services. They are distributed in the following way:

Table 3: Alloc-ID's distribution by T-CONT type

| Alloc-ID | Allocation Type                      |
|----------|--------------------------------------|
| 0-127    | Default Alloc-ID (Dynamic or Static) |
| 128-255  | Reserved                             |
| 256-639  | Dynamic or Static                    |
| 640-1023 | Static                               |

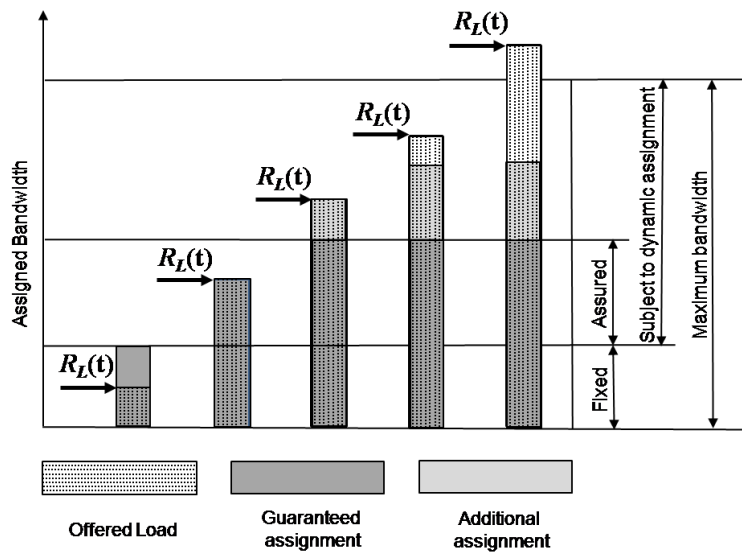


Figure 12: Traffic distribution by service/client

### 2.13.4 Upstream QoS scenarios

- 8 priority queues
- Strict-priority
- Upstream Scheduling:

- Strict Priority (currently supported)
- Strict Priority + rate controller (currently supported)
- Strict Priority + WFQ (can be SW supported)



## 3 General Specifications

### 3.1 Optical Interfaces

#### 3.1.1 10GE BASE-X interfaces

These interfaces (for models SXRxxxxX) are deployed in the form of optical SFP+ 10GBASE-LR/LW transceivers which use LC/PC connectors and have the following characteristics

**Table 3-1 - Optical 10Gbase interfaces characteristics**

| Item                                   | Unit  | 10GBASE-LR/LW (10 km)              |
|--|-------|------------------------------------|
| Laser type emitter                     | -     | SLM (DFB)                          |
| Operation                              | nm    | 1260 to 1355                       |
| Wave length typ.                       | nm    | 1310                               |
| Spectral width Max.                    | nm    | NA                                 |
| Min SMSR                               | dB    | 30                                 |
| Tolerated dispersion Max.              | ps/nm | NA                                 |
| Emission Power Max/min                 | dBm   | 0.5 / -8.2                         |
| Min Extinction Ratio                   | dB    | 3.5                                |
| Receiver Type                          | -     | PIN                                |
| Attenuation Range                      | dB    | NA                                 |
| Sensibility<br>BER < 10 <sup>-10</sup> | dBm   | -12.6                              |
| Receiver Saturation                    | dBm   | -1                                 |
| Max. Penalization per optical course   | dB    | 1                                  |
| Protection against Cuts                | -     | Automatic Laser Shut Down          |
| According to Recommendations           | -     | (IEEE 802.3, Clause 49, 50 and 52) |

#### 3.1.2 XGS-PON optical interfaces

The XGS-PON Fiber Gateway PON interface as ITU-T rec. G.9807.1 uses an SC/APC protected optical connector and has the following characteristics

**Table 2: XGS-PON Interfaces Specification: XGS –PON Fiber Gateway transceivers**

| Items   | Unit |          |
|---|------|----------|
| Maximum fibre distance between S/R and R/S points | Km   | DD20: 20 |
| <b>Fiber Gateway Tx</b>                           |      |          |
| Nominal line rate                                 | Gbps | 9.95328  |

| Items  | Unit        |                   |       |       |
|--|-------------|-------------------|-------|-------|
| Operating wavelength band  | nm          | 1260-1280         |       |       |
| Line code  | --          | Scrambled NRZ     |       |       |
| Maximum reflectance of equipment measured at transmitter wavelength      | dB          | -10               |       |       |
| Minimum ORL of ODN (Note 1)  | dB          | More than 32      |       |       |
| ODN Class  |             | N1                | N2    | E1    |
| Mean launch power minimum (Note 2)                                       | dBm         | +4.0              | +4.0  | +4.0  |
| Mean launch power maximum  | dBm         | +9.0              | +9.0  | +9.0  |
| Maximum transmitter enable transient time (Note 3)                       | bits (nsec) | 1 280<br>(~128.6) |       |       |
| Maximum transmitter disable transient time (Note 3)                      | bits (nsec) | 1 280<br>(~128.6) |       |       |
| Minimum extinction ratio (Note 2)  | dB          | 6.0               |       |       |
| Tolerance to reflected optical power (Note 4)                            | dB          | More than -15     |       |       |
| Dispersion Range   | ps/nm       | 0 to -140         |       |       |
| Minimum side mode suppression ratio                                      | dB          | 30                |       |       |
| Launched optical power without input to the transmitter (Note 3)         | dBm         | -45               |       |       |
| <b>Fiber Gateway Rx</b>  |             |                   |       |       |
| Nominal line rate  | Gbps        | 9.95328           |       |       |
| Receiving wavelength   | nm          | 1575 - 1580       |       |       |
| Maximum optical path penalty (Note 5)                                    | dB          | 1.0               |       |       |
| Maximum reflectance of equipment at R/S, measured at receiver wavelength | dB          | Less than -20     |       |       |
| Bit error ratio reference level  | -           | 10-3 (Note 4)     |       |       |
|  |             | N1                | N2    | E1    |
| Minimum sensitivity at BER reference level (Note 6)                      | dBm         | -28.0             | -28.0 | -28.0 |
| Minimum overload at BER reference level                                  | dBm         | -9.0              | -9.0  | -9.0  |
| Consecutive identical digit immunity                                     | bit         | More than 72      |       |       |
| Receiver tolerance to reflected optical power (Note 7)                   | dB          | Less than 10      |       |       |

**NOTES:**

NOTE 1 – There are optional cases where the "minimum ORL of ODN can be as low as 20 dB. (see Appendix I of ITU-T G.983.1).

NOTE 2 – The minimum average launch power and the minimum ER are consistent with a minimum OMA of 4.78 dBm. (See Appendix I of G.9807.1 for details).

NOTE 3– As defined in clause B.9.2.7.3.1 of G.9807.1. The values in nanoseconds are informative.

NOTE 4 – Parameter known in [ITU-T G.984.2] as "Tolerance to the transmitter incident light power".

NOTE 5 – If a transmitter exhibits a higher penalty that specified, it can still comply if it equally increases the minimum launch power to compensate for extra optical path penalty (OPP), while remaining under the maximum launch power. In no case should the OPP exceed 2 dB.

NOTE 6 – This sensitivity shall be met in the presence of G-PON and video overlay on the same ODN. If either G-PON, or video overlay or both of them are absent, the sensitivity may be different (precise value is for further study).

NOTE 7 – Parameter known in [ITU-T G.984.2] as "Tolerance to the reflected optical power"



## 3.2 Ethernet Interfaces

### 3.2.1 10/100/1000BASE-T

Ethernet is the wired LAN technology and is revised in the IEEE 802.3 standard. At the OSI reference system, Ethernet is at the Data Link layer. In the ONT Gateway equipment the LAN type of physical interfaces is 10/100/1000BASE-T AUTO-MIX Ethernet type over RJ45 connectors.

### 3.2.2 10GE interfaces

#### 3.2.2.1 10GE BASE-X

These interfaces are deployed in the form of optical SFP+ 10GBASE-LR/LW transceivers which use LC/PC connectors. Optical characteristics of the interface described in the section 3.1.1 10GE interfaces

## 3.3 FXS Interfaces

Table 3: FXS interface specifications

| Items                            | State   | Description                 |   |
|----------------------------------|---|-----------------------------|---|
| DC voltage (V)                   | 48V (21 to 56.5V)   | According to ANSI/TI A-1063 |   |
| Ringer voltage (V)               | DC offset: $\geq 15$ Vdc<br>AC voltage: $\geq 55$ Vac rms<br>Frequency: 20Hz +/- 3% | Max Voltage: 100 Vp         |   |
| Ringing signal cadence           | normal ringing  | 2 sec ring / 4 sec pause    |   |
| REN                              | ringer equivalence numbers  | Maximum ringer load: 5      |   |
| Loop Current Characteristics (A) | 25 mA (max)   | -                           |   |
| Hook flash                       | on-hook - register recall/hook flash  | 150 msec                    | Minimum time of recognition of "on-hook" when hook-flash feature does not exist |
|                                  | on-hook - register recall/hook flash  | 1100 msec                   | Minimum time "on-hook" recognition when hook-flash feature does exist           |
|                                  | off-hook  | 40 msec                     | minimum time "off-hook" recognition   |
|                                  | interval  | 300 msec – 1100 msec        | Time calibrated break pulse duration for register recall recognition            |
| Pulse Dialing Detection          | Pulse Frequency: 10 Hz (8 Hz to 12 Hz)<br>Pulse Relation (%): 60/40                 | -                           |   |
| DTMF Dialing Detection           | -   | According to ANSI/TI A-1063 |   |
| Clip                             | -   | According to ANSI/TI A-1063 |   |
| Clip on Call Waiting             | -   | According to ANSI/TI A-1063 |   |

## 3.4 Wi-Fi interfaces

Table 4: Wi-Fi specification

| Items                    | Description  |
|--------------------------|--|
| Standards compliance     | IEEE 802.11 b/g/n/ac/ax  |
| Data Rates               | 802.11a : 6,9,12,18,24,36,48,54 Mbps;<br>802.11b : 1, 2, 5.5, 11 Mbps;<br>802.11g : 6,9,12,18,24,36,48,54 Mbps;<br>802.11n : up to 600 Mbps;<br>802.11ac : up to 3400 Mbps;<br>802.11ax (2.4 GHz): up to 1200 Mbps;<br>802.11ax (5 GHz): up to 4800 Mbps |
| SSID                     | Multiple SSIDs Profiles;   |
| Operation Frequencies    | 2.4GHz + 5GHz UNII-1 / UNII-3;<br>Concurrent Mode  |
| Antennas                 | Internal antennas  |
| Channel Bandwidths       | 20, 40, 80   |
| Security                 | WPA/WPA2 Protected access;<br>64/128 Bits WEP;<br>AES and TKIP Encryption;<br>802.1x Authentication;<br>External RADIUS Authentication;  |
| Wi-Fi Multimedia support | WMM;<br>WMM-PS   |
| MAC Address filtering    | Integrated   |
| Hotspot                  | 2.0  |
| WPS                      | Pushbutton and PIN entry   |

## 3.5 General Features

Table 5: General Features

| Features                       | XGS-PON Fiber Gateway   |
|--------------------------------|---|
| XGS-PON port                   | 1x Singlemode Optical Fiber Cable (SC/APC Connector)                    |
| Ethernet 10/100/1000Base-T     | 4x Ethernet UTP CAT5E direct or crossover AUTO-MDIX cable (RJ45)        |
| Ethernet 10GE BASE-X or BASE-T | BASE-X: SFP/SFP+ GE/10GE<br>BASE-T: SFP/SFP+ GE/10GE or RJ-45 connector |
| FXS Ports                      | 1 voice / fax RJ11 connector  |
| USB Ports                      | 1x USB 3.1  |

| Features                                      | XGS-PON Fiber Gateway  |
|---|--|
| Wi-Fi (802.11a/b/g/n/ac/ax)                   | Yes  |
| ON/OFF button                                 | Yes  |
| RESET button                                  | Yes  |
| OLT Interoperability (BBF.247)                | Yes  |
| DHCP Client                                   | Yes  |
| Number of XGEM ports                          | 256  |
| Number of T-CONT                              | 32   |
| Primary Power Connection (VDC)                | 12 ( $\pm$ 15%)  |
| RAM Memory                                    | 1024MB DDR3  |
| Flash Memory                                  | 8GB eMMC   |
| SoC   | BCM68580X  |
| Primary Power Connection (VAC)                | 230VAC/50Hz or 120VAC/60Hz   |
| AC/DC Adapter Max Power (W)                   | 48   |
| AC/DC Adapter Energy Efficiency               | European Code of Conduct on Energy Consumption of External Power Supplies V7 |
| Energy Efficiency                             | Energy Star - Small Network Equipments v1.0                                  |
| MTBF (h)                                      | 800416   |
| Size (HxWxD) (mm <sup>3</sup> )               | 244/9.61x 35/1.38x202/7.95 <sup>3</sup>                                      |
| Temperature ( <sup>0</sup> C/ <sup>0</sup> F) | +5 to +40 <sup>0</sup> C / 41 <sup>0</sup> F to 104 <sup>0</sup> F           |
| Humidity (%)                                  | 5 to 85 %  |

### 3.6 General Service Description

**Table 6: General Service Description**

|             |   |   |
|-------------|---|---|
| PON Layer   | XGS-PON   | Comply with standards: ITU-T G.9807.1 XGS-PON / ITU-T G.988 (OMCI);<br>Configurable AES (Downstream);<br>In the downstream direction, FEC is statically configurable as on for all ONUs;<br>in the upstream direction, the use of FEC is under dynamic control by the OLT;<br>Bitrates: 9.95328 Gbps (Downstream) / 9.95328 Gbps (Upstream);<br>Optics Classes: N1; N2; E1; DD20. |
| L2/L3 layer | VLAN-ID to GEM port-ID mapping (per TR-156i3):<br>1:1, N:1 VLAN;<br>Transparent VLAN;<br>Classification: DSCP/TOS, 802.1p TCI, VLAN-ID, MAC address;<br>Traffic Management: up to 8 queues per T-CONT in priority-controlled mode or up to 16 queues per T-CONT in rate-controlled scheduling mode;<br>802.1q VLAN processing: Q-in-Q, tagging, removing tag, replacing tag or transparent forwarding;<br>IPv4; IPv6;<br>Routing: Network Access Translation (NAT) and Network Access Port Translation (NAPT);<br>Firewall; VPN;<br>DHCP Client and Server;<br>PPPoE Client;<br>Quality of Service (QoS) prioritization using 802.1p. |   |

|                         |   |
|-------------------------|---|
| IPTV                    | IGMP v2/v3, and MLD (IPv6) snooping and proxy;<br>IGMP processing per VLAN ID to support group of channels;<br>Interactive services (Video On Demand);<br>IPTV streams forwarding simultaneous :128.  |
| VoIP                    | Call control: SIPv1/v2; T.38 Fax relay; Fax/Data bypass;<br>Echo canceller; Echo canceller length; Jitter buffer;<br>Caller ID generation; G.711 PCMU;<br>G.711 PCMA; G.723.1; G.726;<br>G.729; VAD and CNG; Caller ID and call waiting;<br>RTP/RTCP packet encapsulation; RFC 2833 Support;<br>In-band signaling detection and generation (DTMF, call progress tones);<br>Automatic Tone generation (dial, busy, ring back, stutter, distinctive ring); 3-Way conferencing   |
| Services                | Content sharing:<br>- UPnP Media Server;<br>- DLNA DMS;<br>- Metadata Support;<br>OSGI ( Open Service Gateway Interface).   |
| Wi-Fi                   | Functionalities:<br>- 802.1x Authentication; External RADIUS Authentication;<br>- WPA/WPA2 Protected access; 64/128 bits WEP encryption;<br>- AES and TKIP Encryption;<br>- Wi-Fi multimedia support: WMM and WMM-PS;<br>- Multiple SSIDs Profiles;<br>- MAC Address filtering integrated;<br>- WPS (Pushbutton and PIN entry);<br>- Hotspot 2.0;<br>- Band steering.<br><br>Interfaces:<br>- Concurrent Mode 2.4 GHz + 5 GHz via internal antennas;<br>- 2.4 GHz: Compliant with IEEE 802.11 b/g/n/ax with 4x4 MIMO<br><br>- 5 GHz: Compliant with IEEE 802.11 a/n/ac/ax and with 4x4 MIMO<br><br>Transmit Power (EIRP) :<br>- SW configurable according to country;<br>- 2.4GHz band: up to +20dBm (ETSI) or up to +34dBm (FCC)<br>- 5GHz band: up to +30dBm (ETSI) or up to +34dBm (FCC)<br>Channel Bandwidth: 20, 40, 80<br><br>Data rates:<br>802.11a : 6,9,12,18,24,36,48,54 Mbps<br>802.11b : 1, 2, 5.5, 11 Mbps<br>802.11g : 6,9,12,18,24,36,48,54 Mbps<br>802.11n : up to 600 Mbps<br>802.11ac : up to 3400 Mbps<br>802.11ax (2.4 GHz): up to 1200 Mbps<br>802.11ax (5 GHz): up to 4800 Mbps |
| POTS                    | RJ11 FXS port   |
| USB                     | 3.1   |
| Management              | Remote management over the OMCI, PLOAM, OAM and Connected Home: TR-069/098/104/111/140/142/143/181;<br>Secure software download upgrade via OMCI or TR-069;<br>Embedded Telnet server for remote management;<br>G.988 compliant.<br>SNMP V3;<br>Zero Touch configuration;<br>Equipment user interfaces options:<br><ul style="list-style-type: none"> <li>• Web-based GUI;</li> <li>• CLI</li> </ul>  |
| LAN Ethernet interfaces | RJ45 10/100/1000 BASE-T; Support auto-negotiation;<br>Support auto MDI/MDIX;<br>1/10GE:<br><ul style="list-style-type: none"> <li>• BASE-X (SFP/SFP+)</li> </ul>  |

### 3.7 Optical metering

The equipment measures the downstream received power from the OLT and reports this value through OMCI. The accuracy of the measurement is +/- 3dBm, maximum. Optionally, Fiber Gateway has also the chance to have an embedded optical reflective component in order to increase the FTTH probing capabilities in a 50 centimeters resolution factor, which turns to have a single probing system to probe all xPON network ONU/ONTs even when its number increases over Million customers.

### 3.8 Wavelength filtering

The XGS-PON optical interface has WDM filters that allow coexistence with GPON (ITU-T rec.G.984.x), RF video services (1550-1560nm), XG-PON (ITU-T Rec. G987.1) and with NG-PON2 (ITU-T Rec.G.989.x).

### 3.9 XGS-PON characteristics support


XGS-PON characteristics are supported, both functional level and GTC-OMCI configuration, corresponds with the general mandatory characteristics defined in ITU-T G.8907.1 and G.988 Recommendation:

- PON interface: downstream operating rate 9.95328 Gbps, upstream operating rate 9.95328 Gbps;
- 32 T-CONT and 256 simultaneous XGEM ports;
- 1:128 SR support;
- Unmarked or marked bandwidth management;
- Upstream and downstream FEC;
- Downstream AES encryption;
- Ethernet flow control in client's port: 802.3x and 802.3ab;
- Ability to classify and modify VLAN labels (single or double labeling);
- Ability to support multiple VLAN tags per service (Internet, IPTV, VoIP, ACS, etc) from Residential Gateway. And ability to translate those VLAN to one specific service VLAN on OLT side, like, IPTV service VLAN, Internet Service VLAN (SVLAN and CVLAN), and VoIP Service VLAN;
- 802.1 DSCP for CoS support;
- IEEE 802.1Q and 802.1p support;
- Multicast IGMPv2/V3 and MLD(IPv6) snooping and proxy support;
- Firmware upgrade through the PON interface following the mechanisms specified in the ITU-T G.8907.1 and G.988, including a safe dual firmware updates image system and the ability of back-up, allowing the SINGLE PORT Fiber Gateway start in case the software download fails, to enable a new software update.

### 3.10 Standards

**Table 7: Standards compliance**

|            |   |
|------------|---|
| <b>EMC</b> | FCC CFR 47 Part 15 Subpart B Section 15.107 – Conducted Emissions (Class B);<br>FCC CFR 47 Part 15 Subpart B Section 15.109 – Radiated Emissions (Class B). |
|------------|---|

|                       |   |
|-----------------------|---|
| <b>Radio</b>          | FCC CFR 47 Part 15 Subpart C Section 15.247<br>FCC CFR 47 Part 15 Subpart E Section 15.407  |
| <b>Safety</b>         | UL 62368-1  |
| <b>Certifications</b> | <p>ETL Intertek Listing Certification</p>  <p>The logo consists of a circular emblem with 'ETL' inside, 'LISTED' written below it, and 'US' to the right. Below the emblem, the text reads 'Intertek', '4010367', and 'I.T.E.' stacked vertically.</p> |
|                       | FCC Certification   |

## 4 Setup

### 4.1 Equipment Connectivity

Fibergateway connectors are located at the back of the equipment. The number and type of the connectors depend on the specific Fiber Gateway model

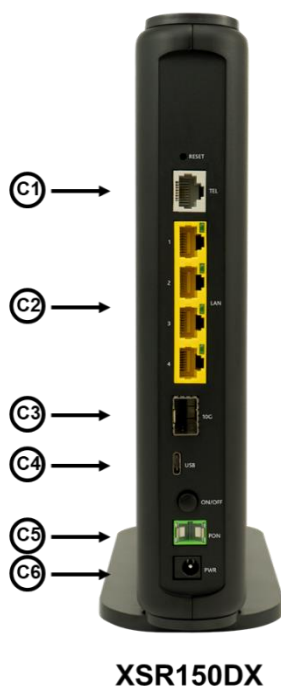


Figure 13: Fiber Gateway connections

Table 8: Fiber Gateway connections description

| Number    | Name              | Description   |
|-----------|-------------------|---|
| <b>C1</b> | TEL               | RJ11 – FXS Ports  |
| <b>C2</b> | LAN (1, 2, 3, 4)  | RJ45 Ports - 10/100/1000Base-T Ethernet with AUTO-MDIX                                |
| <b>C3</b> | 1/2,5/10GE BASE-X | 1 / 2,5 / 10GE port <ul style="list-style-type: none"> <li>• SFP/SFP+ port</li> </ul> |
| <b>C4</b> | USB               | USB type C port   |
| <b>C5</b> | PON               | Equipment Optical port PON; SC/APC  |
| <b>C6</b> | PWR               | 12V DC Power Supply Connector   |

## 4.2 Equipment buttons

Fiber Gateway connections Power ON/OFF and Reset buttons are located at the back side of the equipment; WPS and INFO/WIFI<sup>1</sup> buttons are located at the front side of the equipment.



Figure 14: Fiber Gateway Buttons

Table 9: Fiber Gateway buttons description

| Number | Name      | Description   |
|--------|-----------|---|
| B1     | WPS       | Wi-Fi Protected Set-up Button;<br>With the Wi-Fi interface on, in order to connect a device the interface, pressing the WPS button for 1second will start the association process.  |
| B2     | INFO/WIFI | When pressed allows visualizing the equipment status as the status LEDs, normally off for energy saving, will light up and show equipment current status;<br>Some equipment have a WIFI button to switch on/off equipment Wi-Fi |
| B3     | RESET     | When pressed 5 seconds, will reset the equipment to factory configurations  |

<sup>1</sup> Model dependent; Most of the models INFO is an button pressing lights status LEDs, normally off for energy saving; in some models a WIFI button allows switching equipment Wi-Fi on/off



| Number | Name | Description  |
|--------|------|--|
| B4     | WPS  | Wi-Fi Protected Set-up Button;<br>With the Wi-Fi interface on, in order to connect a device the interface, pressing the WPS button for 1second will start the association process. |

### 4.3 Fiber Gateway Status LEDs

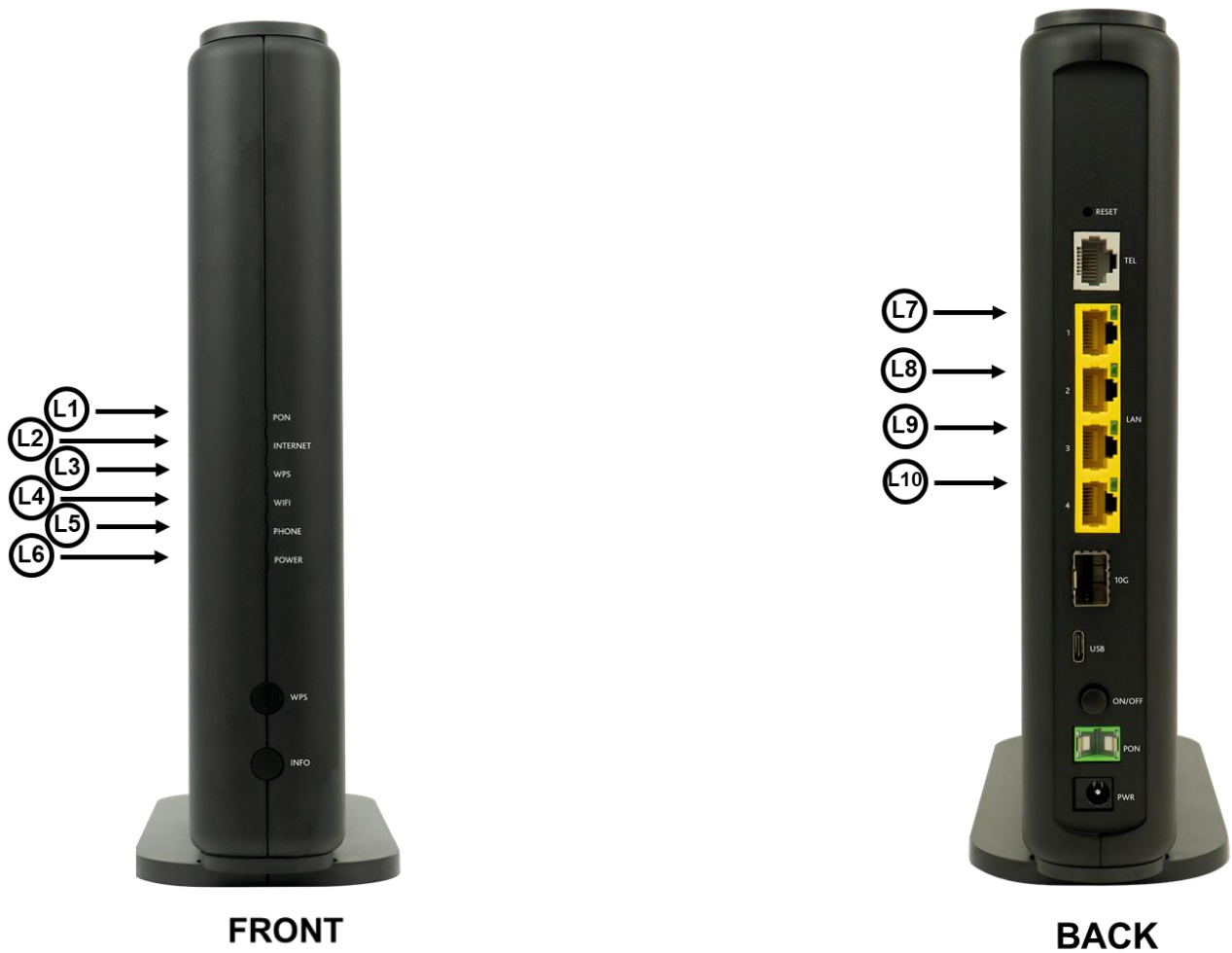


Figure 15: Fiber Gateway Status LEDs

Table 10: Status LEDs information

| LED | Identification | LEDs Status | Description                                       |
|-----|----------------|-------------|---|
| L1  | PON            | ON          | With PON connection; FGW normal operation (green) |
|     |                | OFF         | No PON connection; FGW initial status             |

|           |             |          |   |
|-----------|-------------|----------|---|
|           |             | Flashing | FGW is waiting for initial configuration by the OLT (Standby)<br>OLT is configuring FGW (Serial Number);<br>FGW and OLT synchronization (Ranging) |
| L2        | INTERNET    | ON       | With Internet connection (green)  |
|           |             | OFF      | Inactive port   |
|           |             | Flashing | Without Internet connection (green)   |
| L3        | WPS         | ON       | WPS active (blinking green)   |
|           |             | OFF      | WPS inactive  |
| L4        | WIFI        | ON       | Wi-Fi Radio Signal active   |
|           |             | OFF      | Wi-Fi Radio Signal inactive   |
| L5        | PHONE/(TEL) | ON       | Service configured and authenticated (green)  |
|           |             | OFF      | Service not configured or registration failure  |
|           |             | Flashing | Telephone off the hook  |
| L6        | POWER       | ON       | Power supply ON (green)   |
|           |             | OFF      | Power supply OFF  |
| L7 to L10 | LAN         | ON       | With Ethernet connection (green)  |
|           |             | OFF      | No Ethernet connection  |
|           |             | Flashing | Ethernet IN/OUT activity (green)  |

## 4.4 Typical Fiber Gateway usage scenario

## 4.5 Figure 16 bellow shows a Fiber Gateway Typical usage scenario showing Home Network connections for triple play service provisioning. Fiber Gateway connectors' description can be found in section 4.1 Equipment Connectivity

Fibergateway connectors are located at the back of the equipment. The number and type of the connectors depend on the specific Fiber Gateway model

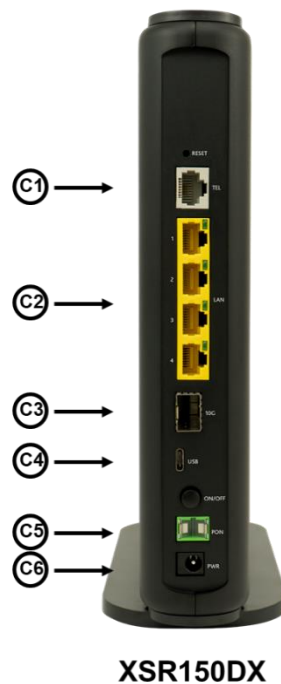


Figure 13: Fiber Gateway connections

Table 8: Fiber Gateway connections description

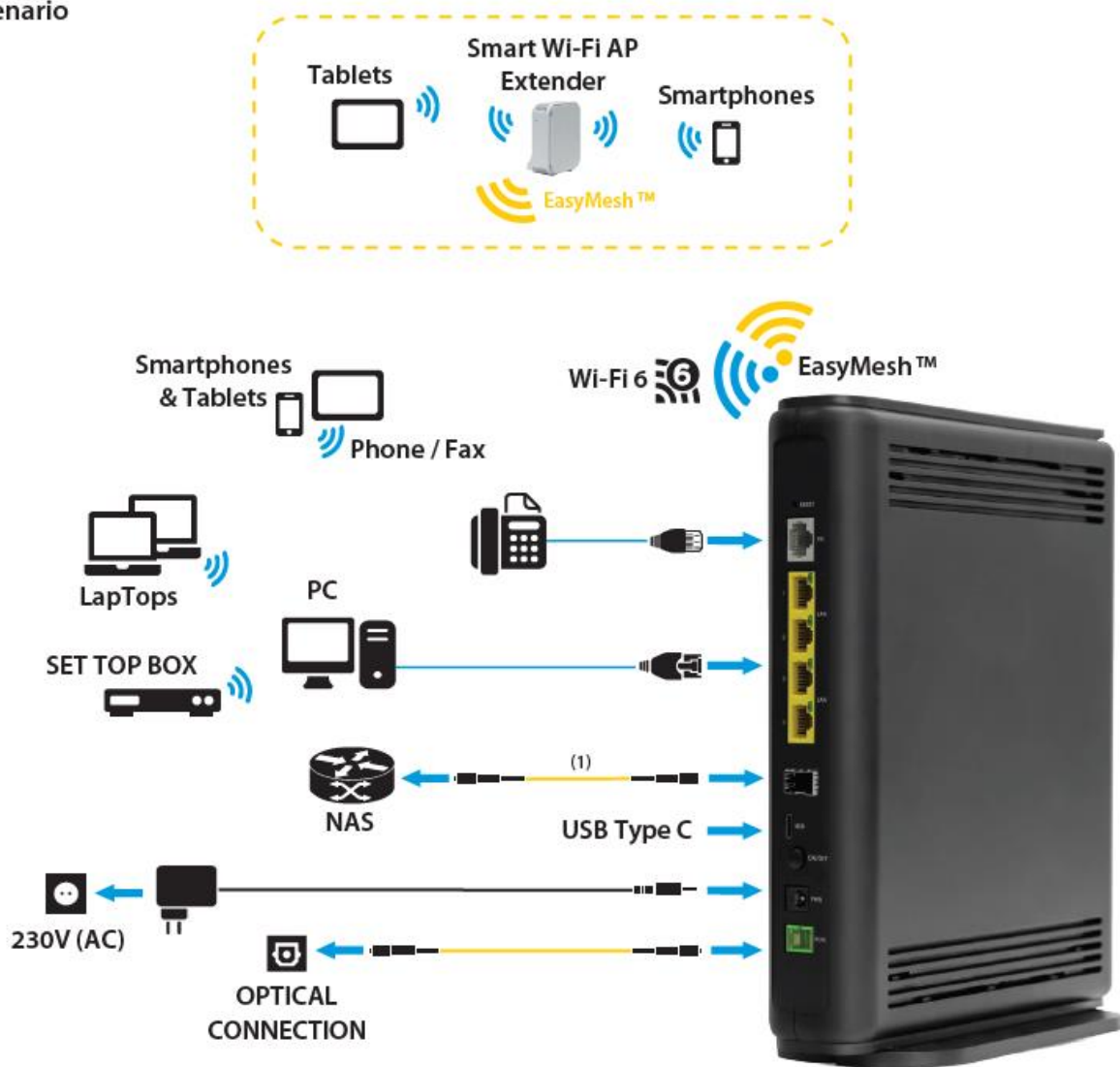
| Number    | Name              | Description   |
|-----------|-------------------|---|
| <b>C1</b> | TEL               | RJ11 – FXS Ports  |
| <b>C2</b> | LAN (1, 2, 3, 4)  | RJ45 Ports - 10/100/1000Base-T Ethernet with AUTO-MDIX                                |
| <b>C3</b> | 1/2,5/10GE BASE-X | 1 / 2,5 / 10GE port <ul style="list-style-type: none"> <li>• SFP/SFP+ port</li> </ul> |

| Number | Name | Description                        |
|--------|------|------------------------------------|
| C4     | USB  | USB type C port                    |
| C5     | PON  | Equipment Optical port PON; SC/APC |
| C6     | PWR  | 12V DC Power Supply Connector      |

## 4.6 Equipment buttons

and type of used connecting cables are described in Table 11: Connection cables.

Scenario



**Notes:**

(1) The physical interface depends on the SFP used

Figure 16: Fiber Gateway Typical usage scenario - Home network connections (XSR150DX example)

Table 11: Connection cables

| Connection | Description   |
|------------|---|
| C1         | RJ11 Telephone cable                                  |
| C2         | Ethernet Cable UTP CAT56 cable (direct or crossover)  |
| C3         | Single-mode Optical Cable with SC/APC Connector (PON) |
| C4         | 12V DC Adapter  |

## 4.7 Before installing the Fiber Gateway equipment

### 4.7.1 Safety Warnings

- Fiber Gateway is a passive cooling device. To prevent equipment overheating do not obstruct the ventilation grids on of the equipment;
- To avoid eye hazard, never look directly into a fiber optic port or connector;

### 4.7.2 Enviromental conditions

- Check for site's temperature and humidity environmental conditions that must be within the operating limits in the table bellow.

|                                 |           |
|---------------------------------|-----------|
| Operation Temperature (°C)      | +5 to +40 |
| Operation Relative Humidity (%) | 5 to 85   |

- Do not install the device in environments where the temperature or humidity exceeds the defined limits!
- The ONT Gateway device is not designed for outdoor setup. Please place it in a convenient indoor/cabinet environment;

### 4.7.3 Powering

- Install the device near a power outlet (110VAC) and the optical access point;
- Use only the provided power kit. The use of a third party power adapter may not guarantee its proper operation;

### 4.7.4 Wireless network installation best practices

In order to achieve Fiber Gateway wireless network best performance the following installation rules should be observed:

- Fiber Gateway front side should be oriented towards the area where the wireless network is to be used;

- Fiber Gateway installation place should be at least 1 meter high and without :
  - Interference sources nearby, such as Microwave ovens, DECT 2.4 GHz phones, Audio/Video transmitters, Bluetooth equipment, Baby Monitors, etc.
  - Obstacles such as walls, stairs, ceilings, doors, Metal Objects, Windows, etc between the installation place and the Wi-Fi usage area.

## 4.8 Connections

### 4.9 Fiber Gateway ports are located at the back side of the equipment. For information on the available ports and its description please refer to section 4.1-Equipment Connectivity

Fibergateway connectors are located at the back of the equipment. The number and type of the connectors depend on the specific Fiber Gateway model

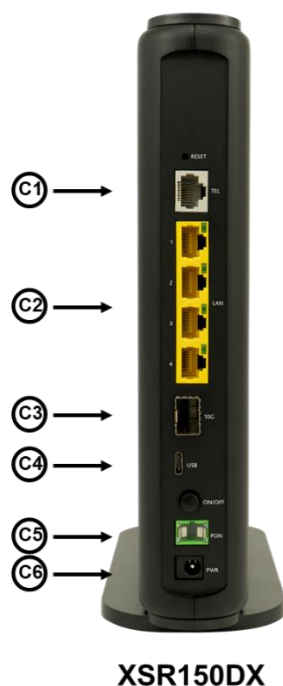


Figure 13: Fiber Gateway connections

Table 8: Fiber Gateway connections description

| Number | Name             | Description  |
|--------|------------------|--|
| C1     | TEL              | RJ11 – FXS Ports                                       |
| C2     | LAN (1, 2, 3, 4) | RJ45 Ports - 10/100/1000Base-T Ethernet with AUTO-MDIX |

| Number | Name              | Description   |
|--------|-------------------|---|
| C3     | 1/2,5/10GE BASE-X | 1 / 2,5 / 10GE port <ul style="list-style-type: none"><li>• SFP/SFP+ port</li></ul> |
| C4     | USB               | USB type C port   |
| C5     | PON               | Equipment Optical port PON; SC/APC  |
| C6     | PWR               | 12V DC Power Supply Connector   |

## 4.10 Equipment buttons

above.

## 4.11 Fiber Gateway Setup

Fiber Gateway is intended to be installed on a flat surface.

The following table identifies the set of materials that may be required to install the equipment, depending on the home network scenario.

**Table 12: Material required for instalation**

| Installation phase          | Item   | Mandatory |
|-----------------------------|--|-----------|
| Powering                    | Power Adapter and Power Cord<br>120VAC/60Hz 12VDC (3A) + 15%                     | √         |
| Network Provider Connection | Optical Patchcord (SM fibre ITU-T G.657B3) with connectors SC/APC, Figure 17, b) | √         |
|                             | Optical connector cleaning kit   | √         |
| Home Network Connections    | Ethernet cables CAT6 568B  | (1)       |
|                             | RJ11 Telephone Cable   | (1)       |
|                             | Device with Wi-Fi connectivity (laptop/smartphone/ ...)                          | (1)       |

(1) Home network scenario dependent

### 4.11.1 Network Provider Connection

An Optical Patchcord (SM fibre ITU-T G.657B3) with connectors SC/APC, Figure 17, b), and Optical connector cleaning material will be required.





**Figure 17: Network provider connection**

- Clean the optical connectors of the optical patchcord, Figure 17, b), of the FiberGateway PON port, Figure 17, a), and the optical wall socket, Figure 17, before connecting using appropriate optical connector cleaning material;
- Plug one of the patchcord cleaned SC/APC optical connectors on the Fiber Gateway PON port, Figure 17, a), observing the **alignment mechanism**, ( the tooth in the connector must fit into the groove in the PON port connector: a click indicates the connector is secure into place)
- Plug the other end optical patchcord SC/APC connector on the optical wall socket observing the **alignment mechanism**, ( the tooth in the connector must fit into the groove in the optical wall socket connector: a click indicates the connector is secure into place)
- Accommodate the patchcord excessive length avoiding small bend radius on the patchcord (30mm minimum bend radius).

#### 4.11.2 Mains connection and power up

- Connect the power adaptor output connector to the 12-VDC power port on the equipment;
- Plug the power adaptor appropriate power cord into an approved 120VAC outlet, Figure 16;
- Switch on the equipment, ON-OFF button

After executing a power-up sequence the equipment will be ready for operation.

## 5 Configuration

Configuration of the Fiber Gateway equipment is done remotely, using OMCI and TR-069.

### 5.1 Fiber Gateway Activation

The equipment activation process has a distributed set of procedures that allow the connection of an inactive equipment to a PON network. This configuration is done following the procedure described in the OMCI protocol.

### 5.2 Costumization

For customization process, the requirements specified in the G.8907.1 are taken into account.

#### 5.2.1 Software download from the OLT

The software download is made following the OMCI-based procedure.

The Managed Entity (ME) in charge of managing the software download is named Software Image. Per each ME containing independently-manageable software, the Fiber Gateway creates two software images. Each image will have three attributes:

- Valid - if it has been verified that it's content is an image with executable code;
- Committed - if once the Fiber Gateway is rebooted, it is loaded and executed;
- Active - if it is loaded and it is being executed in the Fiber Gateway.

There can be only one active image and only one committed image at a given moment. The Fiber Gateway goes through a series of states in order to download and activate a software image. Each state is defined according to the states of the variables of both images. The OLT controls the Fiber Gateway state through a series of commands:

- Start download
  - It starts the software download sequence. This action is only valid for inactive and non-committed software images;
- Download section
  - It downloads a section of a software image. This action is only valid for an image that is being downloaded;
- End download
  - It indicates the end of a download sequence, providing the CRC and information about version for the final verification of the downloaded software image. This action is only valid for a software image that is being downloaded;
- Activate image
  - It loads/executes a valid software image. When this action is applied to an inactive software image, the execution of the current code image is suspended, the associated software image is loaded from the non-volatile memory and the execution of the new code image is started. When this action is applied over a software image that is active, a reboot is executed;
- Commit image
  - It selects a valid SW image to be loaded and executed by default when the Fiber Gateway is restarted;
- Composition of the Software Image

- A software image is divided into sections of 31 bytes, with one section per OMCC message and each section protected by the CRC of the OMCC. A group of sections makes up a window, and a group of windows constituting the image.

## 6 Troubleshooting

The table below, according to the equipment LEDs' status, Table 10: Status LEDs information, identifies a possible cause and describes the procedure to fix the problem.

**Table 13: Troubleshooting Procedures**

| LED                  | State    | Possible Cause   | Solution  |
|----------------------|----------|--|---|
| POWER (L6)           | OFF      | No power supply to the equipment                               | <ul style="list-style-type: none"> <li>• Check that the power cable is correctly connected to both the equipment and the adapter at the electrical socket.</li> <li>• Check that the switch button (6) is at the ON position.</li> </ul>  |
| ETHERNET (L7 to L10) | OFF      | ETHERNET cable incorrectly connected                           | <ul style="list-style-type: none"> <li>• Check that the ETHERNET cable is properly connected to the equipments' ETHERNET port.</li> <li>• Change the ETHERNET cable.</li> <li>• Check that the equipment connected to the Fiber Gateway on this Ethernet port is switched ON.</li> </ul>  |
| PON (L1)             | OFF      | Anomaly in the optical fiber signal                            | <ul style="list-style-type: none"> <li>• Check that the optical cable is correctly inserted in both the equipment's internal optical connector and the optical socket.</li> <li>• Check if the optical connectors are in good state condition and clean;</li> <li>• Check that the optical patchcord is intact, has not been cut or twisted.</li> </ul> |
| PHONE/TEL (L5)       | OFF      | VoIP deactivated in the equipment                              | <ul style="list-style-type: none"> <li>• Contact the technical support</li> </ul>   |
| PON (L1)             | Flashing | If not on the initial state, error in equipment authentication |   |



Rua Eng. José Ferreira Pinto Basto  
3810-106 Aveiro  
Portugal

Tel.: +351 234 403 200  
Fax: +351 234 424 723



[www.alticelabs.com](http://www.alticelabs.com)