Amendment 1 to Technical Specification of the Broadband-Access-Interfaces in the network of Deutsche Telekom

1 TR 112 Version 14

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Summary

Amendment 1 to 1 TR 112 contains the Technical Specification of the IF_{PON}-Interface (R/S-Reference point) between GPON OLT and ONT in the network of Deutsche Telekom, according to the system architecture and requirements defined in ITU-T Recommendation series G.984.x.

History

Version	Published	Remarks
1.0	06/2017	First Edition
14	09/2021	• Add traffic mapping by using 8 GEM Ports • Add Software Download chapter • Add chapter Security • Editorial corrections

Amendment 1 to 1 TR 112 Version 14

Technical Specification of the IF_{PON}-Interface (R/S-Reference point) between GPON OLT and ONT in the network of Deutsche Telekom

Foreword

This Amendment has been produced by Deutsche Telekom AG (in the following named as Deutsche Telekom) and describes the IF_{PON}-Interface (GPON line interface) at the R/S-Reference point at the passive Network Termination Point (NTP, aka Gf-TA) between an Optical Network Termination (ONT) and an Optical Line Termination (OLT) within a Gigabit-capable Passive Optical Network (GPON) system in the network of Deutsche Telekom.

– S: Point on the optical fibre just after the OLT[a]/ONU[b] optical connection point (i.e. optical connector or optical splice).
– R: Point on the optical fibre just before the ONU[a]/OLT[b] optical connection point (i.e. optical connector or optical splice).

Compliance with this document is required for full functional compatibility between the GPON OLT in DT's network and a customer owned ONT device in the customers home.

1 Scope

The present Technical Specification is applicable to Gigabit-capable Passive Optical Network (GPON) systems ONT, connected to the passive Network Termination Point (NTP, aka Gf-TA) of Deutsche Telekom.

The description defines the IF_{PON}-Interface of an ONT and specific Layer 2 transmission requirements for the ONT. Any requirements other than IF_{PON}-Interface related are out of scope of this document.

The term ONT in the context of this document covers:

a) stand-alone ONT devices

b) the ONT-specific submodule of integrated Home-Gateway devices (CPE-Router)

c) pluggable SFP-modules with integrated GPON-ONT-capability (ONT-SFP).

In a wholesale scenario where other service providers are connected to the access network of Deutsche Telekom the IF_{PON}-Interface of their ONT/integrated Home-Gateway must be fully compliant to this document.

In the special case of “wholebuy”, where a Deutsche Telekom Customer is connected to another operator’s GPON access network, DT assures compliance of its own ONTs to this document.

2 Technical description of the IF_{PON}-Interface

2.1 General Requirements

In the context of this specification generally the term ONT has been used. However, if the term ONU is used, from the GPON functionality point of view, these two entities are identical and have an equivalent meaning.

The ONT must meet the following general requirements:

a) The ONT must support the system architecture and requirements defined in ITU-T Recommendation series G.984.x including all Annexes and Amendments in their revisions at the time of publication of this specification.

b) The ONT must support the system architecture and requirements defined in ITU-T G.988 [5] including all Annexes and Amendments in their revisions at the time of publication of this specification.

c) The ONT must be certified according to Broadband Forum BBF.247 [15] certification.
→ https://www.broadband-forum.org/implementation/interop-certification/test-certification-program

The compliance of the ONT with the specifications listed above does not guarantee full functionality in DTs network scenario due to the diversity of implementation options within the standards framework.

2.1.1 General Reference Model of GPON System and Customer ONT/RG

The following reference model encompasses OLT and ONT/ONU elements as well as the R/S reference point.

The interface at reference points S/R and R/S is defined as IF_{PON}. This is a PON-specific interface that supports all the protocol elements necessary to allow transmission between OLT and ONUs.

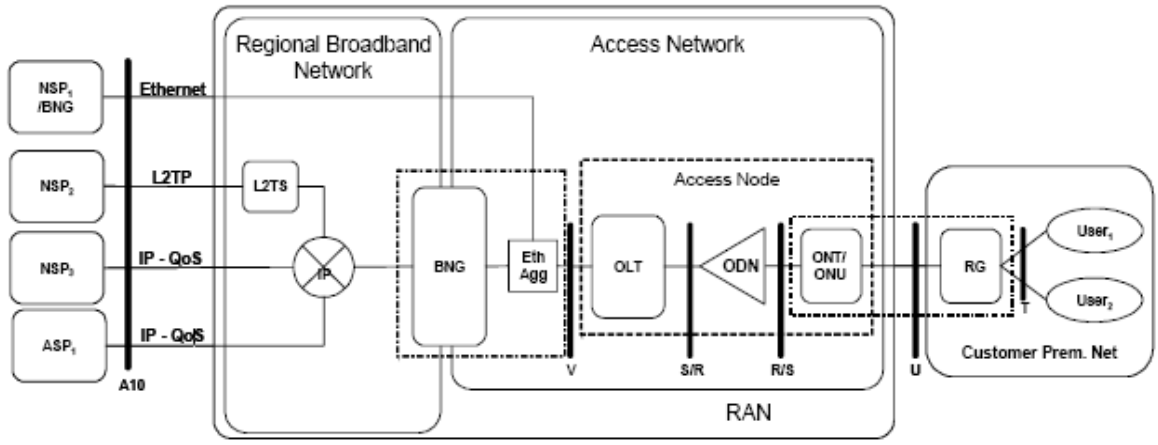

Figure 1: Network architecture for Ethernet-based GPON aggregation (according to BBF TR-156 [14])

Management of the GPON ONT must be based on OMCI Channel according to ITU-T Recommendation G.988 [5] including all amendments solely.

2.1.2 GPON Adaptation Function

In the scope of this document FTTH is deployed in a single-family residential scenario and connects the GPON-OLT in the central office (CO) to a customer owned ONT at the user's premise that provides the GPON adaptation function.

The customer owned ONT provides the adaptation to the GPON uplink, providing mapping of Ethernet frames to the standard GPON specific scheduling and traffic management mechanisms in the upstream direction and extraction of the relevant traffic from the GPON interface in the downstream direction.

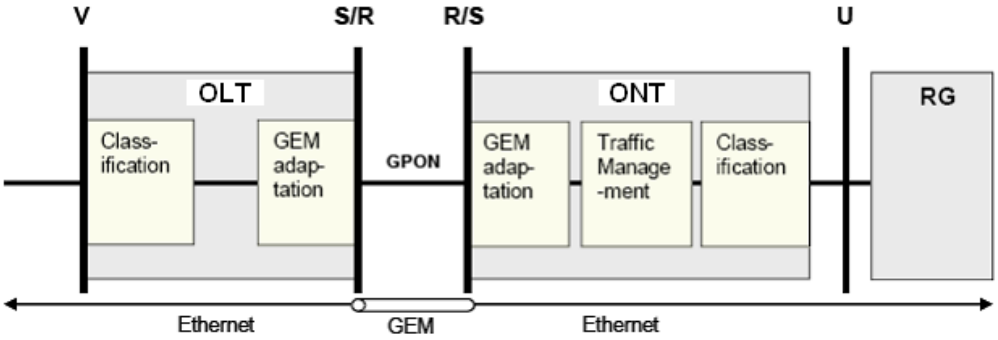

Figure 2: GPON GEM adaptation of Ethernet according to BBF TR-156 [14]

2.2 Physical layer Requirements (PMD-Layer) for GPON-ONT

The ONT must meet the following Physical Layer requirements:

a) The GPON interface implemented in the ONT must fully support ONT functionality according to the following ITU-T Recommendation series: G.984.x (G.984.1 [1], G.984.2 [2], G.984.3 [3], and G.984.5 [4]) and G.988 [5]; including all Annexes and Amendments.

b) The IF_{PON}-interface must be a single fiber interface only.

c) The ONT must operate on a single mode optical fiber according ITU-T G.652 D [6].

d) The ONT must operate on bending loss insensitive single mode optical fiber according to ITU-T G.657 A1 or A2 [7].

e) The downstream (2488.32 Mbit/s) and upstream (1244.16 Mbit/s) bit rates of the ONT optical interfaces must fully comply with the requirements of ITU-T Recommendation series G.984.x.

f) The ONT must use NRZ coding + scrambling for the line code.

g) In the downstream direction the ONT must operate in the wavelength range between 1480 – 1500 nm.
In the upstream direction the ONT must operate in the “Reduced wavelength band option” (1290 – 1330 nm) or in the “Narrow wavelength band option” (1300 - 1320 nm) according to the reduction of the upstream wavelength window described in ITU-T G.984.5 [4].

h) The minimum optical sensitivity requirements of the ONT must be met in the presence of interference signals caused by NG-PON-systems (e.g. XG-PON1, XGS-PON, NG-PON2) and/or video signals (RF-overlay) in the enhancement bands specified in ITU-T Rec. G.984.5 [4], Table 1. To minimize the effect of interference signals, the GPON-ONT must be equipped with appropriate wavelength blocking filters (WBF) and WDM filter to isolate interference signals. The GPON-ONT must meet the X/S-tolerance mask (S is the optical power of the basic band signal and X is the optical power of the interference signal(s)) specified in ITU-T Rec. G.984.5 [4], chapter 8.

i) The ONT must support the minimum requirements for Class B+ according to G.984.2 (08/2019) [2] Annex A (Industry Best Practice), Table A.1/G.984.2.

j) The ONT must support the minimum requirements for Class C+ according to G.984.2 (08/2019) [2] Appendix V, Table V.1/G.984.2.

k) The ONT must support the minimum requirements for Class D according to G.984.2 (08/2019) [2] Appendix V, Table V.2/G.984.2.

NOTE – The ONU sensitivity for Class C+ and/or D assumes the use of the optional RS (255,239) FEC capability of the GPON TC layer with the current class B+ ONU detector technology and a more powerful OLT-Transceiver. It is the discretion of DT to use transceivers for Class B+ or C+ or D in the OLT. A common ONT must comply with this requirement.

2.3 Transmission Convergence Requirements (TC Layer) for GPON-ONT

The ONT must meet the following TC-Layer requirements:

a) The ONT registration process and activation procedure must comply with ITU-T Rec. G.984.3 [3].
The ONT must support all three authentication modes:
- by Serial Number (SN)
- by password (Registration_ID)
- by SN+password.

b) The ONT must support the provisioning of a GPON password by the customer.

c) The GPON system must support GPON Encapsulation Method (GEM) mapping in conformity to ITU-T Rec. G.984.3 [3] (Ethernet over GEM).

d) The ONT must support mapping traffic from one or more UNI interfaces to a single GEM Port in upstream direction. UNI-Port can be a physical interface in case of a standalone ONT or a virtual interface in case of an integrated Home-Gateway or a pluggable SFP-ONT.

e) The ONT must support mapping traffic from a single GEM Port into a single T-CONT based on IEEE802.1p-information (p-bit). Untagged traffic must also be mapped into the same T-CONT using lowest priority queue (Best effort). For QoS a strict priority mechanism must be supported in a way that a dedicated queue is assigned to each p-bit-value.
The basic scheme according to ITU-T G.988 [5] chapter II.3.3 is shown in Figure 3.

f) The ONT must support mapping traffic from eight GEM Ports into a single T-CONT based on IEEE802.1p-information (p-bit). Untagged traffic must also be mapped into the same T-CONT using lowest priority queue (Best effort). For QoS a strict priority mechanism must be supported in a way that a dedicated queue is assigned to each p-bit-value.
The basic scheme according to ITU-T G.988 [5] chapter II.3.3 is shown in Figure 4.

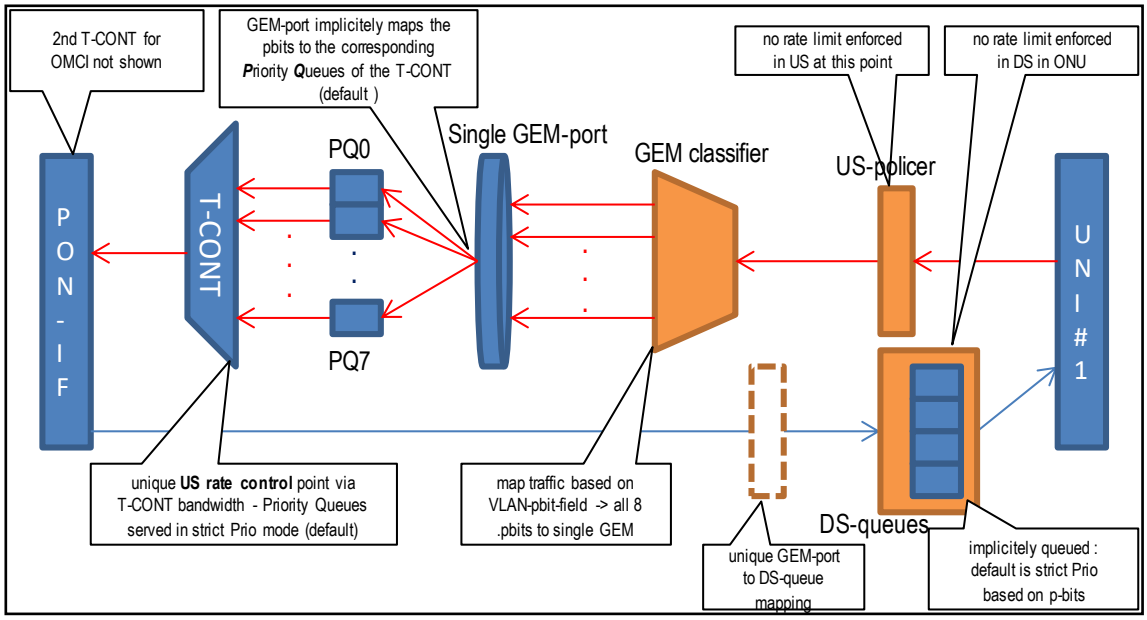

Figure 3 Scheme of user traffic mapping by using single GEM Port

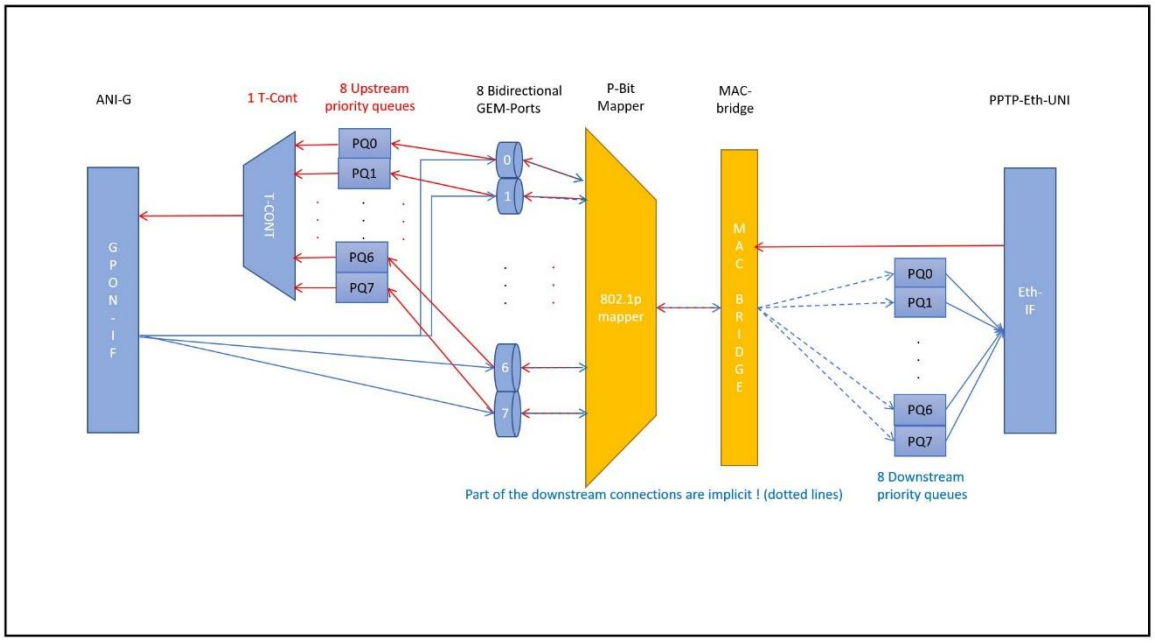

Figure 4 Scheme of user traffic mapping by using 8 GEM Ports

g) The ONT must support mapping traffic from one or more GEM Ports to one UNI interface in the downstream direction. UNI-Port can be a physical interface in case of a standalone ONT or a virtual interface in case of an integrated Home-Gateway or a pluggable SFP-ONT.

h) The ONT must support one bi-directional GEM Port for each class of service configured for the UNI-interface.

i) The ONT must support receiving traffic on at least one unidirectional (downstream only) GEM port (e.g. Multicast-GEM-Port).

j) The ONT must support fragmentation of data packets and OMCI packets in upstream direction. The packets can be fragmented by the auto-sensing length or the fixed length. The auto-sensing fragmentation mode is used by default.

k) The ONT must support variable-length OMCI messages.

l) The ONT must support Dynamic Bandwidth Assignment (DBA) payload processing in conformance to ITU-T Rec.G.984.3 [3]. The ONT must support DBA in status reporting (SR) and non-status reporting (NSR) modes. The DBA in SR mode must be supported by default. The ONT must support piggyback status reporting using DBRu structure of upstream burst in status report format Mode 0.

m) The ONT must support eight T-CONTs. Each T-CONT must support mapping of multiple GEM-ports to a T-CONT.

n) The ONT must support all five T-CONT types whereby in case of using mixed types each parameter can be set to zero, but never all parameters of a T-CONT configured to zero at the same time.

o) The ONT must support Forward Error Correction (FEC) for both upstream and downstream direction (FEC decoding in downstream direction, FEC coding in upstream direction).

p) A FEC on/off selection must be configurable, separate for each transmission direction. In downstream it must be configurable per PON and in upstream separate per ONT.

q) The ONT must support encryption of downstream unicast data channels and OMCI channels (AES-128 encryption algorithm) as described in ITU-T G.984.3 [3].

r) The ONT must be capable of switching the AES-encryption on/off on demand by an OLT command per GEM-port basis. All necessary parameters (selection of flows to be encrypted, etc.) must be configurable and are controlled via OLT.

s) All GEM-ports of a single ONT are to be encrypted with the same key.

t) The ONT must support key generation and responses to key requests from the OLT according to ITU-T G.984.3 [3].

u) The ONT must be capable of fully supporting the G.988 based secure transport of encryption keys.

v) The ONT must guarantee full Gigabit performance (throughput) also in case of short frames with frame sizes below 200 bytes (e.g. numerous parallel voice calls).

w) The GPON ONT must support oversized Ethernet frames of at least 2000 byte as per IEEE 802.3as [13].

x) The GPON ONT must support bridging PPPoE over the encapsulated Ethernet as defined in IETF RFC 2516 [8].

y) The GPON ONT must be able to bridge IP over Ethernet.

z) The ONT must support IPv4 and IPv6 forwarding indiscriminately.

aa) The GPON ONT must support transparent transmission of Ethernet frames, regardless of source and destination MAC addresses (including all multicast MAC addresses).

bb) Performance counter must be implemented as described in RMON-MIB (IETF RFC 2819 [10]), EtherLike-MIB (IETF RFC 3635 [11]) and SMON-MIB (IETF RFC 2613 [9]).

cc) The ONT Hardware must support a minimum of 16 GEM-Ports.

2.4 QoS Requirements for GPON-ONT

The ONT must meet the following QoS requirements:

a) The ONT must support mapping upstream traffic into individual GEM ports based on the .p-bits contained in the user VLAN-tag.

b) The ONT must support transparent forwarding, setting and modifying VLAN-tag and its p-bit markings in the upstream direction.

c) In the upstream direction, the ONT must support 8 queues per R/S interface, one per traffic class.

d) The ONT must support scheduling among all used queues according to a strict priority.

e) The ONT must support at least 8 network facing T-CONTs, one per traffic class (this is in addition to the T-CONT for the internal OMCI Channel).

f) GEM channels which are not explicitly configured for an ONT MUST NOT be forwarded to the U-Interface(s) of this ONT. The only exception is the Multicast-GEM port.

2.5 VLAN Handling Requirements for GPON-ONT

The ONT must meet the following VLAN-handling requirements

a) The ONT must be fully compliant with BBF TR-156 [14].

b) The GPON ONT must support bridging of 802.1q tagged Ethernet frames between U-interface and GPON interface.

c) The ONT must support the VLAN-ID range from 1 to 4094.

d) The ONT must support all VLAN architectures described within BBF TR-156 [14] (1:1, N:1, TLS).

e) If VLAN tags are to be added/modified at the ONT these VLAN tags must be marked with TPID = 0x8100.

f) All untagged frames must be forwarded transparently. It must also be possible to assign a configurable default VLAN-ID (also called “native VLAN”) via OLT command.

g) The ONT must be able to accept both tagged and untagged frames from the customer. This shall be configurable per U-interface (ONT) via OLT command.

2.6 ONT-Requirements for GPON specific Operation, Administration and Maintenance (OAM)

The GPON-System must be able to detect failures in hardware and software as well as monitor the health and performance of links according the ITU-T standard G.984.3 [3].

2.6.1 Signalling of Errors, Malfunctions and Alarms

a) The functionality to detect and notify alarms, based on TC-Layer must be implemented in the ONT according to the ITU-T standard G.984.3 [3].

b) The ONT must support alarm detection and notification according to Figure 5 (alarms and messages generated by the OLT and the ONT).

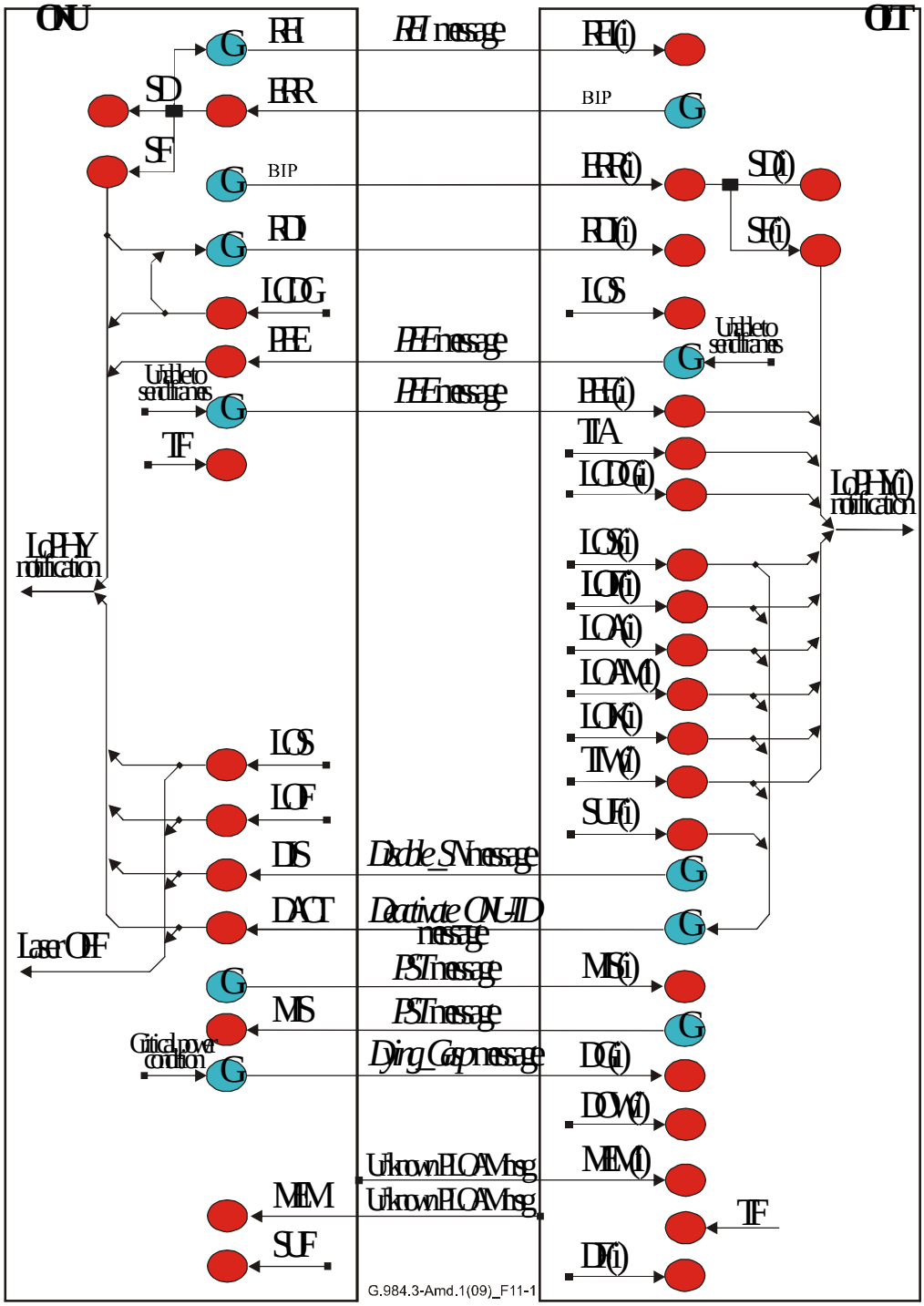

Figure 5 Alarms detection and notification

c) The ONT must be able to detect the Items listed in the following table. Detection conditions and actions to be taken as well as Cancellation conditions and actions to be taken must comply with ITU-T G.984.3 [3].

Type		Description			
		Detection conditions	**Actions**	**Cancellation conditions**	**Actions**
LOS	Loss of signal	No valid signal is received in the downstream.	Switch off laser. Generate Loss_of_phy_layer notification. Change state according to clause 10.	Valid optical signal.	Restart the PSync acquisition state machine. Once LOF is cleared, if in O1 state, move to O2 state; if in O6 state, remain in O6. Restart superframe synchronization state machine.
LOF	Loss of frame	When 5 consecutive invalid PSync from OLT are received.	Switch off laser. Generate Loss_of_phy_layer notification. Change state according to clause 10.	When 2 consecutive frames have correct PSync.	If in O1 state, move to O2 state; if in O6 state, remain in O6. Restart superframe synchroni-zation state machine.
SF	Signal failed	When the downstream BER becomes $\geq 10^{-y}$, this state is entered. Y is configurable in the range of 5 to 8.	Generate Loss_of_PHY_Layer notification.	Set inactive when the downstream BER is $<10^{-(y+1)}$.	–
SD	Signal degraded	When the downstream BER becomes $\geq 10^{-x}$, this state is entered. X is configurable in the range of 6 to 9, but must be higher than Y.	–	Set inactive when the downstream BER is $< 10^{-(x+1)}$.	–
LCDG	Loss of GEM channel delineation	When GEM fragment delineation is lost according to clause 8.3.2 state machine.	Generate Loss_of_phy_layer notification.	When GEM delineation is achieved.	–
TF	Transmitter failure	The ONU transmitter is declared in failure when there is no nominal backfacet photocurrent or when the drive currents go beyond the maximum specification.	–	–	–
SUF	Start-up failure	The ranging of this ONU has failed (see ranging protocol for exact condition).	–	When ranging is successful.	–
MEM	Message error message	When the ONU receives an unknown message.	–	–	–
DACT	Deactivate ONU-ID	When the ONU receives Deactivate_ONU-ID message. It instructs the ONU to deactivate itself.	Switch off the laser and go to *Standby* state. Generate Loss_of_phy_layer notification.	Reception of Upstream_Overhead message.	Enable laser.

Type		Description			
		Detection conditions	**Actions**	**Cancellation conditions**	**Actions**
DIS	Disabled ONU	When the ONU receives a **Disable_Serial_ Number** message with its own serial number and the enable flag equal to 0xFF. It stays in this state even after power off.	Switch off laser. Go to ***Emergency Stop*** state Generate Loss_of_phy_layer notification.	When the ONU receives a **Disable_Serial_Number** message with enable flag equal to 0x0F or when it receives a Disable_ Serial_Number message with its own serial number and the enable flag equal to 0x00.	Go to Initial state.
MIS	Link mismatching	The ONU detects that the received PST and transmitted PST are different.	–	The ONU detects that the received PST and transmitted PST are the same.	–
PEE	Physical equipment error	When the ONU receives a PEE message.	Generate Loss_of_physical_ layer notification.	When the ONU does not receive a PEE message in 3 s.	
RDI	Remote defect indication in ONU	When the OLT transmission is received with defects at the ONU. The defects include general failures of the downstream data path, including excessive bit errors (after FEC), or corrupted overheads. Single bit errors are not considered defects.	Set RDI status bit in PLOu.	When the OLT transmission defect is resolved.	Clear RDI status bit in PLOu.

Table 1

Note that, strictly speaking, switching off the ONU's laser is a result of the ONU activation state transition caused by the alarm, rather than by the alarm itself.

d) The ONT must support “Dying Gasp” reporting (reporting of loss of power).

2.6.2 Performance monitoring

a) The ONT must support downstream FEC performance counters.

b) The ONT must support performance monitoring based on defects and the BIP errors in a frame/transmission.

c) The ONT must support regular reporting of BIP error counters to the OLT at the interval specified in BER Interval messages.

Type		Description	
		Detection conditions	**Actions**
ERR	BIP errors	The received BIP-8 is compared with the calculated BIP-8 on the received stream. In case of a difference, ERR counter is incremented.	The number of differing bits is accumulated in ERR. SD and SF alarms are declared upon BER crossing a defined threshold.

Table 2

d) The ONT must support collection of GEM port performance counters, including the number of sent GEM frames, the number of received GEM frames, the number of received payload bytes, and the number of sent payload bytes.

e) The ONT must support GEM interface performance counters.

f) The ONT must support Ethernet port performance counters. Ethernet-Port can be a physical interface in case of a standalone ONT or a virtual port in case of an integrated Home-Gateway or a pluggable SFP-ONT.

2.6.3 Optical Layer Supervision (OLS) Requirements for GPON-ONT

The fiber testing is a new and significant part of the troubleshooting process on optical access networks (FTTH) at Deutsche Telekom. During the initial customer contact, the goal is to remotely determine the fault cause as well as fault type and fault location.

ONT states and line-specific data will be used to help identify any specific faults which then must be localized or excluded by testing.

a) The ONT must support the identification of the following general system errors and characteristics:

- GPON ONT state
- ONT UNI port states
- Switch on/off ONT (Dying gasp)

The ITU-T recommendation G.984.2 (08/2019) Annex B [2] describes physical layer parameter measurements that are required to provide the GPON system with a basic optical layer supervision capability. Optical Layer Supervision in the context of this document means a set of capabilities relating to the measurement and reporting of the state of the optical link.

b) The ONT must support Optical Line Supervision according to ITU-T G.984.2 (08/2019) Annex B [2].

c) The ONT must support measurement of the parameters in Table 3 below (also refer to ITU-T G.984.2 (08/2019) Annex B [2] Table B.1 – “Optical line supervision related measurement specifications”) The precondition for this scenario is: ONTs are ranged at the OLT.

	Typical Range [Note 1]	Resolution	Accuracy	Repeatability	Typical Response time
Temperature – ONT	-45 to +90 °C	0.25 °C	± 3 °C	± 1 °C	1s
Voltage – ONT [Note 4]	0 to 6.55 V	0.5 % of nominal	± 3 % of nominal	± 1 % of nominal	1s
Bias Current – ONT [Note 4]	0 to 131 mA	1 % of nominal	± 10 % of nominal	± 5 % of nominal	1s
ONT Transmit power	-10 to +8 dBm	0.1 dB	± 3 dB	± 0.5 dB [Note 2]	300ns
ONT Receive power	-34 to -8 dBm	0.1 dB	± 3 dB	± 0.5 dB [Note 2]	300ns

Table 3: Optical Line Supervision related measurement specifications according to G.984.2 Annex B

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

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

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

2.7 Additional Functional Requirements for ONT

2.7.1 Rogue ONT / Continuous-mode detection

a) An ONT MUST NOT violate the correct and secure operation of the PON-tree where it is attached to.

b) The ONT must support rogue ONT messages from the OLT and must support the start-up and shut-down of transmit power of the optical module based on the messages.

c) The ONT must support rogue ONT self-detection and self-isolation.

d) The ONT must switch off laser and go to Emergency Stop State after it receives a Disable_Serial_ Number message (DIS ONU) with its own serial number and the enable flag equal to 0xFF.
The ONT must generate Loss_of_phy_layer notification. It must stay in this state even after power off.

2.7.2 Software download

a) Software download/ Software update must be supported. It is the responsibility of the customer to check Software/Firmware status and to download actual files from support area of the ONT vendor.

b) After a Software update a successful restart of the ONT must be guaranteed without harming any other customers ONTs connected to the same PON/OLT.

3 Mechanical Properties of IF_{PON}- Interface

The ONT must operate on a single mode optical fiber according ITU-T G.652 D [6] and/or on bending loss insensitive single mode optical fiber according to ITU-T G.657 [7], category A1 or A2.

The Fiber interface at the Network Termination Point (Gf-TA) supports connector type in accordance with EN 61754-20:2012 [16], Interface 20-5 (LC-APC 8°) only.

A patch cord for the connection of the ONT to the Network Termination Point (Gf-TA) must be provided by the vendor together with the equipment (delivery unit) or must be provided by the customer.

If the ONT uses any other connector type (e.g. SC-APC) it is the obligation of the ONT-vendor or the customer to provide instead of a simple patch cord a compatible adapter patch cord (LC-APC 8° at Gf-TA-side and ONT-connector type on CPE- side).

The patch cord (simple or adapter) must not impact the optical performance of the PON tree (low optical insertion loss and high return loss >55dB/>60dB unplugged/plugged).

The additional optical connection and the patch cord (simple or adapter) between Gf-TA and ONT must not increase the optical attenuation of the fiber link by more than 0,25 dB (1310 nm).

4 Additional requirements

4.1 Laser safety

The ONT must be compliant to the requirements for laser safety in DIN EN 60825-1 [17] (VDE 0837 Part 1) and DIN EN 60825-2 [18] (VDE 0837-2). The required protective measures regarding identification and, if necessary, safety measures by locking or switching off the laser shall be implemented.

The ONT must be labeled in accordance with DIN EN 60825-2 [18] (VDE 0837, part 2) corresponding to the laser class.

4.2 CE-Label

The ONT must be in conformance with the requirements of the European Community for CE labeling. The CE label shall be affixed to the product and the packaging in accordance with the

requirements listed in the applicable EU Directives and the national laws based on these. Furthermore, it must be ensured that the product, the packaging, and the instructions for use comply with the formal CE requirements.

4.3 Security

The GPON Serial Number format must be compliant to G.984.3, chapter 9.2.4.1 and must be hard-coded. Any possibility to change or overwrite the GPON-SN (e.g. via GUI or other) must be prohibited.

5 New References

[1] ITU-T G.984.1: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS; Digital sections and digital line system – Optical line systems for local and access networks
Gigabit-capable passive optical networks (GPON): General characteristics

[2] ITU-T G.984.2: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS; Digital sections and digital line system – Optical line systems for local and access networks
Gigabit-capable Passive Optical Networks (G-PON): Physical Media Dependent (PMD) layer specification

[3] ITU-T G.984.3: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS; Digital sections and digital line system – Optical line systems for local and access networks
Gigabit-capable passive optical networks (G-PON): Transmission convergence layer specification

[4] ITU-T G.984.5: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS; Digital sections and digital line system – Optical line systems for local and access networks
Gigabit-capable passive optical networks (G-PON): Enhancement band

[5] ITU-T G.988: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS; Digital sections and digital line system – Optical line systems for local and access networks
ONU management and control interface (OMCI) specification

[6] ITU-T G.652: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS; Transmission media and optical systems characteristics – Optical fibre cables
Characteristics of a single-mode optical fibre and cable

[7] ITU-T G.657: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS; Transmission media and optical systems characteristics – Optical fibre cables
Characteristics of a bending-loss insensitive single-mode optical fibre and cable

[8] IETF RFC 2516: A Method for Transmitting PPP Over Ethernet (PPPoE)

[9] IETF RFC 2613: Remote Network Monitoring MIB Extensions for Switched Networks

[10] IETF RFC 2819: Remote Network Monitoring Management Information Base

[11] IETF RFC 3635: Definitions of Managed Objects for the Ethernet-like Interface Types

[12] IEEE 802.1Q - IEEE Standard for Local and Metropolitan Area Networks Virtual Bridged Local Area Networks

[13] IEEE802.3as: Ethernet Frame Expansion

[14] Broadband Forum TR-156: Using GPON Access in the context of TR-101

[15] Broadband Forum TR-247: Abstract Test Plan for GPON ONU Conformance (ATP-247)

[16] EN 61754-20: Fibre optic interconnecting devices and passive components – Fibre optic connector interfaces – Part 20: Type LC connector family

[17] EN 60825-1: Safety of laser products - Part 1: Equipment classification and requirements

[18] EN 60825-2: Safety of laser products -- Part 2: Safety of optical fibre communication systems (OFCS)

6 New Abbreviations

For the purposes of the present document, the following abbreviations apply:

-A-	
AES	Advanced Encryption Standard
-B-	
BIP	Bit Interleaved Parity
-C-	
CPE	Customer Premises Equipment
-D-	
DBA	Dynamic Bandwidth Assignment
DBRu	Dynamic Bandwidth Report upstream
-E-	
-F-	
FEC	Forward Error Correction
FTTH	Fiber to the Home
FSAN	Full Service Access Network
-G-	
GEM	Gigabit-capable passive optical network Encapsulation Method
Gf-TA	Glasfaser-Teilnehmeranschlusseinheit
GPON	Gigabit-capable Passive Optical Network
-H-	
-I-	
-J-	
-K-	
-L-	
-M-	
-N-	
NRZ	Non Return to Zero
NSR	Non-status Reporting
NTP	Network Termination Point
-O-	
OLS	Optical Layer Supervision
OLT	Optical Line Termination
OMCI	ONU management and control interface
ONT	Optical Network Termination
ONU	Optical Network Unit
-P-	
PMD-Layer	Physical Media Dependent Layer

-Q-
-R-
-S-

SFP	Small Form-factor Pluggable
SN	Serial Number
SR	Status Reporting

-T-

TC-Layer	Transmission Convergence Layer
T-CONT	Transmission Container

-U-
-V-
-W-

WBF	Wavelength Blocking Filter

-X-
-Y-
-Z-