Technical Specification – DG – GPON / XGSPON

Informationsklasse: Öffentlich / Information class: Public

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2 Document Control

2.1 Releases

Version	Date	Changes
V.0.1	10-11-2021	Document structure and description of the design
V.0.2	01-04-2022	Extension with technical specifications and visualizations
V.1.0	08-04-2022	Editorial adjustments
V.1.1	09-06-2022	Editorial adjustments
V.1.2	05-10-2022	Editorial adjustments

3   Contact Information

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4 Abbrevations

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CPE	Customer Premises Equipment
FTTH	Fiber To The Home
GPON	Gigabit Passive Optical Network
HÜP	Haus Übergabe Punkt
GEM	G-PON Encapsulation Method
GF-TA	Glasfaser-Teilnehmerabschluss
OLT	Optical Line Terminal
OMCI	ONU Management and Control Interface
ONU	Optical Network Unit
ONT	Optical Network Terminal
PMD	Physical Medium Dependent
PVID	Port VLAN ID
SFP	Small Form Factor Pluggable device
XGEM	10-Gigabit-capable PON Encapsulation Method
XGSPON	10-Gigabit-capable symmetric passive optical network

5 Introduction

5.1 Document Purpose

This document describes the GPON and XGS-PON interface specifition at the R/S reference point as defined by TR-156 (Broadband forum) between ONT and the OLT in the network of Deutsche Glasfaser.

In this technical specification the term ONT is generally used, in other documents or ITU recommendations the term ONU might also be used but from xPON functionality point of view these two terms are identical.

Customers using ONT's which aren't officially entitled as Deutsche Glasfaser certified ONT need to comply to this document. Deutsche Glasfaser has the obligation to provide a stable GPON access network and therefore ONT's not being compliant can be restricted from access to the network of Deutsche Glasfaser. In the event of severe network disturbance caused by customers ONT it's in the jurisdiction of Deutsche Glasfaser to physical disconnect the ONT from the network.

5.2 Document Scope

This document is applicabel to the GF-TA (Glasfaser-Teilnehmerabschluss) of Deutsch Glasfaser which is the interconnection point between HÜP (Hausübergabepunkt) and GPON ONT. This document defines GPON protocol specific and layer 2 (ethernet) forwarding requirements for the GPON ONT for connecting to the network of Deutsche Glasfaser.
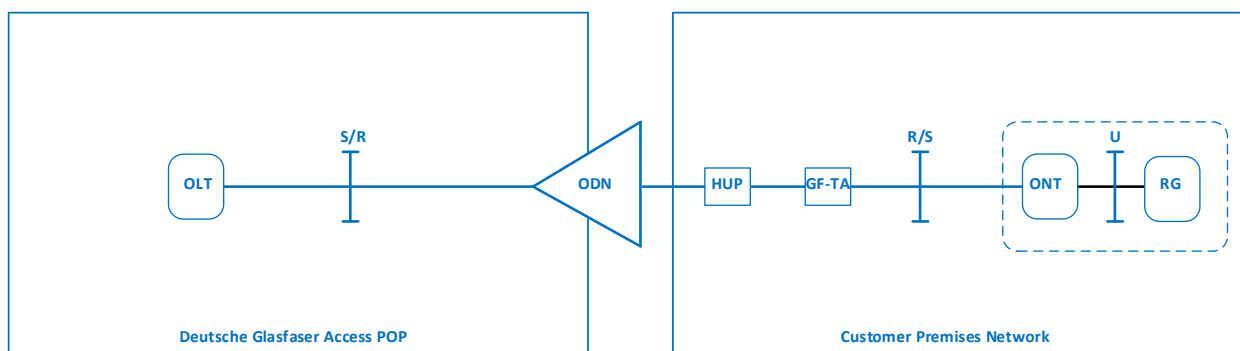
IF_{PON} denotes the the interface at reference points S/R and R/S. This interface must support all protocols that are necessary for transmission between OLT and GPON and XGS-PON ONT's/ONU's.

ONT's come in many different form factors; self contained applicance, integrated in CPE or as a SFP with integrated ONT capabilities. This specification is supporting all previous form factors in case the general requirements for safety and electronics are met.

6   Technical Description

The relevant DG requirements for GPON and XGS-PON ONT's are highlighted in this chapter.

6.1   General ONT Requirements

The ONT R/S interface must comply with below general requirements:

- GPON ONT must follow all requirements defined in ITU-T recommendation series G.984.x:
  - G.984.1 GPON Service Requirements
  - G.984.2 GPON PMD Layer
  - G.984.3 GPON TC Layer
  - G.984.4 GPON OMCI
  - G.984.5 Enhancement Band
  - G.984.6 Reach Extension
  - G.984.7 Long Reach

  This also includes all annexes and amendments at the time of writing this document.

- XGS-PON ONT must follow all requirements defined in ITU-T recommendation series ITU-T G9807.x:
  - G.9807.1   10-Gigabit-capable symmetric passive optical network (XGS-PON)
  - G.9807.2   10 Gigabit-capable passive optical networks (XG(S)-PON): Reach extension

  This also includes all annexes and amendments at the time of writing this document.

- GPON and XGS-PON ONT's must support the requirements defined in ITU-T recommendation G.988. This also includes all annexes and amendments at the time of writing this document.

6.2   Physical Layer (PMD Layer) Requirements

The following requirements must be met on GPON ONT:

- Accordance to ITU-T G.942.2 specification
- Single mode fiber operation of IF_{PON}-interface according to ITU-T G.652 D [6]
- Usage of NRZ coding and scrambling for the line code
- Connector type: LC/APC 8⁰
- Patch cable: duplex fiber 9/125µm, ITU-T G.657 A1 or A2 conform
- Frame structure: GEM
- Wavelengths:
  - downstream (RX):   1480-1500 nm, center 1490 nm
  - upstream (TX):   1260-1360 nm, center 1310 nm
- Max. line rate:
  - downstream: 2.488 Gbit/s
  - upstream: 1.244 Gbit/s

The following requirements must be met on XGS-PON ONT:

- Accordance to ITU-T G.9807.1 Annex B specification
- Usage of NRZ coding and scrambling for the line code
- Connector type: LC/APC 8^0
- Patch cable: duplex fiber 9/125µm, ITU-T … and/or …
- Interface HÜP: SFP+
- Frame structure: XGEM
- Wavelengths:
    - downstream (RX):   1575-1580, center 1577 nm
    - upstream (TX):   1260-1280 nm, center 1270 nm
- Max. line rate:
    - downstream: 9.953 Gbit/s
    - upstream: 9.953 Gbit/s

6.3 Data Link Layer (TC Layer) Requirements

The requirements specified for GPON (ITU-T G.983.3) and XGS-PON (ITU-T G.9807.1) must be met.

Highlighted, important requirements:

- GPON ONT support of GPON Encapsulation Method (GEM)

- XGS-PON ONT support for XGEM

- The ONT must support Dynamic Bandwidth Assignment (DBA) payload processing for GPON and XGS-PON ONT's. Status reporting (SR) and non-status reporting (NSR) operation modes must be supported by ONT.

- Forward Error Correction (FEC) must be supported for upstream ans downstream traffic direction.

- Tagged and untagged VLAN traffic from one or more UNI interfaces must be transported/mapped to a single GEM port in upstream direction

- GEM mapping must allow for granular QoS handling and differentiation based on IEEE802.1p setting (p-bit). Example: untagged traffic in the lowest priority queue (best effort) while Voice traffic is assigned to a strict priority queue.

    The ONT must allow the configuration of P-bit settings on a per VLAN basis.

    Untagged frames received on UNI interface (U reference interface) of the ONT should be tagged with the PVID on the ONT. These frames should be send tagged towards the OLT.

- Support for fragmentation of upstream data and OMCI packets on ONT.

6.4 ONU Management and Control Interface (OMCI) Requirements

GPON and XGS-PON requirement must fullfil the ITU-T G.988 specification.

Important Operation, Administration and Maintenance (OAM) requirements for ONT:

- ONT ability to detect and notify alarms, based on TC-Layer; example for GPON ONT: accordance to ITU-T standard G.984.3 [3]

- Performance monitoring (accumulating and reporting counters)

- Optical Layer Supervision (OLS) for ONT's: the following general system errors and characteristics must be correctly identified:
    - ONT state
    - ONT UNI port states
    - Switch on/off (dying gasp; reporting of loss of power)

6.5 Deutsche Glasfaser specific aspects

6.5.1 ONT Registration and Activation

At the time of writing this document the network of Deutsche Glasfaser uses ONT's serial number for OLT registration (ITU-T G.988). The automated service provisioning process uses the supplied ONT-ID which is acquired during the registration process. For this purpose changing the ONT's hardware requires ONT replacement procedure to be initiated by Deutsche Glasfaser for which a change procedure needs to be started.

Note/delimitation to the GPON authentication methods specified in ITU-T G.984.3[3]:
- Serial Number (SN)
- Password (PW)
- Combination of SN and PW
Currently only SN authentication is used within Deutsche Glasfaser.

6.5.2 Equipment ID

In order to correctly identify a certain type of ONT the netwok of Deutsche Glasfaser uses the "Equipment ID" (ITU G.984.4, ITU G.988) attribute to correctly model the ONT, the "Equipment ID" attribute is a 20 bytes field which can contain the following alphanumeric and special characters.

- 0-9
- aA-zZ
- ~!@#$%^&()-_=+[{]}\|;<>?

The coexistence of GPON and XGSPON ONT's in the network of Deutsche Glafaser is one of the main reasons for this attribute to be set. The parameter must be set by the ONT in the ONT registration procedures.

6.5.3 Important parameters U reference interface

Supported protocols on the U reference interface:

- IPoE with support for
    - DHCPv4 (RFC 2131) and
    - DHCPv6 (RFC 8415)
- PPPoE for LNS/LAC deployments

A maximum of 5 customer MAC addresses are supported per VLAN interface. Traffic from additional MAC addresses will be silently dropped.

Relevant security features are primarily implemented and inforced on the OLT.