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SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Digital sections and digital line system – Optical line systems for local and access networks

Broadband optical access systems based on Passive Optical Networks (PON)

ITU-T Recommendation G.983.1

Nokia Exhibit No. 1025
Nokia v. SPADA
IPR2025-01442, U.S. Patent No. 11,589,142

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For further details, please refer to the list of ITU-T Recommendations.

ITU-T Recommendation G.983.1

Broadband optical access systems based on Passive Optical Networks (PON)

Summary

This Recommendation describes a flexible optical fibre access network capable of supporting the bandwidth requirements of narrowband and broadband services. This Recommendation describes systems with nominal downstream line rates of 155.52, 622.08 and 1244.16 Mbit/s, and nominal upstream line rates of 155.52 and 622.08 Mbit/s. Both symmetrical and asymmetrical systems are described. This Recommendation proposes the physical layer requirements and specifications for the physical media dependent layer, the TC layer and the ranging protocol of an ATM-based Broadband Passive Optical Network (B-PON). This revised version of G.983.1 incorporates the material from: G.983.1 (1998), G.983.1 Cor.1 (1999), G.983.1 Amd.1 (2001), G.983.1 Cor.1 Erratum 1 (2002), G.983.1 Amd.2 (2003), G.983.1 Implementor's Guide (2003).

Source

ITU-T Recommendation G.983.1 was approved on 13 January 2005 by ITU-T Study Group 15 (2005-2008) under the ITU-T Recommendation A.8 procedure.

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FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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ITU-T Recommendation G.983.1

Broadband optical access systems based on Passive Optical Networks (PON)

1 Scope

This Recommendation is intended to describe flexible access networks using optical fibre technology. The focus is primarily on a network to support services with a bandwidth requirement greater than ISDN basic rate; it would include video and distributive services.

This Recommendation describes characteristics of an Optical Access Network (OAN) with the capability of transporting various services between the user-network interface and the Service node interface.

The OAN described in this Recommendation should enable the network operator to provide a flexible upgrade to meet future customer requirements, in particular in the area of the Optical Distribution Network (ODN). The ODN considered is based on point-to-multipoint tree and branch option.

This Recommendation concentrates on the fibre issues; the copper issues of hybrid systems are described elsewhere, e.g., xDSL standardization.

This Recommendation covers issues between the Service node interface and the User network.

Although this Recommendation concentrates on issues relating to ATM over a passive optical network, other solutions are not precluded.

This Recommendation proposes the physical layer requirements and specifications for the physical media dependent layer, the TC layer and the ranging protocol of an ATM-based Broadband Passive Optical Network (B-PON).

This Recommendation is part of the G.983.x series. The other major components of this series include:

- G.983.2 (2002), ONT management and control interface specification for B-PON.
- G.983.3 (2001), A broadband optical access system with increased service capability by wavelength allocation.
- G.983.4 (2001), A broadband optical access system with increased service capability using dynamic bandwidth assignment.
- G.983.5 (2001), A broadband optical access system with enhanced survivability.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[1] ITU-T Recommendation G.652 (2003), *Characteristics of a single-mode optical fibre cable*.

[2] ITU-T Recommendation G.671 (2005), *Transmission characteristics of optical components and subsystems*.

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[3] ITU-T Recommendation G.783 (2004), *Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks*.

[4] ITU-T Recommendation G.902 (1995), *Framework Recommendation on functional access networks (AN) – Architecture and functions, access types, management and service node aspects*.

[5] ITU-T Recommendation G.957 (1999), *Optical interfaces for equipments and systems relating to the synchronous digital hierarchy*.

[6] ITU-T Recommendation G.958 (1994), *Digital line systems based on the synchronous digital hierarchy for use on optical fibre cables.*

[7] ITU-T Recommendation G.982 (1996), *Optical access networks to support services up to the ISDN primary rate or equivalent bit rates*.

[8] ITU-T Recommendation I.321 (1991), *B-ISDN protocol reference model and its application*.

[9] ITU-T Recommendation I.326 (2003), *Functional architecture of transport networks based on ATM*.

[10] ITU-T Recommendation I.356 (2000), *B-ISDN ATM layer cell transfer performance*.

[11] ITU-T Recommendation I.361 (1999), *B-ISDN ATM layer specification*.

[12] ITU-T Recommendation I.432.1 (1999), *B-ISDN user-network interface – Physical layer specification: General characteristics.*

[13] ITU-T Recommendation I.610 (1999), *B-ISDN operation and maintenance principles and functions*.

[14] ITU-T Recommendation I.732 (2000), *Functional characteristics of ATM equipment.*

[15] Federal Information Processing Standard No. 197 (2001), *Advanced Encryption Standard (AES), National Institute of Standards and Technology*.

[16] ITU-T Recommendation G.983.2 (2002), *ONT management and control interface specification for B-PON*.

[17] ITU-T Recommendation G.983.3 (2001), *A broadband optical access system with increased service capability by wavelength allocation.*

[18] ITU-T Recommendation G.983.4 (2001), *A broadband optical access system with increased service capability using dynamic bandwidth assignment*.

[19] ITU-T Recommendation G.983.5 (2002), *A broadband optical access system with enhanced survivability*.

3 Abbreviations

This Recommendation uses the following abbreviations:

AES	Advanced Encryption Standard
AF	Adaptation Function
APS	Automatic Protection Switching
ATM	Asynchronous Transfer Mode
BER	Bit Error Ratio
BIP	Bit Interleaved Parity
B-ISDN	Broadband Integrated Services Digital Network

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B-PON	Broadband Passive Optical Network
CID	Consecutive Identical Digit
CPE	Cell Phase Error
CRC	Cyclic Redundancy Check
DSL	Digital Subscriber Line
ECB	Electronic Code Book
E/O	Electrical/Optical
FP-LD	Fabry-Perot Laser Diode
FTTB/C	Fibre to the Building/Curb
FTTCab	Fibre to the Cabinet
FTTH	Fibre to the Home
HEC	Header Error Control
IEC	International Electrotechnical Commission
ISDN	Integrated Services Digital Network
LAN	Local Area Network
LCD	Loss of Cell Delineation
LCF	Laser Control Field
LSB	Least Significant Bit
LT	Line Terminal
MAC	Media Access Control
MLM	Multi-Longitudinal Mode
MSB	Most Significant Bit
NRZ	Non Return to Zero
NT	Network Termination
O/E	Optical/Electrical
OAM	Operations, Administration and Maintenance
OAN	Optical Access Network
ODF	Optical Distribution Frame
ODN	Optical Distribution Network
OLT	Optical Line Termination
OMCC	ONT Management and Control Channel
OMCI	ONT Management and Control Interface
ONT	Optical Network Termination
ONU	Optical Network Unit
OpS	Operations System
ORL	Optical Return Loss
PLOAM	Physical Layer OAM

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PON	Passive Optical Network
PRBS	Pseudo-Random Bit Sequence
PST	PON Section Trace
PSTN	Public Switched Telephone Network
QoS	Quality of Service
RAU	Request Access Unit
RMS	Root Mean Square
RXCF	Receiver Control Field
SDH	Synchronous Digital Hierarchy
SLM	Single-Longitudinal Mode
SN	Serial Number
SNI	Service Node Interface
TC	Transmission Convergence
TDMA	Time Division Multiple Access
UI	Unit Interval
UNI	User Network Interface
UPC	Usage Parameter Control
VC	Virtual Channel
VP	Virtual Path
VPI	Virtual Path Identifier
WDM	Wavelength Division Multiplexing

4 Definitions

This Recommendation defines the following terms:

4.0 Broadband PON: A term used to refer to the entire system described by the G.983.x family of ITU-T Recommendations. This includes a wide range of broadband services, and goes beyond ATM access. For this reason, B-PON supersedes the older usage of ATM-PON.

4.1 churning: A function which can be applied to the downstream user data from an OLT to its ONUs. Churning provides the necessary function of data scrambling and offers a low level of protection for data confidentiality. It is installed at the TC layer of the ATM-PON system and can be activated for point-to-point downstream connections.

4.2 diplex working: Bidirectional communication using a different wavelength for each direction of transmission over a single fibre.

4.3 duplex working: Bidirectional communication using the same wavelength for both directions of transmission over a single fibre.

4.4 grant: OLT controls each upstream transmission from ONUs by sending a permission. Grant is a permission to transmit an upstream cell of each ONU when an ONU receives own grant.

4.5 logical reach: Defined as the maximum length that can be achieved for a particular transmission system independent of optical budget.

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4.6 mean signal transfer delay: The average upstream and downstream values between reference points "V" and "T", a given value is determined by measuring round-trip delay, then dividing by 2.

4.7 optical access network (OAN): The set of access links sharing the same network-side interfaces and supported by optical access transmission systems. The OAN may include a number of ODNs connected to the same OLT.

4.8 optical distribution network (ODN): An ODN provides the optical transmission means from the OLT towards the users, and vice versa. It utilizes passive optical components.

4.9 optical line termination (OLT): An OLT provides the network-side interface of the OAN, and is connected to one or more ODNs.

4.10 ONT management and control channel (OMCC): The communications circuit connecting the control function of the OLT to that of the ONT. The protocol used for this is defined in ITU-T Rec. G.983.2.

4.11 ONT management and control interface (OMCI): The interface defined in ITU-T Rec. G.983.2 that provides a uniform method for managing faults, configuration, performance, and security on ONTs.

4.12 optical network termination (ONT): An ONU used for FTTH and includes the User Port function. This Recommendation uses the term "ONU" to refer to both ONTs and ONUs. Any reference to ONUs includes ONTs as well within this Recommendation.

4.13 optical network unit (ONU): An ONU provides (directly or remotely) the user-side interface of the OAN, and is connected to the ODN. This Recommendation uses the term "ONU" to refer to both ONTs and ONUs. Any reference to ONUs includes ONTs as well within this Recommendation.

4.14 ranging: It is necessary to transmit an upstream cell without cell collision in this system. Ranging is a function to measure the logical distance between each ONU and OLT and decide the transmission timing when each ONU receives a grant.

4.15 service port function: The Service Port Function (SPF) adapts the requirements defined for a specific SNI to the common bearers handling and selects the relevant information for treatment in the AN system management function.

4.16 time division multiple access (TDMA): Transmission technique involving the multiplexing of many time slots onto the same time payload.

4.17 user port function: The User Port Function (UPF) adapts the specific UNI requirements to the core and management functions. The AN may support a number of different accesses and user network interfaces which require specific functions according to the relevant interface specification and the access bearer capability requirements, i.e., bearers for information transfer and protocols.

4.18 verification: It is possible for a malicious user to masquerade as other ONU and use the network if the user knows that the ONU is off power. Verification is a function to check whether the connected ONU is masqueraded by a malicious user.

4.19 wavelength division multiplexing (WDM): Bidirectional multiplexing using different optical wavelength for up and downstream signals.

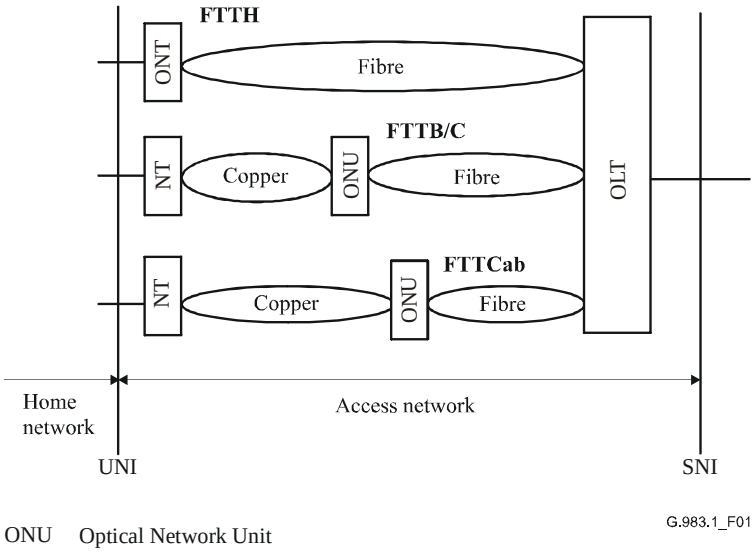
5 Architecture of the optical access network

5.1 Network architecture

The optical section of a local access network system could be either a point-to-point, active, or passive point-to-multipoint architecture. Figure 1 shows the architectures considered, which range

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from Fibre to the Home (FTTH), through Fibre to the Building/Curb (FTTB/C) to Fibre to the Cabinet (FTTCab). The Optical Access Network (OAN) is common to all architectures shown in Figure 1, hence commonality in this system has the potential to generate large world-wide volumes.



ONU Optical Network Unit
ONT Optical Network Termination
OLT Optical Line Termination
NT Network Termination

Figure 1/G.983.1 – Network architecture

The FTTB/C and FTTCab network options are predominantly different only as a result of implementation; therefore, they can be treated similarly in this Recommendation.

5.1.1 FTTCab/C/B scenario

Within this scenario the following service categories have been considered:

– Asymmetric broadband services (e.g., digital broadcast services, VoD, Internet, distant learning, telemedicine, etc.).

– Symmetric broadband services (e.g., telecommunication services for small business customers, teleconsulting, etc.).

– PSTN and ISDN. The access network must be able to provide in a flexible way the narrow-band telephone services with the appropriate timing for the introduction.

5.1.2 FTTH scenario

Fibre to the Home (FTTH) service drivers are similar to those of the previous scenarios and are determined by the following:

_ Indoor ONU's can be considered, resulting in more favorable environmental conditions.

_ No change of intermediate ONU is required to upgrade access network capabilities to accommodate future evolution of broadband and multimedia services.

_ Maintenance is easy, because it requires maintenance only for fibre systems, and all fibre systems are regarded as more reliable than hybrid fibre-metallic ones.

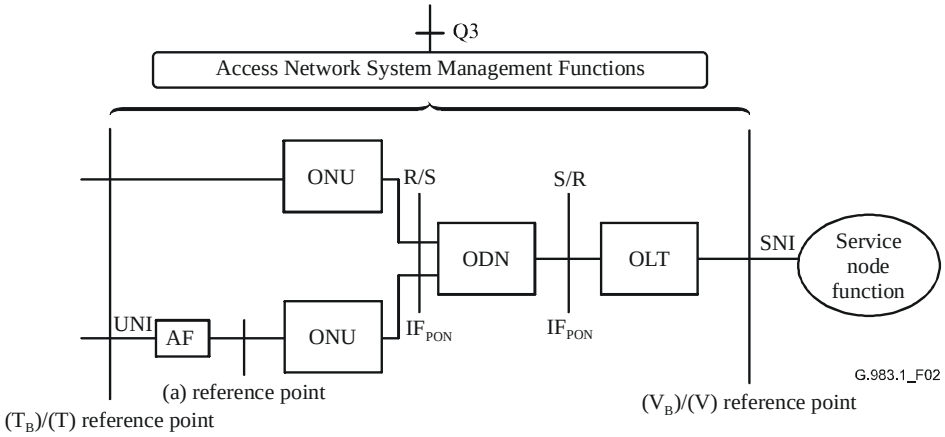
_ FTTH is a driver for the development of advanced optoelectronics technologies. The greater volume in production of optical modules will also accelerate the reduction in cost.

When these factors can be fully exploited they may counterbalance a slightly higher per line cost. In that situation the FTTH scenario may be regarded as economically feasible even in the short term.

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5.2 Reference configuration

The reference configuration from ITU-T Rec. G.982 is shown in Figure 2.



ONU	Optical Network Unit
ODN	Optical Distribution Network
OLT	Optical Line Termination
AF	Adaptation Function
S	Point on the optical fibre just after the OLT[Downstream]/ONU[Upstream] optical connection point (i.e., optical connector or optical splice).
R	Point on the optical fibre just before the ONU[Downstream]/OLT[Upstream] optical connection point (i.e., optical connector or optical splice).
(a)	Reference point – This reference point is added to differentiate the AF from the ONU.

Figure 2/G.983.1 – Reference configuration for an ATM based PON

The ODN offers one or more optical paths between one OLT and one or more ONUs. Each optical path is defined between reference points S and R in a specific wavelength window. The two directions for optical transmission in the ODN are identified as follows:

– downstream direction for signals travelling from the OLT to the ONU(s);

– upstream direction for signals travelling from the ONU(s) to the OLT.

This clause describes the reference architecture for supporting ATM over a PON. This system consists of Optical Line Termination (OLT), Optical Network Unit (ONU) and fibre cable which has a Passive Optical Network (PON) configuration with a passive optical splitter. One fibre is passively split between multiple ONU's who share the capacity of one fibre. Because of the passive splitting, special actions are required with respect to privacy and security. Moreover, in the upstream direction a TDMA protocol is required.

5.2.1 Service Node Interface

See ITU-T Rec. G.902.

5.2.2 Interface at the reference points S/R and R/S

This interface at the 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 the transmission between OLT and ONUs.

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5.3 Functional blocks

5.3.1 Optical Line Termination

The Optical Line Termination (OLT) interface is over the SNI to service nodes, and to the PON. The OLT is responsible for managing all the PON-specific aspects of the ATM transport system. The ONU and OLT provide transparent ATM transport service between the UNIs and the SNI over the PON.

5.3.2 Optical Network Unit

The Optical Network Unit (ONU) interfaces over the IF_{PON} to the OLT, and to the UNI. Together with the OLT, the ONU is responsible for providing transparent ATM transport service between the UNI and the SNI.

In this architecture, the ATM transport protocols at an IFPON are described as consisting of Physical Media Dependent layer, Transmission Convergence layer, and ATM layer. This architecture is only intended to address the transport of ATM, further detail is contained in ITU-T Rec. I.732.

The Physical Media Dependent layer would include the modulation schemes for both the upstream and downstream channels (they may be different). It may be possible for the specification to allow for more than one type of Physical Media Dependent layer in a single direction.

The Transmission Convergence layer will be responsible for managing the distributed access to the upstream PON resource across the multiple ONUs. This is a key protocol element and will directly affect the resulting ATM QoS.

The ATM protocols should see no change in the way they operate over the PON. Within both the OLT and the ONU, the functions performed at the ATM layer at both an OLT and ONU would include cell relaying.

5.3.3 Optical Distribution Network

The Optical Distribution Network provides the optical transmission means from the OLT towards the users and vice versa. It utilizes passive optical components.

5.4 ONU functional block

As an example, the FTTH ONT is active and decouples the access network delivery mechanism from the in-house distribution. The ONT core consists of ODN interface, User Port, Transmission, Services and Customers Multiplexing (MUX)/demultiplexing functions and powering, see Figure 3.

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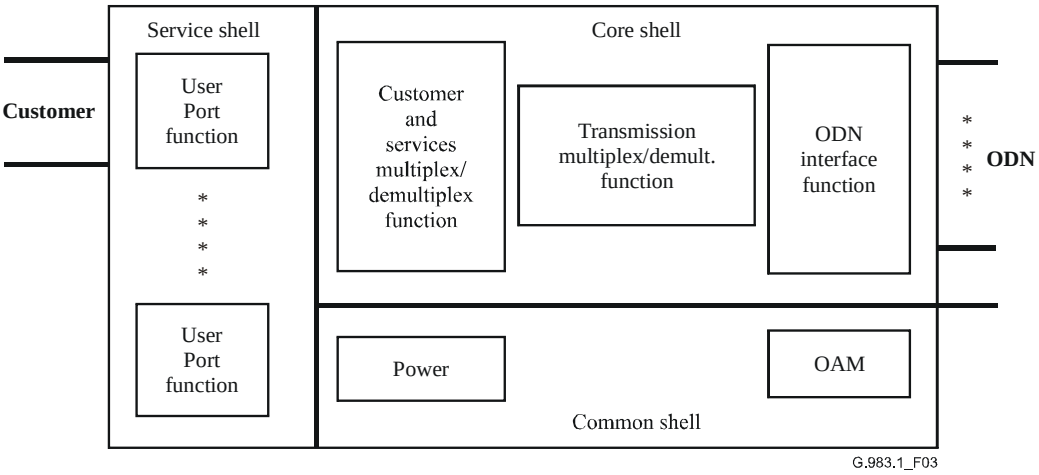


Figure 3/G.983.1 – Example of ONT functional blocks

5.4.1 Optical Distribution Network interface

The ODN interface handles the optoelectronic conversion process. The ODN interface extracts ATM cells from the downstream PON payload and inserts ATM cells into the upstream PON payload based on synchronization acquired from the downstream frame timing.

5.4.2 Multiplexing

Multiplexer (MUX) multiplexes service interfaces to ODN interface. Only valid ATM cells can be passed through the MUX, so many VPs can share the assigned upstream bandwidth effectively.

5.4.3 User Port

The User Port interfaces over UNI to a terminal. The User Port may handle inserting ATM cells into the upstream payload and extracting ATM cells from the downstream payload.

5.4.4 ONU powering

ONU powering may be implementation dependent.

5.5 Optical Line Termination functional block

The OLT is connected to the switched networks via standardized interfaces (VB5.x, V5.x, NNI's). At the distribution side, it presents optical accesses according to the agreed requirements, in terms of bit rate, power budget, etc.

The OLT consists of three parts: the service port function; ODN interface; and MUX for VP grooming (see Figure 4). This combination is not intended to preclude the Virtual Channel (VC) layer function in the OLT. VC layer function is for further study.

1) *Service port function*

   The function interfaces to service nodes. The service port function may handle inserting ATM cells into the upstream SDH payload and extracting ATM cells from the downstream SDH payload. The function may be duplicated, then the protection switching function is necessary.

2) *MUX*

   The MUX provides VP connections between the service port function and the ODN interface and different VPs are assigned to different services at IF_{PON}. Various information such as main contents, signalling, and OAM flows are exchanged by using VCs of the VP.

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3) *ODN interface*

The PON Line Terminal handles the optoelectronic conversion process. The ODN interface handles inserting ATM cells into the downstream PON payload and extracting ATM cells from the upstream PON payload.

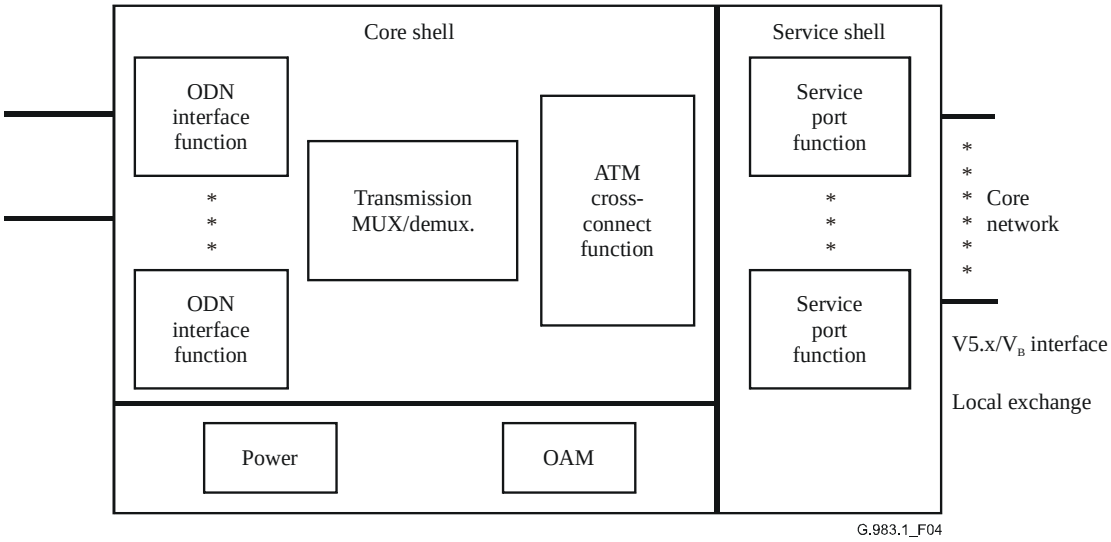


Figure 4/G.983.1 – Example of OLT functional blocks

5.6 Optical Distribution Network functional block

In general, the Optical Distribution Network (ODN) provides the optical transmission medium for the physical connection of the ONUs to the OLTs.

Individual ODNs may be combined and extended through the use of optical amplifiers (see ITU-T Rec. G.982).

5.6.1 Passive optical elements

The ODN consists of passive optical elements:

– single-mode optical fibres and cables;
– optical fibre ribbons and ribbon cables;
– optical connectors;
– passive branching components;
– passive optical attenuators;
– splices.

The specific information required to describe passive optical components is described in ITU-T Rec. G.671.

The specific information required to describe optical fibres and cable is described in ITU-T Rec. G.652.

5.6.2 Optical interfaces

In the context of the reference configuration, Figure 5 shows the generic physical configuration of an ODN.

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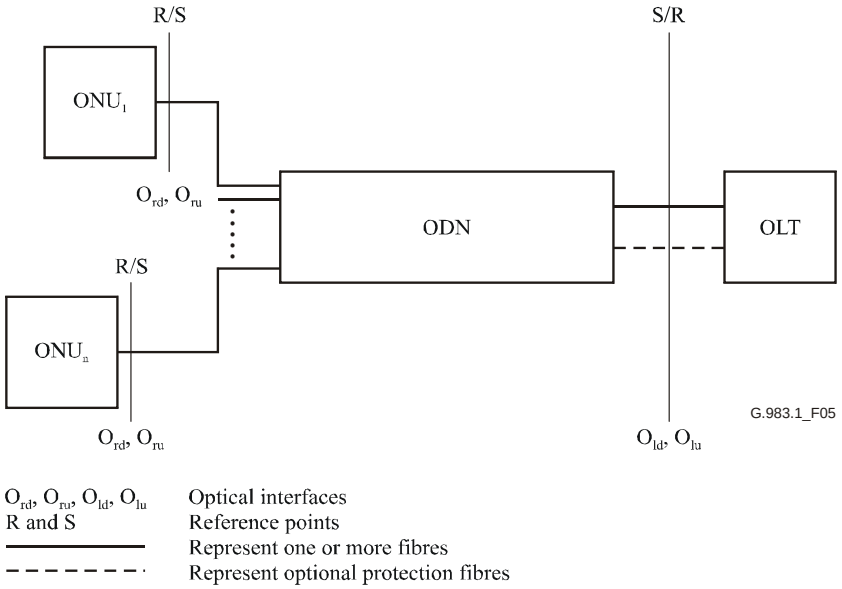


Figure 5/G.983.1 – Generic physical configuration of the Optical Distribution Network

The two directions for optical transmission in the ODN are identified as follows:

– downstream direction for signals travelling from the OLT to the ONU(s);

– upstream direction for signals travelling from the ONU(s) to the OLT.

Transmission in downstream and upstream directions can take place on the same fibre and components (duplex/diplex working) or on separate fibres and components (simplex working).

If additional connectors or other passive devices are needed for ODN rearrangement, they shall be located between S and R and their losses shall be taken into account in any optical loss calculation.

The ODN offers one or more optical path between one OLT and one or more ONUs. Each optical path is defined between reference points in a specific wavelength window.

The following optical interfaces are defined in Figure 5:

– O_{ru}, O_{rd} Optical interface at the reference point R/S between the ONU and the ODN for the upstream and downstream directions respectively.

– O_{lu}, O_{ld} Optical interfaces at the reference point S/R between the OLT and the ODN for the upstream and downstream directions respectively.

At the physical layer, the interfaces may require more than one fibre, e.g., for separation of transmission directions or different types of signals (services).

Specification of the optical interfaces (O_{ru}, O_{rd}, O_{lu}, O_{ld}) are defined in clause 8.

The optical properties of the ODN shall enable the provision of any presently foreseeable service, without the need of extensive modifications to the ODN itself. This requirement has an impact on the properties of the passive optical components which constitute the ODN. A set of essential requirements, which have a direct influence on the optical properties of the ODN, are identified as follows:

– *optical wavelength transparency*: devices, such as optical branching devices, which are not intended to perform any wavelength-selective function, shall be able to support transmission of signals at any wavelength in the 1310 nm and 1550 nm regions;

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– *reciprocity*: reversal of input and output ports shall not cause significant changes of the optical loss through the devices;

– *fibre compatibility*: all optical components shall be compatible with single-mode fibre as specified in ITU-T Rec. G.652.

5.6.2.1 Optical Distribution Network model loss calculations

This is described in ITU-T Rec. G.982.

5.6.2.2 Optical Distribution Network model loss calculation technique

This is described in ITU-T Rec. G.982.

6 Services

Such a high-speed access system could provide the complete range of all currently known and new services being discussed for residential subscribers and business customers. Here, transmission system's service independence has to be regarded.

These services cover a broad range of network requirements like bit rate, symmetry/asymmetry or delay, and range from video distribution, with varying degrees of interactivity, to electronic data transfer, LAN interconnection, transparent Virtual Paths, and so on.

What specific services should be provided are more clear to some operators than to others and depend heavily on the particular regulatory conditions of each operator's markets, as well as on the own market's potential. How these services are delivered in a cost-effective way is a function not only of legal conditions, but also of factors including existing telecommunications infrastructure, dwelling distribution and residential and business customers mix.

In spite of this varied market background there are some features which have been perceived as common to all parties. They can be summarized as follows:

– Some services require bit rates higher than those supported by PSTN and basic ISDN. These bit rates are best delivered on fibre based or fibre hybrid networks.

– As the services evolve and newer services are introduced the bandwidth and management requirements will increase. This requires the access network to be flexible and easily upgradable.

7 User Network Interface and Service Node Interface

The location of UNI and SNI is preliminary given in the reference configuration (see Table 1).

Table 1/G.983.1 – UNI and SNI

Service type	UNI standard	SNI standard
Defined in ITU-T Rec. G.982	ITU-T Rec. G.902	ITU-T Rec. G.902
– Digital broadband video system		ITU-T Rec. G.967.1
– Multimedia services	ITU-T Rec. I.432	ITU-T Rec. G.967.2
– VP leased line	IEEE 802.3	
– ATM SVC		

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8 Optical network requirements

8.1 Layered structure of optical network

Layering is based on ITU-T Rec. G.982. The ODN refers to the fibre distribution network based on passive optical splitters, branching components. The OAN is the system between the "V" and "T" reference points (Figure 2). The ONU may have an Adaptation Function (AF), for Digital Subscriber Line (DSL) transmission over copper to the customer. The OAN is managed as one element, through a Q3 management interface.

The protocol reference model is divided into physical medium, TC, and path layer (see ITU-T Recs G.902, I.326 and G.982). As an example, an ATM-PON is shown in Table 2. In the ATM-PON network, path layer corresponds to the Virtual Path (VP) of the ATM layer.

Table 2/G.983.1 – Layered structure of ATM-PON network

<table>
<tr><th colspan="3">Path layer</th><th>Refer to ITU-T Rec. I.732</th></tr>
<tr><td rowspan="3">Transmission medium layer
(Note)</td><td rowspan="2">TC layer</td><td>Adaptation</td><td>Refer to ITU-T Rec. I.732</td></tr>
<tr><td>PON transmission</td><td>Ranging
Cell slot allocation
Bandwidth allocation
Privacy and security
Frame alignment
Burst synchronization
Bit/byte synchronization</td></tr>
<tr><td colspan="2">Physical medium layer</td><td>E/O adaptation
Wavelength division multiplexing
Fibre connection</td></tr>
<tr><td colspan="4">NOTE – The transmission medium layer must provide the related OAM functions.</td></tr>
</table>

The TC layer is divided into PON transmission and adaptation sublayers, which correspond to the Transmission Convergence sublayer of the Broadband Integrated Services Digital Network (B-ISDN) in ITU-T Rec. I.321. The PON transmission sublayer terminates the required transmission function on the ODN. The PON-specific functions are terminated by the PON transmission sublayer, and it is not seen from the adaptation sublayer.

The two layers considered are the physical medium dependent layer and the TC layer, based on G.958 layering principles.

8.2 Physical medium dependent layer requirements for the ATM-PON

8.2.1 Digital signal nominal bit rate

The transmission line rate should be a multiple of 8 kHz. BPON systems will have nominal line rates (downstream/upstream) of:

- 155.52 Mbit/s/155.52 Mbit/s;
- 622.08 Mbit/s/155.52 Mbit/s;
- 622.08 Mbit/s/622.08 Mbit/s;
- 1244.16 Mbit/s/155.52 Mbit/s;
- 1244.16 Mbit/s/622.08 Mbit/s.

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Parameters to be defined are categorized by downstream and upstream, and nominal bit rate as shown in Table 3.

Table 3/G.983.1 – Relation between parameter categories and tables

Transmission direction	Nominal bit rate	Table
Downstream	155.52 Mbit/s	Table 4-b (downstream, 155 Mbit/s)
	622.08 Mbit/s	Table 4-c (downstream, 622 Mbit/s)
	1244.16 Mbit/s	Table 4-d (downstream 1244 Mbit/s)
Upstream	155.52 Mbit/s	Table 4-e (upstream, 155 Mbit/s)
	622.08 Mbit/s	Table 4-f (upstream, 622 Mbit/s)

All parameters are specified as follows, and shall be in accordance with Table 4-a (ODN), Table 4-b (downstream, 155 Mbit/s), Table 4-c (downstream, 622 Mbit/s), Table 4-d (downstream, 1244 Mbit/s), Table 4-e (upstream, 155 Mbit/s), Table 4-f (upstream 622 Mbit/s). These tables are designated in Table 4 in this Recommendation if not ambiguous.

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

Table 4-a/G.983.1 – Physical medium dependant layer parameters of ODN

Items	Unit	Specification
Fibre type	–	ITU-T Rec. G.652
Attenuation range (ITU-T Rec. G.982)	dB	Class A: 5-20 Class B: 10-25 Class C: 15-30
Differential optical path loss	dB	15
Maximum optical path penalty	dB	1
Max differential logical reach	km	20
Maximum fibre distance between S/R and R/S points	km	20
Minimum supported split ratio	–	Restricted by path loss and ONU addressing limits. PON with passive splitters (16- or 32-way split)
Bidirectional transmission	–	1-fibre WDM or 2-fibre

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Table 4-b/G.983.1 – Optical interface parameters of 155 Mbit/s downstream direction

Items	Unit	Single fibre		Dual fibre	
		OLT transmitter (optical interface O_{ld})			
Nominal bit rate	Mbit/s	155.52		155.52	
Operating wavelength	nm	1480-1580		1260-1360	
Line code	–	Scrambled NRZ		Scrambled NRZ	
Mask of the transmitter eye diagram	–	Figure 6		Figure 6	
Maximum reflectance of equipment, measured at transmitter wavelength	dB	NA		NA	
Minimum ORL of ODN at O_{ld} and O_{lu} (Notes 1 and 2)	dB	more than 32		more than 32	
ODN class		Class B	Class C	Class B	Class C
Mean launched power MIN	dBm	–4	–2	–4	–2
Mean launched power MAX	dBm	+2	+4	+1	+3
Launched optical power without input to the transmitter	dBm	NA		NA	
Extinction ratio	dB	more than 10		more than 10	
Transmitter tolerance to incident light power	dB	more than –15		more than –15	
If MLM Laser – Maximum RMS width	nm	1.8		5.8	
If SLM Laser – Maximum –20 dB width (Note 3)	nm	1		1	
If SLM Laser – Minimum side mode suppression ratio	dB	30		30	
		ONU receiver (optical interface O_{rd})			
Maximum reflectance of equipment, measured at receiver wavelength	dB	less than –20		less than –20	
Bit error ratio	–	less than 10^{-10}		less than 10^{-10}	
ODN class		Class B	Class C	Class B	Class C
Minimum sensitivity	dBm	–30	–33	–30	–33
Minimum overload	dBm	–8	–11	–9	–12
Consecutive identical digit immunity	bit	more than 72		more than 72	
Jitter tolerance	–	Figure 9		Figure 9	
Tolerance to the reflected optical power	dB	less than 10		less than 10	

NOTE 1 – The value of "minimum ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld}" should be more than 20 dB in optional cases which are described in Appendix I.

NOTE 2 – The values on ONU transmitter reflectance for the case that the value of "minimum ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld}" is 20 dB are described in Appendix II.

NOTE 3 – Values of maximum –20 dB width, and minimum side mode suppression ratio are referred to in ITU-T Rec. G.957.

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Table 4-c/G.983.1 – Optical interface parameters of 622 Mbit/s downstream direction

Items	Unit	Single fibre			Dual fibre		
		OLT transmitter (optical interface O_{ld})					
Nominal bit rate	Mbit/s	622.08			622.08		
Operating wavelength	nm	1480-1580			1260-1360		
Line code	–	Scrambled NRZ			Scrambled NRZ		
Mask of the transmitter eye diagram	–	Figure 6			Figure 6		
Maximum reflectance of equipment, measured at transmitter wavelength	dB	NA			NA		
Minimum ORL of ODN at O_{lu} and O_{ld} (Notes 1 and 2)	dB	more than 32			more than 32		
ODN class		Class A	Class B	Class C	Class A	Class B	Class C
Mean launched power MIN	dBm	–7	–2	–2	–7	–2	–2
Mean launched power MAX	dBm	–1	+4	+4	–2	+3	+3
Launched optical power without input to the transmitter	dBm	NA			NA		
Extinction ratio	dB	more than 10			more than 10		
Transmitter tolerance to incident light power	dB	more than –15			more than –15		
If MLM Laser – Maximum RMS width	nm	NA			1.4		
If SLM Laser – Maximum –20 dB width (Note 3)	nm	1			1		
If SLM Laser – Minimum side mode suppression ratio	dB	30			30		
		ONU receiver (optical interface O_{rd})					
Maximum reflectance of equipment, measured at receiver wavelength	dB	less than –20			less than –20		
Bit error ratio	–	less than 10^{-10}			less than 10^{-10}		
ODN class		Class A	Class B	Class C	Class A	Class B	Class C
Minimum sensitivity	dBm	–28	–28	–33	–28	–28	–33
Minimum overload	dBm	–6	–6	–11	–7	–7	–12
Consecutive identical digit immunity	bit	more than 72			more than 72		
Jitter tolerance	–	Figure 9			Figure 9		
Tolerance to the reflected optical power	dB	less than 10			less than 10		

NOTE 1 – The value of "minimum ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld}" should be more than 20 dB in optional cases which are described in Appendix I.

NOTE 2 – The values on ONU transmitter reflectance for the case that the value of "minimum ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld}" is 20 dB are described in Appendix II.

NOTE 3 – Values of maximum –20 dB width, and minimum side mode suppression ratio are referred to in ITU-T Rec. G.957.

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Table 4-d/G.983.1 – Optical interface parameters of 1244.16 Mbit/s downstream direction

Items	Unit	Single fibre			Dual fibre		
		OLT transmitter (optical interface O_{ld})					
Nominal bit rate	Mbit/s	1244.16			1244.16		
Operating wavelength	nm	1480-1500			1260-1360		
Line code	–	Scrambled NRZ			Scrambled NRZ		
Mask of the transmitter eye diagram	–	Figure 6			Figure 6		
Maximum reflectance of equipment, measured at transmitter wavelength	dB	NA			NA		
Minimum ORL of ODN at O_{lu} and O_{ld} (Notes 1 and 2)	dB	more than 32			more than 32		
ODN class		Class A	Class B	Class C	Class A	Class B	Class C
Mean launched power MIN	dBm	–4	+1	+5	–4	+1	+5
Mean launched power MAX	dBm	+1	+6	+9	+1	+6	+9
Launched optical power without input to the transmitter	dBm	NA			NA		
Extinction ratio	dB	more than 10			more than 10		
Transmitter tolerance to incident light power	dB	more than –15			more than –15		
If MLM Laser – Max. RMS width	nm	NA			NA		
If SLM Laser – Max. –20 dB width (Note 3)	nm	1			1		
If SLM Laser – Minimum side mode suppression ratio	dB	30			30		
		ONU receiver (optical interface O_{rd})					
Maximum reflectance of equipment, measured at receiver wavelength	dB	less than –20			less than –20		
Bit error ratio	–	less than 10^{-10}			less than 10^{-10}		
ODN class		Class A	Class B	Class C	Class A	Class B	Class C
Minimum sensitivity	dBm	–25	–25	–26	–25	–25	–25
Minimum overload (Note 4)	dBm	–4	–4	–4	–4	–4	–4
Consecutive identical digit immunity	bit	more than 72			more than 72		
Jitter tolerance	–	Figure 9			Figure 9		
Tolerance to the reflected optical power	dB	less than 10			less than 10		

NOTE 1 – The value of "minimum ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld}" should be more than 20 dB in optional cases which are described in Appendix I.

NOTE 2 – The values on ONU transmitter reflectance for the case that the value of "minimum ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld}" is 20 dB are described in Appendix II.

NOTE 3 – Values of maximum –20 dB width, and minimum side mode suppression ratio are referred to in ITU-T Rec. G.957.

NOTE 4 – While only –6 dBm overload is required to support the class C ODN, a –4 dBm overload value has been chosen here for ONU receiver uniformity across all ODN classes.

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Table 4-e/G.983.1 – Optical interface parameters of 155 Mbit/s upstream direction

Items	Unit	Single fibre		Dual fibre	
		ONU transmitter (optical interface O_{ru})			
Nominal bit rate	Mbit/s	155.52		155.52	
Operating wavelength	nm	1260-1360		1260-1360	
Line code	–	Scrambled NRZ		Scrambled NRZ	
Mask of the transmitter eye diagram	–	Figure 7		Figure 7	
Maximum reflectance of equipment, measured at transmitter wavelength	dB	less than –6		less than –6	
Minimum ORL of ODN at O_{ru} and O_{rd} (Notes 1 and 2)	dB	more than 32		more than 32	
ODN class		Class B	Class C	Class B	Class C
Mean launched power MIN	dBm	–4	–2	–4	–2
Mean launched power MAX	dBm	+2	+4	+1	+3
Launched optical power without input to the transmitter	dBm	less than Min sensitivity –10		less than Min sensitivity –10	
Extinction ratio	dB	more than 10		more than 10	
Transmitter tolerance to incident light power	dB	more than –15		more than –15	
If MLM Laser – Maximum RMS width	nm	5.8		5.8	
If SLM Laser – Max. –20 dB width (Note 3)	nm	1		1	
If SLM Laser – Minimum side mode suppression ratio	dB	30		30	
Jitter transfer	–	Figure 8		Figure 8	
Jitter generation from 0.5 kHz to 1.3 MHz	UI p-p	0.2		0.2	
		OLT receiver (optical interface O_{lu})			
Maximum reflectance of equipment, measured at receiver wavelength	dB	less than –20		less than –20	
Bit error ratio	–	less than 10^{-10}		less than 10^{-10}	
ODN class		Class B	Class C	Class B	Class C
Minimum sensitivity	dBm	–30	–33	–30	–33
Minimum overload	dBm	–8	–11	–9	–12
Consecutive identical digit immunity	bit	more than 72		more than 72	
Jitter tolerance	–	NA		NA	
Tolerance to the reflected optical power	dB	less than 10		less than 10	

NOTE 1 – The value of "minimum ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld}" should be more than 20 dB in optional cases which are described in Appendix I.

NOTE 2 – The values of ONU transmitter reflectance for the case that the value of "minimum ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld}" is 20 dB are described in Appendix II.

NOTE 3 – Values of maximum –20 dB width, and minimum side mode suppression ratio are referred to in ITU-T Rec. G.957.

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Table 4-f/G.983.1 – Optical interface parameters of 622 Mbit/s upstream direction

Items	Unit	Specifications		
		ONU transmitter (optical interface O_{ru})		
Nominal bit rate	Mbit/s	622.08		
Operating wavelength (Note 3)	nm	MLM type 1 or SLM: 1260-1360 MLM type 2: 1280-1350 MLM type 3: 1288-1338		
Line code	–	Scrambled NRZ		
Mask of the transmitter eye diagram	–	Figure 7		
Maximum reflectance of equipment, measured at transmitter wavelength	dB	less than –6		
Maximum ORL of ODN at O_{ld} and O_{lu} (Notes 1 and 2)	dB	more than 32		
ODN class (Note 5)		Class A	Class B	Class C
Mean launched power MIN	dBm	–6	–1	–1
Mean launched power MAX	dBm	–1	+4	+4
Launched optical power without input to the transmitter	dBm	less than Min sensitivity –10		
Extinction ratio	dB	more than 10		
Transmitter tolerance to incident light power	dB	more than –15		
If MLM laser – Maximum RMS width (Note 3)	nm	MLM type 1: 1.4 MLM type 2: 2.1 MLM type 3: 2.7		
If SLM laser – Max. –20 dB width (Note 4)	nm	1		
If SLM laser – Min. side mode suppression ratio	dB	30		
Jitter transfer	–	Figure 8		
Jitter generation from 2.0 kHz to 5.0 MHz	UI p-p	0.2		
		OLT receiver (optical interface O_{lu})		
Maximum reflectance of equipment, measured at receiver wavelength	dB	less than –20		
Bit error ratio	–	less than 10^{-10}		
ODN class (Note 5)		Class A	Class B	Class C
Minimum sensitivity	dBm	–27	–27	–32
Minimum overload	dBm	–6	–6	–11
Consecutive identical digit immunity	bits	more than 72		
Jitter tolerance	–	NA		
Tolerance to the reflected optical power	dB	less than 10		

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Table 4-f/G.983.1 – Optical interface parameters of 622 Mbit/s upstream direction

NOTE 1 – The value of "ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld} MIN" should be more than 20 dB in optional cases that are described in Appendix I.

NOTE 2 – The values of ONU transmitter reflectance for the case that the value of "ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld} MIN" is 20 dB are described in Appendix II.

NOTE 3 – Transmitter types meeting narrower spectral width specifications are allowed wider central wavelength ranges. The specified laser types produce less than 1 dB of optical path penalty over the ODN. Lasers with different optical parameters may be substituted provided that (1) the total wavelength range does not exceed 1260 nm to 1360 nm, and (2) any increase in optical path penalty over 1 dB is compensated by an increase of the minimum transmitted launch power or a decrease of the minimum receiver sensitivity. For interoperability, the specified laser types with less than 1 dB optical path penalty are recommended.

NOTE 4 – Values of –20 dB max width and minimum side mode suppression ratio are referred to in ITU-T Rec. G.957.

NOTE 5 – The values proposed for the upstream Class C are best estimates. They are therefore subject to change in the future.

8.2.2 Physical media and transmission method

8.2.2.1 Transmission medium

This specification is based on the fibre described in ITU-T Rec. G.652.

8.2.2.2 Transmission direction

The signal is transmitted both upstream and downstream through the transmission medium.

8.2.2.3 Transmission methodology

Bidirectional transmission is accomplished by use of either Wavelength Division Multiplexing (WDM) technique of 1310 nm region and 1550 nm region wavelengths on a single fibre, or unidirectional two fibres of 1310 nm region wavelength.

8.2.3 Bit rate

8.2.3.1 Downstream

The nominal bit rate of the OLT-to-ONU signal is 155.52, 622.08, or 1244.16 Mbit/s. When the OLT and the end office are in their normal operating state, this rate is traceable to a Stratum-1 clock (accuracy of 1×10^{-11}). When the end office is in its free-running mode, the rate of the downstream signal is traceable to a Stratum-3 clock (accuracy of 4.6×10^{-6}). When the OLT is in its free-running mode, the accuracy of the downstream signal is that of a Stratum-4 clock (3.2×10^{-5}).

8.2.3.2 Upstream

When in one of its operating states and given a grant, the ONU shall transmit a signal at 155.52 Mbit/s or 622.08 Mbit/s with an accuracy equal to that of the received downstream signal. The ONU shall not transmit any signal when not in one of its operating states or when not given a grant.

8.2.4 Line code

8.2.4.1 Downstream

NRZ coding.

Scrambling method is defined in TC layer specification.

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Convention used for optical logic level is:

– high level of light emission for a binary ONE;

– low level of light emission for a binary ZERO.

8.2.4.2 Upstream

NRZ coding.

Scrambling method is defined in TC layer specification.

Convention used for optical logic level is:

– high level of light emission for a binary ONE;

– low level of light emission for a binary ZERO.

8.2.5 Operating wavelength

8.2.5.1 Downstream direction

The operating wavelength range for the downstream direction on single fibre systems shall be 1480-1580 nm. Please note that ITU-T Rec. G.983.3 describes a more comprehensive wavelength plan that narrows this downstream range for single-fibre systems.

The operating wavelength range for the downstream direction on two fibre systems shall be 1260-1360 nm.

8.2.5.2 Upstream direction

The operating wavelength range for the upstream direction shall be 1260-1360 nm.

8.2.6 Transmitter at O_{ld} and O_{ru}

All parameters are specified as follows, and shall be in accordance with Table 4.

8.2.6.1 Source type

Depending on attenuation/dispersion characteristics, feasible transmitter devices include Multi-Longitudinal Mode (MLM) lasers and Single-Longitudinal Mode (SLM) lasers. For each of the applications, this Recommendation indicates a nominal source type. It is understood that the indication of a nominal source type in this Recommendation is not a requirement and that SLM devices can be substituted for any application showing MLM as the nominal source type without any degradation of system performance.

8.2.6.2 Spectral characteristics

For MLM lasers, spectral width is specified by the maximum Root Mean Square (RMS) width under standard operating conditions. The RMS width is understood to mean the standard deviation of the spectral distribution. The measurement method for RMS widths should take into account all modes which are not more than 20 dB down from the peak mode.

For the SLM lasers, the maximum spectral width is specified by the maximum full width of the central wavelength peak, measured 20 dB down from the maximum amplitude of the central wavelength under standard operating conditions. Additionally, for control of mode partition noise in SLM systems, a minimum value for the laser side-mode suppression ratio is specified.

8.2.6.3 Mean launched power

The mean launched power at O_{ld} and O_{ru} is the average power of a pseudo-random data sequence coupled into the fibre by the transmitter. It is given as a range to allow for some cost optimization and to cover all allowances for operation under standard operating conditions, transmitter connector degradation, measurement tolerances, and ageing effects.

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The lower figure is the minimum power which shall be provided in states O6, O7 and O8. and the higher one is the power which shall never be exceeded in states O6, O7 and O8. In ranging mode, state O4 (only for the optical power start-up), the power may go below the specified minimum launched power, and it cannot exceed the specified maximum launched power with more than 3 dB.

NOTE – For the accuracy of measurement, special care for the way of burst signal output from ONU is necessary.

8.2.6.3.1 Launched optical power without input to the transmitter

In the upstream direction, the ONU transmitter shall launch no power into the fibre in all slots which are not assigned to that ONU. The ONU shall also launch no power during the guard time of slots that are assigned to it with the exception of the last two bits which may be used for laser pre-bias, and the bit immediately following the assigned cell, during which the output falls to zero. The launched power level during laser pre-bias must be less than 0.1 of the one level.

8.2.6.4 Minimum extinction ratio

The convention adopted for optical logic level is:

– high level of light emission for a logical "1";

– low level of light emission for a logical "0".

The Extinction ratio (EX) is defined as:

$$EX = 10 \log_{10} (A/B)$$

where *A* is the average optical power level at the centre of the logical "1" and *B* is the average optical power level at the centre of the logical "0".

The extinction ratio for the upstream direction burst mode signal is applied to from the first bit of the preamble to the last bit of the burst signal inclusive. This does not apply to the optical power set-up procedure (refer to 8.4.4.2 "Ranging procedure in the ONU").

8.2.6.5 Maximum reflectance of equipment, measured at transmitter wavelength

Reflections from equipment (ONU/OLT) back to the cable plant are specified by the maximum permissible reflectance of equipment measured at O_{ld}/O_{ru}. It shall be in accordance with Table 4.

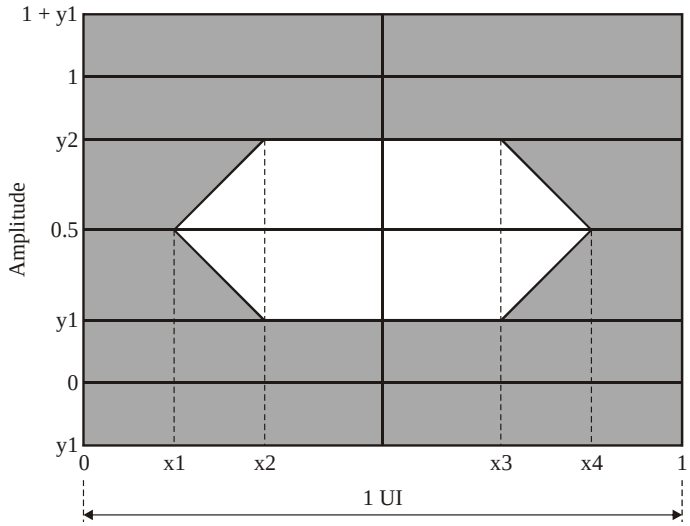
8.2.6.6 Mask of transmitter eye diagram

In this Recommendation, general transmitter pulse shape characteristics including rise time, fall time, pulse overshoot, pulse undershoot, and ringing, all of which should be controlled to prevent excessive degradation of the receiver sensitivity, are specified in the form of a mask of the transmitter eye diagram at O_{ld}/O_{ru}. For the purpose of an assessment of the transmit signal, it is important to consider not only the eye opening, but also the overshoot and undershoot limitations.

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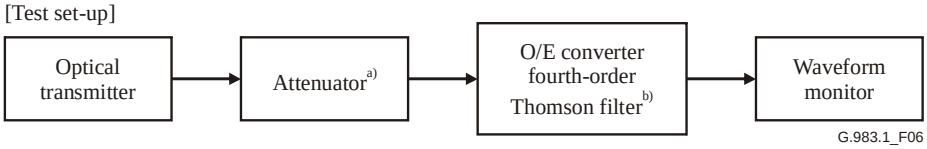
8.2.6.6.1 OLT transmitter

The parameters specifying the mask of the eye diagram are shown in Figure 6.



	155.52 Mbit/s	622.08 Mbit/s	1244.16 Mbit/s
x1/x4	0.15/0.85	0.25/0.75	0.28/0.72
x1/x4	0.35/0.65	0.40/0.60	0.40/0.60
x1/x4	0.20/0.80	0.20/0.80	0.20/0.80

[Test set-up]



a) Attenuator is used if necessary.

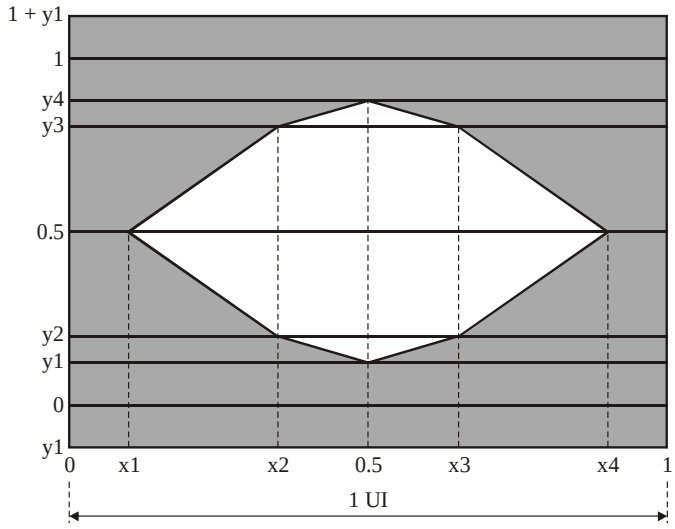
b) Cut-off frequency (3 dB attenuation frequency) of the filter is 0.75 times output nominal bit rate.

Figure 6/G.983.1 – Mask of the eye diagram for the downstream transmission signal

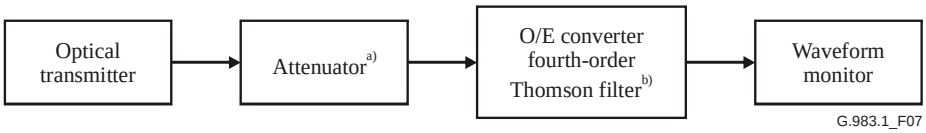
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8.2.6.6.2 ONU transmitter

The parameters specifying the mask of the eye diagram are shown in Figure 7.



	155.52 Mbit/s	622.08 Mbit/s
x1/x4	0.10/0.90	0.20/0.80
x2/x3	0.35/0.65	0.40/0.60
y1/y4	0.13/0.87	0.15/0.85
y2/y3	0.20/0.80	0.20/0.80



a) Attenuator is used if necessary.

b) Cut-off frequency (3 dB attenuation frequency) of the filter is 0.75 times output nominal bit rate.

Figure 7/G.983.1 – Mask of the eye diagram for the upstream transmission signal

The mask of the eye diagram for the upstream direction burst mode signal is applied to from the first bit of the preamble to the last bit of the burst signal inclusive. This does not apply to the optical power set-up procedure (refer to 8.4.4.2 "Ranging procedure in the ONU").

8.2.6.7 Tolerance to the reflected optical power

The specified transmitter performance must be met in the presence at S of the optical reflection level specified in Table 4.

8.2.7 Optical path between O_{ld}/O_{ru} and O_{rd}/O_{lu}

8.2.7.1 Attenuation range

Three classes of attenuation ranges are being specified as defined in ITU-T Rec. G.982:

– 5-20 dB: Class A;

– 10-25 dB: Class B;

– 15-30 dB: Class C.

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Attenuation specifications are assumed to be worst-case values including losses due to splices, connectors, optical attenuators (if used) or other passive optical devices, and any additional cable margin to cover allowances for:

1) future modifications to the cable configuration (additional splices, increased cable lengths, etc.);
2) fibre cable performance variations due to environmental factors; and
3) degradation of any connector, optical attenuators (if used) or other passive optical devices between points S and R, when provided.

8.2.7.2 Minimum optical return loss of the cable plant at point R/S, including any connectors

Overall minimum Optical Return Loss (ORL) specification at point R/S in the ODN shall be better than 32 dB.

Optionally, minimum ORL specification at point S in the ODN shall be better than 20 dB. Appendix I expresses the optional cases.

NOTE – The overall reflectance at the S/R point for an ODN model is dominated by the optical connectors at the Optical Distribution Frame (ODF). The maximum reflectance of a single discrete element within ITU-T Rec. G.982 is −35 dB. The reflectance from the two ODF connectors leads to a figure of −32 dB. However, based on another network model, the overall reflectance may become worse than −32 dB.

8.2.7.3 Maximum discrete reflectance between points S and R

All discrete reflectances in the ODN shall be better than −35 dB as defined in ITU-T Rec. G.982.

8.2.7.4 Dispersion

Systems considered limited by dispersion have maximum values of dispersion (ps/nm) specified in Table 4. These values are consistent with the maximum optical path penalties specified. They take into account the specified transmitter type, and the fibre dispersion coefficient over the operating wavelength range.

Systems considered limited by attenuation do not have maximum dispersion values specified and are indicated in Table 4 with the entry "NA" (not applicable).

8.2.8 Receiver at O_{rd} and O_{lu}

All parameters are specified as follows, and shall be in accordance with Table 4.

8.2.8.1 Minimum sensitivity

Receiver sensitivity is defined as the minimum acceptable value of average received power at point R to achieve 10^{-10} BER. It takes into account power penalties caused by use of a transmitter under standard operating conditions with worst-case values of extinction ratio, pulse rise and fall times, optical return loss at point S, receiver connector degradation and measurement tolerances. The receiver sensitivity does not include power penalties associated with dispersion, jitter, or reflections from the optical path; these effects are specified separately in the allocation of maximum optical path penalty. Ageing effects are not specified separately since they are typically a matter between a network provider and an equipment manufacturer.

8.2.8.2 Minimum overload

Receiver overload is the maximum acceptable value of the received average power at point R for a 10^{-10} BER. The receiver should have a certain robustness against increased optical power level due to start-up or potential collisions during ranging, for which a BER of 10^{-10} is not guaranteed.

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8.2.8.3 Maximum optical path penalty

The receiver is required to tolerate an optical path penalty not exceeding 1 dB to account for total degradations due to reflections, intersymbol interference, mode partition noise, and laser chirp.

8.2.8.4 Maximum reflectance of receiver equipment, measured at receiver wavelength

Reflections from equipment (ONU/OLT) back to the cable plant are specified by the maximum permissible reflectance of equipment measured at O_{rd} and O_{lu}. It shall be in accordance with Table 4.

8.2.8.5 Differential optical path loss

Differential optical path loss means the optical path loss difference between the highest and lowest optical path loss in the same ODN. The maximum differential optical path loss should be 15 dB.

8.2.8.6 Clock extraction capability

NOTE – The clock of the upstream transmission signal is extracted rapidly from several bits alternating continuous code (preamble) of the positive logic "1", "0". The clock extracted from the preamble is maintained at least during receiving signal from the delimiter through the end of the upstream cell, or is continuously extracted from the signal after the preamble during receiving the cell.

8.2.8.7 Jitter performance

This clause deals with jitter requirements for optical interfaces at the ATM-PON.

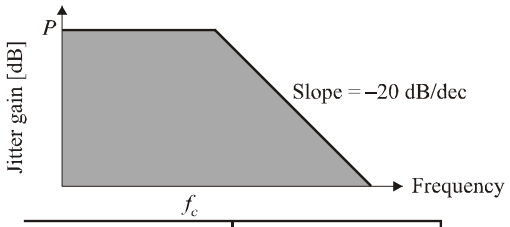
8.2.8.7.1 Jitter transfer

Jitter transfer specification applies only to ONU.

The jitter transfer function is defined as:

$$jitter\ transfer = 20\log_{10}\left[\frac{jitter\ on\ uptstream\ signal\ UI}{jitter\ on\ downstream\ signal\ UI}\times\frac{downstreaam\ bit\ rate}{upstream\ bit\ rate}\right]$$

The jitter transfer function of an ONU shall be under the curve given in Figure 8, when input sinusoidal jitter up to the mask level in Figure 9 is applied, with the parameters specified in this figure for each bit rate.

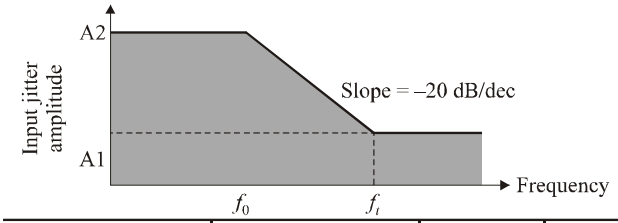


	f_c [kHz]	P [dB]
155.52/155.52	130	0.1
155.52/622.08	500	0.1
155.52/1244.16	1000	0.1
622.08/622.08	500	0.1
622.08/1244.16	1000	0.1

G.983.1_F08

Figure 8/G.983.1 – Jitter transfer for ONU

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	f_t [kHz]	f_0 [kHz]	A1 [U1p-p]	A1 [U1p-p]
155.52/155.52	65	6.5	0.075	0.75
155.52/622.08	250	25	0.075	0.75
155.52/1244.16	500	50	0.075	0.75
622.08/622.08	250	25	0.075	0.75
622.08/1244.16	500	50	0.075	0.75

G.983.1_F09

Figure 9/G.983.1 – Jitter tolerance mask for ONU

8.2.8.7.2 Jitter tolerance

Jitter tolerance is defined as the peak-to-peak amplitude of sinusoidal jitter applied on the input ATM-PON signal that causes a 1-dB optical power penalty at the optical equipment. Note that it is a stress test to ensure that no additional penalty is incurred under operating conditions.

ONU shall tolerate, as a minimum, the input jitter applied according to the mask in Figure 9, with the parameters specified in that figure for each bit rate.

8.2.8.7.3 Jitter generation

Jitter generation specification applies only to ONU.

An ONU shall not generate more than 0.2 UI peak-to-peak jitter, with no jitter applied to the downstream input. The measurement bandwidth for the 155.52-Mbit/s upstream direction has a range from 0.5 kHz to 1.3 MHz. The measurement bandwidth for the 622.08-Mbit/s upstream direction has a range from 2.0 kHz to 5.0 MHz.

8.2.8.8 Consecutive identical digit (CID) immunity

The specific test patterns are made up of consecutive blocks of data of four types:

a) all 1s (zero timing content, high average signal amplitude);

b) pseudo-random data with a mark-density ratio of 1/2;

c) all 0s (zero timing content, low average signal amplitude);

d) a data block consisting of the ATM overhead bytes.

The test pattern is a sequence of data blocks consisting of d), a), b), d), c) and b). The duration of the zero-timing-content periods a) and c) is made equal to the longest like-element sequences. CID immunity is defined as this duration.

8.2.8.9 Tolerance to reflected power

The tolerance to reflected power is the allowable ratio of optical input average power of O_{rd} and O_{lu} to reflected optical average power when multiple reflected light is regarded as a noise light at O_{rd} and O_{lu} respectively.

The tolerance to reflected power is defined at minimum receiving sensitivity.

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8.2.8.10 Transmission quality and error performance

For designing a frame structure, robustness of the overhead bytes for transmission bit errors of around 10^{-6} should be considered to avoid system down or failures. Error characteristics of the optical Physical Medium Dependent layer in the local field environment should be considered whether any error correction mechanism is required or not for the overhead bytes at the section level.

The average transmission quality should have a very low bit error rate of less than 10^{-9} across the entire PON system. An objective error rate required for optical components should be better than 10^{-10} in the environment conditions as defined in ITU-T Rec. G.957.

8.3 Transmission Convergence layer requirements for the ATM-PON

For an ATM-PON, the following TC layer requirements are described in Table 5.

Table 5/G.983.1 – TC layer requirements

Cell rate decoupling	ITU-T Rec. I.432.1
HEC calculation error correction	ITU-T Rec. I.432.1
Maximum number of virtual paths per PON	4096
Minimum addressing capability	64 ONUs

NOTE – PON addressing can use the full 12-bit VP field of the ATM cell header, as it is used across the VB5 reference point; see Figure 10. The VPI values on the PON do not have to be equal to the VPI values across the VB5 reference point, because the OLT will have a VP cross-connect function. The limit of up to 4096 VPs avoids costly addressing tables in the ONU and enables efficient use of the PON resource.

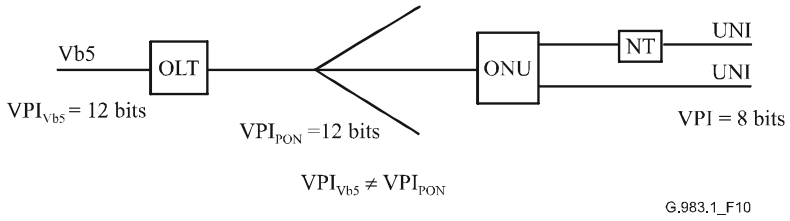


Figure 10/G.983.1 – VP usage on the PON

8.3.1 Point-to-multipoint transmission on the PON

The downstream signal is broadcast to all ONUs on the PON. Each upstream transmission from each ONU is controlled by OLT and is granted by the downstream by Time Division Multiple Access (TDMA) technique.

8.3.2 Maximum payload capacities for downstream and upstream

Minimization of overhead field in the transmission frame should be considered to maximize the payload capacity for downstream and upstream.

Required overhead capacity for the system performance and the OAM functions should be kept to meet the system requirements. However, it is ideally expected that a payload capacity equivalent to a VC4 capacity could be supported in the downstream of the ATM-PON system if possible.

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8.3.3 Downstream interface

The transfer capability for ATM cells includes information cells, signalling cells, OAM cells, unassigned cells and cells used for cell rate decoupling. The Physical Layer overhead cells include the Physical Layer OAM cells (PLOAM cells).

The transfer capacity for the 155.52-Mbit/s interface is 149.97 Mbit/s $\left(155.52 \times \frac{54}{56}\right)$

The transfer capacity for the 622.08-Mbit/s interface is 599.86 Mbit/s.

The transfer capacity for the 1244.16-Mbit/s interface is 1199.72 Mbit/s.

8.3.4 Upstream interface

The Physical Layer overhead includes the PLOAM cells, the minislots for the MAC channel and the overhead bytes which are added in front of each upstream ATM cell, PLOAM cell or minislot.

The transfer capacities for the upstream interfaces have upper limits of:

– 147.2 Mbit/s $\left(155.52 \times \frac{54}{56}\right)$ for the 155.52-Mbit/s interface;

– 588.8 Mbit/s for the 622.08-Mbit/s interface. Some extra bandwidth is allocated by the OLT for the upstream PLOAM channel and MAC channel.

The upstream transfer capacity is shared amongst the ONUs based on their allocated upstream bandwidth.

8.3.5 Transport-specific TC functions

8.3.5.1 Frame structure

The downstream interface structure for both 155.52 Mbit/s, 622.08 Mbit/s, and 1244.16 Mbit/s consists of a continuous stream of timeslots, each timeslot containing 53 octets of an ATM cell or a PLOAM cell.

Every 28 time slots, a PLOAM cell is inserted. A downstream frame contains two such PLOAM cells and is 56 slots long for the 155-Mbit/s downstream case. For the 622-Mbit/s case, it contains eight PLOAM cells and is 224 slots long. For the 1244-Mbit/s case, it contains sixteen PLOAM cells and is 448 slots long.

In the upstream direction, the frame contains 53 time slots of 56 bytes for the 155-Mbit/s upstream case, and for the 622.08-Mbit/s case, it contains 212 time slots. The OLT request an ONU to transmit an ATM cell via grants conveyed in downstream PLOAM cells. At a programmable rate, the OLT requests an ONU to transmit a PLOAM cell or a minislot. The upstream PLOAM rate depends on the required functionality contained in these PLOAM cells. The minimum PLOAM rate per ONU is one PLOAM cell every 100 ms. The OLT defines the bandwidth allocated to the upstream minislots.

The PLOAM cells are used to convey the Physical Layer OAM information. In addition, they carry the grants used by the ONUs for the upstream access.

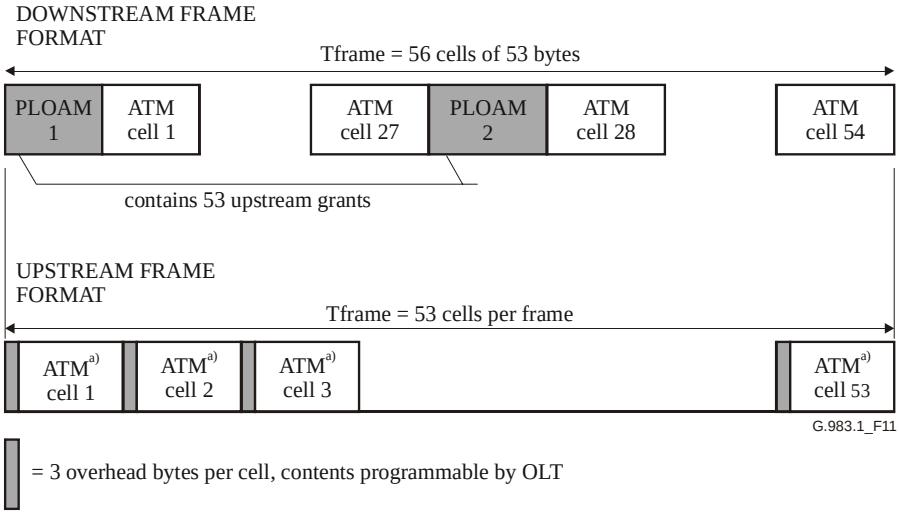
A divided_slot occupies a complete upstream time slot and contains a number of minislots from a set of ONUs. The MAC protocol uses them to transfer to the OLT the status of the ONU's queues, in order to implement a dynamic bandwidth allocation. The usage of these divided_slots is optional.

The described frames, cells, bytes and bits are transmitted in the following order referring to their numbering: frames are transmitted in ascending order, cells within a frame are transmitted in ascending order, the bytes within a cell are transmitted in ascending order and within a byte, the most significant bit is transmitted first. The most significant bit in a byte is bit number 1 and the least significant bit is bit number 8, so for example the MSB of 0b10101010 is equal to 1.

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8.3.5.1.1 Frame structure for 155/155-Mbit/s PON

The frame structure for a 155/155-Mbit/s symmetric PON is shown in Figure 11.



a) Any ATM cell slot can contain an upstream PLOAM or divided slot rate controlled by the OLT.

NOTE – ATM cells are transmitted in the order of ascending cell numbers.

Figure 11/G.983.1 – Frame format for 155.52/155.52-Mbit/s PON

The upstream overhead bytes contain the following fields in Table 6.

Table 6/G.983.1 – Upstream overhead bytes

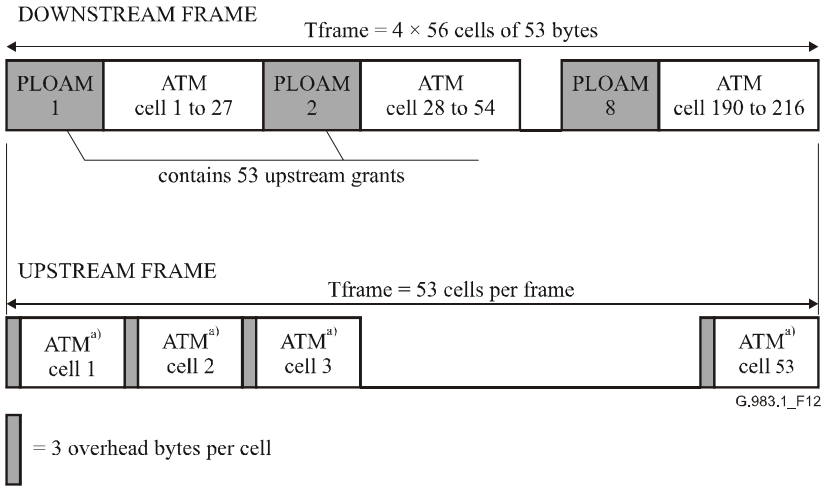
Field	Purpose
Guard time	Provide enough distance between two consecutive cells or minislots to avoid collisions.
Preamble	Extract the phase of the arriving cell or minislot relative to the local timing of the OLT, and/or acquire bit synchronization and amplitude recovery.
Delimiter	A unique pattern indicating the start of the ATM cell or minislot, which can be used to perform byte synchronization.

The minimum guard time length is 4 bits. The total overhead length is 24 bits. The guard time length, preamble pattern and delimiter pattern are programmable under the OLT's control. The content of these fields is defined by the Upstream_overhead message in the downstream PLOAM cells.

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8.3.5.1.2 Frame structure for 622/155-Mbit/s PON

In this case the downstream rate is exactly four times higher; this is shown in Figure 12.



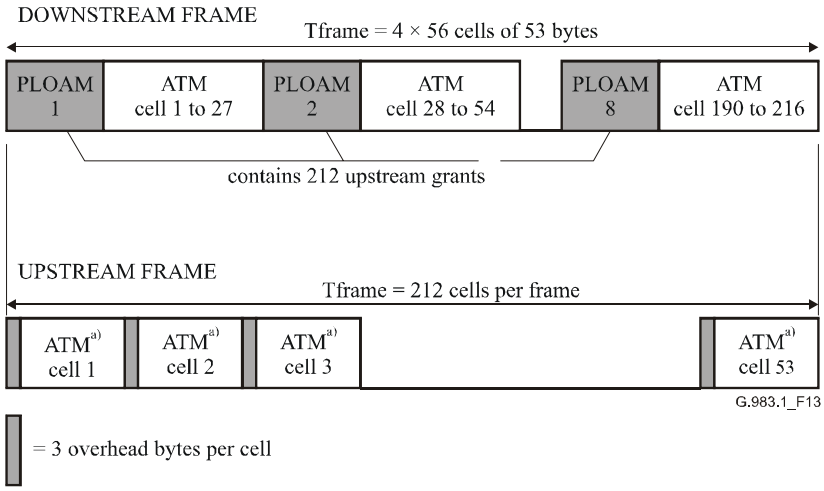
a) Any ATM cell slot can contain an upstream PLOAM or divided slot rate controlled by the OLT.

NOTE – ATM cells are transmitted in the order of ascending cell numbers.

Figure 12/G.983.1 – Frame format for 622.08/155.52 Mbit/s PON

8.3.5.1.3 Frame structure for 622/622-Mbit/s PON

In this case the downstream and upstream rates are both exactly four times higher than the 155-Mbit/s symmetrical case. This is shown in Figure 13.



a) Any ATM cell slot can contain an upstream PLOAM or divided slot rate controlled by the OLT.

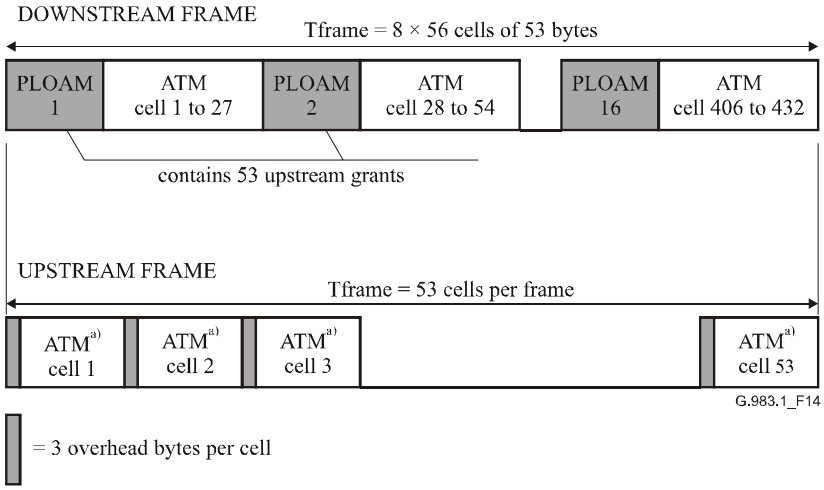
NOTE – ATM cells are transmitted in the order of ascending cell numbers.

Figure 13/G.983.1 – Frame format for 622.08/622.08-Mbit/s PON

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8.3.5.1.4 Frame structure for 1244/155-Mbit/s PON

In this case the downstream rate is exactly eight times higher than the symmetric 155-Mbit/s case. This is shown in Figure 14.



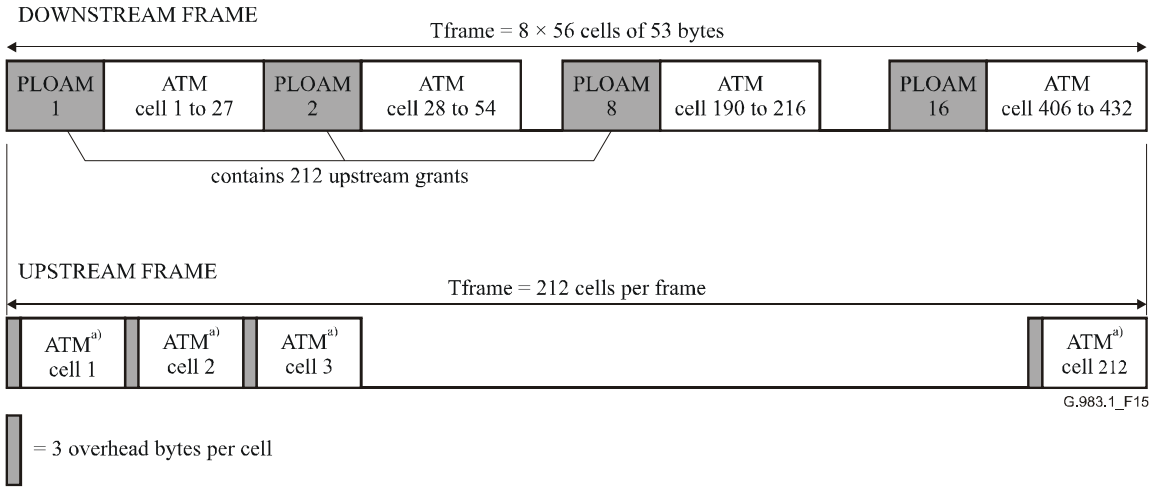
a) Any ATM cell slot can contain an upstream PLOAM or divided slot rate controlled by the OLT.

NOTE – ATM cells are transmitted in the order of ascending cell numbers.

Figure 14/G.983.1 – Frame format for 1244.16/155.52-Mbit/s PON

8.3.5.1.5 Frame structure for 1244/622-Mbit/s PON

In this case the downstream rate is exactly two times higher than the symmetric 622-Mbit/s case. This is shown in Figure 15.



a) Any ATM cell slot can contain an upstream PLOAM or divided slot rate controlled by the OLT.

NOTE – ATM cells are transmitted in the order of ascending cell numbers.

Figure 15/G.983.1 – Frame format for 1244.16/622.08-Mbit/s PON

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8.3.5.1.6 Time relation downstream-upstream frame

In Figures 11, 12, 13, 14 and 15, the start of the downstream frame and the start of the upstream frame are drawn aligned to each other to indicate the equal duration of the two frames. However, the real phase difference at the reference point S/R at the OLT or ONU is undefined. Most likely, the two frames will be aligned to each other inside the OLT at some virtual reference point. The ranging process ensures that upstream cells are aligned to this upstream frame.

For the cases described in Figures 11, 12 and 14, 53 grants are mapped in the first two PLOAM cells of a frame and are numbered from 1 to 53; for the case described in Figures 13 and 15, 212 grants are mapped into the eight PLOAM cells in the frame, and are numbered 1-212. To guarantee a correct upstream TDMA protocol, an ONU addressed by a grant X, queues this grant (X-1) upstream cell periods before applying the equalization_delay as defined in the ranging protocol.

8.3.5.2 Physical layer cell identification

ITU-T Rec. I.361 identifies specific patterns for PLOAM flows. The following pattern is defined for maintenance of ATM-PONs. (See Table 7.)

Table 7/G.983.1 – PLOAM header

	Octet 1	**Octet 2**	**Octet 3**	**Octet 4**	**Octet 5**
Physical layer OAM cell for ATM-PON	0000 0000	0000 0000	0000 0000	0000 1101	HEC = valid code 0111 0110
NOTE – There is no significance to any of these individual fields from the point of view of the ATM layer, as Physical Layer OAM cells are not passed to the ATM layer.					

8.3.5.3 Downstream PLOAM structure

Table 8 shows the contents of the payload of the downstream PLOAM cell. The first and third columns indicate the ordinal number of the payload bytes.

Table 8/G.983.1 – Payload content of downstream PLOAM cell

1	IDENT	25	GRANT20
2	SYNC1	26	GRANT21
3	SYNC2	27	CRC
4	GRANT1	28	GRANT22
5	GRANT2	29	GRANT23
6	GRANT3	30	GRANT24
7	GRANT4	31	GRANT25
8	GRANT5	32	GRANT26
9	GRANT6	33	GRANT27
10	GRANT7	34	CRC
11	CRC	35	MESSAGE_PON_ID
12	GRANT8	36	MESSAGE_ID
13	GRANT9	37	MESSAGE_FIELD1
14	GRANT10	38	MESSAGE_FIELD2
15	GRANT11	39	MESSAGE_FIELD3
16	GRANT12	40	MESSAGE_FIELD4

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Table 8/G.983.1 – Payload content of downstream PLOAM cell

17	GRANT13	41	MESSAGE_FIELD5
18	GRANT14	42	MESSAGE_FIELD6
19	CRC	43	MESSAGE_FIELD7
20	GRANT15	44	MESSAGE_FIELD8
21	GRANT16	45	MESSAGE_FIELD9
22	GRANT17	46	MESSAGE_FIELD10
23	GRANT18	47	CRC
24	GRANT19	48	BIP

8.3.5.3.1 PLOAM cell termination

PLOAM cells are terminated at the Transport-Specific TC layer of the ONU. The payload of the PLOAM cell is processed as long as the ONU is frame synchronized and did not detect OAML, FRML, LCD or LOS. Any cell, numbered "ATM cell 1" up to "ATM cell 54" in Figure 11, or numbered "ATM cell 1" up to "ATM cell 216" in Figure 12 or 13, or numbered "ATM cell 1" up to "ATM cell 432" in Figure 14 or 15 that has a header equal to the specified header of a PLOAM cell, is discarded at the ONU in the ATM-specific TC layer.

8.3.5.3.2 PLOAM identification

Table 9 indicates the contents of the IDENT byte:

Table 9/G.983.1 – Contents of IDENT field

Bits	Type	Encoding	
1..7	FU	all 0	For future use.
8	Frame	X	It is "1" for the first PLOAM cell of a downstream frame and "0" for the others.

8.3.5.3.3 Frame synchronization

The ONU has to synchronize on the downstream frame based on the frame bit in the downstream PLOAM cells before it can access the upstream link. Once the downstream ATM cell delineation is completed, the ONU synchronizes on the PLOAM rate by finding N_ploam consecutive correct PLOAM headers at a Tploam interval. Tploam is the time between two consecutive PLOAM cells. Then it synchronizes on the frame bit by finding N_frame consecutive frame bit = 1 at a Tframe interval. This is shown in Figure 16.

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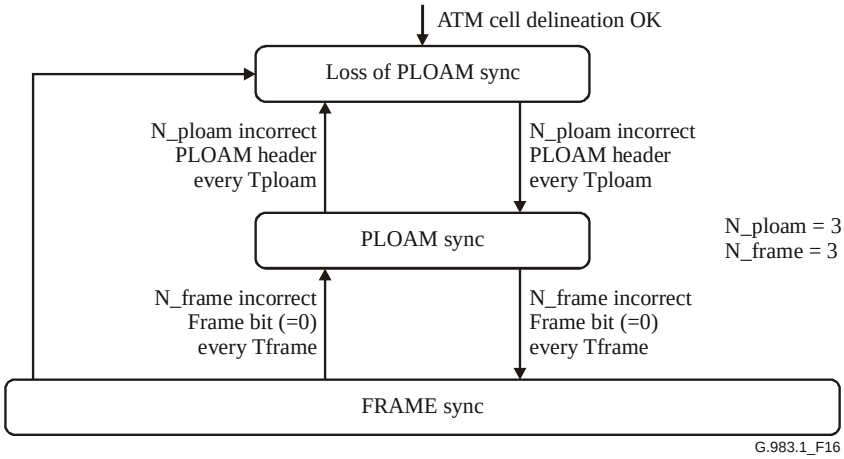


Figure 16/G.983.1 – Frame synchronization flow

8.3.5.3.4 Synchronization field (SYNC1-SYNC2)

The purpose of this field is to transport a 1-kHz reference signal provided at the OLT to the ONUs. This function is optional.

A counter in the OLT is incremented after transmission of one byte in the downstream direction for the 155-Mbit/s downstream case. For the 622-Mbit/s downstream case, this counter increments every four transmitted bytes. For the 1244-Mbit/s downstream case, this counter increments every eight transmitted bytes. This counter is reset every 1 ms for making a 1-kHz reference signal. At the OLT, the value of that counter is taken right before transmission of the first PLOAM cell of a frame and the 15 least significant bits of the counter are placed in the 15 least significant bits of the SYNC1-SYNC2 field.

The most significant bit of the counter is placed in the most significant bit of SYNC1. Depending on the length of the counter, other timing references can be obtained. At reception in the ONU, this field is used to synchronize a local counter. The ONU counter is then locked on the OLT counter. This is illustrated in Figure 17.

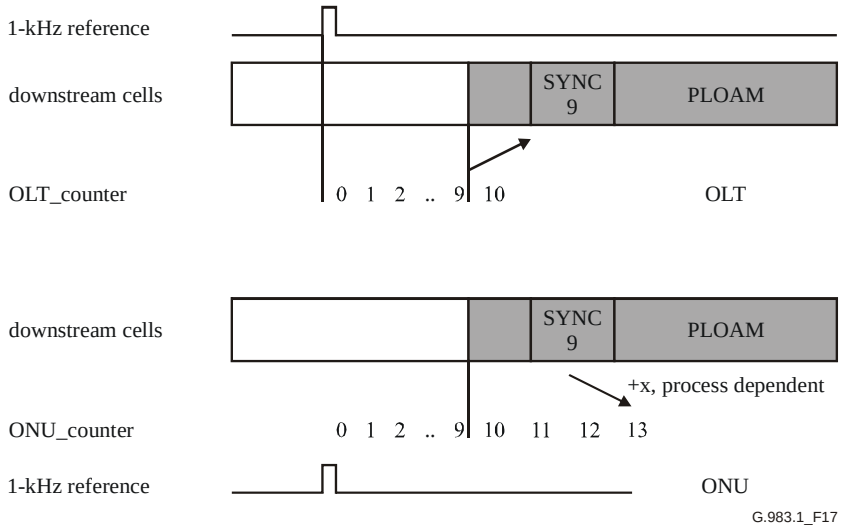


Figure 17/G.983.1 – 1-kHz reference extraction in ONU

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8.3.5.3.5 Grants

Each PLOAM cell is filled with 27 grants. These grants are used by the ONUs for access on the upstream fibre. For the 155-Mbit/s upstream cases, 53 per frame are needed. The 53 active grants are mapped in the first two PLOAM cells of the downstream frame. For the 622-Mbit/s upstream cases, 212 per frame are needed. The 212 active grants are mapped into the first eight PLOAM cells of the downstream frame. The last grant of any even numbered PLOAM cell is filled with an idle grant. The grant fields of the remaining PLOAM cells for the asymmetrical cases are all filled with idle grants and hence will not be used by the ONU. The grant contents of the PLOAM cells are specified in Table 10. The length of a grant is 8 bits and the following types are defined in Table 10.

Table 10/G.983.1 – Specification of the grants

Type	Encoding	Definition
Data grant	Any value except 1111 1101 1111 1110 1111 1111	For indicating an upstream ONU-specific data grant. The value of the data grant is assigned to the ONU during the ranging protocol using the grant_allocation message. The ONU can send a data cell or an idle cell if no data cell is available.
PLOAM grant	Any value except 1111 1101 1111 1110 1111 1111	For indicating an upstream ONU-specific PLOAM grant. The value of the PLOAM grant is assigned to the ONU during the ranging protocol using the grant_allocation message. The ONU always sends a PLOAM cell in response to this grant.
Divided_slot grant	Any value except 1111 1101 1111 1110 1111 1111	For indicating an upstream group of ONU specific divided_slot grant. The OLT allocates the grant to a set of ONUs using the Divided_slot_grant_configuration message. Each ONU of this set sends a minislot. The usage of these grants is described in ITU-T Rec. G.983.4.
Reserved grants	Any value except 1111 1101 1111 1110 1111 1111	In a future version of this Recommendation other grant types will be used for specific data grants (e.g., to address a specific ONU interface or QoS class).
Ranging grant	1111 1101	Used for the ranging process. The condition to react to this grant is described in the ranging protocol.
Unassigned grant	1111 1110	For indicating an unused upstream slot.
Idle grant	1111 1111	For decoupling the downstream PLOAM rate from the upstream cell rate. These grants are ignored by the ONU.

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	Number of grants per PLOAM				
Data rate (Mbit/s)	155/155	622/155	1244/155	622/622	1244/622
PLOAM 1	27	27	27	27	27
PLOAM 2	26	26	26	26	26
PLOAM 3	N/A	0	0	27	27
PLOAM 4	N/A	0	0	26	26
PLOAM 5	N/A	0	0	27	27
PLOAM 6	N/A	0	0	26	26
PLOAM 7	N/A	0	0	27	27
PLOAM 8	N/A	0	0	26	26
PLOAM 9-16	N/A	N/A	0	N/A	0

The OLT can address 32 ONUs at the same time and optionally it may address up to 64 ONUs.

8.3.5.3.6 Grants protection

A Cyclic Redundancy Check (CRC) protects a group of seven grants. The generating CRC polynomial for the grants is:

$$g(x) = x^8 + x^2 + x + 1$$

It can protect up to 15 bytes and has a Hamming distance of 4. It is able to detect up to three bit errors. No error correction is done. Once the ONU is in frame sync and as long as there is no loss of cell delineation, the grant groups are processed independent of the correctness of the PLOAM cell header.

The notation used to describe the CRC is based on the property of cyclic codes. (For example, code vectors such as 100101 can be represented by a polynomial $P(x) = x^5 + x^2 + 1$.) The elements of an n-element code word are thus the coefficients of a polynomial of order $n - 1$. In this application, these coefficients can have the value 0 or 1 and the polynomial operations are performed using modulo 2 operations. The polynomial representing the content of the group of seven grants excluding the CRC field is generated using the first bit of this grant field as the coefficient of the highest order term.

The CRC shall be the remainder of the division (modulo 2) by the generator polynomial $x^8 + x^2 + x + 1$ of the product x^8 multiplied by the polynomial with as coefficients the content of the group of 7 grants excluding the CRC field. The most significant bit of the first grant of the group is the coefficient of the x^{55} term of this polynomial and the least significant bit of last grant of this group is the coefficient of x^0.

At the transmitter, the initial content of the register of the device computing the remainder of the division is preset to all 0s and is then modified by division of the grant field excluding the CRC field by the generator polynomial (as described above); the resulting remainder is transmitted as the 8-bit CRC.

For the last group of six grants, a dummy seventh grant equal to 0b00000000 is added to calculate the CRC of this group.

When the CRC at the receiver is wrong, the entire block is ignored.

8.3.5.3.7 MESSAGE field

All OAM related alarms or threshold-crossing alerts triggered by events are transported via messages in the PLOAM cells. Also all ranging-related messages are mapped in the message field of the PLOAM cell. The processing of a message received at the ONU relating to the ranging

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procedure should be completed within the time of 6 frame periods (6*Tframe). This includes the eventual preparation of an upstream message corresponding to this downstream message. The messages are protected by the same polynomial as the grants. Once the ONU is in frame sync, the message field is processed independent of the correctness of the PLOAM cell header. No error correction is applied to this received message field. The message will be discarded at reception when the CRC is incorrect.

The CRC shall be the remainder of the division (modulo 2) by the generator polynomial $x^8 + x^2 + x + 1$ of the product x^8 multiplied by the polynomial with as coefficients the content of the message field excluding the CRC field. The most significant bit of byte 35 is the coefficient of the x^{95} term of this polynomial and the least significant bit of byte 46 is the coefficient of x^0.

At the transmitter, the initial content of the register of the device computing the remainder of the division is preset to all 0s, and is then modified by division of the message field excluding the CRC field by the generator polynomial (as described above); the resulting remainder is transmitted as the 8-bit CRC.

Table 11 indicates the format of this message field.

Table 11/G.983.1 – Format of the PLOAM message

MESSAGE_PON_ID	It addresses a particular ONU. During the ranging protocol, the ONU is assigned a number, PON_ID. This PON_ID can be from 0 to 63, mapped in the range 0x00 to 0x3F. For a broadcast to all ONUs, this field is set to 0x40.
MESSAGE_ID	Indicates the type of the message.
MESSAGE_FIELD	Contains the message.

8.3.5.3.8 Bit Interleaved Parity (BIP8)

This field is used for monitoring the BER on the downstream link. A one byte BIP8 in each PLOAM cell covers $28 \times 53 - 1$ bytes or 1483 bytes between two consecutive BIPs. Each of the bits of the BIP8 byte is the XOR of all the same-position bits in all the covered bytes before scrambling. The ONU compares the received BIP8 with the BIP8 it calculated on the received byte stream. Each differing bit is counted. The BIP is a good estimate for the real BER when the BER is smaller than 10^{-4}.

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8.3.5.4 Upstream PLOAM structure

Table 12 shows the contents of the payload of the upstream PLOAM cell.

Table 12/G.983.1 – Payload content of the upstream PLOAM cell

1	IDENT	25	LCF11
2	MESSAGE_PON_ID	26	LCF12
3	MESSAGE_ID	27	LCF13
4	MESSAGE_FIELD1	28	LCF14
5	MESSAGE_FIELD2	29	LCF15
6	MESSAGE_FIELD3	30	LCF16
7	MESSAGE_FIELD4	31	LCF17
8	MESSAGE_FIELD5	32	RXCF1
9	MESSAGE_FIELD6	33	RXCF2
10	MESSAGE_FIELD7	34	RXCF3
11	MESSAGE_FIELD8	35	RXCF4
12	MESSAGE_FIELD9	36	RXCF5
13	MESSAGE_FIELD10	37	RXCF6
14	CRC	38	RXCF7
15	LCF1	39	RXCF8
16	LCF2	40	RXCF9
17	LCF3	41	RXCF10
18	LCF4	42	RXCF11
19	LCF5	43	RXCF12
20	LCF6	44	RXCF13
21	LCF7	45	RXCF14
22	LCF8	46	RXCF15
23	LCF9	47	RXCF16
24	LCF10	48	BIP

8.3.5.4.1 PLOAM cell termination

PLOAM cells are terminated at the Transport-Specific TC layer of the OLT. The payload of the PLOAM cell is processed as long as the state of ONUi is not LOSi, LCDi, CPEi, OAMLi.

8.3.5.4.2 PLOAM identification

Table 13 indicates the contents of the IDENT byte.

Table 13/G.983.1 – Contents of IDENT field

Bits	Type	Encoding	
1..8	FU	all 0	For future use

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8.3.5.4.3 MESSAGE field

All OAM related alarms or threshold-crossing alerts triggered by events are transported via messages in the PLOAM cells. Also all ranging related messages are mapped in the message field of the PLOAM cell. They are protected by the same CRC as the CRC used for the downstream message field, no error correction is applied to this received message field. The message will be discarded when the CRC is incorrect or when the header of the PLOAM cell is errored.

The CRC shall be the remainder of the division (modulo 2) by the generator polynomial $x^8 + x^2 + x + 1$ of the product x^8 multiplied by the polynomial with, as coefficients, the content of the message field excluding the CRC field. The most significant bit of byte 2 is the coefficient of the x^{95} term of this polynomial and the least significant bit of byte 13 is the coefficient of x^0.

At the transmitter, the initial content of the register of the device computing the remainder of the division is preset to all 0s, and is then modified by division of the message field excluding the CRC field by the generator polynomial (as described above); the resulting remainder is transmitted as the 8-bit CRC.

Table 14 indicates the format of this message field.

Table 14/G.983.1 – The format of message field

MESSAGE_PON_ID	It contains the PON_ID of the sourcing ONU. However, the OLT knows the implicit ONU_ID since it generated a grant to it. If the contents of this field does not match the possible expected values related to this PON_ID, the message is discarded.
MESSAGE_ID	Indicates the type of message.
MESSAGE_FIELD	Contains the message.

8.3.5.4.4 Bit Interleaved Parity (BIP8)

This field is used for monitoring the BER on the upstream link. A one-byte BIP8 in each PLOAM cell is calculated by the ONU on all the bytes from the cells (though not the overhead bytes) it sent between two consecutive BIPs except the overhead bytes and minislots. Each of the bits of the BIP8 byte is the XOR of all the same position bits in all the covered bytes before scrambling. The OLT compares the received BIP8 with its own calculated BIP8. Each differing bit is counted. The coverage of the BIP8 depends on the number of cells between two consecutive PLOAMs, hence the allocated bandwidth. Since the OLT defines the PLOAM rate of a particular ONU, it can increase this rate to have a higher accuracy for the measured BER.

8.3.5.4.5 Laser Control Field (LCF)

This field is used to maintain the nominal specified mean optical output power and to control the extinction ratio when the ONU is allowed to send a cell. Since the upstream cells are scrambled, this pattern is given by the required optical transmitted pattern summed modulo 2 with the PRBS pattern of the generating polynomial of the upstream scrambler.

The ONU programs this field since it depends on the specific implementation of the upstream laser driver.

8.3.5.4.6 Receiver Control Field (RXCF)

This field is used in the upstream OLT receiver to recover the correct threshold level for regenerating the data from the incoming analog signal. The default pattern is an all ones pattern. The OLT programs this pattern using the Upstream_Rx_control message. Since the upstream cells are scrambled, this pattern is given by the required optical transmitted pattern summed modulo 2 with the PRBS pattern of the generating polynomial.

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8.3.5.5 Divided_slots

An upstream slot can contain a divided_slot. It fits in one upstream slot and contains a number of minislots coming from a set of ONUs. The OLT assigns one divided_slot grant to this set of ONUs for sending their minislot. The format of the divided_slot is shown in Figure 18.

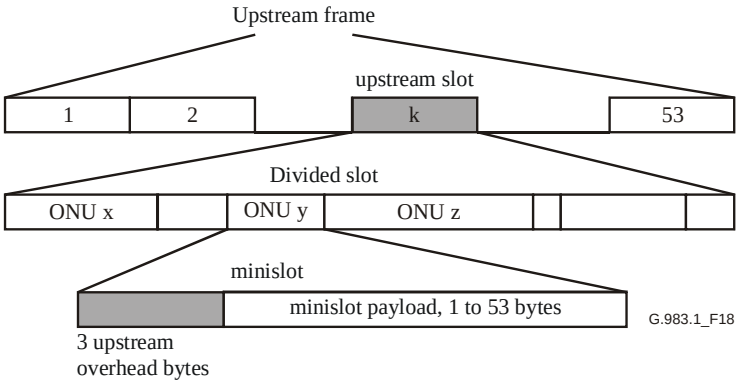


Figure 18/G.983.1 – Format of divided_slot

The start of a minislot is at byte boundaries. The length of the minislot is a multiple number of bytes. The end of the last minislot must be before or coincident with the end of the upstream slot. The three overhead bytes have the same definition as stated in Table 6. A more complete definition of divided slot function is given in ITU-T Rec. G.983.4.

8.3.5.6 Churning

Due to the multicast nature of the PON, downstream cells are churned at the TC layer with a churning key sent upstream by the ONU. The churning is performed for point-to-point downstream connections and churning can only be enabled or disabled per VP at its set-up. The churning key update rate is at least 1 update per second per ONU. If churning is not enough for a security requirement of a provided service, a suitable encryption mechanism should be employed at a higher layer than the TC layer to provide data scrambling.

8.3.5.6.1 Generation of the churn key

The churn function uses a 3-byte key when this method is activated. This churn key is provided by the ONU as requested by the OLT. This key is calculated by Exclusive OR of a 3-byte randomly generated number and 3-byte data extracted from upstream user data to increase security robustness. These 3-byte codes are defined as X1 ~ X8, P1 ~ P15 and P16.

8.3.5.6.2 Notification of a new churn key

A new churn key is notified from ONU to OLT by "New_churn_key message". 3-byte codes, X1 ~ X8, P1 ~ P15 and P16 are conveyed in the payload of this message.

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8.3.5.6.3 Generation of K1 ~ K9 and K10 bits in ONU and OLT

K1 ~ K9 and K10 are used in churning with a churn key. They are generated based on the above 3-byte codes as follows.

K1 and K2 bits are generated by X1 ~ X8, P13 ~ P15 and P16 in ONU and OLT respectively. The generation method is as follows:

K1 = (X1*P13*P14) + (X2*P13*not P14) + (X7*not P13*P14) + (X8*not P13*not P14)

K2 = (X3*P15*P16) + (X4*P15*not P16) + (X5*not P15*P16) + (X6*not P15*not P16)

where:

\+ logical OR

* logical AND

not logical NOT

K3 ~ K9 and K10 bits are generated by K1, K2, P9 ~ P11 and P12 in ONU and OLT. The generation method is as follows:

K3 = (K1*P9) + (K2*not P9)

K4 = (K1*not P9) + (K2*P9)

K5 = (K1*P10) + (K2*not P10)

K6 = (K1*not P10) + (K2*P10)

K7 = (K1*P11) + (K2*not P11)

K8 = (K1*not P11) + (K2*P11)

K9 = (K1*P12) + (K2*not P12)

K10 = (K1*not P12) + (K2*P12)

8.3.5.6.4 Churn function in the OLT

Downstream user data is churned based on 14-bit codes in the OLT. These codes, K1, K2, P1 ~ P11 and P12 are used for churning. Figure 19 shows an example configuration of the churn function in OLT. The ATM header of the ATM cell is not churned. Only the payload of the cells is churned. Churning and dechurning of the downstream user data are performed byte by byte. In Figure 19, Y1 and Z1 are the MSB of the bytes, and Y8 and Z8 are the LSB of the bytes.

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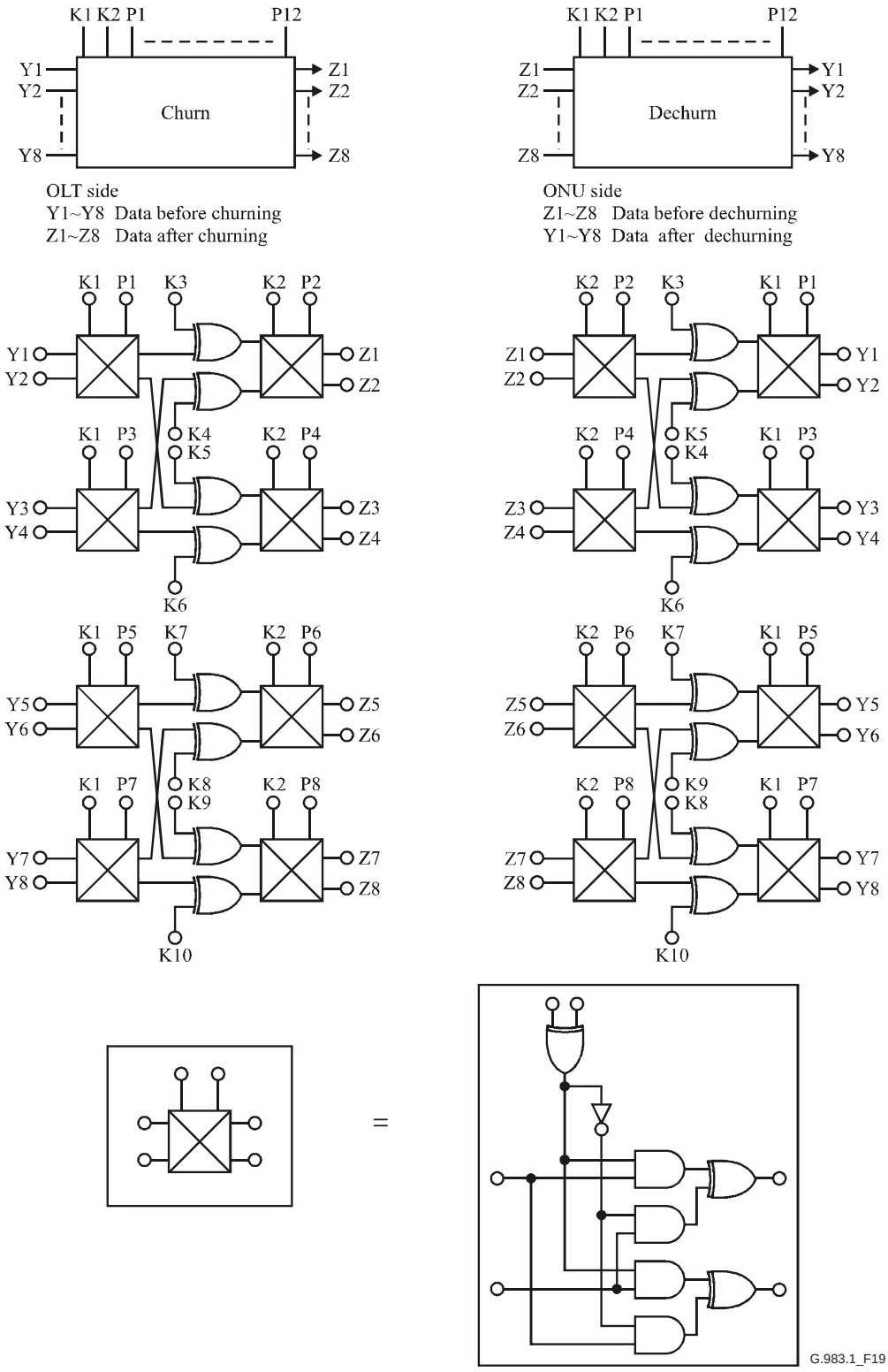


Figure 19/G.983.1 – Churning function

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8.3.5.6.5 Dechurn in ONU

Received user data should be dechurned based on 14 bit codes in ONU. These codes, K1, K2, P1 ~ P11 and P12 are also used for dechurning. Figure 19 also shows an example configuration of the dechurn function in ONU.

8.3.5.6.6 Churning message flow

The churning key is provided by the ONU on the request from the OLT. Churned VPs for previously active ONU(s) should be restored when coming back to the PON. Churning for a ranged or reranged ONU starts after reception of the first key from this ONU. The churning message flow is shown in Figure 20.

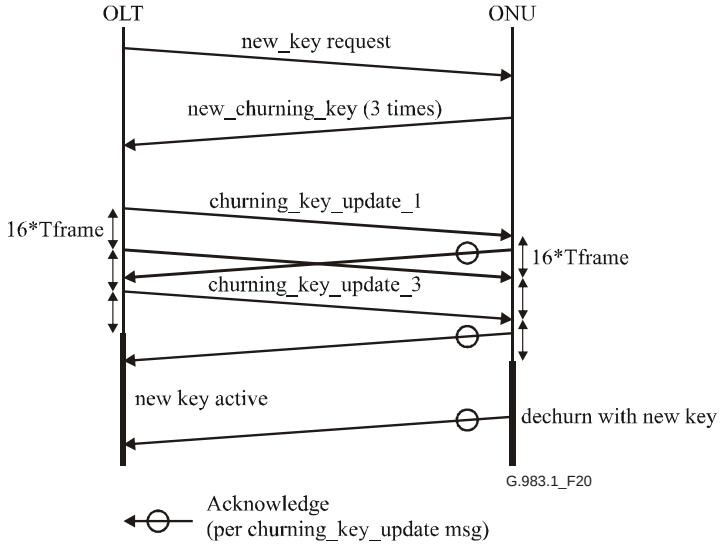


Figure 20/G.983.1 – Churning message flow

On receipt of the new_key_request message, the ONU responds with a new_churning_key. The ONU sends this message in three consecutive PLOAM cells. If the OLT receives three identical new keys, it sends a churning_key_update three times in 3 PLOAM cells with an appropriate interval of 16*Tframe between them to protect against loss of messages. The sequence number of the message (i) is included in these messages. If at least one of these messages is received, the ONU knows when the new key is activated in the OLT since the delay between these messages is *a priori* known. The new key becomes valid 16*Tframe after the third churning_key_update message. The ONU sends an Acknowledge message after each correctly received churning_key_update message. If the OLT receives no acknowledge after a time-out of 300 ms after sending the last churning_key_update message, the OLT detects the Loss of Acknowledge state (LOAi) for this ONU.

The OLT can send a new_key_request if no new_churning_key is received on a previous request within a time-out of 300 ms; or it can send the new_key_request after activating the new key and having received at least one acknowledge.

The OLT indicates to the ONU which VPs are churned sending the churned_VP message three times. It waits for an acknowledge before passing this VP downstream to the ONU. If no acknowledge is received within 300 ms after sending the last churned_VP message, the OLT detects the LOAi state.

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8.3.5.6.7 Advanced Security

As an option, the Advanced Encryption Standard (AES) may be used instead of churning to provide link security. Although there are several modes of operation for AES, only the Electronic Code Book (ECB) mode shall be used in BPON systems. The algorithm will be applied to the 48-byte payload of the cells. Note that since this payload is always an integral number of code blocks (3), no padding is needed. AES may be used for any of the BPON line-rates.

The format of the new big_key message is given in 8.3.8.2.2. This message is a unicast message, and it carried three information fields: the Key_Index, the Frag_Index, and the KeyBYTEs. This structure allows this message to carry keys of arbitrary size over the channel. The Key_Index field is used as a sequence number to make each set of key transmissions unique. The Frag_Index is used to re-assemble the multiple key transmissions. The KeyBYTEs carry 8 bytes of the key in each fragment.

The usage of these fields can be illustrated by the following example. Suppose the ONU is using-128-bit encryption keys, and it receives a 'New Churning Key Request Message'.

The sequence of events at the ONU would include:

– ONU creates a new random key: KeyBYTE0 through KeyBYTE15
– ONU increments the Key_Index
– ONU sends Big_Key message with Frag_Index=0, KeyBYTE0 through KeyBYTE7
– ONU sends Big_Key message with Frag_Index=1, KeyBYTE8 through KeyBYTE15
– ONU sends Big_Key message with Frag_Index=0, KeyBYTE0 through KeyBYTE7
– ONU sends Big_Key message with Frag_Index=1, KeyBYTE8 through KeyBYTE15
– ONU sends Big_Key message with Frag_Index=0, KeyBYTE0 through KeyBYTE7
– ONU sends Big_Key message with Frag_Index=1, KeyBYTE8 through KeyBYTE15

Note that the details of the key exchange, the key switchover, and alarms associated with churning are all unchanged.

8.3.5.7 Verification function

Since all the serial numbers of the ONUs can be extracted from downstream PLOAM cells as they are conveyed during the ranging protocol, a malicious user can masquerade another ONU by eavesdropping the PLOAM cells and extract all the serial numbers. The counteract this, the OLT may requests the password of the ONU. This password is only sent in upstream direction and cannot be recovered by other connected ONUs.

When the OLT requests a password, the ONU responds by sending its password three times. If it receives three identical passwords, the OLT declares this password as verified, and then attempts to validate the password.

Two methods of validation are possible depending on the operator requirements. If the OLT has a table of the valid passwords of the connected ONUs, initialized on operator command, only a comparison is required of the received password with the local table of valid passwords. If the OLT does not know the passwords in advance, the first time the ONU is ranged the received password is taken as the valid reference for the rest of the lifecycle of the ONU.

If the OLT receives a non-valid password, it informs the operator.

8.3.5.8 VP/VC for higher layer

The TC layer activates/deactivates a downstream and an upstream VP/VC. The OLT and ONU use these VP/VCs for communication at the ATM layer. This channel is used for functions like the

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configuration of the UPC function in the ONU, filling filtering tables in an ONU, configuration of the interfaces of an ONU, etc.

The OLT sends three configure_VP/VC messages to an ONU, and expects an acknowledge within 300 ms after sending the last configure_VP/VC messages. If no acknowledge is received, the OLT detects the LOAi state anddeactivates the ONU.

8.3.5.9 Duplex PON system

In case of a duplex system where a redundant PON protects the active PON, protection switching will be activated using specified messages in PLOAM cells. This sequence will require that the line numbers of the OLT must be totally the same as those of the ONU. This line identifier is assigned to a transmitter based on the interconnection scheme of OLTs with ONUs. The line identifier is sent at both OLT and ONU to check whether the received line identifier is the same as its own identifier. This is defined as the PON Section Trace (PST) message. Then each equipment can verify its continued connection to the intended transmitter. If the received line number differs from the own line number, the equipment generates an alarm, MIS (Link Mismatching) to notify an operator or a user.

The PST messages include the K1, K2 bytes as they are specified in ITU-T Rec. G.783 for performing Automatic Protection Switching. The complete description of this is given in ITU-T Rec. G.983.5.

In case of a singular system, link mismatching is optional.

8.3.5.10 MAC protocol

The MAC controller in the OLT allocates the upstream bandwidth on the PON among the ONUs in a fair way and needs information to perform this task. The ONU maps the required information in the minislot payload field of the minislot being part of a Divided_slot. An ONU is allowed to send this minislot after receiving a corresponding divided_slot grant. This grant is set up or released using the Divided_Slot_Grant_configuration message. The length and offset of the minislot are conveyed in the same message. The format for conveying this information and the MAC protocol is for further study.

8.3.6 ATM specific TC functions

8.3.6.1 Downstream

8.3.6.1.1 ATM cell format

The ATM cell is defined in ITU-T Rec. I.361.

8.3.6.1.2 Header error control

As defined in ITU-T Rec. I.432.

8.3.6.1.3 Cell delineation

Downstream cell delineation is performed in the ONU. An optional method is defined in ITU-T Rec. I.432.

8.3.6.1.4 Scrambler operation

As defined in ITU-T Rec. I.432 (distributed cell scrambler method for cell based transport systems).

8.3.6.1.5 Idle cells

Idle cells, as defined in ITU-T Rec. I.432, are inserted at the OLT and discarded at the ONU for cell rate decoupling.

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8.3.6.1.6 PLOAM cells

Any cell, numbered "ATM cell 1" up to "ATM cell 54" in Figure 11, or numbered "ATM cell 1" up to "ATM cell 216" in Figure 12 or 13, or numbered "ATM cell 1" up to "ATM cell 432" in Figure 14 or 15 that has a header equal to the specified header of a PLOAM cell, is discarded at the ONU.

8.3.6.2 Upstream

8.3.6.2.1 ATM cell format

As defined in ITU-T Rec. I.361.

8.3.6.2.2 Header error control

The OLT applies HEC for the upstream as defined in ITU-T Rec. I.432 for every single ONU.

8.3.6.2.3 Cell delineation

Since upstream cells arrive from different ONUs with different phase, the OLT keeps n state diagrams for n active ONUs. Figure 21 shows the state diagram of one ONU.

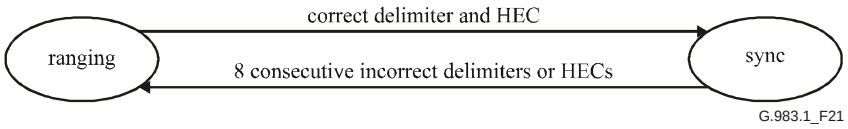


Figure 21/G.983.1 – Cell delineation state diagram

Initially, cell delineation is achieved by the ranging method. The ONU equalizes the round-trip delay to make its cell arrive at the correct time for the OLT. The ranging process can be seen as the HUNT state as defined in ITU-T Rec. I.432.1. After one correct delimiter and HEC, the ONU is declared in sync. For eight consecutive incorrect delimiters or HECs, the ONU is declared out of sync (LCDi, Loss of Cell Delineation) and it will be deactivated and reranged. Still pending grants for this ONU will be discarded.

8.3.6.2.4 Scrambler operation

The upstream cells are scrambled with a generating polynomial $x^9 + x^4 + 1$. It is set at all ones at reference point X shown in Figure 22. This pattern is added modulo 2 to each upstream cell or minislot. The upstream overhead bytes are not scrambled.

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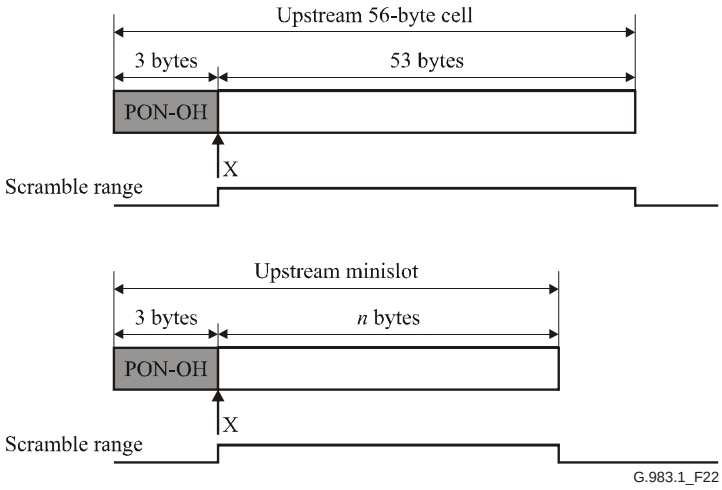


Figure 22/G.983.1 – Upstream scrambler

The implementation of this scrambler should be functionally equivalent to the one shown in Figure 23.

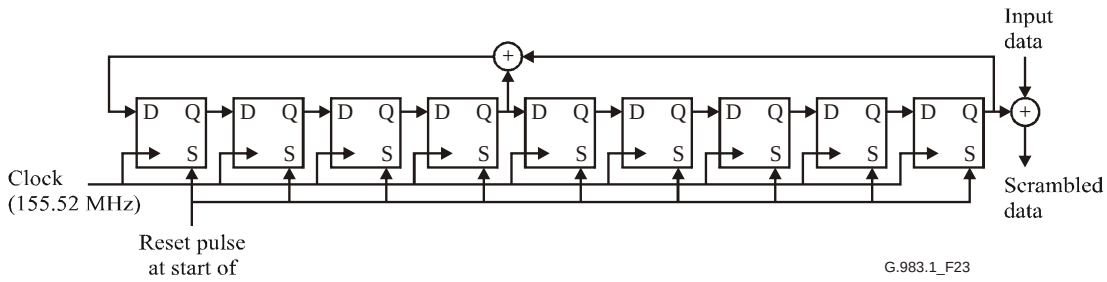


Figure 23/G.983.1 – Upstream scrambler

All FFs are set at 1 by the reset pulse.

8.3.6.2.5 Idle cells

The ONU sends an idle cell, as defined in ITU-T Rec. I.432, when it receives a data grant and has no cells available. Idle cells are inserted at the ONU and discarded at the OLT for cell rate decoupling.

8.3.6.2.6 PLOAM cells

PLOAM cells received from the transport-specific TC layer, which is an exceptional case, are discarded.

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8.3.7 OAM functions

The OAM functions installed in the ONU and OLT are shown in Figure 24. It also shows the notification signals between OLT and ONU. These signals are mapped in the message fields of the PLOAM cells. The general principles as defined in ITU-T Rec. I.610 can be applied to the PON. However, due to the point-to-multipoint nature of the physical medium, some notifications from OLT to ONU are obsolete because principally the ONU slaves to the OLT and the ONU can not do anything with these notifications.

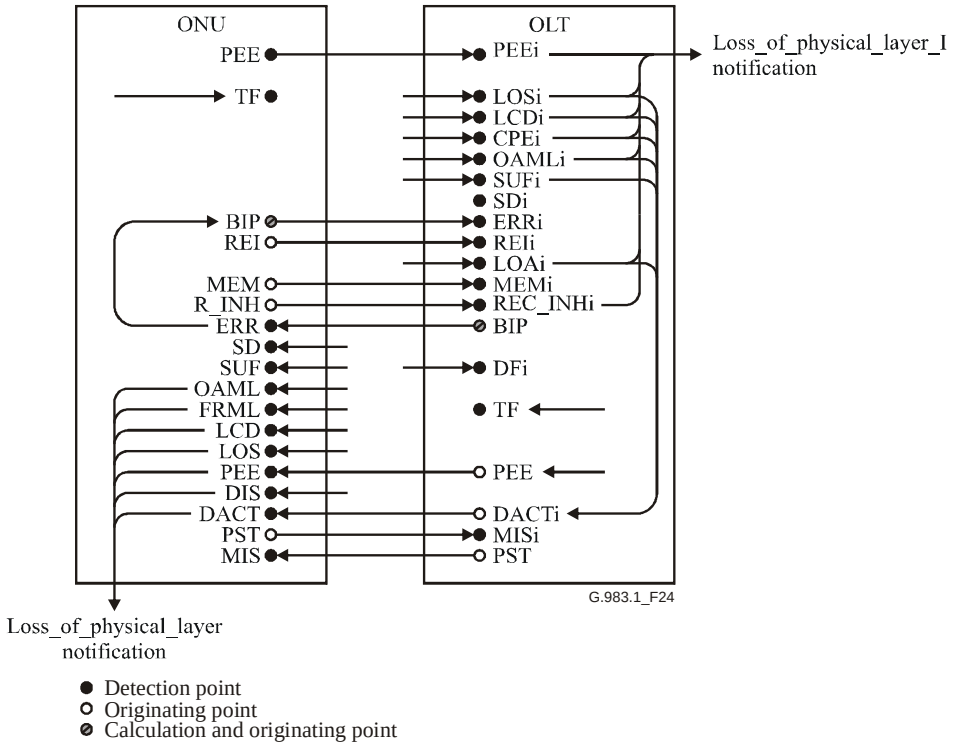


Figure 24/G.983.1 – OAM functions

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8.3.7.1 Items detected at OLT

Table 15/G.983.1 – Items detected at OLT

Type	Description	
	Detection conditions	Actions
	Cancellation conditions	Actions
TF	**Transmitter Failure**	
	The OLT transmitter is declared in failure when there is no nominal backfacet photocurrent or when the drive currents go beyond the maximum specification.	
SUFi	**Startup Failure of ONUi**	
	The ranging of ONUi has failed *n* times (*n* = 2; refer to 8.4.4.3.3) while the OLT has received optical bursts from this ONU.	Send three times deactivate_PON_ID messages.
	The ONU is reranged successfully.	
PEEi	**Physical Equipment Error of ONUi**	
	When the OLT receives a PEE from the ONU	Generate Loss_of_physical_layer_I notification.
	When the OLT does not receive a PEE message from the ONUi in three seconds	Stop Loss_of_physical_layer_I notification.
LCDi	**Loss of Cell Delineation of ONUi**	
	When eight consecutive invalid delimiters or invalid HECs from ONUi are received	Send three times deactivate_PON_ID messages. Generate Loss_of_physical_layer_I notification.
	When cell delineation for ONUi is achieved in the operating state	
OAMLi	**PLOAM cell loss for ONUi**	
	When three consecutive PLOAM cells of ONUi are missing	Send three times deactivate_PON_ID messages. Generate Loss_of_physical_layer_I notification.
	When the OLT receives a PLOAM cell corresponding to its PLOAM grant in the Operating state	
CPEi	**Cell phase Error for ONUi**	
	When the OLT can receive the correct delimiter and the received cell phase is beyond the limits and the corrective actions of the OLT do not solve the problem	Send three times deactivate_PON_ID messages. Generate Loss_of_physical_layer_I notification.
	When the OLT receives a cell in the correct position in the operating state	

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Table 15/G.983.1 – Items detected at OLT

Type	Description	
LOSi	**Loss of signal of ONUi**	
	No valid optical signal at the O/E receiver received for ONUi when expected during eight upstream sequential cells	Send three times deactivate_PON_ID messages. Generate Loss_of_physical_layer_I notification.
	When the OLT receives a valid optical signal corresponding to its grant in the Operating state	
LOAi	**Loss of Acknowledge with ONUi**	
	The OLT does not receive an acknowledge from ONUi after a set of downstream messages that imply an upstream acknowledge	Send three times deactivate_PON_ID messages. Generate Loss_of_physical_layer_I notification.
	When the OLT receives an acknowledge	
DFi	**Deactivate Failure of ONUi**	
	The ONU does not react correctly after three DACT messages	
	Cancelled by the operator	
ERRi	**Block error detection of ONUi**	
	The upstream received BIP8 is compared with the calculated BIP8 on the received stream. When there is a difference between them, the OLT issues ERRi	
	ERRi should be cleared when the next upstream PLOAM cell with a BIP8 that matches the calculated BIP8 is received at the OLT from ONUi	
SDi	**Signal Degraded of ONUi**	
	The number of differing bits is accumulated in Error_I during interval Tmeasure. The BER is defined as BER=Error_i/(BW*Tmeasure) where BW is the allocated upstream bandwidth. When the upstream BER of ONUi becomes $\geq 10^{-5}$, this state is entered.	
	When the upstream BER of ONUi becomes $<10^{-5}$, this state is cleared.	

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Table 15/G.983.1 – Items detected at OLT

Type	Description	
REIi	**Remote Error Indication of ONUi**	
	When the OLT receives a non-zero REI message, it issues REIi.	
	REIi should be cleared when an REI message reporting zero errors is received at OLT from ONUi.	
MEMi	**Message_Error Message from ONUi**	
	When the OLT receives an unknown message from ONUi or received message_error message	
	When the operator is informed	
R-INHi	**Receive Alarm Inhibition of ONUi**	
	When the OLT receives R-INH message from ONUi, R-INHi is detected	Ignore received alarms from this ONU. Generate Loss_of_physical_layer_I notification.
	When the OLT receives a PLOAM cell in the ranging process of ONUi	–
MISi	Link Mismatch of ONUi	
	The OLT detects that the received PSTi and the transmitted PST are different	
	The OLT detects that received PSTi and the transmitted PST are the same	

8.3.7.2 Items detected at ONU

Table 16/G.983.1 – Items detected at ONU

Type	Description	
	Detection conditions	Actions
	Cancellation conditions	Actions
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.	
LOS	**Loss Of Signal**	
	No valid optical signal. E.g., this can be generated by the logical function (OAML.AND.FRML.AND.LCD).	Switch off laser. Generate Loss_of_physical_layer notification.
	Valid optical signal. E.g., this can be generated by the negated logical function given above.	

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Table 16/G.983.1 – Items detected at ONU

Type	Description	
PEE	**Physical_Equipment_error Signal**	
	When the ONU receives a PEE message	Generate Loss_of_physical_layer notification.
	When the ONU does not receive a PEE message in three seconds	
SUF	**Startup Failure**	
	The ranging of this ONU has failed (see ranging protocol for exact condition).	
	When ranging is successful	
OAML	**PLOAM cell loss**	
	When three consecutive PLOAM headers are wrong	Switch off laser. Generate Loss_of_physical_layer notification.
	OAM sync when three consecutive correct PLOAM headers	
LCD	**Loss of Cell Delineation**	
	When seven consecutive ATM cells have an invalid HEC	Switch off laser. Generate Loss_of_physical_layer notification.
	When *N* consecutive ATM cells have correct HEC (*N* = 9 or 17)	
FRML	**FRML Loss of downstream frame**	
	When the frame bit is "0" for three consecutive frames.	Switch off laser. Generate Loss_of_physical_layer notification.
	When frame bit is "1" for three consecutive frames	
ERR	**Block error detection**	
	The downstream received BIP8 is compared with the calculated BIP8 on the received stream. The number of differing bits is accumulated in ERR. At regular intervals, the content is sent via REI to the OLT. This interval is programmed by the OLT with a BER_interval_timer message. ERR is renewed at every reception of a downstream PLOAM cell.	REI is transmitted in the cycle of BER_interval time.
SD	**Signal Degraded**	
	Set active when the downstream BER $\geq 10^{-5}$	
	Set inactive when the downstream BER is $<10^{-5}$	
MEM	**Message Error Message**	
	When the ONU receives an unknown message	Send upstream Message_error message.

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Table 16/G.983.1 – Items detected at ONU

Type	Description	
DACT	**Deactivate PON_ID**	
	Reception of the Deactivate_PON_ID message addressed to this ONU, requesting the ONU to deactivate itself	Switch off the laser and go to state O2. Generate Loss_of_physical_layer notification
	Reception of Upstream_overhead message	Proceed with normal ranging procedures.
DIS	**Disabled ONU**	
	When the ONU receives a Disable_serial_number message with its own serial number and the enable flag = 0xFF. It stays in this state even after power-off	Switch off laser. Go to Emergency Stop State O9. Generate Loss_of_physical_layer notification
	When the ONU receives a Disable_serial_number message with Enable flag = 0x0F or when it receives a Disable_serial_number message with its own serial number and the enable flag = 0x00	Go to state O1.
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.	

8.3.8 MESSAGES in the PLOAM channel

The processing time of all downstream messages is within 6*Tframe, which is the time needed by the ONU to process the downstream message and prepare any corresponding upstream action. The downstream churning_key_update message has priority on all other downstream messages. The priority level is indicated in the "function" column. On some messages, the ONU has to reply with an upstream message. The priority level of upstream messages is also indicated in the "function" column. If not indicated, the priority level is 0 (0 is lowest priority).

Also note that the special messages Divided_Slot_Grant_configuration and PST are not used in systems without DBA or duplex protection. However, all systems should be able to receive such messages without causing an error. For further description of the detailed behaviour, refer to ITU-T Recs G.983.4 and G.983.5 for these messages.

8.3.8.1 Message definition

See Table 17.

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Table 17/G.983.1 – Message definition

	Message name	Function	Direction	Trigger	Number of times sent	Effect of receipt
1	No message	No message available when a PLOAM cell is transmitted	OLT → ONU	Empty message queue	–	Discard.
2	New_churning_key_rq	It requests a new churning key from the ONU.	OLT → ONU	OLT needs a new key for the churning mechanism.	1	ONU generates a new key and conveys the key to the OLT with a new_churning_key message.
3	Upstream_RX_control	To instruct the ONU which pattern to fill in the RXCF part of the upstream PLOAM cell	OLT → ONU	Each time a ranging process is started	3	The ONU sets the upstream RXCF field of the upstream PLOAM cell.
4	Upstream_overhead	To instruct the ONU which overhead and pre-assigned equalization delay (Te) to use in the upstream direction	OLT → ONU	Each time a ranging process is started	3	The ONU sets the upstream overhead and the pre-assigned equalization delay (Te).
5	Serial_number_mask	It provides a serial number and a mask masking a part of this serial number.	OLT → ONU	To find the serial number of a unique ONU	1	If serial number and mask match the ONU's serial number, the ONU is enabled to react on ranging grants.
6	Assign_PON_ID	It links a free PON_ID number with the serial number also provided in this message.	OLT → ONU	When the OLT has found the serial number of a unique ONU	3	The ONU with this serial number uses this PON_ID and will be addressed by this PON_ID.

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Table 17/G.983.1 – Message definition

	Message name	Function	Direction	Trigger	Number of times sent	Effect of receipt
7	Ranging_time	It indicates the value expressed in number of upstream bits that an ONU with PON_ID must fill in into its equalization delay register (Td).	OLT → ONU	When the OLT decides that the delay (Td) must be updated; see ranging protocol	3	The ONU fills in the equalization delay (Td) register with this value.
8	Deactivate_PON_ID	It instructs an ONU with this PON_ID to stop sending upstream traffic and reset itself. It can also be a broadcast message.	OLT → ONU	When the LOSi, LCDi,OAMLi, LOAi, SUFi or CPEi are detected	3	The ONU with this PON_ID switches off the laser and the PON_ID is discarded. It should be activated when the MPU becomes out of order.
9	Disable_serial_number	To disable an ONU with this serial number	OLT → ONU	On command from the OpS	3 or until no burst is detected.	Moves the ONU to the emergency stop state. The ONU cannot respond to grants.
10	Churning_key_update	To indicate to the ONU when the new churning key becomes valid Priority level is 1.	OLT → ONU	When the OLT is ready to churn data for ONU with PON_ID	3	The ONU switches to the new churning key 48*Tframe after the first update message. Send one acknowledge after each correctly received message.
11	Grant_allocation message	To allocate a data and PLOAM grant to an ONU	OLT → ONU	After a PON_ID is allocated to the ONU, it needs a data and PLOAM grant for sending the upstream data and PLOAM cells.	3	The ONU stores the two grant types.

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Table 17/G.983.1 – Message definition

	Message name	Function	Direction	Trigger	Number of times sent	Effect of receipt
12	Divided_Slot_Grant_ configuration message	To allocate or deallocate a Divided_slot_grant to an ONU and identify the minislot length and offset position	OLT → ONU	The OLT needs/no longer needs the service provided by the minislot.	3	The ONU sends the minislot after receiving this allocated divided_slot grant. If deallocated, it no longer reacts to this Divided_Slot_grant.
13	Configure_VP/VC	This message activates or deactivates a VP/VC in downstream and upstream for communication at the ATM layer.	OLT → ONU	When the OLT wants to set up or tear down a connection with the ONU, for example, for configuration of the UPC function, filling filtering tables or configuration of the interfaces of the ONU	3	The ONU activates/deactivates these VP/VCs for the communication channel. Send one acknowledge after each correctly received message.
14	BER_interval	It defines the accumulation interval per ONU expressed in the number of downstream frames for the ONU counting the number of downstream bit errors. Same time-out as for Configure_VP/VC	OLT → ONU	OpS defines this interval and can focus on one particular ONU.	3	The ONU starts a BER_interval timer and accumulates the downstream bit errors. Send one acknowledge after each correctly received message. The sequence number in the REI messages is reset.
15	PST message	To check the OLT-ONU connectivity in a redundant configuration and to perform APS	OLT → ONU	Send it at a certain rate	1 time/second	ONU checks link number with own link number and generates a Link Mismatch MIS if different.

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Table 17/G.983.1 – Message definition

	Message name	Function	Direction	Trigger	Number of times sent	Effect of receipt
16	Physical_equipment_ error message (PEE)	To indicate to the ONUs that the OLT is unable to send both ATM cells and OMCC cells in the direction from ATM layer to TC layer	OLT → ONU	When the OLT detects it cannot send both ATM cells and OMCC cells in the direction from ATM layer to TC layer	1 time/second	Depends on the system
17	Churned_VP	To indicate to the ONUs which VP/VC are churned or not	OLT → ONU	When a new VP must be churned or not	3	(Un)Mark this VP as churning. Send one acknowledge after each correctly received message.
18	Request_password message	To request the password from an ONU in order to verify it. The OLT has a local table of passwords of the connected ONUs. If after a reranging, the password has changed, it will not activate this ONU.	OLT → ONU	After an ONU is ranged This is optional.	1	Send the password message three times.
19	POPUP message	The OLT can request all connected ONUs to restore their settings except the equalization delay and force them to go from POPUP state to Operating standby state 3 (O7).	OLT → ONU	To speed up the reranging of a subset or all of the connected ONUs	3	The ONU restores the parameters it was using in operating state before it detected an LOS, LCD, OAML or FRML, except the equalization delay which is set to the pre-assigned equalization delay.
20	Vendor_specific message	A number of Message_IDs are reserved for vendor-specific messages.	OLT → ONU	Vendor-specific.	Vendor-specific.	Vendor-specific.
21	No message	No message available when a PLOAM cell is transmitted	OLT ← ONU	Empty message queue		Discard.

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Table 17/G.983.1 – Message definition

	Message name	Function	Direction	Trigger	Number of times sent	Effect of receipt
22	New_churning_key	Contains a new key to be used on the downstream churned cells to this ONU Priority level is 1.	OLT ← ONU	After the OLT request, the ONU fetches a new key and sends it to the OLT.	3 times	The OLT initializes the churning engine with this new key if it receives three consecutive identical keys and switches to the new key 48*Tframe after the first churning_key_update message.
23	Acknowledge	It is used by the ONU to indicate the reception of a downstream Configure_VP/VC, Churning_key_update, Churned_VP or BER_interval message. Priority is 1 for the acknowledge on the churning_key_update message. The priority level is 0 for the others. The time-out for the acknowledge is 300 ms.	OLT ← ONU	After receiving every correct corresponding downstream message	1 time	The OLT is informed of good reception of the downstream message it was sending and performs the corresponding actions.
24	Serial_number_ONU	It contains the serial number of an ONU.	OLT ← ONU	The ONU sends this message when in ranging mode and on receipt of a ranging grant or a PLOAM grant.	*X* (may be sent several times during the ranging protocol).	The OLT extracts the serial number and can assign a free PON_ID to this ONU.

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Table 17/G.983.1 – Message definition

	Message name	Function	Direction	Trigger	Number of times sent	Effect of receipt
25	Message_error message	It indicates that the ONU is unable to comply with a message from the OLT.	OLT ← ONU	When the ONU is unable to comply with a message contained in a downstream PLOAM cell	3	Inform the operator
26	REI (Remote Error Indication)	It contains the number of downstream BIP mismatches (one count per bit mismatch) counted during the BER_interval.	OLT ← ONU	When the BER_interval has expired	1 time/BER_interval	The OLT can show the average BER in function of time for an ONU.
27	R-INH	To inform the OLT that the ONU will power-off in a normal operation. This is to prevent the OLT from issuing unnecessary alarm reports. Priority level is 2.	OLT ← ONU	The ONU generates this message when the power-off (such as the power switch-off or the power cord extraction without battery backup) is activated in a normal operation.	At least 3 times	Discard any following alarms from this ONU Inform OpS
28	PST message	To check the OLT-ONU connectivity in a redundant configuration and to perform APS	OLT ← ONU	Send it at a certain rate.	1 time/second	OLT checks link number with own link number and generates a Link Mismatch MISi if different.
29	Physical_equipment_ error	To indicate to the OLT that the ONU is unable to send both ATM cells and OMCC cells in the direction from ATM layer to TC layer	OLT ← ONU	When the ONU detects it cannot send both ATM cells and OMCC Cells in the direction from ATM layer to TC layer	1 time/second	Depends on the system.

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Table 17/G.983.1 – Message definition

	Message name	Function	Direction	Trigger	Number of times sent	Effect of receipt
30	Password	To verify an ONU based on its password	OLT ← ONU	When the OLT requests the password by the request_password message	3	If OLT receives three identical passwords, it is declared as valid. Further processing is system dependent.
31	Vendor_specific message	A number of Message_Ids are reserved for vendor-specific messages.	OLT ← ONU	Vendor-specific	Vendor-specific	Vendor-specific
32	Big_Key message (optional)	Carries a large key for use with data encryption Priority level is 1.	OLT ← ONU	After the OLT request, the ONU fetches a new key and sends it to the OLT	3 times per fragment	The OLT initializes the encryption logic with this new key if it receives three consecutive identical keys and switches to the new key 48*Tframe after the first churning_key_update message.

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8.3.8.2 Message formats

This clause defines the contents of the messages in the previous clause.

8.3.8.2.1 Downstream message formats

No message		
Octet	**Content**	**Description**
35	0100 0000	Broadcast message to all ONUs
36	0000 0000	Message identification "no message"
37..46	Unspecified	

Upstream_Rx_Control message		
Octet	**Content**	**Description**
35	0100 0000	Broadcast message to all ONUs
36	0000 0001	Message identification "Upstream_Rx_control"
37	Submessage count *n*	*n* can be 0x00 or 0x01. It indicates which part of the RXCF field is indicated in the remaining octets of this message.
38	dddd dddd	RXCF1 for *n* = 0x00 and RXCF10 for *n* = 0x01
39	dddd dddd	RXCF2 for *n* = 0x00 and RXCF11 for *n* = 0x01
40	dddd dddd	RXCF3 for *n* = 0x00 and RXCF12 for *n* = 0x01
41	dddd dddd	RXCF4 for *n* = 0x00 and RXCF13 for *n* = 0x01
42	dddd dddd	RXCF5 for *n* = 0x00 and RXCF14 for *n* = 0x01
43	dddd dddd	RXCF6 for *n* = 0x00 and RXCF15 for *n* = 0x01
44	dddd dddd	RXCF7 for *n* = 0x00 and RXCF16 for *n* = 0x01
45	dddd dddd	RXCF8 for *n* = 0x00 and unspecified for *n* = 0x01
46	dddd dddd	RXCF9 for *n* = 0x00 and unspecified for *n* = 0x01

Upstream_overhead message		
Octet	**Content**	**Description**
35	0100 0000	Broadcast message to all ONUs
36	0000 0010	Message identification "Upstream_overhead"
37	gggg gggg	Number of guard bits of the upstream overhead, count starting from the first bit of the upstream overhead bytes ($4 \leq$ gggggggg ≤ 24). The value of the first gggg gggg bits of overhead data in bytes 38-40 are ignored by the ONU.
38	bbbb bbbb	Data to be programmed in overhead byte 1
39	bbbb bbbb	Data to be programmed in overhead byte 2
40	bbbb bbbb	Data to be programmed in overhead byte 3
41	Unspecified	
42	Unspecified	

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Upstream_overhead message		
Octet	**Content**	**Description**
43	xxxx xxxp	Message identification "preassigned equalization delay (Te)" p = "0" indicates Te = 0 p = "1" indicates Te is defined by octets 44-46
44	dddd dddd	MSB of pre-assigned equalization delay (Te)
45	dddd dddd	
46	dddd dddd	LSB of pre-assigned equalization delay (Te)

Ranging_time message		
Octet	**Content**	**Description**
35	PON_ID	Directed message to one ONU
36	0000 0011	Message identification "Ranging_time"
37	dddd dddd	MSB of equalization_delay (Td)
38	dddd dddd	
39	dddd dddd	LSB of equalization_delay (Td)
40..46	Unspecified	

Serial_number_mask message		
Octet	**Content**	**Description**
35	0100 0000	Broadcast message to all ONUs
36	0000 0100	Message identification "Serial_number_mask"
37	nnnn nnnn	Number of valid bits (nnnnnnnn ≤ 64), count started from LSB of byte 45 counting up to the MSB of byte 38
38	abcd efgh	Serial number byte 1
…	…	
45	stuv wxyz	Serial number byte 8
46	Unspecified	

Assign_PON_ID message		
Octet	**Content**	**Description**
35	0100 0000	Broadcast message to all ONUs
36	0000 0101	Message identification "Assign_PON_ID"
37	pppp pppp	PON_ID (pppppppp ≤ 63)
38	abcd efgh	Serial number byte 1
…	…	
45	stuv wxyz	Serial number byte 8
46	Unspecified	

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Deactivate PON_ID message		
Octet	**Content**	**Description**
35	PON_ID	Directed message to one ONU or all ONUs. As a broadcast to all ONUs, PON_ID = 0x40
36	0000 0110	Message identification "Deactivate_PON_ID"
37..46	Unspecified	

Disable_serial_number message		
Octet	**Content**	**Description**
35	0100 0000	Broadcast message to all ONU
36	0000 0111	Message identification "Disable_serial_number"
37	Enable	0xFF: The ONU with this serial number is denied upstream access. 0x0F: All ONUs which were denied upstream access, can participate in ranging process. The content of bytes 38~45 are irrelevant. 0x00: The ONU with this serial number can participate in the ranging process.
38	abcd efgh	Serial number byte 1
…	…	
45	stuv wxyz	Serial number byte 8
46	Unspecified	

New_churning_key_request message		
Octet	**Content**	**Description**
35	PON_ID	Directed message to one ONU
36	0000 1000	Message identification "New_churning_key_request"
37..46	Unspecified	

Churning_key_update message		
Octet	**Content**	**Description**
35	PON_ID	Directed message to one ONU
36	0000 1001	Message identification "Churning_key_update"
37	COUNT	Goes from 1 to 3
38..46	Unspecified	

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Grant_allocation message		
Octet	**Content**	**Description**
35	PON_ID	Directed message to one ONU
36	0000 1010	Message identification "Grant_allocation"
37	dddd dddd	Data grant allocated to the ONU with this PON_ID
38	0000 000a	a:1 = Activate data grant for this ONU a:0 = Deactivate data grant for this ONU
39	pppp pppp	PLOAM grant allocated to the ONU with this PON_ID
40	0000 000a	a:1 = Activate PLOAM grant for this ONU a:0 = Deactivate PLOAM grant for this ONU
41..46	Unspecified	

Divided_Slot_Grant_configuration message		
Octet	**Content**	**Description**
35	PON_ID	Directed message to one ONU
36	0000 1011	Message identification "Divided_Slot_Grant_configuration"
37	0000 000a	a:1 = Activate grant for this ONU a:0 = Deactivate grant for this ONU
38	DS_GR	Defines the grant value allocated to this ONU for sending a minislot.
39	LENGTH	Defines the length of the minislot payload in number of bytes. Within the range [1 .. (53 – OFFSET)]
40	OFFSET	Defines the offset of the start of the minislot in number of bytes from the start of an upstream cell slot OFFSET = 0 means minislot starts at the first byte of the upstream slot
41	Service_ID	Defines the service to be mapped into the minislot 0000 0000 is used for the MAC protocol. Other values are for FU.
42..46	Unspecified	

Configure VP/VC message		
Octet	**Content**	**Description**
35	PON_ID	Directed message to one ONU
36	0000 1100	Message identification "Configure VP/VC"
37	0000 000a	Bytes 38-41 define downstream and upstream VP/VC. a:1 Activates this VP/VC a:0 Deactivates this VP/VC
38	HEADER1	ATM header byte 1 (MSB)
39	HEADER2	ATM header byte 2
40	HEADER3	ATM header byte 3

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Configure VP/VC message		
Octet	**Content**	**Description**
41	HEADER4	ATM header byte 4 (LSB). The 4 least significant bits (PTI and CLP) are transparent for the TC layer.
42	MASK1	All the bits of MASK that are set to 1 define the corresponding bits in HEADER that must be used for termination or generation of cells at the ATM layer.
43	MASK2	
44	MASK3	
45	MASK4	Only the 4 most significant bits are used.
46	Unspecified	

Physical_equipment_error message		
Octet	**Content**	**Description**
35	0100 0000	Broadcast message to all ONUs
36	0000 1101	Message identification "Physical_equipment_error"
37..46	Unspecified	

Request_Password message		
Octet	**Content**	**Description**
35	PON_ID	Directed message to one ONU
36	0000 1110	Message identification "Request_Password"
37..46	Unspecified	

Churned_VP message		
Octet	**Content**	**Description**
35	PON_ID	Directed message to one ONU
36	0000 1111	Message identification "Churned_VP"
37	xxxx xxxa	a = 1 Churned a = 0 Not churned
38	abcd efgh	abcdefgh = VPI[11..4]
39	ijkl 0000	ijkl = VPI[3..0]
40..46	Unspecified	

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POPUP message		
Octet	**Content**	**Description**
35	0100 0000	Broadcast message to all ONUs
36	0001 0000	Message identification "POPUP"
37..46	Unspecified	

Vendor_specific message		
Octet	**Content**	**Description**
35	xxxx xxxx	Directed message to one ONU or broadcast
36	0111 1zzz	Message identification "Vendor_specific"
37..46	yyyy yyyy	Vendor specific. These messages can be used for proprietary use by different vendors and will never be standardized.

PST message		
Octet	**Content**	**Description**
35	0100 0000	Broadcast message to all ONUs
36	1000 0000	Message identification "PST"
37	Line number	Can be 0 or 1
38	Control	This is the K1 byte as specified in ITU-T Rec. G.783.
39	Control	This is the K2 byte as specified in ITU-T Rec. G.783.
40..46	Unspecified	

BER_interval message		
Octet	**Content**	**Description**
35	PON_ID	Directed message to one ONU
36	1000 0001	Message identification "BER_interval"
37	Interval1	32-bit interval, MSB
38	Interval2	
39	Interval3	
40	Interval4	32-bit interval, LSB, interval in number of frames
41..46	Unspecified	

8.3.8.2.2 Upstream message formats

No message		
Octet	**Content**	**Description**
2	PON_ID	Indicates the ONU sourcing this message
3	0000 0000	Message identification "no message"
4..13	Unspecified	

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New_churning_key message		
Octet	**Content**	**Description**
2	PON_ID	Indicates the ONU sourcing this message
3	0000 0001	Message identification "New_churning_key"
4	Churning_key1	(MSB) X1, X2, ..., X8 (LSB)
5	Churning_key2	(MSB) P1, P2, ..., P8
6	Churning_key3	P9, P10, ..., P16 (LSB)
7..13	Unspecified	

Acknowledge message		
Octet	**Content**	**Description**
2	PON_ID	Indicates the ONU sourcing this message
3	0000 0010	Message identification "Acknowledge"
4	DM_ID	Message identification of downstream message
5	DMBYTE37	Byte 37 of downstream message
6	DMBYTE38	Byte 38 of downstream message
7	DMBYTE39	Byte 39 of downstream message
8	DMBYTE40	Byte 40 of downstream message
9	DMBYTE41	Byte 41 of downstream message
10	DMBYTE42	Byte 42 of downstream message
11	DMBYTE43	Byte 43 of downstream message
12	DMBYTE44	Byte 44 of downstream message
13	DMBYTE45	Byte 45 of downstream message

Serial_number_ONU		
Octet	**Content**	**Description**
2	0100 0000 PON_ID	Operating standby state 2 Operating standby state 3
3	0000 0011	Message identification "Serial_number_ONU"
4	0000 0000	Byte 5 to byte 12 form the complete serial number of the ONU.
5	VID1	Vendor_ID byte 1
6	VID2	Vendor_ID byte 2
7	VID3	Vendor_ID byte 3
8	VID4	Vendor_ID byte 4
9	VSSN1	Vendor specific Serial number byte 1
10	VSSN2	Vendor specific Serial number byte 2
11	VSSN3	Vendor specific Serial number byte 3
12	VSSN4	Vendor specific Serial number byte 4
13	Unspecified	

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The codeset for the Vendor_ID is specified in ANSI T1.220. The four characters are mapped in the 4 byte field by taking each ASCII/ANSI character code and concatenating them.

Example: Vendor_ID = ABCD ⇒ VID1 = 0x41, VID2 = 0x42, VID3 = 0x43, VID4 = 0x44.

Password message		
Octet	**Content**	**Description**
2	PON_ID	Indicates the ONU sourcing this message
3	0000 0100	Message identification "Password"
4	pppp pppp	Password1
…	…	…
13	pppp pppp	Password10

Physical_equipment_error message		
Octet	**Content**	**Description**
2	PON_ID	Indicates the ONU sourcing this message
3	0000 0101	Message identification "Physical_equipment_error"
4..13	Unspecified	

Vendor_specific message		
Octet	**Content**	**Description**
2	xxxx xxxx	Indicates ONU sourcing this message
3	0111 1zzz	Message identification "Vendor_specific"
4..13	yyyy yyyy	Vendor-specific. These messages can be used for proprietary use by different vendors and will never be standardized.

REI message		
Octet	**Content**	**Description**
2	PON_ID	Indicates the ONU sourcing this message
3	1000 0000	Message identification "REI message"
4	Error_count1	32-bit error counter, MSB
5	Error_count2	32-bit error counter
6	Error_count3	32-bit error counter
7	Error_count4	32-bit error counter, LSB
8	0000 SSSS	Sequence number. The 4 LSB bits SSSS are incremented every time this message is sent
9..13	Unspecified	

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R-INH message		
Octet	**Content**	**Description**
2	PON_ID	Indicates the ONU sourcing this message
3	1000 0001	Message identification "R-INH"
4..13	Unspecified	

PST message		
Octet	**Content**	**Description**
2	PON_ID	Indicates the ONU sourcing this message
3	1000 0010	Message identification "PST"
4	Linenumber	Can be 0 or 1
5	Control	This is the K1 byte as specified in ITU-T Rec. G.783.
6	Control	This is the K2 byte as specified in ITU-T Rec. G.783.
7..13	Unspecified	

Message_error message		
Octet	**Content**	**Description**
2	PON_ID	Indicates the ONU sourcing this message
3	1000 0011	Message identification "Message_error"
4	Message_id	Indicates unrecognized downstream message_id
5..13	Unspecified	

Big_Key Message (optional)		
Octet	**Content**	**Description**
2	PON_ID	Indicates the ONU sourcing this message
3	0000 0110	Message identification "Big Churning Key message"
4	Key_Index	Index indicating which ONU key this message carries
5	Frag_Index	Index indicating which part of the key this message carries
6	KeyBYTE0	Byte 0 of fragment (Frag_Index) of Key (Key_Index)
7	KeyBYTE1	Byte 1 of fragment (Frag_Index) of Key (Key_Index)
8	KeyBYTE2	Byte 2 of fragment (Frag_Index) of Key (Key_Index)
9	KeyBYTE3	Byte 3 of fragment (Frag_Index) of Key (Key_Index)
10	KeyBYTE4	Byte 4 of fragment (Frag_Index) of Key (Key_Index)
11	KeyBYTE5	Byte 5 of fragment (Frag_Index) of Key (Key_Index)
12	KeyBYTE6	Byte 6 of fragment (Frag_Index) of Key (Key_Index)
13	KeyBYTE7	Byte 7 of fragment (Frag_Index) of Key (Key_Index)

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8.3.9 Automatic Protection Switching

Automatic Protection Switching (APS) at the PON TC layer may be provided as an optional function. APS use depends on the number of users and service reliability. Redundant configurations of dual ODNs or dual ONUs should be considered for business applications. Some control bits for the protection protocol are reserved in the PST message field defined in 8.3.8.2.1 and 8.3.8.2.2. A complete description of APS function is given in ITU-T Rec. G.983.5. See Annex D for further details.

Time required for APS including ranging time for 32 ONUs shall be considered to support POTS and/or ISDN services; on-going connections should not be disconnected when APS is carried out.

8.4 Ranging method

8.4.1 Scope of the applied ranging method

A full digital in-band based ranging method should be used by the PON system to measure the logical reach distances between each ONU and the OLT. The maximum range of the PON is at least 20 km. The transmission delay measurement for each ONU should be capable of being performed whilst the PON is in-service without disrupting service to other ONUs.

The window size for the delay measurement signal can be minimized by using some information about the position of the ONU. The network operator may provision the PON with an a *priori* minimum and maximum OLT-ONU distance (if not, the default is 0 km minimum and 20 km maximum). The minimum and maximum distances can be provisioned with a granularity as defined by the network operator. For ONUs which have not been previously ranged, the start and end of the ranging window is determined from these provisioned minimum and maximum distances.

The ranging protocol is specified and applicable for several types of installation methods of ONUs and several types of ranging processes, if necessary, with additional or optional functions.

8.4.1.1 The installation method of ONUs

There are two possible example methods to install an ONU:

Method A: The serial number of the ONU is registered at the OLT by the OpS system.

Method B: The serial number of the ONU is not registered at the OLT by the OpS system. It requires an automatic detection mechanism of the serial number (or soft coded unique number) of the ONU.

For either Method A or Method B, ranging of an ONU may be initiated in two possible ways:

1) The network operator enables the ranging process to start when it is known that a new ONU has been connected. After successful ranging (or a time-out), ranging is automatically stopped.
2) The OLT periodically and automatically initiates the ranging process, testing to see if any new ONUs have been connected. The frequency of polling is programmable such that a ranging window can be opened every millisecond or every second under instruction of the OpS system.

8.4.1.2 Type of ranging process

Different situations as described below are possible where the ranging process may occur. There are four categories under which the ranging process would occur.

8.4.1.2.1 Cold PON, cold ONU

This situation is characterized when no upstream traffic is running on the PON and the ONUs have not yet received PON-IDs from the OLT.

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8.4.1.2.2 Warm PON, cold ONU

This situation is characterized by the addition of new ONU(s) which have not been previously ranged, or by the addition of previously active ONU(s) having power restored and coming back to the PON while traffic is running on the PON.

8.4.1.2.3 Warm PON, warm ONU

This situation is characterized by a previously active ONU which remains powered-on and connected to an active PON but be in the POPUP state described in 8.4.4.2.1. Also, this situation includes an active ONU connected to an active PON with running traffic.

8.4.1.2.4 Switch over

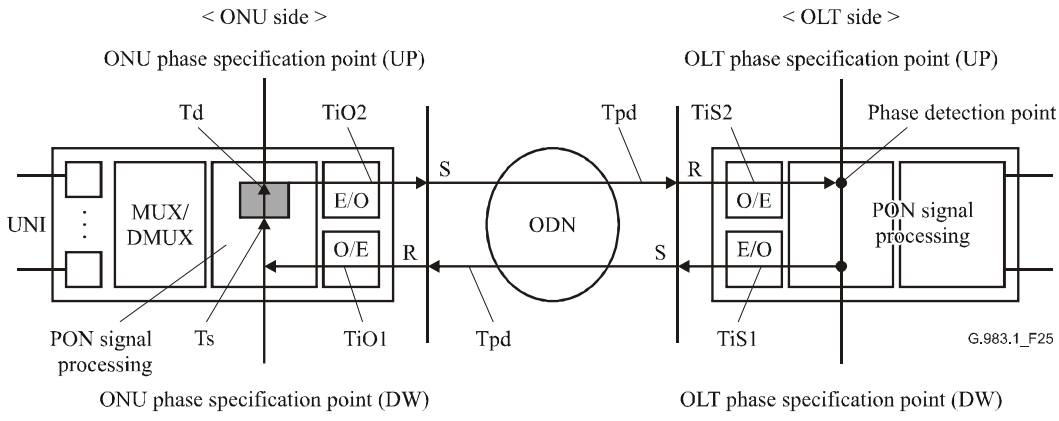
There can be several types of possible duplex and/or partially duplexed ATM-PON configurations. The ranging protocol should be applicable in these cases.

8.4.2 Phase relation specification between downstream and upstream

The phase relation between downstream and upstream must be defined for the ranging process.

8.4.2.1 Definition of the phase specification points

Configuration of the specification points described below is shown in Figure 25.



$$Tconst = TiS1 + Tpd + TiO1 + Ts + Td + TiO2 + Tpd + TiS2$$

$$Tresponse(ONU) = TiO1 + Ts + Td + TiO2 \text{ (at } Td = 0)$$

$$= TiO1 + Ts + TiO2$$

$$0 \le Td \text{ (Equalization\_delay)} \le Max$$

Figure 25/G.983.1 – Configuration of the specification points

8.4.2.1.1 Phase specification points of the ONU and the OLT

The ONU phase specification point is defined for the sake of convenience to specify the cell transmission phase. It is virtually located on the ONU side of the Reference point S/R. The OLT phase specification point is also defined to specify the cell transmission phase. It is virtually located on the OLT side of the Reference point R/S.

8.4.2.1.2 Basic cell transmission delay (Ts)

The basic cell transmission delay (Ts) is defined as the upstream cell phase, which corresponds to the first grant of the first PLOAM cell in the downstream frame, to its downstream frame at the ONU phase specification point when the equalization_delay (Td) is 0. This delay (Ts) is due to PON signal processing in the ONU.

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8.4.2.1.3 ONU cell transmission delay

The ONU cell transmission delay is defined as the upstream cell phase, which corresponds to the first grant of the first PLOAM cell in the downstream frame, to its downstream frame at the ONU phase specification point. The ONU cell transmission delay is the sum of the basic cell transmission delay (Ts) and the equalization_delay (Td) in the ranging procedure.

8.4.2.1.4 Phase of interface specification points S/R and R/S

Cells in the downstream transmission at the Reference point R of the ONU reach the ONU phase specification point after a certain delay TiO1. Cells in the upstream transmission at the ONU phase specification point reach the Reference point S of the ONU after TiO2.

Also, cells in the downstream transmission at the OLT phase specification point reach the Reference point S of the OLT after a certain delay TiS1. Cells in the upstream transmission at the Reference point R of the OLT reach the OLT phase specification point after TiS2.

The delays, TiO1, TiO2, TiS1 and TiS2 are due to optoelectrical and electro-optical conversion in the ONU and OLT (see Figure 25).

8.4.2.2 ONU response time specification

The response time in the ONU, Tresponse(ONU), at the Reference point S/R shall be specified to ensure connectivity of the furthest ONU in multivendor environments.

The response time Tresponse(ONU) is defined below:

$$\text{Tresponse(ONU)} = \text{TiO1} + \text{Ts} + \text{Td} + \text{TiO2 (at Td = 0)}$$

$$= \text{TiO1} + \text{Ts} + \text{TiO2}$$

The value of Tresponse(ONU) shall be between 3136 and 4032 bits (at 155.52 Mbit/s), which is equivalent to between 7 and 9 cells (with a 56 byte-cell). This is estimated as sufficient signal processing time in the ONU.

$$3136 \text{ bits} \leq \text{Tresponse(ONU)} \leq 4032 \text{ bits (at 155.52 Mbit/s)}$$

$$6272 \text{ bits} \leq \text{Tresponse(ONU)} \leq 8064 \text{ bits (at 622.08 Mbit/s)}$$

NOTE – The delay variation due to Tresponse(ONU) is considered as an ONU location ambiguity of about the equivalent of 600 m and 300 m for upstream rates of 155 and 622 Mbit/s, respectively.

8.4.2.3 Phase relation in the normal operation state

The relationship between the phases for the downstream and upstream cells at the Reference point S/R of the ONU, the ONU phase specification point, the Reference point R/S of the OLT, and the OLT phase specification point is shown in Figure 26. Tpd represents the optical fibre propagation delay from the OLT to the ONU (or vice versa).

The upstream cell time slot of cell #1 corresponds to the first grant-field of the first downstream PLOAM cell of the downstream frame. The delay between the PLOAM cell with the first grant and the corresponding upstream cell is defined as the equalized round-trip delay (Teqd).

This equalized round-trip delay (Teqd), is defined at the OLT phase specification point (as defined above).

$$\text{Teqd} = 2*\text{Tpd} + \text{Ts} + \text{Td} + \text{TiO1} + \text{TiO2} + \text{TiS1} + \text{TiS2}$$

$$= 2*\text{Tpd} + \text{Tresponse(ONU)} + \text{Td} + \text{TiS1} + \text{TiS2}$$

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In the normal operating state, Teqd is constant for all ONUs. Allowing for the variation of Tpd and Tresponse(ONU), the equalization_delay (Td) is specified below:

the maximum value of Td ≥ 32 000 bits (at 155.52 Mbit/s)

the maximum value of Td ≥ 128 000 bits (at 622.08 Mbit/s)

The maximum round-trip delay of about 200 µs (equal to 20 km optical fibre) is equal to 69 cells (56-byte cells) + 192 bits and the maximum Tresponse(ONU) is 9 cells with a variation of 2 cells, so the equalization_delay should cover the delay variation from 0 to 32 000 bits (at 155.52 Mbit/s).

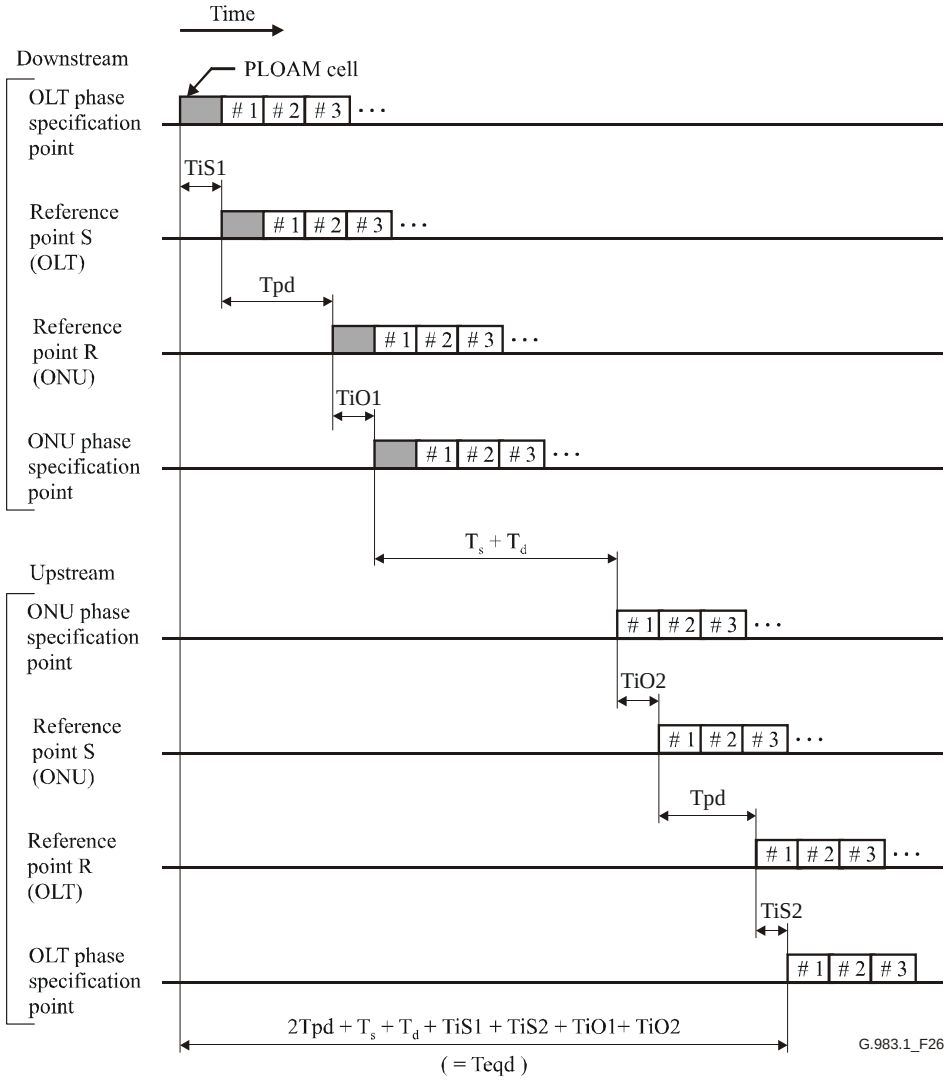


Figure 26/G.983.1 – Phase relationship between downstream and upstream

8.4.2.4 Granularity of the equalization_delay

The equalization_delay (Td) should be defined with a granularity of 1 bit for all rates.

8.4.2.5 Opening the ranging window in the ranging procedure

NOTE – The following text presents examples that use 155.52 Mbit/s for the upstream rate. The values given for Tresponse and Td depend on the upstream rate. Therefore, these values do not apply to the 622 Mbit/s case. See the specifications above for those values.

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8.4.2.5.1 Normal procedure

Before initiating the ranging process, the OLT sends an Upstream_overhead message to indicate to new ONUs which overhead they have to use. Then the OLT initiates the ranging process. The upstream data grants are queued.

The OLT generates a following string as:

– unassigned grants to open the window; and

– a ranging grant (or a PLOAM grant); and

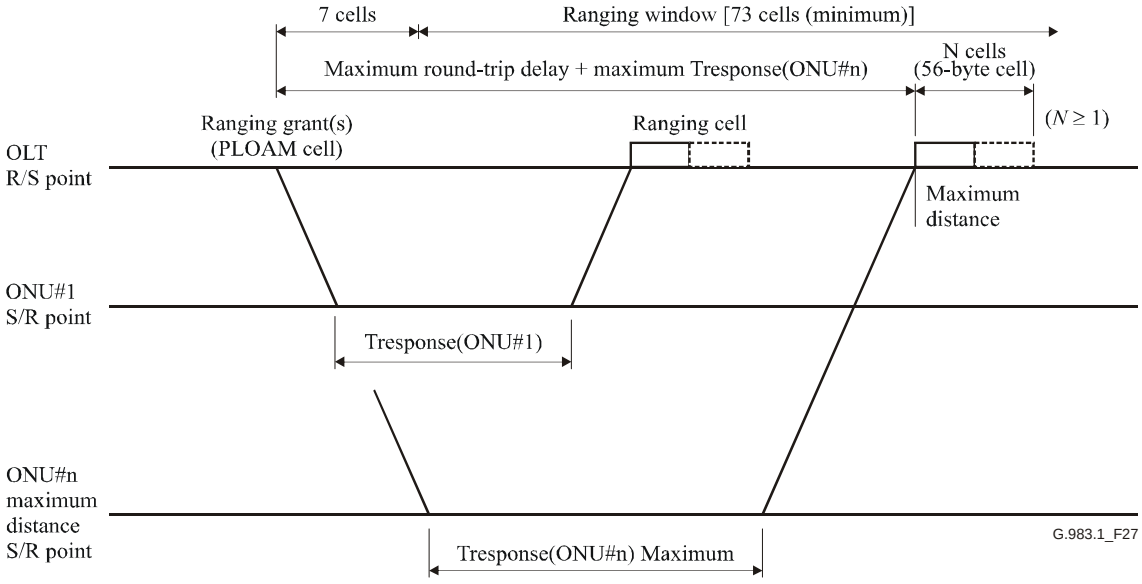
– additional ranging grants or PLOAM grants if necessary.

These are mapped into the downstream PLOAM cells. This ensures that after the ranging grant leaves the OLT, an upstream window is opened to receive a ranging PLOAM cell. The additional ranging grants or PLOAM grants allow the ONU optical power set-up and/or the OLT threshold control or amplitude finding, etc. The number of additional grants for the ONU optical power set-up should be one, and those for the OLT receiver should be decided by the OLT as necessary.

When more grants are required for completion of the ONU optical power set-up, the optical power set-up can be completed by allowing several failures during ranging and repeated re-ranging. In the case that serial number acquisition (binary tree mechanism stated in 8.4.4.1) is applied, the ONU may use grants for the ONU optical power set-up. Also, if the OLT periodically initiates the ranging process to check recently connected ONUs, it is useful for this purpose.

Some of the unassigned grants for the window can be replaced by data grants and/or PLOAM grants in order to minimize the window size.

This ranging window opening scheme is shown in Figure 27 for the case where the ranging grant is located in the first grant field in the first PLOAM cell of the downstream frame.



NOTE – If the ONU receives the ranging grant, the ONU sends a ranging cell(s) immediately.

Ranging cell is received after Tresponse(ONU) + round-trip delay, in case of corresponding to the first grant of the first PLOAM cell in the downstream frame.

Ranging window size should be determined by considering additional grants.

Figure 27/G.983.1 – Ranging window and phase relation

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Each ONU which is permitted to send a cell(s) should send a ranging PLOAM cell(s) immediately upon receiving the ranging grant.

NOTE – In this context the word "immediately" means that each ONU sends a PLOAM cell at the designated time corresponding to the ranging grant location in a downstream PLOAM cell.

The equalization_delay (Td) can be measured as in the example in Figure 27.

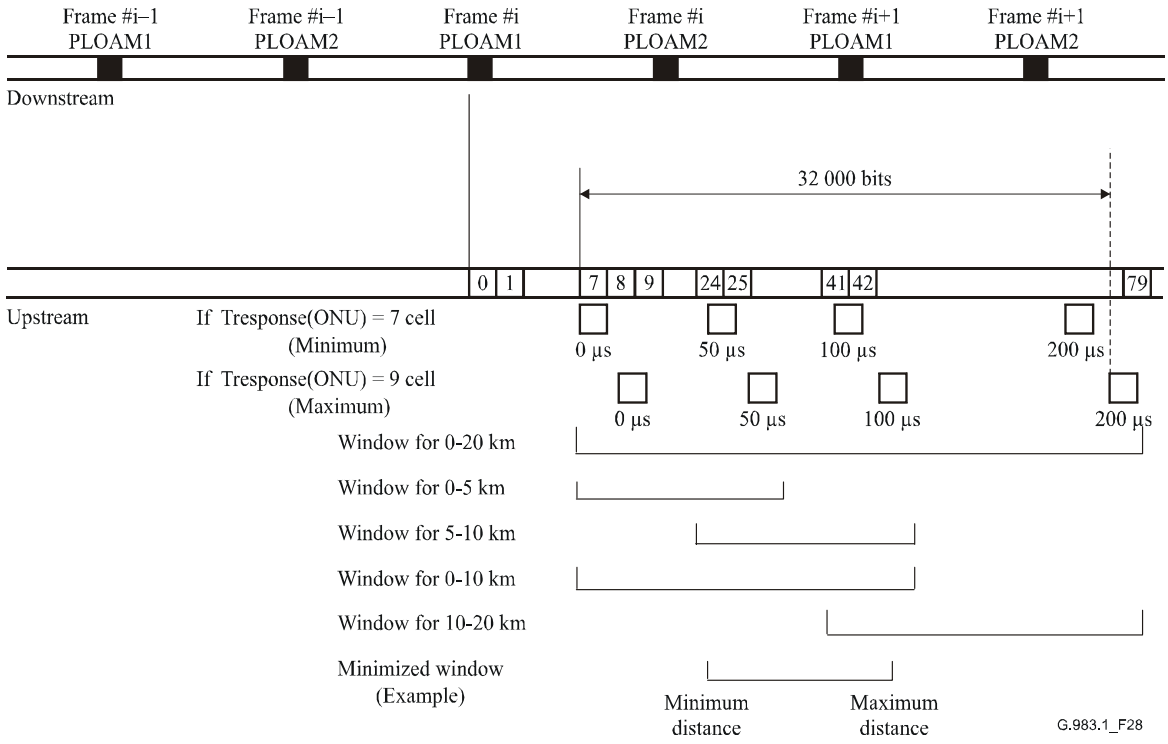
$$Td = Teqd - (T2 - T1)$$

T1 = The transmission time of the downstream PLOAM cell containing a ranging grant at the OLT phase specification point.

T2 = The arrival time of the upstream ranging cell at the OLT phase specification point.

Teqd = 79 cells (as an example).

Using knowledge of the distance between the ONU and OLT, the ranging window size is programmable by assigning appropriate unassigned grants, as shown in Figure 28.



NOTE – Assuming the first grant of Frame #i is a ranging grant.

Figure 28/G.983.1 – Programmable ranging window (example)

If a reduced length ranging window is requested to be opened in a fixed location in the upstream frame, then a pre-assigned equalization_delay can be used.

During the ranging process, further upstream windows can be opened as necessary. An example is shown in Figure 29.

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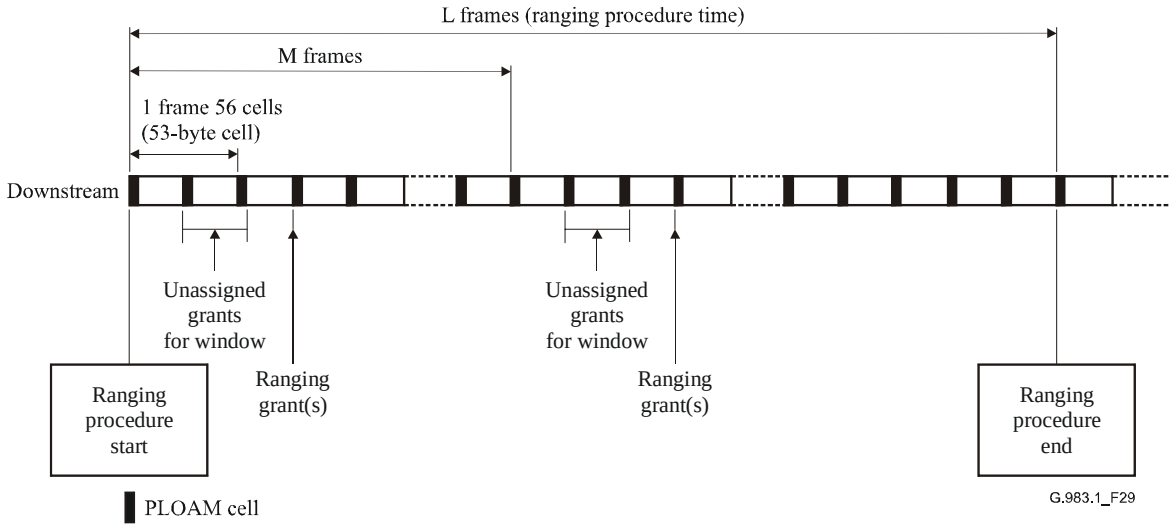


Figure 29/G.983.1 – Repeated opening of the ranging window

The value "M" in Figure 29 indicates the interval between opening windows. This value "M" should be determined from the viewpoint of avoiding a degradation in the quality of service.

The value "L" indicates the time taken to complete the ranging procedure.

8.4.2.5.2 Fixed location window with some knowledge of ONU locations

Where some information about the ONU position is known, the OLT may transmit a pre-assigned equalization_delay (Te) to the ONU, where Te is equivalent to the approximate equalization_delay (Td). The pre-assigned equalization_delay (Te) can be transmitted in the Upstream_overhead message from the OLT to each ONU. The default value of Te is equal to 0.

The OLT will transmit unassigned grants to open a ranging window, whose size is reduced from the maximum depending upon the confidence with which the OLT-ONU distance is known. It will then send a ranging grant to the ONU.

When the ONU receives the ranging grant, it will respond with a ranging cell after a pre-assigned equalization_delay (Te) plus Tresponse(ONU). This will ensure that the ranging cell arrives within the opened window which is in a fixed position in the upstream frame.

An example is shown in Figure 30. In this case, the equalization_delay (Td) can be measured as follows:

$$Td = Teqd - (T2 - T1) + Te$$

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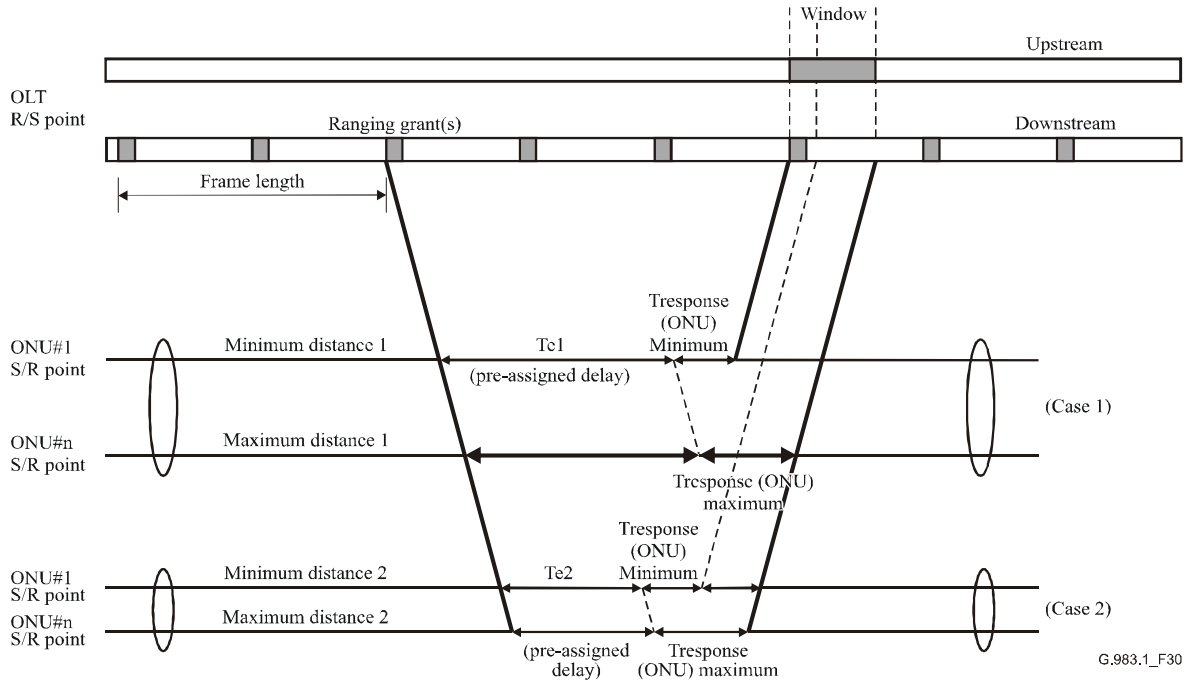


Figure 30/G.983.1 – Fixed location window with some knowledge about ONU locations

8.4.3 Definition of messages used in the ranging protocol

Messages used in the ranging protocol are defined in the TC layer specification section.

Timing relationship between downstream messages and grants in the ranging procedure should be interpreted as follows:

– If a downstream PLOAM cell contains both grants and a message, the correct interpretation is defined by first acting on the grants and then on the message. The processing of messages received at the ONU relating to the ranging procedure should be completed within six frame periods (6*Tframe).

– Upon receipt of the Ranging_time message, Td should also be updated within the time of 6*Tframe. This means that the OLT should not send a PLOAM grant or a data grant to the designated ONU till 6*Tframe seconds later after sending the first three Ranging_time messages to that ONU in ranging procedure. Because upstream cell collisions should be avoided during a message processing time in the ONU.

The timing relationship between the downstream PLOAM cells and the upstream slots is not affected by the definition described above.

8.4.4 Ranging procedure

8.4.4.1 Overall ranging procedure

The ranging is performed under the control of the OLT. The ONU responds to messages which are initiated in the OLT.

The outline of the ranging procedure is:

– the OLT measures the arrival phase of the upstream cell from the ONU;

– the OLT notifies the ONU of the equalization_delay; and

– the ONU adjusts the transmission phase to the notified value.

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This procedure is performed by the exchange of in-band digital data conveyed by upstream and downstream cells.

The ranging procedure is performed using some kind of grants and messages.

In the normal operating state, all cells can be used for monitoring the phase of the arriving cell. Based on monitoring cell phase information, the equalization_delay can be updated.

A problem with ranging may occur using installation method B when the OLT is attempting to range ONUs, and more than one ONU comes on-line at the same time. The serial number of the ONUs are not known so a ranging grant has been issued directed at all ONUs in the standby state. This can produce a response from more than one ONU, whose signals may overlap at the OLT thus causing a collision at the OLT. The Binary Tree Mechanism is used to resolve this problem.

NOTE – Binary Tree Mechanism: After a ranging cell collision has been detected at the OLT, the OLT sends a Serial_number_mask message followed by a ranging grant to allow any ONU whose serial number matches the mask to transmit a ranging cell. The size of the Serial_number_mask is increased one bit at a time until only one ONU is transmitting a ranging cell. This allows the ONU to be ranged individually. Then the general ranging grant can be re-issued allowing other ONUs still to be ranged to transmit ranging cells. If a collision still occurs, then the mechanism is repeated.

This Binary Tree Mechanism may also be useful to avoid overloading the optical input of the OLT receiver during ONU power set-up.

8.4.4.2 Ranging procedure in the ONU

The ranging procedure is specified by the functional behaviour in the virtually defined states and the state transition as shown below.

An example ranging flow in the ONU is described in III.1.

8.4.4.2.1 States of the ONU

Ten states are used for the description of the ranging behaviour.

a) *Initial state (O1)*

State where LOS, LCD, OAML, or FRML is still detected after the ONU has first been switched on.

b) *Ranging standby state 1 (O2)*

Preparation state for ranging, but downstream messages are detectable. Upstream_overhead message reception is executed. Pre-assigned equalization_delay conveyed by this Upstream_overhead message is also detected in this state.

c) *Ranging standby state 2 (O3)*

The ONU optical power set-up procedure is executed, if necessary. The Binary Tree Mechanism may be applied for ONU optical power set-up.

No PLOAM cell can be transmitted in response to a ranging grant.

d) *Ranging standby state 3 (O4)*

The ONU optical power set-up procedure is executed, if necessary. The Binary Tree Mechanism may be applied for ONU optical power set-up.

A PLOAM cell can be transmitted in response to a ranging grant.

e) *Operating standby state 1 (O5)*

PON_ID acquisition state. Binary Tree Mechanism is applicable for Serial number acquisition.

No PLOAM cell can be transmitted in response to a ranging grant.

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f) *Operating standby state 2 (O6)*

PON_ID acquisition state. Binary tree mechanism is applicable for Serial number acquisition.

A PLOAM cell with the Serial_number_ONU message will be transmitted in response to a ranging grant.

g) *Operating standby state 3 (O7)*

Delay measurement executed state.

A PLOAM cell with the Serial_number_ONU message will be transmitted in response to a PLOAM grant.

h) *Operating state (O8)*

The equalization_delay is updated by receipt of the Ranging_time message.

i) *Emergency stop state (O9)*

Emergency stop state after receiving Disable_serial_number message with a matching Serial_number and the enable field of FFh.

No PLOAM cell can be transmitted in response to a ranging grant. Once the ONU enters this state, the ONU should not go out of this state by any of the other events listed in Table 18 such as a Deactivate_PON_ID message or LOS, etc., and/or ONU power-off.

Only when the Disable_serial_number message is received with a matching Serial_number and the enable field of 00h or with the enable field of 0Fh irrespective of the Serial_number, then the state transition to O1 occurs.

j) *POPUP state (O10)*

The ONU enters this state after detection of LOS, LCD, OAML, or FRML in the Operating state (O8). When a POPUP message is received, the ONU restores the laser settings, Upstream_overhead, LCF and RXCF fields, Pre-equalization delay of Te, PON_ID, and Grant_allocations. A transition to O7 occurs after the timer TO1 is set to start.

8.4.4.2.2 Behaviour specification in the ONU

The state diagram in Table 18 is used for the description of the functional behaviour in the ONU. The first column in Table 18 indicates the generated events including message reception, and the first row indicates the states in the ONU.

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Table 18/G.983.1 – The state diagram of the ONU

	Initial state (O1)	Ranging standby state 1 (O2)	Ranging standby state 2 (O3)	Ranging standby state 3 (O4)	Operating standby state 1 (O5)
Upstream_overhead message	–	extract overhead set pre-assigned delay Te ⇒ O3	–	–	–
Optical power set-up complete	–	–	– timer TO1 start ⇒ O5	– timer TO1 start ⇒ O5	–
Serial_number_mask message	–	–	match SN (valid bits)? ⇒ O4	unmatch SN (valid bits)? ⇒ O3	match SN (valid bits)? ⇒ O6
Assign_PON_ID message	–	–	–	–	match SN? – assign PON_ID
Grant_allocation message	–	–	–	–	match PON_ID? – allocate data/PLOAM grant ⇒ O7
POPUP message	–	–	–	–	–
timer TO2 expire	–	–	–	–	–
timer TO1 expire	–	–	–	–	⇒ O3 (alarm SUF)
Ranging_time message	–	–	–	–	–
data grant	–	–	–	–	–
PLOAM grant	–	–	–	–	–
ranging grant	–	–	–	send PLOAM cell	–
Deactivate_PON_ID message [a)]	–	–	match PON_ID? ⇒ O2	match PON_ID? ⇒ O2	match PON_ID? – timer TO1 stop ⇒ O2
Disable_serial_number message	–	match SN and enable = FFh? ⇒ O9	match SN and enable = FFh? ⇒ O9	match SN and enable = FFh? ⇒ O9	match SN and enable = FFh? – timer TO1 stop ⇒ O9
detect LOS or LCD or OAML or FRML	–	⇒ O1	⇒ O1	⇒ O1	Timer TO1 stop ⇒ O1
clear LOS and LCD and OAML and FRML	⇒ O2	–	–	–	–

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Table 18/G.983.1 – The state diagram of the ONU

	Operating standby state 2 (O6)	**Operating standby state 3 (O7)**	**Operating state (O8)**	**Emergency stop state 1 (O9)**	**POPUP state (O10)**
Upstream_overhead message	–	–	–	–	–
Optical power set-up complete	–	–	–	–	–
Serial_number_mask message	unmatch SN(valid bits)? ⇒ O5	–	–	–	–
Assign_PON_ID message	match SN? – assign PON_ID	–	–	–	–
Grant_allocation message	match PON_ID? – allocate data/PLOAM grant ⇒ O7	–	–	–	–
POPUP message	–	–	–	–	Restore laser settings, Upstream_overhead, LCF and RXCF fields, Te, PON_ID, and Grant allocation, timer TO1 start ⇒ O7
timer TO2 expire	–	–	–	–	⇒ O1
timer TO1 expire	⇒ O3 (alarm SUF)	⇒ O3 (alarm SUF)	–	–	–
Ranging_time message	–	match PON_ID? – timer TO1 stop – set equalization delay ⇒ O8	match PON_ID? – update equalization delay	–	–
data grant	–	–	send ATM cell	–	–
PLOAM grant	–	send PLOAM cell	send PLOAM cell	–	–
ranging grant	send PLOAM cell	–	–	–	–
Deactivate_PON_ID message [a)]	match PON_ID? – timer TO1 stop ⇒ O2	match PON_ID? – timer TO1 stop ⇒ O2	match PON_ID? ⇒ O2	–	–

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Table 18/G.983.1 – The state diagram of the ONU

	Operating standby state 2 (O6)	**Operating standby state 3 (O7)**	**Operating state (O8)**	**Emergency stop state 1 (O9)**	**POPUP state (O10)**
Disable_serial_number message	match SN and enable = FFh? – timer TO1 stop ⇒ O9	match SN and enable = FFh? – timer TO1 stop ⇒ O9	match SN and enable = FFh? ⇒ O9	match SN and enable = 00h? or enable = 0Fh and SN irrelevant ⇒ O1	–
detect LOS or LCD or OAML or FRML	timer TO1 stop ⇒ O1	timer TO1 stop ⇒ O1	Start timer TO2 ⇒ O10	–	⇒ O10
clear LOS and LCD and OAML and FRML	–	–	–	–	–

– An ONU will leave the Operating state if a fault occurs or power is removed from the ONU. Only maintenance signals of LOS, LCD, OAML, and FRML are considered in this state diagram.

– "–" means no action for corresponding event.

– PLOAM cell in the state of O6 or O7 should be transmitted with its Serial_number_ONU message with pre-assigned delay Te, and in the state of O4 should be transmitted in pre-assigned delay Te.

– PON_ID and Grant allocation should be cleared or discarded when the state transitions to O1, O2, O3 and O9 occur, and pre-assigned delay Te should be cleared in transitions to O1 and O2.

[a] Receive-event of a broadcast Deactivate_ PON_ID message (the 35th octet of PON_ID = 40h) is also assumed.

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8.4.4.2.2.1 Message reception

The messages conveyed in the PLOAM cells from the OLT should be protected by the CRC, and the message receive-event should be generated when the CRC check is correct. In the case of a), c), d) and e) below, these messages are sent three times to ensure correct reception at the ONU. In these cases the message receive-event is generated after the message has been received correctly at least once.

a) *The receive-event of Upstream_overhead message*

This event occurs in the Ranging standby state 1 only. After successful reception of the Upstream_overhead message, transition of the ONU state to Ranging standby state 2 occurs.

b) *The receive-event of Serial_number_mask message*

This event is processed in Ranging standby state 2, Ranging standby state 3, Operating standby state 1, and Operating standby state 2.

In Ranging standby state 2 and Ranging standby state 3:

When the valid serial number matches its own serial number, the ONU state undergoes a transition to Ranging standby state 3. If the valid serial number does not match its serial number, a transition to Ranging standby state 2 occurs

In Operating standby state 1 and Operating standby state 2:

When the valid serial number matches its own serial number, the ONU state undergoes a transition to Operating standby state 2. If the valid serial number does not match its serial number, a transition to Operating standby state 1 occurs.

c) *The receive-event of Assign_PON_ID message*

This event is processed only in Operating standby state 1 and Operating standby state 2.

When the serial number in the Assign_PON_ID message matches its own serial number, the ONU acquires its PON_ID.

d) *The receive-event of the Grant_allocation message*

When the PON_ID in the Grant_allocation message matches its own PON_ID, a data grant and a PLOAM grant for its ONU is assigned, and then the ONU state is set to Operating standby state 3.

e) *The receive-event of Ranging_time message*

This event is processed only in Operating standby state 3 and Operating state when the PON_ID matches its own PON_ID.

The equalization_delay is received in the Ranging_time message and used as the equalization_delay of Td defined in 8.4.2.3.

(In Operating standby state 3)

The equalization_delay is set, and the ONU state is set to the Operating state.

(In the Operating state)

The equalization_delay is updated.

f) *The receive-event of Deactivate_PON_ID message*

When the PON_ID matches its own PON_ID, the ONU state undergoes a transition to Ranging standby state 1. A broadcast Deactivate_PON_ID message is also applied.

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g) *The receive-event of Disable_serial_number message*

When the serial number (64 bits) matches its own serial number and the 37th octet of Enable in this message is equal to FFh, the ONU state undergoes a transition to Emergency stop state.

When the serial number (64 bits) matches its own serial number and the 37th octet of Enable in this message is equal to 00h, or when the Enable field is equal to 0Fh irrespective of the serial number, then the ONU state undergoes a transition to Initial state (O1) from the Emergency stop state.

h) *The receive-event of POPUP message*

This event occurs only in the POPUP state (O10). When a POPUP message is received, the ONU restores the laser settings, Upstream_overhead, LCF and RXCF fields, Pre-equalization delay of Te, PON_ID, and Grant_allocations. Timer TO1 is started and then a transition to O7 occurs.

8.4.4.2.2.2 Grant reception

The data grant is processed only in the Operating state, and then an ATM cell is transmitted to the OLT. A PLOAM cell is transmitted to the OLT in response to a PLOAM grant in the Operating standby state 3 and the Operating state. The PLOAM cell transmitted in Operating standby state 3 should include the Serial_number_ONU message for confirming the ranging cell in response to the PLOAM grant.

The Ranging grant is valid only in Ranging standby state 3 and Operating standby state 2. In Ranging standby state 3, the ONU sends a PLOAM cell according to the reception of the ranging grant. This PLOAM cell may not be transmitted correctly by the ONU during laser set-up. In Operating standby state 2 the ONU sends a PLOAM cell at the designated time corresponding to the ranging grants. This PLOAM cell should be transmitted with Serial_number_ONU message for serial number acquisition by the OLT.

8.4.4.2.2.3 Other events

a) *Optical power set-up complete*

This event is generated in Ranging standby state 2 and Ranging standby state 3, only when the ONU optical power set-up has been completed. This event causes a state transition to Operating standby state 1 after timer TO1 is set to start. Sending PLOAM cells in Ranging standby state 3 are only used for ONU optical power set-up corresponding to the reception of ranging grants, if necessary. Where no optical power set-up is required, then the ONU in ranging standby state 1 (O2) will extract the overhead and pre-assigned delay value from the Upstream_overhead message, move to ranging standby state 2 (O3) and then immediately generate the optical power set-up complete event and move to Operating standby state 1 (O5).

b) *Timer TO1 expire*

This event is generated when the delay measurement procedure is not completed within a certain time period. This event generates a state transition to Ranging standby state 2.

The value of TO1 is 10 seconds.

c) *LOS, LCD, OAML, or FRML detection*

This event causes the ONU state to move to the Initial state (O1) except when it is in Operating state (O8).

In Operating state (O8), this event cause the ONU state to move to the POPUP state (O10) after the timer TO2 is set to start.

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d) *Clear of LOS, LCD, OAML, and FRML*

This event causes the ONU state to move from the Initial state to Ranging standby state 1.

e) *Timer TO2 expire*

This event is generated when the POPUP message is not received in the POPUP state within a certain time period. This event generates a state transition to Initial state (O1).

The value of TO2 is 100 milliseconds.

8.4.4.3 Ranging procedure in the OLT

The ranging procedure is specified by the functional behaviour in the virtually defined states and the state transition as shown below.

An example ranging flow in the OLT is described in III.2.

8.4.4.3.1 States of the OLT

The OLT functions for the ranging procedure can be divided into the Common-part and the Individual-ONU-dealing-part(n), where n corresponds to each ONU. The Common-part treats a common function in one line-interface, and the Individual-ONU-dealing-part(n) treats each ONU supported in one line-interface. Each state for both parts is described below respectively with each behaviour.

8.4.4.3.2 Behaviour specification in the OLT

8.4.4.3.2.1 Common-part behaviour

The state diagram used for the description of the functional behaviour in the Common-part, is shown in Table 19. The first column of Table 19 indicates the generated events and the first row indicates the states in the Common-part.

Table 19/G.983.1 – State diagram for the Common-part in the OLT

	Delay measurement standby/executing state (OLT-COM1)	**Serial number (SN) acquisition state (OLT-COM2)**
SN acquisition request	⇒ OLT-COM2	–
Receive valid PLOAM in the window	(Note)	Extract SN allocate free n allocate free PON-ID
Binary tree search end	–	⇒ OLT-COM1
Not-[Delay measurement condition complete(n)]	Update n	–
Delay measurement condition complete(n)	Delay measurement start order(n)	–
NOTE – Delay measurement (Measure Td) can be performed either in the OLT Common-part or Individual-ONU-dealing-part. Therefore, this diagram does not describe this function explicitly.		

The states are defined as:

– Delay measurement standby/executing state (OLT-COM1);

– Serial number (SN) acquisition state (OLT-COM2).

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The events are defined as follows:

a) Received valid PLOAM in the window.

b) Binary tree search end.

c) Delay measurement condition complete(n).

This event is generated when the nth Individual-ONU-dealing-part(n) is ready for its delay measurement.

d) Not-[Delay measurement condition complete(n)].

Notification of delay measurement end(n).

This event is generated for convenience when the n-th Individual-ONU-dealing-part(n) has completed its delay measurement either successfully or unsuccessfully. The event defined is useful for sequential ranging as the trigger of updating the ranged ONU number of "n", but may not be used for parallel ranging as the updating trigger. Therefore, this event is not explicitly defined in the state diagram.

e) SN acquisition request.

8.4.4.3.2.2 Individual ONU dealing part behaviour

The state diagram used for the description of the functional behaviour in the Individual-ONU-dealing-part(n), is shown in Table 20. The first column of Table 20 indicates the generated events and the first row indicates the states in the Individual-ONU-dealing-part(n).

Table 20/G.983.1 – State diagram for the Individual-ONU-dealing-part(n) in the OLT

	Initial state (OLT-IDV1)	**Delay measurement state (OLT-IDV2)**	**Operating state (OLT-IDV3)**
Delay measurement start order(n)	⇒ OLT-IDV2	–	–
Delay measurement complete(n)	–	Send Ranging_time message 3 times. Notification of delay measurement end(n). ⇒ OLT-IDV3	–
Delay measurement abnormal stop(n)	–	Send Deactivate_PON_ID message 3 times. Notification of delay measurement end(n). ⇒ OLT-IDV1	–
detect LOSi(n), CPEi(n), LCDi(n), OAMLi(n), LOAi(n), or R-INHi(n)	–	–	⇒ OLT-IDV1
NOTE – Notification of delay measurement end(n) is explicitly described but this event is only described for convenience. Therefore, this event should be considered as informative.			

The states are defined as:

– Initial state (OLT-IDV1);

– State awaiting for the delay measurement start order;

– Delay measurement state (OLT-IDV2);

– Operating state (OLT-IDV3).

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The events are defined as follows:

a) *Delay measurement start order(n)*

This event is generated when instruction is received from the Common-part.

b) *Delay measurement complete(n)*

This event is generated when the delay measurement has been performed successfully.

After the Ranging_time message containing the equalization_delay has been sent to the designated ONU three times, Notification of delay measurement end(n) is issued for convenience to the OLT Common part, then the state transition to the Operating state (OLT-IDV3) occurs.

c) *Delay measurement abnormal stop(n)*

This event is generated when the delay measurement has failed.

After the Deactivate_PON_ID message has been sent to the designated ONU three times, Notification of delay measurement end(n) is issued for convenience to the OLT Common part, then the state transition to the Initial state (OLT-IDV1) occurs.

d) *Detect of LOSi(n), CPEi(n), LCDi(n), OAMLi(n),) LOAi(n), or R-INHi(n)*

This event causes the state to move to the Initial state (OLT-IDV1).

8.4.4.3.3 Procedure for the equalization_delay

The equalization_delay (Td) shall be defined as described in 8.4.2.3. The specified bytes in the Ranging_time message field in the downstream PLOAM cell are set to this equalization_delay value, and this is transmitted to the ONU.

A successful equalization_delay measurement is indicated if all of the following conditions are satisfied:

1) a valid PLOAM cell is detected in the ranging window;

2) the Serial_number_ONU message in the PLOAM cell matches that of the addressed ONU;

3) the measured Td is less than or equal to a certain value (for example; 79 cells);

4) the acquisition phase of the ONU is located in less than or equal to ±2 bits, compared with the phase of the reference cell.

NOTE – The reference cell is defined as follows:

– The first acquisition phase has no reference cell, therefore, the equalization_delay measurement is considered as an initial success if the first received PLOAM cell satisfies all the above conditions (1-3). This first acquisition phase is considered as the reference phase for the next received PLOAM cell. The reference cell is updated every time the OLT receives a new valid PLOAM cell which satisfies the above conditions (1-3), irrespective of whether condition 4) is satisfied or not.

The delay measurement procedure consists of a series of measurements and is considered completed on having obtained two successful or two failed measurements. If performed S(=2) times this indicates a successful equalization_delay measurement and this generates the event of Delay measurement complete.

On the contrary, F(=2) times indicates failure of the equalization_delay measurement, which means that the conditions for the successful equalization_delay measurement have not been satisfied, and this generates the event of Delay measurement abnormal stop. The failure times can exclude those for threshold settings in the OLT receiver if necessary.

The calculation and transport method of the equalization_delay is as follows:

When the event of Delay measurement complete occurs, the latest successful equalization_delay value and the equalization_delay value of its reference cell are averaged and fractions of a bit are ignored. This averaged value is transmitted to the ONU as the equalization_delay.

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8.4.4.3.4 Phase monitoring and updating equalization_delay

While the ONU is active, the phase of the received cell at the OLT is continuously checked to prevent collision with neighbouring cells. Jitter generated by the OLT clock is absorbed by the clock phase alignment method. Wander caused by temperature variation makes the upstream cell of an ONU drift towards it predecessor or successor.

The phases of the cells arriving at the OLT are averaged over a certain period with an appropriate sampling of cells for each ONU, and the updated equalization_delay is sent via the Ranging_time message to that ONU which will adjust its equalization_delay. This Ranging_time message should be transmitted at least once within a certain maximum period.

If the OLT detects that the ONU has not adjusted its equalization_delay after a certain time-out, or if the OLT detects a cell phase error in a certain time, the OLT sends the updated equalization_delay several times. If still unsuccessful (CPEi), the OLT sends Deactivate_PON_ID message three times. If the ONU does not react to this message, the operator is informed of this anomaly. If the ONU is silenced, grant reception for this ONU is suspended. The operator is informed of this action. The operator may decide to put this ONU out of service or repeat the complete ranging procedure.

8.4.5 Ranging time requirements

The ranging time should be satisfied as in Table 21.

Table 21/G.983.1 – Ranging time requirements

Item	PON condition (Note 1)	ONU condition (Note 1)	Method	Number of ONUs	Requirement
1	cold	cold	A	each ONU	2 s
2	cold	cold	B	each ONU	10 s
3	warm	cold	A	1	1 s
4	warm	cold	B	1	3 s
5	warm	cold	A/B	31	93 s
6 (Note 2)	warm	warm	A	16	100 ms
7 (Note 3)	switchover	warm	Refer to 8.3.9.		

NOTE 1 – For explanation of the PON and ONU conditions, see 8.4.1.2.

NOTE 2 – Requirement of Item 6 should be an optional, but its capability should be provisioned.

The capability of opening windows with programmable frequency such as every millisecond, as stated in 8.4.1.1, could support this requirement. This may cause some traffic QOS degradation.

NOTE 3 – The ranging time requirements under switchover conditions are not defined here.

The complete switchover process must be completed within the time stated in 8.3.9.

8.4.6 Conventional ranging sequence

The diagram shown in Figure 31 illustrates the normal exchange of messages between the OLT and ONU during the ranging process.

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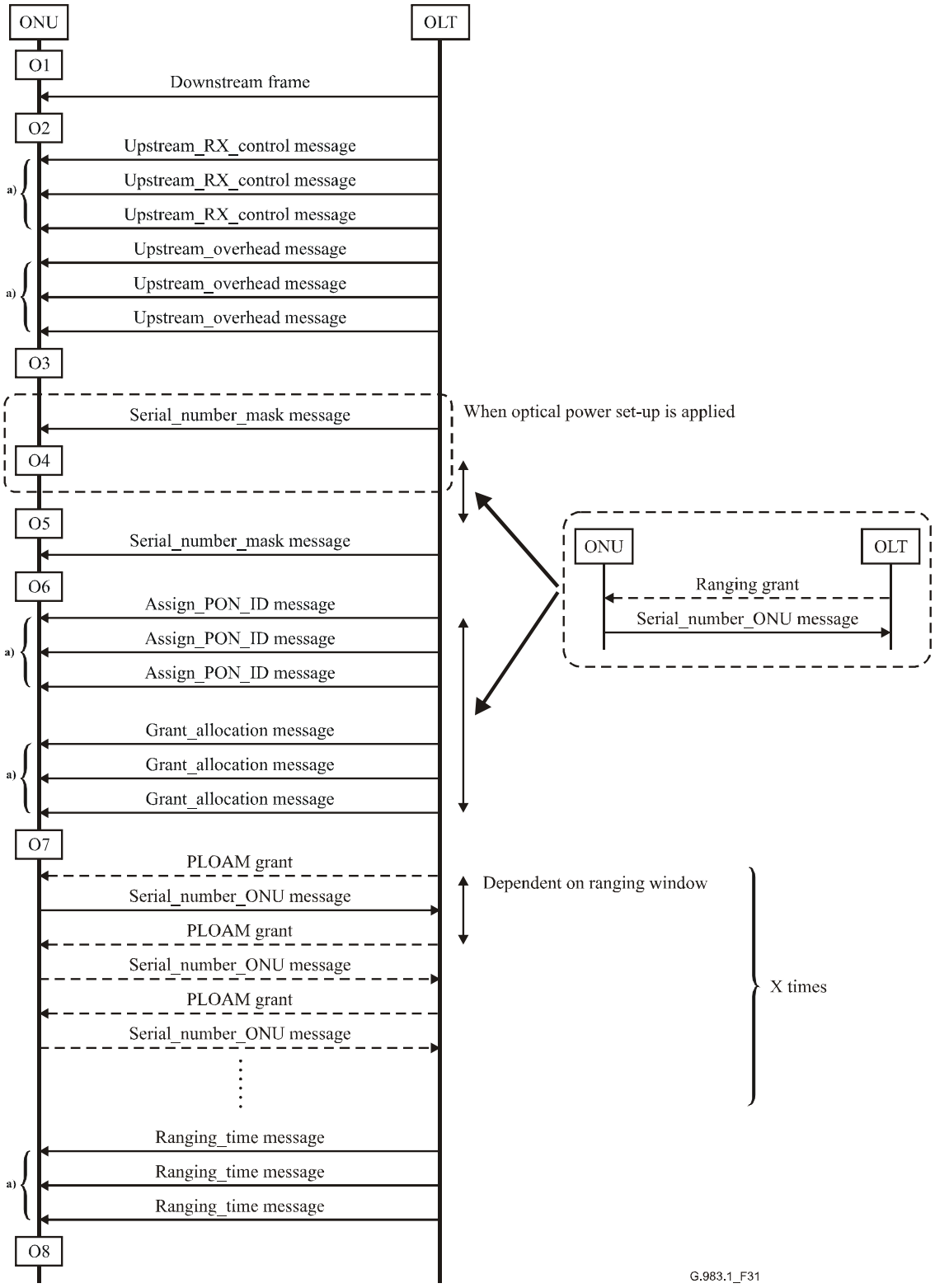


Figure 31/G.983.1 – Message sequence for ranging

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Notes to Figure 31

NOTE 1 – It is specified that the processing time for each PLOAM message in ONU is within 6 T frame (6*Tframe). ONU can receive PLOAM messages from OLT at any interval.

NOTE 2 – There are two ways to complete Optical power set-up. One is that ONU in O3 completes Optical power set-up by itself, and the other is that ONU in O4 receives some ranging grants and sends some upstream PLOAM cells. In the latter case, OLT must know beforehand the number of times and timing of sending ranging grants. These values are related to the ranging time and the number of ranging windows. Therefore the way to complete Optical power set-up should be selected by operators according to their service requirements.

NOTE 3 – In O4 and O6, if OLT gives Ranging grants to ONU, ONU has to send Serial_number_ONU message to OLT.

NOTE 4 – ONU can move to the next action, when it receives one message at least in 3 consecutive messages indicated by ([a]). The detailed operations are as follows:

- ONU can move to O3 from O2 when it receives one Upstream_overhead message at least.
- ONU can receive Grant_allocation messages when it receives one Assigned_PON_ID message at least.
- ONU can move to O7 from O6 when it receives one Grant_allocation message at least.
- ONU can move to O8 from O7 when it receives one Ranging_time message at least.

NOTE 5 – If an OLT is going to utilize the Rx control field, the OLT will send the Upstream_RX_control message before it tries to use that facility.

NOTE 6 – Serial_number_ONU messages are sent from ONU according to PLOAM grants in O7 *X* times. *X* is specified by OLT implementation.

9 Operations, Administration and Maintenance (OAM) functionality

A framework has been used which consists of two axes along which the OAM functions can be classified. The first axis consists of the functional subsystem of the OAN to which the OAM function relates. The second axis is the OAM functional category.

The following functional subsystems fulfil the OAM requirements:

1) equipment (enclosure and power);
2) transmission;
3) optical subsystem;
4) service subsystem.

OAM requirements by functional category can be defined by the five categories according to ITU-T Rec. M.3010:

a) configuration management;
b) performance management;
c) fault management;
d) security management;
e) accounting management: out of scope.

Refer to Appendix III/G.982 for further information.

10 Performance

Mean signal transfer delay time between T-V (or a-V) should be less than 1.5 ms as defined in ITU-T Rec. G.982. 1.5 ms is a guideline for telephony service.

ATM cell delay variation at the ATM layer is defined by ATM performance, (ITU-T Rec. I.356).

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11 Environmental condition

The conditions of IEC 60721-3-3 is recommended.

The conditions of IEC 60801-2 and 60801-3 for electromagnetic compatibility are recommended.

Examples of applied environmental conditions of temperature and relative humidity for OLT and ONU are described in Table 22. The other environmental conditions such as environmental pollutants and chemicals are for further study.

Table 22/G.983.1 – Examples of environmental conditions

Applied example	Temperature (C)		Relative humidity (%)		Remarks
	Normal	Short term	Normal	Short term	
OLT	5 to 40	0 to 50 (Note)	5 to 85	5 to 90 (Note)	IEC 60721-3-3 class 3k3
Indoor ONU	–5 to 45	–	5 to 95	–	IEC 60721-3-3 class 3k5
Outdoor ONU	–	–	–	–	For further study
NOTE – Option 1: "Short term" refers to a period of not more than 72 consecutive hours and a total of not more than 15 days in one year. Option 2: "Short term" refers to a period of not more than 12 consecutive hours and a total of not more than four days in one year.					

12 Safety

12.1 Electrical safety and protection

The electrical safety aspects of ATM-PON equipment are for further study.

12.2 Optical safety and protection

The ONU transmitter optical power levels shall not exceed Class 1 as defined in IEC 60825-1 (1993).

NOTE – ONU optical shutdown is not required for safety reasons. An upstream link disruption caused by extraction of an optical connector or a fault condition may not lead to shutdown of the laser. ONU transmitter shutdown may however be a result from TC-layer actions.

Appendix I

Optional cases of overall minimum ORL of ODN at O_{ru} and O_{rd}, and O_{ld} and O_{lu}

I.1 Introduction

In 8.2.7.2, the minimum ORL of ODN at O_{ru} and O_{rd}, and O_{ld} and O_{lu} is specified better than 32 dB. This appendix describes example cases for the ORL that becomes less than 32 dB.

I.2 Effect of open connectors located at ONU side of star coupler

In the case that all ports of the star coupler are terminated, the minimum ORL in the ODN shall be better than 32 dB, but in the case that all ports of the star coupler are not terminated, the minimum ORL in the ODN shall not be better than 32 dB. As shown in Figure I.1, when the optical fibre is

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protected between the OLT and the star coupler and one port is not terminated at the 2-branch star coupler, subject that the reflectance on the port is −14 dB and the round trip optical loss in the star coupler is −6 dB, the ORL of the ODN as viewed from the OLT is −(−14 – 6) = 20 dB.

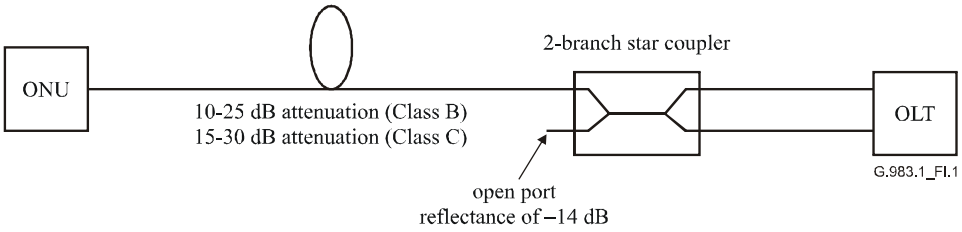


Figure I.1/G.983.1 – Effect of open connectors located at ONU side of star coupler

I.3 Effect of open connectors located at OLT side of star coupler

As shown in Figure I.2, when one port is not terminated at the 2-branch star coupler, subject that the reflectance of the port is −14 dB and the round-trip optical loss in the star coupler is −6 dB, the ORL of the ODN as viewed from the ONU is −(−14 – 6) = 20 dB.

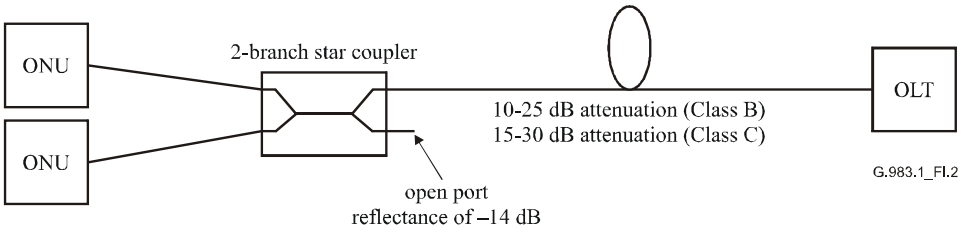


Figure I.2/G.983.1 – Effect of open connectors located at OLT side of star coupler

Especially in the case of FTTH, many connectors are allocated near the ONU. In this case, this 20 dB corresponds to a reflection of 4 PC connectors whose reflectance is −25 dB for each connector.

I.4 Effect of disconnecting a connector near ONU

NOTE – In Figure I.3, a connector-C is disconnected with live ONU-A located near OLT and a very narrow gap appears. In this case, the optical signal from the ONU-A is reflected at the connector-C, still transmission optical signal for both upstream and downstream are not disconnected. The reflected light returns into the ONU-A and reflects again at ONU-A. This "double reflected" signal may overlap a burst signal from ONU-B. Figure I.4 shows the overlap of signal.

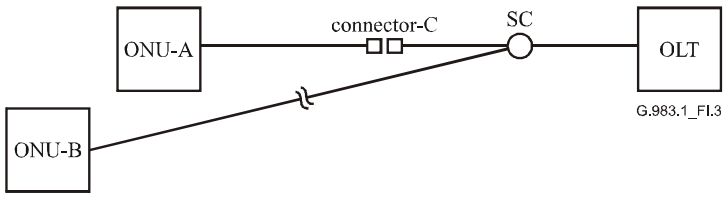
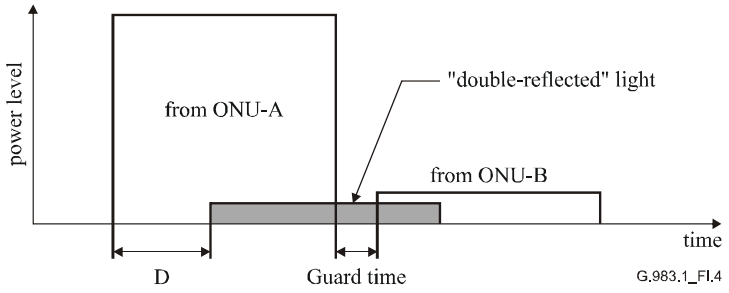


Figure I.3/G.983.1 – Effect of disconnecting a connector near ONU

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D Round-trip time between ONU-A and connector-C.

Figure I.4/G.983.1 – Overlap of burst signal and reflected light

Appendix II

Effect of optical return loss of ODN

II.1 Introduction

Each network model has its own optical return loss (ORL) of ODN and PON is sensitive to the ORL of ODN. This appendix describes the relationship among some types of reflectance to be considered, WDM isolation of ONU and OLT, and ONU equipment reflectance for transmitter and receiver for each case that ORL of ODN is 32 dB and 20 dB.

In the calculation of optical parameters, we assume that ONU equipment reflectance for receiver is −20 dB and OLT equipment reflectance for receiver is −20 dB. We describe condition equations and calculation results for the reflectance which restrict the parameters.

II.2 ODN optical return loss of 32 dB

II.2.1 Reflectance model to be considered

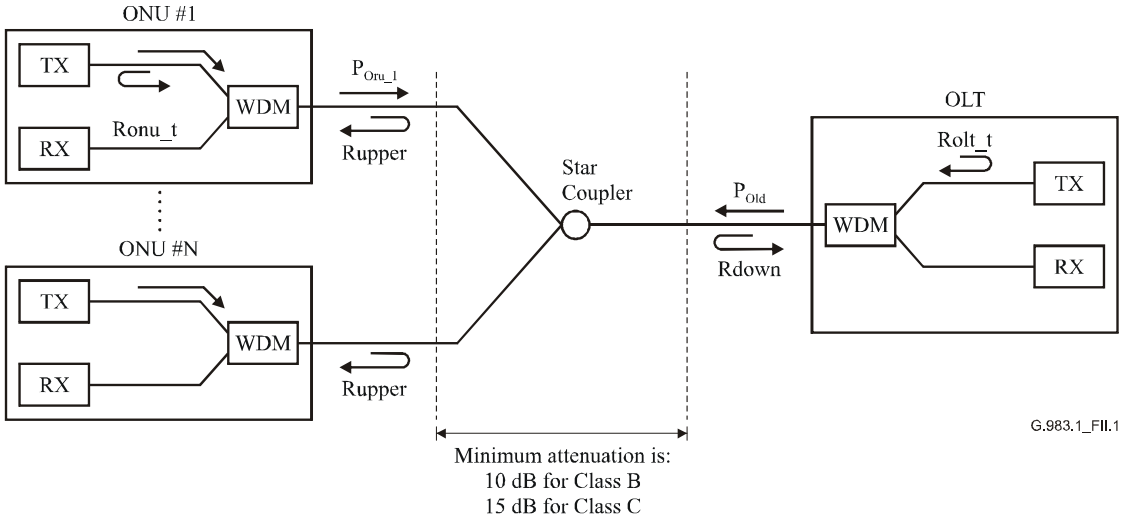


Figure II.1/G.983.1 – Reflectance model to be considered

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The following notations are used in this appendix:

P_{Oru_n} Optical output power of ONU #n transmitter at O_{ru}

P_{Old} Optical output power of OLT transmitter at O_{ld}

Ronu_t ONU transmitter equipment reflectance

Rolt_t OLT transmitter equipment reflectance

Rupper ORL of ODN at O_{ru} and O_{rd}

Rdown ORL of ODN at O_{ld} and O_{lu}

Iolt_t WDM isolation for OLT transmitter

Iolt_r WDM isolation for OLT receiver

Ionu_r WDM isolation for ONU receiver

These values are all treated as positive in this appendix.

II.2.2 Influence of reflectance into ONU receiver

Figure II.2 shows the path of reflected signal to be considered. Equation A must be satisfied:

$$P_{Oru\_1} - Rupper - Ionu\_r \text{ (permissible interference optical power)} \qquad \text{(Equation A)}$$

In Figure II.2, transmitted signals from the other ONUs (#2 – #N) input into ONU #1. Because their transmission time is different from one of ONU #1, they are not added.

Regarding Class B, assuming permissible interference optical power is equal to (minimum sensitivity –10 dB), permissible interference optical power = –30 dBm – 10 dB = –40 dBm.

Then:

$$+2 - 32 - Ionu\_r < -40 \qquad \text{(II-1)}$$

We obtain:

$$Ionu\_r > 10 \text{ dB} \qquad \text{(II-2)}$$

Regarding Class C, assuming permissible interference optical power is equal to (minimum sensitivity –10 dB), permissible interference optical power = –33 dBm – 10 dB = –43 dBm.

Then:

$$+4 - 32 - Ionu\_r < -43 \qquad \text{(II-3)}$$

We obtain:

$$Ionu\_r > 15 \text{ dB} \qquad \text{(II-4)}$$

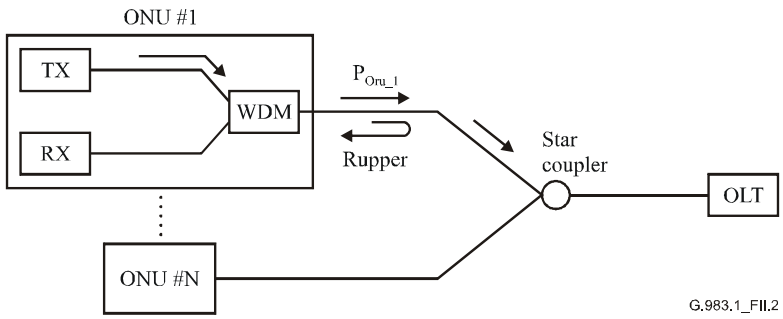


Figure II.2/G.983.1 – Model for incidence into ONU receiver

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II.2.3 Influence of reflectance into OLT receiver (in the signal region)

The analysis for the influence of reflectance into OLT receiver is performed in two conditions: one is that the reflected signal overlaps the upstream burst signal region and the other is that the reflected signal is in the delay measurement window where there is no signal.

In the signal region, the following three cases are to be considered.

II.2.3.1 Case 1

Figure II.3 shows the path of reflectance signals. Equation B must be satisfied:

$$\begin{gathered}\text{(maximum differential of bursted signal optical levels)} - Rupper - Ronu\_t < \\ \text{(permissible interference optical power ratio)}\end{gathered} \quad \text{(Equation B)}$$

Assuming permissible interference optical power ratio is −10 dB, we obtain:

$$(15+6) - 32 - Ronu\_t < -10 \quad \text{(II-5)}$$

then:

$$Ronu\_4 > -1\ dB \quad \text{(II-6)}$$

Therefore, requirement for Ronu_t in this case is not necessary.

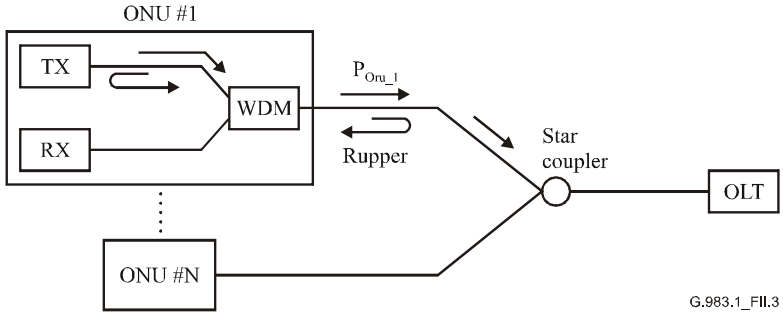


Figure II.3/G.983.1 – Model 1 for incidence into OLT receiver

II.2.3.2 Case 2

Figure II.4 shows the path of reflectance signals. Equation C must be satisfied:

$$\begin{gathered}\text{(maximum differential of burst signal optical level)} - Rolt\_t - Rdown - Iolt\_t \times 2 < \\ \text{(permissible interference optical power)}\end{gathered} \quad \text{(Equation C)}$$

Assuming permissible interference optical power is equal to −10 dB, we obtain:

$$(15+6) - Rolt\_t - 32 - Iolt\_t \times 2 < -10 \quad \text{(II-7)}$$

then:

$$Rolt\_t + Iolt\_t \times 2 > -1\ \text{dB} \quad \text{(II-8)}$$

Both of Rolt_t and Iolt_t are positive numbers, so requirement for Rolt_t and Iolt_t in this case is not necessary.

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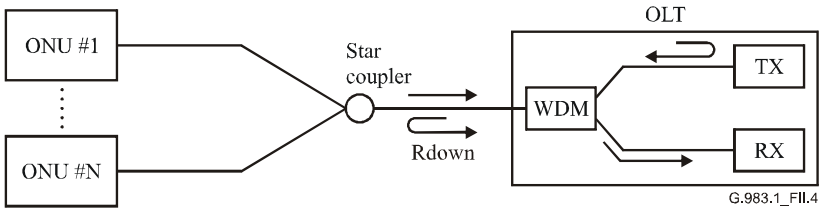


Figure II.4/G.983.1 – Model 2 incidence into OLT receiver

II.2.3.3 Case 3

Figure II.5 shows the path of reflectance signals. Equation D must be satisfied:

$$P_{Old} - Rdown - Iolt\_r < \text{(permissible interference optical power)} \qquad \text{(Equation D)}$$

Regarding Class B, assuming permissible interference optical power is equal to minimum sensitivity –10 dB, permissible interference optical power = –30 dBm – 10 dB = –40 dBm.

Then:

$$+2 - 32 - Iolt\_r < -40 \qquad \text{(II-9)}$$

We obtain:

$$Iolt\_r > 10 \text{ dB} \qquad \text{(II-10)}$$

Regarding Class C, assuming permissible interference optical power is equal to minimum sensitivity –10 dB, permissible interference optical power = –33 dBm – 10 dB = –43 dBm.

Then:

$$+4 - 32 - Iolt\_r < -43 \qquad \text{(II-11)}$$

We obtain:

$$Iolt\_r > 15 \text{ dB} \qquad \text{(II-12)}$$

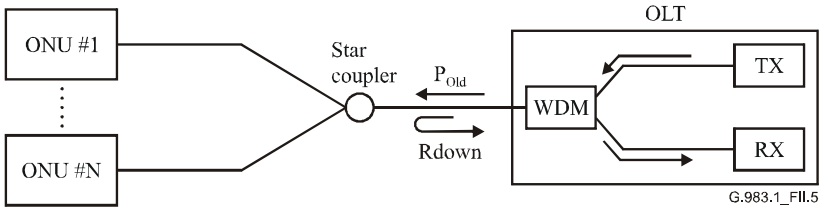


Figure II.5/G.983.1 – Model 3 for incidence into OLT receiver

II.2.4 Influence of reflectance into OLT receiver (in the no signal region)

In the no signal region, main cases of reflectance to be considered are the following two cases.

II.2.4.1 Case 1

Figure II.3 shows the path of reflectance signals. Equation E must be satisfied:

$$P_{Oru\_1} - Rupper - Ronu\_t - \text{(minimum optical path attenuation)} < \text{(determination level as no signal)} \qquad \text{(Equation E)}$$

Regarding Class B, assuming determination level as no signal is equal to minimum sensitivity –10 dB, determination level as no signal = –30 dBm – 10 dB = –40 dBm.

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Then:

$$+2-32-Ronu\_t-10<-40 \quad \text{(II-13)}$$

We obtain:

$$Ronu\_t>0 \text{ dB} \quad \text{(II-14)}$$

Therefore, requirement for Ronu_t in this case is not necessary.

Regarding Class C, assuming determination level as no signal is equal to minimum sensitivity −10 dB, determination level as no signal = –33 dBm – 10 dB = –43 dBm.

Then:

$$+4-32Ronu\_t-15<-43 \quad \text{(II-15)}$$

We obtain:

$$Ronu\_t>0 \text{ dB} \quad \text{(II-16)}$$

Therefore, requirement for Ronu_t in this case is not necessary.

II.2.4.2 Case 2

Figure II.5 shows the path of reflectance signals. Equation F must be satisfied:

$$P_{Old}-Rdown-Iolt\_r< \text{(determination level as no signal)} \quad \text{(Equation F)}$$

Regarding Class B, assuming determination level as no signal is equal to minimum sensitivity −10 dB, determination level as no signal = –30 dBm – 10 dB = –40 dBm.

Then:

$$+2-32-Iolr\_r<-40 \quad \text{(II-17)}$$

We obtain:

$$Iolt\_r>10 \text{ dB} \quad \text{(II-18)}$$

Regarding Class C, assuming determination level as no signal is equal to minimum sensitivity −10 dB, determination level as no signal = –33 dBm – 10 dB = –43 dBm.

Then:

$$+4-32-Iolt\_r<-43 \quad \text{(II-19)}$$

We obtain:

$$Iolr\_r>15 \text{ dB} \quad \text{(II-20)}$$

II.3 Other case of ODN reflectance

The calculation method mentioned above is available for the case that ODN reflectance is −20 dB. Table II.1 shows the requirement for optical parameters when minimum ORL of ODN is 32 dB and 20 dB.

WDM isolation parameter is an implementation matter, and values concerning WDM isolation parameters in the Table II.1 are just informative. This appendix includes ONU and OLT equipment reflectance. Considering the characteristic of the WDM, Ronu_t is equal to the reflectance of ONU measured at transmitter wavelength.

When ORL of ODN is 32 dB, ONU transmitter equipment reflectance must be less than incident optical power. Therefore, it shall be 6 dB which is available in an ordinary FP-LD module.

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In the case that ORL of ODN is 20 dB, ONU transmitter equipment reflectance must be less than 12 dB.

As mentioned above, maximum ONU transmitter equipment reflectance is sensitive to the value of ORL of ODN, which depends on the network built by the common carrier. In the case that ORL of ODN is 32 dB and 20 dB, values of equipment reflectance for ONU transmitter in Table II.1 are applicable. In the other case, the appropriate value is derived by means of the calculation method mentioned above.

Table II.1/G.983.1 – Values for ONU transmitter equipment reflectance

Min ORL of ODN	Class	Optical parameters	Required characteristics					
			A[a)]	**B**[a)]	**C**[a)]	**D**[a)]	**E**[a)]	**F**[a)]
32 dB	B	WDM isolation for ONU receiver	10 dB					
		WDM isolation for ONU transmitter						
		WDM isolation for OLT receiver				10 dB		10 dB
		WDM isolation for OLT transmitter			NA			
		Equipment reflectance for ONU transmitter		NA			NA	
	C	WDM isolation for ONU receiver	15 dB					
		WDM isolation for ONU transmitter						
		WDM isolation for OLT receiver				15 dB		15 dB
		WDM isolation for OLT transmitter			NA			
		Equipment reflectance for ONU transmitter		NA			NA	
20 dB	B	WDM isolation for ONU receiver	22 dB					
		WDM isolation for ONU transmitter						
		WDM isolation for OLT receiver				22 dB		22 dB
		WDM isolation for OLT transmitter			2.5 dB			
		Equipment reflectance for ONU transmitter		11 dB			12 dB	
	C	WDM isolation for ONU receiver	27 dB					
		WDM isolation for ONU transmitter						
		WDM isolation for OLT receiver				27 dB		27 dB
		WDM isolation for OLT transmitter			2.5 dB			
		Equipment reflectance for ONU transmitter		11 dB			12 dB	

[a)] A, B, C, D, E and F represent Equation A, Equation B, Equation C, Equation D, Equation E and Equation F, respectively.

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Appendix III

Ranging flow diagrams

The ranging flow diagrams shown here are examples of the normal operation of the ranging procedure. To simplify the diagrams, the effects of alarms (such as LOS, LCD, OAML and FRML) are not shown. The effects of certain messages (such as Disable_serial_number and Deactivate_PON_ID) are also not shown.

III.1 Ranging flow in the ONU (example)

Figure III.1 (sheets 1 to 7 of 7) indicate an example ranging flow in the ONU. It is not intended to specify the ranging procedure and is only shown for information.

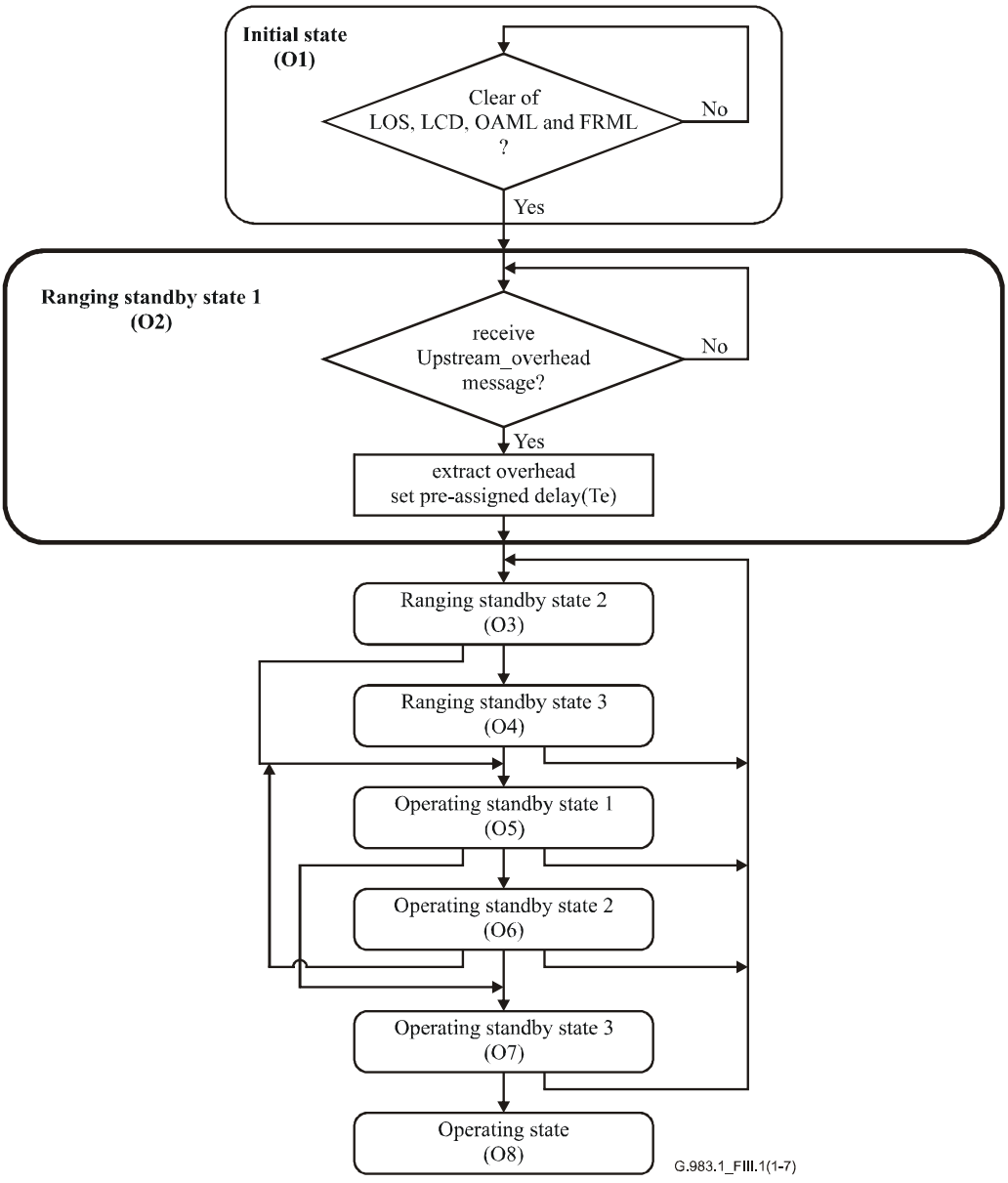


Figure III.1/G.983.1 – Ranging flow [ONU] (example) ***(sheet 1 of 7)***

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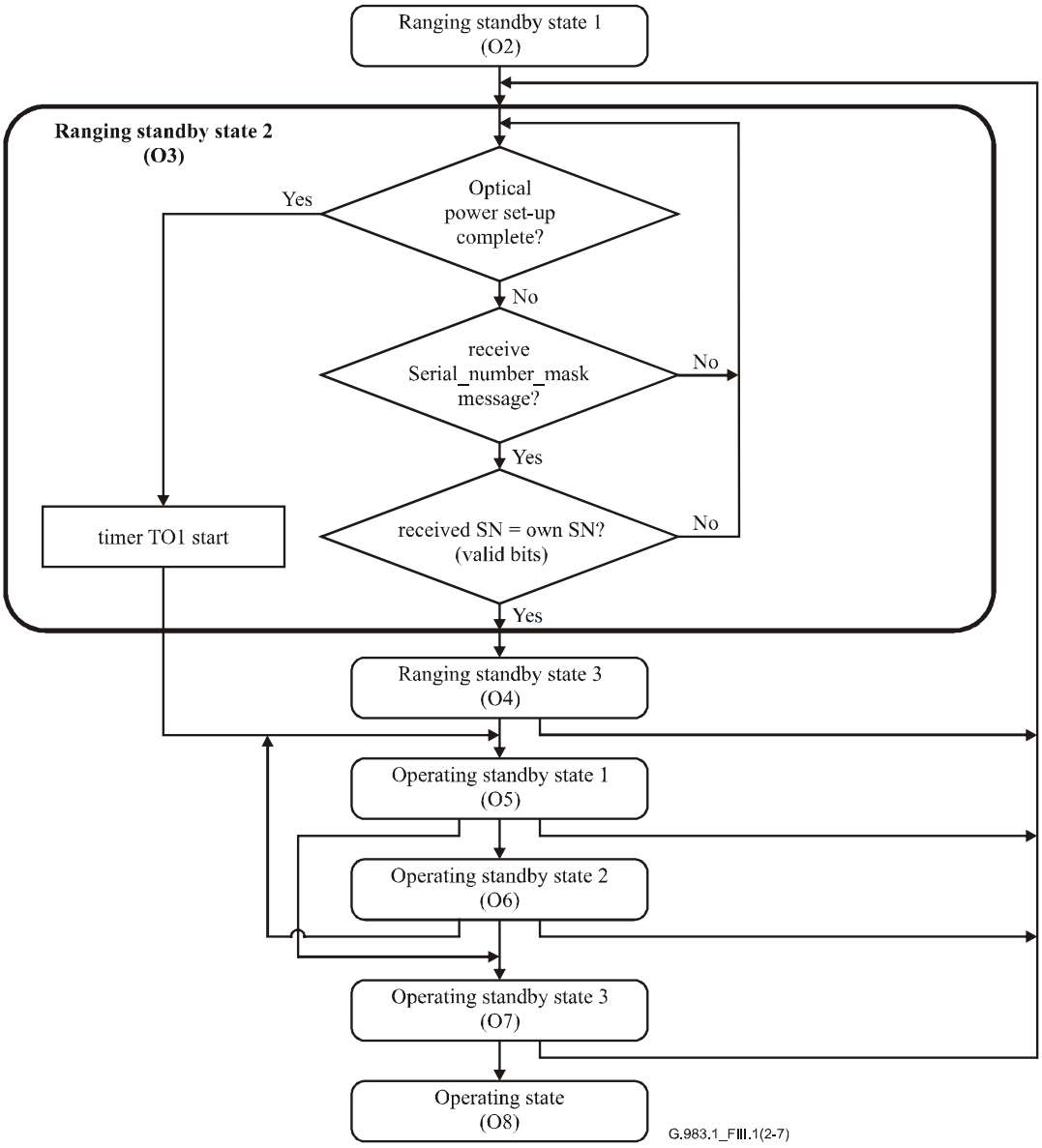


Figure III.1/G.983.1 – Ranging flow [ONU] (example) ***(sheet 2 of 7)***

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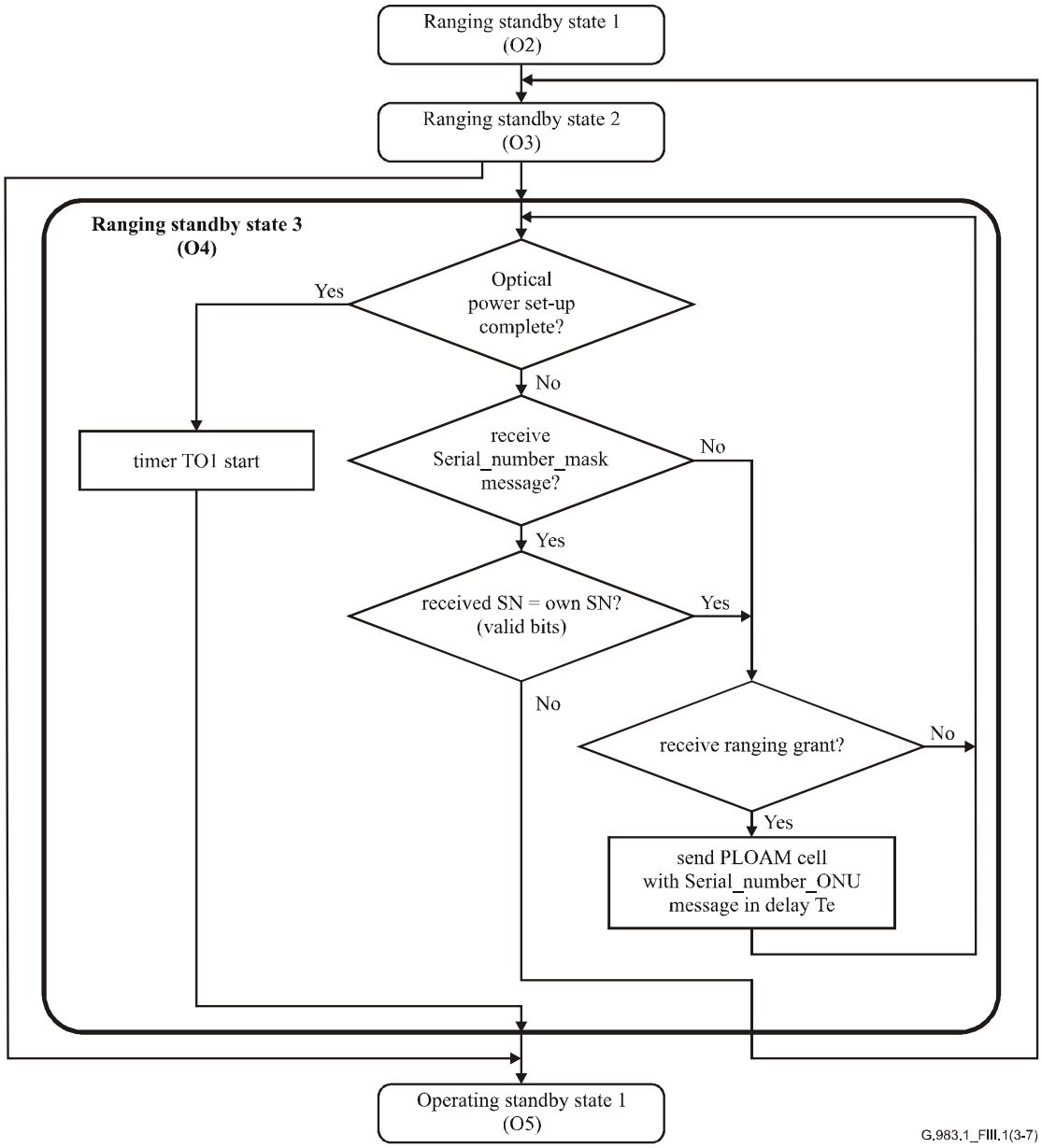


Figure III.1/G.983.1 – Ranging flow [ONU] (example) ***(sheet 3 of 7)***

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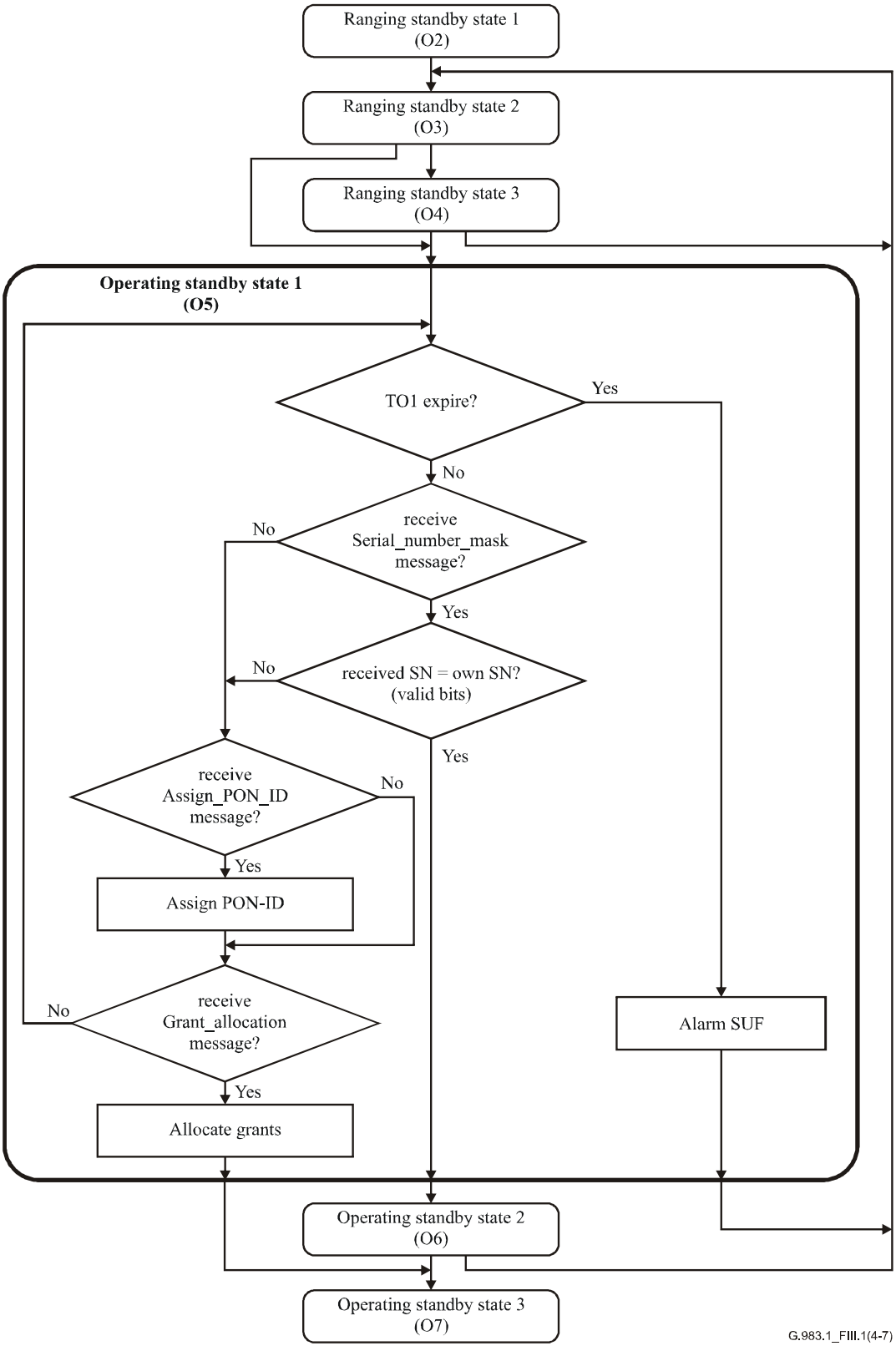


Figure III.1/G.983.1 – Ranging flow [ONU] (example) ***(sheet 4 of 7)***

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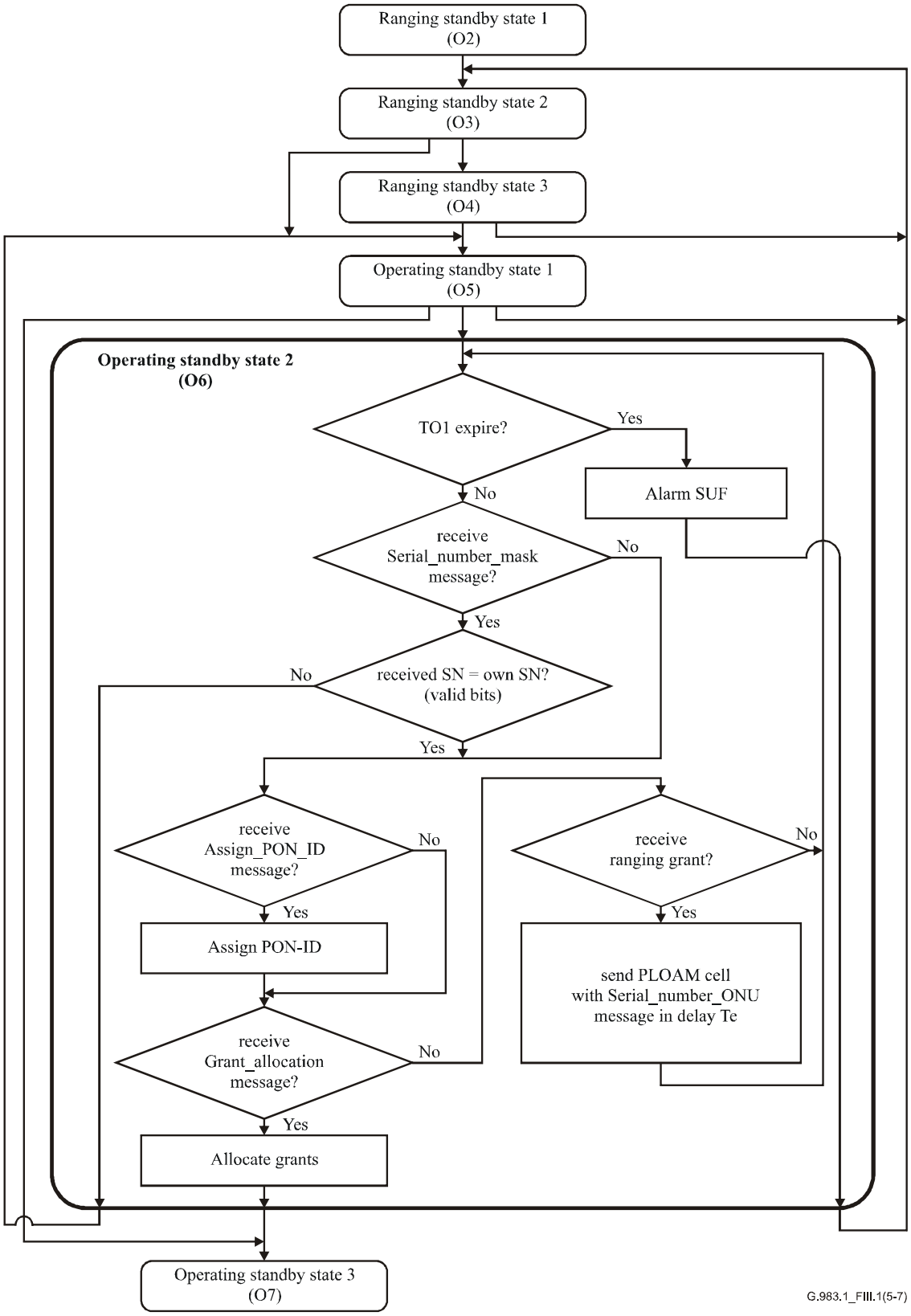


Figure III.1/G.983.1 – Ranging flow [ONU] (example) ***(sheet 5 of 7)***

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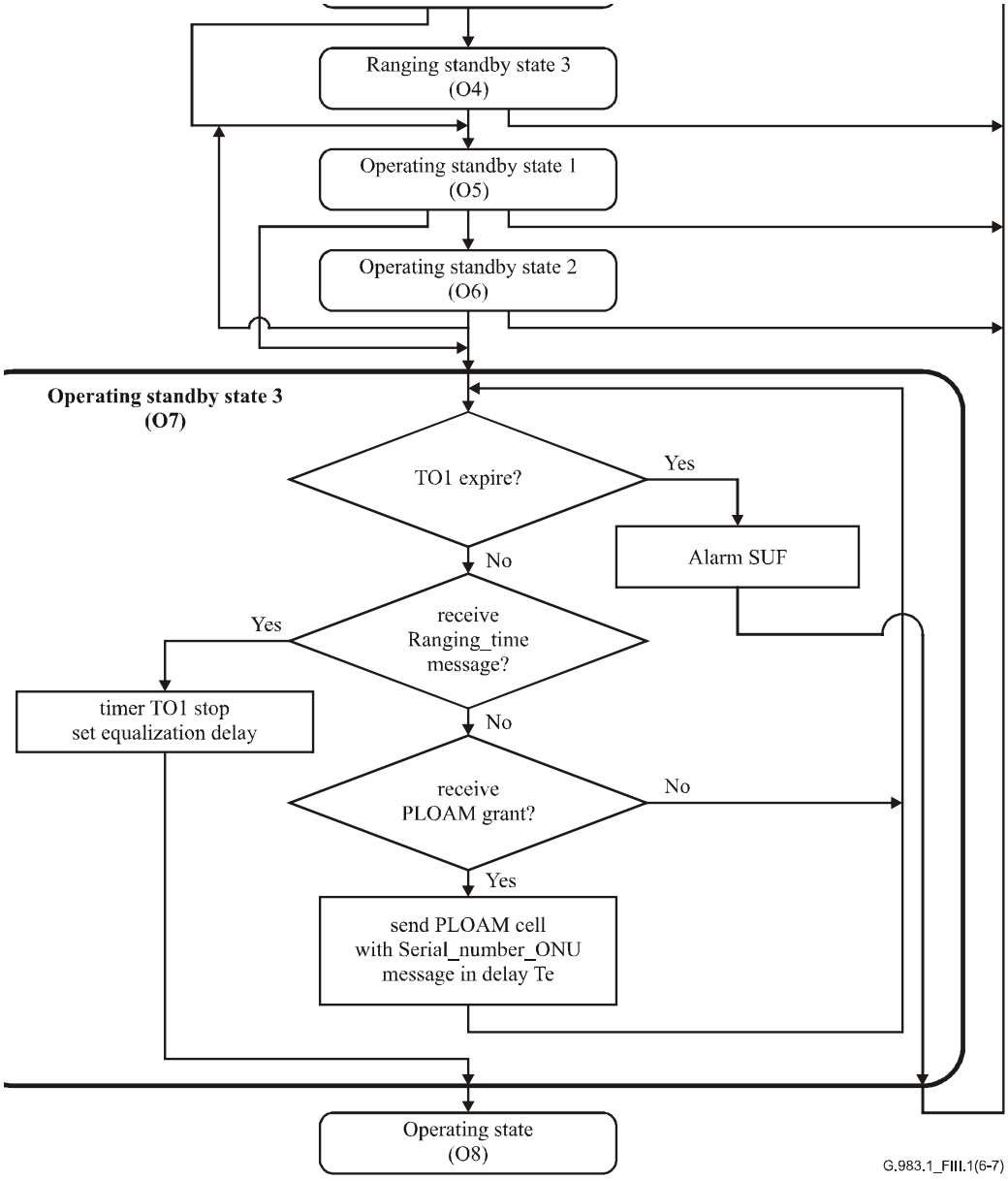


Figure III.1/G.983.1 – Ranging flow [ONU] (example) ***(sheet 6 of 7)***

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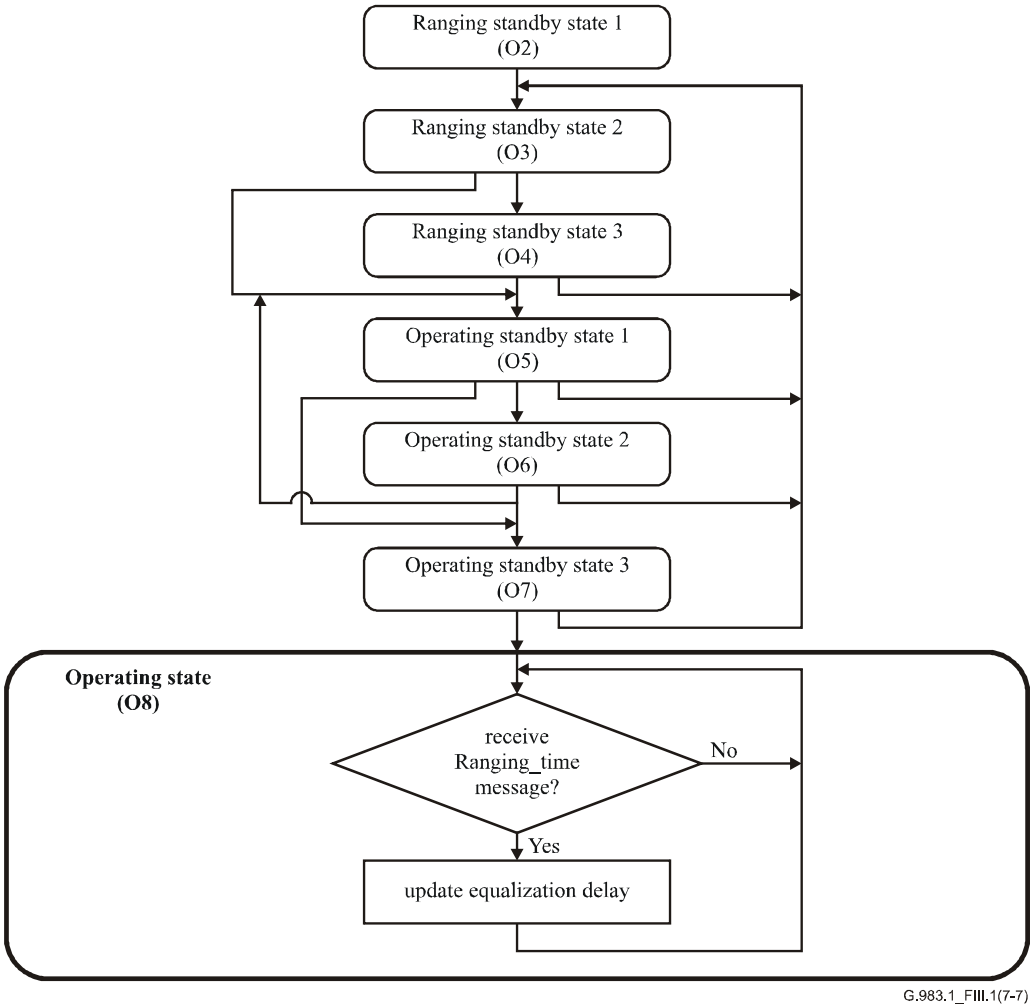


Figure III.1/G.983.1 – Ranging flow [ONU] (example) ***(sheet 7 of 7)***

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III.2 Ranging flow in the OLT (example)

Figure III.2 (sheets 1 to 7 of 7) indicates an example ranging flow in the OLT. It is not intended to specify the ranging procedure and is only shown for information.

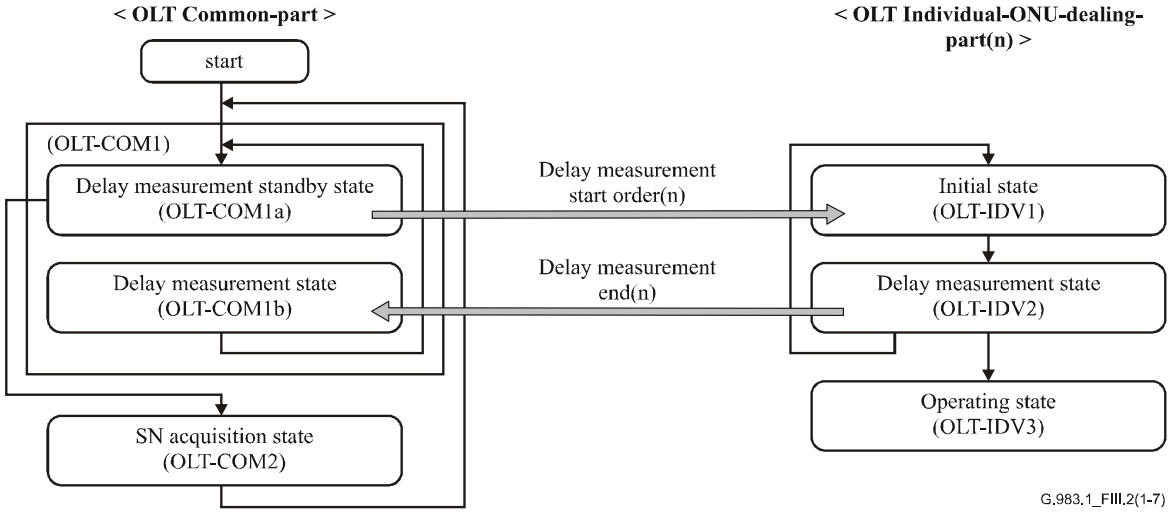


Figure III.2/G.983.1 – Ranging flow [OLT] (example) ***(sheet 1 of 7)***

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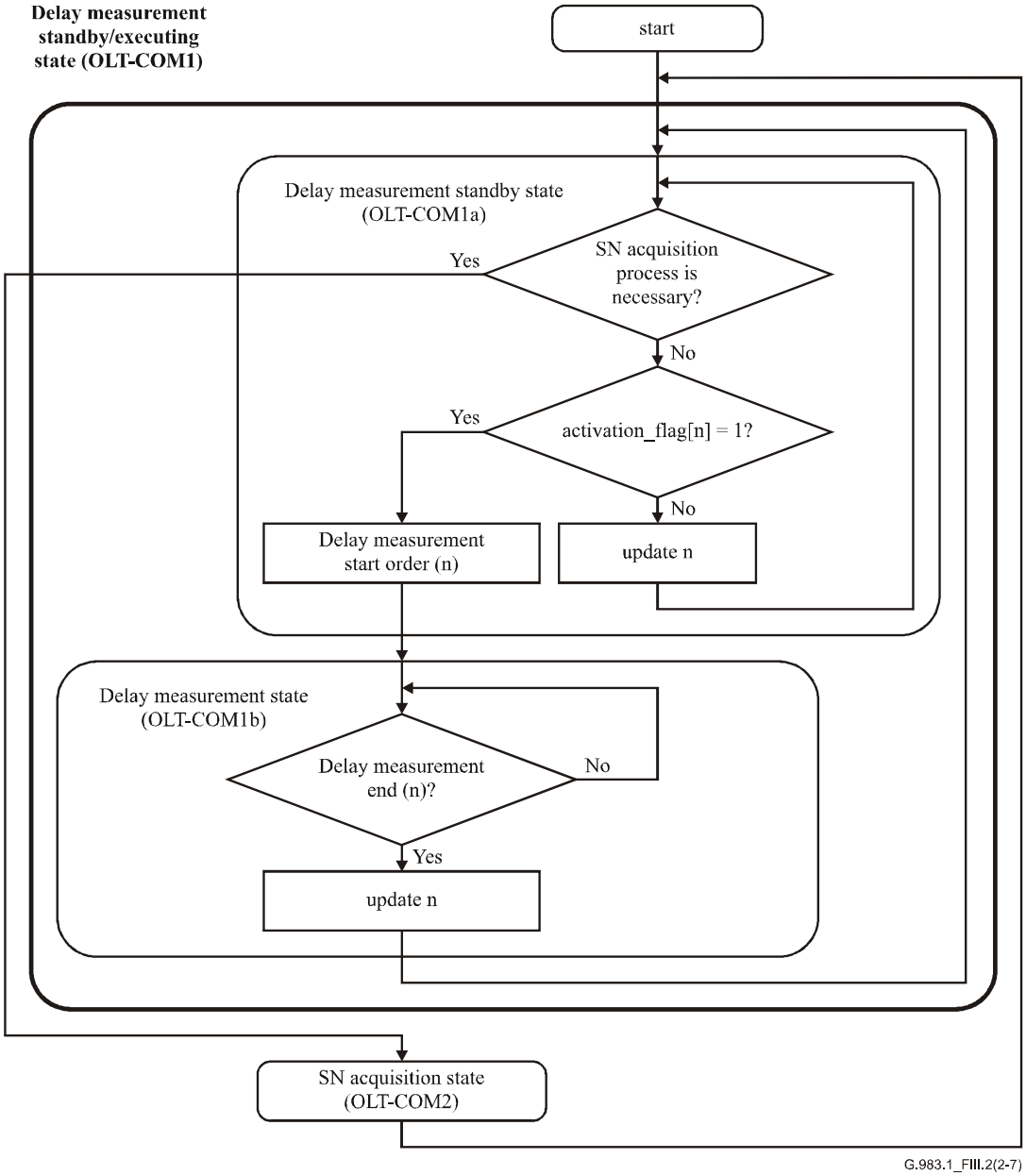


Figure III.2/G.983.1 – Ranging flow [OLT] (example) ***(sheet 2 of 7)***

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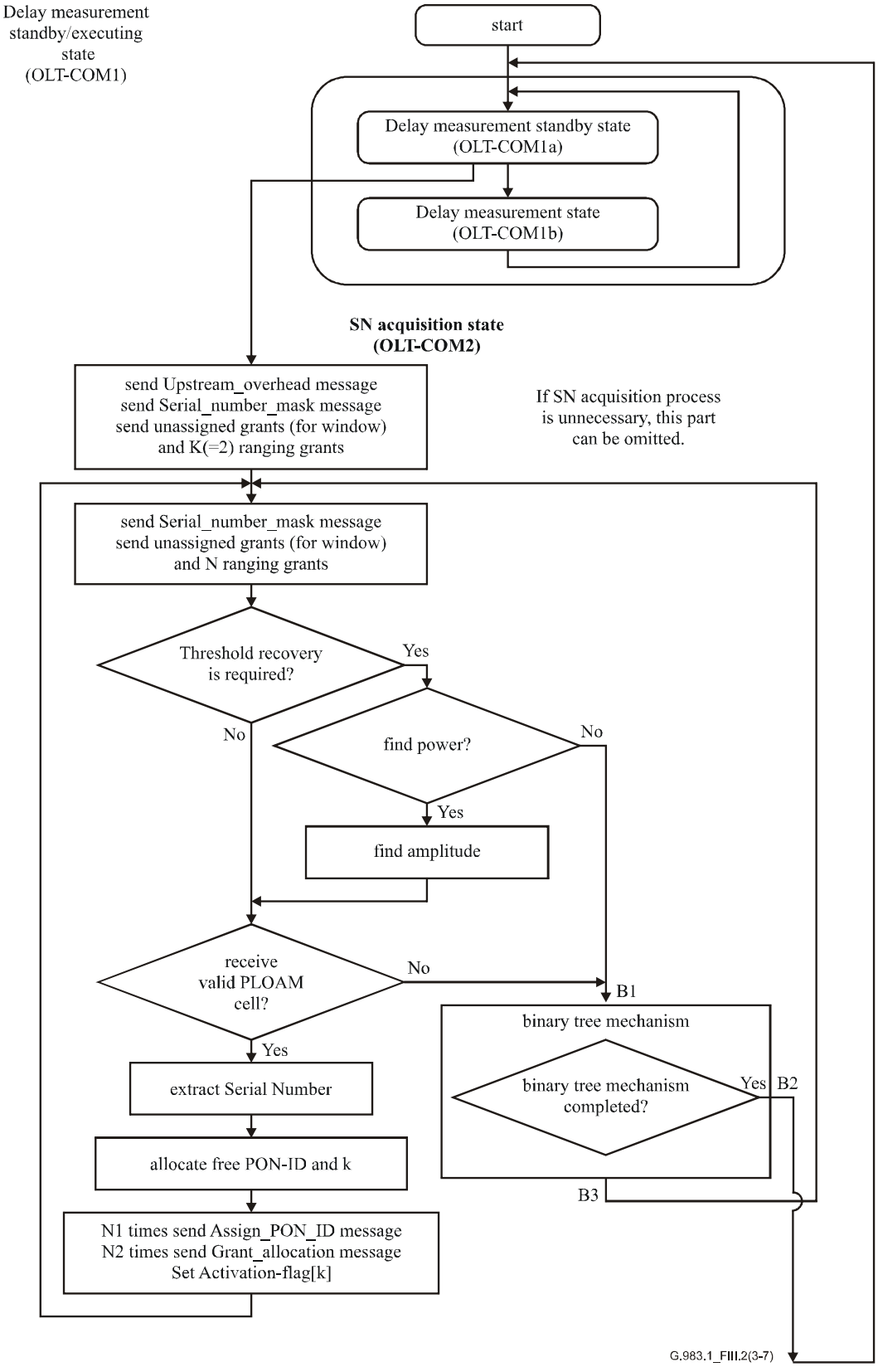
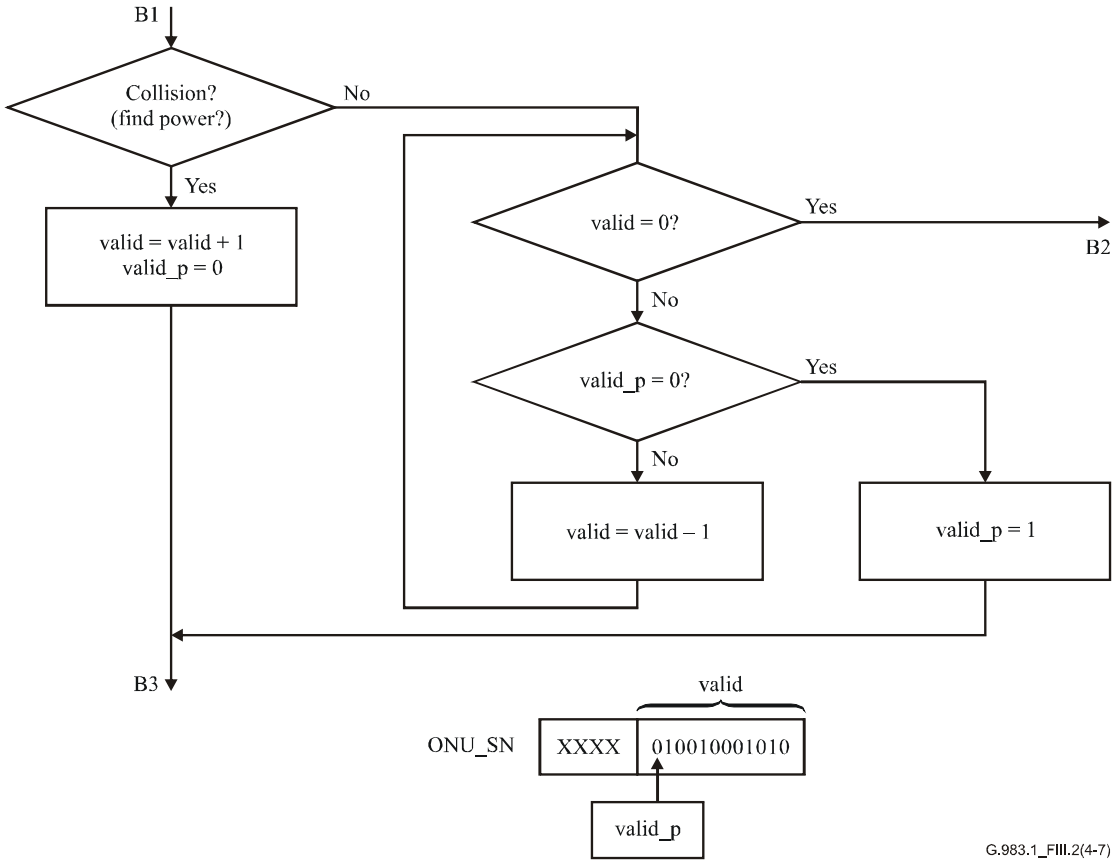


Figure III.2/G.983.1 – Ranging flow [OLT] (example) ***(sheet 3 of 7)***

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NOTE – The points of B1, B2 and B3 correspond to the points of B1, B2 and B3 in Figure III.2 respectively.
"valid" means the number of valid bits of ONU serial number.
"valid_p indicates the bit of the most significant bit of valid bits.

Figure III.2/G.983.1 – Ranging flow [OLT] (example) ***(sheet 4 of 7)***

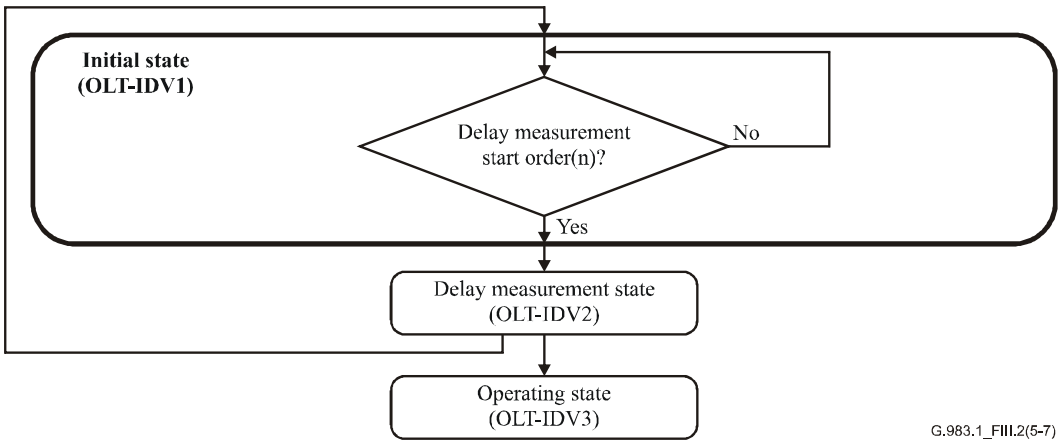


Figure III.2/G.983.1 – Ranging flow [OLT] (example) ***(sheet 5 of 7)***

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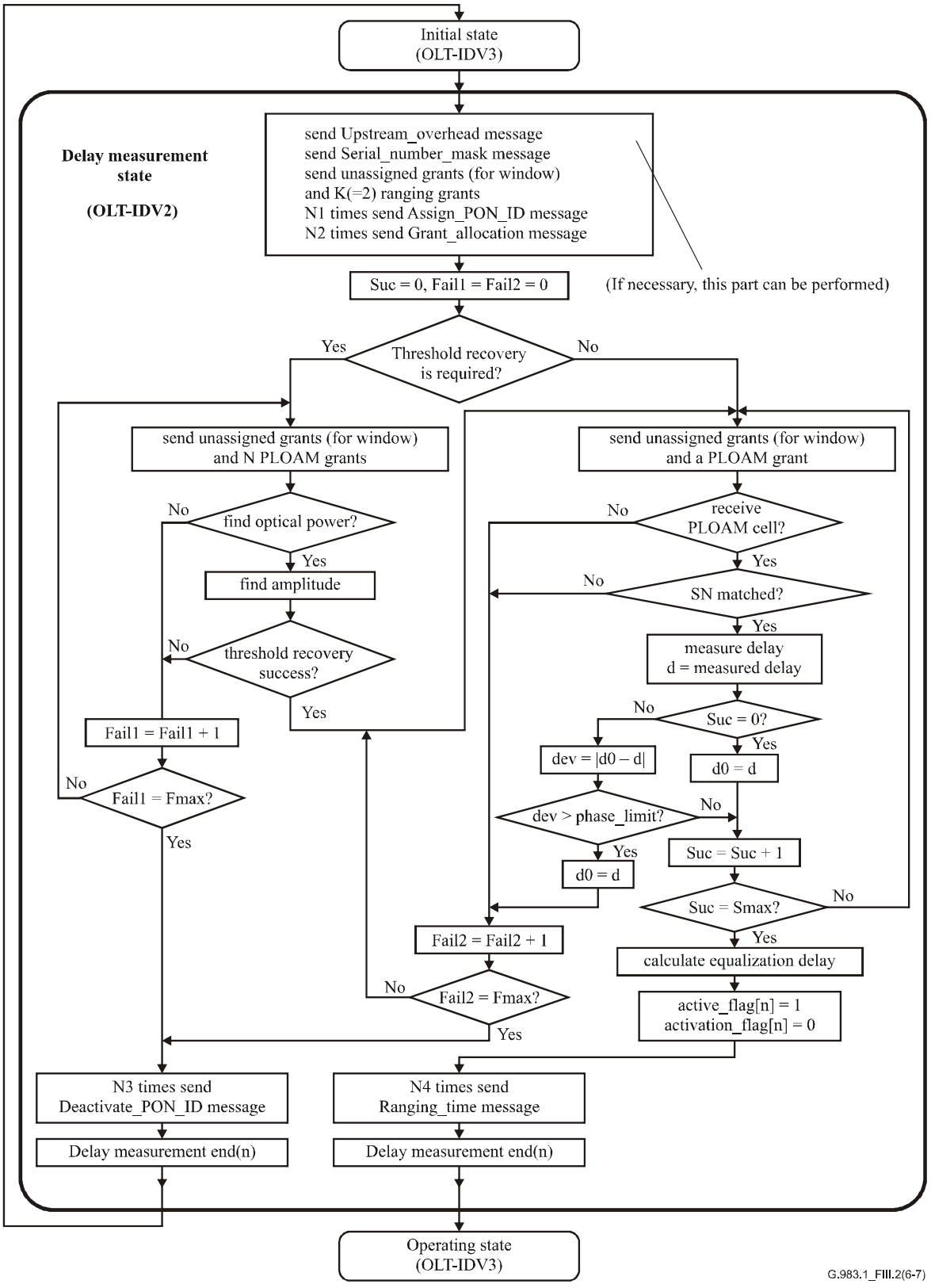
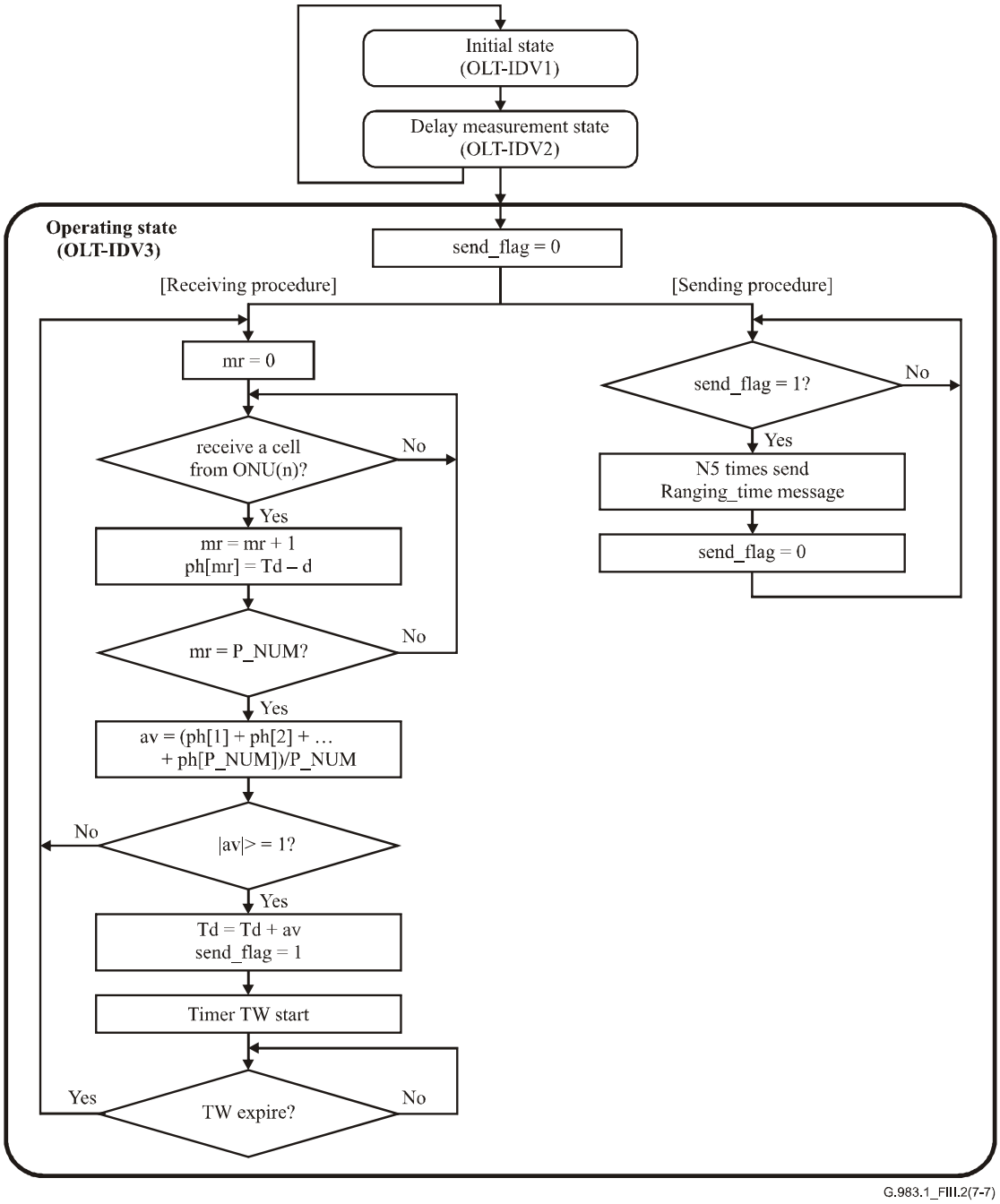


Figure III.2/G.983.1 – Ranging flow [OLT] (example) ***(sheet 6 of 7)***

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mr	Counter of received cells from ONU(n)
ph[j]	Deviation value of phase difference
P_NUM	Number of phase measurement
av	Average of ph[1], ph[2], ..., ph[P_NUM]
Td	Currently used equalization_delay
d	Newly measured equalization_delay
TW	Timer for phase difference measurement
send_flag	Transmission requirement flag of Ranging_time message

Figure III.2/G.983.1 – Ranging flow [OLT] (example) ***(sheet 7 of 7)***

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Appendix IV

Access network survivability

IV.1 Introduction

From the view point of administration of the access network, the protection architecture of the ATM-PON is considered to enhance the reliability of the access networks. However, the protection shall be considered as an optional mechanism, which is appropriate for this appendix. Its implementation depends on the realization of the economical system.

This appendix presents some possible duplex configurations and the related requirements as examples of ATM-PON to stimulate further discussion. In addition, the required OAM message for the protection is mentioned. For further information, please see ITU-T Rec. G.983.5.

IV.2 Possible switching types

There are two types of protection switching:

i) automatic switching; and

ii) forced switching,

which are in an analogy of SDH system. The first one is triggered by the fault detection, such as loss of signal, loss of frame, signal degrade (BER becomes worse than the pre-determined threshold), and so on. The second one will be activated by the administrative events, such as fibre re-routing, fibre replacement, etc. Both types should be possible in the ATM-PON system, if required, even though they are optional functions. The switching mechanism is generally realized by the OAM function; therefore, the required OAM information field should be reserved in the PLOAM cells.

Figure IV.1 shows the duplex system model for the access network. The relevant part of the protection in the ATM-PON system should be a part of the protection between the ODN interface in the OLT and the ODN interface in the ONU via the ODN, excluding the SNI redundancy in the OLT.

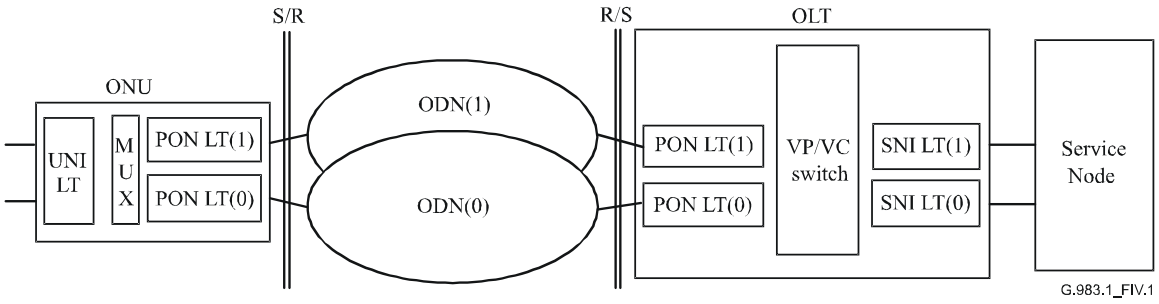


Figure IV.1/G.983.1 – Duplex system model

IV.3 Possible duplex ATM-PON configurations and characteristics

There can be several types of duplex ATM-PON system, as shown in Figure IV.2 a) to d). The control protocols for each configuration should be specified independently with each other.

For example, any switching protocol is not required for OLT/ONU in Figure IV.2 a), since the switching is only applied for the optical fibres. Also in Figure IV.2 b), any switching protocol is not required, since the switching is carried out only in the OLT.

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IV.3.1 Configuration examples

Type A: The first configuration doubles only the optical fibres, as shown in Figure IV.2 a). In this case, the ONUs and OLTs are singular.

Type B: The second one [Figure IV.2 b)] doubles the OLTs and optical fibres between the OLTs and the optical splitter, and the splitter has two input/output ports on the OLT side. This configuration reduces the cost of duplexing the ONUs, although only the SLT side can be recovered.

Type C: The third configuration [Figure IV.2 c)] doubles not only the OLT side facilities, but also the ONU side. In this configuration, failure at any point can be recovered by switching to the standby facilities. Therefore, the full duplex cost enables a high reliability.

Type D: If the ONUs are installed in the customer buildings, the in-house wiring may or may not be duplexed. Additionally, if each ONU is owned by different users, the reliability requirement depends on each user and only a limited number of ONUs may have the duplex configuration. Based on this consideration, the last one [Figure IV.2 d)] permits a partial duplexing on the ONU side. This Figure shows an example where there are duplex ONU#1 and single ONU#N. Its key principles are:

1) using double N:2 optical splitters to connect PON LT(0) in the ONU#1 to splitter N(0) and PON LT(1) in the ONU#1 to splitter N(1);
2) connecting PON LT in the ONU#N to either optical splitter, because it is single;
3) using double 2:1 optical splitters to connect PON LT(0) in the OLT to splitter(0) and PON LT(1) in the OLT to splitter(1);
4) connecting double N:2 optical splitters and double 2:1 optical splitters, where one port of splitter(1) is connected to splitter N(0), and one port of splitter(0) to splitter N(1);
5) using the cold standby method in both OLT and ONUs to avoid the optical signal collision from PON LT(0) and PON LT(1) in the OLT, or PON LT(0) an PON LT(1) in the ONU #1.

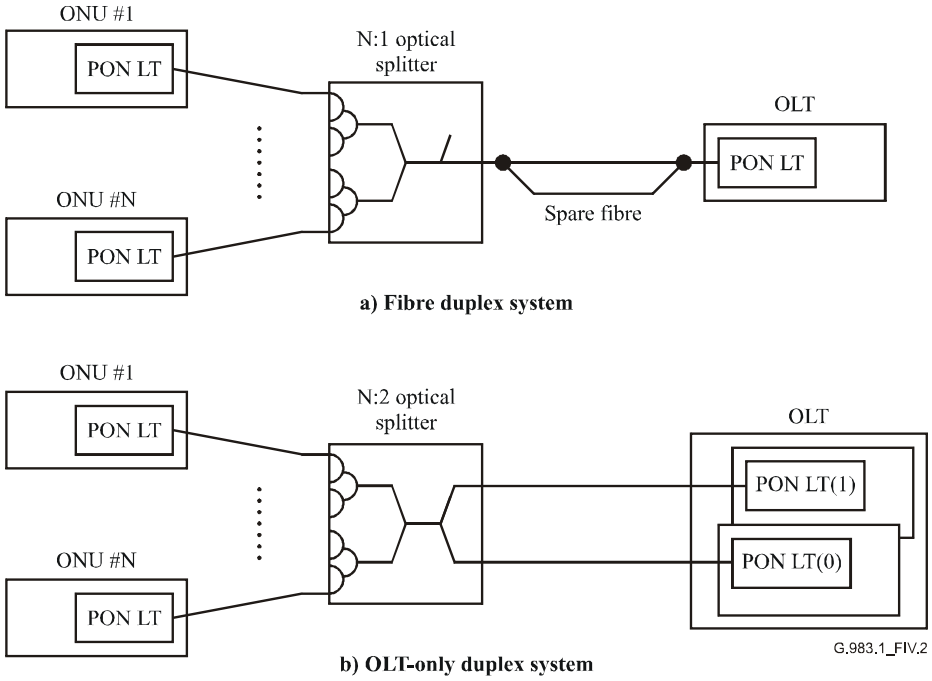


Figure IV.2/G.983.1 – Duplex ATM-PON system

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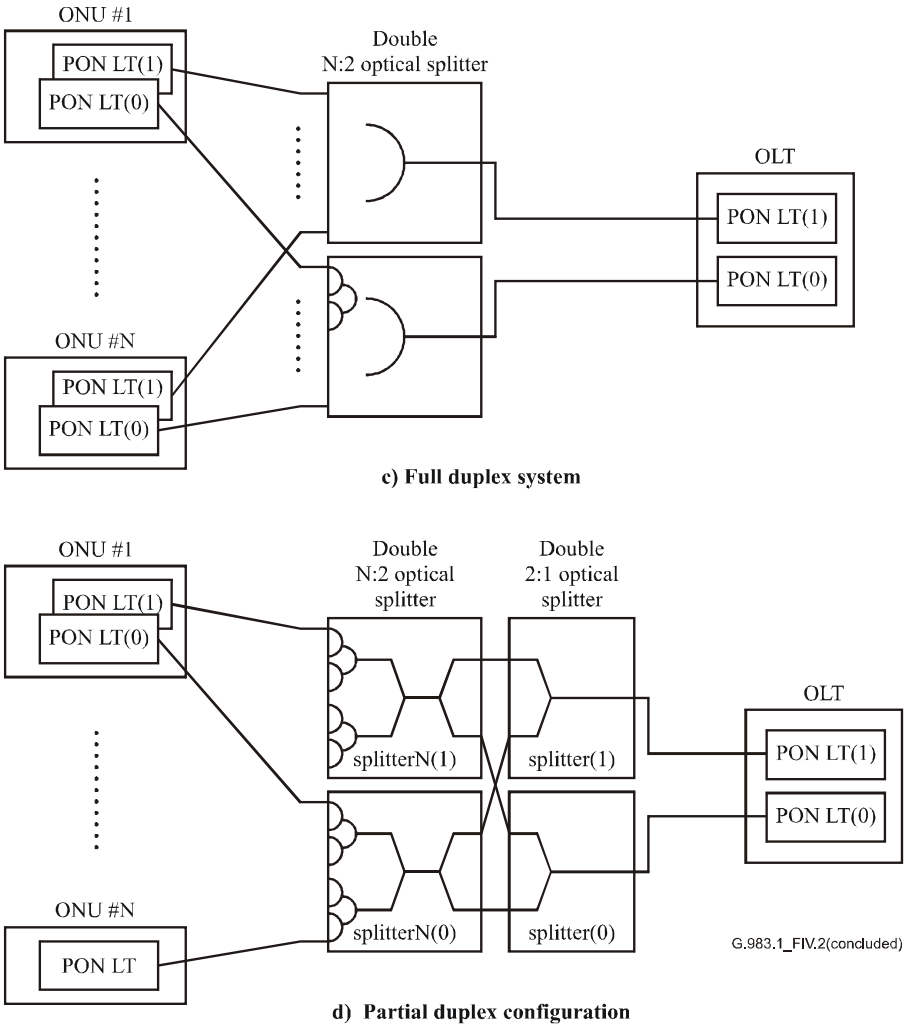


Figure IV.2/G.983.1 – Duplex ATM-PON system *(concluded)*

IV.3.2 Characteristics

Type A: In this case, the signal loss or even cell loss is inevitable in the switching period. However, all the connections between the service node and the terminal equipment should be held after this fibre switching.

Type B: This configuration requires cold standby of the spare circuit in the OLT side. In this case, the signal loss or even cell loss is, in general, inevitable in the switching period. However, all the connections supported between the service node and the terminal equipment should be held after this switching.

Type C: In this case, the hot standby of the spare receiver circuits is possible in both ONU and OLT sides. In addition, the hit-less switching (without cell loss) is also possible in this configuration.

Type D: The characteristics of this type are the same as Type B.

IV.4 Requirements

i) The protection switching function should be optional.

ii) Both automatic protection switching and forced switching are possible in the ATM-PON system, if required, even though they are optional functions.

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iii) All the configuration examples of IV.3 will be possible, even though they are optional functions.

iv) The switching mechanism is generally realized by the OAM function; therefore, the required OAM information field must be reserved in the PLOAM cells.

v) All the connections supported between the service node and the terminal equipment should be held after this switching.

Regarding the last requirement, one implementation of the POTS service node (exchange) requires the cell loss period to be less than 120 ms. If the cell loss period becomes longer than that, the service node disconnects the call, and the call set-up is required again after the protection switching. Since ATM-PON supports the emulation of the conventional services, such as POTS and ISDN, this value should be taken into consideration.

IV.5 Required information fields for PLOAM cell

According to the analogy of the SDH system, the protection switching requires less than ten codes to be used for both upstream and downstream, which will be realized by the field of the PLOAM cell. The field mapping of the PLOAM cell for the protection will be required to be defined.

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Series F	Non-telephone telecommunication services
Series G	**Transmission systems and media, digital systems and networks**
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects and next-generation networks
Series Z	Languages and general software aspects for telecommunication systems

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International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.983.2

(07/2005)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Digital sections and digital line system – Optical line systems for local and access networks

ONT management and control interface specification for B-PON

ITU-T Recommendation G.983.2

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TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

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INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES	G.300–G.399
GENERAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON RADIO-RELAY OR SATELLITE LINKS AND INTERCONNECTION WITH METALLIC LINES	G.400–G.449
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For further details, please refer to the list of ITU-T Recommendations.

ITU-T Recommendation G.983.2

ONT management and control interface specification for B-PON

Summary

In the B-PON system defined in ITU-T Rec. G.983.1 [3] (called ATM-PON in ITU-T Rec. G.983.1), the ONTs are located at the customer site. The B-PON element management system will only manage ONTs as part of the B-PON system through the OLT using the ONT management and control interface (OMCI).

This Recommendation presents requirements for the OMCI. Firstly, it specifies managed entities of a protocol-independent Management Information Base (MIB) that models the exchange of information between the OLT and ONT, then it covers the ONT management and control channel, protocol and detailed messages. This 2nd revised version of ITU-T Rec. G.983.2 incorporates the material from G.983.2 Amendment 1 (2003), G.983.2 Amendment 2 (2005), G.983.2 Implementers' Guide (2003), G.983.6 (2002), G.983.7 (2001), G.983.8 (2003), G.983.9 (2004), G.983.10 (2004) into the base text of G.983.2 (2002). It also includes minor corrections, clarifications, and augmentation of functions.

Source

ITU-T Recommendation G.983.2 was approved on 14 July 2005 by ITU-T Study Group 15 (2005-2008) under the ITU-T Recommendation A.8 procedure.

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FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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ITU-T Recommendation G.983.2

ONT management and control interface specification for B-PON

1 Scope

This Recommendation specifies the ONT Management and Control Interface (OMCI) for the B-PON system defined in ITU-T Rec. G.983.1 [3] (called ATM-PON in ITU-T Rec. G.983.1) to enable multi-vendor interoperability between the OLT and the ONT.

The OMCI specification addresses the ONT configuration management, fault management and performance management for B-PON system operation and for several services including:

- ATM adaptation layers 1, 2, and 5;
- Circuit Emulation Service;
- Ethernet services, including MAC Bridged LAN, VLAN tagging and filtering;
- Internet Protocol Routing;
- Wireless LAN (IEEE 802.11) service;
- ADSL and VDSL services;
- Voice services, including ISDN;
- Wavelength division multiplexing, including video;
- PON protection switching;
- Dynamic Bandwidth Assignment;
- Enhanced Security.

The focus of this OMCI specification is on FTTH and FTTBusiness ONTs. The Recommendation defines a protocol necessary to support the capabilities identified for these ONTs. It also allows optional components and future extensions.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[1] ITU-T Recommendation G.784 (1999), *Synchronous digital hierarchy (SDH) management*.

[2] ITU-T Recommendation G.774 (2001), *Synchronous digital hierarchy (SDH) – Management information model for the network element view*.

[3] ITU-T Recommendation G.983.1 (2005), *Broadband optical access systems based on Passive Optical Networks (PON).*

[4] ITU-T Recommendation I.321 (1991), *B-ISDN protocol reference model and its application.*

[5] ITU-T Recommendation I.363.1 (1996), *B-ISDN ATM Adaptation Layer specification: Type 1 AAL*.

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[6] ITU-T Recommendation I.363.5 (1996), *B-ISDN ATM Adaptation Layer specification: Type 5 AAL*.

[7] ITU-T Recommendation I.371 (2004), *Traffic control and congestion control in B-ISDN*.

[8] ITU-T Recommendation I.610 (1999), *B-ISDN operation and maintenance principles and functions*.

[9] ITU-T Recommendation I.751 (1996), *Asynchronous transfer mode management of the network element view*.

[10] ITU-T Recommendation Q.824.6 (1998), *Stage 2 and stage 3 description for the Q3 interface – Customer administration: Broadband Switch Management*.

[11] ITU-T Recommendation I.432.1 (1999), *B-ISDN user-network interface – Physical layer specification: General characteristics*.

[12] ITU-T Recommendation I.356 (2000), *B-ISDN ATM layer cell transfer performance*.

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[14] ITU-T Recommendation I.363.2 (2000), *B-ISDN ATM Adaptation Layer specification: Type 2 AAL*.

[15] ITU-T Recommendation I.366.1 (1998), *Segmentation and Reassembly Service Specific Convergence Sublayer for the AAL type 2*.

[16] ITU-T Recommendation I.366.2 (2000), *AAL type 2 service specific convergence sublayer for narrow-band services*.

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[21] IETF RFC 3728 (2004), *Definitions of Managed Objects for Very High Speed Digital Subscriber Lines (VDSL)*.

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[23] ITU-T Recommendation G.983.4 (2001), *A broadband optical access system with increased service capability using dynamic bandwidth assignment*.

[24] ITU-T Recommendation G.983.5 (2002), *A broadband optical access system with enhanced survivability*.

[25] SCTE 55-1 (2002), *Digital Broadband Delivery System: Out Of Band Transport Part 1: Mode A*.

[26] SCTE 55-2 (2002), *Digital Broadband Delivery System: Out Of Band Transport Part 2: Mode B*.

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3 Abbreviations

This Recommendation uses the following abbreviations:

AAL	ATM Adaptation Layer
ABR	Available Bit Rate
ABT/DT	ATM Block Transfer Delayed Transmission
ABT/IT	ATM Block Transfer Immediate Transmission
ADSL	Asymmetrical Digital Subscriber Line
AES	Advanced Encryption Standard
AN	Access Node
ANI	Access Node Interface
AP	Access Point
APON	ATM over Passive Optical Network
APS	Automatic Protection Switching
ARC	Alarm Reporting Control
ARP	Address Resolution Protocol
ATC	ATM Transfer Capabilities
ATM	Asynchronous Transfer Mode
ATU-C	ADSL Transceiver Unit, Central office end
ATU-R	ADSL Transceiver Unit, Remote terminal end
AVC	Attribute Value Change
BER	Bit Error Rate
BES	Block Errored Second
B-ISDN	Broadband Integrated Services Digital Network
B-PON	Broadband Passive Optical Network
BRAS	Broadband Remote Access Server
BSS	Basic Service Set
CBR	Constant Bit Rate
CCA	Clear Channel Assessment
CES	Circuit Emulation Service
CFI	Canonical Format Indicator
CFP	Contention Free Period
CLEI	Common Language Equipment Identification
CLP	Cell Loss Priority
CNR	Carrier-to-Noise Ratio
CRC	Cyclic Redundancy Check
CSO	Composite Second Order
CSS	Controlled Slip Second

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CTB	Composite Triple Beat
CTP	Connection Termination Point
CTS	Clear To Send
DBA	Dynamic Bandwidth Assignment
DBR	Deterministic Bit Rate
DCF	Distributed Coordination Function
DSL	Digital Subscriber Line
DSSS	Direct-Sequence Spread Spectrum
DTIM	Delivery Traffic Indication Message
ES	Errored Second
ESS	Extended Service Set
FEC	Forward Error Correction
FHSS	Frequency-Hopping Spread Spectrum
FTTB	Fibre to the Building
FTTBusiness	Fibre to the Business
FTTC	Fibre to the Curb
FTTCab	Fibre to the Cabinet
FTTH	Fibre to the Home
GFR	Guaranteed Frame Rate
HE	Head End
HEC	Header Error Control
HN	Home Network
HOL	Head of the Line
IBSS	Independent Basic Service Set
ICMP	Internet Control Message Protocol
ICV	Integrity Check Value
IF	Interface
IP	Internet Protocol
IR	Infrared
ISDN	Integrated Services Digital Network
LAN	Local Area Network
LIM	Line Interface Module
LME	Sublayer Management Entity
LSB	Least Significant Bit
LT	Line Terminal
MAC	Media Access Control
MCM	Multiple Carrier Modulation

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ME	Managed Entity
MIB	Management Information Base
MLME	MAC Layer Management Entity
MMPDU	MAC Management Protocol Data Unit
MPDU	MAC Protocol Data Unit
MSDU	MAC Service Data Unit
MSB	Most Significant Bit
MSDU	MAC Service Data Unit
MTU	Maximum Transmission Unit
NMS	Network Management System
NSCds	Number of Subcarrier – Downstream
NSCus	Number of Subcarrier – Upstream
NT	Network Terminal
OAN	Optical Access Network
ODN	Optical Distribution Network
OLT	Optical Line Terminal
OMCC	ONT Management and Control Channel
OMCI	ONT Management and Control Interface
ONT	Optical Network Terminal
ONU	Optical Network Unit
OpS	Operations System
PCF	Point Coordination Function
PHY	Physical Interface
PLCP	Physical Layer Convergence Protocol
PM	Performance Monitoring
PMD	Physical Medium Dependent
PMS-TC	Physical Media Specific – Transmission Convergence
PON	Passive Optical Network
POTS	Plain Old Telephone Service
PSD	Power Spectral Density
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RFI	Radio Frequency Interference
RM	Resource Management
RTS	Request To Send
SBR	Statistical Bit Rate

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SCM	Single Carrier Modulation
SDP	Simple Device Protocol
SDT	Structured Data Transfer
SES	Severely Errored Second
SIFS	Short Interframe Space
SME	Station Management Entity
SNI	Service Node Interface
SNR	Signal-to-Noise Ratio
SSCS	Service-Specific Convergence Sublayer
STA	Station
STB	Set Top Box
TC	Transmission Convergence
TCA	Threshold Crossing Alert
TCI	Tag Control Information
TE	Terminal Equipment
TPID	Tag Protocol Identifier
TU	Time Unit
UAS	Unavailable Seconds
UBR	Unspecified Bit Rate
UNI	User Network Interface
UPC	Usage Parameter Control
VBR	Variable Bit Rate
VC	Virtual Channel
VCC	Virtual Channel Connection
VCI	Virtual Channel Identifier
VDSL	Very High Speed DSL
VID	VLAN Identifier
VLAN	Virtual Local Area Network
VP	Virtual Path
VPC	Virtual Path Connection
VPI	Virtual Path Identifier
VRP	Video Return Path
VTU-O	VDSL Transceiver Unit, ONU end (a.k.a. VTU-C)
VTU-R	VDSL Transceiver Unit, Remote Terminal end
WEP	Wired Equivalent Privacy
WRR	Weighted Round Robin
xDSL	x Digital Subscriber Line

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4 Reference model and terms

4.1 OMCI in ITU-T Rec. G.983.1

The network architecture reference model for B-PON is described in ITU-T Rec. G.983.1 [3] and shown in Figure 1. The B-PON fits various access network architectures, i.e., Fibre to the Home (FTTH), Fibre to the Building/Curb (FTTB/C) and Fibre to the Cabinet (FTTCab).

The terminology of ONT, which will be used throughout this Recommendation, is more broadly defined as an ONU used for the FTTH and Fibre to the Business (FTTBusiness) configurations. In general, the differences between FTTH and FTTBusiness are that FTTBusiness will serve more than one end user, have stricter availability requirements, and be able to afford more features and functions than FTTH. Throughout the text, with the exception of the $ONT_{B\text{-}PON}$ Data managed entity description, the term ONT should generally be read as implying either ONT or ONU, whichever is appropriate for the particular instance.

The OMCI specification fits into the overall G.983.1 [3] model for an access network system as illustrated in Figure 1.

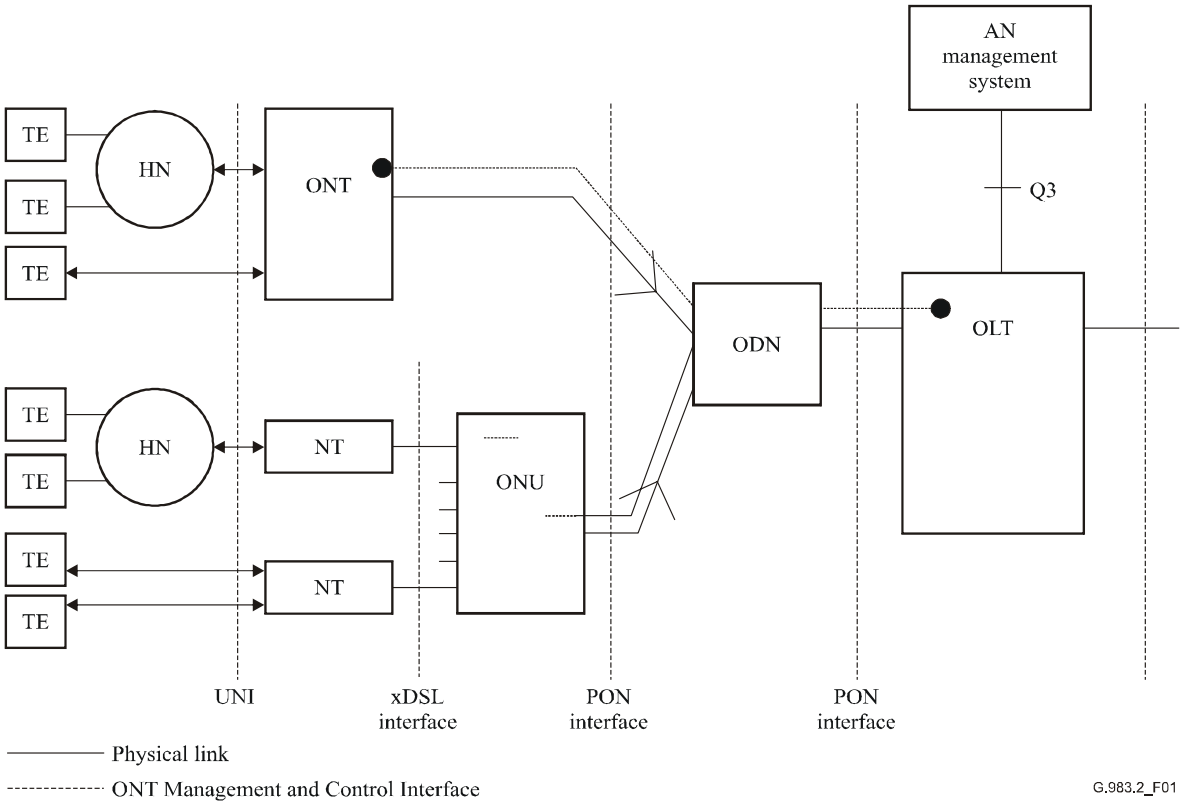


Figure 1/G.983.2 – Reference model

For protected B-PON systems, three reference logical models are possible. Protected models 1 and 2 correspond to protection architectures described in ITU-T Rec. G.983.5. Protected model 3 describes an additional protection scheme option.

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1) Protected reference model-1

In this model, the termination point of the OMCI is common between the working side and the protection side. The OMCI specifications specific to this arrangement are described in this Recommendation in 4.2.1, 7.2.3, and clause I.3.

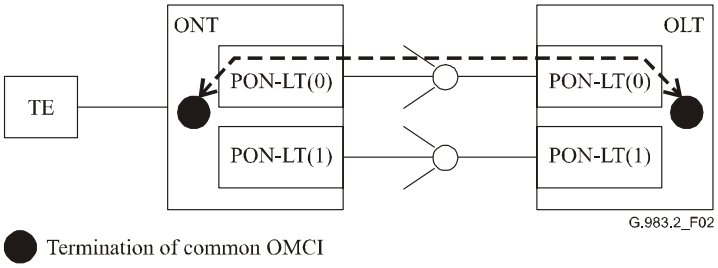


Figure 2/G.983.2 – Protected reference model-1

2) Reference model-2

In this model, the OMCI has two distinct termination points: one for the working side and one for the protection side. The OMCI specifications are the same as those in unprotected systems, as either OMCI connection is identical to that shown in Figure 1.

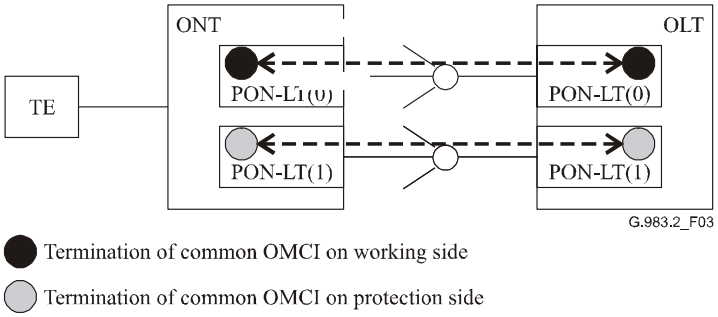


Figure 3/G.983.2 – Protected reference model-2

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3) Reference model-3

In this model, the OMCI has two distinct termination points: one for the working side and one for the protection side. In addition, this model includes separate ONTs for the working side and the protection side. The OMCI specifications for this model are the same as those for protected reference model 2.

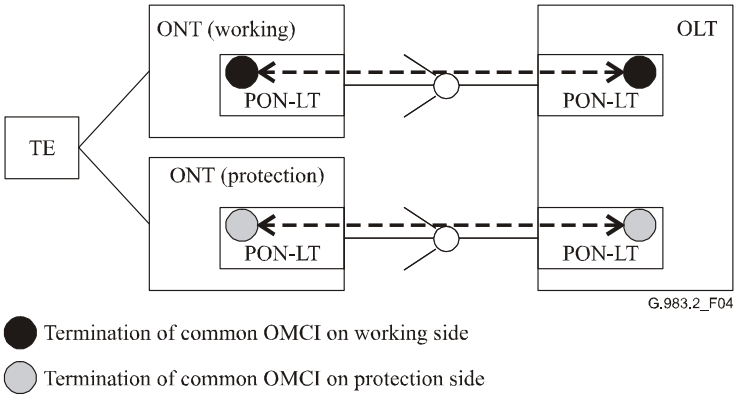


Figure 4/G.983.2 – Protected reference model-3

4.2 ONT functions

As shown in Figure 5, the functions of the ONT are:

a) access network line termination function (AN-LT);

b) user network interface line termination function (UNI-LT), noting that in the Fibre to the Business case the UNIs from one ONT may belong to different users;

c) ATM multiplexing and de-multiplexing function (ATM-Mux).

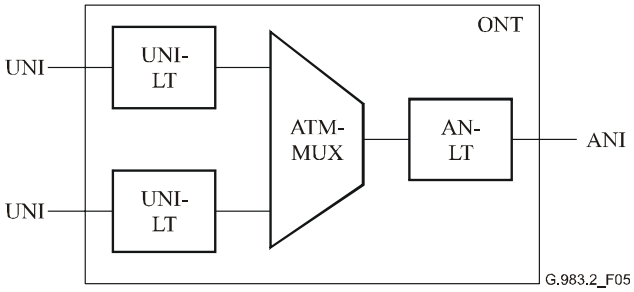


Figure 5/G.983.2 – ONT functional diagram

4.2.1 Protection switching modelling

According to ITU-T Rec. G.983.5, there are two types of protection architecture: 1+1 architecture and 1:1 architecture. Thus, two models can be considered when describing the relationship between ONT features and protection features.

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1) 1+1 model

Figure 6 shows a 1+1 model ONT. In this model, the traffic in the working entity and the traffic in the protection entity are the same. The TC Adaptor provides the same traffic to the working PON-LT and the protection PON-LT.

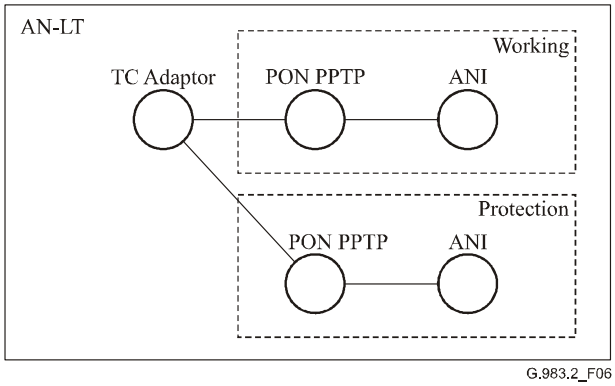


Figure 6/G.983.2 – 1+1 model ONT (ANI side)

2) 1:1 model

Figure 7 shows a 1:1 model ONT. In this model, extra traffic can be supported. The working entity conveys the traffic in normal operation. If the working entity has failed, or a forced switch/manual switch to the protection entity operation has been carried out, only the protection entity conveys the traffic. The TC Adaptor for normal traffic provides the traffic to the working PON-LT when the working PON-LT is enabled. The TC Adaptor for normal traffic provides the traffic to the protection entity when the working PON-LT is disabled. The TC Adaptor for extra traffic provides the extra traffic to the protection entity only when the working entity is enabled.

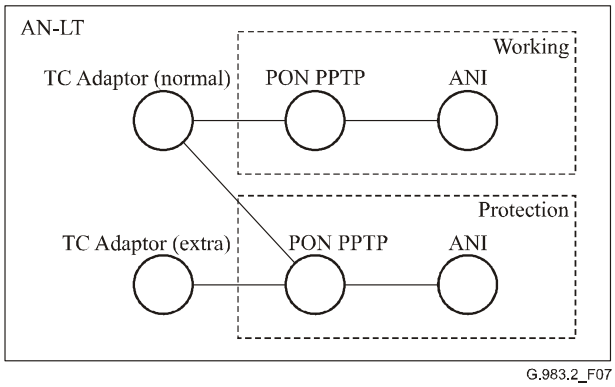


Figure 7/G.983.2 – 1:1 model ONT (ANI side)

4.2.2 Dynamic bandwidth assignment modelling

A T-CONT buffer managed entity is introduced in order to specify the DBA function. T-CONT buffer can contain Priority Queues and Traffic Schedulers and be associated with the TC Adapter. Two models are considered regarding the association between the T-CONT buffers and Priority Queues or Traffic Schedulers.

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In model 1, the Priority Queues, Traffic Schedulers and the T-CONT Buffers are inherently associated with each other in a fixed fashion. In model 2, the Priority Queues, Traffic Schedulers and T-CONT buffers can be associated flexibly. Figures 8 and 9 show the two models.

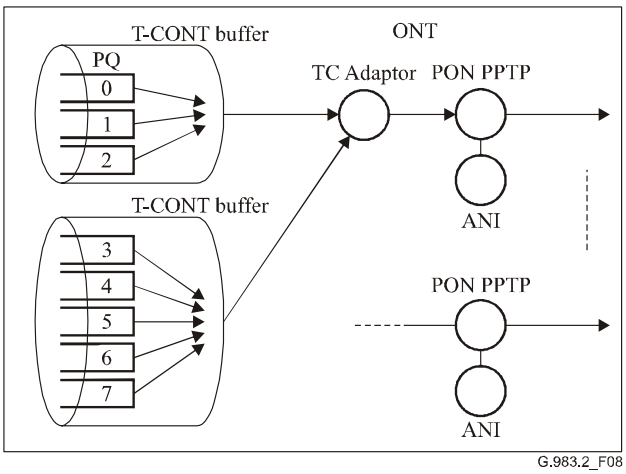


Figure 8/G.983.2 – ONT model 1

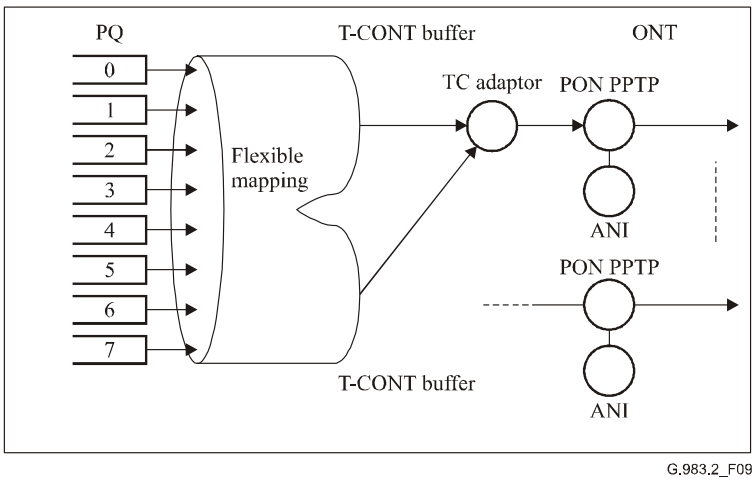


Figure 9/G.983.2 – ONT model 2

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The simplest and default configuration is for the Priority Queues and T-CONT buffers. This can guarantee the minimum delay of traffic assuming enough bandwidth is provided for the ONT. Optionally, one or more stages of WRR and/or HOL scheduling can be installed in order to guarantee minimum bandwidths, classes of services, and other traffic controls. A multi-stage Traffic Scheduler can be implemented as shown in Figure 10 as an example.

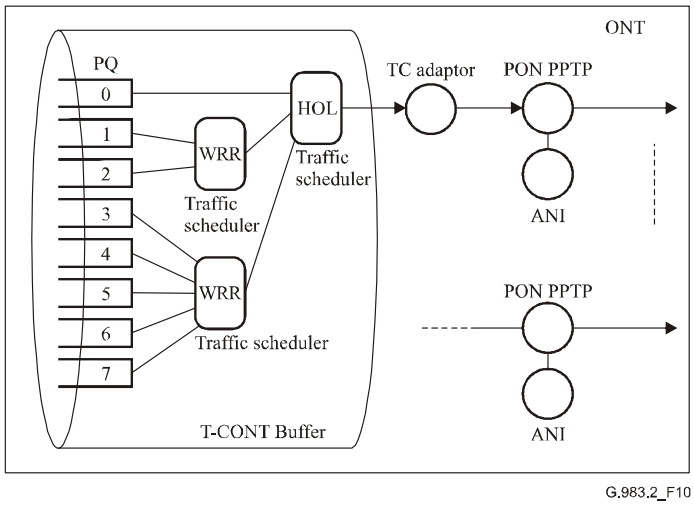


Figure 10/G.983.2 – ONT model with traffic scheduler

4.3 VP and VC Mux functionality in the ONT

In ITU-T Rec. G.983.1 [3], the end-to-end B-PON system (i.e., OLT, ODN and ONT) can function as an ATM VP cross-connection with both provisioned and on-demand connectivity. The configuration of the ATM VP Cross-Connection can be initiated by:

a) the network element operations system via the management interface (e.g., Q3);

b) the Service Node (SN) over a VB5.2 Broadband Bearer Connection Control (B-BCC) protocol.

The ONT, in contrast, always acts as a provisioned ATM multiplexer. The OMCI itself does not distinguish between these two cases, because the OLT always provisions the ONT connections via the OMCI. The OLT can, however, assign different priorities to OMCI messages such that, in the case of b), a fast response time of the OMCI is achieved.

The OLT and ONT as a whole can function as a VP as well as a VC switch. The ONT itself can cross-connect traffic at the VP level or the VC level, depending upon implementation. Additionally, this choice can be different for the ATM and non-ATM UNIs. This is more fully described in 5.1.

5 Requirements of the management interface specification

The OMCI is used by the OLT to control an ONT. This protocol allows the OLT to:

a) establish and release connections across the ONT;

b) manage the UNIs at the ONT;

c) request configuration information and performance statistics;

d) autonomously inform the system operator of events such as link failures.

The OMCI protocol runs across an ATM connection between the OLT controller and the ONT controller that is established at ONT initialization. The OMCI protocol is asymmetric: the controller

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in the OLT is the master and the one in the ONT is the slave. A single OLT controller using multiple instances of the protocol over separate control channels may control multiple ONTs.

The ONT management and control interface requirements given in this Recommendation are needed to manage the ONT in the following areas:

a) Configuration management;

b) Fault management;

c) Performance management;

d) Security management.

5.1 Configuration management

Configuration management provides functions to exercise control over, identify, collect data from and provide data to the ONT. This involves the following:

a) Configuration of equipment;

b) Configuration of the UNIs;

c) Configuration of the VP Network $CTP_{B\text{-}PON}$s and ATM Cross-Connections;

d) Configuration of Interworking VCC Termination Points (non-ATM UNIs only);

e) Configuration of the OAM flows;

f) Configuration of the physical ports;

g) Configuration of AAL profiles;

h) Configuration of service profiles;

i) Configuration of traffic descriptors;

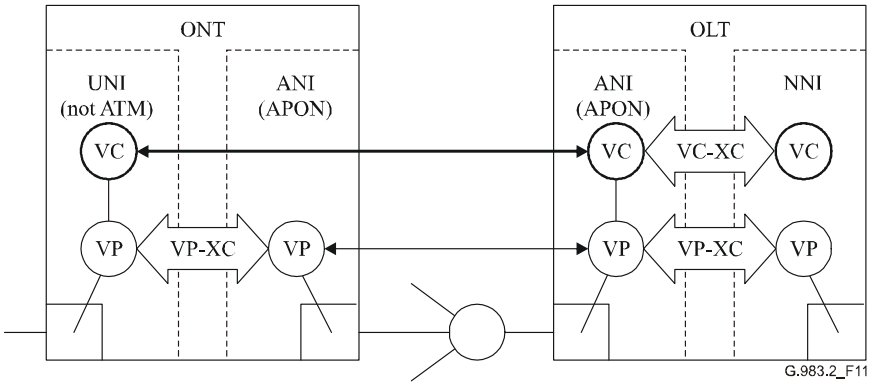
j) Configuration of T-CONT buffers and Traffic Schedulers.

The ONT can support various cross connect and non-cross connect modes at the VP and VC level.

In cases where the ONT provides standard ATM UNI services, the ONT typically supports VP cross-connection in order to free VPI values on the UNI (the VPI value on the ANI is not free because the same VPI value cannot be assigned to different ONTs due to the specification of ITU-T Rec. G.983.1, and VP cross-connection on the ONT resolves this limitation for the UNI).

In the case of non-ATM UNI services, the VC providing the service must be terminated. To represent this, the OMCI unifies the VC termination and interworking VCCTP into the Interworking VCC Termination Point ME. Figure 11 shows the termination model. For non-ATM LIMs, the aggregate of traffic parameters for the various VC terminations is represented by the Traffic Descriptor Profile Pointer associated with the VP Network CTP that contains the VC terminations.

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NOTE – VC represents unification of VCCTP and Interworking VCCTP.

Figure 11/G.983.2 – VP cross-connection termination model

For cases such as the support of ONUs with xDSL interfaces, it is generally necessary to implement VC cross-connections. VC cross-connection can be supported by the ONT/ONU, as indicated by the termination model shown in Figure 12.

For cases when the ONT provides no ATM interfaces, there are non-cross connected modes of operation that are available, in either the VP or VC level. However, the implementer may choose to use cross-connect modes even in this case.

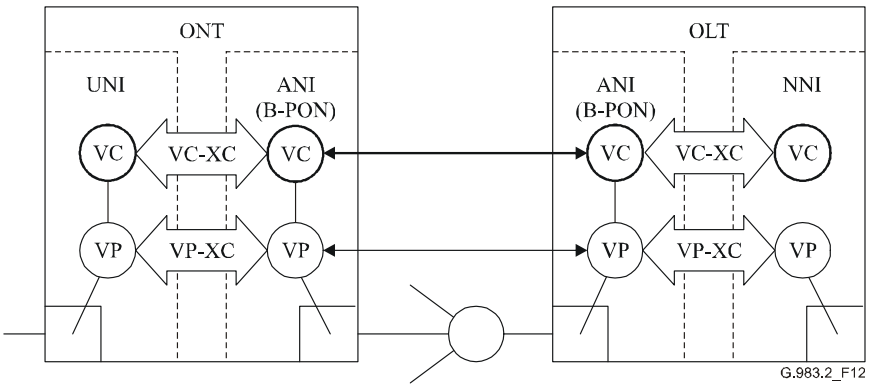


Figure 12/G.983.2 – VC cross-connection termination model

There are eight combinations of cross-connection modes for an ONT. These are listed in Table 0. Related to this, the ONT has two traffic management modes: Priority-based, or Cell Rate-based. An ONT implementer is free to choose any cross-connect and traffic management mode combination.

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Table 0/G.983.2 – Cross-connection modes for ONTs

Mode	ATM IF	non-ATM IF	
Value	ATM layer	Cross connection	ATM layer
0	VP	no	VP
1	VP	yes	VP
2	VP	yes	VC
3	VP	no	VC
4	VC	no	VP
5	VC	yes	VP
6	VC	yes	VC
7	VC	no	VC

5.2 Fault management

The ONT supports *limited* fault management only. Most of the operations are limited to failure indication. The OMCI supports failure reporting on the following managed entities that are described throughout clause 7:

a) $ONT_{B\text{-}PON}$;

b) Subscriber Line Cardholder;

c) Subscriber Line Card;

d) Physical Path Termination Point ATM UNI;

e) Physical Path Termination Point Ethernet UNI;

f) Physical Path Termination Point CES UNI;

g) TC $Adapter_{B\text{-}PON}$;

h) Interworking VCC Termination Point;

i) VP Network $CTP_{B\text{-}PON}$;

j) Physical Path Termination Point POTS UNI;

k) Physical Path Termination Point ADSL UNI;

l) Physical Path Termination Point VDSL UNI;

m) $ONU_{B\text{-}PON}$;

n) VC Network $CTP_{B\text{-}PON}$.

An alarm table is defined for each of these entities.

The ONT shall also support selective OAM cell loop-back testing at the UNI. The ONT diagnostics are limited to the ONT self test. The OLT or element manager will process the information from the ONT; for example, the OLT will determine the severity of each alarm when reporting it to the network operator. ATM management of continuity monitoring is not a part of this Recommendation (see [B-1] and ITU-T Rec. I.751 [9]).

5.3 Performance management

The ONT has only *limited* performance monitoring. For the low-cost FTTH ONT, the performance monitoring is limited to PMD and TC layer performance monitoring. However, for the FTTBusiness ONT, ATM cell level protocol monitoring, traffic management and UPC disagreement monitoring may be required. The following are related managed entities:

a) UPC Disagreement Monitoring History $Data_{B\text{-}PON}$;

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b) AAL 1 Protocol Monitoring History Data$_{B\text{-}PON}$;
c) AAL 5 Protocol Monitoring History Data$_{B\text{-}PON}$;
d) Ethernet Performance Monitoring History Data;
e) CES Physical Interface Monitoring History Data;
f) TC Adapter Protocol Monitoring History Data;
g) AAL 2 CPS Protocol Monitoring History Data$_{B\text{-}PON}$;
h) Priority Queue$_{B\text{-}PON}$;
i) MAC Bridge PM History Data;
j) MAC Bridge Port PM History Data;
k) Voice PM History Data;
l) VP PM History Data;
m) IP Router PM History Data 1;
n) IP Router PM History Data 2;
o) ICMP PM History Data 1;
p) ICMP PM History Data 2;
q) VC PM History Data;
r) Ethernet Performance Monitoring History Data 2;
s) IEEE 802.11 Counters;
t) ADSL ATU-C Performance Monitoring History Data;
u) ADSL ATU-R Performance Monitoring History Data;
v) ADSL ATU-C Channel Performance Monitoring History Data;
w) ADSL ATU-R Channel Performance Monitoring History Data;
x) TC Adaptor Performance Monitoring History Data ADSL;
y) VDSL VTU-O Physical Interface Monitoring History Data;
z) VDSL VTU-R Physical Interface Monitoring History Data;
z1) VDSL VTU-O Channel Performance Monitoring History Data;
z2) VDSL VTU-R Channel Performance Monitoring History Data;
z3) AAL 2 SSCS Protocol Monitoring History DataB-PON.

Note that it is not required to upload all the performance monitoring-related managed entities during the MIB upload (see 7.1.2). Furthermore, all PM objects are created at the request of the OLT.

All the history data shall be maintained in the OLT. ATM management of performance monitoring is not a part of this Recommendation (see [B-1] and ITU-T Rec. I.751 [9]).

5.4 Security management

There are no security features of the OMCI.

6 Protocol-independent MIB for the OMCI

The OMCI should be defined to allow vendors to offer modular, incremental capabilities to meet different levels of customer needs. This Recommendation first targets FTTH and FTTBusiness ONTs. It defines a protocol necessary to support capabilities identified by ITU-T Rec. G.983.1 [3]. It is important for early deployment and interoperability, yet it allows for optional components and future extensions.

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A protocol-independent MIB is used to describe the exchange of information across the OMCI and forms the basis from which protocol-specific models (e.g., Simple Device Protocol for the ONT) are defined. This MIB has as much commonality as possible with the related generic MIB as defined in other ITU-T Recommendations. It is intended to make the OMCI relatively simple while maintaining consistency with the MIB used by the interface between the network-element manager and the OLT.

6.1 Managed entities

The protocol-independent MIB presented in this Recommendation has been defined in terms of *managed entities*. The managed entities are abstract representations of resources and services in an ONT.

This Recommendation uses three levels for indicating the degree of compliance necessary for specific functions and managed entities associated with the OMCI specification:

- **Requirement (R)**: Entities necessary for operational compatibility;
- **Conditional Requirements (CR)**: Entities necessary when the specified optional function is implemented;
- **Option (O)**: Entities that may be useful and required by an operator but that are not necessary for operational compatibility.

The possible managed entities are listed in Table 1.

Table 1/G.983.2 – Managed entities in the OMCI

Managed entity	Required/ Optional	Description	Defined in clause
802.1p Mapper Service Profile	O	Used to define mapping of 802.1 frames to VCC TPs based on 802.1p priority bits	7.3.95
802.11 Counters	O	Used for IEEE 802.11 interface supported by the ONT	7.3.61
802.11 General Purpose Object	CR	Used for IEEE 802.11 interface supported by the ONT	7.3.59
802.11 MAC&PHY Operation and Antenna Data	CR	Used for IEEE 802.11 interface supported by the ONT	7.3.60
802.11 PHY FHSS DSSS IR Tables	O	Used for IEEE 802.11 interface supported by the ONT	7.3.62
802.11 Station Management data 1	CR	Used for IEEE 802.11 interface supported by the ONT	7.3.57
802.11 Station Management data 2	CR	Used for IEEE 802.11 interface supported by the ONT	7.3.58
802.1p Mapper Service Profile	CR	Used for 802.1p Priority Mapping of data interfaces	7.3.95
AAL 1 $Profile_{B\text{-}PON}$	CR	Used when the ONT supports CES UNIs	7.3.8
AAL 1 Protocol Monitoring History $Data_{B\text{-}PON}$	O	Used when AAL 1 layer performance monitoring is supported	7.3.9
AAL 2 CPS Protocol Monitoring History $Data_{B\text{-}PON}$	O	Used when AAL 2 layer performance monitoring is supported	7.3.20
AAL 2 $Profile_{B\text{-}PON}$	CR	Used when the ONT supports AAL 2	7.3.18
AAL 2 PVC $Profile_{B\text{-}PON}$	CR	Used when the ONT supports AAL 2 PVC	7.3.19

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Table 1/G.983.2 – Managed entities in the OMCI

Managed entity	Required/ Optional	Description	Defined in clause
AAL 2 SSCS Parameter Profile 1	CR	Used when the ONT supports AAL 2 SSCS	7.3.22
AAL 2 SSCS Parameter Profile 2	CR	Used when the ONT supports AAL 2 SSCS	7.3.23
AAL 2 SSCS Protocol Monitoring History Data$_{B\text{-}PON}$	CR	Used when AAL 2 layer performance monitoring is supported	7.3.21
AAL 5 Profile$_{B\text{-}PON}$	CR	Used when the ONT supports LAN UNIs	7.3.10
AAL 5 Protocol Monitoring History Data$_{B\text{-}PON}$	O	Used when AAL 5 layer performance monitoring is supported	7.3.11
ADSL ATU-C Channel Performance Monitoring History Data	O	Performance monitoring data for an ADSL ATU-C channel	7.3.79
ADSL ATU-C Performance Monitoring History Data	O	Performance monitoring data for an ADSL ATU-C modem Path	7.3.77
ADSL ATU-R Channel Performance Monitoring History Data	O	Performance monitoring data for an ADSL ATU-R Channel	7.3.80
ADSL ATU-R Performance Monitoring History Data	O	Performance monitoring data for an ADSL ATU-R modem path	7.3.78
ADSL Channel Configuration Profile	CR	Contains Configuration for a Channel	7.3.72
ADSL Channel Downstream Status Data	CR	Contains status on the Downstream Channel	7.3.67
ADSL Channel Upstream Status Data	CR	Contains status on the Upstream Channel	7.3.68
ADSL Downstream PSD Mask Profile	CR	Contains Masking information for the Downstream PSD	7.3.75
ADSL Downstream RFI Bands Profile	CR	Contains information on the Downstream RFI Bands	7.3.76
ADSL Line Configuration Profile Part 1	CR	Contains the Line Parameters for an ADSL line	7.3.69
ADSL Line Configuration Profile Part 2	CR	Contains the Line Parameters for an ADSL line	7.3.70
ADSL Line Configuration Profile Part 3	CR	Contains the Line Parameters for an ADSL line	7.3.71
ADSL Line Inventory and Status Data Part 1	CR	Contains the inventory and status information on the ADSL Line	7.3.65
ADSL Line Inventory and Status Data Part 2	CR	Contains the inventory and status information on the ADSL Line	7.3.66
ADSL Subcarrier Masking Downstream Profile	CR	Contains masking information for the Downstream subcarriers	7.3.73
ADSL Subcarrier Masking Upstream Profile	CR	Contains masking information for the Upstream subcarriers	7.3.74

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Table 1/G.983.2 – Managed entities in the OMCI

Managed entity	Required/ Optional	Description	Defined in clause
ANI	O	PON IF, description purposes only, see clause 7.2 (ANI Management)	7.2.2
ARP Configuration Data	CR	Used for IP Port supported by the ONT	7.3.47
ARP Service Profile	CR	Used for IP Port supported by the ONT	7.3.46
ATM VC Cross-Connection	O	Used for VC multiplexing with VCI translation in the ONU	7.4.5
ATM VP Cross-Connection	CR	Used for VP multiplexing with VPI translation in the ONT	7.4.2
CES Physical Interface Monitoring History Data	O	Used for the CES interface performance monitoring	7.3.15
CES Service Profile$_{B\text{-}PON}$	CR	Used for CES services supported by the ONT	7.3.12
Ethernet Performance Monitoring History Data	O	Used for Ethernet interface performance monitoring	7.3.14
Ethernet Performance Monitoring History Data 2	O	Used for Ethernet performance monitoring	7.3.55
ICMP PM History Data 1	O	Used for ICMP performance monitoring	7.3.42
ICMP PM History Data 2	O	Used for ICMP performance monitoring	7.3.43
Interworking VCC Termination Point	CR	Used for non-ATM UNIs	7.3.7
IP Port Configuration Data	CR	Used for IP Port supported by the ONT	7.3.37
IP Route Table	CR	Used for IP Router supported by the ONT	7.3.44
IP Router Configuration Data	CR	Used for IP Router supported by the ONT	7.3.39
IP Router PM History Data 1	O	Used for IP Router performance monitoring	7.3.40
IP Router PM History Data 2	O	Used for IP Router performance monitoring	7.3.41
IP Router Service Profile	CR	Used for IP Router supported by the ONT	7.3.38
IP Static Routes	CR	Used for IP Router supported by the ONT	7.3.45
LES Service Profile	CR	Used for LES services supported by the ONT	7.3.25
Logical N × 64 kbit/s Sub-port ConnectionTermination Point	CR	Used as logical interface for structured CES	7.3.4
MAC Bridge Configuration Data	CR	Used for MAC bridge supported by the ONT	7.3.30
MAC Bridge PM History Data	O	Used for MAC bridge performance monitoring	7.3.35
MAC Bridge Port Bridge Table Data	CR	Used for MAC bridge supported by the ONT	7.3.34
MAC Bridge Port Configuration Data	CR	Used for MAC bridge supported by the ONT	7.3.31
MAC Bridge Port Designation Data	CR	Used for MAC bridge supported by the ONT	7.3.32

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Table 1/G.983.2 – Managed entities in the OMCI

Managed entity	Required/ Optional	Description	Defined in clause
MAC Bridge Port Filter Preassign Table	O	Used for Ether type filtering	7.3.51
MAC Bridge Port Filter Table Data	CR	Used for MAC bridge supported by the ONT	7.3.33
MAC Bridge Port PM History Data	O	Used for MAC bridge port performance monitoring	7.3.36
MAC Bridge Service Profile	CR	Used for MAC bridge supported by the ONT	7.3.29
Multicast Interworking VCC Termination Point	CR	Used to manage multicasting support	7.3.97
$OLT_{B\text{-}PON}$	O	Used for OLT identification for interoperability facilitation	7.3.96
ONT Data	R	Used for OMCI MIB management	7.1.2
$ONT_{B\text{-}PON}$	R	Used for ONT equipment management	7.1.1
$ONU_{B\text{-}PON}$	O	Used for ONU equipment management	7.1.8
Physical Path Termination Point 802.11 UNI	CR	Used for IEEE 802.11 interface supported by the ONT	7.3.56
Physical Path Termination Point ADSL UNI Part 1	CR	Used for the physical path termination point at an ADSL CO modem	7.3.63
Physical Path Termination Point ADSL UNI Part 2	CR	Used for the physical path termination point at an ADSL CO modem	7.3.64
Physical Path Termination Point ATM UNI	CR	Used for physical path termination point at the ATM UNI	7.3.1
Physical Path Termination Point CES UNI	CR	Used for physical path termination point at the CES UNI	7.3.3
Physical Path Termination Point Ethernet UNI	CR	Used for physical path termination point at the Ethernet UNI	7.3.2
Physical Path Termination Point ISDN UNI	O	Used for ISDN port supported by the ONT	7.3.48
Physical Path Termination Point LCT UNI	O	Used for local craft terminal port	7.3.54
Physical Path Termination Point POTS UNI	CR	Used for physical path trail termination point at the POTS UNI	7.3.26
Physical Path Termination Point VDSL UNI	CR	Used for the physical path termination point at a VDSL connection	7.3.82
Physical Path Termination Point Video ANI	O	Used for video input port	7.3.53
Physical Path Termination Point Video UNI	O	Used for video port	7.3.52
PON IF Line Card	CR	Used for the PON line card plug-in, only used if PON interface is implemented on a plug-in unit	7.1.6

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Table 1/G.983.2 – Managed entities in the OMCI

Managed entity	Required/ Optional	Description	Defined in clause
PON IF Line Cardholder	CR	Used for the PON line card plug-in slot, only used if PON interface is implemented on a plug-in unit	7.1.5
PON Physical Path Termination Point	O	Used for physical path at the ANI, description purpose only, see 7.2 (ANI Management)	7.2.1
PON TC Adapter	O	Used for TC layer at PON interface, description purpose only, see 7.2 (ANI Management)	7.2.3
Priority Queue$_{B\text{-}PON}$	CR	Used for ONTs that support priority queues to multiplex ATM traffic flows	7.5.1
Software Image	R	Used for the software image of the ONT. Software image for the subscriber line cards is optional	7.1.7
Subscriber Line Card	CR (Note)	Used for the UNI line card plug-in	7.1.4
Subscriber Line Cardholder	CR (Note)	Used for the UNI line card plug-in slot	7.1.3
TC Adapter Protocol Monitoring History Data	O	Used when TC layer performance monitoring is supported	7.3.16
TC Adapter$_{B\text{-}PON}$	CR	Used for TC layer at the UNI side for the ATM UNI	7.3.6
TC Adaptor Performance Monitoring History Data ADSL	O	Performance monitoring data for the ADSL ATM Data Path	7.3.81
T-CONT Buffer	CR	Used when one or more T-CONT buffers are supported.	7.2.4
Threshold Data$_{B\text{-}PON}$	CR	Used for the set-up of threshold values	7.3.17
Traffic Descriptors	CR	Used for the ONT that supports traffic shaper to specify ATM layer traffic characteristics in the case of accommodation of non-ATM UNI. Moreover, in the case of accommodation of ATM UNI, Traffic Descriptors may be used for the UPC function in the ONT, if it is required.	7.5.2
Traffic Scheduler	CR	Used when Traffic Scheduler is used.	7.5.5
UNI$_{B\text{-}PON}$	R	User network interface	7.3.5
UPC Disagreement Monitoring History Data$_{B\text{-}PON}$	CR	Used for the ONT that supports UPC	7.5.4
VC Network CTP$_{B\text{-}PON}$	O	Used for VC link termination in the VC MUX	7.4.4
VC PM History Data	O	Used for VC performance monitoring	7.4.6
VDSL Band Plan Configuration Profile	CR	Parameters used to configure a VDSL Band Plan Configuration Profile.	7.3.88
VDSL Channel Configuration Profile	CR	Parameters used to configure a VDSL Channel Configuration Profile	7.3.87

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Table 1/G.983.2 – Managed entities in the OMCI

Managed entity	Required/ Optional	Description	Defined in clause
VDSL Channel Data	CR	Contains the Channel Parameters for VDSL Fast and Slow channels	7.3.85
VDSL Line Configuration Profile	CR	Parameters used to configure a VDSL Line Configuration Profile	7.3.86
VDSL VTU-O Channel Performance Monitoring History Data	O	Performance monitoring data for a VDSL VTU-O channel	7.3.91
VDSL VTU-O Physical Data	CR	Contains the Physical Layer Parameters for a VTU-O	7.3.83
VDSL VTU-O Physical Interface Monitoring History Data	O	Monitoring Data for a VDSL VTU-O Physical Interface	7.3.89
VDSL VTU-R Channel Performance Monitoring History Data	O	Performance monitoring data for an VDSL VTU-R channel	7.3.92
VDSL VTU-R Physical Data	CR	Contains the Physical Layer Parameters for a VTU-R	7.3.84
VDSL VTU-R Physical Interface Monitoring History Data	O	Monitoring Data for a VDSL VTU-R Physical Interface	7.3.90
Video Return Path Service Profile	CR	Used for Video Return Path service	7.3.93
Video Return Path Statistics	O	Used for Video Return Path service	7.3.94
VLAN Tagging Filter Data	O	Used for VLAN tagging	7.3.50
VLAN Tagging Operation Configuration Data	O	Used for VLAN tagging	7.3.49
Voice CTP	CR	Used for Voice termination point supported by the ONT	7.3.27
Voice PM History Data	O	Used for voice performance monitoring	7.3.28
Voice Service Profile AAL	CR	Used for AAL Voice services supported by the ONT	7.3.24
VP Network $CTP_{B\text{-}PON}$	R	Used for the VP link termination in the VP Mux	7.4.1
VP PM History Data	O	Used for VP performance monitoring	7.4.3
NOTE – The preferred solution is that the Subscriber Line Card and Subscriber Line Cardholder managed entities should always be modelled, regardless of whether or not the ONT has integrated interfaces; however, for reasons of backward compatibility, these managed entities remain as "CR."			

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6.2 Managed entity relation diagrams

The relationships between the required managed entities are given in Figures 13 to 31. Figure 13 gives the legend of symbols used in these diagrams. Note that the Threshold $Data_{B\text{-}PON}$ managed entity may be associated with any managed entity that has thresholded counters. This is indicated by a special symbol to reduce congestion on the figures. Also note that several managed entities in the figures are optional or conditionally required; hence, they may not be used in some implementations.

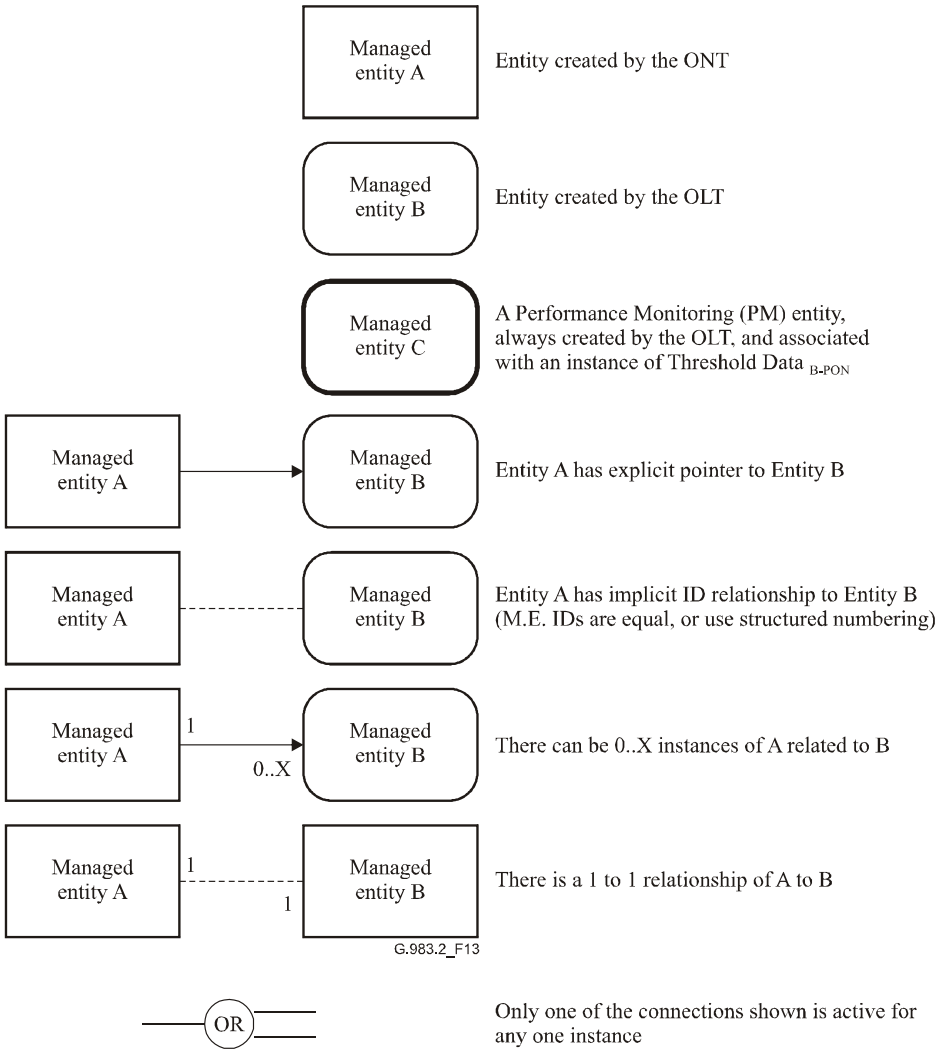


Figure 13/G.983.2 – Legend for managed entity relation diagrams

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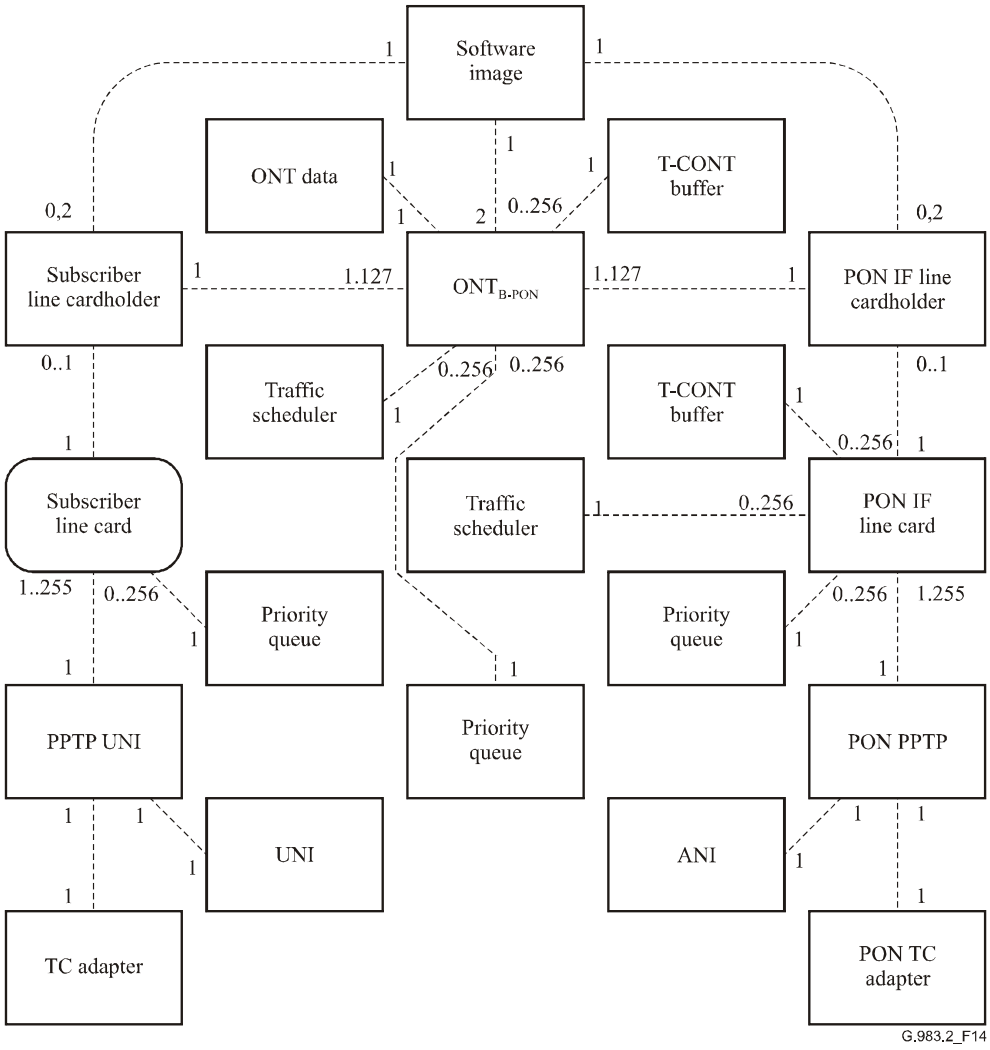


Figure 14/G.983.2 – Managed entity relation diagram for non-integrated interfaces

NOTE – Physical Path Termination Point refers to any/all actual physical trails (CES, Ethernet, ATM, etc.). However, the relationship between Physical Path Termination Point and TC Adapter$_{B\text{-}PON}$ is only applied for Physical Path Termination Point ATM UNI.

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Figure 14 shows an ONT with cardholders on both UNI and ANI side (an ONT with integrated interfaces on the UNI and/or ANI side can be modelled by Figure 14 as well, since integrated interfaces use "pseudo" Subscriber Line Cards and Cardholders). Note that extensions of Figure 14 are possible as well, e.g., an ONT with several Subscriber Line Cardholders on the UNI side and one integrated PON interface.

As for the ATM functions, there are 12 possible models allowed for ONTs: with four models for the ATM interfaces, and eight models for the non-ATM interfaces. The six VP models are illustrated in Figures 15 to 20. It should be noted that in each diagram, the term "VP" can be replaced with "VC", to produce the VC model.

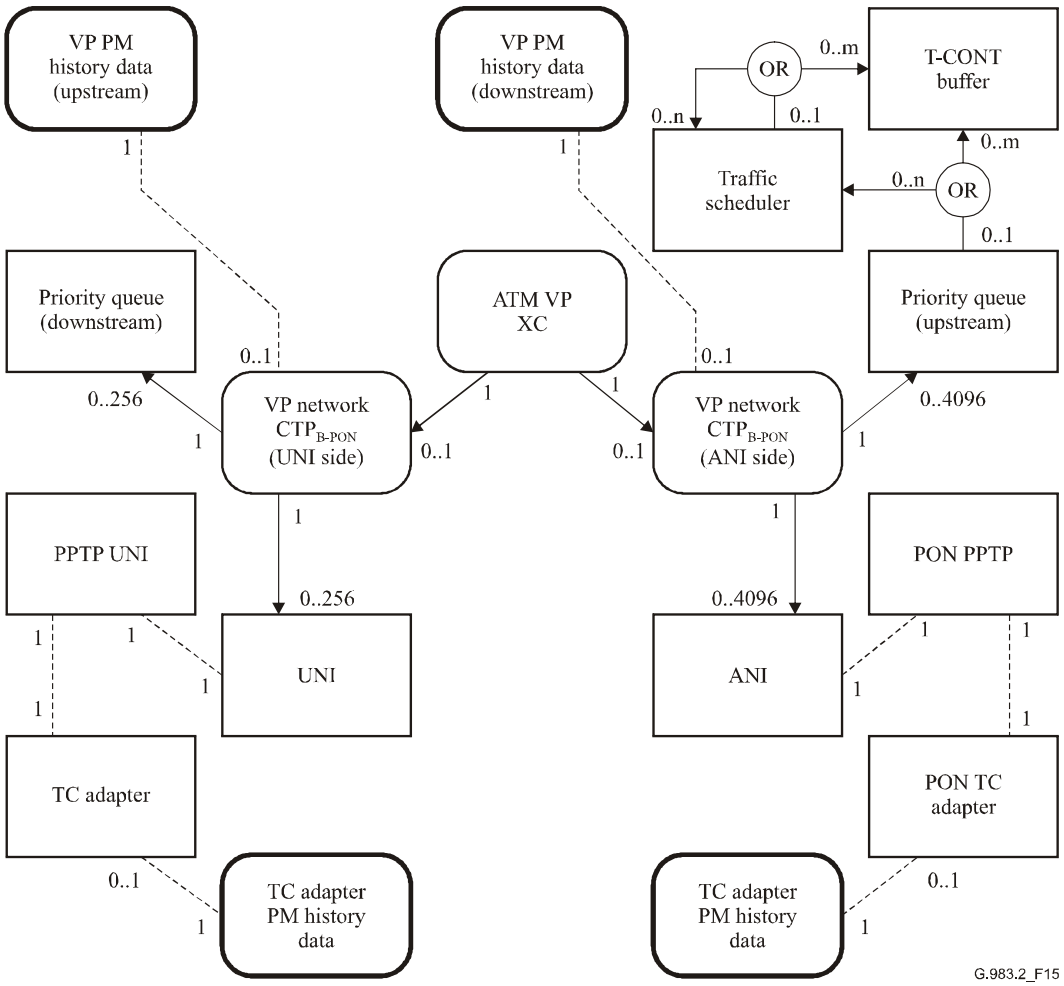


Figure 15/G.983.2 – Managed entity relation diagram for ATM interfaces with VP level cross-connections and priority queue-based traffic management

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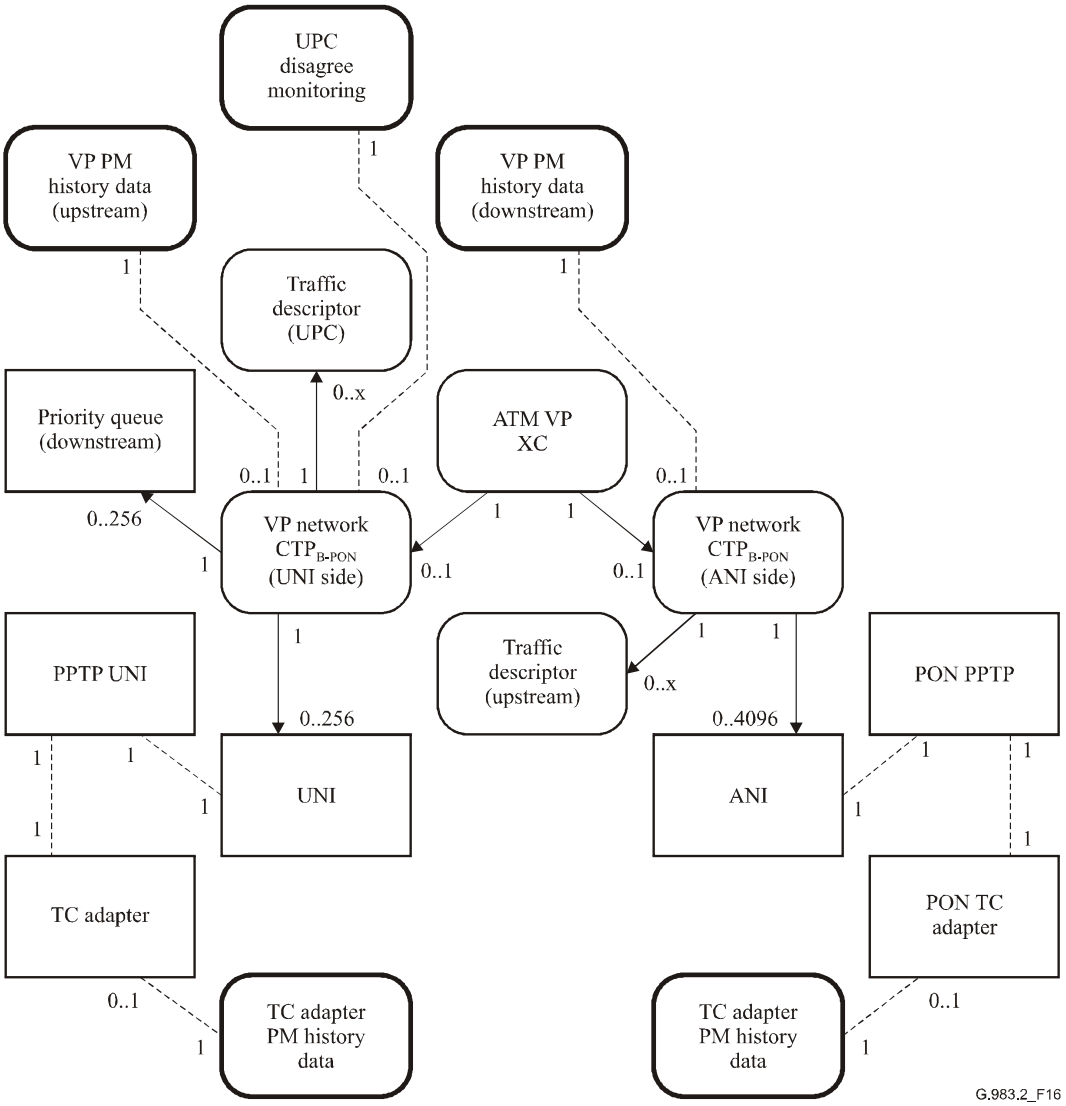


Figure 16/G.983.2 – Managed entity relation diagram for ATM interfaces with VP level cross-connections and cell rate-based traffic management

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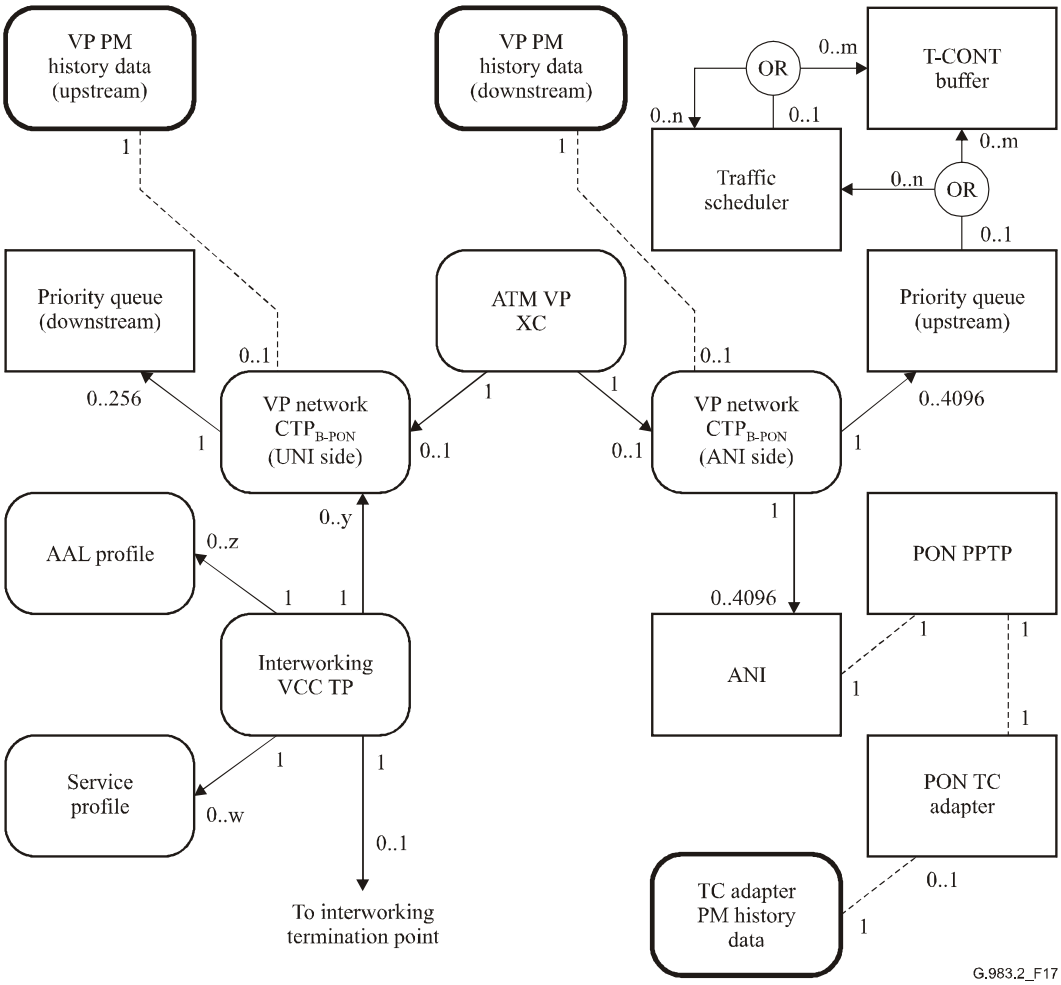


Figure 17/G.983.2 – Managed entity relation diagram for non-ATM interfaces with VP level cross-connections and priority queue-based traffic management

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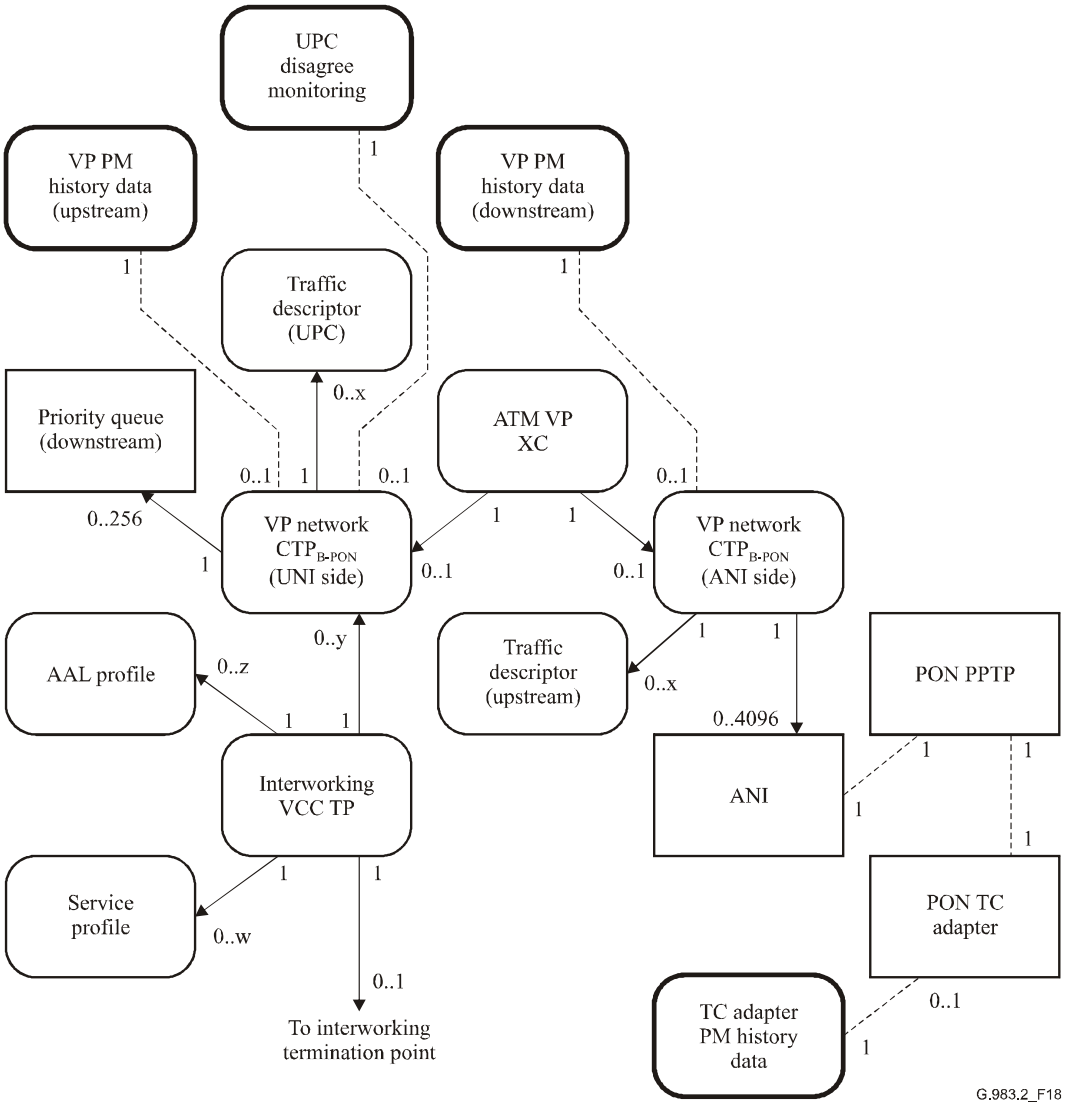


Figure 18/G.983.2 – Managed entity relation diagram for non-ATM interfaces with VP level cross-connections and cell rate-based traffic management

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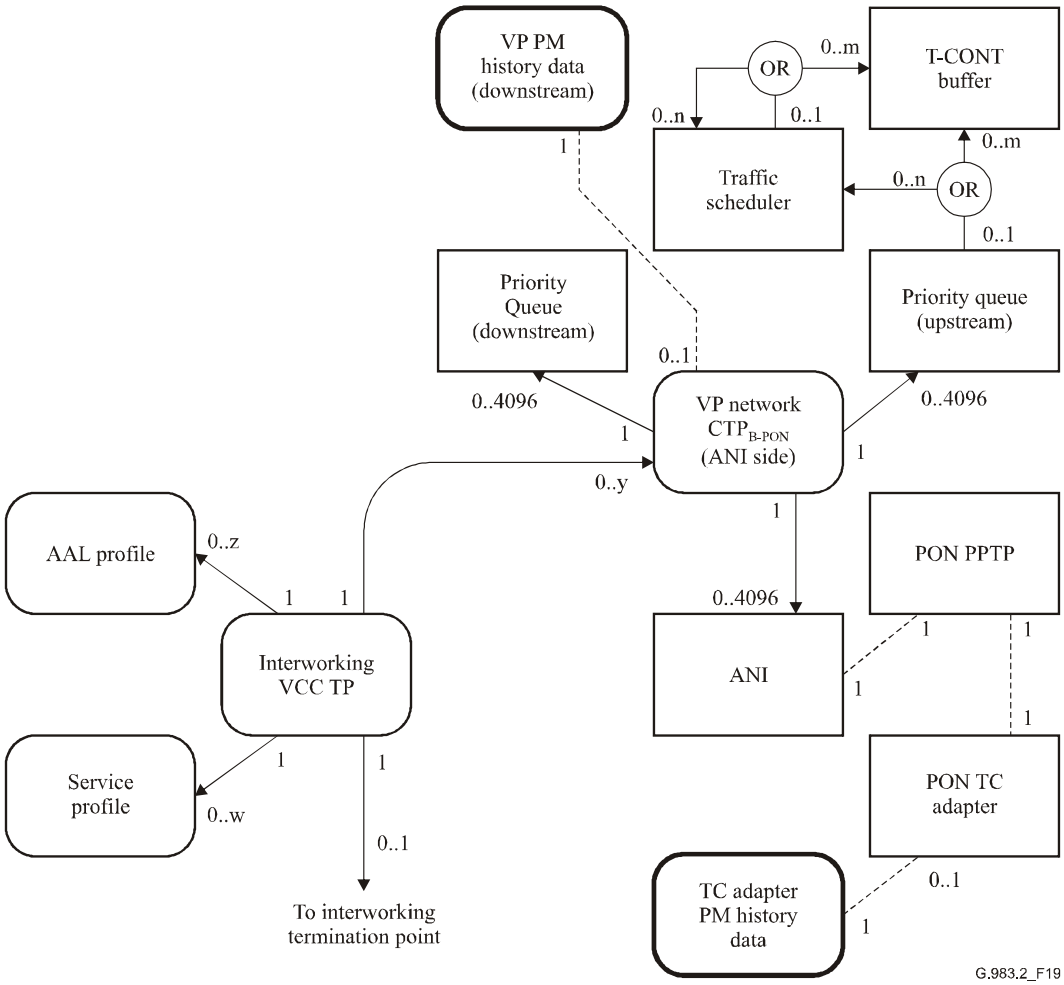


Figure 19/G.983.2 – Managed entity relation diagram for non-ATM interfaces with VP level non-cross-connect and priority queue-based traffic management

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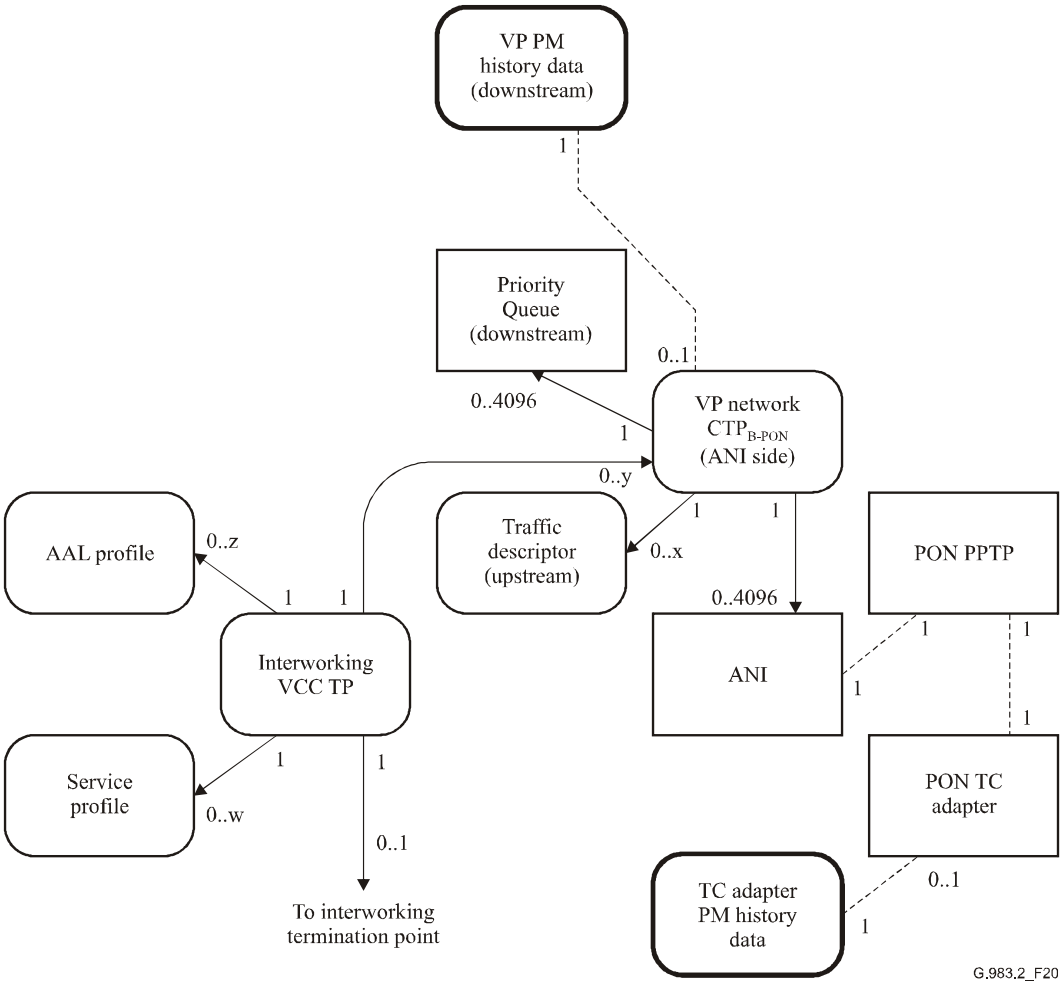


Figure 20/G.983.2 – Managed entity relation diagram for non-ATM interfaces with VP level non-cross-connect and cell rate-based traffic management

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Figures 21 to 31 show the relation diagrams for the non-ATM interfaces supported to date in the OMCI. Please note that the Interworking VCC TP managed entity is common between Figures 17 to 20 and between Figures 21 to 31. The diagrams are partitioned in this way for brevity and clarity.

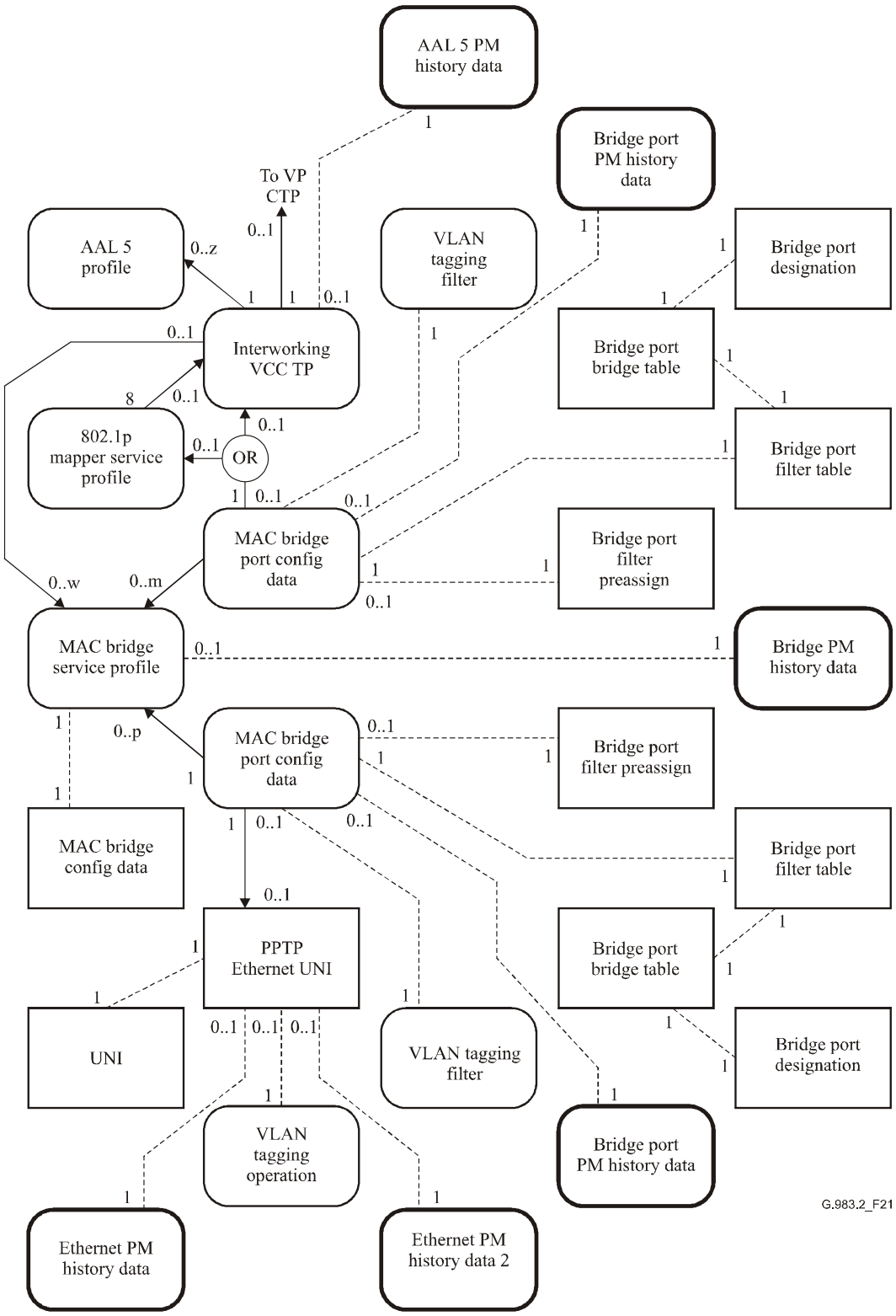


Figure 21/G.983.2 – Managed entity relation diagram for MAC Bridged LAN interfaces

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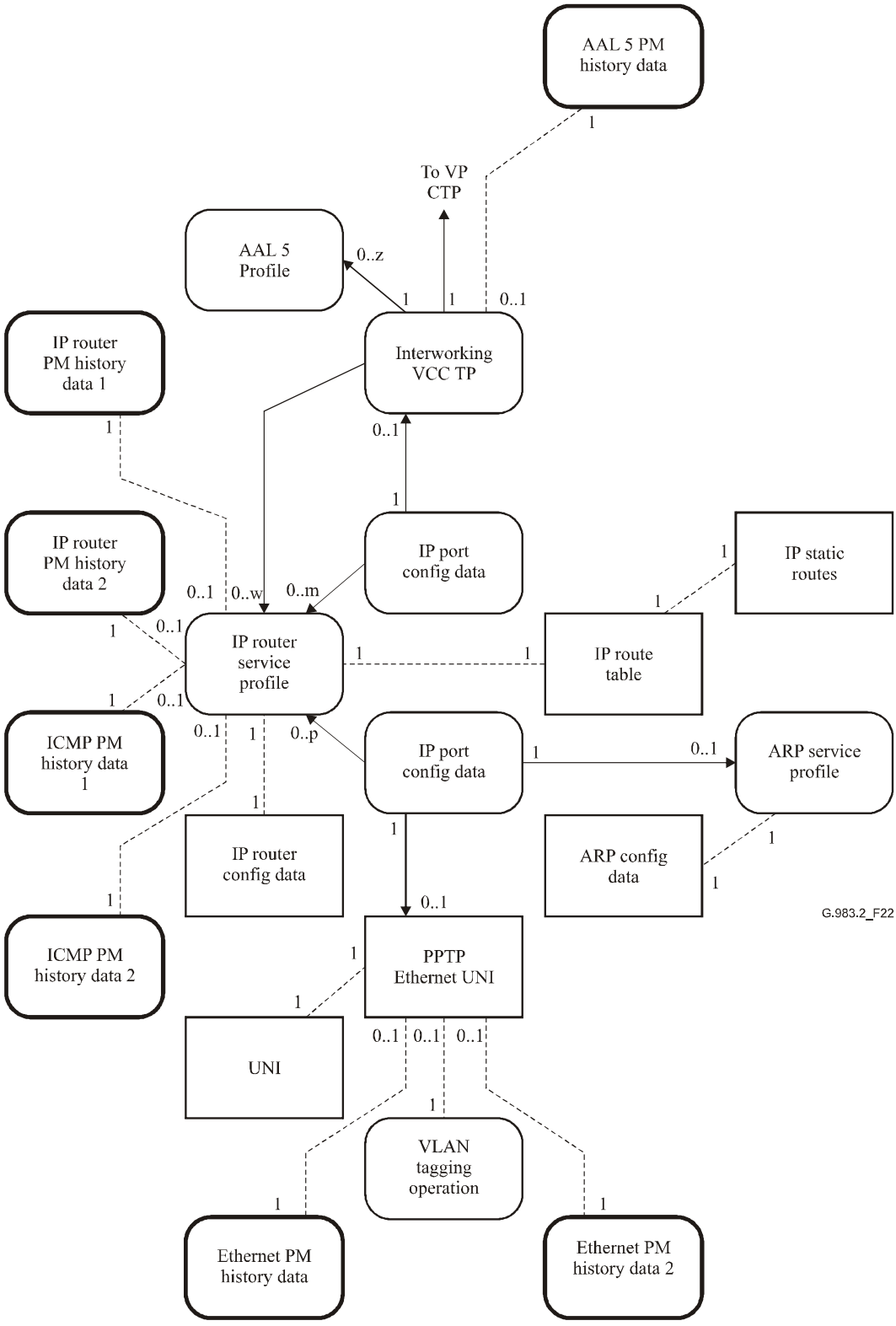


Figure 22/G.983.2 – Managed entity relation diagram for IP router interfaces

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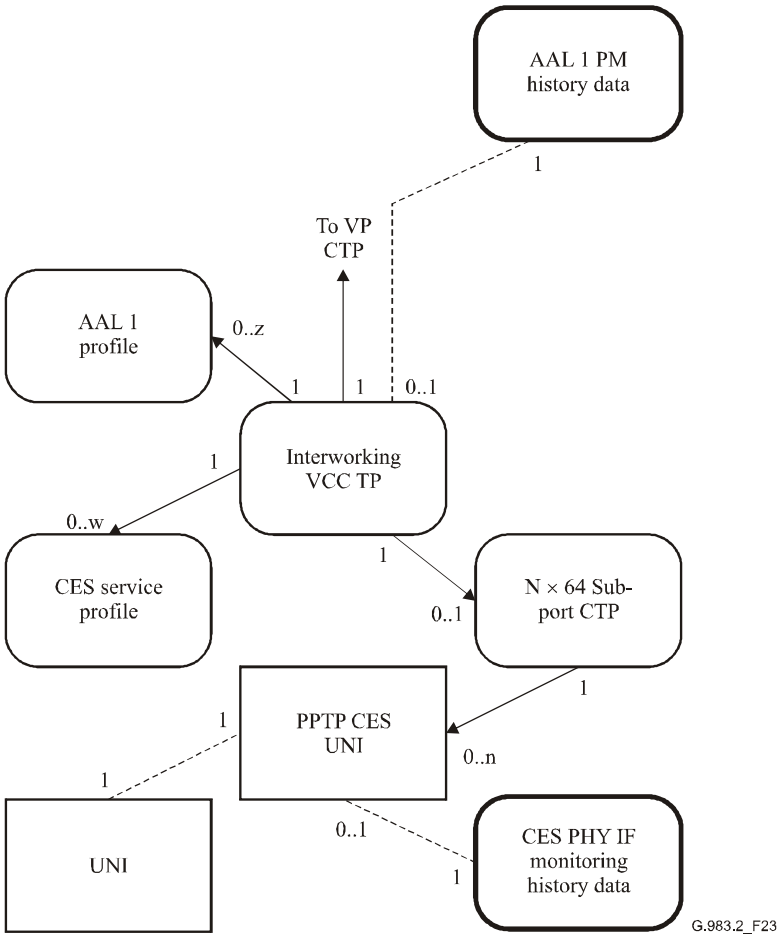


Figure 23/G.983.2 – Managed entity relation diagram for structured CES interfaces

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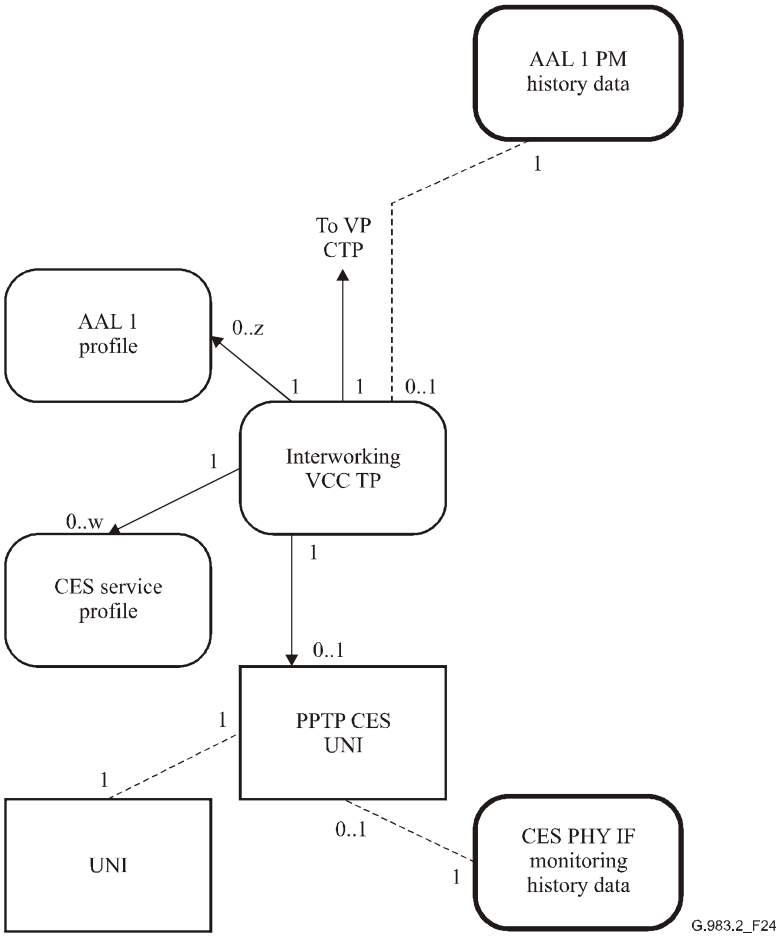


Figure 24/G.983.2 – Managed entity relation diagram for unstructured CES interfaces

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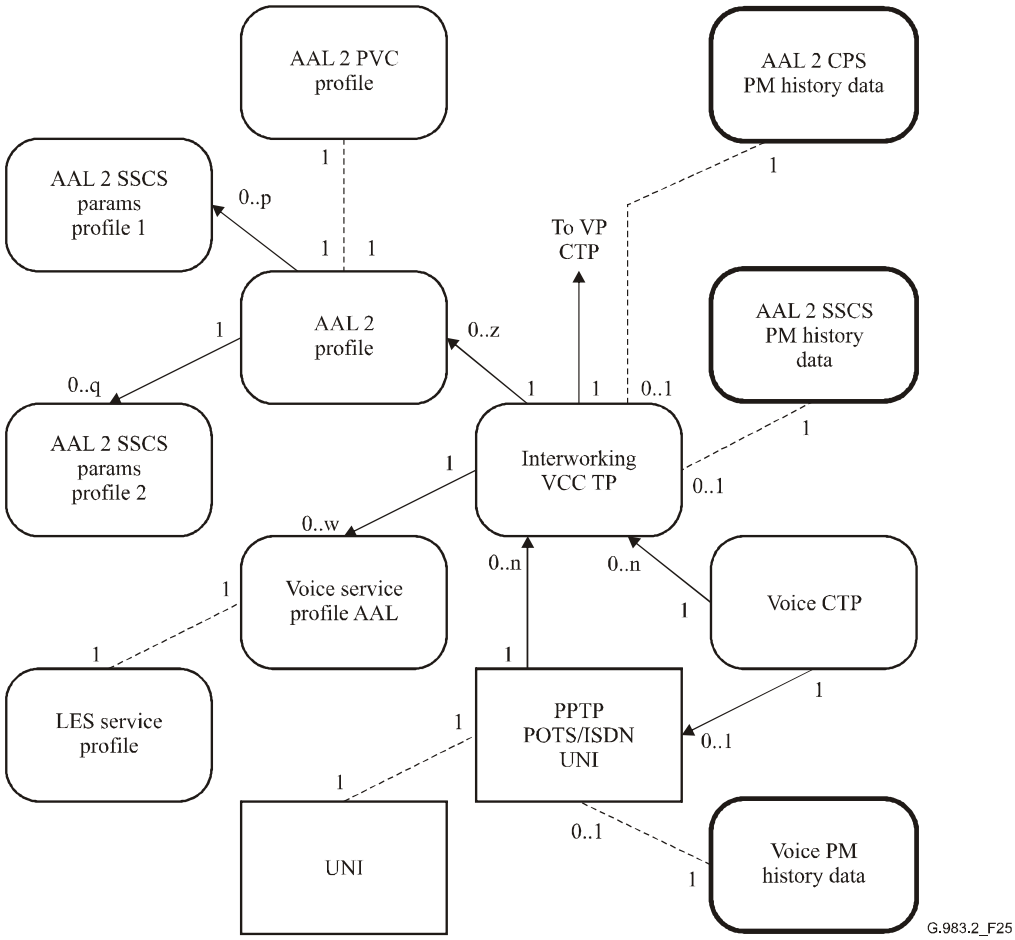


Figure 25/G.983.2 – Managed entity relation diagram for AAL 2-based voice interfaces

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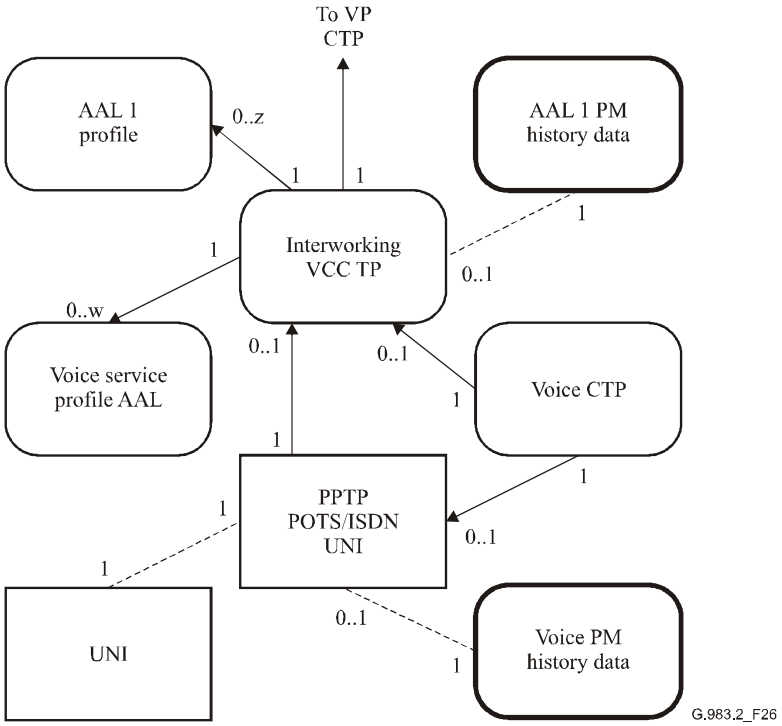


Figure 26/G.983.2 – Managed entity relation diagram for AAL 1-based voice interfaces

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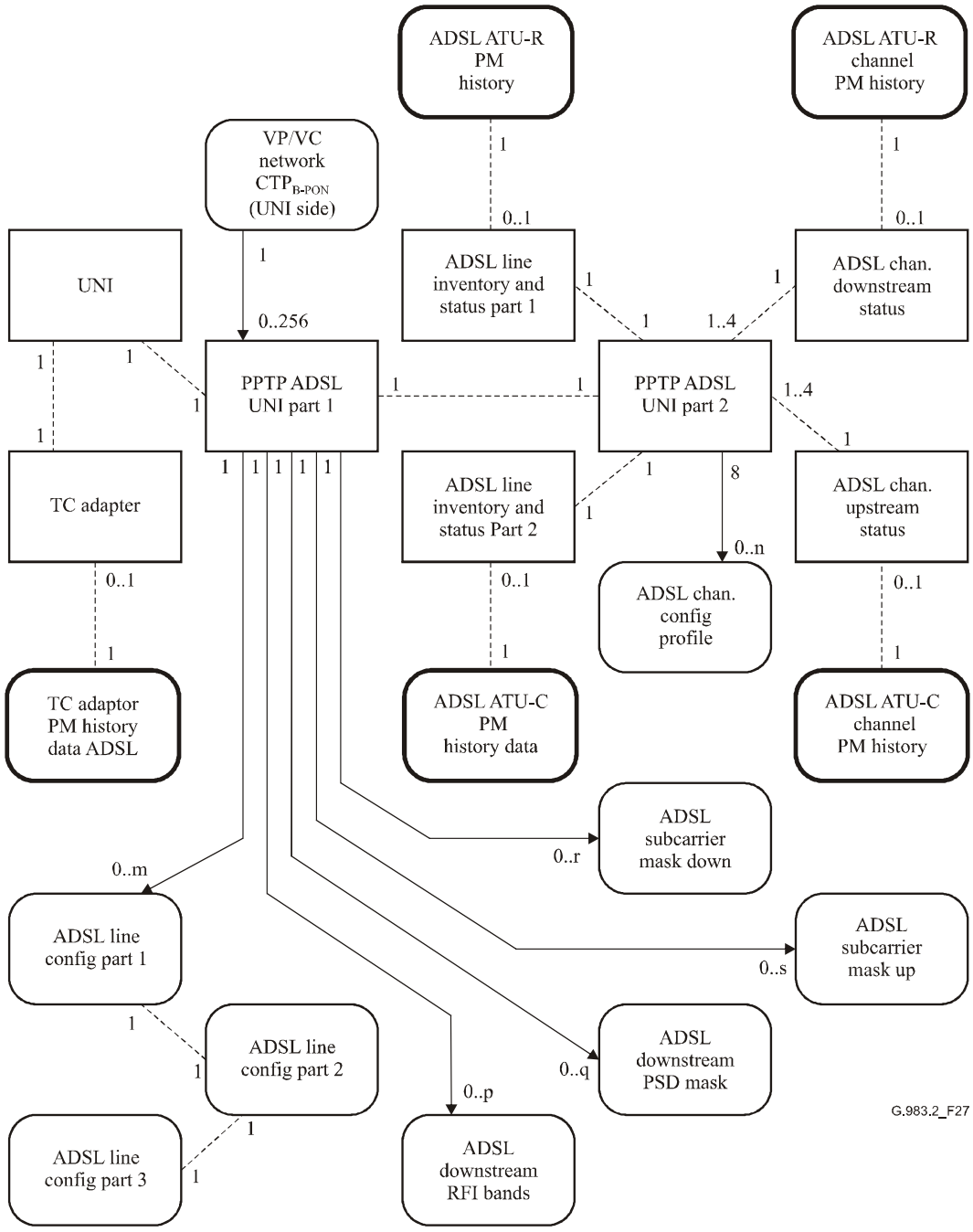


Figure 27/G.983.2 – Managed entity relation diagram for ADSL interfaces

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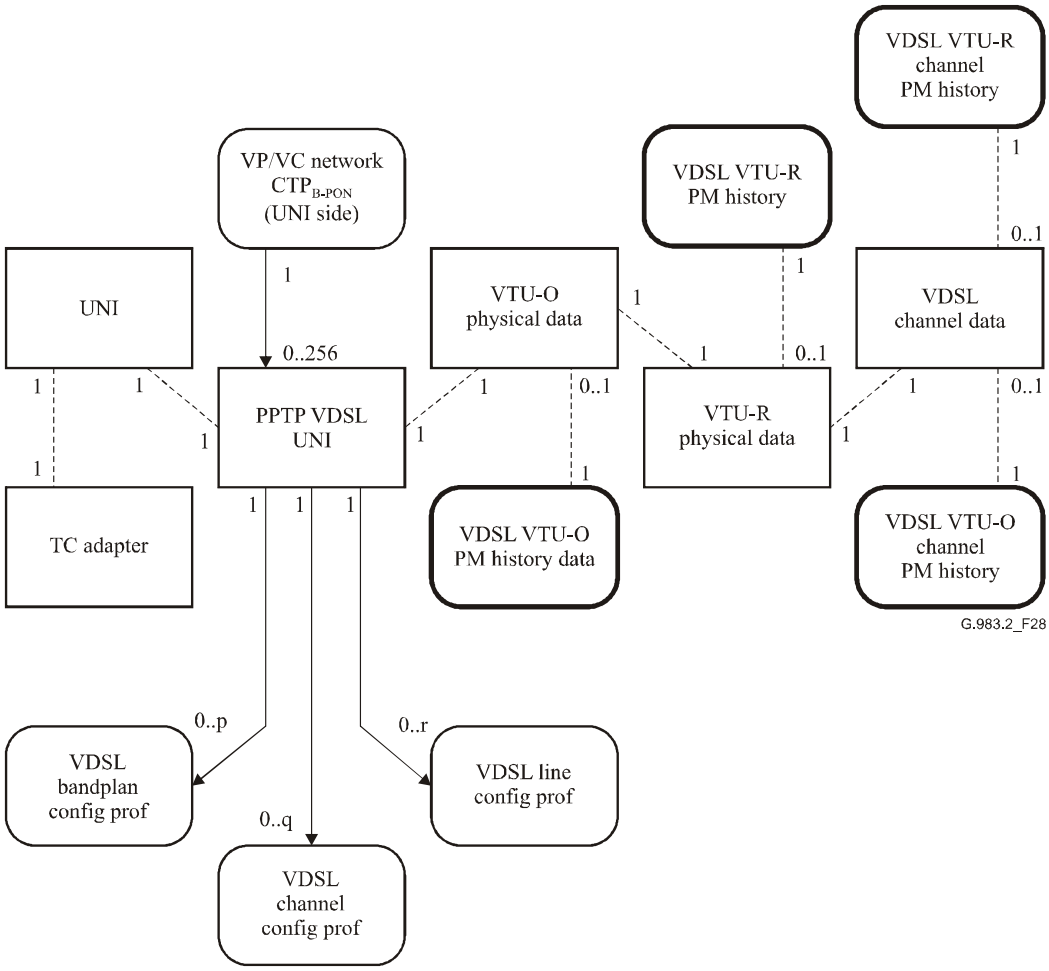


Figure 28/G.983.2 – Managed entity relation diagram for VDSL interfaces

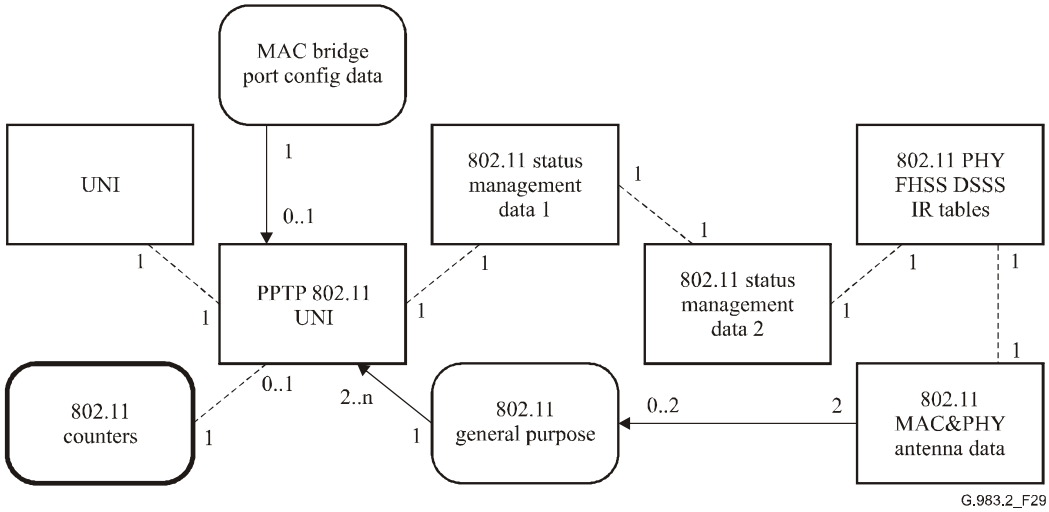


Figure 29/G.983.2 – Managed entity relation diagram for IEEE 802.11 interfaces

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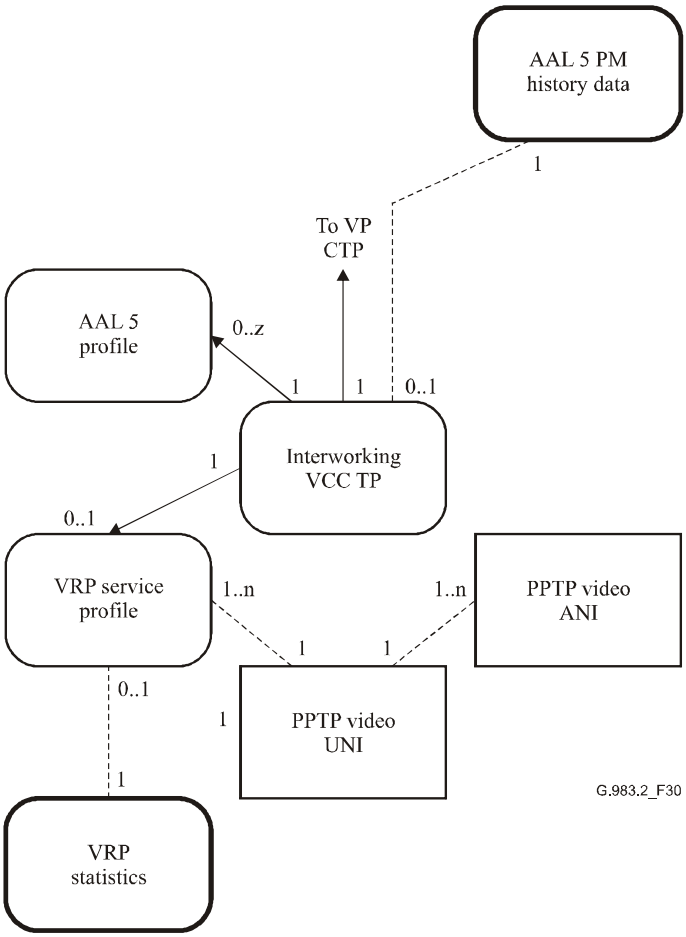


Figure 30/G.983.2 – Managed entity relation diagram for video interfaces, including the optional video return path function

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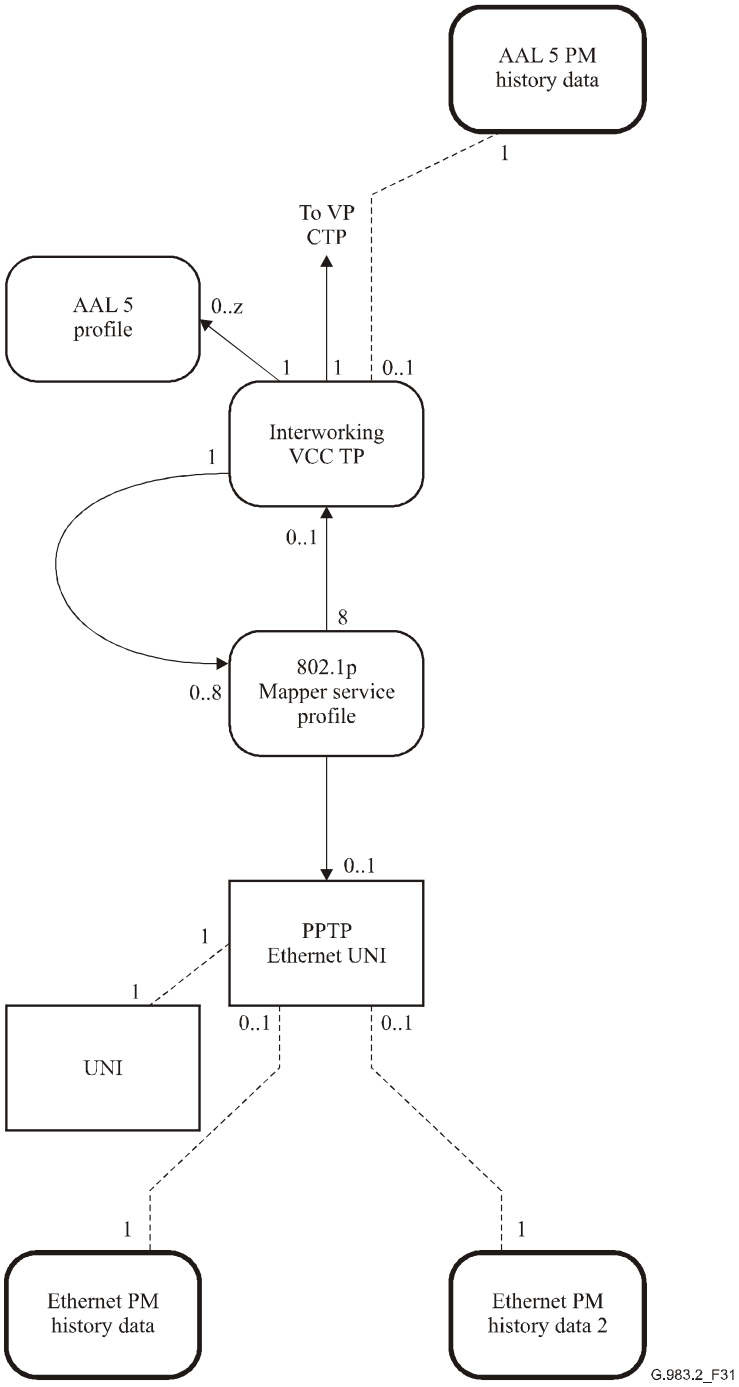


Figure 31/G.983.2 – Managed entity relation diagram for 802.1p mapper interfaces

7 MIB description

A detailed description of all ONT managed entities is provided in the clauses that follow. The descriptions include:

a) the purpose of the entity;

b) the relationship(s) that the entity supports with other managed entities;

c) the attributes of the entity;

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d) the management operations that may be performed on the entity;

e) the notifications generated by the managed entity.

These clauses are organized as follows:

a) ONT equipment management;

b) ANI (i.e., PON IF) management;

c) UNI management;

d) VP layer management;

e) traffic management.

A managed entity can be instantiated by the ONT autonomously or on explicit request of the OLT via a create command.

Attributes of a managed entity for which no create action exists (i.e., a managed entity which is auto-instantiated by the ONT) can be (R), (W), or (R, W). On the other hand, attributes of a managed entity for which a create action exists (i.e., a managed entity which is instantiated on explicit request by the OLT) can be either (R), (W), (R, W), (R, Set-by-create), (W, Set-by-create), or (R, W, Set-by-create). For attributes that are not "Set-by-create", a default value will be specified in this Recommendation which will be assigned to the attribute on instantiation of the managed entity.

The following gives a more detailed explanation for each of the possible cases:

(R): On instantiation of the managed entity (either autonomously or on request of the OLT via a create action), the ONT sets the attribute to a default value. The OLT can only read the value of the attribute. In case of an autonomous attribute value change, the ONT will send an attribute value change notification to the OLT.

(W): On instantiation of the managed entity (either autonomously or on request of the OLT via a create action), the ONT sets the attribute to a default value. The OLT can only write the value of the attribute. In case of an autonomous attribute value change, the ONT will NOT send an attribute value change notification to the OLT.

(R, W): On instantiation of the managed entity (either autonomously or on request of the OLT via a create action), the ONT sets the attribute to a default value. The OLT can both read and write the value of the attribute. In case of an autonomous attribute value change, the ONT will send an attribute value change notification to the OLT.

(R, Set-by-create): On instantiation of the managed entity (by necessity on request of the OLT via a create action), the ONT sets the attribute to the value specified in the create command. Subsequently, the OLT can only read the value of the attribute. In case of an autonomous attribute value change, the ONT will send an attribute value change notification to the OLT.

(W, Set-by-create): On instantiation of the managed entity (by necessity on request of the OLT via a create action), the ONT sets the attribute to the value specified in the create command. Subsequently, the OLT can only write the value of the attribute. In case of an autonomous attribute value change, the ONT will NOT send an attribute value change notification to the OLT.

(R, W, Set-by-create): On instantiation of the managed entity (by necessity on request of the OLT via a create action), the ONT sets the attribute to the value specified in the create command. Subsequently, the OLT can both read and write the value

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of the attribute. In case of an autonomous attribute value change, the ONT will send an attribute value change notification to the OLT.

In all bit vectors indicated in this Recommendation, bit 1 represents the least significant bit, while bit 8 represents the most significant bit within a byte. If the bit vector is made up of more than one byte, then the numbering starts from the least significant byte onwards.

In all attribute descriptions that refer to the Boolean values "true" and "false", true will be coded as 0x01 and false will be coded as 0x00.

In all attribute descriptions that refer to spaces, the value 0x20 must be used for the entire size of the attribute.

The notifications generated by a managed entity stem from the following events: Alarms, Attribute Value Changes (AVCs), Threshold Crossing Alerts (TCAs), and Test results. Alarms, TCAs, and failures of autonomous self tests are all reported via "Alarm" messages. AVCs are reported via "Attribute Value Change" messages. Test results are reported:

a) via a "Test result" message if the test is invoked by a "Test" command from the OLT;

b) via an "Alarm" message in the case of failure of an autonomous self test (in start-up phase). Details about these messages and the related coding are in Appendix II.

7.1 ONT equipment management

7.1.1 $ONT_{B\text{-}PON}$

This managed entity represents the ONT as equipment.

An instance of this managed entity is automatically created by the ONT after initialization. After the creation of this managed entity, the associated attributes are updated according to the data within the ONT itself.

Relationships

All other managed entities in this Recommendation are related directly or indirectly to the $ONT_{B\text{-}PON}$ entity.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. There is only one instance and it has the number 0x0000. (R) (mandatory) (2 bytes)

Vendor id: This attribute identifies the vendor of the ONT, and is the same as the 4 most significant bytes of the ONT serial number as specified in ITU-T Rec. G.983.1. Upon autonomous instantiation, this attribute consists of all spaces. (R) (mandatory) (4 bytes)

Version: This attribute identifies the version of the ONT as defined by the vendor. The printable value of "0" shall be used when version information is not available or applicable to the ONT being represented. Upon autonomous instantiation, this attribute consists of all spaces. (R) (mandatory) (14 bytes)

Serial Number: The serial number is unique for each ONT. Note that the serial number of the ONT is already defined in ITU-T Rec. G.983.1 [3] and contains the vendor id and/or the version number. The first four bytes are the ASCII encoded vendor ID four letter mnemonic. The second four bytes are a binary encoded 'serial number', under the complete control of the vendor in question. Upon autonomous instantiation, this attribute consists of all zeroes. (R) (mandatory) (8 bytes)

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Traffic management option: This attribute identifies the upstream traffic management function implemented in the ONT. There are two options:

1) "Priority controlled upstream traffic" (0x00): the upstream traffic coming from the user is given a priority.
2) "Cell rate controlled upstream traffic" (0x01): the maximum upstream traffic of each individual connection is guaranteed.

Note that the Traffic management option will not apply to downstream traffic. In other words, there is no need for a traffic descriptor for the downstream direction and downstream priority queues can be used. Upon autonomous instantiation, this attribute is set to the value that describes the ONT's implementation. The OLT must adapt its model to conform to the ONT's selection. (R) (mandatory) (1 byte)

VP/VC cross-connection function option: This attribute identifies the support of ATM VP or VC cross-connection management functions for the interworking connections to non-ATM UNIs. The value is set according to Table 0. Upon autonomous instantiation, this attribute is set to the value that describes the ONT's implementation. The OLT must adapt its model to conform to the ONT's selection. (R) (mandatory) (1 byte)

Battery backup: This attribute provides a Boolean indication of whether or not the ONT supports battery backup. False will indicate that no battery is provisioned; true indicates that a battery is provisioned. Upon autonomous instantiation, this attribute is set to false. (R, W) (mandatory) (1 byte)

Administrative State: This attribute is used to activate (unlock: value 0x00) and deactivate (lock: value 0x01) the functions performed by instances of this managed entity. Selection of a default value for this attribute is outside the scope of this Recommendation as it is normally handled through supplier-operator negotiations. (R, W) (mandatory) (1 byte)

Operational State: This attribute indicates whether or not a managed entity is capable of performing its task. Valid values are enabled (0x00) and disabled (0x01). (R) (optional) (1 byte)

Equipment id: This attribute may be used to identify the specific type of ONT. In North America, this may be used for the equipment CLEI code. Upon autonomous instantiation, this attribute consists of all spaces. (R) (optional) (20 bytes)

OMCC Version: This attribute is used to identify the specific version of the OMCC protocol being used by the ONT. This is used to allow the OLT to manage a network with ONTs that support different OMCC versions. Valid values include 0x00 (2000 version), 0x01 (2002 version), and 0x02 (2005 version). Future versions will be added sequentially. Default value is 0x00. (R) (optional) (1 byte)

Vendor Product Code: This attribute is used to provide a vendor-specific product code for the ONT. Upon autonomous instantiation, this attribute consists of all spaces. (R) (optional) (2 bytes)

Security Capability: This attribute is used to advertise the advanced security modes of the ONT. The following codepoints are defined:

0: No extra security features are supported;

1: AES encryption of the downstream payload is supported;

2:.255: Reserved for future use.

Upon autonomous instantiation, this attribute will be set to zero. (R) (optional) (1 byte)

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SecurityMode: This attribute is used to select the advanced security mode for the ONT. Note that all secure VPs in an ONT must use the same security mode at any time. The following codepoints are defined:

0: Churning algorithm will be used;

1: AES algorithm will be used;

2..255: Reserved for future use.

Upon autonomous instantiation, this attribute will be set to zero. (R, W) (optional) (1 byte)

Total T-CONT buffer number: This attribute provides a total number of T-CONT buffers, which are not associated with the PON IF line card. Upon autonomous instantiation, this attribute will be set to zero. (R) (mandatory if DBA supported) (1 byte)

Total Priority Queue number: This attribute provides a total number of priority queues, which are not associated with the PON IF line card. Upon autonomous instantiation, this attribute will be set to zero. (R) (mandatory if DBA supported) (1 byte)

Total Traffic Scheduler number: This attribute provides a total number of Traffic Schedulers, which are not associated with the PON IF line card. The ONT supports NULL function, HOL (Head Of the Line) scheduling and WRR (Weighted Round Robin) from the priority control and guarantee of minimum rate control points of view, respectively. If the ONT does not have any Traffic Scheduler, this attribute should be 0x00. Upon autonomous instantiation, this attribute will be set to zero. (R) (mandatory if DBA supported) (1 byte)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Reboot: Reboot the ONT.

Test: This action is used to initiate an ONT self test. Test outcome is "Pass" or "Fail".

Synchronize Time: This action is used to synchronize the start time of all Monitoring managed entities of the ONT with the reference time of the OLT and to reset the registers of the Monitoring managed entities. The effect of this action is that all counters of all Monitoring managed entities are set to 0x00 and restart counting. Also, the value of the Interval End Time attribute of the Monitoring managed entities is set to 0x00 and restarts counting.

Note that no other OMCI action has the same effect: synchronization of the start time is not guaranteed at start-up or after a MIB reset command (optional).

Notifications

Attribute value change: This notification is used to report autonomous changes to the attributes of this managed entity. The attribute value change notification shall identify the attribute changed and its new value. The list of AVCs for this managed entity is given in Table 2a.

Alarm: This notification is used to notify the managed system when a failure has been detected or cleared. Both ONT and OLT should know the alarm list used by this entity. The alarm list for this entity is given in Table 2b.

Test result: For the "Test result" event, notification is sent to the OLT via an alarm ONLY if the ME fails the autonomous self test.

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Table 2a/G.983.2 – AVC list for $ONT_{B\text{-}PON}$

Number	Attribute value change	Description
1-7	N/A	
8	OpState	Operational state of $ONT_{B\text{-}PON}$
9-16	Reserved	

Table 2b/G.983.2 – Alarm list for $ONT_{B\text{-}PON}$

Number	Event	Description
	Alarm	
0	EquipmentAlarm	A functional failure on an internal interface
1	PoweringAlarm	Loss of external power
2	BatteryMissing	Battery is provisioned but missing
3	BatteryFailure	Battery is provisioned and present but cannot recharge
4	BatteryLow	Battery is provisioned and present but its voltage is too low
5	PhysicalIntrusionAlarm	Applies if the ONT is supported with detection such as door or box open
	Test result	
6	ONTSelfTestFailure	ONT has failed autonomous self test
7	DyingGasp	ONT is powering off imminently
8-223	Reserved	
224-239	Vendor-specific alarms	Not to be standardized

7.1.2 ONT data

This managed entity is contained in the ONT managed entity and is used to model the MIB itself. Clause I.1.2 explains the use of this managed entity with respect to MIB synchronization. Clause I.1.4 explains the alarm synchronization process, also issued on this managed entity.

An instance of this managed entity is automatically created by the ONT after initialization. After the creation of this managed entity, the associated attributes are updated according to the data within the ONT itself.

Relationships

One instance of this managed entity is contained in the instance of the ONT managed entity.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. There is only one instance and it has the number 0x0000. (R) (mandatory) (2 bytes)

MIB data sync: This attribute is used to check the alignment of the MIB of the ONT with the corresponding MIB within the OLT. MIB data sync is a "sequence number" checked by the OLT to see if the MIB snapshots for the OLT and ONT have the same sequence number. Refer to I.1.1 for a detailed description of this attribute. Upon autonomous instantiation, this attribute is set to 0x00. (R, W) (mandatory) (1 byte)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

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Get all alarms: Latch a snapshot (i.e., copy) of the current alarm statuses of all managed entities and reset the alarm message counter.

Get all alarms next: Get the latched alarm status of the next managed entity within the current snapshot.

MIB reset: Reset the MIB data sync attributes to 0x00 and reset the MIB of the ONT to its default state. This default MIB consists of one instance of the $ONT_{B\text{-}PON}$ managed entity, one instance of the ONT Data managed entity, two instances of the Software Image managed entity, zero or more instances of the Subscriber Line Cardholder managed entity, zero or more instances of the PON IF Line Cardholder, and zero or more instances of the Priority $Queue_{B\text{-}PON}$ managed entity (for the priority queues that reside in the ONT).

MIB upload: Latch a snapshot (i.e., copy) of the current MIB.

MIB upload next: Get the latched attribute values of the managed entity within the current snapshot.

Notifications

None.

7.1.3 Subscriber line cardholder

This managed entity represents the slots of the ONT that are capable of holding Subscriber Line Cards. One or more of these entities are contained in the ONT. Each Subscriber Line Cardholder can contain 0 or 1 subscriber Linecard.

An instance of this managed entity shall exist for each slot. Instances of this managed entity are created automatically by the ONT after the ONT initialization. After the creation of this managed entity, the associated attributes are updated according to the data within the ONT itself.

Instances of this managed entity are also created for ONTs with integrated interfaces on the UNI side. They then represent virtual Subscriber Line Cardholders.

Relationships

An instance of the Subscriber Line Cardholder may contain instances of the Subscriber Line Card managed entity to model the containment of Subscriber Line Cards within slots of the ONT.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The first byte of this two-byte identifier is set to:

- 0x00 if the ONT has non-integrated interfaces on the UNI side
- 0x01 if the ONT has integrated interfaces on the UNI side.

The second byte of this identifier is the slot id.

To accommodate a universal code for the ONT slot id for both PON and UNI interfaces, one could interpret the least significant 7 bits of the slot id as the actual physical slot number with the most significant bit serving as an interface type (UNI/ANI) indicator. Therefore, the coding of the UNI slot id is in the range of 0x01-0x7F (1-127). For reasons of backward compatibility, integrated Subscriber Line interfaces (i.e., no plug-in UNI cards) can also be associated with a "pseudo" slot id 0x00. The code 0x01 is used for the leftmost lower slot of the ONT when looking at the side where the Subscriber Line Cards are plugged in, 0x02 is used for the next slot just to the right of the previous one, and so forth; numbering on the next higher shelf continues at its left edge.

NOTE 1 – Up to 127 slots are supported.

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(R) (mandatory) (2 bytes)

Actual Plug-in unit Type: This attribute is equal to the type of the LIM in the cardholder or equal to a value of 0x00 (= no LIM) if the cardholder is empty. This attribute will then be redundant with attribute "Type" of the managed entity Subscriber Line Card. (R) (mandatory) (1 byte)

Expected Plug-in unit Type: This attribute identifies which type of plug-in unit is provisioned for the slot. For type coding, see Table 3. The value of 0x00 (no LIM) means that the Subscriber Line Cardholder is not provisioned to contain a LIM. The value of 0xFF (255) means that the Subscriber Line Cardholder is configured for plug-and-play. Upon autonomous instantiation, this attribute is set to 0x00. For integrated interfaces, this attribute represents the type of interface. (R, W) (mandatory) (1 byte)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

Attribute Value Change: This notification is used to report autonomous changes of the Actual Plug-in unit type. The attribute value change notification shall identify the attribute changed and its new value. The AVCs for this managed entity are listed in Table 4a. For ONTs with integrated interfaces, AVCs are not supported.

NOTE 2 – In the AVC tables, the numbering follows that of the Attribute mask coding found in Table II.1. Accordingly, each AVC table has a maximum of 16 entries. If an existing attribute does not emit AVCs, then "N/A" (not applicable) is listed in the AVC column. "Reserved" is used for numbers that do not correspond to an existing attribute.

Alarm: This notification is used to notify the management system that there is something wrong with the provisioned plug-in unit. Both ONT and OLT should know the alarm list (see Table 4b) used by this entity. In case of no provisioning (no LIM configured) or in case the SubscriberLine Cardholder has been configured for plug-and-play, no alarms are raised. If the plugInLIMMissingAlarm is active, the plugInTypeMismatchAlarm shall not be raised. For ONTs with integrated interfaces, alarms are not supported.

Table 3/G.983.2 – Subscriber line card types

Coding	Contents	Description
0	no LIM	Default value
1	A1.5	ATM 1.544 Mbit/s module
2	A2	ATM 2.048 Mbit/s
3	A6.3	ATM 6.312 Mbit/s module
4	A6.3U	ATM 6.312 Mbit/s module, Remote (U-interface)
5	A8	ATM 8.448 Mbit/s
6	A25	ATM 25.6 Mbit/s module
7	A34	ATM 34.368 Mbit/s module
8	A45	ATM 44.736 Mbit/s module
9	A45/34	Configurable ATM 44.736/34.368 Mbit/s module
10	A150SMF SDH	ATM STM-1 SMF UNI
11	A150MMF SDH	ATM STM-1 MMF UNI

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Table 3/G.983.2 – Subscriber line card types

Coding	Contents	Description
12	A150UTP SDH	ATM STM-1 UTP UNI
13	C1.5 (DS1)	1.544 Mbit/s Local (T-interface) AAL 1 module
14	C2.0 (E1)	2.048 Mbit/s Local (T-interface) AAL 1 module
15	C6.3 (J2)	6.312 Mbit/s Local (T-interface) AAL 1 module
16	C-DS1/E1	Configurable DS1/E1 AAL 1 module
17	C-DS1/E1/J1	Configurable DS1/E1/J1 AAL 1 module
18	C6.3U (J2)	6.312 Mbit/s Remote (U-interface) AAL 1 module
19	C192k	192 kbit/s Local (T-interface) AAL 1 module
20	C44.7 (DS3)	44.736 Mbit/s Local (T-interface) AAL 1 module
21	C34.3 (E3)	34.368 Mbit/s Local (T-interface) AAL 1 module
22	10Base-T	10 Base-T Ethernet LAN IF
23	100Base-T	100 Base-T Ethernet LAN IF
24	10/100Base-T	10/100 Base-Tx Ethernet LAN IF
25	Token Ring	Token Ring LAN IF
26	FDDI	FDDI LAN IF
27	FR	Frame relay
28	C1.5 (J1)	1.544 Mbit/s Local (T-interface) AAL 1 module
29	A150SMF SONET	ATM OC-3 SMF UNI
30	A150MMF SONET	ATM OC-3 MMF UNI
31	A150UTP SONET	ATM OC-3 UTP UNI
32	POTS	Plain Old Telephony Service
33	ISDN-BRI	ISDN Basic Rate Interface
34	Gigabit Ethernet	Gigabit Ethernet IF
35	ADSL	ADSL IF
36	SHDLS	SHDSL IF
37	VDSL	VDSL IF
38	Video Service	Video module
39	LCT	Local craft terminal interface
40	802.11	IEEE 802.11 interface
41	ADSL/POTS	Combination ADSL and POTS interfaces
42	VDSL/POTS	Combination VDSL and POTS interfaces
43..249	Reserved	
250	PON1244155	Asymmetric 1244/155 Mbit/s PON IF
251	PON1244622	Asymmetric 1244/622 Mbit/s PON IF
252	PON622symm	Symmetric 622/622 Mbit/s PON IF
253	PON155	Symmetric 155/155 Mbit/s PON IF
254	PON622	Asymmetric 155/622 Mbit/s PON IF

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Table 3/G.983.2 – Subscriber line card types

Coding	Contents	Description
255	Plug-and-play/Unknown	Plug-and-play (for the Subscriber Line Cardholder managed entity only) Unrecognized module (for the Subscriber Line Card managed entity only)

Table 4a/G.983.2 – AVC list for subscriber line cardholder

Number	Attribute value change	Description
1	ActualType	Actual type of LIM in cardholder
2-16	Reserved	

Table 4b/G.983.2 – Alarm list for subscriber line cardholder

Number	Alarm	Description
0	PlugInLimMissingAlarm	Configured Plug-in LIM is not present
1	PlugInTypeMismatchAlarm	Inserted Plug-in LIM is wrong type
2	ImproperCardRemoval	Card has been removed without being deprovisioned. (This is a redundant alarm that is used to help the OLT distinguish between transitions from state S2 to state S1 and transitions from state S4 to state S1. This alarm is sent only when a transition occurs from state S2 to state S1. See Table 32 for state diagrams.)
3-223	Reserved	
224-239	Vendor-specific alarms	Not to be standardized

Figure 32 shows a state diagram of the various behaviours of inserting/removing a particular Subscriber Line Card into/from a Subscriber Line Cardholder that is provisioned to a specific type or to plug-and-play.

In the figure, state S3' is conceptually identical to state S3 except in the behaviour when entering or leaving this state upon provisioning or deprovisioning.

In order to avoid a cluttered picture, the following state transitions, although possible, are not shown in the figure: from S3 to S9 on provisioning of plug-and-play mode, from S3' to S8 on provisioning of plug-and-play mode, from S9 to S3 on deprovisioning of plug and play-mode, and from S8 to S3' on deprovisioning of plug-and-play mode.

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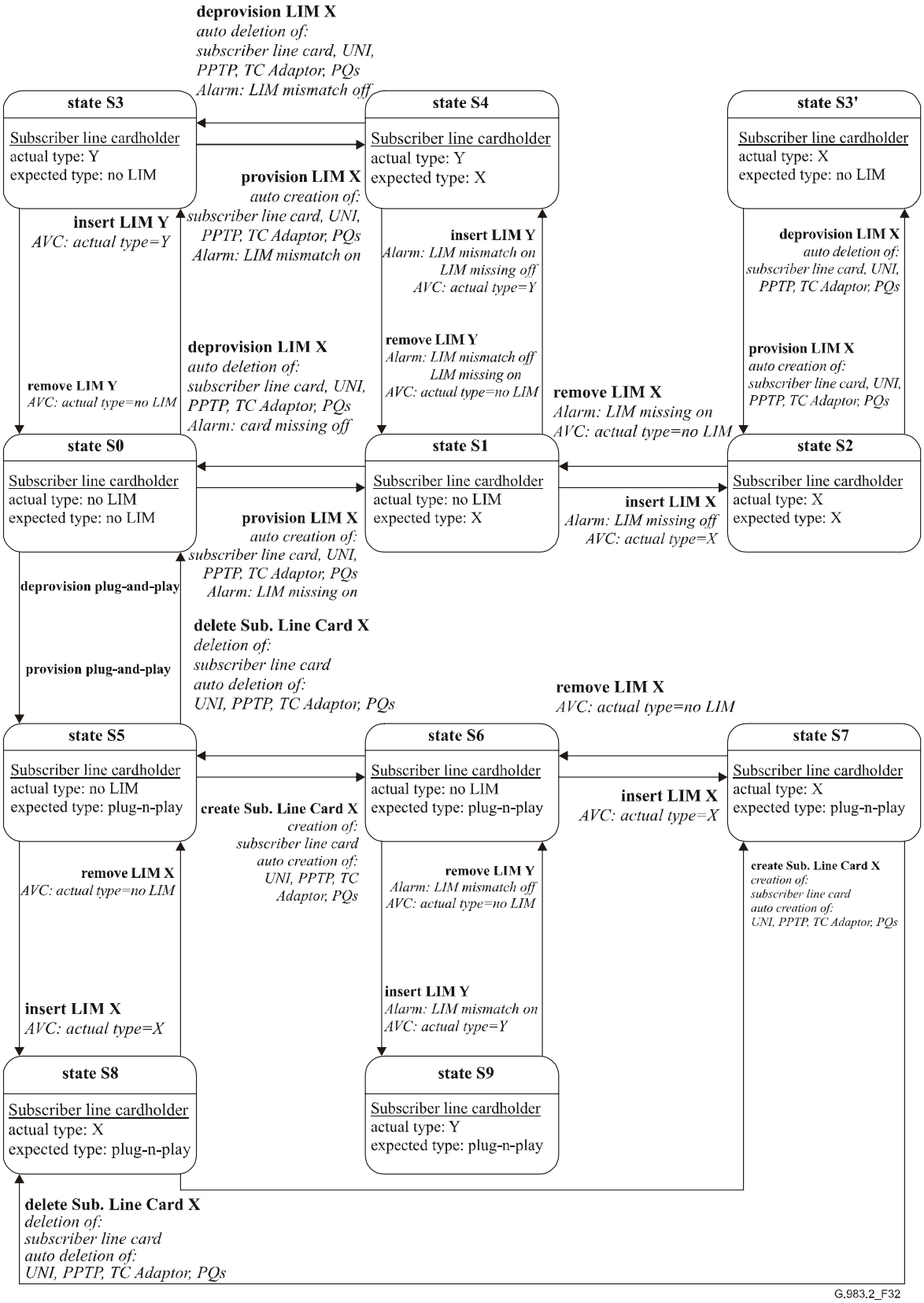


Figure 32/G.983.2 – Subscriber line cardholder state diagram

NOTE 3 – The state diagram presented in Figure 32 is not applicable for ONTs with integrated interfaces.

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7.1.4 Subscriber line card

This managed entity is used to represent the subscriber line card that is provisioned in an ONT slot. For ONTs with integrated interfaces on the UNI side, this managed entity represents available types of interfaces. An instance of this managed entity shall be automatically created by the ONT when the OLT has provisioned the subscriber line card (i.e., when the OLT has set attribute "Expected Plug-in Unit Type" of the Subscriber Line Cardholder to a specific LIM type). See 7.1.3. Moreover, an instance of this managed entity can also be created by the ONT at the request of the OLT if the attribute "Expected Plug-in Unit Type" of the corresponding Subscriber Line Cardholder is equal to the value 0xFF (255), which corresponds to "plug-and-play". For ONTs with integrated interfaces on the UNI side, an instance of this managed entity is automatically created for each instance of the Subscriber Line Cardholder managed entity.

An instance of this managed entity shall be deleted by the ONT when the OLT has deprovisioned the subscriber line card (i.e., when the OLT has set attribute "Expected Plug-in Unit Type" of the Subscriber Line Cardholder to 0x00, i.e., "no LIM"). Moreover, an instance of this managed entity can also be deleted by the ONT on request of the OLT if the attribute "Expected Plug-in Unit Type" of the corresponding Subscriber Line Cardholder is equal to the value 0xFF, i.e., "plug-and-play". For ONTs with integrated interfaces on the UNI side, an instance of this managed entity cannot be deleted by an OLT request.

Relationships

One instance of this managed entity is contained by an instance of the Subscriber Line Cardholder.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The number used is the same as the instance number used for the Subscriber Line Cardholder managed entity instance containing this Subscriber Line Card instance. (R, Set-by-create (if applicable)) (mandatory) (2 bytes)

Type: This attribute identifies the Subscriber Line Card type. This attribute is a unique code as defined in Table 3. The value of 0xFF (255) means "unknown", i.e., the inserted Subscriber Line Card cannot be recognized by the ONT. In this case, the attribute's Serial Number, Version and Vendor id do not contain valid information. Upon autonomous instantiation, this attribute is set to 0x00. (R, Set-by-create (if applicable)) (mandatory) (1 byte)

Number of ports: This attribute gives the quantity of access ports on the Subscriber Line Card. Upon instantiation, this attribute is set equal to 0x01. (R) (optional) (1 byte)

Serial Number: The serial number is unique for each Subscriber Line Card. Note that the serial number may contain the vendor id and/or version number. For ONTs with integrated interfaces on the UNI side, this value is identical to the value of the Serial Number attribute of the $ONT_{B\text{-}PON}$ managed entity Upon instantiation, this attribute consists of all spaces. (R) (mandatory) (8 bytes)

Version: This attribute identifies the version of the Subscriber Line Card as defined by the vendor. A value of 0x00 shall be used when version information is not available or applicable to the ONT being represented. For ONTs with integrated interfaces on the UNI side, this value is identical to the value of the Version attribute of the $ONT_{B\text{-}PON}$ managed entity. Upon autonomous instantiation, this attribute consists of all spaces. (R) (mandatory) (14 bytes)

Vendor id: This attribute identifies the vendor of the Subscriber Line Card. For ONTs with integrated interfaces on the UNI side, this value is identical to the value of the Vendor id attribute of the $ONT_{B\text{-}PON}$ managed entity. Upon instantiation, this attribute consists of all spaces. (R) (optional) (4 bytes)

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Administrative State: This attribute is used to "unlock" (value 0x00) and "lock" (value 0x01) the functions performed by the Subscriber Line Card. When the administrative state is set to "lock", all user traffic to and from this Subscriber Line Card is blocked and alarms for this Subscriber Line Card and all associated managed entities are no longer generated. Selection of a default value for this attribute is outside the scope of this Recommendation as it is normally handled through supplier-operator negotiations. (R, W, Set-by-create (if applicable)) (mandatory) (1 byte)

Operational State: This attribute indicates whether or not the managed entity is capable of performing its task. Valid values are enabled (0x00), disabled (0x01), and unknown (0x02). Upon instantiation, this attribute is set to (0x02). (R) (optional) (1 byte)

BridgedorIPInd: This attribute indicates whether the Ethernet interface is bridged or derived from an IP router function (Bridged: 0x00; IP router: 0x01; 0x02 Bridged and IP Router). 0x02 means that both bridged and IP router functions are supported by the subscriber line card. Upon autonomous instantiation, the value 0x00 is used. (R, W) (optional, only applicable for subscriber line cards with Ethernet interfaces) (1 byte)

Equipment id: This attribute may be used to identify the vendor's specific type of line card. This attribute applies only to line cards that do not have integrated interfaces. In North America, this may be used for the equipment CLEI code. Upon instantiation, this attribute consists of all spaces. (R) (optional) (20 bytes)

CardConfiguration: This attribute is used to select the appropriate configuration on configurable line cards (e.g., T1/E1). Table 3 specifies 3 configurable card types: A45/34 (code 9), C-DS1/E1 (code 16), and C-DS1/E1/J1 (code 17). Values are indicated below for the allowed card types and configurations.

Card Type	Configuration	Value
A45/34	ATM 44.736 Mbit/s	0x00
	ATM 34.368 Mbit/s	0x01
C-DS1/E1	DS1	0x00
	E1	0x01
C-DS1/E1/J1	DS1	0x00
	E1	0x01
	J1	0x02

Upon autonomous instantiation, the value 0x00 is used. (R, W, Set-by-create (if applicable)) (mandatory for configurable line cards) (1 byte)

Actions

Create: Create an instance of this managed entity (optional, only when plug-and-play is supported).

Delete: Delete an instance of this managed entity (optional, only when plug-and-play is supported).

Get: Get one or more attributes.

Set: Set one or more attributes.

Reboot: Reboot the Subscriber Line Card.

Test: Test the Subscriber Line Card (this action is optional).

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Notifications

Attribute value change: This notification is used to report autonomous changes of attributes of this managed entity. The notification shall identify the attribute and its new value. The list of AVCs for this managed entity is given in Table 5a.

Alarm: This notification is used to notify the management system when a failure has been detected or cleared. Both ONT and OLT should know the alarm list used by this entity. The alarm list for this entity is given in Table 5b.

NOTE – For ONTs with integrated interfaces on the UNI side, alarms are not applicable except perhaps for video support. Use of alarms for video support is considered optional and is for future study.

Test result: For the "Test result" event, notification is sent to the OLT via an alarm ONLY if the ME fails the autonomous self test.

Table 5a/G.983.2 – AVC list for subscriber line card

Number	Attribute value change	Description
1-6	N/A	
7	OpState	Operational state of Subscriber Line Card
8	N/A	
9-16	Reserved	

Table 5b/G.983.2 – Alarms list for subscriber line card

Number	Event	Description
0	EquipmentAlarm	A failure on an internal interface or failed self test
1	PoweringAlarm	LIM fuse failure or failure of LIM DC/DC converter
	Test result	
2	SelfTestFailure	Failure of Subscriber Line Card autonomous self test
3-223	Reserved	
224-239	Vendor-specific alarms	Not to be standardized

7.1.5 PON IF line cardholder

This managed entity represents slots of the ONT that are capable of holding a network card on the ANI side. An instance of this managed entity shall exist for each slot. Instances of this managed entity are created automatically by an ONT that supports PON IF plug-in after the ONT initialization. (For integrated PON interfaces, no instances of this managed entity need to be created. However, if PON IF-based traffic management features (T-CONTs, Priority queues, and Traffic Schedulers) are to be modelled, an instance of this entity facilitates this.)

NOTE 1 – This definition merely provides a placeholder to facilitate equipment management of removable PON IF line cards.

Relationships

An instance of the PON IF Line Cardholder may contain instances of the PON IF Line Card managed entity to model the containment of PON IF Line Cards within slots of the ONT.

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Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The first byte of this two-byte identifier is always 0x00. The second byte of this identifier is the slot id.

To accommodate a universal code of the ONT slot id for both PON and UNI interfaces, one must interpret the least significant 7 bits of the slot id as the actual physical slot number with the most significant bit serving as an interface type (UNI/ANI) indicator. Therefore, the coding of the PON IF Line Card slot id is in the range of 0x81-0xFF (129-255). The code 0x81 (129) is used for the leftmost lower slot of the ONT when looking at the side where the PON IF Line Cards are plugged in, 0x82 (130) is used for the next slot just to the right of the previous one, and so forth; numbering on the next higher shelf continues at its left edge. (R) (mandatory) (2 bytes)

NOTE 2 – Only up to 127 slots are supported.

Actions

Get: Get one or more attributes.

Notifications

None.

7.1.6 PON IF line card

This managed entity is used to model a field-replaceable PON IF Line Card contained within an ONT.

An instance of this managed entity shall be automatically created by the ONT. (For integrated PON interfaces, no instances of this managed entity need to be created. However, if PON IF-based traffic management features (T-CONTs, Priority queues, and Traffic Schedulers) are to be modelled, an instance of this entity facilitates this.)

NOTE – This definition merely provides a placeholder to facilitate equipment management of removable PON IF line cards.

Relationships

One instance of this managed entity is contained by an instance of the PON IF Line Cardholder.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The number used is the same as the instance number used for the PON IF Line Cardholder managed entity instance containing this PON IF Line Card instance. (R) (mandatory) (2 bytes)

Serial Number: The serial number is unique for each PON IF Line Card. Upon autonomous instantiation, this attribute consists of all spaces. (R) (mandatory) (8 bytes)

Version: This attribute identifies the version of the PON IF Line Card as defined by the vendor. Upon autonomous instantiation, this attribute consists of all spaces. (R) (mandatory) (14 bytes)

Vendor id: This attribute identifies the vendor of the PON IF Line Card. Upon autonomous instantiation, this attribute consists of all spaces. (R) (optional) (4 bytes)

Equipment id: This attribute may be used to identify the vendor's specific type of PON interface card. This attribute applies only to PON interface cards that do not have integrated interfaces. In North America, this may be used for the equipment CLEI code. Upon instantiation, this attribute consists of all spaces. (R) (optional) (20 bytes)

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Total T-CONT buffer number: This attribute provides a total number of T-CONT buffers, which are associated with the PON IF line card. Upon autonomous instantiation, the value 0x00 is used. (R) (mandatory) (1 byte)

Total Priority Queue number: This attribute provides a total number of priority queues, which are associated with the PON IF line card. Upon autonomous instantiation, the value 0x00 is used. (R) (mandatory) (1 byte)

Total Traffic Scheduler number: This attribute provides a total number of Traffic Schedulers, which are associated with the PON IF line card. The ONT supports NULL function, HOL (Head Of the Line) scheduling and WRR (Weighted Round Robin) from the priority control and guarantee of minimum rate control points of view, respectively. If the ONT does not have any Traffic Scheduler, this attribute should be 0x00. Upon autonomous instantiation, the value 0x00 is used. (R) (mandatory) (1 byte)

Actions

Get: Get one or more attributes.

Reboot: Reboot the PON IF Line Card.

Test: Test the PON IF Line Card (this action is optional and for further study). If testing is used, a "Test Result" event should be added to the notifications and event list.

Notifications

Attribute Value Change: This notification is used to report autonomous changes to the attributes of this managed entity. The notification shall identify the attribute that changed and its new value. If additional attributes are added, any relevant AVCs should be listed in a table.

Alarm: Alarms on the PON IF are transmitted to the OLT by PLOAM messages (see ITU-T Rec. G.983.1 [3]). There are no OMCI-based alarms for the PON IF.

7.1.7 Software image

This managed entity represents a program stored in the ONT.

Two instances of this managed entity shall be automatically created by the ONT after the creation of an ONT managed entity (mandatory) and each Subscriber Line Card managed entity (optional – not applicable for ONTs with integrated interfaces on the UNI side). It is used to report to the management system the software currently installed in non-volatile memory. After the creation of the instances of this managed entity, the associated attributes are updated according to the data within the ONT and Subscriber Line Cards.

Relationships

Two instances of this managed entity are contained in an instance of the ONT and Subscriber Line Card managed entities.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The number consists of a two-byte field. The first field (MSB) identifies the ME instance (ONT (value 0x00) or removable Subscriber/PON IF Line Card (value 0x01-0x7F/0x81-0xFF)) containing the associated Software Image ME. The second field (LSB) distinguishes between the two (redundant) Software Image ME instances (values 0x00 and 0x01). (R) (mandatory) (2 bytes)

Version: This attribute identifies the version of the software. Upon autonomous instantiation, this attribute consists of all spaces. (R) (mandatory) (14 bytes)

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Is committed: This attribute indicates whether the associated software image is "committed" (value 0x01) or "uncommitted" (value 0x00). By definition, the "committed" software image will be loaded and executed upon a reboot of the ONT and/or associated removable Subscriber/PON IF Line Card ME. During normal operation, one software image will always be "committed" while the other is "uncommitted". Under no circumstances are both software images allowed to be "committed" at the same time. On the other hand, both software images are only allowed to be non-committed at the same time if both are invalid. Upon autonomous instantiation, this attribute of instance 0 shall be initialized to "committed" and this attribute of instance 1 shall be initialized to "uncommitted". (R) (mandatory) (1 byte)

Is active: This attribute indicates whether the associated software image is "active" (value 0x01) or "inactive" (value 0x00). By definition, the active software image is one that is currently loaded and executing in the ONT (or associated Subscriber/PON IF Line Card). Under normal operation, one software image will always be "active" while the other is "inactive". Under no circumstances are both software images allowed to be "active" at the same time. On the other hand, both software images are only allowed to be inactive at the same time if both are invalid. Upon autonomous instantiation, this attribute of instance 0 shall be initialized to "active" and this attribute of instance 1 shall be initialized to "inactive". (R) (mandatory) (1 byte)

Is valid: This attribute indicates whether the associated software image is "valid" (value 0x01) or "invalid" (value 0x00). By definition, a software image is "valid" if it has been verified to be an executable code image. The verification mechanism is not subject to standardization; however, at a minimum it must include a data integrity (CRC) check of the entire code image. Upon autonomous instantiation, the associated code image is verified and this attribute is set according to the result of this verification. (R) (mandatory) (1 byte)

Actions

Get: Get one or more attributes.

Start Download: Initiate a software download sequence to the alternate (i.e., currently inactive) software image. This action is only valid for a software image that is currently inactive and is not committed (i.e., is not selected as the bootable image). (optional)

Download Section: Download a section of a software image. This action is only valid for a software image that is currently being downloaded (image 1 in state S2/image 0 in state S2'). (optional)

End Download: Signal the completion of a download sequence, providing both the valid CRC and version information for a final verification of an associated downloaded software image. This action is only valid for a software image that is currently being downloaded (image 1 in state S2/image 0 in state S2'). (optional)

Activate Image: Load/execute a valid software image. When this action is applied to a software image that is currently inactive, execution of the current code image is suspended; the associated software image is loaded from non-volatile memory; and execution of this new code image is initiated. When this action is applied to a software image that is already active, a soft restart is performed (i.e., the software image is not reloaded from non-volatile memory, execution of the current volatile code image is simply restarted). This action is only valid for a valid software image. (optional)

Commit Image: Select a valid software image to be the default image to be loaded and executed by the boot code upon start-up (i.e., set the Is_committed attribute value to 0x01 for the associated Software Image ME and set the Is_committed attribute value to 0x00 for the other Software Image ME). This action is only valid for a valid software image. (optional)

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In Figure 33, a state diagram is given, showing an example of the "life cycle" of software images under the actions given above. State S0 is a conceptual initialization state when neither of the software images is valid (i.e., executable). During S0, the OMCC is not functional.

Notifications

None.

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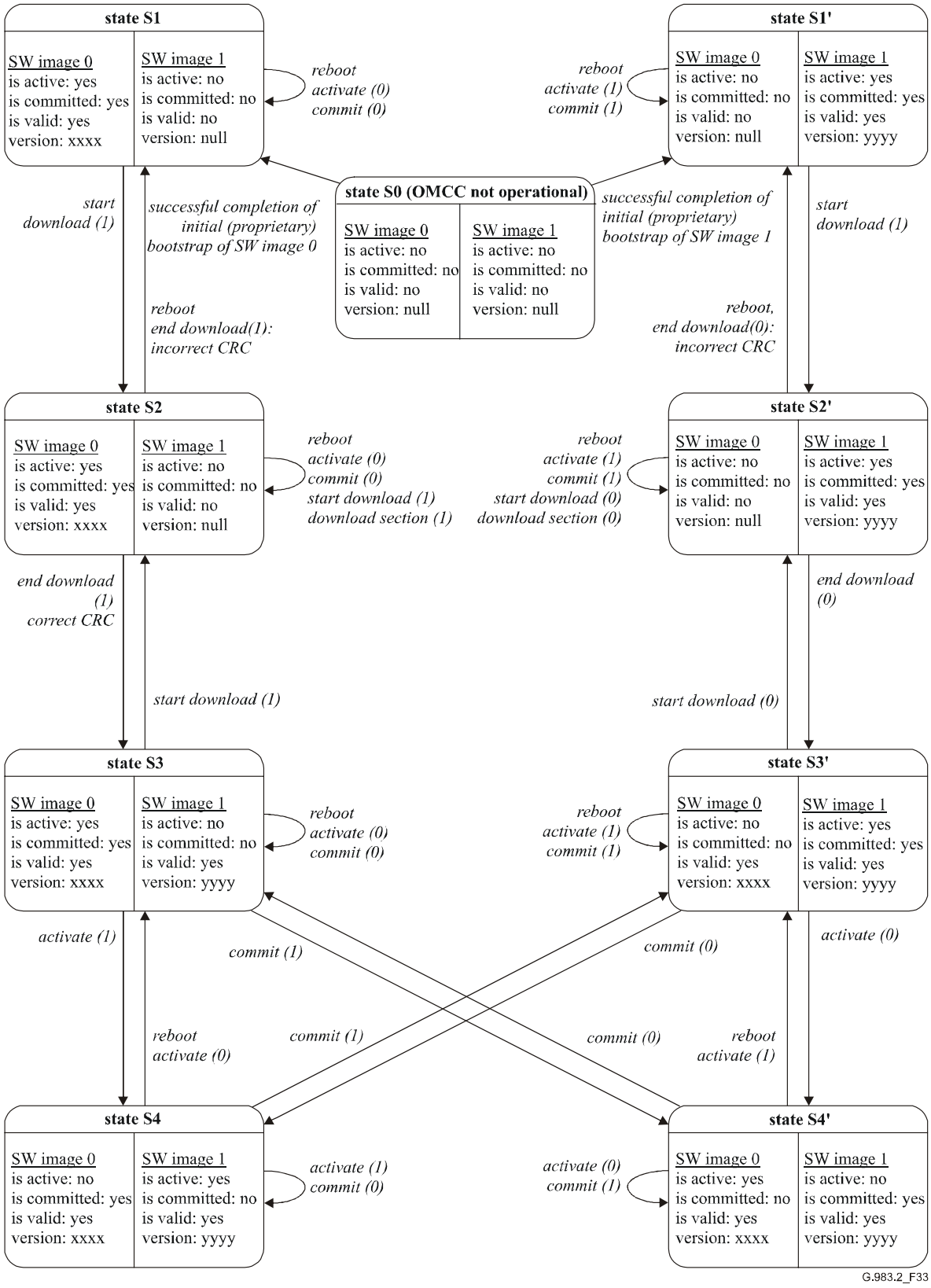


Figure 33/G.983.2 – Software image state diagram

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7.1.8 $ONU_{B\text{-}PON}$

This managed entity represents the ONU as equipment.

An instance of this managed entity is automatically created by the ONU after initialization. After the creation of this managed entity, the associated attributes are updated according to the data within the ONU itself.

The $ONU_{B\text{-}PON}$ managed entity has the same Relationships, Attributes, Actions, and Notifications as the $ONT_{B\text{-}PON}$ managed entity. The only difference is the M.E. type, which is useful to higher layer management systems to identify ONUs as shared network equipment and ONTs as dedicated termination equipment.

7.2 ANI management

The OMCI will not maintain the basic PON interface information. The OLT will maintain the PON interface related managed entities and will get all the basic ONT-related information needed for those managed entities via PLOAM cells (e.g., Transmit Failure) as specified in ITU-T Rec. G.983.1 [3]. However, these entities are used to hold DBA and APS control information. For the purpose of description, the ONT will autonomously create one instance of each of the managed entities "PON Physical Path Termination Point", "ANI" and "PON TC Adapter" upon creation of the $ONT_{B\text{-}PON}$ managed entity. In cases where DBA or APS are provided, the appropriate attributes will be set accordingly.

7.2.1 PON physical path termination point

An instance of this managed entity represents a point in the ONT where a PON Physical Path terminates and physical path level functions (e.g., path overhead functions) are performed.

An instance of this managed entity is automatically created by the ONT after initialization. However, this instance will not be reported during a MIB upload.

Relationships

One or more instances of this managed entity are contained in an instance of the ONT or PON IF Line Card managed entities.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the PON IF. The first byte is the slot id (defined in 7.1.5). If the PON IF is integrated, this value is 0x80 (128). The second byte is the port id with value range from 0x01 to 0xFF (1 to 255): 0x01 is used for the leftmost/lowest port on a PON IF Line Card, 0x02 is used for the next right/upper port, and so forth. (R) (mandatory) (2 bytes)

Actions

None.

Notifications

None.

7.2.2 ANI

This managed entity is used to organize data associated with the Access Network Interface (ANI) supported by the ONT. One instance of this managed entity shall exist for each ONT.

An instance of this managed entity is automatically created by the ONT after initialization. However, this instance will not be reported during a MIB upload, unless DBA is supported.

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Relationships

One or more instances of this managed entity are contained in an instance of the $ONT_{B\text{-}PON}$ or PON IF Line Card managed entities.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the PON IF. The assigned number is the same as the id of the PON Physical Path Termination Point with which this ANI is associated. (R) (mandatory) (2 bytes)

SR indication: This boolean attribute indicates the capability of status reporting. The value TRUE means that the status reporting is available for all T-CONT buffers which are associated with the ANI. The default value is false. (R) (Mandatory if DBA supported) (1 byte)

Total Data Grant: This attribute provides the total number of data grants that are able to be supported in this ANI port. Upon autonomous instantiation, this attribute will be set to zero. (R) (Mandatory if DBA supported) (1 byte)

Total DS Grant: This attribute provides the total number of divided slot grants that are able to be supported in this ANI port. Upon autonomous instantiation, this attribute will be set to zero. (R) (Mandatory if DBA supported) (1 byte)

T-CONT reporting types: This attribute provides a special code that indicates the kinds of reports that this ONT can perform. Value 0x00 means that T-CONT buffer reporting uses one byte. Value 0x01 means that T-CONT buffer reporting uses one byte or two bytes. Value 0x02 means that T-CONT buffer reporting uses one byte or two or four bytes. More explanation is described in ITU-T Rec. G.983.4. Upon autonomous instantiation, this attribute will be set to zero. (R) (Optional) (1 byte)

Actions

Get: Get one or more attributes.

Notifications

Attribute value change: This notification is used to report autonomous changes of attributes of this managed entity. The notification shall identify the attribute and its new value. The AVCs for this managed entity are given in Table 6a.

Table 6a/G.983.2 – AVC list for physical path termination point ATM ANI

Number	Attribute value change	Description
1	N/A	
2	Total Data Grant	Number of data grants supported
3	Total DS Grant	Number of Divided slot grants supported
4	T-CONT reporting type	The type of DBA reports supported
5-16	Reserved	

7.2.3 PON TC adapter

An instance of this managed entity represents a point in the ONT where the adaptation of the ATM Layer to the underlying physical infrastructure (i.e., the PON) takes place. One instance of this managed entity shall exist for each ONT.

An instance of this managed entity is automatically created by the ONT after initialization. However, this instance will not be reported during an MIB upload, unless APS is supported.

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Relationships

One instance of this managed entity will exist for the PON Physical Path Termination Point managed entity.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the PON Physical Path Termination Point with which this PON TC Adapter is associated. For the 1+1 protection model, the PON TC Adapter is associated with the PON Physical Path Termination Point of the working entity. For the 1:1 protection model, the PON TC Adapter is associated with the PON Physical Path Termination Point of the working entity for normal traffic and of the protection entity for extra traffic. (R) (mandatory) (2 bytes)

TC Adapter type: This attribute represents PON TC Adapter type. Valid values are provided below.

0x0: protection function is not available;

0x1: 1+1 architecture is available;

0x2: 1:1 architecture is available and normal traffic shall be adapted;

0x3: 1:1 architecture is available and extra traffic shall be adapted.

Upon autonomous instantiation, this attribute will be set to zero. (R) (mandatory for PON protection) (1 byte)

Protection pointer: This attribute provides the instance id of the PON Physical Path Termination Point that serves as the protection entity. This attribute is valid only when TC adapter type is 0x1 or 0x2. Upon autonomous instantiation, this attribute will be set to zero. (R) (mandatory for PON protection) (2 bytes)

Revertive Ind: This attribute indicates whether the protection scheme uses revertive mode (= TRUE, value 0x01) or non-revertive mode (= FALSE, value 0x00). Upon autonomous instantiation, this attribute will be set to false. (R) (mandatory for PON protection) (1 byte)

Wait To Restore Time: This attribute specifies the amount of time, in seconds, to wait after a fault clears before restoring traffic to the protected trail/connection/line that initiated the switching. Upon autonomous instantiation, this attribute will be set to zero. (R, W) (mandatory for PON protection) (2 bytes)

Switching Guard Time: This attribute specifies the amount of time, in milliseconds, that must elapse after detection of a fault before a protection trail/connection/line can be used to transport the normal traffic signal and/or to select the normal traffic signal. Upon autonomous instantiation, this attribute will be set to zero. (R, W) (optional) (2 bytes)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

7.2.4 T-CONT buffer

An instance of this managed entity represents a logical object to the data grant provided by the OLT. A T-CONT buffer can accommodate ATM cells in priority queues or Traffic Schedulers that exist in the ATM layer. Therefore, the T-CONT buffer is regarded as a logical buffer.

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Relationships

One or more instances of this managed entity are contained in an instance of the ONT managed entity.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is associated with the physical capability that realizes the T-CONT buffer. The first byte is the slot id of the PON IF card with which this T-CONT buffer is associated. For integrated PON IF interfaces, this byte can be associated with "pseudo" slot id 0x80 (128). If the ONT has T-CONT buffers that are not associated with the PON IF card at the creation of this instance, the first byte of this T-CONT buffer is 0xFF. The second byte is the T-CONT id that is numbered by the ONT itself. The T-CONT id is numbered in ascending order with the range of 0x00 to 0xFF in each PON-IF Line Card or ONT core. (R) (mandatory) (2 bytes)

ANI Pointer: This attribute provides the ANI instance id in which this T-CONT buffer can send ATM cells in response to one of data grants. Upon autonomous instantiation this attribute consists of the 0x8001 or 0x8101. (The default value should be decided in consideration of the backward compatibility.) (R,W) (Mandatory) (2 bytes)

Policy: This attribute represents scheduling policy. Valid values include but are not limited to "Null" (value 0x00), "HOL" (value 0x01) or "WRR" (value 0x02). Upon autonomous instantiation this attribute consists of the 0x01. (R) (mandatory) (1 byte)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

7.3 UNI management

7.3.1 Physical path termination point ATM UNI

This managed entity represents the point at an ATM UNI in the ONT where physical paths terminate and physical path level functions (e.g., path overhead functions) are performed.

An instance of this managed entity shall be automatically created/deleted by the ONT upon the creation/deletion of a Subscriber Line Card of ATM type.

Relationships

One or more instances of this managed entity shall be contained in an instance of a Subscriber Line Card managed entity classified as ATM type.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The first byte is the slot id (defined in 7.1.3). The second byte is the port id with a value range from 0x01 to 0xFF (1 to 255): 0x01 is used for the leftmost/lowest port on a subscriber line card, 0x02 is used for the next right/upper port, and so forth. (R) (mandatory) (2 bytes)

Expected type: The following coding is used for this attribute: 0x00 = by autosensing, 0x01 to 0xFE (1 to 254) = one of the values from Table 3 that is compatible with the type of the LIM. Upon autonomous instantiation, the value 0x00 is used. (R, W) (mandatory) (1 byte)

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Sensed type: If the value of "Expected type" is not equal to 0x00, then the value of "Sensed type" equals the value of "Expected type". If the value of "Expected type" equals 0x00, then the value of "Sensed type" equals one of the values from Table 3 (0x01 to 0xFE) and by necessity is compatible with the Type of the Subscriber Line Card managed entity. Upon autonomous instantiation, the value 0x00 is used. (R) (mandatory if the ONT supports LIMs with configurable interface types, e.g., ATM45/34) (1 byte)

Cable configuration: For an ATM45 interface, there are two options for the cable length. This attribute is used to select the option. Value 0x00: cable length ≤ 68.6 m; value 0x01 cable length > 68.6 m. (R, W) (mandatory for interfaces with cable configuration options) (1 byte)

Loopback Configuration: This attribute represents the loopback configuration of this physical interface. Value 0x00: no loopback; value 0x01: loopback2 ("Loopback2" refers to a loopback at the ONT to the OLT. The OLT can execute a physical level loopback test after loopback2 is set.). Upon autonomous instantiation, the value 0x00 is used. (R, W) (mandatory) (1 byte)

Administrative State: This attribute is used to activate (unlock: value 0x00) and deactivate (lock: value 0x01) the functions performed by instances of this managed entity. Selection of a default value for this attribute is outside the scope of this Recommendation as it is normally handled through supplier-operator negotiations. (R, W) (mandatory) (1 byte)

Operational State: This attribute indicates whether or not this managed entity is capable of performing its task. The operational state reflects the perceived ability to receive or to generate a valid signal. Valid values are enabled (0x00) and disabled (0x01). (R) (optional) (1 byte)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

Attribute value change: This notification is used to report autonomous changes of attributes of this managed entity. The notification shall identify the attribute and its new value. The AVCs for this managed entity are given in Table 6b.

Alarm: This notification is used to notify the management system when a failure has been detected or cleared. Both ONT and OLT should know the alarm list used by this entity. The alarms for this entity are given in Table 6c. The SDH and SONET interface related alarm should be consistent with the existing standards. The relevant Recommendations are ITU-T Recs G.744, M.3100 and Q.834.1.

Table 6b/G.983.2 – AVC list for physical path termination point ATM UNI

Number	Attribute value change	Description
1	N/A	
2	SensedType	Sensed SLC type (values given in Table 3)
3	N/A	
4	N/A	
5	N/A	
6	OpState	Operational state
7-16	Reserved	

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Table 6c/G.983.2 – Alarm list for physical path termination point ATM UNI

Number	Alarm	Description
0	TF	Transmitter failure
1	LOS	Loss of signal
2	LOF	Loss of frame
3	OOF	Out of frame
4	RAI	Remote alarm indication
5	ERR	Block error
6	OOF (PLCP)	Out of frame (physical layer convergence protocol)
7	RAI (PLCP)	Remote alarm indication (physical layer convergence protocol)
8	ERR (PLCP)	Block error (physical layer convergence protocol)
9	REI (PLCP)	Remote error indication (physical layer convergence protocol)
10	SONET/SDH MS-SD	Multiplex section – signal degraded
11	SONET/SDH MS-RDI	Multiplex section – remote defect indication
12	SONET/SDH MS-ERR	Multiplex section – block error
13	SONET/SDH MS-REI	Multiplex section – remote error indication
14	SONET/SDH MS-AIS	Multiplex section – alarm indication signal
15	SONET/SDH P-RDI	Path – remote defect indication
16	SONET/SDH P-ERR	Path – block error
17	SONET/SDH P-REI	Path – remote error indication
18	SONET/SDH P-AIS	Path-alarm indication signal
19	SONET/SDH LOP	Loss of pointer in the VC4
20	1.5 M REC	1.544 Mbit/s receive alarm
21	1.5 AIS	1.544 Mbit/s alarm indication signal
22	1.5 M BAIS	1.544 Mbit/s back alarm indication signal
23	6 M REC	6.312 Mbit/s receive alarm
24	6 M SEND	6.312 Mbit/s send alarm
25	6 M ERR	6.312 Mbit/s block error
26	2 M RDI	2.048 Mbit/s remote defect indication
27	2 M E-ERR	2.048 Mbit/s CRC-4 error indication
28	2 M AIS	2.048 Mbit/s alarm indication signal
29	8 M RDI	8.448 Mbit/s remote defect indication
30	8 M AIS	8.448 Mbit/s alarm indication signal
31	34 M RDI	34.368 Mbit/s remote defect indication
32	34 M AIS	34.368 Mbit/s alarm indication signal
33	34 M FEBE	34.368 Mbit/s far end block error
34	45 M RDI	44.736 Mbit/s remote defect indication
35	45 M AIS	44.736 Mbit/s alarm indication signal
36	45 IDLE	44.736 Mbit/s idle
37-223	Reserved	
224-239	Vendor-specific alarms	Not to be standardized

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7.3.2 Physical path termination point Ethernet UNI

This managed entity represents the points at an Ethernet UNI in the ONT where physical paths terminate and physical path level functions (e.g., Ethernet function) are performed.

An instance of this managed entity shall be automatically created/deleted by the ONT upon the creation/deletion of a Subscriber Line Card of Ethernet type.

Relationships

One or more instances of this managed entity shall be contained in an instance of a Subscriber Line Card managed entity classified as a native LAN type (e.g., Ethernet).

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The first byte is the slot id (defined in 7.1.3). The second byte is the port id with value range from 0x01 to 0xFF (1 to 255): 0x01 is used for the leftmost/lowest port on a subscriber line card, 0x02 is used for the next right/upper port, and so forth. (R) (mandatory) (2 bytes)

Expected type: The following coding is used for this attribute: 0x00 = by autosensing, 0x01 to 0xFE (1 to 254) equals one of the values from Table 3 that is compatible with the type of the LIM. Upon autonomous instantiation, the value 0x00 is used. (R, W) (mandatory) (1 byte)

Sensed type: If the value of "Expected type" is not equal to 0x00, then the value of "Sensed type" equals the value of "Expected type". If the value of "Expected type" equals 0x00, then the value of "Sensed type" = one of the values from Table 3 and by necessity is compatible with the Type of Subscriber Line Card managed entity. Upon autonomous instantiation, the value 0x00 is used. (R) (mandatory if the ONT supports LIMs with configurable interface types, e.g., 10/100 BaseT card) (1 byte)

Auto Detection Configuration: For 10/100 Base-Tx Ethernet interfaces, this attribute is used to set the configuration options: Auto-sensing: 0x00; 10BaseT: 0x01; 100BaseT: 0x02: Gigabit Ethernet: 0x03; 10BaseT Auto-sensing: 0x10; 10BaseT (half duplex): 0x11; 100BaseT (half duplex): 0x12; Gigabit Ethernet (half duplex): 0x13; Gigabit Ethernet Auto-sensing: 0x20. Upon autonomous instantiation, the value 0x00 is used. (R, W) (mandatory for interfaces with auto detection options) (1 byte)

Ethernet loopback configuration: This attribute is used to set the Ethernet loopback configuration: No loopback (value 0x00), Loop3 (value 0x03, Loopback of downstream traffic after PHY transceiver). Loop 3 is depicted in Figure 34. Upon autonomous instantiation, the value 0x00 is used. (R, W) (mandatory) (1 byte)

Administrative State: This attribute is used to activate (unlock: value 0x00) and deactivate (lock: value 0x01) the functions performed by instances of this managed entity. Selection of a default value for this attribute is outside the scope of this Recommendation as it is normally handled through supplier-operator negotiations. (R, W) (mandatory) (1 byte)

Operational State: This attribute indicates whether or not this managed entity is capable of performing its task. The operational state reflects the perceived ability to receive or to generate a valid signal. Valid values are enabled (0x00) and disabled (0x01). (R) (optional) (1 byte)

ConfigurationInd: This attribute indicates the configuration status of the Ethernet UNI. 10BaseT (full duplex): 0x01; 100BaseT (full duplex): 0x02; Gigabit Ethernet (full duplex): 0x03; 10BaseT (half duplex): 0x11; 100BaseT (half duplex): 0x12 Gigabit Ethernet (half duplex): 0x13; When the configuration status is not detected (e.g., Ethernet link is not established or line card is not yet installed), the value 0x00 is used. Upon autonomous instantiation, the value 0x00 is used. (R) (mandatory) (1 byte)

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MaxFrameSize: This attribute denotes the maximum allowed frame size to be transmitted across this interface. Upon autonomous instantiation, the value 1518 is used. (R,W) (mandatory) (2 bytes)

DTEorDCEInd: This attribute indicates whether the Ethernet interface wiring is DTE or DCE (DCE: 0x00; DTE: 0x01). Upon autonomous instantiation, the value 0x00 is used. (R, W) (mandatory) (1 byte)

PauseTime: This attribute allows the ONT line card to request that the customer terminal temporarily suspend sending data. Units are in "pause_quanta" (1 pause_quantum equals 512 bits times of the particular implementation). Values: 0x0000 to 0xFFFF. Upon autonomous instantiation, the value 0x0000 is used. (R,W) (optional) (2 bytes)

BridgedorIPInd: This attribute indicates whether the Ethernet interface is bridged or derived from an IP router function (Bridged: 0x00; IP router: 0x01; 0x02: depends on Subscriber Line Card.) 0x02 means that the SLC "BridgedorIPInd" attribute will be either 0x00 or 0x01. Upon autonomous instantiation, the value 0x02 is used. (R, W) (optional) (1 byte)

ARC: This attribute is used to control alarm reporting from this managed entity. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

ARCInterval: This attribute provides a provisionable length of time. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

PPPoE Filter: This attribute may be used to control filtering of PPPoE packets on this Ethernet port. The value 0x00 is used to disable filtering. The value 0x01 is used to enable filtering. When filtering is enabled, all packets other than PPPoE packets will be discarded. Default value is 0x00. (R,W) (optional) (1 byte)

Power control: This attribute controls whether power is provided to an external equipment over the Ethernet PPTP. Value 0x01 enables power over Ethernet. The default value 0x00 disables power feed. (R, W) (optional) (1 byte)

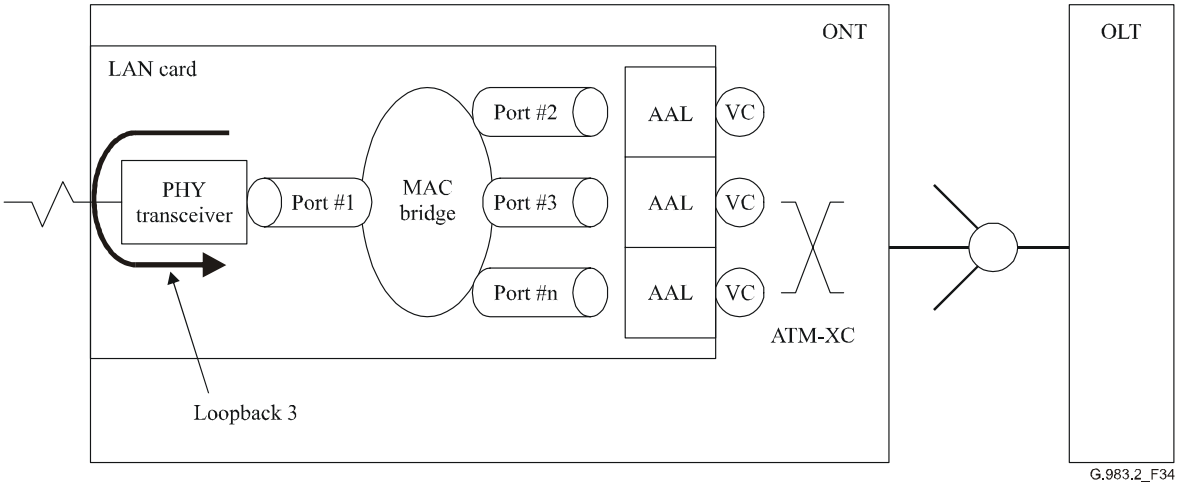


Figure 34/G.983.2 – Schematic diagram of Loop 3

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

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Notifications

Attribute value change: This notification is used to report autonomous changes of attributes of this managed entity. The notification shall identify its new value. The AVC list is given in Table 6d.

Alarm: This notification is used to notify the management system when a failure has been detected or cleared. Both ONT and OLT should know the alarm list used by this entity. The alarm list for this entity is given in Table 6e. See also Appendix III.

Table 6d/G.983.2 – AVC list for physical path termination point Ethernet UNI

Number	Attribute value change	Description
1	N/A	
2	SensedType	Sensed type of Ethernet interface. Valid values are 0x01 (10BaseT), 0x02 (100BaseT) and 0x03 (Gigabit).
3	N/A	
4	N/A	
5	N/A	
6	OpState	Operational state
7-10	N/A	
11-16	Reserved	

Table 6e/G.983.2 – Alarm list for physical path termination point Ethernet UNI

Number	Alarm	Description
0	LAN-LOS	No carrier at the Ethernet UNI
1-223	Reserved	
224-239	Vendor-specific alarms	Not to be standardized

7.3.3 Physical path termination point CES UNI

This managed entity represents the points at a CES UNI in the ONT where physical paths terminate and physical path level functions are performed.

An instance of this managed entity shall be automatically created/deleted by the ONT upon the creation/deletion of a Subscriber Line Card of CES type.

Relationships

One or more instances of this managed entity shall be contained in an instance of a Subscriber Line Card managed entity classified as CES type.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The first byte is the slot id (defined in 7.1.3). The second byte is the port id with a value range from 0x01 to 0xFF (1 to 255): 0x01 is used for the leftmost/lowest port on a subscriber line card, 0x02 is used for the next right/upper port, and so forth. (R) (mandatory) (2 bytes)

Expected type: The following coding is used for this attribute: 0x00 = by autosensing, 0x01 to 0xFE (1 to 254) equals one of the values from Table 3 that is compatible with the type of the LIM. Upon autonomous instantiation, the value 0x00 is used. (R, W) (mandatory) (1 byte)

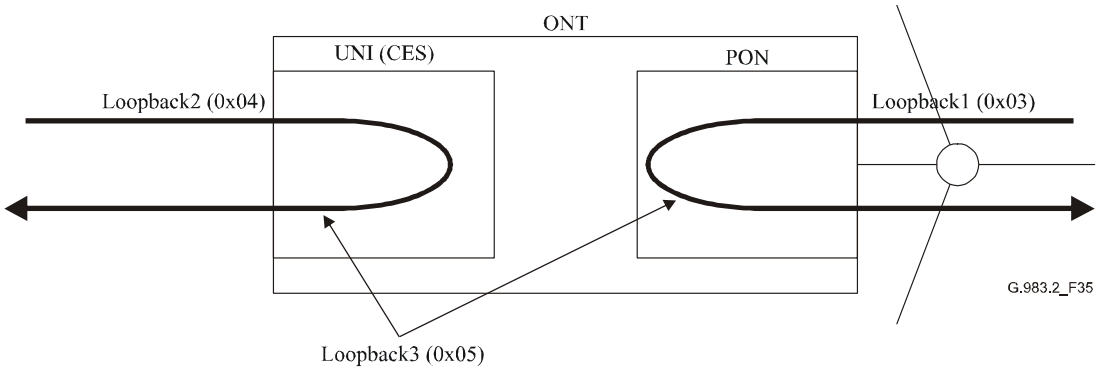
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Sensed type: If the value of "Expected type" is not equal to 0x00, then the value of "Sensed type" equals the value of "Expected type". If the value of "Expected type" equals 0x00, then the value of "Sensed type" = one of the values from Table 3 and by necessity is compatible with the Type of the Subscriber Line Card managed entity. Upon autonomous instantiation, the value 0x00 is used. (R) (mandatory for the case of ONT supports LIMs with configurable interface types, e.g., C1.5/2/6.3) (1 byte)

CES loopback configuration: This attribute represents the loopback configuration of the physical interface. (See Figure 35.)

- Value 0x00: no loopback;
- value 0x01: payload loopback;
- value 0x02: line loopback;
- value 0x03: OpS-directed loopback1 (loopback from/to ATM network side);
- value 0x04: OpS-directed loopback2 (loopback from/to CES UNI side);
- value 0x05: OpS-directed loopback3 (loopback of both ATM network side and CES UNI side);
- value 0x06: Manual button-directed loopback (Read only);
- value 0x07: Network-side Code inband-directed loopback (Read only);
- value 0x08: SmartJack-directed loopback (Read only);
- value 0x09: Network-side Code inband-directed loopback. (ARMED) (Read only).

Upon autonomous instantiation, the value 0x00 is used. (R, W) (mandatory) (1 byte)



NOTE – For loopback3, note that both paths are wrapped independently.

Figure 35/G.983.2 – Schematic diagram of loopback1, loopback2, and loopback3

Administrative State: This attribute is used to activate (unlock: value 0x00) and deactivate (lock: value 0x01) the functions performed by instances of this managed entity. Selection of a default value for this attribute is outside the scope of this Recommendation as it is normally handled through supplier-operator negotiations. (R, W) (mandatory) (1 byte)

Operational State: This attribute indicates whether or not this managed entity is capable of performing its task. The operational state reflects the perceived ability to receive or to generate a valid signal. Valid values are enabled (0x00) and disabled (0x01). (R) (optional) (1 byte)

DS1Framing: This attribute indicates the framing structure used. Valid values are "ExtendedSuperFrame" (0x00), "SuperFrame" (0x01), "UnFrame" (0x02), "G.704" (0x03) and "JT-G.704" (0x04). Upon autonomous instantiation, the value 0x00 is used. (R, W) (1 byte) (mandatory)

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Encoding: This attribute denotes the encoding scheme required. Valid values are "B8ZS" (value 0x00), "AMI" (value 0x01), "HDB3" (0x02), and "B3ZS" (0x03). Upon autonomous instantiation, the value 0x00 is used. (R, W) (1 byte) (mandatory)

LineLength: This attribute provides the length of the twisted pair cable from the physicalPathTTP of type "DS1" interface to the DSX1 cross-connect point or the length of the DS3 cable from the physicalPathTTP of type "DS3" to the DSX3 cross-connect point. Valid values are given in Table 6f. Upon autonomous instantiation for DS1 interfaces, the value 0x00 is used for non-power feed type DS1, and the value 0x06 is used for power feed type DS1. Upon autonomous instantiation for DS3 interfaces, the value 0x0F is used. (R, W) (1 byte) (optional)

DS1Mode: This attribute indicates the mode of DS1 used. The valid values are "Mode#1" (value 0x00), "Mode#2" (value 0x01), "Mode#3" (value 0x02), and "Mode#4" (value 0x03). Moreover, each Mode is defined as described in Table 6g. Upon autonomous instantiation, the value 0x00 is used. (R,W) (optional) (1 byte)

Table 6f/G.983.2 – Valid values for LineLength attribute

Value	Power feed	Line length
0x00	Non-power feed type DS1	0-33.5 m (0-110 ft)
0x01	Non-power feed type DS1	33.5-67.1 m (110-220 ft)
0x02	Non-power feed type DS1	67.1-100.6 m (220-330 ft)
0x03	Non-power feed type DS1	100.6-134.1 m (330-440 ft)
0x04	Non-power feed type DS1	132.1-167.6 m (440-550 ft)
0x05	Non-power feed type DS1	167.6-201.2 m (550-660 ft)
0x06	Power feed type DS1 (Wet-T1), short-haul	0-40.5 m (0-133 ft)
0x07	Power feed type DS1 (Wet-T1), short-haul	40.5-81.1 m (133-266 ft)
0x08	Power feed type DS1 (Wet-T1), short-haul	81.1-121.6 m (266-399 ft)
0x09	Power feed type DS1 (Wet-T1), short-haul	121.6-162.5 m (399-533 ft)
0x0A	Power feed type DS1 (Wet-T1), short-haul	162.5-199.6 m (533-655 ft)
0x0B	Power feed type DS1 (Wet-T1), long-haul	0 dB
0x0C	Power feed type DS1 (Wet-T1), long-haul	7.5 dB
0x0D	Power feed type DS1 (Wet-T1), long-haul	15 dB
0x0E	Power feed type DS1 (Wet-T1), long-haul	22.5 dB
0x0F	DS3 power feed	0-68.5 m (0-225 ft)
0x10	DS3 power feed	68.5-137.1 m (226-450 ft)

Table 6g/G.983.2 – Coding of DS1Mode attribute

Mode	Connect	Line length	Power feed	Loop back
#1	DS1-CPE	Short Haul	Without power feed	Smart Jack
#2	DS1-CPE	Long Haul	Without power feed	Smart Jack
#3	DS1-NIU-CPE	Long Haul	Without power feed	Intelligent Office Repeater
#4	DS1-NIU-CPE	Long Haul	With power feed	Intelligent Office Repeater

ARC: This attribute is used to control alarm reporting from this managed entity. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

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ARCInterval: This attribute provides a provisionable length of time. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

LineType: This attribute denotes the line type used in the application for DS3 or E3 interfaces. Valid values are:

- 0x00, Other;
- 0x01, ds3m23;
- 0x02, ds3syntran;
- 0x03, ds3CbitParity;
- 0x04, ds3ClearChannel;
- 0x05, e3Framed;
- 0x06, e3plcp.

(R, W) (mandatory for DS3 and E3 interfaces, not applicable to other interfaces) (1 byte)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

Attribute value change: This notification is used to report autonomous changes of attributes of this managed entity. The notification shall identify its new value. The list of AVCs for this managed entity is given in Table 7a.

Alarm: This notification is used to notify the management system when a failure has been detected or cleared. Both ONT and OLT should know the alarm list used by this entity. The alarm list for this entity is given in Table 7b. These alarms should be consistent with the existing standards.

Table 7a/G.983.2 – AVC list for physical path termination point CES UNI

Number	Attribute value change	Description
1	N/A	
2	SensedType	Sensed SLC type (values given in Table 3)
3	CESLoopbackConfig	Loopback configuration of physical interface
4	N/A	
5	OpState	Operational state
6-8	N/A	
9-16	Reserved	

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Table 7b/G.983.2 – Alarm list for physical path termination point CES UNI

Number	Alarm	Description
0	TF	Transmitter failure
1	LOS	Loss of signal
2	LOF	Loss of frame
3	OOF	Out of frame
4	RAI	Remote alarm indication
5	1.5 M BAIS	1.544 Mbit/s back alarm indication signal
6	R-INH	Receive alarm – inhibit
7	6 M REC	6.312 Mbit/s receive alarm
8	6 M SEND	6.312 Mbit/s send alarm
9	6 M ERR	6.312 Mbit/s block error
10	6 M BERR	6.312 Mbit/s back error
11	34 M REC	34.368 Mbit/s receive alarm
12	34 M AIS	34.368 Mbit/s alarm indication signal
13	2 M REC	2.048 Mbit/s receive alarm
14	2 M AIS	2.048 Mbit/s alarm indication signal
15	1.5 M REC	1.544 Mbit/s receive alarm
16	1.5 AIS	1.544 Mbit/s alarm indication signal
17	INFO0	INFO0 reception (INFO0)
18	45 M RDI	44.736 Mbit/s remote defect indication
19	45 M AIS	44.736 Mbit/s alarm indication signal
20-223	Reserved	
224-239	Vendor-specific alarms	Not to be standardized

7.3.4 Logical N × 64 kbit/s sub-port connection termination point

This managed entity is used to generically model *logical* sub-ports contained within a higher level physical layer interface (e.g., DS0s within a DS1, DS1s within a DS3, etc.). A single instance of this managed entity can represent an arbitrary (i.e., consecutive or non-consecutive) group of multiple channels/time slots (e.g., multiple DS0/DS1) at the user side as an integral bundle.

An instance of this managed entity shall be created by the OLT before the creation of an associated Interworking VCC Termination Pointer (see 7.3.7, Interworking VCC termination point).

Relationships

Zero or more instances of this ME shall be contained in an instance of the Physical Path Termination Point CES UNI.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

Physical Path Termination Pointer: This attribute provides a pointer to the instance of the corresponding Physical Path Termination Point CES UNI managed entity id. (R, Set-by-create) (mandatory) (2 bytes)

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List of Time Slots: This attribute provides a bitmap, which indicates the time slots. Each bit indicates whether the corresponding time slot is included in the connection or not. The correspondence is as indicated in Table 8. (R, Set-by-create) (mandatory) (12 bytes)

Table 8/G.983.2 – Coding list of time slots

Byte	Bit							
	8	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1	TS 0	TS 1	TS 2	TS 3	TS 4	TS 5	TS 6	TS 7
2	TS 8	TS 9	TS 10	TS 11	TS 12	TS 13	TS 14	TS 15
...								
12	TS 88	TS 89	TS 90	TS 91	TS 92	TS 93	TS 94	TS 95

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Notifications

None.

7.3.5 $UNI_{B\text{-}PON}$

This managed entity is used to organize data associated with the ATM User Network Interfaces (UNIs) supported by the ONT. For non-ATM UNIs, this is used as a logical ATM UNI. One instance of this managed entity shall exist for each UNI supported by the ONT.

Instances of this managed entity shall be automatically created/deleted by the ONT immediately following the creation/deletion of a Subscriber Line Card managed entity. After the creation of an instance of this managed entity, the associated attributes are updated according to the data within the Subscriber Line Card (if present) or within the ONT for the case of integrated interfaces on the UNI side.

Note that this managed entity is an aggregation of UNI and UNIinfo managed entities.

Relationships

Zero or more instances of the $UNI_{B\text{-}PON}$ managed entity may be contained in an instance of a Subscriber Line Card managed entity.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The assigned number is the same as the id of the Physical Path Termination Point with which this UNI is associated. (R) (mandatory) (2 bytes)

Local Maximum Number of Supportable VPCs: This attribute identifies the number of VPCs that can be supported by the ONT at this end of the interface. Default is 0x0100 (256). (R) (mandatory for ATM interfaces) (2 bytes)

Local Maximum Number of Allocated VPI Bits: This attribute identifies the maximum number of allocated bits of the VPI sub-field that can be supported by the ONT at this UNI. Default is 0x08. (R) (mandatory for ATM interfaces) (1 byte)

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Loopback Location Code: This attribute provides the code that identifies incoming ATM layer OAM loopback cells that are to be looped-back at this UNI (see also Appendix III). The default of this attribute consists of all 0xFFs. (R, W) (mandatory for ATM interfaces) (16 bytes)

Configuration Option Status: This attribute holds the UNI Configuration Code field. Its bits are assigned as described in Table 9. Upon autonomous instantiation, the value zero is used. (R, W) (mandatory) (2 bytes)

Administrative State: This attribute is used to "unlock" (value 0x00) and "lock" (value 0x01) the functions performed by the UNI. When the Administrative State attribute is set to "lock", all user traffic to and from this UNI is blocked and alarms for this UNI and all associated managed entities are no longer generated. Selection of a default value for this attribute is outside the scope of this Recommendation as it is normally handled through supplier-operator negotiations. (R, W) (mandatory) (1 byte)

Table 9/G.983.2 – Coding of the configuration option status attribute

Bit	Name	Setting
1	ServerTrailFaultPropagation ATM layer	0: Upstream VP-AIS generation in the ATM cell flow is deactivated 1: Upstream VP-AIS generation in the ATM cell flow is activated
2	ServerTrailFaultPropagation TC layer	0: All TC layer alarm reporting through the OMCC is inhibited 1: All TC layer alarm reporting through the OMCC is not inhibited
3	ServerTrailFaultPropagation PHY layer	0: All PHY layer alarm reporting through the OMCC is inhibited 1: All PHY layer alarm reporting through the OMCC is not inhibited
4	ServerTrailFaultPropagation AAL layer	0: All AAL layer alarm reporting through the OMCC is inhibited 1: All AAL layer alarm reporting through the OMCC is not inhibited
5-16	Reserved	

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

7.3.6 TC Adapter$_{\text{B-PON}}$

An instance of this managed entity represents a point in the ATM subscriber line card where the adaptation of the ATM layer to the underlying physical infrastructure (e.g., SDH or PDH transport network) takes place. ITU-T Rec. I.321 [4] identifies this adaptation function as one of many functions performed at the Transmission Convergence (TC) Sublayer of the B-ISDN protocol stack. This managed entity is responsible for generating alarms that report the (in)ability of the managed entity to delineate ATM cells from the payload of a terminated digital transmission path.

An instance of this managed entity shall be automatically created/deleted by the ONT upon the creation/deletion of an ATM UNI and its Physical Path Termination Point.

Relationships

Zero or more instances of this managed entity shall be contained in the Subscriber Line Card managed entity. One instance of this managed entity shall exist for each instance of the Physical Path Termination Point managed entity.

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Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the Physical Path Termination Point with which this TC Adapter$_{B\text{-}PON}$ is associated. (R) (mandatory) (2 bytes)

Framer configuration: Some UNIs such as the ATM45 have two methods of mapping ATM cells into the payload of a DS3 frame: physical layer convergence protocol (PLCP) based mapping and HEC based mapping. This attribute is used to select the "PLCP option" (value 0x01) or the "HEC option" (value 0x00). Upon autonomous instantiation, this attribute is set to "PLCP option". (R, W) (mandatory for interfaces with framer configuration options) (1 byte)

Cell Scrambling Control: This attribute is used to activate/deactivate the ATM cell scrambling function. This attribute is only present for ATM interfaces where ATM cell scrambling may be controlled, i.e., "activated" (value 0x01) or "deactivated" (value 0x00). [B-7] requires cell scrambling for ATM/SONET interfaces but allows cell scrambling to be controlled (i.e., turned on and off) for ATM/DS3 interfaces. Upon autonomous instantiation, this attribute is set to "activated". (R, W) (mandatory for interfaces with scrambling options) (1 byte)

Cell Rate Decoupling Type: This attribute is used to select the cell rate decoupling type whenever ITU-T Rec. I.432.1 [11] and [B-8] give different definitions. ITU-T defined type: 0x00; ATM Forum defined type: 0x01. Upon autonomous instantiation, 0x00 is used. (R, W) (mandatory for interfaces with decoupling options) (1 byte)

Operational State: This attribute indicates whether or not this managed entity is capable of performing its task. The operational state reflects the perceived ability to receive or to generate a valid signal. Valid values are enabled (0x00) and disabled (0x01). (R) (optional) (1 byte)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

Attribute value change: This notification is used to report autonomous changes of attributes of this managed entity. The notification shall identify the attribute and its new value. The list of AVCs for this managed entity is given in Table 10a.

Alarm: This notification is used to notify the management system when a failure has been detected or cleared. Both ONT and OLT should know the alarm list used by this entity. The alarm list for this entity is given in Table 10b.

Table 10a/G.983.2 – AVC list for TC Adapter$_{B\text{-}PON}$

Number	Attribute value change	Description
1-3	N/A	
4	OpState	Operational state of TC Adapter$_{B\text{-}PON}$
5-16	Reserved	

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Table 10b/G.983.2 – Alarm list for TC Adapter$_{B\text{-}PON}$

Number	Alarm	Description
0	LCD	Loss of cell delineation
1-223	Reserved	
224-239	Vendor-specific alarms	Not to be standardized

7.3.7 Interworking VCC termination point

An instance of this managed entity represents a point in the ONT where the interworking of a service (e.g., CES, IP) or underlying physical infrastructure (e.g., nxDSO/DS1/DS3/E3/Ethernet) takes place. At this point, ATM cells are generated from a bit stream (e.g., nxDSO/DS1/DS3/E3/Frame Relay/Ethernet) or a bit stream is reconstructed from ATM cells.

Instances of this managed entity are created and deleted by the ONT on request of the OLT.

Establishment of a "CES interworking connection"

Since it is more complicated to introduce the "pointer list" as an attribute, the following mechanism will be used to create a CES interworking connection:

- for structured service: Create first a VP Network CTP$_{B\text{-}PON}$ instance *and* an N × 64 kbit/s Sub-port Connection Termination Point instance, and then create an Interworking VCC Termination Point; the latter would contain a reference to the VP Network CTP$_{B\text{-}PON}$ instance on one hand and the N × 64 kbit/s Sub-port Connection Termination Point instance on the other hand; or
- for unstructured service: Create first a VP Network CTP$_{B\text{-}PON}$ instance, and then create an interworking VCC Termination Point; the latter would contain a reference to the VP Network CTP$_{B\text{-}PON}$ instance on one hand and to the Physical Path Termination Point CES UNI instance on the other hand.

Establishment of other connection types

Create first a VP Network CTP$_{B\text{-}PON}$ instance, and then create an interworking VCC Termination Point. The latter would contain a reference to the VP Network CTP$_{B\text{-}PON}$.

Relationships

One instance of this managed entity shall exist for each occurrence of transformation of a data stream into ATM cells and vice versa. Note that the attributes "AAL Profile pointer" and "Service Profile pointer" imply relationships to these managed entities.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The value 0xFFFF is reserved. (R, Set-by-create) (mandatory) (2 bytes)

VCI Value: This attribute identifies the VCI value associated with this Interworking VCC Termination Point. (R, Set-by-create) (mandatory) (2 bytes)

VP/VCNetworkCTP Connectivity Pointer: This attribute provides an instance identifier of the VP Network CTP$_{B\text{-}PON}$ or VC Network CTP$_{B\text{-}PON}$ that is associated with this Interworking VCC Termination Point. (R, Set-by-create) (mandatory) (2 bytes)

Interworking Option: This attribute identifies the type of non-ATM function that is being interworked; the option can be CES (0x00), MAC Bridge LAN (0x01), Voice (0x02) service, IP Router (0x03), VRP (0x04), or 802.1p mapper (0x05). (R, Set-by-create) (mandatory) (1 byte)

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Service Profile Pointer: This attribute provides the service profile type and a pointer to the instance of a service profile, such as the CES Service Profile$_{B\text{-}PON}$ (if the interworking option = 0x00), MAC Bridge Service Profile (if the interworking option = 0x01), Voice Service Profile AAL (if the interworking option = 0x02), IP Router Service Profile (if the interworking option = 0x03), Video Return Path (if the interworking option = 0x04), or 802.1p mapper service profile (if interworking option = 0x05). (R, Set-by-create) (mandatory) (2 bytes)

AAL Profile Pointer: This attribute provides the AAL profile type and a pointer to an instance of AAL Profile such as AAL 1 Profile$_{B\text{-}PON}$ if the interworking option = 0x00, AAL 1 Profile$_{B\text{-}PON}$ or AAL 2 Profile$_{B\text{-}PON}$ if the interworking option = 0x02, or AAL 5 Profile$_{B\text{-}PON}$ if the interworking option = 0x01, 0x03, 0x05, or 0x04 mode 1. If the interworking option is 0x04 mode 2, then this pointer is not used. (R, Set-by-create) (mandatory) (2 bytes)

Interworking Termination Point pointer: This attribute is used for in the case of Circuit Emulation Services, and provides a pointer to the associated instance(s) of the following managed entities (depending on the service provided):

– Physical Path Termination Point CES UNI;

– logical N × 64 kbit/s sub-port Connection Termination Point

In all other non-ATM services, the relationship between the Interworking Termination Point and the IW VCC Termination point is derived from other managed entity relations, and this attribute is set to 0x0000, and not used. (R, Set-by-create) (mandatory) (2 bytes)

AAL Loopback configuration: This attribute is used to set the loopback configuration: No loopback (value 0x00), Loopback 1 (value 0x01, loopback of downstream traffic before FEC of AAL 1), Loopback 2 (value 0x02, loopback of downstream traffic after FEC of AAL 1), loopback after AAL (value 0x03, loopback of downstream traffic after any AAL). Loopback after AAL is depicted in Figure 36. Upon autonomous instantiation, the value 0x00 is used. (R, W) (mandatory) (1 byte)

PPTP Counter: This attribute represents the number of instances of PPTP managed entities associated with this instance of the Interworking VCC Termination Point managed entity. If only one instance of a PPTP managed entity is associated with this instance of the Interworking VCC Termination Point managed entity, this attribute is set to 0x01. If multiple instances of PPTP managed entities are associated with this instance of the Interworking VCC Termination Point managed entity (i.e., in case of AAL 2 multiplexing), this attribute is set to 0xZZ, where ZZ represents the number of associated PPTP instances. (R) (optional) (1 byte)

Operational State: This attribute indicates whether or not this managed entity is capable of performing its task. The operational state reflects the perceived ability to receive or to generate a valid signal. Valid values are enabled (0x00) and disabled (0x01). (R) (optional) (1 byte)

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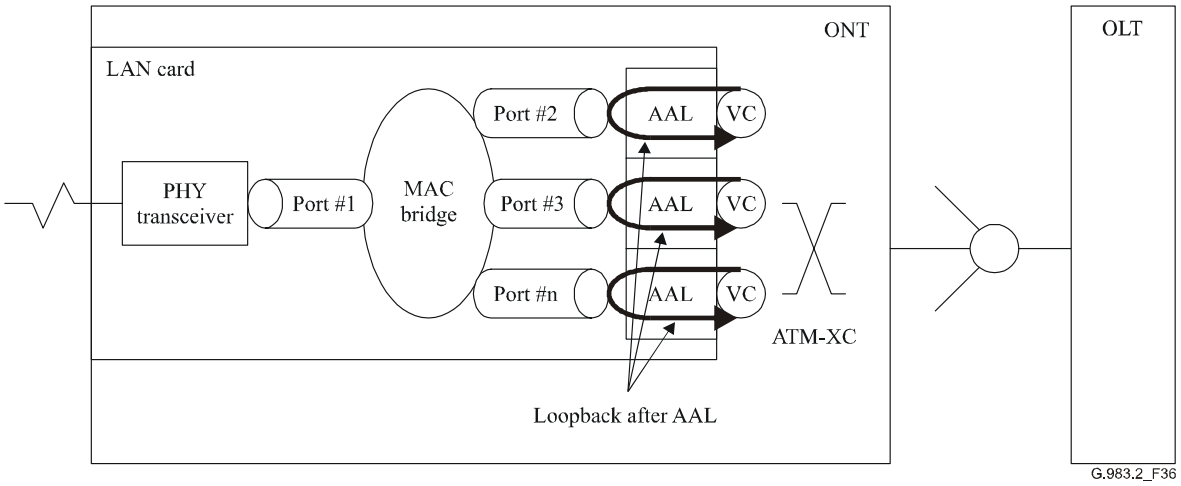


Figure 36/G.983.2 – Schematic diagram of loopback after AAL

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

Attribute value change: This notification is used to report autonomous changes of attributes of this managed entity. The notification shall identify the attribute and its new value. The list of AVCs for this managed entity is given in Table 11a.

Alarm: This notification is used to notify the management system when a failure has been detected or cleared. Both ONT and OLT should know the alarm list used by this entity. The alarm list for this entity is given in Table 11b. See also Appendix III.

Table 11a/G.983.2 – AVC list for interworking VCC termination point

Number	Attribute value change	Description
1-9	N/A	
10	OpState	Operational state of Interworking VCC Termination Point
11-16	Reserved	

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Table 11b/G.983.2 – Alarm list for interworking VCC termination point

Number	Alarm	Description
0	End-to-end VC-AIS-LMIR	End-to-end VC-AIS receiving indication (optional)
1	End-to-end VC-RDI-LMIR	End-to-end VC-RDI receiving indication (optional)
2	End-to-end VC-AIS-LMIG	End-to-end VC-AIS generation indication (optional)
3	End-to-end VC-RDI-LMIG	End-to-end VC-RDI generation indication (optional)
4	Segment Loss of Continuity	Loss of continuity is detected when the Interworking VCC Termination Point is a segment end point (optional)
5	End-to-End Loss of Continuity	Loss of continuity is detected at the Interworking VCC Termination Point (optional)
6	CSA	Cell starvation alarm
7-223	Reserved	
224-239	Vendor-specific alarms	Not to be standardized

7.3.8 AAL 1 Profile$_{B\text{-}PON}$

This managed entity organizes data that describes the AAL Type 1 processing functions of the ONT. It is used with the Interworking VCC Termination Point managed entity.

In an ATM environment, AAL Type 1 configuration parameters are associated with an Interworking VCC Termination Point managed entity through a pointer relationship. Each instance of this managed entity defines a combination of parameter values that may be associated with multiple Interworking VCC Termination Point instances.

This managed entity is instantiated/deleted on request of the OLT.

Relationships

One instance of this managed entity shall exist for each combination of AAL 1 parameter values used within an ONT and may be associated with zero or more instances of the Interworking VCC Termination Point.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

Subtype: This attribute identifies the AAL subtype. Valid values for this attribute are "null" (value 0x00), "voice-band based on 64 kbit/s" (value 0x01), "Synchronous Circuit Emulation" (value 0x02), "Asynchronous Circuit Emulation" (value 0x03), "High-quality Audio" (value 0x04) and "Video" (value 0x05). (R, Set-by-create) (mandatory) (1 byte)

CBR Rate: This attribute represents the rate of the CBR service supported by the AAL. Allowed values are 64 kbit/s (value 0x40), 1544 kbit/s (value 0x0608), 44 736 kbit/s (value 0xAEC0), n × 64 kbit/s (value n × 0 × 40), 2048 kbit/s (value 0 × 0800), etc. (R, Set-by-create) (mandatory) (2 bytes)

Forward Error Correction Type: This attribute indicates the FEC method: no FEC (value 0x00), FEC for Loss Sensitive Signal Transport (value 0x01), or FEC for Delay Sensitive Signal Transport (value 0x02). (R, Set-by-create) (optional) (1 byte)

Structured Data Transfer: This attribute indicates whether Structured Data Transfer (SDT) has been configured at the AAL. A value of 0x01 means SDT has been selected. A value of 0x00 means that no SDT has been selected. This attribute value cannot be set to 0x01 when the Forward Error Correction Type attribute equals 0x01. (R, Set-by-create) (optional) (1 byte)

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Partially Filled Cells: This attribute identifies the number of leading octets in use. (R, Set-by-create) (optional) (1 byte)

Clock Recovery Type: This attribute indicates whether the clock recovery type is "synchronous" (value 0x00), which indicates that timing is derived from the physical interface, "SRTS" (Synchronous Residual Time Stamp, value 0x01), or "ACR" (Adaptive Clock Recovery, value 0x02). (R, Set-by-create) (mandatory) (1 byte)

Cell Loss Integration Period: This attribute represents the duration in milliseconds of the cell loss integration period. If the cell loss persists for such a period, the Interworking VCC Termination Point managed entity associated with this entity will generate a cell starvation alarm. (R, Set-by-create) (mandatory) (2 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Notifications

None.

7.3.9 AAL 1 protocol monitoring history $Data_{B\text{-}PON}$

This managed entity contains the last completed 15-minute interval performance monitoring data collected as a result of performing Segmentation and Reassembly (SAR) Level and Convergence Sublayer (CS) protocol monitoring. All the attribute counters, e.g., the Header Errors, are only updated at the end of each period. Instances of this managed entity are created by the OLT whenever an instance of the Interworking VCC Termination Point managed entity is created that represents AAL 1 functions. Instances of this managed entity are deleted by the OLT.

Relationships

One instance of this managed entity can exist for each instance of the Interworking VCC Termination Point managed entity that represents AAL 1 functions.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the Managed Entity id of the corresponding Interworking VCC Termination Point. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. The attribute counters are updated at the end of the interval. (R) (mandatory) (1 byte)

Threshold $Data_{B\text{-}PON}$ id: This attribute provides a pointer to an instance of the Threshold $Data_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0xFFFF is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

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Header Errors: This attribute represents a count of the number of AAL 1 header errors detected, including those corrected. Header errors include correctable and not correctable CRC and parity errors. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

Sequence Violations: This attribute represents a count of incoming AAL Type 1 SAR-PDUs where the sequence count in the PDU header causes a transition from the SYNC state to the OUT OF SEQUENCE state as defined by ITU-T Rec. I.363.1. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

Cell Loss: This attribute represents a count of the number of lost cells, as detected by the AAL 1 sequence number processing, for example. This count records the number of cells detected as lost in the network prior to the destination interworking function AAL 1 layer processing. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

Cell Misinsertion: This attribute represents a count of sequence violation events that the AAL CS interprets as misinserted cells as defined by ITU-T Rec. I.363.1. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

Buffer Underflows: This attribute represents a count of the number of times the reassembly buffer underflows. In the case of a continuous underflow caused by a loss of ATM cell flow, a single buffer underflow should be counted. If the interworking function is implemented with multiple buffers, such as a cell level buffer and a bit level buffer, then either buffer underflow will cause this count to be incremented. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

Buffer Overflows: This attribute represents a count of the number of times the reassembly buffer overflows. If the interworking function is implemented with multiple buffers, such as a cell level buffer and a bit level buffer, then either buffer overflow will cause this count to be incremented. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

SDT Pointer Reframes: This attribute represents a count of the number of events in which the AAL 1 reassembler finds that a structured data pointer is not where it is expected and must be reacquired. This count is only meaningful for structured data transfer modes as unstructured modes do not use pointers. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (optional) (4 bytes)

SDT Pointer Parity Check Failures: This attribute represents a count of the number of times the AAL reassembler detects a parity check failure at the point where a structured data pointer is expected. This count is only meaningful for structured data transfer modes as unstructured modes do not use pointers. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (optional) (4 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Get current data: This action returns the *current* value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval.

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NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

Support of this action is optional.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a Threshold Crossing Alert (TCA) has been detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. The event list for this entity is given in Table 12.

Table 12/G.983.2 – Alarm list for AAL 1 Protocol Monitoring History Data$_{B\text{-}PON}$

Number	Event	Description	Threshold data counter # (Note)
	Threshold Crossing Alert		
0	Header errors	Header errors threshold crossing	1
1	Sequence Violation	Sequence Violation threshold crossing	2
2	Cell loss	Cell loss threshold crossing	3
3	Cell misinsertion	Cell misinsertion threshold crossing	4
4	Buffer Underflows	Buffer Underflows threshold crossing	5
5	Buffer Overflows	Buffer Overflows threshold crossing	6
6	SDT Pointer Reframes	SDT Pointer Reframes threshold crossing	7
7	SDT Pointer Parity Check Failures	SDT Pointer Parity Check Failures threshold crossing	8
8-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.10 AAL 5 Profile$_{B\text{-}PON}$

This managed entity organizes data that describe the AAL Type 5 processing functions of the ONT. It is used with the Interworking VCC Termination Point managed entity.

In an ATM environment, AAL Type 5 configuration parameters are associated with an Interworking VCC Termination Point managed entity through a pointer relationship. Each instance of the managed entity defines a combination of parameter values that may be associated with multiple Interworking VCC Termination Point instances.

This managed entity is instantiated/deleted on request of the OLT.

Relationships

One instance of this managed entity shall exist for each combination of AAL 5 parameter values used within an ONT and may be associated with zero or more instances of the Interworking VCC Termination Point.

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Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

Max CPCS PDU Size: This multi-valued attribute represents the maximum CPCS PDU size that will be transmitted over the connection in both the upstream and downstream direction of transmission. (R, Set-by-create) (mandatory) (2 bytes)

AAL Mode: This attribute indicates whether the AAL for the supporting VPC is operating in one of the following optional modes: message assured (0x00), message unassured (0x01), streaming assured (0x02), or streaming non-assured (0x03). (R, Set-by-create) (mandatory) (1 byte)

SSCS Type: This attribute identifies the SSCS type for the AAL. Valid values are "null" (0x00), "Data SSCS based on SSCOP, assured operation" (0x01), "Data SSCS based on SSCOP, non-assured operation" (0x02), or "Frame Relay SSCS" (0x03). (R, Set-by-create) (mandatory) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Notifications

None.

7.3.11 AAL 5 protocol monitoring history $Data_{B\text{-}PON}$

This managed entity contains the last completed 15-minute interval performance monitoring data collected as a result of performing Segmentation and Reassembly (SAR) Level and Convergence Sublayer (CS) protocol monitoring. All of the attribute counters, e.g., the CRC violations, are only updated at the end of each period.

Instances of this managed entity are created automatically by the OLT whenever an instance of the Interworking VCC Termination Point managed entity is created that represents the AAL 5 functions. Instances of this managed entity are deleted by the OLT.

Relationships

One instance of this managed entity can exist for each instance of the Interworking VCC Termination Point managed entity that represents AAL 5 functions.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the Managed Entity id of the corresponding Interworking VCC Termination Point. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. The attribute counters are updated at the end of the interval. (R) (mandatory) (1 byte)

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Threshold Data$_{B\text{-}PON}$ id: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Sum of Invalid CS Field Errors: This attribute provides a sum-of-errors count for invalid Convergence Sublayer (CS) field errors. For AAL Type 5, this attribute provides a single count of the number of CS PDUs discarded due to one of the following error conditions: Invalid Common Part Indicator (CPI), oversized received SDU, or length violation. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

CRC Violations: This attribute represents a count of CRC violations that were detected for the incoming SAR PDUs. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

Reassembly Timer Expirations: This attribute provides a count of reassembly timer expirations. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory if reassembly timer is implemented) (4 bytes)

BufferOverflows: This attribute indicates the number of times that there was not enough buffer space for a reassembled packet. Default value is 0x00. (R) (mandatory) (4 bytes)

EncapProtocolErrors: This attribute indicates the number of times that the RFC 1483 encapsulation protocol detects a bad header. Default value is 0x00. (R) (mandatory) (4 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Get current data: This action returns the *current* value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

Support of this action is optional.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a threshold crossing alert (TCA) is detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-minute period since that is when the actual counters are reset to 0x00. The alarm list for this entity is given in Table 13.

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Table 13/G.983.2 – Alarm list for AAL 5 protocol monitoring history data$_{B\text{-}PON}$

Number	Event	Description	Threshold data counter # (Note)
	Threshold Crossing Alert		
0	Invalid Fields	Exceeds threshold	1
1	CRC Violation	Exceeds threshold	2
2	Reassembly Timer Expirations	Exceeds threshold	3
3	Buffer Overflows	Exceeds threshold	4
4	Encap Protocol Errors	Exceeds threshold	5
5-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.12 CES Service Profile$_{B\text{-}PON}$

An instance of this managed entity is used to organize data that describe the CES Service functions of the ONT. An instance of this managed entity shall be created and deleted by the OLT.

Relationships

Zero or more instances of this managed entity shall be contained in the ONT$_{B\text{-}PON}$ managed entity. One instance of this managed entity may be associated with zero or more instances of the Interworking VCC Termination Point.

Attributes

Managed Entity id: This attribute provides a unique number for the instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

CES Buffered CDV Tolerance: This attribute represents the duration of user data that must be buffered by the CES interworking entity to offset the Cell Delay Variation. This timing will be in 10 µs increment. The default value for DS1 CES is 750 µs and 1000 µs for DS3 CES. (R, W, Set-by-create) (mandatory) (2 bytes)

Channel Associated Signalling: This attribute selects which AAL 1 format should be used. It applies to structured interfaces only. For unstructured interfaces, this value, if present, must be set to the default of 0x00. The valid values are basic (0x00), e1Cas (0x01), SfCas (0x02), ds1EsfCas (0x03), and j2Cas (0x04). (R, W, Set-by-create) (optional) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

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7.3.13 This clause intentionally left blank

7.3.14 Ethernet performance monitoring history data

This managed entity contains the last completed 15-minute interval collected statistic data for an Ethernet interface. The statistic data value is only updated at the end of each period.

Instances of this managed entity are created/deleted by the OLT after an instance of Physical Path Termination Point Ethernet UNI managed entity is created/deleted.

Relationships

One instance of this Ethernet Performance Monitoring History Data managed entity can exist for each instance of the Physical Path Termination Point Ethernet UNI.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is the same as the id of the Physical Path Termination Point Ethernet UNI. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the statistic data values are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. The statistic data value is updated at the end of the interval. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ id: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

FCSErrors: This attribute provides a count of frames received on a particular interface that are an integral number of octets in length but do not pass the Frame Check Sequence (FCS) check. The count represented by an instance of this object is incremented when the MAC service returns the frameCheckError status to the Link Layer Control (LLC) or other MAC user. Received frames for which multiple error conditions are obtained are counted exclusively according to the error status presented to the LLC. Default value is 0x00. (R) (mandatory) (4 bytes)

Excessive Collision Counter: This attribute provides a count of frames for which transmission on a particular interface fails due to excessive collisions. Default value is 0x00. (R) (mandatory) (4 bytes)

Late Collision Counter: This attribute indicates the number of times that a collision is detected on a particular interface later than 512 bit-times into the transmission of a packet. Default value is 0x00. (R) (mandatory) (4 bytes)

FrameTooLongs: This attribute provides a count of frames received on a particular interface that exceed the maximum permitted frame size. The count is incremented when the MAC service returns the frameTooLong status to the LLC. Default value is 0x00. (R) (mandatory) (4 bytes)

BufferOverflows on Receive: This attribute provides a count of the number of times that the buffer overflows on receive. Default value is 0x00. (R) (mandatory) (4 bytes)

BufferOverflows on Transmit: This attribute provides a count of the number of times that the buffer overflows on transmit. Default value is 0x00. (R) (mandatory) (4 bytes)

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Single Collision Frame Counter: This attribute provides a count of successfully transmitted frames on a particular interface for which transmission is inhibited by exactly one collision. Default value is 0x00. (R) (mandatory) (4 bytes)

Multiple Collisions Frame Counter: This attribute provides a count of successfully transmitted frames on a particular interface for which transmission is inhibited by more than one collision. Default value is 0x00. (R) (mandatory) (4 bytes)

SQECounter: This attribute provides a count of times that the SQE TEST ERROR message is generated by the PLS sublayer for a particular interface. Default value is 0x00. (R) (mandatory) (4 bytes)

Deferred Transmission Counter: This attribute provides a count of frames for which the first transmission attempt on a particular interface is delayed because the medium is busy. The count represented by an instance of this object does not include frames involved in collisions. Default value is 0x00. (R) (mandatory) (4 bytes)

InternalMACTransmit ErrorCounter: This attribute provides a count of frames for which transmission on a particular interface fails due to an internal MAC sublayer transmit error. Default value is 0x00. (R) (mandatory) (4 bytes)

CarrierSenseError Counter: This attribute indicates the number of times that the carrier sense condition was lost or never asserted when attempting to transmit a frame on a particular interface. Default value is 0x00. (R) (mandatory) (4 bytes)

AlignmentError Counter: This attribute provides a count of frames received on a particular interface that are not an integral number of octets in length and do not pass the FCS check. Default value is 0x00. (R) (mandatory) (4 bytes)

InternalMACReceive ErrorCounter: This attribute provides a count of frames for which reception on a particular interface fails due to an internal MAC sublayer receive error. Default value is 0x00. (R) (mandatory) (4 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Get current data: This action returns the *current* value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

Support of this action is optional.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a threshold crossing alert (TCA) is detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. The event list for this entity is given in Table 13a.

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Table 13a/G.983.2 – Alarm list for Ethernet performance monitoring history data

Number	Event	Description	Threshold data counter # (Note)
	Threshold Crossing Alert		
0	FCS Errors	Exceeds threshold	1
1	Excessive Collision Counter	Exceeds threshold	2
2	Late Collision Counter	Exceeds threshold	3
3	FrameTooLongs	Exceeds threshold	4
4	Buffer Overflows on Receive	Exceeds threshold	5
5	Buffer Overflows on Transmit	Exceeds threshold	6
6	Single Collision Frame Counter	Exceeds threshold	7
7	Multiple Collisions Frame Counter	Exceeds threshold	8
8	SQE Counter	Exceeds threshold	9
9	Deferred Transmission Counter	Exceeds threshold	10
10	Internal MAC Transmit Error Counter	Exceeds threshold	11
11	Carrier Sense Error Counter	Exceeds threshold	12
12	Alignment Error Counter	Exceeds threshold	13
13	Internal MAC Receive Error Counter	Exceeds threshold	14
14-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{\text{B-PON}}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.15 CES physical interface monitoring history data

This managed entity contains the last completed 15-minute interval collected statistic data for a physical interface (e.g., DS1/E1/J1/J2) of the CES UNI.

Instances of this managed entity are created/deleted by the OLT after an instance of the Physical Path Termination Point CES UNI managed entity is created/deleted.

The performance management of the physical interfaces used by the CES UNI shall be supported. Possible interfaces include DS1/DS3/E1/E3/J1/J2. The performance management requirements of particular interfaces are described in the corresponding ITU-T Recommendation or other standard document (e.g., ITU-T Rec. G.784 [1]). Failure/notifications should include threshold alerts for unacceptable performance (error) rates. Performance data should include transmission counts of Errored Seconds (ES), Severely Errored Seconds (SES) and Unavailable Seconds (UAS).

Notice that, because of the various operators' requirements and cost advantages, each vendor's ONT may support different levels of performance management of the physical interfaces. It is not stated here that the errored seconds stated below have to be generated for all the possible combinations such as near-end path, far-end path, near-end line, far-end line, etc. Each vendor may use vendor-specific combinations for its implemented features.

Relationships

One instance of this managed entity shall exist for each instance of the Physical Path Termination Point CES UNI.

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Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is the same as the id of the Physical Path Termination Point CES UNI. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ id: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Error Seconds: The number of Errored Seconds encountered by a physical interface in the last completed 15-minute interval. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (2 bytes)

Severely Error Seconds: The number of Severely Errored Seconds encountered by a physical interface in the last completed 15-minute interval. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (2 bytes)

Bursty Error Seconds: The number of Bursty Errored Seconds encountered by a physical interface in the last completed 15-minute interval. A BES is any second that is not a UAS that contains between 2 and 319 error events but no LOS, AIS, or OOF condition. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (Optional) (2 bytes)

Unavailable Seconds: The number of Unavailable Seconds encountered by a physical interface in the last completed 15-minute interval. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (2 bytes)

Controlled Slip Seconds: The number of Controlled Slip Seconds encountered by a physical interface in the last completed 15-minute interval. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (2 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Get current data: This action returns the *current* value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

Support of this action is optional.

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Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a threshold crossing alert (TCA) is detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. Both ONT and OLT should know the event list used by this entity. The list of TCAs for this entity is given in Table 14.

Table 14/G.983.2 – Alarm list for CES physical interface monitoring history data

Number	Event	Description	Threshold Data counter # (Note)
	Threshold Crossing Alert		
0	ES	Exceeds threshold	1
1	SES	Exceeds threshold	2
2	BES	Exceeds threshold	3
3	UAS	Exceeds threshold	4
4	CSS	Exceeds threshold	5
5-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.16 TC adapter protocol monitoring history data

This managed entity contains the last completed 15-minute interval collected performance monitoring as a result of performing Transmission Convergence level protocol monitoring. All the attribute counters, e.g., the discarded cells due to HEC violations, are only updated at the end of each period.

Instances of this managed entity are created/deleted by the OLT after an instance of the corresponding TC Adapter$_{B\text{-}PON}$ managed entity is created/deleted.

Relationships

One instance of this managed entity can exist for each instance of TC Adapter$_{B\text{-}PON}$ or PON TC Adapter.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is the same as the id of the corresponding TC Adapter$_{B\text{-}PON}$ or PON TC Adapter. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. The attribute counters are updated at the end of the interval. (R) (mandatory) (1 byte)

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Threshold Data$_{B\text{-}PON}$ id: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Discarded Cells due to HEC violations: This read-only attribute provides a raw, thresholded count of the number of ATM cells that were discarded (per interface) due to an HEC violation. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

Errored Cells due to HEC violations: This read-only attribute provides a raw, thresholded count of the number of ATM cells that were errored (per interface) due to an HEC violation. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Get current data: This action returns the *current* value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

Support of this action is optional.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a threshold crossing alert (TCA) is detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. Both ONT and OLT should know the event list, given in Table 15, used by this entity.

Table 15/G.983.2 – Alarm list for TC adapter protocol monitoring history data

Number	Event	Description	Threshold data counter # (Note)
	Threshold Crossing Alert		
0	Discarded Cells due to HEC violations	Exceeds threshold	1
1	Errored cells due to HEC violations	Exceeds threshold	2
2-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data B-PON managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

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7.3.17 Threshold Data$_{B\text{-}PON}$

An instance of this managed entity contains threshold values for the performance monitoring parameters maintained in one or more instances of other managed entities.

Instances of this managed entity are created and deleted by request of the OLT.

Relationships

Zero or more instances of this managed entity shall be contained in the ONT$_{B\text{-}PON}$ managed entity. This managed entity may be related to multiple instances of History Data type managed entities, which have a Threshold Data$_{B\text{-}PON}$ id attribute that points to an instance of this managed entity.

Related Managed Entities:

- AAL 1 Protocol Monitoring History Data$_{B\text{-}PON}$;
- AAL 5 Protocol Monitoring History Data$_{B\text{-}PON}$;
- CES Physical Interface Monitoring History Data;
- Ethernet Performance Monitoring History Data;
- TC Adapter Protocol Monitoring History Data;
- UPC Disagreement Monitoring History Data$_{B\text{-}PON}$;
- AAL 2 CPS Protocol Monitoring History Data$_{B\text{-}PON}$;
- AAL 2 SSCS Protocol Monitoring History Data$_{B\text{-}PON}$;
- MAC Bridge PM History Data;
- MAC Bridge Port PM History Data;
- Voice PM History Data;
- VP PM History Data;
- IP Router PM History Data 1;
- IP Router PM History Data 2;
- ICMP PM History Data 1;
- ICMP PM History Data 2;
- VC PM History Data;
- Ethernet Performance Monitoring History Data 2;
- 802.11 Counters;
- ADSL ATU-C Channel Performance Monitoring History Data;
- ADSL ATU-C Performance Monitoring History Data;
- ADSL ATU-R Channel Performance Monitoring History Data;
- ADSL ATU-R Performance Monitoring History Data;
- TC Adaptor Performance Monitoring History Data ADSL;
- VDSL VTU-O Channel Performance Monitoring History Data;
- VDSL VTU-O Physical Interface Monitoring History Data;
- VDSL VTU-R Channel Performance Monitoring History Data;
- VDSL VTU-R Physical Interface Monitoring History Data.

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Attributes

Managed Entity id: This attribute provides a unique number for the instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

Threshold Value 1: This attribute provides the associated threshold value for the 1st thresholded counter in the History Data type managed entity. (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold Value 2: This attribute provides the associated threshold value for the 2nd thresholded counter in the History Data type managed entity. (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold Value 3: This attribute provides the associated threshold value for the 3rd thresholded counter in the History Data type managed entity. (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold Value 4: This attribute provides the associated threshold value for the 4th thresholded counter in the History Data type managed entity. (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold Value 5: This attribute provides the associated threshold value for the 5th thresholded counter in the History Data type managed entity. (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold Value 6: This attribute provides the associated threshold value for the 6th thresholded counter in the History Data type managed entity. (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold Value 7: This attribute provides the associated threshold value for the 7th thresholded counter in the History Data type managed entity. (R, W, Set-by-create) (mandatory) (4 bytes)

Threshold Value 8: This attribute provides the associated threshold value for the 8th thresholded counter in the History Data type managed entity. The default value is 0. (R, W) (mandatory) (4 bytes)

Threshold Value 9: This attribute provides the associated threshold value for the 9th thresholded counter in the History Data type managed entity. The default value is 0. (R, W) (mandatory) (4 bytes)

Threshold Value 10: This attribute provides the associated threshold value for the 10th thresholded counter in the History Data type managed entity. The default value is 0. (R, W) (mandatory) (4 bytes)

Threshold Value 11: This attribute provides the associated threshold value for the 11th thresholded counter in the History Data type managed entity. The default value is 0. (R, W) (mandatory) (4 bytes)

Threshold Value 12: This attribute provides the associated threshold value for the 12th thresholded counter in the History Data type managed entity. The default value is 0. (R, W) (mandatory) (4 bytes)

Threshold Value 13: This attribute provides the associated threshold value for the 13th thresholded counter in the History Data type managed entity. The default value is 0. (R, W) (mandatory) (4 bytes)

Threshold Value 14: This attribute provides the associated threshold value for the 14th thresholded counter in the History Data type managed entity. The default value is 0. (R, W) (mandatory) (4 bytes)

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Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

7.3.18 AAL 2 Profile $_{\text{B-PON}}$

This managed entity organizes data that describe the AAL Type 2 processing functions of the ONT. It is used with the Interworking VCC Termination Point managed entity. In an ATM environment, AAL Type 2 configuration parameters are associated with an Interworking VCC Termination Point managed entity through a pointer relationship. Each instance of the managed entity defines a combination of parameter values that may be associated with multiple Interworking VCC Termination Point instances. This managed entity is instantiated/deleted on request of the OLT. These attributes must be provisioned for both PVC and SVC VCCs.

Relationships

One instance of this managed entity shall exist for each combination of AAL 2 parameter values used within an ONT associated with a VCC that is either an SVC or a PVC. One instance of this managed entity may be associated with one or more instances of an Interworking VCC Termination Point.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

SSCSParameterProfile1Ptr: This attribute points to the SSCSParameterProfile1 instance containing the default values for the Service Specific Convergence Sublayer parameters associated with channels carrying control and management plane traffic (e.g., CCS, ELCP, ISDN D-channels, and LES-EOC). (R, Set-by-create) (mandatory) (2 bytes)

SSCSParameterProfile2Ptr: This attribute points to the SSCSParameterProfile2 instance containing the default values for the Service Specific Convergence Sublayer parameters associated with channels carrying media streams (e.g., POTS or ISDN B-channels). (R, Set-by-create) (mandatory) (2 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Notifications

None.

7.3.19 AAL 2 PVC Profile$_{\text{B-PON}}$

This managed entity organizes data that describe the AAL Type 2 processing functions of the ONT. It is used with the Interworking VCC Termination Point managed entity. In an ATM environment, AAL Type 2 configuration parameters are associated with an Interworking VCC Termination Point managed entity through a pointer relationship. Each instance of the managed entity defines a

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combination of parameter values that may be associated with multiple Interworking VCC Termination Point instances. This managed entity is instantiated/deleted on request of the OLT. These attributes must be provisioned for PVCs (including soft-PVCs).

Relationships

One instance of this managed entity shall exist for each combination of AAL 2 parameter values used within an ONT associated with a VCC that is a PVC. One instance of this managed entity may be associated with one or more instances of an Interworking VCC Termination Point.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the AAL 2 $Profile_{B\text{-}PON}$ with which this AAL 2 PVC $Profile_{B\text{-}PON}$ is associated. (R, Set-by-create) (mandatory) (2 bytes)

AppId: This attribute specifies the protocol combinations used between the Interworking Functions found in the Voice Gateway and the ONT. Valid values include those provided in Section 4.1.1 of ATM Forum Well-Known Addresses and Assigned Codes. (R, Set-by-create) (mandatory) (1 byte)

MaximumNumChan: This attribute provides the maximum number of AAL 2 channels that can be carried by the VC Trail associated with the Interworking VCCTP. It ranges from 0x01 to 0xFF (1 to 255). (R, Set-by-create) (mandatory) (1 byte)

MinimumChanIdVal: This attribute provides the minimum value for the Channel Id allowed for any AAL 2 channel within the connection. (R, Set-by-create) (mandatory) (1 byte).

NOTE 1 – Values from 0 to 15 are reserved.

MaximumChanIdVal: This attribute provides the maximum value for the Channel Id allowed for the AAL 2 channel within the connection (R, Set-by-create) (mandatory) (1 byte).

NOTE 2 – Values from 224 to 255 are reserved.

MaxCPS_SDULen: This attribute provides the maximum allowed length of the Common Part Sublayer Service Data Unit (or CPS SDU) that will be allowed over the connection in either the upstream or downstream direction of transmission. The value is 0x2d or 0x40 (45 or 64 octets). (R, Set-by-create) (mandatory) (1 byte)

TimerCULen: This attribute provides the value (in 10ths of a millisecond) for the "combined use" timer Timer_CU on the ITU-T Rec. I.363.2. (R, Set-by-create) (mandatory) (2 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Notifications

None.

7.3.20 AAL 2 CPS Protocol Monitoring History Data$_{B\text{-}PON}$

This managed entity contains the last completed 15-minute interval performance monitoring data collected as a result of AAL 2 protocol conversion monitoring. All the attribute counters, e.g., the CPSInPkts, are only updated at the end of each period. Instances of this managed entity are created automatically by the OLT whenever an instance of the Interworking VCC Termination Point managed entity is created that represents the AAL 2 functions. Instances of this managed entity are deleted by the OLT.

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Relationships

One instance of this managed entity can exist for each instance of the Interworking VCC Termination Point managed entity that represents AAL 2 functions.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the Managed Entity id of the corresponding Interworking VCC Termination Point. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. The attribute counters are updated at the end of the interval. (R) (mandatory) (1 byte)

Threshold Data$_{\text{B-PON}}$ id: This attribute provides a pointer to an instance of the Threshold Data$_{\text{B-PON}}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

CPSInPkts: This attribute records the number of CPS packets received by the port group associated with the Interworking VCC Termination Point. (R) (mandatory) (4 bytes)

CPSOutPkts: This attribute records the number of CPS packets transmitted by the port group associated with the Interworking VCC Termination Point. (R) (mandatory) (4 bytes)

ParityErrors: This attribute records the number of CPS PDUs discarded because of incorrect parity value in the STF field. (See errnum 0 in Table 6/I.363.2 [14].) If the actual counter saturates, it remains on its maximum value. (R) (mandatory) (4 bytes)

SeqNumErrors: This attribute records the number of CPS PDUs received with incorrect sequence number in the STF. (See errnum 1 in Table 6/I.363.2 [14].) If the actual counter saturates, it remains on its maximum value. (R) (mandatory) (4 bytes)

CPS_OSFMismatchErrors: This attribute records the number of CPS PDUs received for which the number of octets expected for a CPS Packet that overlaps into the next CPS PDU does not match the information contained in the STF field. (See errnum 2 in Table 6/I.363.2 [14].) If the actual counter saturates, it remains on its maximum value. (R) (mandatory) (4 bytes)

CPS_OSFErrors: This attribute records the number of CPS PDUs discarded because of an incorrect Offset Field (OSF) value in the STF field. (See errnum 3 in Table 6/I.363.2 [14].) If the actual counter saturates, it remains on its maximum value. (R) (mandatory) (4 bytes)

CPS_HECErrors: This attribute records the number of CPS packets having a header value indicating transmission errors in the header. (See errnum 4 in the Table 6/I.363.2 [14].) If the actual counter saturates, it remains on its maximum value. (R) (mandatory) (4 bytes)

OversizedSDUErrors: This attribute records the number of times the received CPS packet payload exceeds the maximum length indicated in MaxCPS_SDULen attribute. (See errnum 5 in Table 6/I.363.2 [14].) If the actual counter saturates, it remains on its maximum value. (R) (mandatory) (4 bytes)

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ReassemblyErrors: This attribute records the number of times that partial CPS packets are discarded because errors were detected before reassembly could be completed. (See errnum 6 in Table 6/I.363.2 [14].) If the actual counter saturates, it remains on its maximum value. (R) (mandatory) (4 bytes)

HECOverlapErrors: This attribute records the number of times that a CPS packet is received with a HEC that overlaps a CPS PDS boundary. (See errnum 7 in Table 6/I.363.2 [14].) If the actual counter saturates, it remains on its maximum value. (R) (mandatory) (4 bytes)

UUIErrors: This attribute records the number of times that a UUI is received with a value that is reserved for future use. (See errnum 8 in Table 6/I.363.2 [14].) If the actual counter saturates, it remains on its maximum value. (R) (mandatory) (4 bytes)

CIDErrors: This attribute records the number of times that a CPS PDU is received with an incorrect CID value. (See errnum 9 in Table 6/I.363.2 [14].) If the actual counter saturates, it remains on its maximum value. (R) (mandatory) (4 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Get current data: This action returns the *current* value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

Support of this action is optional.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a threshold crossing alert (TCA) is detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since then the actual counters are reset to 0x00. The event list for this entity is given in Table 15a.

Table 15a/G.983.2 – Alarm list for AAL 2 CPS protocol monitoring history data$_{B\text{-}PON}$

Number	Event	Description	Threshold data counter # (Note)
	Threshold Crossing Alert		
0	Reserved		
1	Reserved		
2	ParityErrors	Exceeds threshold	1
3	SeqNumErrors	Exceeds threshold	2
4	CPS_OSFMismatchErrors	Exceeds threshold	3
5	CPS_OSFErrors	Exceeds threshold	4
6	CPS_HECErrors	Exceeds threshold	5

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Table 15a/G.983.2 – Alarm list for AAL 2 CPS protocol monitoring history data$_{B\text{-}PON}$

Number	Event	Description	Threshold data counter # (Note)
7	OversizedSDUErrors	Exceeds threshold	6
8	ReassemblyErrors	Exceeds threshold	7
9	HECOverlapErrors	Exceeds threshold	8
10	UUIErrors	Exceeds threshold	9
11	CIDErrors	Exceeds threshold	10
12-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data$_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.21 AAL 2 SSCS Protocol Monitoring History Data$_{B\text{-}PON}$

This managed entity contains the last completed 15-minute interval performance monitoring data collected as a result of AAL 2 protocol conversion monitoring. All of the attribute counters are updated only at the end of each period. Instances of this managed entity are created automatically by the OLT whenever an instance of the Interworking VCC Termination Point managed entity is created that represents AAL 2 functions. Instances of this managed entity are deleted by the OLT.

Relationships

One instance of this managed entity can exist for each instance of the Interworking VCC Termination Point managed entity that represents AAL 2 functions.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the Managed Entity id of the corresponding Interworking VCC Termination Point. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. The attribute counters are updated at the end of the interval. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ id: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

OversizedSSSARSDU Errors: This attribute records the number of times that an SSSAR SDU exceeds the maximum length allowed for an SSSAR-SDU of the Segmentation and Reassembly Service Specific Convergence sublayer. See "MaxSSSARSDULen" attribute of AAL 2 SSCS Parameter Profile1 managed entity. (See errnum 10 in Table 3/I.366.1 [15].) If the actual counter saturates, it remains on its maximum value. (R) (optional – used when LES EOC is carried all the way to the ONT) (4 bytes)

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RASTimerExpiry Errors: This attribute records the number of times that the reassembly timer has expired. See "RASTimer" attribute of AAL 2 SSCS Parameter Profile1 managed entity. (See errnum 11 in Table 3/I.366.1 [15].) If the actual counter saturates, it remains on its maximum value. (R) (optional – used when LES EOC is carried all the way to the ONT) (4 bytes)

UndersizedSSTEDPDUErrors: This attribute records the number of times that an SSTED-PDU of length 8 or less has been received. (See errnum 20 in Table 5/I.366.1 [15].) If the actual counter saturates, it remains on its maximum value. (R) (optional – used when LES EOC is carried all the way to the ONT) (4 bytes)

PDULengthMismatchErrors: This attribute records the number of times that the value of the Length field in the SSTED-PDU does not match the length of the received SSTED-PDU. (See errnum 21 in Table 5/I.366.1 [15].) If the actual counter saturates, it remains on its maximum value. (R) (optional – used when LES EOC is carried all the way to the ONT) (4 bytes)

CRCMismatchErrors: This attribute records the number of times that the value of the CRC field is not equal to the CRC calculated over the received information. If the actual counter saturates, it remains on its maximum value. (R) (optional – used when LES EOC is carried all the way to the ONT) (4 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Get current data: This action returns the *current* value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

Support of this action is optional.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a threshold crossing alert (TCA) is detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since then the actual counters are reset to 0x00. The event list for this entity is given in Table 15b.

Table 15b/G.983.2 – Alarm list for AAL 2 SSCS protocol monitoring history data$_{B\text{-}PON}$

Number	Event	Description	Threshold data counter # (Note)
	Threshold Crossing Alert		
0	OversizedSSSARSDUErrors	Exceeds threshold	1
1	RASTimerExpiryErrors	Exceeds threshold	2
2	UndersizedSSTEDPDUErrors	Exceeds threshold	3
3	PDULengthMismatchErrors	Exceeds threshold	4
4	CRCMismatchErrors	Exceeds threshold	5

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Table 15b/G.983.2 – Alarm list for AAL 2 SSCS protocol monitoring history data$_{B\text{-}PON}$

Number	Event	Description	Threshold data counter # (Note)
5-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.22 AAL 2 SSCS Parameter Profile1

This managed entity groups default values for Service Specific Convergence Sublayer parameters for channels carried in an AAL 2 VCC that provide control and management plane traffic. These parameters are defined in ITU-T Rec. I.366.1 [15]. Instances of this managed entity are created and deleted by request of the OLT.

Relationships

Zero or more instances of this managed entity shall exist for each instance of the AAL 2 Profile$_{B\text{-}PON}$ used within an ONT. One instance of this managed entity may be associated with one or more instances of an Interworking VCC Termination Point.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

SegmentLength: This attribute provides the segment length for the Segmentation and Reassembly Service Specific Convergence sublayer. It ranges from 0 to the maximum value provided by MaxCPS_SDULen attribute. (R, Set-by-create) (mandatory) (1 byte)

RASTimer: This attribute provides the reassembly time (in seconds) of the Segmentation and Reassembly Service Specific Convergence sublayer for ITU-T Rec. I.366.1 [15]. (R, Set-by-create) (mandatory) (1 byte)

MaxSSSARSDULen: This attribute provides the maximum length allowed for an SSSAR-SDU of the Segmentation and Reassembly Service Specific Convergence sublayer. It ranges from 0x01 to 0x010020 (1 to 65 568). (R, Set-by-create) (mandatory) (3 bytes)

SSTEDInd: This Boolean attribute indicates whether or not the transmission error detection mechanisms have been selected, with value TRUE indicating selection. (R, Set-by-create) (mandatory) (1 byte)

SSADTInd: This Boolean attribute indicates whether or not the assured data transfer mechanism has been selected, with value TRUE indicating selection. (R, Set-by-create) (mandatory) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Notifications

None.

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7.3.23 AAL 2 SSCS Parameter Profile2

This managed entity groups default values for Service Specific Convergence Sublayer parameters for channels carried in an AAL 2 VCC that provide media streams. These parameters are defined in ITU-T Rec. I.366.2 [17]. Instances of this managed entity are created and deleted by request of the OLT.

Relationships

Zero or more instances of this managed entity shall exist for each instance of the AAL 2 $Profile_{B\text{-}PON}$ used within an ONT. One instance of this managed entity may be associated with one or more instances of an Interworking VCC Termination Point.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

ServiceCatType: This attribute indicates the type of service category provided by AAL 2. Valid values include but are not limited to "Audio" (value is 0x01) and "Multirate" (value is 0x02). (R, Set-by-create) (mandatory) (1 byte)

EncSrcType: This attribute indicates the source for the encoding profile format. Valid values include but are not limited to "ITU-T" predefined (value 0x01) and "ATM Forum" predefined (value 0x02). (R, Set-by-create) (mandatory) (1 byte)

EncProfileIndex: This attribute indicates the specific predefined encoding profile used. Table 15c provides a list of possible values. (R, Set-by-create) (mandatory) (1 byte)

AudioServInd: This Boolean attribute indicates whether or not audio service is transported, where the value TRUE implies the presence of this service. (R, Set-by-create) (mandatory) (1 byte)

PCMEncType: This attribute indicates the type of PCM coding. Valid values include but are not limited to "mu-law PCM coding" (value 0x01) and "alpha-law PCM coding" (value 0x02). (R, Set-by-create) (mandatory) (1 byte)

CMDataInd: This Boolean attribute indicates whether or not Circuit Mode Data is carried on this connection, where the value TRUE implies its presence. (R, Set-by-create) (mandatory) (1 byte)

CMMultiplierNum: This attribute provides the N value in N × 64 kbit/s circuit mode data. (R, Set-by-create) (mandatory) (1 byte)

FMDataInd: This Boolean attribute indicates whether or not Frame Mode Data is carried on this connection, where the value TRUE implies its presence. (R, Set-by-create) (mandatory) (1 byte)

FMMaxFrameLen: This attribute indicates the maximum length of a frame mode data unit. It ranges from 0x01 to 0xFFFF (1 to 65535). (R, Set-by-create) (mandatory) (2 bytes)

CASInd: This Boolean attribute indicates whether or not Channel Associated Signalling is enabled on the connection, where the value TRUE implies it is enabled. (R, Set-by-create) (mandatory) (1 byte)

DTMFInd: This Boolean attribute indicates whether or not Dual Tone Multi-Frequency dialed digits are transported on the connection, where the value TRUE implies their presence. (R, Set-by-create) (mandatory) (1 byte)

MFR1Ind: This Boolean attribute indicates whether or not Multi-Frequency R1 dialed digits are transported on the connection, where the value TRUE implies their presence. (R, Set-by-create) (mandatory) (1 byte)

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MFR2Ind: This Boolean attribute indicates whether or not Multi-Frequency R2 dialed digits are transported on the connection, where the value TRUE implies their presence. (R, Set-by-create) (mandatory) (1 byte)

RateControlInd: This Boolean attribute indicates whether or not rate control is transported on the connection, where the value TRUE implies its presence. (R, Set-by-create) (mandatory) (1 byte)

SynchChangeInd: This Boolean attribute indicates whether or not synchronization of change in SSCS operation is transported on the connection, where the value TRUE implies its presence. (R, Set-by-create) (mandatory) (1 byte)

FaxDemodulationInd: This Boolean attribute indicates whether fax demodulation is enabled or disabled on the connection, where the value TRUE implies it is enabled. (R, Set-by-create) (mandatory) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Notifications

None.

Table 15c/G.983.2 – Coding of the EncProfileIndex attribute

EncSrcType	EncProfileIndex		
1: ITU-T predefined	0:	Not used.	
	1:	PCM-64	ITU-T Rec. I.366.2
	2:	PCM-64 and silence	ITU-T Rec. I.366.2
	3:	ADPCM and silence	ITU-T Rec. I.366.2
	4:	G.728 with higher efficiency	ITU-T Rec. I.366.2
	5:	G.728 with lower delay	ITU-T Rec. I.366.2
	6:	G.729 with higher efficiency and G.726 for voiceband data	ITU-T Rec. I.366.2
	7:	G.729 with lower delay	ITU-T Rec. I.366.2
	8:	G.729 with lower delay and G.726-32 for voiceband data at lower rates.	ITU-T Rec. I.366.2
	9:	G.729 with lower delay and G.726-40 for voiceband data at higher rates.	ITU-T Rec. I.366.2
	10:	G.729 with full variable bit rates	ITU-T Rec. I.366.2
	11:	AMR	ITU-T Rec. I.366.2
	12:	G.723	ITU-T Rec. I.366.2
	13:	PCM 64 kbits/s and ADPCM 32 kbits/s	ITU-T Rec. I.366.2
	14-255:	Reserved for future ITU-T assignment	

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Table 15c/G.983.2 – Coding of the EncProfileIndex attribute

EncSrcType	EncProfileIndex		
2: ATM Forum predefined	0:	Not used.	
	1:	LPC-10 (High efficiency)	af-vtoa-0113.000
	2:	LPC-10 (Low delay)	af-vtoa-0113.000
	3:	CVSD-32	af-vtoa-0113.000
	4:	CVSD-16	af-vtoa-0113.000
	5:	CVSD-12	af-vtoa-0113.000
	6:	G.723.1	af-vtoa-0113.000
	7:	PCM-64, ADPCM-32, 44 octet packets, and silence.	af-vmoa-0145.000
	8:	PCM-64, 44 octet packets, and silence.	af-vmoa-0145.000
	9:	PCM-64, 44 octet packets, without silence.	af-vmoa-0145.000
	10:	PCM-64 and ADPCM-32, 44 octet packets, without silence.	af-vmoa-0145.000
	11:	PCM-64, ADPCM-32, 40 octet packets, without silence.	af-vmoa-0145.000
	12:	PCM-64, ADPCM-32, 40 octet packets, with silence.	af-vmoa-0145.000
	13-255:	Reserved for future ATM Forum assignment.	af-vmoa-0145.000

7.3.24 Voice service profile AAL

This managed entity is used to organize data that describes the Voice Service functions of the ONT if supported by AAL 2 or AAL 1. Instances of this managed entity are created and deleted by request of the OLT.

Relationships

Zero or more instances of this managed entity shall be contained in the $ONT_{B\text{-}PON}$ managed entity. One instance of this managed entity may be associated with zero or more instances of the Interworking VCC Termination Point carrying voice services.

Attributes

Managed Entity id: This attribute provides a unique number for the instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

AnnouncementType: This attribute provides the announcement to the customer going off-hook when no call has been attempted. Valid values include but are not limited to "silence" (0x01), "reorderTone" (0x02), "fastBusy" (0x03), "voiceAnnouncement" (0x04), and "N/A" (0xFF). (R, Set-by-create) (mandatory) (1 byte)

JitterTarget: This attribute provides the target value of the jitter buffer. The system will try to maintain the jitter buffer at the target value. Units are in milliseconds. (R, W, Set-by-create) (mandatory for AAL 2) (2 bytes)

JitterBufferMax: This attribute provides the maximum depth of the jitter buffer associated with this service. Units are in milliseconds. (R, W, Set-by-create) (mandatory for AAL 2) (2 bytes)

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EchoCancelInd: This Boolean attribute indicates whether echo cancellation is on or off, where the value TRUE implies that it is on. (R, Set-by-create) (mandatory) (1 byte)

PSTNProtocolVariant: This attribute controls which variant of POTS signalling shall be used on the associated UNIs. The value used is equal to the 'country code'. (R, Set-by-Create) (optional) (2 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

7.3.25 LES service profile

This managed entity is used to organize data that describes voice grade Loop Emulation Service functions of the ONT associated with AAL 2 interworking. Instances of this managed entity shall be created and deleted by the OLT.

Relationships

Zero or more instances of this managed entity shall be contained in the $ONT_{B\text{-}PON}$ managed entity. One instance of this managed entity may be associated with zero or more instances of the Interworking VCC Termination Point.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the Voice Service Profile AAL with which this LES Service Profile is associated. (R, Set-by-create) (mandatory) (2 bytes)

ELCPInd: This Boolean attribute indicates whether or not Emulated Loop Control Protocol is in use. The value TRUE means enabled. (R, Set-by-create) (mandatory) (1 byte)

POTSSignalling: This attribute selects which signalling format should be used for POTS service. Valid values include but are not limited to CCS (value 0x01), CAS (value 0x02), and other (0xFF). (R, Set-by-create) (mandatory) (1 byte)

BRISignalling: This attribute selects which signalling format should be used for Basic Rate ISDN. Valid values include but are not limited to DSS1 (0x01), and other (0xFF). The default value is 0x01. (R, W) (mandatory) (1 byte)

MaxNumCIDs: This attribute specifies the maximum number of channels within the VCC that can be active. (R, Set-by-create) (mandatory) (1 byte)

MaxPacketLength: This attribute specifies the maximum packet length (in bytes). (R, Set-by-create) (mandatory) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

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Notifications

None.

7.3.26 Physical path termination point POTS UNI

This managed entity represents the point at the POTS UNI in the ONT where physical paths terminate and physical path level functions (e.g., analog telephony, facsimile function) are performed. An instance of this managed entity shall be automatically created/deleted by the ONT upon the creation/deletion of a Subscriber Line Card with POTS type.

Relationships

One or more instances of this managed entity shall be contained in an instance of the $ONT_{B\text{-}PON}$ or a Subscriber Line Card managed entity classified as POTS type.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The first byte is the slot id (defined in 7.1.3). If the UNI is integrated, this value is 0x00. The second byte is the port id with value range from 0x01 to 0xFF (1 to 255), 0x01 is used for the leftmost/lowest port on a Subscriber Line Card, 0x02 is used for the next right/upper port, and so forth. (R) (mandatory) (2 bytes)

Administrative State: This attribute is used to activate (unlock: value 0x00) and deactivate (lock: value 0x01) the functions performed by instances of this managed entity. Selection of a default value for this attribute is outside the scope of this Recommendation as it is normally handled through supplier-operator negotiations. (R, W) (mandatory) (1 byte)

Interworking VCC Pointer: This attribute provides a pointer to the instance of the Interworking VCC managed entity to which this instance is connected. The value 0x0000 is interpreted as a Null pointer. (R, W) (optional) (2 bytes)

ARC: This attribute is used to control alarm reporting from this managed entity. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

ARCInterval: This attribute provides a provisionable length of time. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

Impedance: This attribute allows the impedance for the Physical Path Termination Point POTS UNI to be configured by the user. Valid values include 600 Ohm Impedance (value 0x00) and 900 Ohm Impedance (value 0x01). In addition, the following parameter sets from ETSI TS 101 270-1 (1999-10), Annex C, are valid:

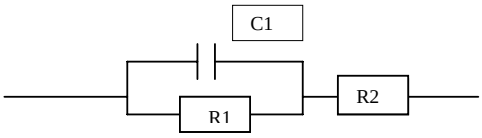
– value 0x02: C1=150 nF, R1=750 Ohm, R2=270 Ohm;

– value 0x03: C1=115 nF, R1=820 Ohm, R2=220 Ohm;

– value 0x04: C1=230 nF, R1=1050 Ohm, R2=320 Ohm,

where C1, R1, and R2 are related as shown below. Upon autonomous instantiation, the value 0x00 is used. (R,W) (optional) (1 byte)

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Transmission Path: This attribute allows for setting the Physical Path Termination Point POTS UNI to be put in either full-time or part-time on-hook transmission mode. Valid values include full-time on-hook transmission (value 0x00) and part-time on-hook transmission (value 0x01) Upon autonomous instantiation, the value 0x00 is used. (R,W) (optional) (1 byte)

Rx Gain: This attribute provides a gain value for the received signal. Valid values are –12 dB to +6 dB in 0.1 dB increments. (value –120 to +60, 0 = 0 dB gain, –120 = –12.0 dB, etc.) Upon autonomous instantiation, the value 0x00 is used. (R,W) (optional) (1 byte)

Tx Gain: This attribute provides a gain value for the transmit signal. Valid values are –6 dB to +12 dB in 0.1 dB increments. (value –60 to +120, 0 = 0 dB gain, 60 = +6.0 dB, etc.). Upon autonomous instantiation, the value 0x00 is used. (R,W) (optional) (1 byte)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Test: Request that the ONT perform one or more MLT tests or a dial tone make/break test. See "Test" and "Test result" message layouts in II.2.27 and II.2.45 respectively.

Notifications

Alarm: This notification is used to notify the management system when a failure has been detected or cleared. Both ONT and OLT should know the alarm list used by this entity. The alarm list for this entity is given in Table 15d. See also Appendix III.

Table 15d/G.983.2 – Alarm list for physical path termination point POTS UNI

Number	Alarm	Description
0-223	Reserved	
224-239	Vendor-specific alarms	Not to be standardized

7.3.27 Voice CTP

This managed entity is used to represent the point in the ONT where the voice channel is terminated/originated. Instances of this managed entity are created and deleted by request of the OLT.

Relationships

Zero or more instances of this managed entity shall be contained in an instance of the $ONT_{B\text{-}PON}$ or Subscriber Line Card managed entity classified as a POTS type.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

InterworkingVCCTPPtr: This attribute points to the instance of the Interworking VCC Termination Point carrying this voice channel. (R, Set-by-create) (mandatory) (2 bytes)

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InterworkingPPTPPtr: This attribute provides a pointer to the associated instance of the Termination Point managed entity for the case of POTS or ISDN services. When this Voice CTP is associated with a Subscriber Line Card managed entity classified as a POTS type, this attribute points to the instance of the Physical Path Termination Point POTS UNI. When this Voice CTP is associated with a Subscriber Line Card managed entity classified as ISDN type, this attribute points to the instance of the Physical Path Termination Point ISDN UNI. (R, Set-by-create) (mandatory) (2 bytes)

ChannelId: This attribute identifies the logical Channel Id for this service if AAL 2 is employed. This attribute is null (not used) if another type of adaptation is employed. (R, Set-by-create) (mandatory) (1 byte)

SignallingCode: This attribute specifies whether "loop start" (0x01), "ground start" (0x02), "loop reverse battery" (0x03), "coin first" (0x04), "dial tone first" (0x05), or "multi-party" (0x06) signalling is employed. (R, Set-by-create) (mandatory) (1 byte)

RobbedBitSignalling: This attribute describes the robbed bit signalling in use on the telephony port. Valid values include "a" (value 0x01), "ab" (value 0x02), "abcd" (value 0x03), "transparent" (value 0x04), and "other" (value 0xFF). (R, Set-by-create) (mandatory) (1 byte)

SilenceSuppression Ind: This Boolean attribute indicates whether silence suppression is on or off. The value TRUE means on. (R, Set-by-create) (mandatory) (1 byte)

VoiceCompression Type: This attribute identifies the voice compression applied to the voice channel. Valid values include but are not limited to the following: PCM-64 (value 0x01), ADPCM-32 (value 0x02), LD-CELP16 (value 0x03), CS-ACELP8 (value 0x04), and unknown (value 0xFF). (R, Set-by-create) (mandatory) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Notifications

None.

7.3.28 Voice PM history data

This managed entity contains the last completed 15-minute interval performance monitoring data collected as a result of monitoring a voice port on an ONT. The statistic data value is only updated at the end of each period. Instances of this managed entity are created/deleted by the OLT after an instance of a Physical Path Termination Point POTS UNI or Physical Path Termination Point ISDN UNI managed entity is created/deleted.

Relationships

One instance of this managed entity can exist for each instance of a Physical Path Termination Point POTS UNI or Physical Path Termination Point ISDN UNI.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is the same as the id of a Physical Path Termination Point POTS UNI or Physical Path Termination Point ISDN UNI. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute

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interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. The attribute counters are updated at the end of the interval. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ id: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

VoicePortBufferOverflows: This attribute provides the total number of payload octets dropped due to buffer overflow at this port (NOTE – this number does not include octets that are dropped because they arrived late and had already been substituted by a filler octet). If the actual counter saturates, it remains on its maximum value. (R) (mandatory) (4 bytes)

VoicePortBufferUnderflows: This attribute provides the total number of filler octets injected into the active media stream on this port due to playout buffer underflow. If the actual counter saturates, it remains on its maximum value. (R) (mandatory) (4 bytes)

ActiveSeconds: This attribute provides the total length of time, in seconds, that the AAL 2 channel associated with this port has been active. If the counter saturates, it remains on its maximum value. (R) (mandatory) (4 bytes)

DchannelBufferOverflows: This attribute provides the total number of payload octets for the D channel that are dropped due to buffer overflow at this port (NOTE – this number does not include octets that are dropped because they arrived late and had already been substituted by a filler octet). If the actual counter saturates, it remains on its maximum value. (R) (mandatory, if this voice port carries ISDN traffic) (4 bytes)

B1ChannelBufferOverflows: This attribute provides the total number of payload octets for the B1 channel that are dropped due to buffer overflow at this port (NOTE – this number does not include octets that are dropped because they arrived late and had already been substituted by a filler octet). If the actual counter saturates, it remains on its maximum value. (R) (mandatory, if this voice port carries ISDN traffic) (4 bytes)

B2ChannelBufferOverflows: This attribute provides the total number of payload octets for the B2 channel that are dropped due to buffer overflow at this port (NOTE – this number does not include octets that are dropped because they arrived late and had already been substituted by a filler octet). If the actual counter saturates, it remains on its maximum value. (R) (mandatory, if this voice port carries ISDN traffic) (4 bytes)

DchannelBufferUnderflows: This attribute provides the total number of filler octets injected into the D channel of the active media stream on this port due to playout buffer underflow. If the actual counter saturates, it remains on its maximum value. (R) (mandatory, if this voice port carries ISDN traffic) (4 bytes)

B1ChannelBufferUnderflows: This attribute provides the total number of filler octets injected into the B1 channel of the active media stream on this port due to playout buffer underflow. If the actual counter saturates, it remains on its maximum value. (R) (mandatory, if this voice port carries ISDN traffic) (4 bytes)

B2ChannelBufferUnderflows: This attribute provides the total number of filler octets injected into the B2 channel of the active media stream on this port due to playout buffer underflow. If the actual counter saturates, it remains on its maximum value. (R) (mandatory, if this voice port carries ISDN traffic) (4 bytes)

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DchannelActiveSeconds: This attribute provides the total length of time, in seconds, that the D channel associated with this port has been active. If the counter saturates, it remains on its maximum value. (R) (mandatory, if this voice port carries ISDN traffic) (4 bytes)

B1ChannelActiveSeconds: This attribute provides the total length of time, in seconds, that the B1 channel associated with this port has been active. If the counter saturates, it remains on its maximum value. (R) (mandatory, if this voice port carries ISDN traffic) (4 bytes)

B2ChannelActiveSeconds: This attribute provides the total length of time, in seconds, that the B2 channel associated with this port has been active. If the counter saturates, it remains on its maximum value. (R) (mandatory, if this voice port carries ISDN traffic) (4 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Get current data: This action returns the *current* value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

Support of this action is optional.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a threshold crossing alert (TCA) is detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. The event list for this entity is given in Table 15e.

Table 15e/G.983.2 – Alarm list for voice PM history data

Number	Event	Description	Threshold data counter # (Note)
	Threshold Crossing Alert		
0	Reserved		
1	Reserved		
2	VoicePortBufferOverflows	Exceeds threshold	1
3	VoicePortBufferUnderflows	Exceeds threshold	2
4	B1ChannelBufferOverflows	Exceeds threshold	3
5	B2ChannelBufferOverflows	Exceeds threshold	4
6	DchannelBufferUnderflows	Exceeds threshold	5
7	B1ChannelBufferUnderflows	Exceeds threshold	6
8	B2ChannelBufferUnderflows	Exceeds threshold	7
9-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{\text{B-PON}}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

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7.3.29 MAC Bridge service profile

This managed entity is used to organize data that affects all ports on a MAC Bridge at a bridged LAN Ethernet UNI interface on the ONT. Instances of this managed entity are created and deleted by request of the OLT.

Relationships

Zero or more instances of this managed entity shall be referred to by the Physical Path Termination Point Ethernet UNI managed entity.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The first byte is the slot id (defined in 7.1.3). If the UNI is integrated, this value is 0x00. The second byte is the bridge group id. (R) (mandatory) (2 bytes)

SpanningTreeInd: This Boolean attribute indicates whether or not a spanning tree algorithm is enabled. The value TRUE means enabled. (R, W, Set-by-create) (mandatory) (1 byte)

LearningInd: This Boolean attribute indicates whether or not the learning functions of the bridge are enabled. The value TRUE means enabled. (R, W, Set-by-create) (mandatory) (1 byte)

ATMPortBridgingInd: This Boolean attribute indicates whether or not bridging between ATM ports on this bridge service is enabled. The value TRUE means enabled. (R, W, Set-by-create) (mandatory) (1 byte)

Priority: This attribute indicates the bridge priority set on the LAN card. The range is 0x00 to 0xFFFF (0 to 65535). The value of this attribute is copied to the BridgePriority attribute of the MAC Bridge Configuration Data managed entity. (R, W, Set-by-create) (mandatory) (2 bytes)

MaxAge: This attribute indicates the maximum age (in 256ths of a second) for an entry in the spanning tree listing. It indicates the maximum age in 256ths of a second for received protocol information before it is discarded. The range is 0x0600 to 0x2800 (6 s to 40 s) in accordance with IEEE 802.1D [13]. (R, W, Set-by-create) (mandatory) (2 bytes)

HelloTime: This attribute provides the time interval (in 256ths of a second) between hello packets. It is the time interval, in 256ths of a second, that a bridge advertises its presence while as a root or attempting to become a root. The range is 0x0100 to 0x0a00 (1 s to 10 s) in accordance with IEEE 802.1D [13]. (R, W, Set-by-create) (mandatory) (2 bytes)

ForwardDelay: This attribute gives the time (in 256ths of a second) that the bridge on the Ethernet card in the ONT retains a packet before forwarding it. (It indicates the value in 256ths of a second that the bridge uses for Forward Delay when the bridge acts as the root.) The range is 0x0400 to 0x1e00 (4 s to 30 s) in accordance with IEEE 802.1D [13]. (R, W, Set-by-create) (mandatory) (2 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

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7.3.30 MAC Bridge configuration data

This managed entity is used to organize and record data that is associated with bridged LAN configurations. Some of the data is volatile. Instances of this managed entity shall be automatically created/deleted by the ONT upon the creation/deletion of a MACBridgeServiceProfile.

Relationships

This managed entity is associated with one instance of a MACBridgeServiceProfile.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the MACBridgeServiceProfile with which this MACBridgeConfigurationData is associated. (R) (mandatory) (2 bytes)

BridgeMACAddress: This attribute indicates the MAC address used by the bridge. Upon autonomous instantiation, this attribute consists of all 0x00. (R) (mandatory) (6 bytes)

BridgePriority: This attribute denotes the priority of the bridge and is positive integer-valued. Upon autonomous instantiation, the value 0x8000 is used. The value of this attribute follows the value of the associated MAC Bridge Service Profile: Priority attribute, if present. (R) (mandatory) (2 bytes)

DesignatedRoot: This attribute provides the bridge identifier for the root of the spanning tree. This attribute consists of Bridge Priority (2 bytes) and MAC address (6 bytes). (R) (mandatory) (8 bytes)

RootPathCost: This attribute provides the cost of the best path to the root as seen from the bridge. Upon autonomous instantiation, the value 0x00 is used. (R) (mandatory) (4 bytes)

BridgePortCount: This attribute provides the number of existing ports controlled by this bridge. (R) (mandatory) (1 byte)

RootPortNum: This attribute provides the port number that has the lowest cost from the bridge to the root bridge. The value 0x00 means that the bridge itself is the root. Upon autonomous instantiation, the value 0x00 is used. (R) (mandatory) (2 bytes)

HelloTime: This attribute provides the time interval (in 256ths of a second) between hello packets. It is the "HelloTime" received from the designated root. The range is 0x0100 to 0x0a00 (1 s to 10 s) in accordance with IEEE 802.1D [13]. (R) (optional) (2 bytes)

ForwardDelay: This attribute gives the time (in 256ths of a second) that the bridge on the Ethernet card in the ONT retains a packet before forwarding it. It is the "ForwardDelay" time received from the designated root. The range is 0x0400 to 0x1e00 (4 s to 30 s) in accordance with IEEE 802.1D [13]. (R) (optional) (2 bytes)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

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7.3.31 MAC Bridge port configuration data

This managed entity is used to organize and record data that is associated with a bridge port. Some of the data is volatile. Instances of this managed entity are created and deleted by request of the OLT.

Relationships

Zero or more instances of this managed entity shall be contained in an instance of the MACBridgeServiceProfile.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

BridgeIdPointer: This attribute identifies the MAC bridge controlling the port. This attribute points to the instance of the MACBridgeServiceProfile. (R, Set-by-create) (mandatory) (2 bytes)

PortNum: This attribute provides the port number. (R, Set-by-create) (mandatory) (1 byte)

TPType: This attribute identifies the type of the termination point associated with this MAC bridge port. The value is set to 0x01 if this bridge port is associated with the LAN side's termination point. The value is set to 0x02 if this bridge port is associated with the ATM side's termination point. The value is set to 0x03 if this bridge port is associated with an ATM side 802.1p mapper service profile. (R, Set-by-create) (mandatory) (1 byte)

TPPointer: This attribute points to the termination point associated with this MAC bridge port. If the TPType = 0x01, the value of this attribute is the same as the id of the Physical Path Termination Point Ethernet UNI associated with this MAC bridge port. If the TPType = 0x02, the value of this attribute is the same as the id of the Interworking VCC Termination Point associated with this MAC bridge port. If the TPType = 0x03, the value of this attribute is the same as the id of the 802.1p mapper service profile associated with this MAC bridge port. (R, Set-by-create) (mandatory) (2 bytes)

PortPriority: This attribute denotes the priority of the port. The range is 0x00 to 0x00FF (0 to 255). (R, W, Set-by-create) (mandatory) (2 bytes)

PortPathCost: This attribute provides the cost contribution of the port to the path cost towards the spanning tree root bridge. The range is 0x0001 to 0xFFFF (1 to 65535). (R, W, Set-by-create) (mandatory) (2 bytes)

PortSpanningTreeInd: This Boolean attribute indicates whether or not STP LAN topology change detection is enabled at this port. The value TRUE means enabled. (R, W, Set-by-create) (mandatory) (1 byte)

EncapsulationMethod: This attribute identifies the frame encapsulation method that is used. Value 0x00: identification by ATM VC; value 0x01: LLC encapsulation. This attribute is effective only for ports towards the ANI side of the MAC bridge. Upon autonomous instantiation, the value 0x00 is used. (R,W, Set-By-Create) (mandatory) (1 byte)

LANFCSInd: This attribute indicates whether LAN FCS (Frame Check Sequence) bytes are forwarded (value 0x00) or discarded (value 0x01). This applies in both directions of transmission, and applies regardless of EncapsulationMethod. This attribute is effective only for ports towards the ANI side of the MAC bridge. Upon autonomous instantiation, the value 0x00 is used. (R, W, Set-By-Create) (optional) (1 byte)

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Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

7.3.32 MAC Bridge port designation data

This managed entity is used to organize and record data that is associated with a bridge port. Some of the data is volatile. Instances of this managed entity shall be automatically created/deleted by the ONT upon the creation/deletion of a MACBridgePortConfigurationData.

Relationships

This managed entity is associated with one instance of a MACBridgePortConfigurationData.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the MACBridgePortConfigurationData with which this MACBridgePortDesignationData is associated. (R) (mandatory) (2 bytes)

DesignatedBridgeRootCostPort: This attribute provides the Designated Root, Designated Cost, Designated Bridge, and Designated Port outputs of the "Read port parameters" operation defined in 14.8.2.1 of IEEE 802.1D [13], i.e.,

– bridge identifier of the designated bridge for the port's segment (8 bytes);

– bridge identifier of the root transmitted by the designated bridge for the segment (8 bytes);

– port number of the designated port on the designated bridge considered to be part of this port's segment (4 bytes);

– path cost contribution of the designated port to this port's segment (4 bytes).

Upon autonomous instantiation, this attribute consists of all 0x00. (R) (mandatory) (24 bytes).

PortState: This attribute provides status information on the port. Valid values include "disabled" (value 0x00), "listening" (value 0x01), "learning" (value 0x02), "forwarding" (0x03), "blocking" (value 0x04), "linkdown" (value 0x05), and "stp_off" (value 0x06) in accordance with IEEE 802.1D [13].

NOTE – The value "linkdown" is introduced to denote the port status where the Ethernet link state is down. This value is necessary to distinguish the case where Ethernet is physically down and the case where Ethernet is administratively down, which can be denoted by "disabled." The value "stp_off" is introduced to denote the port status where Spanning Tree Protocol is disabled, by setting "PortSpanningTreeInd" of "MAC Bridge Port Configuration Data" to FALSE, and Ethernet link state is up. This value is used to distinguish whether or not a bridge port forwarding frames is under control of STP.

Upon autonomous instantiation, the value 0x00 is used. (R) (mandatory) (1 byte)

Actions

Get: Get one or more attributes.

Notifications

None.

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7.3.33 MAC Bridge port filter table data

This managed entity is used to organize and record data that is associated with a bridge port. Some of the data is volatile. Instances of this managed entity shall be automatically created/deleted by the ONT upon the creation/deletion of a MACBridgePortConfigurationData managed entity.

NOTE – Alternative schemes for this managed entity may be included in future Recommendations. Caution must be exercised when writing to the table attribute when learning is active, as the contents of the table is volatile. If OLT plans to write to the table, learning mode should be off at that time.

Relationships

This managed entity is associated with one instance of a MACBridgePortConfigurationData managed entity.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the MACBridgePortConfigurationData with which this MACBridgePortFilterTableData is associated. (R) (mandatory) (2 bytes)

MACFilterTable: This attribute lists destination MAC Addresses associated with the bridge port and an allow/disallow forwarding indicator for each of inbound traffic (towards the LAN physical port) and outbound (towards the ATM side) traffic. One entry provides the Entry number (1 byte) which is an index in this attribute list, Filter byte (1 byte), and MAC address (6 bytes). Moreover, the bits of the Filter byte are assigned as described in Table 15f. Upon autonomous instantiation, this attribute is a null list. An OMCI set message can carry a maximum of 3 entries at the same time. (R, W) (mandatory) ($N \times 8$ bytes, N is the number of entries in the list.)

Table 15f/G.983.2 – Coding of filter byte in the MACFilterTable attribute

Bit	Name	Setting
8	Add/remove	0: remove this entry 1: add this entry
7-2	Reserved	(0)
1	Filter/forward	0: forward 1: filter

Actions

Get: Get one or more attributes. Latch a snapshot (i.e., copy) of the current MACFilterTable and respond with the size of data (4 bytes), which should be obtained using the "Get next" command.

Get next: Get the latched attribute values of the managed entity within the current snapshot.

Set: Generally, this action is used to set one or more entire attribute values. When used on the "MACFilterTable" attribute, the "Set" action either adds or deletes table entries from "MACFilterTable". A maximum of 3 table entries can be added/deleted by a single "Set" action.

Notifications

None.

7.3.34 MAC Bridge port bridge table data

This managed entity is used to organize and record data that is associated with a bridge port. Some of the data is volatile. Instances of this managed entity shall be automatically created/deleted by the ONT upon the creation/deletion of a MACBridgePortConfigurationData.

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Relationships

This managed entity is associated with one instance of a MACBridgePortConfigurationData.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the MACBridgePortConfigurationData with which this MACBridgePortBridgeTableData is associated. (R) (mandatory) (2 bytes).

BridgeTable: This attribute lists the destination MAC Addresses, whether they are learned or statically assigned, whether packets having them as destination addresses are filtered or forwarded, and their ages. One entry provides Information (2 bytes) and MAC address (6 bytes). Moreover, the Information bits are assigned as described in Table 15g. Upon autonomous instantiation, this attribute is a null list. (R) (mandatory) ($M \times 8$ bytes, M is the number of entries in the list.)

Table 15g/G.983.2 – Coding of information in the BridgeTable attribute

Bit	Name	Setting
16-5	Age	Age in seconds (1 s to 4095 s)
4	Reserved	(0)
3	Dynamic/static	0: this entry is statically assigned. 1: this entry is dynamically learned.
2	Reserved	(0)
1	Filter/forward	0: forward 1: filter

Actions

Get: Get one or more attributes. Latch a snapshot (i.e., copy) of the current MACFilterTable and respond with the size of the data (4 bytes) that should be obtained using the "Get next" command.

Get next: Get the latched attribute values of the managed entity within the current snapshot.

Notifications

None.

7.3.35 MAC Bridge PM history data

This managed entity contains the past performance monitoring data collected at a MAC bridging function supporting bridging interfaces on the ONT. Instances of this managed entity are created/deleted by the OLT after/before an instance of the MACBridgeServiceProfile managed entity is created/deleted.

Relationships

This managed entity is associated with one instance of a MACBridgeServiceProfile.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the MACBridgeServiceProfile with which this MACBridgePMHistoryData is associated. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and

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the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. The attribute counters are updated at the end of the interval. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ id: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

BridgeLearningEntryDiscardCount: This attribute records the number of forwarding database entries that have been or would have been learned but were discarded or replaced due to lack of space in the database table. (R) (mandatory) (4 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Get current data: This action returns the *current* value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

Support of this action is optional.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a Threshold Crossing Alert (TCA) has been detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. The event list for this managed entity is given in Table 15g1.

Table 15g1/G.983.2 – Alarm list for MAC Bridge PM history data

Number	Event	Description	Threshold data counter # (Note)
	Threshold Crossing Alert		
0	BridgeLearningEntryDiscard	BridgeLearningEntryDiscard threshold crossing	1
1-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

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7.3.36 MAC Bridge port PM history data

This is a managed entity that contains the past performance monitoring data collected at the port bridging function on the ONT. Instances of this managed entity are created/deleted by the OLT after an instance of the MACBridgePortConfigurationData managed entity is created/deleted.

Relationships

This managed entity is associated with one instance of a MACBridgePortConfigurationData.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the MACBridgePortConfigurationData with which this MACBridgePortPMHistoryData is associated. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. The attribute counters are updated at the end of the interval. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ id: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

ForwardedFrameCounter: This attribute provides a count of successfully transmitted frames on this port. (R) (mandatory) (4 bytes)

DelayExceededDiscardCounter: This attribute provides a count of frames discarded on this port because transmission is delayed. (R) (mandatory) (4 bytes)

MTUExceededDiscardCounter: This attribute provides a count of frames discarded on this port because MTU is exceeded. (R) (mandatory) (4 bytes)

ReceivedFrameCounter: This attribute provides a count of frames received on this port. (R) (mandatory) (4 bytes)

ReceivedAndDiscardedCounter: This attribute provides a count of frames received on this port that have been discarded due to errors. (R) (mandatory) (4 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Get current data: This action returns the *current* value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

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Support of this action is optional.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a Threshold Crossing Alert (TCA) has been detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. The event list for this managed entity is given in Table 15g2.

Table 15g2/G.983.2 – Alarm list for MAC Bridge port PM history data

Number	Event	Description	Threshold data counter # (Note)
	Threshold Crossing Alert		
0	Reserved		
1	DelayExceededDiscard	DelayExceededDiscard threshold crossing	1
2	MTUExceededDiscard	MTUExceededDiscard threshold crossing	2
3	Reserved		
4	ReceivedAndDiscarded	ReceivedAndDiscarded threshold crossing	3
5-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{\text{B-PON}}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.37 IP Port configuration data

This managed entity is used to organize data that is associated with IP address and IP port provisioning. Instances of this managed entity are created and deleted by request of the OLT.

Relationship

Zero or one instances of this managed entity may exist for each instance of the Interworking VCC Termination Point managed entity and a Subscriber Line Card managed entity classified as a native LAN type (e.g., Ethernet).

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

PortNum: This attribute identifies the port at which IP provisioning takes place. (R, Set-by-create) (mandatory) (1 byte)

TPType: This attribute identifies the type of the termination point associated with this IP port. The value is set to 0x01 if this IP port is associated with the LAN side's TP. The value is set to 0x02 if this IP port is associated with the ATM side's TP. (R, Set-by-create) (mandatory) (1 byte)

TPPointer: This attribute points to the instance of the TP associated with this port. When this IP port is associated with the LAN side's TP, this attribute points to the instance of the PPTP Ethernet UNI. When this IP port is associated with the ATM side's TP, this attribute points to the instance of the Interworking VCC Termination Point. (R, Set-by-create) (mandatory) (2 bytes)

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PortAddress: This attribute identifies the provisioned IP address. When an IP address is not assigned, this attribute consists of all 0x00. (R, Set-by-create) (mandatory) (4 bytes)

PortMask: This attribute identifies the address mask associated with the provisioned IP address. When an IP address mask is not assigned, this attribute consists of all 0x00. (R, Set-by-create) (mandatory) (4 bytes)

Unnumbered: This boolean attribute indicates whether or not this IP port has an IP address. The value TRUE means unnumbered. (For future use by IP router function.) (R, Set-by-create) (mandatory) (1 byte)

AdministrativeState: This boolean attribute is used to activate (unlock, value 0x00) and deactivate (lock, value 0x01) the functions performed by instances of this managed entity. (R, W, Set-by-create) (1 byte)

PortState: This boolean attribute provides status information on the port. Valid values include "up" (value 0x00) and "down" (value 0x01). (R, Set-by-create) (mandatory) (1 byte)

AllowRemoteAccess: This boolean attribute indicates whether or not this IP port may be accessed remotely. The value TRUE means remote access is enabled. (R, Set-by-create) (mandatory) (1 byte)

Router Id Pointer: This attribute identifies the IP router controlling the port, if it exists. This attribute points to the instance of the IP Router Service Profile. If no IP router controls the port, this attribute consists of a null pointer (0xFFFF). (R, Set-by-create) (mandatory) (2 bytes)

ARP Pointer: This attribute identifies the instance of ARP Service Profile associated with the IP port. (R, Set-by-create) (mandatory) (2 bytes)

EncapsulationMethod: This attribute identifies the frame encapsulation method that is used. Value 0x00: identification by ATM VC; value 0x01: LLC encapsulation. Upon autonomous instantiation, the value 0x00 is used. (R. W) (mandatory) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

7.3.38 IP router service profile

This managed entity is used to organize data that affects all ports on an IP router on a routed LAN UNI interface on the ONT. Instances of this managed entity are created and deleted by request of the OLT.

Relationship

Zero or more instances of this managed entity shall be contained in an instance of a Subscriber Line Card managed entity classified as a native LAN type (e.g., Ethernet).

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The first byte is the slot id (defined in 7.1.3). If the UNI is integrated, this value is 0x00. The second byte is the router group id. (R, Set-by-create) (mandatory) (2 bytes)

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ForwardingInd: This boolean attribute indicates whether or not forwarding of IP packets as a whole is enabled. The value TRUE means enabled. The initial value is enabled. (R, W, Set by-create) (mandatory) (1 byte)

ProxyARPInd: This boolean attribute indicates whether or not proxy ARP is enabled. The value TRUE means enabled. The initial value is enabled. (R, W, Set-by-create) (mandatory) (1 byte)

DirectedBroadcastInd: This boolean attribute indicates whether or not relaying of directed broadcast packets is enabled. The value TRUE means enabled. The initial value is disabled. (R, W, Set-by-create) (mandatory) (1 byte)

UpstreamMulticastFiltering: This attribute indicates whether upstream IP multicast packets are forwarded (value 0x00) or filtered (value 0x01). The initial value is 0x01. (R,W, Set-by-create) (mandatory) (1 byte)

DownstreamMulticastFiltering: This attribute indicates whether downstream IP multicast packets are forwarded (value 0x00) or filtered (value 0x01). The initial value is 0x01. (R,W, Set-by-create) (mandatory) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

7.3.39 IP router configuration data

This managed entity is used to record data that is associated with IP router configurations. An instance of this managed entity shall be automatically created/deleted by the ONT upon creation/deletion of the associated instance of IP Router Service Profile.

Relationship

An instance of this managed entity is associated with one instance of IP Router Service Profile.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the IP Router Service Profile with which this IP Router Configuration Data is associated. (R) (mandatory) (2 bytes)

IpReasmTimeout: This attribute indicates the maximum number of seconds that received fragments are held while they are awaiting reassembly at this router. (R) (mandatory) (4 bytes)

Actions

Get: Get one or more attributes.

Notifications

None.

7.3.40 IP router PM history data 1

This managed entity contains some IP-related past performance monitoring data collected at IP router function. Instances of this managed entity are created/deleted by the OLT after/before an instance of IP Router Service Profile is created/deleted.

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Relationship

An instance of this managed entity is associated with one instance of IP Router Service Profile.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the IP Router Service Profile with which this IP Router PM History Data 1 is associated. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. The attribute counters are updated at the end of the interval. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ id: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

IpInReceivesCounter: This attribute provides a count of packets received from interfaces, including those with errors. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

IpInHdrErrorsCounter: This attribute provides a count of packets discarded due to errors in their IP headers, including bad checksums, version number mismatch, other format errors, time-to-live exceeded, errors discovered in processing their IP options, etc. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

IpInAddrErrorsCounter: This attribute provides a count of packets discarded because the IP address in their IP header's destination field was not a valid address to be received at this router. This counter includes invalid addresses (e.g., 0.0.0.0) and addresses of unsupported Classes (e.g., Class E). If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

IpForwPacketsCounter: This attribute provides a count of packets for which this router was not their final IP destination, as a result of which an attempt was made to find a route to forward them to that final destination. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

IpInUnknownProtosCounter: This attribute provides a count of packets which were locally-addressed and received successfully but discarded because of an unknown or unsupported protocol. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

IpInDiscardsCounter: This attribute provides a count of input packets for which no problems were encountered to prevent their continued processing, but which were discarded (e.g., for lack of buffer space). Note that this counter does not include any packets discarded while awaiting reassembly. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

IpInDeliversCounter: This attribute provides a count of input packets successfully delivered to IP user-protocols (including ICMP). If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

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IpOutRequestsCounter: This attribute provides a count of packets that local IP user-protocols (including ICMP) supplied to IP in requests for transmission. Note that this counter does not include any packets counted in ipForwPacketsCounter. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

IpOutDiscardsCounter: This attribute provides a count of output packets for which no problem was encountered to prevent their transmission to their destination, but which were discarded (e.g., for lack of buffer space). Note that this counter would include packets counted in ipForwPacketsCounter if any such packets met this (discretionary) discard criterion. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

IpOutNoRoutesCounter: This attribute provides a count of packets discarded because no route could be found to transmit them to their destination. Note that this counter includes any packets counted in ipForwPacketsCounter which meet this 'no-route' criterion. Note that this includes any packets that a host cannot route because all of its default gateways are down. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Get current data: This action returns the *current* value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

Support of this action is optional.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a Threshold Crossing Alert (TCA) has been detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. The event list for this entity is given in Table 15h/G.983.2.

Table 15h/G.983.2 – Alarm list for IP router PM history data 1

Number	Event	Description	Threshold data counter # (Note)
	Threshold Crossing Alert		
0	IpInReceives	Exceeds threshold	1
1	IpInHdr	Exceeds threshold	2
2	IpInAddr	Exceeds threshold	3
3	IpForwPackets	Exceeds threshold	4
4	IpInUnknownProtos	Exceeds threshold	5

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Table 15h/G.983.2 – Alarm list for IP router PM history data 1

Number	Event	Description	Threshold data counter # (Note)
5	IpInDiscards	Exceeds threshold	6
6	IpInDelivers	Exceeds threshold	7
7	IpOutRequests	Exceeds threshold	8
8	IpOutDiscards	Exceeds threshold	9
9	IpOutNoRoutes	Exceeds threshold	10
10-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.41 IP router PM history data 2

This managed entity contains other IP-related past performance monitoring data collected at IP router function. Instances of this managed entity are created/deleted by the OLT after/before an instance of IP Router Service Profile is created/deleted.

Relationship

An instance of this managed entity is associated with one instance of IP Router Service Profile.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the IP Router Service Profile with which this IP Router PM History Data 2 is associated. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. The attribute counters are updated at the end of the interval. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ id: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

IpReasmReqdsCounter: This attribute provides a count of received packets that needed to be reassembled at this entity. Default value is 0x00. (R) (mandatory) (4 bytes)

IpReasmOKsCounter: This attribute provides a count of packets successfully reassembled. Default value is 0x00. (R) (mandatory) (4 bytes)

IpReasmFailsCounter: This attribute provides a count of failures detected by the IP reassembly algorithm (for whatever reason: timed out, errors, etc.). Note that this is not necessarily a count of discarded IP fragments since some algorithms (notably the algorithm in RFC 815) can lose track of the number of fragments by combining them as they are received. Default value is 0x00. (R) (mandatory) (4 bytes)

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IpFragOKsCounter: This attribute provides a count of packets that have been successfully fragmented at this entity. Default value is 0x00. (R) (mandatory) (4 bytes)

IpFragFailsCounter: This attribute provides a count of packets that have been discarded because they needed to be fragmented at this router but could not be, e.g., because their Don't Fragment flag was set. Default value is 0x00. (R) (mandatory) (4 bytes)

IpFragCreatesCounter: This attribute provides a count of IP fragments that have been generated as a result of fragmentation at this entity. Default value is 0x00. (R) (mandatory) (4 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Get current data: This action returns the *current* value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

Support of this action is optional.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a Threshold Crossing Alert (TCA) has been detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. The event list for this entity is given in Table 15i.

Table 15i/G.983.2 – Alarm list for IP router PM history data 2

Number	Event	Description	Threshold data counter # (Note)
	Threshold Crossing Alert		
0	IpReasmReqds	Exceeds threshold	1
1	IpReasmOKs	Exceeds threshold	2
2	IpReasmFails	Exceeds threshold	3
3	IpFragOKs	Exceeds threshold	4
4	IpFragFails	Exceeds threshold	5
5	IpFragCreates	Exceeds threshold	6
6-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

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7.3.42 ICMP PM history data 1

This managed entity contains some ICMP-related past performance monitoring data collected at IP router function. Instances of this managed entity are created/deleted by the OLT after/before an instance of IP Router Service Profile is created/deleted.

Relationship

An instance of this managed entity is associated with one instance of IP Router Service Profile.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the IP Router Service Profile with which this ICMP PM History Data 1 is associated. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. The attribute counters are updated at the end of the interval. (R) (mandatory) (1 byte)

Threshold $Data_{B\text{-}PON}$ id: This attribute provides a pointer to an instance of the Threshold $Data_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

IcmpInMsgsCounter: This attribute provides a count of received ICMP messages. Note that this counter includes all those counted by IcmpInErrorsCounter. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpInErrorsCounter: This attribute provides a count of ICMP messages that were received but determined as having ICMP-specific errors (bad ICMP checksums, bad length, etc.). Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpInDestUnreachsCounter: This attribute provides a count of received ICMP Destination Unreachable messages. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpInTimeExcdsCounter: This attribute provides a count of received ICMP Time Exceeded messages. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpInParmProbsCounter: This attribute provides a count of received ICMP Parameter Problem messages. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpInSrcQuenchsCounter: This attribute provides a count of received ICMP Source Quench messages. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpInRedirectsCounter: This attribute provides a count of received ICMP Redirect messages. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpInEchosCounter: This attribute provides a count of received ICMP Echo (request) messages. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpInEchoRepsCounter: This attribute provides a count of received ICMP Echo Reply messages. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpInTimestampsCounter: This attribute provides a count of received ICMP Timestamp (request) messages. Default value is 0x00. (R) (mandatory) (4 bytes)

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IcmpInTimestampRepsCounter: This attribute provides a count of received ICMP Timestamp Reply messages. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpInAddrMasksCounter: This attribute provides a count of received ICMP Address Mask (request) messages. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpInAddrMaskRepsCounter: This attribute provides a count of received ICMP Address Mask Reply messages. Default value is 0x00. (R) (mandatory) (4 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Get current data: This action returns the *current* value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

Support of this action is optional.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a Threshold Crossing Alert (TCA) has been detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. The event list for this entity is given in Table 15j.

Table 15j/G.983.2 – Alarm list for ICMP PM history data 1

Number	Event	Description	Threshold data counter # (Note)
	Threshold Crossing Alert		
0	IcmpInMsgs	Exceeds threshold	1
1	IcmpInErrors	Exceeds threshold	2
2	IcmpInDestUnreachs	Exceeds threshold	3
3	IcmpInTimeExcds	Exceeds threshold	4
4	IcmpInParmProbs	Exceeds threshold	5
5	IcmpInSrcQuenchs	Exceeds threshold	6
6	IcmpInRedirects	Exceeds threshold	7
7	IcmpInEchos	Exceeds threshold	8
8	IcmpInTimestamps	Exceeds threshold	9
9	IcmpInTimestampReps	Exceeds threshold	10
10	IcmpInAddrMasks	Exceeds threshold	11
11	IcmpInAddrMaskReps	Exceeds threshold	12
12-223	Reserved		

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Table 15j/G.983.2 – Alarm list for ICMP PM history data 1

Number	Event	Description	Threshold data counter # (Note)
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.43 ICMP PM history data 2

This managed entity contains other ICMP-related past performance monitoring data collected at IP router function. Instances of this managed entity are created/deleted by the OLT after/before an instance of IP Router Service Profile is created/deleted.

Relationship

An instance of this managed entity is associated with one instance of IP Router Service Profile.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the IP Router Service Profile with which this ICMP PM History Data 2 is associated. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. The attribute counters are updated at the end of the interval. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ id: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

IcmpOutMsgsCounter: This attribute provides a count of ICMP messages that this router attempted to send. Note that this counter includes all those counted by IcmpOutErrorsCounter. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpOutErrorsCounter: This attribute provides a count of ICMP messages that this router did not send due to problems discovered within ICMP such as a lack of buffers. This value should not include errors discovered outside the ICMP layer such as the inability of IP to route the resultant packet. In some implementations, there may be no types of error that contribute to this counter's value. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpOutDestUnreachsCounter: This attribute provides a count of sent ICMP Destination Unreachable messages. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpOutTimeExcdsCounter: This attribute provides a count of sent ICMP Time Exceeded messages. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpOutParmProbsCounter: This attribute provides a count of sent ICMP Parameter Problem messages. Default value is 0x00. (R) (mandatory) (4 bytes)

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IcmpOutSrcQuenchsCounter: This attribute provides a count of sent ICMP Source Quench messages. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpOutRedirectsCounter: This attribute provides a count of sent ICMP Redirect messages. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpOutEchosCounter: This attribute provides a count of sent ICMP Echo (request) messages. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpOutEchoRepsCounter: This attribute provides a count of sent ICMP Echo Reply messages. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpOutTimestampsCounter: This attribute provides a count of sent ICMP Timestamp (request) messages. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpOutTimestampRepsCounter: This attribute provides a count of sent ICMP Timestamp Reply messages. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpOutAddrMasksCounter: This attribute provides a count of sent ICMP Address Mask (request) messages. Default value is 0x00. (R) (mandatory) (4 bytes)

IcmpOutAddrMaskRepsCounter: This attribute provides a count of sent ICMP Address Mask Reply messages. Default value is 0x00. (R) (mandatory) (4 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Get current data: This action returns the *current* value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

Support of this action is optional.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a Threshold Crossing Alert (TCA) has been detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. The event list for this entity is given in Table 15k.

Table 15k/G.983.2 – Alarm list for ICMP PM history data 2

Number	Event	Description	Threshold data counter # (Note)
	Threshold Crossing Alert		
0	IcmpOutMsgs	Exceeds threshold	1
1	IcmpOutErrors	Exceeds threshold	2
2	IcmpOutDestUnreachs	Exceeds threshold	3

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Table 15k/G.983.2 – Alarm list for ICMP PM history data 2

Number	Event	Description	Threshold data counter # (Note)
3	IcmpOutTimeExcds	Exceeds threshold	4
4	IcmpOutParmProbs	Exceeds threshold	5
5	IcmpOutSrcQuenchs	Exceeds threshold	6
6	IcmpOutRedirects	Exceeds threshold	7
7	IcmpOutEchos	Exceeds threshold	8
8	IcmpOutTimestamps	Exceeds threshold	9
9	IcmpOutTimestampReps	Exceeds threshold	10
10	IcmpOutAddrMasks	Exceeds threshold	11
11	IcmpOutAddrMaskReps	Exceeds threshold	12
12-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{\text{B-PON}}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.44 IP route table

This managed entity is used to record data that is associated with IP routes. Some of the data is volatile. Instances of this managed entity shall be automatically created/deleted by the ONT upon creation/deletion of the associated instances of IP Router Service Profile.

Relationship

An instance of this managed entity is associated with one instance of IP Router Service Profile.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the IP Router Service Profile with which this IP Route Table is associated. (R) (mandatory) (2 bytes)

IpRouteNumber: This attribute indicates the number of current routes in the route table. Default value is 0x00. (R) (mandatory) (2 bytes)

IpRouteTableMaxSize: This attribute indicates the maximum number of routes that can be stored in the route table. (R) (mandatory) (2 bytes)

IpRouteTable: This attribute lists current routes in the route table. A route consists of route-id, destination-address, destination-address-mask, tos, next-hop, output-port, route-type, route-protocol, route-age, and metric, which are further described below. (R) (mandatory) ($N \times 30$ bytes. N is the number of routes.)

– route-id: a unique identifier of a route within the route table (2 bytes);

– destination-address: the destination IP address of this route (4 bytes);

– destination-address-mask: the address mask associated with the destination address (4 bytes);

– tos: TOS value defined in RFC 2096 [17] (ipCidrRouteTos) for use with policy routing; otherwise, 0; (1 byte)

– next-hop: the address of the next router on remote routes (4 bytes);

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– output-port: the port number of the IP port through which the next hop of this route should be reached (1 byte);
– route-type: the type of route as defined in RFC 2096 [17] (ipCidrRouteType) (1 byte);
– route-protocol: the routing mechanism via which this route was learned, as defined in RFC 2096 [17] (ipCidrRouteProto). For example, static route is 3 (1 byte);
– route-age: the number of seconds since this route was last updated or otherwise determined to be correct. Static routes can return the maximum value (4 bytes);
– metric: the primary (first 4 bytes) and secondary (second 4 bytes) routing metrics for this route. The semantics of this metric are determined by the routing-protocol specified in the route's route-protocol value. If part of this metric is not used, its value should be set to –1 (2×4 bytes).

Actions

Get: Get one or more attributes. Latch a snapshot (i.e., copy) of the current ipRouteTable and respond with the size of data (4 bytes) that should be obtained using the Get next command.

Get next: Get the latched attribute values of the managed entity within the current snapshot.

Notifications

None.

7.3.45 IP static routes

This managed entity is used to set or delete IP static routes. Instances of this managed entity shall be automatically created/deleted by the ONT upon creation/deletion of the associated instances of IP Router Service Profile.

Relationship

An instance of this managed entity is associated with one instance of IP Router Service Profile.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the IP Router Service Profile with which this IP Static Routes is associated. (R) (mandatory) (2 bytes)

IpStaticRouteTableMaxSize: This attribute indicates the maximum number of routes that can be set as static routes. (R) (mandatory) (2 bytes)

IpStaticRouteTable: This attribute is used to set or delete static routes in the route table. A route consists of route-id, action, destination-address, destination-address-mask, next-hop, output-port, and metric, which are further described below. (The same scenario is used for the MAC Filter Table attribute of the MAC Bridge Port Filter Table Data managed entity. See I.1.3 and I.1.4.) When this attribute is used to set a static route through the parameter action:add(1), the route table is searched for the route-id parameter associated with the static route that is to be added. If the same route-id is found, the route is overwritten. (R, W) (mandatory) ($N \times 21$ bytes. N is the number of routes.)

– route-id: a unique identifier of a route within the static route table (1 byte);
– action: remove (0) or add (1) this route. When a static route is being removed, only static-route-id field is used to identify the route (1 byte);
– destination-address: the destination IP address of this route. This field may be set at the default route address (0.0.0.0) (4 bytes);
– destination-address-mask: the address mask associated with the destination address (4 bytes);

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– next-hop: the address of the next router on remote routes. This field is not used when the next-hop is reached through an unnumbered link (4 bytes, 0xFFFFFFFF when not used);
– output-port: the port number of the IP port through which the next hop of this route should be reached. This field is used when the next-hop is reached through an unnumbered link and when a static route is set to support a fully meshed network over ATM (1 byte, 0xFF when not used);
– iVCCTPointer: the pointer to the instance of Interworking VCC Termination Point which identifies one of the ATM links of the fully meshed network which is being set by this attribute. The value 0x0000 is interpreted as a Null pointer. (optional, 2 bytes);
– metric: the routing metric for this route (4 bytes).

Actions

Get: Get one or more attributes. Latch a snapshot (i.e., copy) of the current IpStaticRouteTable and respond with the size of data (4 bytes) that should be obtained using the Get next command.

Set: Generally, this action is used to set one or more entire attribute values. When used on the "IpStaticRouteTable" attribute, the "Set" action either adds or deletes table entries from "IpStaticRouteTable". Only one entry can be added/deleted by a single "Set" action.

Get next: Get the latched attribute values of the managed entity within the current snapshot.

Notifications

None.

7.3.46 ARP service profile

This managed entity is used to organize data that is associated with the ARP function used by an IP router function that contains an IP port of native LAN type. Instances of this managed entity are created/deleted by the OLT after/before an instance of IPPortConfigurationData is created/deleted.

Relationship

An instance of this managed entity is associated with one instance of IP Port Configuration Data of native LAN type.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The first byte is the slot id (defined in 7.1.3). If the UNI is integrated, this value is 0x00. The second byte is the ARP group id. (R, Set-by-create) (mandatory) (2 bytes)

ARP Timer: This attribute indicates the maximum number of seconds that IP packets are held while they are awaiting address resolution by ARP at this router. (R) (mandatory) (4 bytes)

ARP Cache Clear: This boolean attribute is used by the management system to initialize the ARP cache associated with an instance of this entity. This attribute is used only to trigger the "Cache Clear" action. The value TRUE means clear, and the value FALSE has no significance. As the value of this attribute has no physical meaning, the action "Get" will always return the value FALSE for this attribute. (R, W, Set-by-create) (mandatory) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

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Notifications

None.

7.3.47 ARP configuration data

This managed entity is used to organize data that is associated with the ARP function related to an IP router that contains an IP port of native LAN type. Some of the data is volatile. Instances of this managed entity shall be automatically created/deleted by the ONT upon creation/deletion of the associated instance of ARP Service Profile.

Relationship

An instance of this managed entity is associated with one instance of ARP Service Profile.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the ARP Service Profile with which this ARP Configuration Data is associated. (R) (mandatory) (2 bytes)

ARPTableMaxSize: This attribute indicates the maximum number of ARP entries that can be set in the ARP table. (R) (mandatory) (2 bytes)

ARP Table: This attribute lists current entries in the ARP cache. An ARP cache entry consists of port, IP-address, MAC-address, and type, which are further described below. (R) (mandatory) ($N \times 12$ bytes. N is the number of entries.)

– port: the port number of the IP port associated with the entry (1 byte);
– IP-address: an IP address (4 bytes);
– MAC-address: an equivalent MAC-address resolved by the ARP procedure (6 bytes);
– type: the entry type such as dynamic (3) or static (4) (1 byte).

Actions

Get: Get one or more attributes. Latch a snapshot (i.e., copy) of the current ARP Table and respond with the size of data (4 bytes) that should be obtained using the Get next command.

Get next: Get the latched attribute values of the managed entity within the current snapshot.

Notifications

None.

7.3.48 Physical path termination point ISDN UNI

This managed entity represents the point at the ISDN UNI in the ONT where physical paths terminate and physical path level functions (e.g., analog telephony, facsimile function) are performed. An instance of this managed entity shall be automatically created/deleted by the ONT upon the creation/deletion of a Subscriber Line Card with ISDN type.

Relationships

One or more instances of this managed entity shall be contained in an instance of the $ONT_{B\text{-}PON}$ or a Subscriber Line Card managed entity classified as ISDN type.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The first byte is the slot id (defined in 7.1.3). If the UNI is integrated, this value is 0x00. The second byte is the port id with value range from 0x01 to 0xFF (1 to 255), 0x01 is used for the leftmost/lowest

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port on a Subscriber Line Card, 0x02 is used for the next right/upper port, and so forth. (R) (mandatory) (2 bytes)

Administrative State: This attribute is used to activate (unlock: value 0x00) and deactivate (lock: value 0x01) the functions performed by instances of this managed entity. Selection of a default value for this attribute is outside the scope of this Recommendation as it is normally handled through supplier-operator negotiations. (R, W) (mandatory) (1 byte)

Interworking VCC Pointer: This attribute provides a pointer to the instance of the Interworking VCC Termination Point managed entity to which this instance is connected. The value 0x0000 is interpreted as a Null pointer. (R, W) (optional) (2 bytes)

DchannelID: This attribute provides the channel identifier of the AAL 2 connection transporting the D channel associated with this ISDN BRI port. (R, W) (mandatory) (1 byte)

B1ChannelID: This attribute provides the channel identifier of the AAL 2 connection transporting the B1 channel associated with this ISDN BRI port. (R, W) (mandatory) (1 byte)

B2ChannelID: This attribute provides the channel identifier of the AAL 2 connection transporting the B2 channel associated with this ISDN BRI port. (R, W) (mandatory) (1 byte)

ARC: This attribute is used to control alarm reporting from this managed entity. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

ARCInterval: This attribute provides a provisionable length of time. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

ISDN Loopback Configuration: This attribute represents the loopback configuration of this physical interface. Value 0x00: no loopback; value 0x01: simultaneous loopback of all channels; value 0x01: loopback of D channel only; value 0x02: loopback of B1 channel only; value 0x03: loopback of B2 channel only. Upon autonomous instantiation, the value 0x00 is used. (R, W) (mandatory) (1 byte)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Test: Request that the ONT perform one or more MLT tests. See "Test" and "Test result" message layouts in II.2.27 and II.2.45.

Notifications

Alarm: This notification is used to notify the management system when a failure has been detected or cleared. Both ONT and OLT should know the alarm list used by this entity. The alarm list for this entity is given in Table 15l.

Table 15l/G.983.2 – Alarm list for physical path termination point ISDN UNI

Number	Alarm	Description
0	AIS	Alarm indication signal
1	RDI	Remote defect indication
2-223	Reserved	
224-239	Vendor-specific alarms	Not to be standardized

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7.3.49 VLAN tagging operation configuration data

This managed entity is used to organize data associated with VLAN tagging. Instances of this managed entity are created/deleted at the request of the OLT.

Relationship

Zero or one instance of this managed entity may exist for each instance of Physical Path Termination Point Ethernet UNI.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the Physical Path Termination Point Ethernet UNI with which this VLAN Tagging Operation Configuration Data instance is associated. (R, Set-by-create) (mandatory) (2 bytes)

Upstream VLAN Tagging Operation Mode: This attribute selects whether or not upstream VLAN tagging is sent. Valid values are 0x00 (upstream frame is sent "as is", regardless of whether or not the received frame is tagged) and 0x01 (The upstream frame is sent as tagged whether or not the received frame is tagged. TCI, consisting of VID, CFI and user priority, is attached or overwritten by using the Upstream VLAN Tag TCI Value.). (R, W, Set-by-create) (mandatory) (1 byte)

Upstream VLAN Tag TCI Value: This attribute indicates the TCI value for upstream VLAN tagging. It is used when the Upstream VLAN Tagging Operation Mode is 0x01. Any 2-byte value is acceptable. (R, W, Set-by-create) (mandatory) (2 bytes)

Downstream VLAN Tagging Operation Mode: This attribute selects whether or not downstream VLAN tagging is sent. Valid values are 0x00 (downstream frame is sent "as is", regardless of whether or not the received frame is tagged) and 0x01 (The downstream frame is sent as untagged whether or not the received frame is tagged). (R, W, Set-by-create) (mandatory) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

7.3.50 VLAN tagging filter data

This managed entity is used to organize data associated with VLAN tagging. Instances of this managed entity are created/deleted at the request of the OLT.

Relationships

Zero or one instance of this managed entity may exist for each instance of MAC Bridge Port Configuration Data which is associated with Interworking VCC Termination Point (PON side) or Physical Path Termination Point Ethernet UNI.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the MACBridgePortConfigurationData with

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which this VLAN Tagging Filter Data instance is associated. (R, Set-by-create) (mandatory) (2 bytes)

VLAN Filter Table: This attribute lists TCI values which are provisioned at a bridging port. Since a TCI value (consisting of user priority, CFI and VID) is represented by 16 bits, 2 bytes are reserved for this attribute per VLAN. Twelve separate VLAN entries are supported. The first N are valid, where N is given by the NumberOfEntries attribute. (R, W, Set-by-create) (mandatory) (24 bytes)

Forward Operation: When a frame is received, the frame is processed according to the following Forward Operations. The operations are invoked based on the value of VID, user priority, or the entire TCI or whether or not the TCI field exists. This attribute indicates the received frame is treated as indicated below. (R,W, set-by-create) (mandatory) (1 byte)

NumberOfEntries: This attribute provides the number of entries in the VLAN Filter Table that are valid. (R, W, Set-by-Create) (mandatory) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

Supplementary explanation

1) *Ethernet frame and fields format for VLAN services*

The detailed format of Ethernet frame for VLAN services is described in IEEE 802.1Q [18] and is depicted in Figure 37.

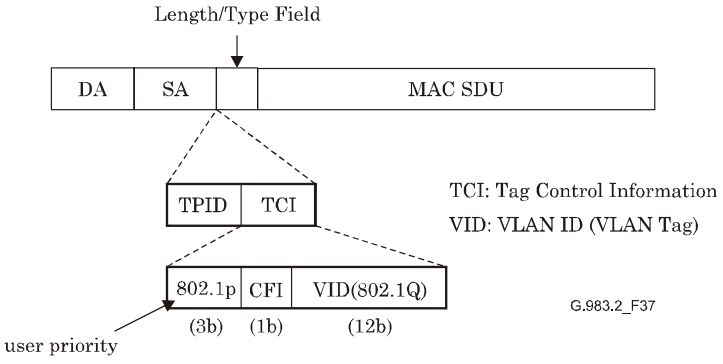


Figure 37/G.983.2 – Detailed format for Ethernet frame with VLAN tag

2) *Operations*

Operations specified in the attribute "Forward Operation" are explained. Forward Operations are specified by a combination of the basic actions mentioned.

a) **Basic MAC bridge operation**: As shown in Figure 38, if DA (Destination MAC Address) in the received frame is listed in one or more ports with MAC Bridge Port Bridge Table Data, this frame is forwarded to the indicated ports. Otherwise, it is broadcasted to all of the ports excepting for its receiving port.

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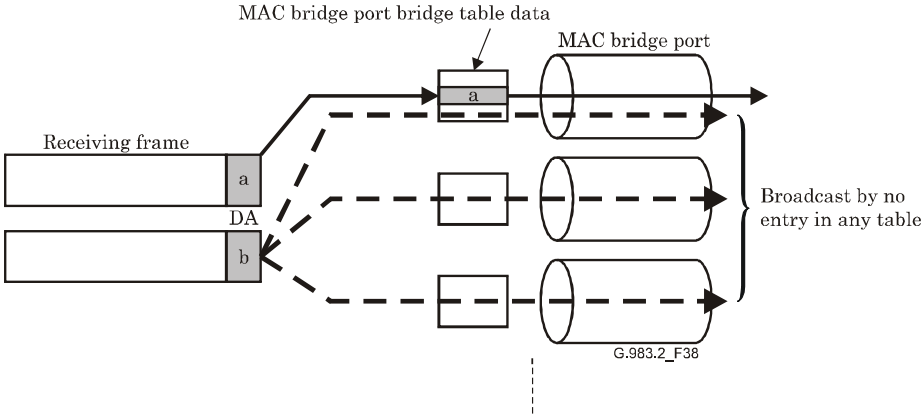


Figure 38/G.983.2 – Basic MAC Bridge operation

b) **Unconditional forwarding for Tagged frame**: If a tagged frame is received, it is forwarded without investigation of TCI.

c) **Unconditional discarding for Tagged frame**: If a tagged frame is received, it is discarded without investigation of TCI.

d) **Unconditional forwarding for Untagged frame**: If an untagged frame is received, it is forwarded without investigation of TCI.

e) **Unconditional discarding for Untagged frame**: If an untagged frame is received, it is discarded without investigation of TCI.

f) **Positive filtering by TCI**: If a part or all of the fields in the TCI of the received frame are included in VLAN Tag Filter Data, it is forwarded according to Action a) to the indicted ports as shown in Figure 39. Otherwise, its TCI is ignored and it is controlled by Action a).

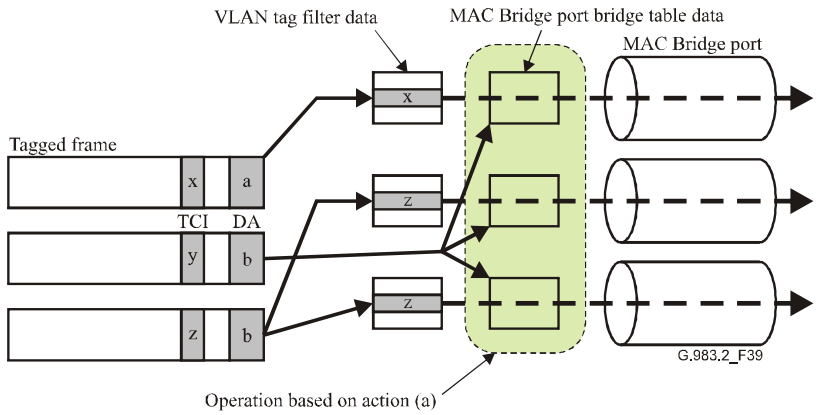


Figure 39/G.983.2 – Positive filtering by TCI operation

g) **Negative filtering by TCI**: If a part or all of the fields in the TCI of the received frame are included in VLAN Tag Filter Data, it is discarded. Otherwise, it is forwarded according to Action a) as shown in Figure 40.

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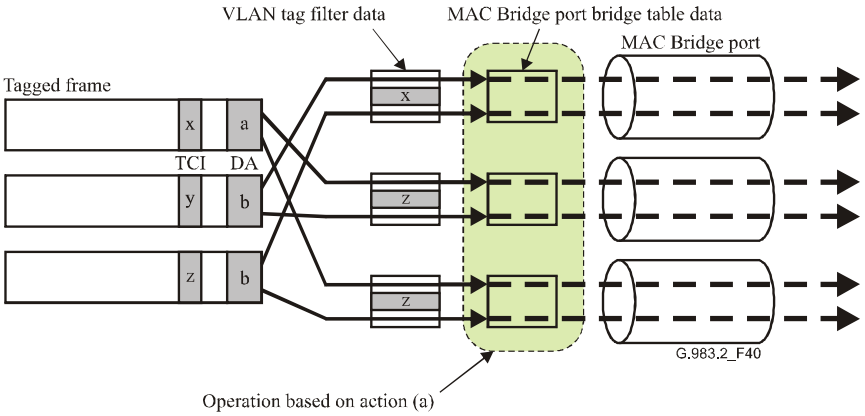


Figure 40/G.983.2 – Negative filtering by TCI operation

The Forwarding Operation is specified by a combination of these actions.

	The type of received frame	
	Tagged	**Untagged**
0x00	Action a)	Action a)
0x01	Action c)	Action a)
0x02	Action a)	Action e)
0x03	Action f) (VID investigation)	Action a)
0x04	Action f) (VID investigation)	Action e)
0x05	Action g) (VID investigation)	Action a)
0x06	Action g) (VID investigation)	Action e)
0x07	Action f) (user priority investigation)	Action a)
0x08	Action f) (user priority investigation)	Action e)
0x09	Action g) (user priority investigation)	Action a)
0x0A	Action g) (user priority investigation)	Action e)
0x0B	Action f) (TCI investigation)	Action a)
0x0C	Action f) (TCI priority investigation)	Action e)
0x0D	Action g) (TCI investigation)	Action a)
0x0E	Action g) (TCI investigation)	Action e)

7.3.51 MAC Bridge port filter preassign table

This managed entity provides an alternate approach to address filtering than that supported through MACBridgePortFilterTableData. This alternate approach is useful when all the groups of addresses are stored beforehand in the line card, and this managed entity is used to designate which groups are valid or invalid for filtering. The MAC addresses and Ether types for various protocols are provided in Appendix VI. Instances of this managed entity are created/deleted autonomously after creation/deletion of a Subscriber Line Card ME of Ethernet type in which all groups of addresses are preassigned and stored in the card.

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Relationships

This managed entity is associated with one instance of a MACBridgePortConfigurationData managed entity.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the id of the MACBridgePortConfigurationData with which this MAC Bridge Port Filter Preassign Table instance is associated. (R) (mandatory) (2 bytes)

IPv4MulticastFiltering: This attribute indicates whether IPv4Multicast Ether types are forwarded (value 0x00) or filtered (value 0x01). Initial value is 0x00. (R,W) (mandatory) (1 byte)

IPv6MulticastFiltering: This attribute indicates whether Ipv6Multicast Ether types are forwarded (value 0x00) or filtered (value 0x01). Initial value is 0x00. (R,W) (mandatory) (1 byte)

IPv4BroadcastFiltering: This attribute indicates whether IPv4Broadcast Ether types are forwarded (value 0x00) or filtered (value 0x01). Initial value is 0x00. (R,W) (mandatory) (1 byte)

RARPFiltering: This attribute indicates whether RARP Ether types are forwarded (value 0x00) or filtered (value 0x01). Initial value is 0x00. (R,W) (mandatory) (1 byte)

IPXFiltering: This attribute indicates whether IPX Ether types are forwarded (value 0x00) or filtered (value 0x01). Initial value is 0x00. (R,W) (mandatory) (1 byte)

NetBEUIFiltering: This attribute indicates whether NetBEUI Ether types are forwarded (value 0x00) or filtered (value 0x01). Initial value is 0x00. (R,W) (mandatory) (1 byte)

AppleTalkFiltering: This attribute indicates whether AppleTalk Ether types are forwarded (value 0x00) or filtered (value 0x01). Initial value is 0x00. (R,W) (mandatory) (1 byte)

BridgeManagementInformationFiltering: This attribute indicates whether BridgeManagementInformation Ether types are forwarded (value 0x00) or filtered (value 0x01). Initial value is 0x00. (R,W) (mandatory) (1 byte)

Note that some MAC addresses should not be handled, considering the following rules of IEEE 802.1D [13]:

1) Addresses from 0x0180C2000000 to 0x0180C200000F are reserved;
2) Addresses from 0x0180C2000020 to 0x0180C20002F are used for GARP Application Address.

ARPFiltering: This attribute indicates whether ARP Ether types are forwarded (value 0x00) or filtered (value 0x01). Initial value is 0x00. (R,W) (mandatory) (1 byte)

PPPoEFiltering: This attribute indicates whether PPPoE Ether types are forwarded (value 0x00) or filtered (value 0x01). Initial value is 0x00. (R,W) (mandatory) (1 byte)

Actions

Set: Set one or more attributes.

Notifications

None.

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7.3.52 Physical path termination point video UNI

This managed entity represents the point at the video UNI in the ONT where physical paths terminate and physical path level functions are performed.

An instance of this managed entity shall be automatically created/deleted by the ONT upon creation/deletion of a Subscriber Line Card of Video type.

Relationships

One or more instances of this managed entity shall be contained in an instance of a Subscriber Line Card managed entity classified as Video type.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The first byte is the slot id (defined in 7.1.3). If the UNI is integrated, this value is 0x00. The second byte is the port id with value range from 0x01 to 0xFF (1 to 255); 0x01 is used for the leftmost/lowest port on a Subscriber Line Card, 0x02 is used for the next right/upper port, and so forth. (R) (mandatory) (2 bytes)

Administrative State: This attribute is used to activate (unlock: value 0x00) and deactivate (lock: value 0x01) functions performed by instances of this managed entity. Selection of a default value for this attribute is outside the scope of this Recommendation, as it is normally handled through supplier-operator negotiations. (R,W) (mandatory) (1 byte)

Operational State: This attribute indicates whether or not this managed entity is capable of performing its task. The operational state reflects the perceived ability to receive or to generate a valid signal. Valid values are enabled (0x00) and disabled (0x01). (R) (optional) (1 byte)

ARC: This attribute is used to control alarm reporting from this managed entity. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

ARCInterval: This attribute provides a provisionable length of time. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

Power control: This attribute controls whether power is provided to an external equipment over the video PPTP. Value 0x01 enables power over co-ax. The default value 0x00 disables power feed. (R, W) (optional) (1 byte)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

Attribute value change: This notification is used to report autonomous changes of attributes of this managed entity. The notification shall identify its new value. The AVC list is given in Table 15m.

Alarm: This notification is used to notify the management system when a failure has been detected or cleared. Both ONT and OLT should know the alarm ist used by this entity. The alarm list for this entity is given in Table 15n.

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Table 15m/G.983.2 – AVC list for physical path termination point video UNI

Number	Attribute value change	Description
1	N/A	
2	OpState	Operational state of video UNI
3-16	Reserved	Reserved for AVCs of vendor-specific attributes

Table 15n/G.983.2 – Alarm list for physical path termination point video UNI

Number	Event	Description
0	Video-LOS	No signal at the video UNI
1-223	Reserved	Reserved for vendor-specific alarms
224-239	Vendor-specific alarms	Not to be standardized

7.3.53 Physical path termination point video ANI

This managed entity represents the point at the video ANI in the ONT where physical paths terminate and physical path level functions are performed.

An instance of this managed entity shall be automatically created/deleted by the ONT upon creation/deletion of a Subscriber Line Card of Video type.

Relationships

One or more instances of this managed entity shall be contained in an instance of a Subscriber Line Card managed entity classified as Video type.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. There is only one instance, and it has the number 0x0000. (R) (mandatory) (2 bytes)

Administrative State: This attribute is used to activate (unlock: value 0x00) and deactivate (lock: value 0x01) functions performed by instances of this managed entity. Selection of a default value for this attribute is outside the scope of this Recommendation, as it is normally handled through supplier-operator negotiations. (R,W) (mandatory) (1 byte)

Operational State: This attribute indicates whether or not this managed entity is capable of performing its task. The operational state reflects the perceived ability to receive or to generate a valid signal. Valid values are enabled (0x00) and disabled (0x01). (R) (optional) (1 byte)

ARC: This attribute is used to control alarm reporting from this managed entity. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

ARCInterval: This attribute provides a provisionable length of time. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

FrequencyRangeLow: This attribute indicates the lower of the possibly two frequency ranges supported. Different frequency ranges are indicated by code points, as given below:

– 0 indicates no low band is supported;
– 1 indicates 50-550 MHz is supported;
– 2 indicates 50-750 MHz is supported;
– 3 indicates 50-870 MHz is supported;
– 4..255 are reserved for future use.

(R) (mandatory) (1 byte)

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FrequencyRangeHigh: This attribute indicates the higher of the two frequency ranges supported. Different frequency ranges are indicated by code points, as given below:

– 0 indicates no high band is supported;
– 1 indicates 550-750 MHz is supported;
– 2 indicates 550-870 MHz is supported;
– 3 indicates 950-2050 MHz is supported;
– 4 indicates 2150-3250 MHz is supported;
– 5 indicates 950-3250 MHz is supported;
– 6..255 are reserved for future use.

(R) (mandatory) (1 byte)

SignalCapability: This attribute indicates the capability of the ONT to measure the video signal level. Different capabilities are indicated by code points, as given below:

– 0 indicates no signal level capability is supported;
– 1 indicates total optical power level is supported;
– 2 indicates fixed frequency pilot tone power level is supported;
– 3 indicates total optical power level and fixed frequency pilot tone power level are supported;
– 4 indicates variable frequency pilot tone power level is supported;
– 5 indicates total optical power level and variable frequency pilot tone power level are supported;
– 6 indicates broadband RF power level is supported;
– 7 indicates total optical power level and broadband RF power level is supported;
– 8..255 are reserved for future use.

(R) (mandatory) (1 byte)

OpticalSignalLevel: This attribute indicates the current measurement of the total optical signal level. The unit of this attribute is dBμW optical.

If SignalCapability = 0, 2, or 4 then this attribute is undefined.

If SignalCapability = 1, 3, 5, or 7, then this attribute describes the total optical power that is generating photocurrent on the receiver.

(R) (optional) (1 byte)

PilotSignalLevel: This attribute indicates the current measurement of the pilot signal level or broadband RF level. The unit of this attribute is dBμV at the RF video service port.

If SignalCapability = 0 or 1, then this attribute is undefined.

If SignalCapability = 2, 3, 4, or 5, then this attribute describes the pilot signal level at the output of the video UNI.

If SignalCapability = 6, or 7, then this attribute describes the total RF power level at the output of the video UNI.

(R) (optional) (1 byte)

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SignalLevelMin: This attribute indicates the minimum optical RF power per channel that will result in a CNR of 47 dBc for a channel of 4.5 MHz in bandwidth at a receive optical power of –5 dBm. The unit of this attribute is dBμW optical.

(R) (mandatory) (1 byte)

SignalLevelMax: This attribute indicates the maximum optical RF power per channel that will result in a CTB of –57 dBc for an 80-channel ensemble of carriers at a per-channel optical modulation index of 3.5%. The units of the attributes are in dBμW optical.

(R) (mandatory) (1 byte)

PilotFrequency: This attribute indicates the frequency of the pilot channel receiver. This unit of this attribute is Hz.

If SignalCapability = 0 or 1, this attribute is undefined;

If SignalCapability = 2 or 3, this attribute is functionally read only;

If SignalCapability = 4 or 5, this attribute is read-write.

(R, W) (optional) (4 bytes)

AGCmode: This attribute allows the discovery and configuration of the ONT's AGC capabilities. The attribute contains a codepoints for the several AGC types. The ONT displays the currently used AGC mode. The OLT can discover new modes via the set command. The code points are:

– 0, no AGC is used;

– 1, broadband RF AGC is used;

– 2, optical AGC is used;

– 3-255, reserved for future use.

(R, W) (optional) (1 byte)

AGCsetting This attribute indicates the measurement offset that the ONT should use if using broadband RF signal level or total optical power as a basis for AGC. The theoretical nominal RF signal is 80-channels of NTSC video, each having a per-channel optical modulation index of 3.5%. An ONT presented with such a signal should produce its specified output when this attribute is set to zero. The attribute will have a step-size of 0.1 dB, represented as a signed integer. The usage of the attribute depends on the signal capability used for the AGC.

If total optical power is used for AGC, then this attribute provides the ONT with the OMI offset for any NTSC carriers present from the theoretical 3.5% value. So, if the actual signal uses an OMI of 7.0% per channel (3 dB higher), then the ONT should be given an AGC setting of 30. (Coded 0x1E).

If broadband RF power is used for AGC, then this attribute provides the ONT with the total power offset for any NTSC carriers present from the theoretical 80 channel value. So, if an actual signal contains 40 NTSC channels (3 dB lower), then the ONT should be given an AGC setting of –30. (Coded 0xE2).

(R, W) (optional) (1 byte)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

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Notifications

Attribute value change: This notification is used to report autonomous changes of attributes of this managed entity. The notification shall identify its new value. The AVC list is given in Table 15o.

Alarm: This notification is used to notify the management system when a failure has been detected or cleared. Both ONT and OLT should know the alarm list used by this entity. The alarm list for this entity is given in Table 15p.

Table 15o/G.983.2 – AVC list for physical path termination point video ANI

Number	Attribute value change	Description
1	N/A	
2	OpState	Operational state of video ANI
3-16	Reserved	Reserved for AVCs of vendor-specific attributes

Table 15p/G.983.2 – Alarm list for physical path termination point video ANI

Number	Event	Description
0	Video-LOS	No signal at the video ANI
1-223	Reserved	Reserved for vendor-specific alarms
224-239	Vendor-specific alarms	Not to be standardized

7.3.54 Physical path termination point LCT UNI

This managed entity represents the point at the local craft terminal UNI in the ONT where physical paths terminate and physical path level functions are performed.

An instance of this managed entity shall be automatically created/deleted by the ONT upon creation/deletion of a Subscriber Line Card of LCT type. However, this instance will not be reported during a MIB upload.

Relationships

One or more instances of this managed entity shall be contained in an instance of a Subscriber Line Card managed entity classified as LCT type.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The first byte is the slot id (defined in 7.1.3). If the UNI is integrated, this value is 0x00. The second byte is the port id with value range from 0x01 to 0xFF (1 to 255); 0x01 is used for the leftmost/lowest port on a Subscriber Line Card, 0x02 is used for the next right/upper port, and so forth. (R) (mandatory) (2 bytes)

Administrative State: This attribute is used to activate (unlock: value 0x00) and deactivate (lock: value 0x01) functions performed by instances of this managed entity. Selection of a default value for this attribute is outside the scope of this Recommendation, as it is normally handled through supplier-operator negotiations. (R,W) (mandatory) (1 byte)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

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Notifications

None.

7.3.55 Ethernet performance monitoring history data 2

This managed entity contains the last completed 15-minute interval collected statistic data for an Ethernet interface. The statistic data value is only updated at the end of each period.

Instances of this managed entity are created/deleted by the OLT after an instance of Physical Path Termination Point Ethernet UNI managed entity is created/deleted.

Relationships

One instance of this Ethernet Performance Monitoring History Data 2 managed entity can exist for each instance of the Physical Path Termination Point Ethernet UNI.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is the same as the id of the Physical Path Termination Point Ethernet UNI. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the statistic data values are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. The statistic data value is updated at the end of the interval. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ id: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

PPPoEFilteredFrame Counter: This attribute provides a count of the number of frames that have been discarded due to PPPoE filtering. Default value is 0x00. (R) (mandatory) (4 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Get Current Data: This action returns the current value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters would be reset at the end of the interval.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

Support of this action is optional.

Set: Set one or more attributes.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a threshold crossing alert (TCA) is detected or cleared. The TCA change notification "on" will be

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sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. The event list for this entity is given in Table 15q.

Table 15q/G.983.2 – Alarm list for Ethernet performance monitoring history data 2

Number	Event	Description	Threshold data counter # (Note)
	Threshold Crossing Alert		
0	PPPoEFilteredFrameCounter	Exceeds threshold	1
1-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{\text{B-PON}}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.56 Physical path termination point 802.11 UNI

Relationships

One instance of this managed entity may exist for each instance of an IEEE 802.11 interface. An instance of this entity is created/deleted by the ONU whenever an IEEE 802.11 UNI card is inserted/removed from the ONU.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The first byte is the slot id (defined in 7.1.3). If the UNI is integrated, this value is 0x00. The second byte is the port id with value range from 0x01 to 0xFF (1 to 255), 0x01 is used for the leftmost/lowest port on a Subscriber Line Card, 0x02 is used for the next right/upper port, and so forth. (R) (mandatory) (2 bytes)

Administrative State: This attribute is used to activate (unlock: value 0x00) and deactivate (lock: value 0x01) the functions performed by instances of this managed entity. Selection of a default value for this attribute is outside the scope of this Recommendation as it is normally handled through supplier-operator negotiations. (R, W) (mandatory) (1 byte)

Operational State: This attribute indicates whether or not this managed entity is capable of performing its task. The operational state reflects the perceived ability to receive or to generate a valid signal. Valid values are enabled (0x00) and disabled (0x01). (R) (optional) (1 byte)

dot11SupportedDataRatesTx: This attribute shall specify the set of data rates (maximum of 8 data rates) at which the station is capable of transmitting data. Each octet contains a value representing a rate. Each rate shall be within the range from 2 to 127, corresponding to data rates in increments of 500 kbit/s from 1 Mbit/s to 63.5 Mbit/s, and shall be supported (as indicated in the supported rates table) for transmitting data. If fewer than 8 data rates are specified, each of the remaining bytes shall use the value 0x00. (R) (mandatory) (8 bytes)

dot11SupportedDataRatesRx: This attribute shall specify the set of data rates (maximum of 8 data rates) at which the station is capable of receiving data. Each octet contains a value representing a rate. Each rate shall be within the range from 2 to 127, corresponding to data rates in increments of 500 kbit/s from 1 Mbit/s to 63.5 Mbit/s, and shall be supported (as indicated in the supported rates table) for receiving data. If fewer than 8 data rates are specified, each of the remaining bytes shall use the value 0x00. (R) (mandatory) (8 bytes)

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dot11TxPowerLevels: This attribute shall specify the set of transmit power levels (maximum of 8 power levels) which the station is capable of using. Each 16 bit word contains an integer representation of the power setting, in units of mW. If fewer than 8 power levels are specified, each of the remaining words shall use the value 0x0000. (R) (mandatory) (16 bytes)

ARC: This attribute is used to control alarm reporting from this managed entity. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

ARCInterval: This attribute provides a provisionable length of time. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

Attribute Value Change: This notification is used to report autonomous changes to the attributes of this managed entity. The attribute value change notification shall identify the attribute changed and its new value. The list of AVCs for this managed entity is given in Table 16.

Table 16/G.983.2 – AVC list for physical path termination point 802.11 UNI (reproduced from Table 2/G.983.9)

Number	Attribute value change	Description
1	N/A	
2	OpState	Operational state of Physical Path Termination Point 802.11 UNI
3-9	N/A	
10-16	Reserved	

7.3.57 UNI 802.11 station management data 1

Relationships

One instance of this managed entity may exist for each instance of an IEEE 802.11 interface. The ONU automatically creates an instance of this entity whenever a PPTP 802.11 UNI instance is created.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This ME id shall be the same as that of the related instance of Physical Path Termination Point 802.11 UNI. (R) (mandatory) (2 bytes)

dot11MediumOccupancyLimit: This attribute shall indicate the maximum amount of time, in TU, that a point coordinator may control the usage of the wireless medium without relinquishing control for long enough to allow at least one instance of DCF access to the medium. The default value of this attribute shall be 100, and the maximum value shall be 1000. (R, W) (mandatory) (2 bytes)

dot11CFPollable: When this Boolean attribute is true, it shall indicate that the STA is able to respond to a CF-Poll with a data frame within a SIFS time. This attribute shall be false if the STA is not able to respond to a CF-Poll with a data frame within a SIFS time. (R) (mandatory) (1 byte)

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dot11CFPPeriod: This attribute shall describe the number of DTIM intervals between the start of CFPs. (R,W) (mandatory) (1 byte)

dot11CFPMaxDuration: This attribute shall describe the maximum duration of the CFP in TU that may be generated by the PCF. (R, W) (mandatory) (2 bytes)

dot11AuthenticationResponseTimeOut: This attribute shall specify the number of TU that a responding STA should wait for the next frame in the authentication sequence. (R, W) (mandatory) (4 bytes)

dot11PrivacyOptionImplemented: This Boolean attribute, when true, shall indicate that the IEEE 802.11 WEP option is implemented. The default value of this attribute shall be false. (R) (mandatory) (1 byte)

dot11PowerManagementMode: This attribute shall specify the power management mode of the STA. When set to active (0x00), it shall indicate that the station is not in power-save mode. When set to powersave (0x01), it shall indicate that the station is in power-save mode. (R, W) (mandatory) (1 byte)

dot11DesiredSSID1: This attribute contains the first half of the Service Set ID used in the DesiredSSID parameter of the most recent MLME_Scan.request. This value may be modified by an external management entity and used by the local SME to make decisions about the scanning process. (R, W) (mandatory) (16 bytes)

dot11DesiredSSID2: This attribute contains the second half of the Service Set ID used in the DesiredSSID parameter of the most recent MLME_Scan.request. This value may be modified by an external management entity and used by the local SME to make decisions about the scanning process. (R, W) (mandatory) (16 bytes)

dot11DesiredBSSType: This attribute shall specify the type of BSS the station shall use when scanning for a BSS with which to synchronize. This value is used to filter Probe Response frames and Beacons. When set to infrastructure (0x00), the station shall only synchronize with a BSS whose Capability Information field has the ESS subfield set to 1. When set to independent (0x01), the station shall only synchronize with a BSS whose Capability Information field has the IBSS subfield set to 1. When set to any (0x02), the station may synchronize to either type of BSS. (R, W) (mandatory) (1 byte)

dot11OperationalRateSet: This attribute shall specify the set of data rates (maximum of 8 data rates) at which the station may transmit data. Each octet contains a value representing a rate. Each rate shall be within the range from 2 to 127, corresponding to data rates in increments of 500 kbit/s from 1 Mbit/s to 63.5 Mbit/s, and shall be supported (as indicated in the supported rates table) for receiving data. If fewer than 8 data rates are specified, each of the remaining bytes shall use the value 0x00. This value is reported in transmitted Beacon, Probe Request, Probe Response, Association Request, Association Response, Reassociation Request, and Reassociation Response frames, and is used to determine whether a BSS with which the station desires to synchronize is suitable. (R, W) (mandatory) (8 bytes)

dot11BeaconPeriod: This attribute shall specify the number of TU that a station shall use for scheduling Beacon transmissions. This value is transmitted in Beacon and Probe Response frames. (R, W) (mandatory) (2 bytes)

dot11DTIMPeriod: This attribute shall specify the number of beacon intervals that shall elapse between transmission of Beacons frames containing a TIM element whose DTIM Count field is 0. This value is transmitted in the DTIM Period field of Beacon frames. (R, W) (mandatory) (1 byte)

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dot11AssociationResponseTimeOut: This attribute shall specify the number of TU that a requesting STA should wait for a response to a transmitted association-request MMPDU. (R, W) (mandatory) (4 bytes)

dot11AuthenticationAlgorithm: This attribute shall indicate all of the authentication algorithms supported by the STAs. The attribute is a bit-mapped coding, formatted as follows:

0000 0000 0000 0000 0000 0000 0000 00yx,

where

0 = reserved, must be set to zero

x = Open System (1=Supported, 0=Not supported)

y = Shared Key Supported (1=Supported, 0=Not supported)

(R) (mandatory) (4 bytes)

dot11AuthenticationAlgorithmsEnable: This attribute shall indicate the enable status of the authentication algorithms supported by the STAs. The attribute is a bit-mapped coding, formatted as follows:

0000 0000 0000 0000 0000 0000 0000 00yx,

where

0 = reserved, must be set to zero

x = Open System (1=Enabled, 0=Not Enabled)

y = Shared Key (1=Enabled, 0=Not Enabled)

(R, W) (mandatory) (4 bytes)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

7.3.58 802.11 station management data 2

Relationships

One instance of this managed entity may exist for each instance of an IEEE 802.11 interface. The ONU automatically creates an instance of this entity whenever a PPTP 802.11 UNI instance is created.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This ME id shall be the same as that of the related instance of Physical Path Termination Point 802.11 UNI. (R) (mandatory) (2 bytes)

dot11DisassociateReason: This attribute holds the most recently transmitted Reason Code in a disassociation frame. If no Disassociation frame has been transmitted, the value of this attribute shall be 0. (R) (mandatory) (2 bytes)

dot11DisassociateStation: This attribute holds the MAC address from the Address 1 field of the most recently transmitted Disassociation frame. If no Disassociation frame has been transmitted, the value of this attribute shall be 0. (R) (mandatory) (6 bytes)

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dot11DeauthenticateReason: This attribute holds the most recently transmitted Reason Code in a Deauthentication frame. If no Deauthentication frame has been transmitted, the value of this attribute shall be 0. (R) (mandatory) (2 bytes)

dot11DeauthenticateStation: This attribute holds the MAC address from the Address 1 field of the most recently transmitted Deauthentication frame. If no Deauthentication frame has been transmitted, the value of this attribute shall be 0. (R) (mandatory) (6 bytes)

dot11AuthenticateFailStatus: This attribute holds the most recently transmitted Status Code in a failed Authentication frame. If no failed Authentication frame has been transmitted, the value of this attribute shall be 0. (R) (mandatory) (2 bytes)

dot11AuthenticateFailStation: This attribute holds the MAC address from the Address 1 field of the most recently transmitted failed Authentication frame. If no failed Authentication frame has been transmitted, the value of this attribute shall be 0. (R) (mandatory) (6 bytes)

dot11WEPDefaultKeyValue1: This attribute holds WEP Default Key #1. The WEP default secret keys are logically WRITE-ONLY. Attempts to read the entries in this table shall return unsuccessful status and values of null or zero. The default value of each WEP default key shall be null. (W) (mandatory) (5 bytes)

dot11WEPDefaultKeyValue2: This attribute holds WEP Default Key #2. (W) (mandatory) (5 bytes)

dot11WEPDefaultKeyValue3: This attribute holds WEP Default Key #3. (W) (mandatory) (5 bytes)

dot11WEPDefaultKeyValue4: This attribute holds WEP Default Key #4. (W) (mandatory) (5 bytes)

dot11PrivacyInvoked&dot11ExcludeUnencrypted: This attribute holds two truth values. It is coded 0000 00yx, where x indicates the dot11PrivacyInvoked value, and y indicates the dot11ExcludeUnencrypted value. When dot11PrivacyInvoked is true, it shall indicate that the IEEE 802.11 WEP mechanism is used for transmitting frames of type Data. The default value of this attribute shall be false. When dot11ExcludeUnencrypted is true, the STA shall not indicate at the MAC service interface received MSDUs that have the WEP subfield of the Frame Control field equal to zero. When this attribute is false, the STA may accept MSDUs that have the WEP subfield of the Frame Control field equal to zero. The default value of this attribute shall be false. (R, W) (mandatory) (1 byte)

dot11WEPDefaultKeyID: This attribute shall indicate the use of the first, second, third, or fourth WEPDefaultKey when set to values of zero, one, two, or three. The default value of this attribute shall be 0. (R, W) (mandatory) (1 byte)

dot11WEPKeyMappingLength: The maximum number of tuples that dot11WEPKeyMappings can hold. (R, W) (mandatory) (4 bytes)

dot11WEPICVErrorCount: This counter shall increment when a frame is received with the WEP subfield of the Frame Control field set to one and the value of the ICV as received in the frame does not match the ICV value that is calculated for the contents of the received frame. (R) (mandatory) (4 bytes)

dot11WEPExcludedCount: This counter shall increment when a frame is received with the WEP subfield of the Frame Control field set to zero and the value of dot11ExcludeUnencrypted causes that frame to be discarded. (R) (mandatory) (4 bytes)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

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Notifications

Attribute Value Change: This notification is used to report autonomous changes to the attributes of this managed entity. The attribute value change notification shall identify the attribute changed and its new value. The list of AVCs for this managed entity is given in Table 17. Notifications should be sent when a Disassociate, Deauthenticate, or AuthenticationFail event occurs. These events will normally coincide with a change in the DisassociateStation, DeauthenticateStation, or AuthenticationFailStation attributes.

Table 17/G.983.2 – AVC list for 802.11 station management data 2 (reproduced from Table 3/G.983.9)

Number	Attribute value change	Description
1	N/A	
2	dot11DisassociateStation	MAC address from the Address 1 field of the most recently transmitted Disassociation frame
3	N/A	
4	dot11DeauthenticateStation	MAC address from the Address 1 field of the most recently transmitted Deauthentication frame
5	N/A	
6	dot11AuthenticateFailStation	MAC address from the Address 1 field of the most recently transmitted failed Authentication frame
7-15	N/A	
16	Reserved	

7.3.59 802.11 general purpose object

Relationships

Many instances of this managed entity may exist for each instance of an IEEE 802.11 interface. This object is used to contain the following IEEE 802.11 data: WEP Key Mappings, Group Addresses, Reg Domain Supported, and Antennas List. Each of these uses has its own attributes defined, and a type attribute indicates which subset of attributes is active for each instance. Regardless of which attributes are active, each attribute shall be numbered (in attribute mask) according to the ordering of the full attribute set indicated below.

For object types 0 and 1, the OLT may create and delete instances of this object. For object types 2 and 3, the ONU instantiates as many instances as required to model the UNI's capabilities.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

ObjectType: This attribute indicates how this entity is to be used, defined as:

– 0: WEP Key Mapping;
– 1: Group Addresses;
– 2: Reg Domain Supported;
– 3: Antennas List.

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For any given type, only the relevant attributes have valid contents. The other attributes are unspecified. (R, Set-by-create) (mandatory) (1 byte)

PhysicalPathTerminationPoint802.11Pointer: This attribute indicates the specific Physical Path Termination Point to which this object corresponds. (R, Set-by-create) (mandatory) (2 bytes)

dot11WEPKeyMappingAddress: Valid if ObjectType = 0. The MAC address of the STA for which the values from this key mapping entry are to be used. (R, W, Set-by-create) (mandatory) (6 bytes)

dot11WEPKeyMappingWEPOn: Valid if ObjectType = 0. Boolean as to whether WEP is to be used when communicating with the dot11WEPKeyMappingAddress STA (R, W, Set-by-create) (mandatory) (1 byte)

dot11WEPKeyMappingValue: Valid if ObjectType = 0. A WEP secret key value. (W, Set-by-create) (mandatory) (5 bytes)

dot11Address: Valid if ObjectType = 1. MAC address identifying a multicast addresses from which this STA will receive frames (R, Set-by-create) (mandatory) (6 bytes)

dot11RegDomainsSupportValue: Valid if ObjectType = 2. There are different operational requirements dependent on the regulatory domain. This attribute list describes the regulatory domains the PLCP and PMD support in this implementation. Currently defined values and their corresponding Regulatory Domains are: FCC (USA) = X'10', DOC (Canada) = X'20', ETSI (most of Europe) = X'30', Spain = X'31', France = X'32', MKK (Japan) = X'40' (R) (mandatory) (1 byte)

dot11SupportedTxAntenna: Valid if ObjectType = 3. When true, this Boolean object indicates that the antenna represented by this managed entity id can be used as a transmit antenna. (R) (mandatory) (1 byte)

dot11SupportedRxAntenna: Valid if ObjectType = 3. When true, this Boolean object indicates that the antenna represented by this managed entity id can be used as a receive antenna. (R) (mandatory) (1 byte)

dot11DiversitySelection Rx: Valid if ObjectType = 3. When true, this Boolean object indicates that the antenna represented by managed entity id can be used for receive diversity. This object may only be true if the antenna can be used as a receive antenna, as indicated by dot11SupportedRxAntenna (R, W) (mandatory) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

7.3.60 802.11 MAC&PHY operation and antenna data

Relationships

One instance of this managed entity may exist for each instance of an IEEE 802.11 interface. The ONU automatically creates an instance of this entity whenever a PPTP 802.11 UNI instance is created.

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Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This ME id shall be the same as that of the related instance of Physical Path Termination Point 802.11 UNI. (R) (mandatory) (2 bytes)

dot11MACAddress: Unique MAC Address assigned to the STA. (R) (mandatory) (6 bytes)

dot11RTSThreshold: This attribute shall indicate the number of octets in an MPDU, below which an RTS/CTS handshake shall not be performed. An RTS/CTS handshake shall be performed at the beginning of any frame exchange sequence where the PDU is of type Data or Management, the MPDU has an individual address in the address1 field, and the length of the MPDU is greater than this threshold. Setting this attribute to be larger than the maximum MSDU size shall have the effect of turning off the RTS/CTS handshake for frames of Data or Management type transmitted by this STA. Setting this attribute to zero shall have the effect of turning on the RTS/CTS handshake for all frames of Data or Management type transmitted by this STA. The default value of this attribute shall be 2347. (R, W) (mandatory) (2 bytes)

dot11ShortRetryLimit: This attribute shall indicate the maximum number of transmission attempts of a frame, the length of which is less than or equal to dot11RTSThreshold, that shall be made before a failure condition is indicated. The default value of this attribute shall be 7. (R, W) (mandatory) (1 byte)

dot11LongRetryLimit: This attribute shall indicate the maximum number of transmission attempts of a frame, the length of which is greater than dot11RTSThreshold, that shall be made before a failure condition is indicated. The default value of this attribute shall be 4. (R, W) (mandatory) (1 byte)

dot11FragmentationThreshold: This attribute shall specify the current maximum size, in octets, of the MPDU that may be delivered to the PHY. An MSDU shall be broken into fragments if its size exceeds the value if this attribute after adding MAC headers and trailers. An MSDU or MMPDU shall be fragmented when the resulting frame has an individual address in the Address1 field, and the length of the frame is larger than this threshold. The default value for this attribute shall be the lesser of 2346 or the aMPDUMaxLength of the attached PHY and shall never exceed the lesser of 2346 or the aMPDUMaxLength of the attached PHY. The value of this attribute shall never be less than 256. (R, W) (mandatory) (2 bytes)

dot11MaxTransmitMSDULifetime: The MaxTransmitMSDULifetime shall be the elapsed time in TU, after the initial transmission of an MSDU, after which further attempts to transmit the MSDU shall be terminated. The default value of this attribute shall be 512. (R, W) (mandatory) (4 bytes)

dot11MaxReceiveLifetime: The MaxReceiveLifetime shall be the elapsed time in TU, after the initial reception of a fragmented MMPDU or MSDU, after which further attempts to reassemble the MMPDU or MSDU shall be terminated. The default value shall be 512. (R, W) (mandatory) (4 bytes)

dot11PHYType: This is an 8-bit integer value that identifies the PHY type supported by the attached PLCP and PMD. Currently defined values and their corresponding PHY types are: FHSS 2.4 GHz = 0x01, DSSS 2.4 GHz = 0x02, IR Baseband = 0x03. (R) (mandatory) (1 byte)

dot11CurrentRegDomain: The current regulatory domain this instance of the PMD is supporting. This object corresponds to one of the RegDomains listed in dot11RegDomainsSupported. (R, W) (mandatory) (4 bytes)

dot11TempType: There are different operating temperature requirements dependent on the anticipated environmental conditions. This attribute describes the current PHY's operating temperature range capability. Currently defined values and their corresponding temperature

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ranges are: Type 1 = 0x01: Commercial range of 0 to 40 degrees C, Type 2 = 0x02: Industrial range of –30 to 70 degrees C. (R) (mandatory) (1 byte)

dot11CurrentTxAntennaPointer: The current antenna being used to transmit. This value is one of the values appearing in the dot11SupportedTxAntenna attribute of a General Purpose Object ME instance of ObjectType = 3. This may be used by a management agent to control which antenna is used for transmission. The value 0x0000 is interpreted as a Null pointer. (R, W) (mandatory) (2 bytes)

dot11DiversitySupport: This implementation's support for diversity, encoded as: 0x01: diversity is available and is performed over the fixed list of antennas defined by the dot11DiversitySelectionRx attribute values of the set of General Purpose Object ME instances of ObjectType = 3. 0x02: diversity is not supported. 0x03: diversity is supported and control of diversity is also available, in which case the attribute dot11DiversitySelectionRx can be dynamically modified by the LME. (R) (mandatory) (1 byte)

dot11CurrentRxAntennaPointer: The current antenna being used to receive, if the dot11DiversitySupport indicates that diversity is not supported. The selected antenna shall be one of the antennae marked for receive via the dot11SupportedRxAntenna attribute of a General Purpose Object ME instance of ObjectType = 3. The value 0x0000 is interpreted as a Null pointer. (R, W) (mandatory) (2 bytes)

dot11CurrentTxPowerLevel: The TxPowerLevel currently being used to transmit data. Some PHYs also use this value to determine the receiver sensitivity requirements for CCA. Valid values range from 0 to 7 and indicate which word in the dot11TxPowerLevels attribute of the Physical Path Termination Point 802.11 UNI object shall be the current power level. (R, W) (mandatory) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

7.3.61 802.11 counters

Relationships

One instance of this managed entity may exist for each instance of an IEEE 802.11 interface. An instance of this managed entity is created/deleted by the OLT after an instance of a Physical Path Termination Point 802.11 UNI managed entity is created/deleted.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0x0100 (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of

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the last completed interval. The actual counters of this managed entity start counting directly. The attribute counters are updated at the end of the interval. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ id: This attribute provides a pointer to an instance of the Threshold Data managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

dot11TransmittedFragmentCount: This counter shall be incremented for an acknowledged MPDU with an individual address in the address 1 field or an MPDU with a multicast address in the address 1 field of type Data or Management. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

dot11MulticastTransmittedFrame Count: This counter shall increment only when the multicast bit is set in the destination MAC address of a successfully transmitted MSDU. When operating as a STA in an ESS, where these frames are directed to the AP, this implies having received an acknowledgment to all associated MPDUs. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

dot11FailedCount: This counter shall increment when an MSDU is not transmitted successfully due to the number of transmit attempts exceeding either the dot11ShortRetryLimit or dot11LongRetryLimit (specified in the corresponding attributes of the associated 802.11 MAC&PHY Operation and Antenna Data managed entity). If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

dot11RetryCount: This counter shall increment when an MSDU is successfully transmitted after one or more retransmissions. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

dot11MultipleRetryCount: This counter shall increment when an MSDU is successfully transmitted after more than one retransmission. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

dot11FrameDuplicateCount: This counter shall increment when a frame is received that the Sequence Control field indicates is a duplicate. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

dot11RTSSuccessCount: This counter shall increment when a CTS is received in response to an RTS. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

dot11RTSFailureCount: This counter shall increment when a CTS is not received in response to an RTS. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

dot11ACKFailureCount: This counter shall increment when an ACK is not received when expected. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

dot11ReceivedFragmentCount: This counter shall be incremented for each successfully received MPDU of type Data or Management. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

dot11MulticastReceivedFrameCount: This counter shall increment when a MSDU is received with the multicast bit set in the destination MAC address. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

dot11FCSErrorCount: This counter shall increment when an FCS error is detected in a received MPDU. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

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dot11TransmittedFrameCount: This counter shall increment for each successfully transmitted MSDU. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

dot11WEPUndecryptableCount: This counter shall increment when a frame is received with the WEP subfield of the Frame Control field set to one and the WEPOn value for the key mapped to the TA's MAC address indicates that the frame should not have been encrypted or that frame is discarded due to the receiving STA not implementing the privacy option. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (4 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Get current data: This action returns the current value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval. Support of this action is optional.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a Threshold Crossing Alert (TCA) has been detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. The event list for this entity is given in Table 18.

Table 18/G.983.2 – Alarm list for 802.11 counters (reproduced from Table 4/G.983.9)

Number	Event	Description	Threshold data counter # (Note)
	Threshold crossing alert		
0	dot11Failed	MSDU transmit failure threshold crossing	1
1	dot11RTSFailure	RTS failure count threshold crossing	2
2	dot11ACKFailure	ACK failure count threshold crossing	3
3	dot11FCSError	FCS error count threshold crossing	4
4	dot11WEPUndecryptable	WEP undecryptable count threshold crossing	5
5-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data managed entity. Threshold Data counter 1 indicates the 1st thresholded counter that is associated with the Threshold Value 1 attribute of the Threshold $Data_{B\text{-}PON}$ managed entity.			

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7.3.62 802.11 PHY FHSS DSSS IR tables

Relationships

One instance of this managed entity may exist for each instance of an IEEE 802.11 interface. The ONU automatically creates an instance of this entity whenever a PPTP 802.11 UNI instance is created.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This ME id shall be the same as that of the related instance of Physical Path Termination Point 802.11 UNI. (R) (mandatory) (2 bytes)

dot11HopTime: The time in microseconds for the PMD to change from channel 2 to channel 80. (R) (mandatory) (1 byte)

dot11CurrentChannelNumber: The current channel number of the frequency output by the RF synthesizer. (R, W) (mandatory) (1 byte)

dot11MaxDwellTime: The maximum time in TU that the transmitter is permitted to operate on a single channel. (R) (mandatory) (2 bytes)

dot11CurrentDwellTime: The current time in TU that the transmitter shall operate on a single channel, as set by the MAC. Default is 19 TU. (R, W) (mandatory) (2 bytes)

dot11CurrentSet: The current set of patterns the PHY LME is using to determine the hopping sequence. (R, W) (mandatory) (1 byte)

dot11CurrentPattern: The current pattern the PHY LME is using to determine the hop sequence. (R, W) (mandatory) (1 byte)

dot11CurrentIndex: The current index value the PHY LME is using to determine the CurrentChannelNumber. (R, W) (mandatory) (1 byte)

dot11CurrentChannel: The current operating frequency channel of the DSSS PHY. Valid channel numbers are as defined in [B-13] Section 15.4.6.2. (R, W) (mandatory) (1 byte)

dot11CCAModeSupported: dot11CCAModeSupported is a bit-significant value, representing all of the CCA modes supported by the PHY. Valid values are: energy detect only (ED_ONLY) = 0x01, carrier sense only (CS_ONLY) = 0x02, carrier sense and energy detect (ED_and_CS) = 0x04 or the logical sum of any of these values. (R) (mandatory) (1 byte)

dot11CurrentCCAMode: The current CCA method in operation. Valid values are: energy detect only (edonly) = 0x01, carrier sense only (csonly) = 0x02, carrier sense and energy detect (edandcs)= 0x04. (R, W) (mandatory) (1 byte)

dot11EDThreshold: The current Energy Detect Threshold being used by the DSSS PHY. (R, W) (mandatory) (4 bytes)

dot11CCAWatchdogTimerMax: This parameter, together with CCAWatchdogCountMax, determines when energy detected in the channel can be ignored. Units are in time ticks. (R, W) (mandatory) (4 bytes)

dot11CCAWatchdogCountMax: This parameter, together with CCAWatchdogTimerMax, determines when energy detected in the channel can be ignored. Units are in time ticks. (R, W) (mandatory) (4 bytes)

dot11CCAWatchdogTimerMin: The minimum value to which CCAWatchdogTimerMax can be set. Units are in time ticks. (R, W) (mandatory) (4 bytes)

dot11CCAWatchdogCountMin: The minimum value to which CCAWatchdogCount can be set. Units are in time ticks. (R, W) (mandatory) (4 bytes)

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Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

7.3.63 Physical path termination point ADSL UNI part 1

This managed entity represents the point at an ATM UNI in the ONU where physical paths terminate to an ADSL CO Modem.

One or more instances of this managed entity shall be automatically created/deleted by the ONU upon the creation/deletion of a Subscriber Line Card of ADSL type.

Establishment of a "Physical Path Termination Point ADSL UNI"

The Physical Path Termination Point ADSL UNI is auto created when the Subscriber Line Card of type ADSL is created. On auto creation, the 5 profile pointers within the Managed Entity are set to their default values of 0x00. However, the PPTP ADSL UNI Part 1 must refer to 5 valid profiles before it can be operational.

Relationships

One or more instances of this managed entity shall be contained in an instance of a Subscriber Line Card managed entity classified as ADSL type.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The first byte is the slot ID (defined in 7.1.3). The second byte is the port ID with a value range from 0x01 to 0xFF (1 to 255): 0x01 is used for the leftmost/lowest port on a subscriber line card, 0x02 is used for the next right/upper port, and so forth. (R) (mandatory) (2 bytes)

Loopback Configuration: This attribute represents the loopback configuration of this physical interface. Value 0x00: no loopback; value 0x01: loopback2 ("Loopback2") refers to a loopback at the ONU to the OLT. The OLT can execute a physical level loopback test after loopback2 is set. Upon autonomous instantiation, the value 0x00 is used. (R, W) (mandatory) (1 byte)

Administrative State: This attribute is used to activate (unlock: value 0x00) and deactivate (lock: value 0x01) the functions performed by instances of this managed entity. Selection of a default value for this attribute is outside the scope of this Recommendation as it is normally handled through supplier-operator negotiations. (R, W) (mandatory) (1 byte)

Operational State: This attribute indicates whether or not this managed entity is capable of performing its task. The operational state reflects the perceived ability to receive or to generate a valid signal. Valid values are enabled (0x00) and disabled (0x01). (R) (optional) (1 byte)

ADSL Line Configuration Profile: This attribute contains the Managed Entity ID of the ADSL Line Configuration Profiles (parts 1, 2, and 3) managed entities that contains the data necessary for initializing an ADSL MODEM. The value 0x00 is used to indicate that this ME does not point to an ADSL Line Configuration Profile. The value 0x00 is the default value, which is set when this ME is auto-created. (R, W) (mandatory) (2 bytes)

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ADSL Subcarrier Masking Downstream Profile: This attribute provides a pointer to an instance of the ADSL Subcarrier Masking Downstream Profile managed entity that contains the data necessary for initializing an ADSL MODEM. The value 0x00 is used to indicate that this ME does not point to an ADSL Subcarrier Masking Downstream Profile. The value 0x00 is the default value, which is set when this ME is auto-created. (R, W) (mandatory) (2 bytes)

ADSL Subcarrier Masking Upstream Profile: This attribute provides a pointer to an instance of the ADSL Subcarrier Masking Upstream Profile managed entity that contains the data necessary for initializing an ADSL MODEM. The value 0x00 is used to indicate that this ME does not point to an ADSL Subcarrier Masking Upstream Profile. The value 0x00 is the default value, which is set when this ME is auto-created. (R, W) (mandatory) (2 bytes)

ADSL Downstream PSD Mask Profile: This attribute provides a pointer to an instance of the ADSL Downstream PSD Mask Profile managed entity that contains the data necessary for initializing an ADSL MODEM. The value 0x00 is used to indicate that this ME does not point to an ADSL Downstream PSD Mask Profile. The value 0x00 is the default value, which is set when this ME is auto-created. (R, W) (mandatory) (2 bytes)

ADSL Downstream RFI Bands Profile: This attribute provides a pointer to an instance of the ADSL Downstream RFI Bands Profile managed entity that contains the data necessary for initializing an ADSL MODEM. The value 0x00 is used to indicate that this ME does not point to an ADSL Downstream RFI Bands Profile. The value 0x00 is the default value, which is set when this ME is auto-created. (R, W) (mandatory) (2 bytes)

ARC: This attribute is used to control alarm reporting from this managed entity. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

ARCInterval: This attribute provides a provisionable length of time. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

Attribute value change: This notification is used to report autonomous changes of attributes of this managed entity. The notification shall identify the attribute and its new value. The AVCs for this managed entity are given in Table 19.

Table 19/G.983.2 – AVC list for physical path termination point ADSL UNI (reproduced from Table 2/G.983.10)

Number	AVC	Description
1-2	N/A	
3	OpState	Operational state
4-10	N/A	
11-16	Reserved	

Alarm: This notification is used to notify the management system when a failure has been detected or cleared. Both ONU and OLT should know the alarm list used by this entity. The alarms for this entity are given in Table 20.

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Table 20/G.983.2 – Alarm list for physical path termination point ADSL UNI (reproduced from Table 3/G.983.10)

Number	Event	Description
	Alarm	
0	NE_LOF	Near End Loss of Frame
1	NE_LOS	Near End Loss of Signal
2	NE_LOL	Near End Loss of Link
3	NE_LPR	Near End Loss of Power
4	CARD_ALM	Card in Alarm
5	FE_LOF	Far End Loss of Frame
6	FE_LOS	Far End Loss of Signal
7	FE_LOL	Far End Loss of Link
8	FE_LPR	Far End Loss of Power
9	DRT_UP	Data Rate Threshold Up-shift alarm
10	DRT_DOWN	Data Rate Threshold Down-shift alarm
11-223	reserved	
224-239	Vendor-specific alarms	Not to be standardized

7.3.64 Physical path termination point ADSL UNI part 2

This managed entity represents the point at an ATM UNI in the ONU where physical paths terminate to an ADSL CO Modem.

One or more instances of this managed entity shall be automatically created/deleted by the ONU upon the creation/deletion of a Subscriber Line Card of ADSL type.

Establishment of a "Physical Path Termination Point ADSL UNI"

The Physical Path Termination Point ADSL UNI is auto created when the Subscriber Line Card of type ADSL is created. On auto creation the 8 profile pointers within the Managed Entity are set to their default values of 0x00. However, the PPTP ADSL UNI Part 2 must refer to at least 2 valid profiles before it can be operational.

Relationships

One or more instances of this managed entity shall be contained in an instance of a Subscriber Line Card managed entity classified as ADSL type.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The first byte is the slot ID (defined in 7.1.3). The second byte is the port ID with a value range from 0x01 to 0xFF (1 to 255): 0x01 is used for the leftmost/lowest port on a subscriber line card, 0x02 is used for the next right/upper port, and so forth. (R) (mandatory) (2 bytes)

ADSL Channel Configuration Profile (For Bearer Channel 0 Downstream): This attribute provides a pointer to an instance of the ADSL Channel Configuration Profile managed entity for Bearer Channel 0 Downstream that contains the data necessary for initializing an ADSL MODEM. The value 0x00 is used to indicate that this ME does not point to an ADSL Channel Configuration Profile. The value 0x00 is the default value, which is set when this ME is auto created. (R, W) (optional) (2 bytes)

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ADSL Channel Configuration Profile (For Bearer Channel 1 Downstream): This attribute provides a pointer to an instance of the ADSL Channel Configuration Profile managed entity for Bearer Channel 1 Downstream that contains the data necessary for initializing an ADSL MODEM. The value 0x00 is used to indicate that this ME does not point to an ADSL Channel Configuration Profile. The value 0x00 is the default value, which is set when this ME is auto created. (R, W) (optional) (2 bytes)

ADSL Channel Configuration Profile (For Bearer Channel 2 Downstream): This attribute provides a pointer to an instance of the ADSL Channel Configuration Profile managed entity for Bearer Channel 2 Downstream that contains the data necessary for initializing an ADSL MODEM. The value 0x00 is used to indicate that this ME does not point to an ADSL Channel Configuration Profile. The value 0x00 is the default value, which is set when this ME is auto created. (R, W) (optional) (2 bytes)

ADSL Channel Configuration Profile (For Bearer Channel 3 Downstream): This attribute provides a pointer to an instance of the ADSL Channel Configuration Profile managed entity for Bearer Channel 3 Downstream that contains the data necessary for initializing an ADSL MODEM. The value 0x00 is used to indicate that this ME does not point to an ADSL Channel Configuration Profile. The value 0x00 is the default value, which is set when this ME is auto created. (R, W) (optional) (2 bytes)

ADSL Channel Configuration Profile (For Bearer Channel 0 Upstream): This attribute provides a pointer to an instance of the ADSL Channel Configuration Profile managed entity for Bearer Channel 0 Upstream that contains the data necessary for initializing an ADSL MODEM. The value 0x00 is used to indicate that this ME does not point to an ADSL Channel Configuration Profile. The value 0x00 is the default value, which is set when this ME is auto created. (R, W) (optional) (2 bytes)

ADSL Channel Configuration Profile (For Bearer Channel 1 Upstream): This attribute provides a pointer to an instance of the ADSL Channel Configuration Profile managed entity for Bearer Channel 1 Upstream that contains the data necessary for initializing an ADSL MODEM. The value 0x00 is used to indicate that this ME does not point to an ADSL Channel Configuration Profile. The value 0x00 is the default value, which is set when this ME is auto created. (R, W) (optional) (2 bytes)

ADSL Channel Configuration Profile (For Bearer Channel 2 Upstream): This attribute provides a pointer to an instance of the ADSL Channel Configuration Profile managed entity for Bearer Channel 2 Upstream that contains the data necessary for initializing an ADSL MODEM. The value 0x00 is used to indicate that this ME does not point to an ADSL Channel Configuration Profile. The value 0x00 is the default value, which is set when this ME is auto created. (R, W) (optional) (2 bytes)

ADSL Channel Configuration Profile (For Bearer Channel 3 Upstream): This attribute provides a pointer to an instance of the ADSL Channel Configuration Profile managed entity for Bearer Channel 3 Upstream that contains the data necessary for initializing an ADSL MODEM. The value 0x00 is used to indicate that this ME does not point to an ADSL Channel Configuration Profile. The value 0x00 is the default value, which is set when this ME is auto created. (R, W) (optional) (2 bytes)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Actions

None.

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7.3.65 ADSL line inventory and status data part 1

This managed entity contains Part 1 of the Line Inventory and Status Data for an ADSL line. One or more instances of this managed entity shall be automatically created/deleted by the ONU upon the creation/deletion of a Subscriber Line Card of ADSL type.

Relationships

One or more instances of this managed entity shall be contained in an instance of a Subscriber Line Card managed entity classified as ADSL type. All attributes other than Managed Entity ID will default to zero.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the ID of the Physical Path Termination Point ADSL UNI with which this ADSL Line Inventory Data is associated. (R) (mandatory) (2 bytes)

ATU-C G.994.1 Vendor ID: The ATU-C G.994.1 Vendor ID is the Vendor ID as inserted by the ATU-C in the G.994.1 CL message. It consists of 8 binary octets, including a country code followed by a (regionally allocated) provider code, as defined in ITU-T Rec. T.35. (R) (mandatory) (8 bytes)

ATU-R G.994.1 Vendor ID: The ATU-R G.994.1 Vendor ID is the Vendor ID as inserted by the ATU-R in the G.994.1 CLR message. It consists of 8 binary octets, with same format as the ATU-C G.994.1 Vendor ID (R) (mandatory) (8 bytes)

ATU-C System Vendor ID: The ATU-C System Vendor ID is the Vendor ID as inserted by the ATU-C in the Overhead Messages (ITU-T Recs G.992.3 and G.992.4). It consists of 8 binary octets, with same format as the ATU-C G.994.1 Vendor ID. (R) (mandatory) (8 bytes)

ATU-R System Vendor ID: The ATU-R System Vendor ID is the Vendor ID as inserted by the ATU-R in the Embedded Operations Channel (ITU-T Recs G.992.1 and G.992.2) and the Overhead Messages (ITU-T Recs G.992.3 and G.992.4). It consists of 8 binary octets, with same format as the ATU-C G.994.1 Vendor ID. (R) (mandatory) (8 bytes)

ATU-C Version Number: The ATU-C version number is the version number as inserted by the ATU-C in the Overhead Messages (ITU-T Recs G.992.3 and G.992.4). It is for version control and is vendor-specific information. It consists of up to 16 binary octets. (R) (mandatory) (16 bytes)

ATU-R Version Number: The ATU-R version number is the version number as inserted by the ATU-R in the Embedded Operations Channel (ITU-T Recs G.992.1 and G.992.2) or Overhead Messages (ITU-T Recs G.992.3 and G.992.4). It is for version control and is vendor-specific information. It consists of up to 16 binary octets. (R) (mandatory) (16 bytes)

ATU-C Serial Number Part 1: The ATU-C serial number is the serial number as inserted by the ATU-C in the Overhead Messages (ITU-T Recs G.992.3 and G.992.4). It is vendor-specific information. It consists of up to 32 ASCII characters. This attribute contains the first 16 characters. (R) (mandatory) (16 bytes)

ATU-C Serial Number Part 2: The ATU-C serial number is the serial number as inserted by the ATU-C in the Overhead Messages (ITU-T Recs G.992.3 and G.992.4). It is vendor-specific information. It consists of up to 32 ASCII characters. This attribute contains the second 16 characters. (R) (mandatory) (16 bytes)

ATU-R Serial Number Part 1: The ATU-R version number is the version number as inserted by the ATU-R in the Embedded Operations Channel (ITU-T Recs G.992.1 and G.992.2) or Overhead Messages (ITU-T Recs G.992.3 and G.992.4). It is vendor-specific information. It

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consists of up to 32 ASCII characters. This attribute contains the first 16 characters. (R) (mandatory) (16 bytes)

ATU-R Serial Number Part 2: The ATU-R version number is the version number as inserted by the ATU-R in the Embedded Operations Channel (ITU-T Recs G.992.1 and G.992.2) or Overhead Messages (ITU-T Recs G.992.3 and G.992.4). It is vendor-specific information. It consists of up to 32 ASCII characters. This attribute contains the second 16 characters. (R) (mandatory) (16 bytes)

ATU-C Self Test Results: This parameter defines the ATU-C self-test result. It is coded as a 32-bit integer. The most significant octet of the self-test result is 00hex if the self-test passed and 01hex if the self-test failed. The interpretation of the other octets is vendor-discretionary and can be interpreted in combination with ITU-T Rec. G.994.1 and system Vendor IDs. (R) (mandatory) (4 bytes)

ATU-R Self Test Results: This parameter defines the ATU-R self-test result. It is coded as a 32-bit integer. The most significant octet of the self-test result is 00hex if the self-test passed and 01hex if the self-test failed. The interpretation of the other octets is vendor-discretionary and can be interpreted in combination with ITU-T Rec. G.994.1 and system Vendor IDs. (R) (mandatory) (4 bytes)

ATU-C Transmission System Capability: This parameter defines the ATU-C transmission system capability list of the different coding types. It is coded in a bit-map representation with the bits defined in Table 21. (R) (mandatory) (7 bytes)

ATU-R Transmission System Capability: This parameter defines the ATU-R transmission system capability list of the different coding types. It is coded in a bit-map representation with the bits defined in Table 21. (R) (mandatory) (7 bytes)

Initialization – Success/Failure Cause: This parameter represents the success or failure cause of the last full initialization performed on the line. It is coded as an integer in the 0 to 5 range, coded as follows:

0 Successful

1 Configuration error

This error occurs with inconsistencies in configuration parameters, e.g., when the line is initialized in an ADSL Transmission system where an ATU does not support the configured Maximum Delay or the configured Minimum or Maximum Data Rate for one or more bearer channels.

2 Configuration not feasible on the line

This error occurs if the Minimum Data Rate cannot be reached on the line with the Minimum Noise Margin, Maximum PSD level, Maximum Delay and Maximum Bit Error Ratio for one or more bearer channels.

3 Communication problem

This error occurs e.g., due to corrupted messages or bad syntax messages or if no common mode can be selected in the G.994.1 handshaking procedure or due to a timeout.

4 No peer ATU detected

This error occurs if the peer ATU is not powered or not connected or if the line is too long to allow detection of a peer ATU.

5 Any other or unknown Initialization Failure cause.

(R) (mandatory) (1 byte)

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Actions

Get: Get one or more attributes.

Notifications

None.

The following is an explanation of the ATU Transmission System Capability Attributes in the ADSL Managed entity. It is coded in a bit-map representation (0 if not allowed, 1 if allowed) with following definition:

Table 21/G.983.2 – ATU transmission system table (reproduced from Table 4/G.983.10)

Bit	Representation
Octet 1	
1	ANSI T1.413
2	Annex C of TS 101 388 v1.3.1
3	G.992.1 operation over POTS non-overlapped spectrum (Annex A/G.992.1)
4	G.992.1 operation over POTS overlapped spectrum (Annex A/G.992.1)
5	G.992.1 operation over ISDN non-overlapped spectrum (Annex B/G.992.1)
6	G.992.1 operation over ISDN overlapped spectrum (Annex B/G.992.1)
7	G.992.1 operation in conjunction with TCM-ISDN non-overlapped spectrum (Annex C/G.992.1)
8	G.992.1 operation in conjunction with TCM-ISDN overlapped spectrum (Annex C/G.992.1)
Octet 2	
9	G.992.2 operation over POTS non-overlapped spectrum (Annex A/G.992.2)
10	G.992.2 operation over POTS overlapped spectrum (Annex B/G.992.2)
11	G.992.2 operation in conjunction with TCM-ISDN non-overlapped spectrum (Annex C/G.992.2)
12	G.992.2 operation in conjunction with TCM-ISDN overlapped spectrum (Annex C/G.992.2)
13	Reserved
14	Reserved
15	Reserved
16	Reserved
Octet 3	
17	Reserved
18	Reserved
19	G.992.3 operation over POTS non-overlapped spectrum (Annex A/G.992.3)
20	G.992.3 operation over POTS overlapped spectrum (Annex A/G.992.3)
21	G.992.3 operation over ISDN non-overlapped spectrum (Annex B/G.992.3)
22	G.992.3 operation over ISDN overlapped spectrum (Annex B/G.992.3)
23	Reserved
24	Reserved

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Table 21/G.983.2 – ATU transmission system table (reproduced from Table 4/G.983.10)

Bit	Representation
Octet 4	
25	G.992.4 operation over POTS non-overlapped spectrum (Annex A/G.992.4)
26	G.992.4 operation over POTS overlapped spectrum (Annex A/G.992.4)
27	Reserved
28	Reserved
29	G.992.3 All Digital Mode operation with non-overlapped spectrum (Annex I/G.992.3)
30	G.992.3 All Digital Mode operation with overlapped spectrum (Annex I/G.992.3)
31	G.992.3 All Digital Mode operation with non-overlapped spectrum (Annex J/G.992.3)
32	G.992.3 All Digital Mode operation with overlapped spectrum (Annex J/G.992.3)
Octet 5	
33	G.992.4 All Digital Mode operation with non-overlapped spectrum (Annex I/G.992.4)
34	G.992.4 All Digital Mode operation with overlapped spectrum (Annex I/G.992.4)
35	G.992.3 Reach Extended operation over POTS, Mode 1 (non-overlapped, wide upstream) (Annex L/G.992.3)
36	G.992.3 Reach Extended operation over POTS, Mode 2 (non-overlapped, narrow upstream) (Annex L/G.992.3)
37	G.992.3 Reach Extended operation over POTS, Mode 3 (overlapped, wide upstream) (Annex L/G.992.3)
38	G.992.3 Reach Extended operation over POTS, Mode 4 (overlapped, narrow upstream) (Annex L/G.992.3)
39	G.992.3 Extended upstream operation over POTS non-overlapped spectrum (Annex M/G.992.3)
40	G.992.3 Extended upstream operation over POTS overlapped spectrum (Annex M/G.992.3)
Octet 6	
41	G.992.5 operation over POTS non-overlapped spectrum (Annex A/G.992.5)
42	G.992.5 operation over POTS overlapped spectrum (Annex A/G.992.5)
43	G.992.5 operation over ISDN non-overlapped spectrum (Annex B/G.992.5)
44	G.992.5 operation over ISDN overlapped spectrum (Annex B/G.992.5)
45	Reserved
46	Reserved
47	G.992.5 All Digital Mode operation with non-overlapped spectrum (Annex I/G.992.5)
48	G.992.5 All Digital Mode operation with overlapped spectrum (Annex I/G.992.5)
Octet 7	
49	G.992.5 All Digital Mode operation with non-overlapped spectrum (Annex J/G.992.5)
50	G.992.5 All Digital Mode operation with overlapped spectrum (Annex J/G.992.5)
51	G.992.5 Extended upstream operation over POTS non-overlapped spectrum (Annex M/G.992.5)
52	G.992.5 Extended upstream operation over POTS overlapped spectrum (Annex M/G.992.5)
53	Reserved

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Table 21/G.983.2 – ATU transmission system table (reproduced from Table 4/G.983.10)

Bit	Representation
54	Reserved
55	Reserved
56	Reserved

7.3.66 ADSL line inventory and status data part 2

This managed entity contains Part 2 of the Line Inventory and Status Data for an ADSL line. One or more instances of this managed entity shall be automatically created/deleted by the ONU upon the creation/deletion of a Subscriber Line Card of ADSL type.

Relationships

One or more instances of this managed entity shall be contained in an instance of a Subscriber Line Card managed entity classified as ADSL type.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the ID of the Physical Path Termination Point ADSL UNI with which this ATU-R Physical Data is associated. (R) (mandatory) (2 bytes)

ADSL Transmission System: This parameter defines the transmission system in use. It is coded in bitmap representation with the bits defined in Table 21. (R) (mandatory) (7 bytes)

Line Power Management State: The Line has four possible power management states, numbered 0 to 3 and corresponding to respectively:

0 = L0 – Synchronized – This Line state (L0) is when the Line has full transmission (i.e., showtime).

1 = L1 – Power Down Data transmission – This line state (L1) is when there is transmission on the line but the net data rate is reduced (e.g., only for OAM and higher layer connection and session control). This state applies to ITU-T Rec. G.992.2 only.

2 = L2 – Power Down Data transmission – This line state (L2) is when there is transmission on the line but the net data rate is reduced (e.g., only for OAM and higher layer connection and session control). This state applies to ITU-T Recs G.992.3 and G.992.4 only.

3 = L3 – No-power – This Line state (L3) is when there is No Power transmitted on the line at all.

(R) (mandatory) (1 byte)

Downstream Line Attenuation: This parameter is the measured difference in the total power transmitted by the ATU-C and the total power received by the ATU-R over all subcarriers during diagnostics mode and initialization. The downstream line attenuation ranges from 0 (0) to +127 (1270) dB with 0.1 dB steps. A special value (0xFFFF) indicates the line attenuation is out of range to be represented. (R) (mandatory) (2 bytes)

Upstream Line Attenuation: This parameter is the measured difference in dB in the total power transmitted by the ATU-R and the total power received by the ATU-C over all subcarriers during diagnostics mode and initialization. The upstream line attenuation ranges from 0 (0) to +127 (1270) dB with 0.1 dB steps. A special value (0xFFFF) indicates the line attenuation is out of range to be represented. (R) (mandatory) (2 bytes)

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Downstream Signal Attenuation: This parameter is the measured difference in the total power transmitted by the ATU-C and the total power received by the ATU-R over all subcarriers during showtime. The downstream line attenuation ranges from 0 (0) to +127 (1270) dB with 0.1 dB steps. A special value (0xFFFF) indicates the line attenuation is out of range to be represented. (R) (mandatory) (2 bytes)

Upstream Signal Attenuation: This parameter is the measured difference in dB in the total power transmitted by the ATU-R and the total power received by the ATU-C over all subcarriers during showtime. The upstream line attenuation ranges from 0 (0) to +127 (1270) dB with 0.1 dB steps. A special value (0xFFFF) indicates the line attenuation is out of range to be represented. (R) (mandatory) (2 bytes)

Downstream Signal-to-Noise Ratio Margin: The downstream signal-to-noise ratio margin is the maximum increase in dB of the noise power received at the ATU-R, such that the BER requirements are met for all downstream bearer channels. The downstream SNR margin ranges from –64 (0) dB to +63 (1280) dB with 0.1 dB steps. A special value (0xFFFF) indicates the parameter is out of range to be represented. (R) (mandatory) (2 bytes)

Upstream Signal-to-Noise Ratio Margin: The upstream signal-to-noise ratio margin is the maximum increase in dB of the noise power received at the ATU-C, such that the BER requirements are met for all upstream bearer channels. The upstream SNR margin ranges from –64 (0) dB to +63 (1280) dB with 0.1 dB steps. A special value (0xFFFF) indicates the parameter is out of range to be represented. (R) (mandatory) (2 bytes)

Downstream Maximum Attainable Data Rate: This parameter indicates the maximum downstream net data rate currently attainable by the ATU-C transmitter and the ATU-R receiver. The rate is coded in bit/s. (R) (mandatory) (4 bytes)

Upstream Maximum Attainable Data Rate: This parameter indicates the maximum upstream net data rate currently attainable by the ATU-R transmitter and the ATU-C receiver. The rate is coded in bit/s. (R) (mandatory) (4 bytes)

Downstream Actual Power Spectrum Density: This parameter is the average downstream transmit power spectrum density over the used subcarriers (subcarriers to which downstream user data are allocated) delivered by the ATU-C at the U-C reference point, at the instant of measurement. The power spectrum density level ranges from –90 (0) dBm/Hz to 0 (900) dBm/Hz with 0.1 dB steps. A special value (0xFFFF) indicates the parameter is out of range to be represented. (R) (mandatory) (2 bytes)

Upstream Actual Power Spectrum Density: This parameter is the average upstream transmit power spectrum density over the used subcarriers (subcarriers to which upstream user data are allocated) delivered by the ATU-C at the U-C reference point, at the instant of measurement. The power spectrum density level ranges from –90 (0) dBm/Hz to 0 (900) dBm/Hz with 0.1 dB steps. A special value (0xFFFF) indicates the parameter is out of range to be represented. (R) (mandatory) (2 bytes)

Downstream Actual Aggregate Transmit Power: This parameter is the total amount of transmit power delivered by the ATU-C at the U-C reference point, at the instant of measurement. The total output power level ranges from –31 (0) dBm to +31 (620) dBm with 0.1 dB steps. A special value (0xFFFF) indicates the parameter is out of range to be represented.

NOTE – The downstream nominal aggregate transmit power may be taken as a best estimate of the parameter.

(R) (mandatory) (2 bytes)

Upstream Actual Aggregate Transmit Power: This parameter is the total amount of transmit power delivered by the ATU-R at the U-R reference point, at the instant of measurement. The

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total output power level ranges from –31 (0) dBm to +31 (620) dBm with 0.1 dB steps. A special value (0xFFFF) indicates the parameter is out of range to be represented.

NOTE – The upstream nominal aggregate transmit power may be taken as a best estimate of the parameter.

(R) (mandatory) (2 bytes)

Initialization – Last State Transmitted Downstream: This parameter represents the last successful transmitted initialization state in the downstream direction in the last full initialization performed on the line. Initialization states are defined in the individual ADSL Recommendations and are counted from 0 (if ITU-T Rec. G.994.1 is used) or 1 (if ITU-T Rec. G.994.1 is not used) up to Showtime. This parameter must be interpreted along with the ADSL Transmission System.

This parameter is available only when, after a failed full initialization, the line diagnostics procedures are activated on the line. Line diagnostics procedures can be activated by the operator of the system (through the Line State Forced line configuration parameter) or autonomously by the ATU-C or ATU-R. (R) (mandatory) (1 byte)

Initialization – Last State Transmitted Upstream: This parameter represents the last successful transmitted initialization state in the upstream direction in the last full initialization performed on the line. Initialization states are defined in the individual ADSL Recommendations and are counted from 0 (if ITU-T Rec. G.994.1 is used) or 1 (if ITU-T Rec. G.994.1 is not used) up to Showtime. This parameter must be interpreted along with the ADSL Transmission System.

This parameter is available only when, after a failed full initialization, the line diagnostics procedures are activated on the line. Line diagnostics procedures can be activated by the operator of the system (through the Line State Forced line configuration parameter) or autonomously by the ATU-C or ATU-R. (R) (mandatory) (1 byte)

Actions

Get: Get one or more attributes.

Notifications

None.

7.3.67 ADSL channel downstream status data

This managed entity contains the ADSL Channel Downstream Status Data. One or more instances of this managed entity shall be automatically created/deleted by the ONU upon the creation/deletion of a Subscriber Line Card of ADSL type.

Relationships

One or more instances of this managed entity shall be contained in an instance of a Subscriber Line Card managed entity classified as ADSL type.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The two most significant bits of the first byte is the Bearer Channel ID. The six least significant bits of the first byte is the slot ID (defined in 7.1.3). The second byte is the port ID with a value range from 0x01 to 0xFF (1 to 255): 0x01 is used for the leftmost/lowest port on a subscriber line card, 0x02 is used for the next right/upper port, and so forth. (R) (mandatory) (2 bytes)

Actual Interleaving Delay: This parameter is the actual one-way interleaving delay introduced by the PMS-TC between the alpha and beta reference points excluding delay in L1 and L2 state. In L1 and L2 state, the parameter contains the interleaving delay in the previous L0 state. This

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parameter is derived from the S and D parameters as ⌈S*D⌉/4 ms, where "S" is the Symbols per codeword, and "D" is the "Interleaving Depth" and ⌈x⌉ denotes rounding to the higher integer. The Actual Interleaving Delay is coded in ms rounded to the nearest ms. 0-255 ms. (R) (mandatory) (1 byte)

Actual Data Rate: This parameter reports the actual net data rate the bearer channel is operating at excluding rate in L1 and L2 states. In L1 or L2 states, the parameter contains the net data rate in the previous L0 state. The data rate is coded in bit/s. (R) (mandatory) (4 bytes)

Previous Data Rate: This parameter reports the previous net data rate the bearer channel was operating at just before the latest rate change event occurred excluding all transitions between L0 state and L1 or L2 states. A rate change can occur at a power management state transition, e.g., at full or short initialization, fast retrain, or power down or at a dynamic rate adaptation. The rate is coded in bit/s. (R) (mandatory) (4 bytes)

Actions

Get: Get one or more attributes.

Notifications

None.

7.3.68 ADSL channel upstream status data

This managed entity contains the ADSL Channel Upstream Status Data.

One or more instances of this managed entity shall be automatically created/deleted by the ONU upon the creation/deletion of a Subscriber Line Card of ADSL type.

Relationships

One or more instances of this managed entity shall be contained in an instance of a Subscriber Line Card managed entity classified as ADSL type.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The two most significant bits of the first byte is the Bearer Channel ID. The six least significant bits of the first byte is the slot ID (defined in 7.1.3). The second byte is the port ID with a value range from 0x01 to 0xFF (1 to 255): 0x01 is used for the leftmost/lowest port on a subscriber line card, 0x02 is used for the next right/upper port, and so forth. (R) (mandatory) (2 bytes)

Actual Interleaving Delay: This parameter is the actual one-way interleaving delay introduced by the PMS-TC between the alpha and beta reference points excluding delay in L1 and L2 state. In L1 and L2 state, the parameter contains the interleaving delay in the previous L0 state. This parameter is derived from the S and D parameters as ⌈S*D⌉/4 ms, where "S" is the Symbols per codeword, and "D" is the "Interleaving Depth" and ⌈x⌉ denotes rounding to the higher integer. The Actual Interleaving Delay is coded in ms (rounded to the nearest ms). (R) (mandatory) (1 byte)

Actual Data Rate: This parameter reports the actual net data rate the bearer channel is operating at excluding rate in L1 and L2 states. In L1 or L2 states, the parameter contains the net data rate in the previous L0 state. The data rate is coded in bit/s. (R) (mandatory) (4 bytes)

Previous Data Rate: This parameter reports the previous net data rate the bearer channel was operating at just before the latest rate change event occurred excluding all transitions between L0 state and L1 or L2 states. A rate change can occur at a power management state transition,

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e.g., at full or short initialization, fast retrain, or power down or at a dynamic rate adaptation. The rate is coded in bit/s. (R) (mandatory) (4 bytes)

Actions

Get: Get one or more attributes.

Notifications

None.

7.3.69 ADSL line configuration profile part 1

This managed entity contains part 1 of the Line Configuration Profile for an ADSL line. An instance of this managed entity is created/deleted on request of the OLT.

Relationships

Zero or more instances of this managed entity shall exist and may be associated with zero or more instances of the Physical Path Termination Point ADSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. The value 0x00 is reserved. (R, Set-by-create) (mandatory) (2 bytes)

ATU Transmission System Enabling: This configuration parameter defines the transmission system coding types to be allowed by the near-end ATU on this line. This parameter only applies to the Q-interface. It is coded in a bit-map representation with the bits defined in Table 21. (R, W, Set-by-create) (mandatory) (7 bytes)

Power Management State Forced: This configuration parameter defines the line states to be forced by the near-end ATU on this line. It is coded as an integer value with following definition:

0 Force the line to transition from the L3 idle state to the L0 full-on state. This transition requires the (short) initialization procedures. After reaching the L0 state, the line may transition into or exit from the L2 low power state (if L2 state is enabled). If the L0 state is not reached (after a vendor discretionary number of retries and/or within a vendor-discretionary timeout), then an Initialization Failure occurs. Whenever the line is in the L3 state, attempts shall be made to transition to the L0 state until it is forced into another state through this configuration parameter.

2 Force the line to transition from L0 full on to L2 low power state. This transition requires the entry into L2 mode. This is an out-of-service test value for triggering the L2 mode.

3 Force the line to transition from the L0 full-on or L2 low power state to the L3 idle state. This transition requires the (orderly) shutdown procedure. After reaching the L3 state, the line shall remain in the L3 idle state until it is forced into another state through this configuration parameter.

(R, W, Set-by-create) (mandatory) (1 byte)

Power Management State Enabling: This configuration parameter defines the line states the ATU-C or ATU-R may autonomously transition to on this line. It is coded in a bit-map representation (0 if not allowed, 1 if allowed) with following definition:

Bit 0: L3 state (Idle state);

Bit 1: L1/L2 state (Low power state).

(R, W, Set-by-create) (mandatory) (1 byte)

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Downstream Target Noise Margin: This is the Noise Margin the ATU-R receiver shall achieve, relative to the BER requirement for each of the downstream bearer channels, or better, to successfully complete initialization. The target noise margin ranges from 0 (0) to 31 (310) dB with 0.1 dB steps. (R, W, Set-by-create) (mandatory) (2 bytes)

Upstream Target Noise Margin: This is the Noise Margin the ATU-C receiver shall achieve, relative to the BER requirement for each of the upstream bearer channels, or better, to successfully complete initialization. The target noise margin ranges from 0 (0) to 31 (310) dB with 0.1 dB steps. (R, W, Set-by-create) (mandatory) (2 bytes)

Downstream Maximum Noise Margin: This is the maximum noise margin the ATU-R receiver shall try to sustain. If the Noise Margin is above this level, the ATU-R shall request the ATU-C to reduce the ATU-C transmit power to get a noise margin below this limit (if this functionality is supported). The maximum noise margin ranges from 0 (0) to 31 (310) dB with 0.1 dB steps. A special value of 0xFFFF is used to indicate that no Maximum Noise Margin limit is to be applied. (R, W, Set-by-create) (mandatory) (2 bytes)

Upstream Maximum Noise Margin: This is the maximum noise margin the ATU-C receiver shall try to sustain. If the Noise Margin is above this level, the ATU-C shall request the ATU-R to reduce the ATU-R transmit power to get a noise margin that is below this limit (if this functionality is supported). The maximum noise margin ranges from 0 (0) to 31 (310) dB with 0.1 dB steps. A special value of 0xFFFF is used to indicate that no Maximum Noise Margin limit is to be applied. (R, W, Set-by-create) (mandatory) (2 bytes)

Downstream Minimum Noise Margin: This is the minimum Noise Margin the ATU-R receiver shall tolerate. If the noise margin falls below this level, the ATU-R shall request the ATU-C to increase the ATU-C transmit power. If an increase to ATU-C transmit power is not possible, a loss-of-margin (LOM) defect occurs, the ATU-R shall fail and attempt to re-initialize and the NMS shall be notified. The minimum noise margin ranges from 0 (0) to 31 (310) dB with 0.1 dB steps. (R, W, Set-by-create) (mandatory) (2 bytes)

Upstream Minimum Noise Margin: This is the minimum Noise Margin the ATU-C receiver shall tolerate. If the noise margin falls below this level, the ATU-C shall request the ATU-R to increase the ATU-R transmit power. If an increase of ATU-R transmit power is not possible, a loss-of-margin (LOM) defect occurs, the ATU-C shall fail and attempt to re-initialize and the NMS shall be notified. The minimum noise margin ranges from 0 (0) to 31 (310) dB with 0.1 dB steps. (R, W, Set-by-create) (mandatory) (2 bytes)

Downstream Rate Adaptation Mode: This parameter specifies the mode of operation of a rate-adaptive ATU-C in the transmit direction. The parameter can take three values.

1 = **Mode 1**: MANUAL – Rate changed manually.

At startup

The Downstream Minimum Data Rate parameter specifies the data rate the ATU-C transmitter shall operate at for each of the bearer channels, with a downstream noise margin which is at least as large as the specified Downstream Target Noise Margin, relative to the required BER for each of the downstream bearer channels, or better. If the ATU-C fails to achieve the Downstream Minimum Data Rate for one of the bearer channels, the ATU-C will fail to initialize, and the NMS will be notified. Although the ATU-C and the line might be able to support a higher data rate, the ATU-C shall not transmit a higher data rate than what is requested for each of the bearer channels.

At showtime

The ATU-C transmitter shall maintain the specified Downstream Minimum Data Rate for each of the bearer channels.

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2 = **Mode 2**: AT_INIT-Rate automatically selected at startup only and does not change after that.

At startup

The Downstream Minimum Rate parameter specifies the minimum data rate the ATU-C transmitter shall operate at for each of the bearer channels, with a downstream noise margin which is at least as large as the specified Downstream Target Noise Margin, relative to the required BER for each of the bearer channels, or better. If the ATU-C fails to achieve the Downstream Minimum Data Rate for one of the bearer channels, the ATU-C will fail to initialize, and the NMS will be notified. If the ATU-C transmitter is able to support a higher downstream data rate at initialization, the excess data rate will be distributed amongst the downstream bearer channels according to the ratio (0 to 100%) specified by the Rate Adaptation Ratio parameter for each bearer channel (adding up to 100% over all bearer channels). When the Downstream Maximum Data Rate is achieved in one of the bearer channels, then the remaining excess bit rate is assigned to the other bearer channels, still according to their relative Rate Adaptation Ratio parameters. As long as the downstream data rate is below the Downstream maximum Data Rate for one of the bearer channels, data rate increase shall take priority over transmit power reduction.

At showtime

During showtime, no downstream data rate adaptation is allowed. The downstream data rate, which has been settled during initialization for each of the bearer channels, shall be maintained.

3 = **Mode 3**: DYNAMIC – Data rate is automatically selected at initialization and is continuously adapted during operation (showtime). The DYNAMIC Rate Adaptation mode is optional. All related configuration parameters are also optional.

At startup

In Mode 3, the ATU-C shall start up as in Mode 2.

At showtime

During showtime, rate adaptation is allowed with respect to the Ratio Adaptation Ratio for distributing the excess data rate amongst the bearer channels (see Mode 2), and assuring that the Downstream Minimum Data Rate remains available at the required BER for each of the bearer channels, or better. The downstream data rate can vary between the Downstream Minimum Data Rate and the Downstream Maximum Data Rate. Downstream Rate Adaptation is performed when the conditions specified for Downstream Upshift Noise Margin and Downstream Upshift Interval – or for Downstream Downshift Noise Margin and Downstream Downshift Interval – are satisfied. This means:

- For an Upshift action: Allowed when the downstream noise margin is above the Downstream Upshift Noise Margin during Downstream Minimum Time Interval for Upshift Rate Adaptation (i.e., upon RAU anomaly).
- For a Downshift action: Allowed when the downstream noise margin is below the Downstream Downshift Noise Margin during Downstream Minimum Time Interval for Downshift Rate Adaptation (i.e., upon RAD anomaly).

As long as the downstream data rate is below the Downstream Maximum Data Rate for one of the bearer channels, data rate increase shall take priority over transmit power reduction. (R, W, Set-by-create) (mandatory) (1 byte)

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Upstream Rate Adaptation Mode: This parameter specifies the mode of operation of a rate-adaptive ATU-R in the transmit direction. The parameter is used only if the rate-adaptive functionality is supported and can take three values:

1 = MANUAL

2 = AT_INIT

3 = DYNAMIC

The definition of each of the values is identical to their definition in the Downstream Rate Adaptation Mode (with replacing of ATU-C with ATU-R and downstream with upstream). (R, W, Set-by-create) (mandatory) (1 byte)

Downstream Up-shift Noise Margin: If the downstream noise margin is above the Downstream Upshift Noise Margin and stays above that for more than the time specified by the Downstream Minimum Upshift Rate Adaptation Interval, the ATU-R shall attempt to increase the downstream net data rate. The Downstream Up-shift Noise Margin ranges from 0 (0) to 31 (310) dB with 0.1 dB steps. (R, W, Set-by-create) (optional) (2 bytes)

Upstream Up-shift Noise Margin: If the upstream noise margin is above the Upstream Up-shift Noise Margin and stays above that for more than the time specified by the Upstream Minimum Upshift Rate Adaptation Interval, the ATU-C shall attempt to increase the upstream net data rate. The Upstream Up-shift Noise Margin ranges from 0 (0) to 31 (310) dB with 0.1 dB steps. (R, W, Set-by-create) (optional) (2 bytes)

Upstream PSD Mask Selection: This configuration parameter defines which upstream PSD mask is enabled. This parameter is used only for Annexes J and M of ITU-T Recs G.992.3 and G.992.5. As only one selection parameter is defined in the MIB, the same selection value applies to all relevant modes enabled in the ATSE line configuration parameter. It ranges from 1 to 9 and selects the mask with the following definition.

Selected mask		
Upstream PSD mask selection value	**Annex J of ITU-T Rec. G.992.3/5**	**Annex M of ITU-T Rec. G.992.3/5**
1	ADLU-32	EU-32
2	ADLU-36	EU-36
3	ADLU-40	EU-40
4	ADLU-44	EU-44
5	ADLU-48	EU-48
6	ADLU-52	EU-52
7	ADLU-56	EU-56
8	ADLU-60	EU-60
9	ADLU-64	EU-64

(R, W, Set-by-create) (mandatory) (1 byte)

Minimum Overhead Rate Upstream: This attribute defines the minimum rate of the message-based overhead that shall be maintained by the ATU in upstream direction. MSGMINus is expressed in bits per second and ranges from 4000 to 64000 bit/s. This attribute is only valid for ITU-T Recs G.992.3, G.992.4 and G.992.5. (R, W, Set-by-create) (optional) (2 bytes)

Minimum Overhead Rate Downstream: This attribute defines the minimum rate of the message based overhead that shall be maintained by the ATU in downstream direction. MSGMINds is expressed in bits per second and ranges from 4000 to 64000 bit/s. This attribute is

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only valid for ITU-T Recs G.992.3, G.992.4 and G.992.5. (R, W, Set-by-create) (optional) (2 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

7.3.70 ADSL line configuration profile part 2

This managed entity contains part 2 of the Line Configuration Profile for an ADSL line. An instance of this managed entity is created/deleted on request of the OLT.

Relationships

Zero or more instances of this managed entity shall exist and may be associated with zero or more instances of the Physical Path Termination Point ADSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. The value 0x00 is reserved. (R, Set-by-create) (mandatory) (2 bytes)

Downstream Minimum Time Interval for Up-shift Rate Adaptation: This parameter defines the interval of time the downstream noise margin should stay above the Downstream Up-shift Noise Margin before the ATU-R shall attempt to increase the downstream net data rate. The time interval ranges from 0 to 16 383 s. (R, W, Set-by-create) (optional) (2 bytes)

Upstream Minimum Time Interval for Up-shift Rate Adaptation: This parameter defines the interval of time the upstream noise margin should stay above the Upstream Up-shift Noise Margin before the ATU-C shall attempt to increase the upstream net data rate. The time interval ranges from 0 to 16 383 s. (R, W, Set-by-create) (optional) (2 bytes)

Downstream Down-shift Noise Margin: If the downstream noise margin is below the Downstream Down-shift Noise Margin and stays below that for more than the time specified by the Downstream Minimum Downshift Rate Adaptation Interval, the ATU-R shall attempt to decrease the downstream net data rate. The Downstream Down-shift Noise Margin ranges from 0 (0) to 31 (310) dB with 0.1 dB steps. (R, W, Set-by-create) (optional) (2 bytes)

Upstream Down-shift Noise Margin: If the upstream noise margin is below the Upstream Down-shift Noise Margin and stays below that for more than the time specified by the Upstream Minimum Downshift Rate Adaptation Interval, the ATU-C shall attempt to decrease the upstream net data rate. The Upstream Down-shift Noise Margin ranges from 0 (0) to 31 (310) dB with 0.1 dB steps. (R, W, Set-by-create) (optional) (2 bytes)

Downstream Minimum Time Interval for Downshift Rate Adaptation: This parameter defines the interval of time the downstream noise margin should stay below the Downstream Down-shift Noise Margin before the ATU-R shall attempt to decrease the downstream net data rate. The time interval ranges from 0 to 16 383 s. (R, W, Set-by-create) (optional) (2 bytes)

Upstream Minimum Time Interval for Downshift Rate Adaptation: This parameter defines the interval of time the upstream noise margin should stay below the Upstream Downshift Noise

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Margin before the ATU-C shall attempt to decrease the upstream net data rate. The time interval ranges from 0 to 16 383 s. (R, W, Set-by-create) (optional) (2 bytes)

ATU Impedance State forced: This configuration parameter defines the impedance state to be forced on the near-end ATU. It applies only to the T/S-interface. It is only valid for Annex A/G.992.3, Annex A/G.992.4 and Annex A/G.992.5. It is coded as an integer value with following definition:

1 Force the near-end ATU to the disabled state.

2 Force the near-end ATU to the inactive state.

3 Force the near-end ATU to the active state.

(R, W, Set-by-create) (mandatory) (1 byte)

L0-TIME: This parameter represents the minimum time (in seconds) between an Exit from the L2 state and the next Entry into the L2 state. It is only valid for ITU-T Recs G.992.3, G.992.4 and G.992.5. It ranges from 0 to 255 s. (R, W, Set-by-create) (mandatory) (1 byte)

L2-TIME: This parameter represents the minimum time (in seconds) between an Entry into the L2 state and the first Power Trim in the L2 state and between two consecutive Power Trims in the L2 State. It is only valid for ITU-T Recs G.992.3, G.992.4 and G.992.5. It ranges from 0 to 255 s. (R, W, Set-by-create) (mandatory) (1 byte)

Downstream Maximum Nominal Power Spectral Density: This parameter represents the maximum nominal transmit PSD in the downstream direction during initialization and showtime (in dBm/Hz). A single MAXNOMPSDds parameter is defined per mode enabled in the ATSE line configuration parameter. It is only valid for ITU-T Recs G.992.3, G.992.4 and G.992.5. It ranges from –60 (0) to –30 (900) dBm/Hz, with 0.1 dB steps. (R, W, Set-by-create) (mandatory) (2 bytes)

Upstream Maximum Nominal Power Spectral Density: This parameter represents the maximum nominal transmit PSD in the upstream direction during initialization and showtime (in dBm/Hz). A single MAXNOMPSDus parameter is defined per mode enabled in the ATSE line configuration parameter. It is only valid for ITU-T Recs G.992.3, G.992.4 and G.992.5. It ranges from –60 (0) to –30 (900) dBm/Hz, with 0.1 dB steps. (R, W, Set-by-create) (mandatory) (2 bytes)

Downstream Maximum Nominal Aggregate Transmit Power: This parameter represents the maximum nominal aggregate transmit power in the downstream direction during initialization and showtime (in dBm). It is only valid for ITU-T Recs G.992.3, G.992.4 and G.992.5. It ranges from 0 (0) to 25.5 (255) dBm, with 0.1 dB steps. (R, W, Set-by-create) (mandatory) (1 byte)

Upstream Maximum Nominal Aggregate Transmit Power: This parameter represents the maximum nominal aggregate transmit power in the upstream direction during initialization and showtime (in dBm). It is only valid for ITU-T Recs G.992.3, G.992.4 and G.992.5. It ranges from 0 (0) to 25.5 (255) dBm, with 0.1 dB steps. (R, W, Set-by-create) (mandatory) (1 byte)

Upstream Maximum Aggregate Receive Power: This parameter represents the maximum upstream aggregate receive power over a set of subcarriers (in dBm) as specified in the relevant Recommendation. The ATU-C shall request an upstream power cutback such that the upstream aggregate receive power over that set of subcarriers is at or below the configured maximum value. It is only valid for ITU-T Recs G.992.3, G.992.4 and G.992.5. It ranges from –25.5 (0) to 25.5 (510) dBm, with 0.1 dB steps. A special value of 0xFFFF is used to indicate that no Upstream Maximum Aggregate Receive Power limit is to be applied. (R, W Set-by-create) (mandatory) (2 bytes)

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Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

7.3.71 ADSL line configuration profile part 3

This managed entity contains part 3 of the Line Configuration Profile for an ADSL line. An instance of this managed entity is created/deleted on request of the OLT.

Relationships

Zero or more instances of this managed entity shall exist and may be associated with zero or more instances of the Physical Path Termination Point ADSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. The value 0x00 is reserved. (R, Set-by-create) (mandatory) (2 bytes)

Loop Diagnostics Mode Forced: This configuration parameter defines whether the line should be forced into the loop diagnostics mode by the near-end ATU on this line. It is only valid for ITU-T Recs G.992.3, G.992.4 and G.992.5. It is coded as an integer value with following definition:

0 Inhibits the near-end ATU from performing loop diagnostics mode procedures on the line. Loop diagnostic mode procedures may still be initiated by the far-end ATU.

1 Forces the near-end ATU to perform the loop diagnostics procedures.

The line needs to be forced to the L3 state before it can be forced to the loop diagnostics mode. Only while the line power management state is the L3 state, the line can be forced into the loop diagnostics mode procedures. When the loop diagnostics mode procedures are completed successfully, the Access Node shall reset the LDSF MIB element to 0 and the line shall returns to remain in the L3 idle state. The loop diagnostics data shall be available at least until the line is forced to the L0 state. If the loop diagnostics procedures cannot be completed successfully, (after a vendor-discretionary number of retries and/or within a vendor-discretionary timeout), then an Initialization Failure occurs. As long as loop diagnostics procedures are not completed successfully, attempts shall be made to do so, until the loop diagnostics mode is no longer forced on the line through this configuration parameter. (R, W, Set-by-create) (mandatory) (1 byte)

Automode Cold Start Forced: This parameter is defined in order to improve testing of the performance of ATUs supporting automode when it is enabled in the MIB. The valid values are 0 and 1. A change in value of this parameter indicates a change in loop conditions applied to the devices under test. The ATUs shall reset any historical information used for automode and for shortening G.994.1 handshake and initialization.

Automode is defined as the case where multiple operation-modes are enabled in the MIB in the G.997.1 "ATU Transmission System Enabling (ATSE)" table and where the selection of the operation-mode to be used for transmission does not only depend on the common capabilities of both ATUs (as exchanged in ITU-T Rec. G.994.1), but depends also on achievable data rates under given loop conditions. (R, W, Set-by-create) (mandatory) (1 byte)

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L2-ATPR: This parameter represents the maximum aggregate transmit power reduction (in dB) that can be performed in the L2 Request (i.e., at transition of L0 to L2 state) or through a single Power Trim in the L2 state. It is only valid for ITU-T Recs G.992.3, G.992.4 and G.992.5. It ranges from 0 (0) dB to 31 (31) dB (R, W, Set-by-create) (mandatory) (1 byte)

L2-ATPRT: This parameter represents the total maximum aggregate transmit power reduction (in dB) that can be performed in an L2 state. This is the sum of all reductions of L2 Request (i.e., at transition of L0 to L2 state) and Power Trims. It ranges from 0 (0) dB to 31 (31)dB. (R, W, Set-by-create) (mandatory) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

7.3.72 ADSL channel configuration profile

This managed entity contains the Channel Configuration Profile for an ADSL line. An instance of this managed entity is created/deleted on request of the OLT.

Relationships

Zero or more instances of this managed entity shall exist and may be associated with zero or more instances of the Physical Path Termination Point ADSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. The value 0x00 is reserved. (R, Set-by-create) (mandatory) (2 bytes)

Minimum Data Rate: This parameter specifies the minimum net data rate for the bearer channel as desired by the operator of the system. The rate is coded in bit/s. (R, Set-by-create) (mandatory) (4 bytes)

Maximum Data Rate: This parameter specifies the maximum net data rate for the bearer channel as desired by the operator of the system. The data rate is coded in bit/s. (R, Set-by-create) (mandatory) (4 bytes)

Rate Adaptation Ratio: This parameter (expressed in %) specifies the ratio that should be taken into account for the bearer channel when performing rate adaptation in the direction of the bearer channel. The ratio is defined as a percentage in the 0 to 100 range. A ratio of 20% means that 20% of the available data rate (in excess of the Minimum Data Rate summed over all bearer channels) will be assigned to this bearer channel and 80% to the other bearer channels.

The sum of rate adaptation ratios over all bearers in one direction shall be equal to 100%. (R, Set-by-create) (optional) (1 byte)

Maximum Interleaving Delay: This parameter is the maximum one-way interleaving delay introduced by the PMS-TC between the alpha and the beta reference points, in the direction of the bearer channel. The one-way interleaving delay is defined in individual ADSL Recommendations as $\lceil S*D \rceil /4$ ms, where "S" is the S-factor and "D" is the "Interleaving Depth" and $\lceil x \rceil$ denotes rounding to the higher integer.

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The ATUs shall choose the S and D values such that the actual one-way interleaving delay is less or equal than the configured Maximum Interleaving Delay. The delay is coded in ms, with the value 0 and 1 special values. The value 0 indicates no delay bound is being imposed. The value 1 indicates the Fast Latency Path shall be used in the G.992.1 operating mode and S and D shall be selected such that $S \leq 1$ and $D = 1$ in G.992.2, G.992.3 and G.992.4 operating modes. Value range: 2-255. (R, Set-by-create) (mandatory) (1 byte)

Data Rate Threshold Up-shift: This parameter is a threshold on the net data rate up-shift achieved over one or more bearer channel data rate adaptations. An up-shift rate change alarm (event) is triggered when the actual data rate exceeds the data rate at the last entry into showtime by more than the threshold. The data rate threshold is coded in bit/s. (R, Set-by-create) (mandatory) (4 bytes)

Data Rate Threshold Down-shift: This parameter is a threshold on the net data rate down-shift achieved over one or more bearer channel data rate adaptations. A down-shift rate change alarm (event) is triggered when the actual data rate is below the data rate at the last entry into showtime by more than the threshold. The data rate threshold is coded in bit/s. (R, Set-by-create) (mandatory) (4 bytes)

Minimum Reserved Data Rate: This parameter specifies the minimum reserved net data rate for the bearer channel as desired by the operator of the system. The rate is coded in bit/s. (R, Set-by-create) (mandatory) (4 bytes)

Minimum Data Rate in low power state: This parameter specifies the minimum net data rate for the bearer channel as desired by the operator of the system during the low power state (L1/L2). The power management low power states L1 and L2 are defined in ITU-T Recs G.992.2 and G.992.3 respectively. The data rate is coded in bit/s. (R, Set-by-create) (mandatory) (4 bytes)

Minimum Impulse Noise Protection: This parameter specifies the minimum impulse noise protection for the bearer channel. It is only valid for ITU-T Recs G.992.3, G.992.4 and G.992.5. The impulse noise protection is expressed in symbols and can take the following integer values:

1 = 0 symbol

2 = ½ symbol

3 = 1 symbol

4 = 2 symbol

(R, Set-by-create) (mandatory) (1 byte)

Maximum Bit Error Ratio: This parameter specifies the maximum bit error ratio for the bearer channel as desired by the operator of the system. It is only valid for ITU-T Recs G.992.3, G.992.4 and G.992.5. The bit error ratio can take the following integer values:

1 = 1E-3

2 = 1E-5

3 = 1E-7

(R, Set-by-create) (mandatory) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

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Notifications

None.

7.3.73 ADSL subcarrier masking downstream profile

This managed entity contains the Subcarrier Masking Downstream Profile for an ADSL line. An instance of this managed entity is created/deleted on request of the OLT.

Relationships

Zero or more instances of this managed entity shall exist and may be associated with zero or more instances of the Physical Path Termination Point ADSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. The value 0x00 is reserved. (R, Set-by-create) (mandatory) (2 bytes)

Downstream Subcarrier Mask1: This configuration parameter is a bitmap representing the downstream mask values for subcarriers 1 to 128. The MSB of the first byte corresponds to subcarrier 1, and the LSB of the last byte corresponds to subcarrier 128.

Each bit position defines whether the corresponding subcarrier is masked on this line in the downstream direction. It is coded as 1 if masked and 0 if not masked (default).

Subcarrier number 1 is the lowest, and subcarrier number NSCds is the highest subcarrier that can be transmitted in the downstream direction.

NOTE – For ITU-T Recs G.992.3 and G.992.4, the number of subcarrier downstream (NSCds) is defined in the corresponding Recommendations. For ITU-T Rec. G.992.1, NSCds = 256, for ITU-T Rec. G.992.2, NSCds = 128, and for ITU-T Rec. G.992.5, NSCds = 512.

(R, W, Set-by-create) (mandatory) (16 bytes)

Downstream Subcarrier Mask2: This configuration parameter is a bitmap representing the downstream mask values for subcarriers 129 to 256. The MSB of the first byte corresponds to subcarrier 129, and the LSB of the last byte corresponds to entry 256.

Each bit position defines whether the corresponding subcarrier is masked on this line in the downstream direction. It is coded as 1 if masked and 0 if not masked (default).

Subcarrier number 1 is the lowest, and subcarrier number NSCds is the highest subcarrier that can be transmitted in the downstream direction.

NOTE – For ITU-T Recs G.992.3 and G.992.4, the number of subcarrier downstream (NSCds) is defined in the corresponding Recommendations. For ITU-T Rec. G.992.1, NSCds = 256, for ITU-T Rec. G.992.2, NSCds = 128, and for ITU-T Rec. G.992.5, NSCds = 512.

(R, W) (mandatory for modems that support NSCds > 128) (16 bytes)

Downstream Subcarrier Mask3: This configuration parameter is a bitmap representing the downstream mask values for subcarriers 257 to 384. The MSB of the first byte corresponds to subcarrier 257, and the LSB of the last byte corresponds to entry subcarrier 384.

Each bit position defines whether the corresponding subcarrier is masked on this line in the downstream direction. It is coded as 1 if masked and 0 if not masked (default).

Subcarrier number 1 is the lowest, and subcarrier number NSCds is the highest subcarrier that can be transmitted in the downstream direction.

NOTE – For ITU-T Recs G.992.3 and G.992.4, the number of subcarrier downstream (NSCds) is defined in the corresponding Recommendations. For ITU-T Rec. G.992.1, NSCds = 256, for ITU-T Rec. G.992.2, NSCds = 128, and for ITU-T Rec. G.992.5, NSCds = 512.

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(R, W) (mandatory for modems that support NSCds > 256) (16 bytes)

Downstream Subcarrier Mask4: This configuration parameter is a bitmap representing the downstream mask values for subcarriers 385 to 512. The MSB of the first byte corresponds to subcarrier 385, and the LSB of the last byte corresponds to entry subcarrier 512.

Each bit position defines whether the corresponding subcarrier is masked on this line in the downstream direction. It is coded as 1 if masked and 0 if not masked (default).

Subcarrier number 1 is the lowest, and subcarrier number NSCds is the highest subcarrier that can be transmitted in the downstream direction.

NOTE – For ITU-T Recs G.992.3 and G.992.4, the number of subcarrier downstream (NSCds) is defined in the corresponding Recommendations. For ITU-T Rec. G.992.1, NSCds = 256, for ITU-T Rec. G.992.2, NSCds = 128, and for ITU-T Rec. G.992.5, NSCds = 512.

(R, W) (mandatory for modems that support NSCds > 384) (16 bytes)

TableValid: This boolean attribute controls and reports the operational status of this downstream subcarrier mask attributes.

If this attribute is true (coded as 0x01), then the downstream subcarrier mask represented in this ME has been impressed on the DSL equipment.

If this attribute is false (coded as 0x00), then the downstream subcarrier mask represented in this ME has not been impressed on the DSL equipment. Default value is false.

The value of this attribute can be modified by the ONU and OLT, as follows:

If the OLT changes any of the four mask attributes or sets TableValid to false, then TableValid is set to false.

If the TableValid is false and OLT sets TableValid to true, then the ONU will impress the downstream subcarrier mask data to the DSL equipment.

(R, W) (mandatory) (1 byte)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes. Note that setting the mask attributes does not directly change the DSL equipment operating mode, because of the TableValid attribute.

Notifications

None.

7.3.74 ADSL subcarrier masking upstream profile

This managed entity contains the Subcarrier Masking Upstream Profile for an ADSL line. An instance of this managed entity is created/deleted on request of the OLT.

Relationships

Zero or more instances of this managed entity shall exist and may be associated with zero or more instances of the Physical Path Termination Point ADSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. The value 0x00 is reserved. (R, Set-by-create) (mandatory) (2 bytes)

Upstream Subcarrier Mask: This configuration parameter is a bitmap representing the upstream mask values for subcarriers 1 to 64. The MSB of the first byte corresponds to subcarrier 1, and the LSB of the last byte corresponds to subcarrier 64.

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Each bit position defines whether the corresponding subcarrier is masked on this line in the upstream direction. It is coded as 1 if masked and 0 if not masked (default).

Subcarrier number 1 is the lowest, and subcarrier number NSCus is the highest subcarrier that can be transmitted in the upstream direction.

NOTE – For ITU-T Recs G.992.3 and G.992.4, the number of subcarrier upstream (NSCus) is defined in the corresponding Recommendations. For Annex A/G.992.1 and ITU-T Rec. G.992.2, NSCus = 32, for Annex B/G.992.1, NSCus = 64, and for ITU-T Rec. G.992.5, NSCus = 64.

(R, W, Set-by-create) (mandatory) (8 bytes)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes. Note that in this case, setting this attribute will result in the mask information being impressed on the DSL equipment immediately.

Notifications

None.

7.3.75 ADSL downstream PSD mask profile

This managed entity contains the Downstream PSD Mask Profile for an ADSL line. An instance of this managed entity is created/deleted on request of the OLT.

Relationships

Zero or more instances of this managed entity shall exist and may be associated with zero or more instances of the Physical Path Termination Point ADSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. The value 0x00 is reserved. (R, Set-by-create) (mandatory) (2 bytes)

Downstream PSD Mask: This configuration parameter is a table where each entry consists of an Entry Number (1 byte, first entry numbered 1) field, Subcarrier Index (2 bytes) field, and a MIB PSD Mask Level (1 byte) field. This table defines the downstream PSD mask applicable at the U-C2 reference point. This MIB PSD mask may impose PSD restrictions in addition to the Limit PSD mask defined in the relevant Recommendation (e.g., ITU-T Rec. G.992.5).

The downstream PSD mask in the CO-MIB shall be specified through a set of breakpoints. Each breakpoint shall consist of a subcarrier index i (using the same definition of 'i' as given in 7.3.73) and a MIB PSD mask level (expressed in dBm/Hz) at that subcarrier. The set of breakpoints can then be represented as [(i1, PSD-1), (i2, PSD-2), ... , (iN, PSD-N)]. The MIB PSD Mask Level field shall be coded as an unsigned integer representing the MIB PSD mask levels 0 (0) dBm/Hz to –95 (190) dBm/Hz, in steps of 0.5 dBm/Hz. The maximum number of breakpoints is 32.

This attribute is only valid for ITU-T Rec. G.992.5.

The requirements for a valid set of breakpoints are defined in the relevant Recommendations (e.g., ITU-T Rec. G.992.5). The entries will have default value of 0x00 for Subcarrier Index and 0x0 for MIB PSD Mask Level (i.e., no breakpoints). Table entries for this attribute are added or modified using the Set action. Setting an entry with a non-zero Subcarrier Index and MIB PSD Mask Level implies insertion into the table. Setting an entry's Subcarrier Index and MIB PSD Mask Level to 0 implies deletion from the table, if present.

(R, W) (mandatory) ($N \times 4$ bytes where N is the number of breakpoints)

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TableValid: This boolean attribute controls and reports the operational status of this Downstream PSD Mask attribute.

If this attribute is true (coded as 0x01), then the downstream PSD mask represented in this ME has been impressed on the DSL equipment.

If this attribute is false (coded as 0x00), then the downstream PSD mask represented in this ME has not been impressed on the DSL equipment. Default value is false.

The value of this attribute can be modified by the ONU and OLT, as follows:

If the OLT changes any of the PSD mask table entries or sets TableValid to false, then TableValid is set to false.

If the TableValid is false and OLT sets TableValid to true, then the ONU will impress the downstream PSD mask data to the DSL equipment.

(R, W) (mandatory) (1 byte)

Actions

Get: Get one or more attributes. Latch a snapshot (i.e., copy) of the current Downstream PSD Mask and use 4 bytes to respond with the size of data which should be obtained using the "Get next" command.

Get next: Get the latched attribute values of the managed entity within the current snapshot.

Set: Generally, this action is used to set one or more entire attribute values. When used on the Downstream PSD Mask attribute, the Set action either adds, modifies, or deletes table entries in Downstream PSD Mask. A maximum of 7 table entries can be added/modified/deleted by a single Set action.

Notifications

None.

7.3.76 ADSL downstream RFI bands profile

This managed entity contains the Downstream RFI Bands Profile for an ADSL line. An instance of this managed entity is created/deleted on request of the OLT.

Relationships

Zero or more instances of this managed entity shall exist and may be associated with zero or more instances of the Physical Path Termination Point ADSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. The value 0x00 is reserved. (R, Set-by-create) (mandatory) (2 bytes)

Downstream RFI Bands: This configuration parameter is a table where each entry consists of an Entry Number (1 byte, first entry numbered 1) field, Subcarrier Index1 (2 bytes) field, and Subcarrier Index2 (2 bytes) field. The subcarrier indices are defined in 7.3.73. This table defines the subset of downstream RFI Bands breakpoints, as specified in Downstream PSD Mask ME, that shall be used to notch an RFI band. This subset consists of couples of consecutive subcarrier indices belonging to breakpoints [i1;i2], corresponding to the low level of the notch. The maximum number of RFI bands is 32. This attribute is only valid for ITU-T Rec. G.992.5.

The specific interpolation around these points is defined in the relevant Recommendations (e.g., ITU-T Rec. G.992.5). The CO-MIB shall define the RFI notches using breakpoints in the Downstream PSD Mask ME as specified in the relevant Recommendations (e.g., ITU-T Rec. G.992.5).

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The entries will have default value of 0x00 for Subcarrier Index1 and Subcarrier Index2. Table entries for this attribute are added or modified using the Set action. Setting an entry with a non-zero Subcarrier Index1 and Subcarrier Index2 implies insertion into the table. Setting an entry's Subcarrier Index1 and Subcarrier Index2 to 0 implies deletion from the table, if present.

(R, W) (mandatory) ($N \times 5$ bytes where N is the number of RFI bands)

TableValid: This boolean attribute controls and reports the operational status of this Downstream RFI Bands attribute.

If this attribute is true (coded as 0x01), then the downstream RFI bands represented in this ME has been impressed on the DSL equipment.

If this attribute is false (coded as 0x00), then the downstream RFI bands represented in this ME has not been impressed on the DSL equipment. Default value is false.

The value of this attribute can be modified by the ONU and OLT, as follows:

If the OLT changes any of the RFI bands table entries or sets TableValid to false, then TableValid is set to false.

If the TableValid is false and OLT sets TableValid to true, then the ONU will impress the downstream RFI bands data to the DSL equipment.

(R, W) (mandatory) (1 byte)

Actions

Get: Get one or more attributes. Latch a snapshot (i.e., copy) of the current Downstream RFI Bands and use 4 bytes to respond with the size of data which should be obtained using the "Get next" command.

Get next: Get the latched attribute values of the managed entity within the current snapshot.

Set: Generally, this action is used to set one or more entire attribute values. When used on the Downstream RFI Bands attribute, the Set action either adds, modifies, or deletes table entries in Downstream RFI Bands. A maximum of 6 table entries can be added/modified/deleted by a single Set action.

Notifications

None.

7.3.77 ADSL ATU-C performance monitoring history data

This managed entity represents the last completed 15-minute interval collected performance monitoring of the ATU-C – ATU-R ADSL modem path as seen from the ATU-C.

Instances of this managed entity are created/deleted by the OLT after an instance of the corresponding Physical Path Termination Point ADSL UNI managed entity is created/deleted.

Relationships

One instance of this managed entity can exist for each instance of a Physical Path Termination Point ADSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the ID of the Physical Path Termination Point ADSL UNI with which this ATU-C Performance Monitoring History Data is associated. (R, W, Set-by-create) (mandatory) (2 bytes)

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Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ ID: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Loss of Frame Seconds: This attribute is the count of seconds in the previous 15-minute interval when there was Loss of Framing. (R) (mandatory) (2 bytes)

Loss of Signal Seconds: This attribute is the count of seconds in the previous 15-minute interval when there was Loss of Signal. (R) (mandatory) (2 bytes)

Loss of Link Seconds: This attribute is the count of seconds in the previous 15-minute interval when there was Loss of Link. (R) (mandatory) (2 bytes)

Loss of Power Seconds: This attribute is the count of seconds in the previous 15-minute interval when there was Loss of Power. (R) (mandatory) (2 bytes)

Errored Seconds: This attribute is the count of Errored Seconds in the previous 15-minute interval. (R) (mandatory) (2 bytes)

Severely Errored Seconds: This attribute is the count of Severely Errored Seconds in the previous 15-minute interval. (R) (mandatory) (2 bytes)

Line Initializations: This attribute is the count of Line Initializations in the previous 15-minute interval. (R) (mandatory) (2 bytes)

Failed Line Initializations: This attribute is a count of the total number of failed full initializations in the previous 15-minute interval. (R) (mandatory) (2 bytes)

Short Initializations: This attribute is a count of the total number of fast retrains or short initializations attempted on the line (successful and failed) in the previous 15-minute interval. (R) (optional) (2 bytes)

Failed Short Initializations: This attribute is a count of the total number of failed fast retrains or short initializations in the previous 15-minute interval. (R) (optional) (2 bytes)

FEC Seconds: This attribute is the count of seconds in the previous 15-minute interval when there was a Forward Error Correction anomaly. (R) (mandatory) (2 bytes)

Unavailable Seconds: This attribute is the count of seconds in the previous 15-minute interval the ATU-C was unavailable. (R) (mandatory) (2 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Get Current Data: Get the current value of one or more attributes.

Set: Set one or more attributes.

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Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a Threshold Crossing Alert (TCA) has been detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. The event list for this entity is given in Table 22.

Table 22/G.983.2 – Alarm list for ADSL performance monitoring history data (reproduced from Table 5/G.983.10)

Number	Event	Description	Threshold data counter number (Note)
	Threshold Crossing Alert		
0	Loss of Frame Seconds	Loss of Frame Seconds threshold crossing	1
1	Loss of Signal Seconds	Loss of Signal Seconds threshold crossing	2
2	Loss of Link Seconds	Loss of Link Seconds threshold crossing	3
3	Loss of Power Seconds	Loss of Power seconds threshold crossing	4
4	Errored Seconds	Errored seconds threshold crossing	5
5	Severely Errored Seconds	Severely Errored seconds threshold crossing	6
6	Line Initializations	Line Initializations threshold crossing	7
7	Failed Line Initializations	Failed Line Initializations threshold crossing	8
8	Short Initializations	Short Initializations threshold crossing	9
9	Failed Short Initializations	Failed Short Initializations threshold crossing	10
10	FEC Seconds	FEC Seconds threshold crossing	11
11	Unavailable Seconds	Unavailable Seconds threshold crossing	12
12-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data$_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.78 ADSL ATU-R performance monitoring history data

This managed entity represents the last completed 15-minute interval collected performance monitoring of the ATU-C-ATU-R ADSL modem path as seen from the ATU-R.

Instances of this managed entity are created/deleted by the OLT after an instance of the corresponding Physical Path Termination Point ADSL UNI managed entity is created/deleted.

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Relationships

One instance of this managed entity can exist for each instance of a Physical Path Termination Point ADSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the ID of the Physical Path Termination Point ADSL UNI with which this ATU-R Performance Monitoring History Data is associated. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ ID: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Loss of Frame Seconds: This attribute is the count of seconds in the previous 15-minute interval when there was Loss of Framing. (R) (mandatory) (2 bytes)

Loss of Signal Seconds: This attribute is the count of seconds in the previous 15-minute interval when there was Loss of Signal. (R) (mandatory) (2 bytes)

Loss of Power Seconds: This attribute is the count of seconds in the previous 15-minute interval when there was Loss of Power. (R) (mandatory) (2 bytes)

Errored Seconds: This attribute is the count of Errored Seconds in the previous 15-minute interval. (R) (mandatory) (2 bytes)

Severely Errored Seconds: This attribute is the count of Severely Errored Seconds in the previous 15-minute interval. (R) (mandatory) (2 bytes)

FEC Seconds: This attribute is the count of seconds in the previous 15-minute interval when there was a Forward Error Correction anomaly. (R) (mandatory) (2 bytes)

Unavailable Seconds: This attribute is the count of seconds in the previous 15-minute interval the ATU-R was unavailable. (R) (mandatory) (2 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Get Current Data: Get the current value of one or more attributes.

Set: Set one or more attributes.

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Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a Threshold Crossing Alert (TCA) has been detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. The event list for this entity is given in Table 23.

Table 23/G.983.2 – Alarm list for ATU-R performance monitoring history data (Reproduced from Table 6/G.983.10)

Number	Event	Description	Threshold Data Counter Number (Note)
	Threshold Crossing Alert		
0	Loss of Frame Seconds	Loss of Frame Seconds threshold crossing	1
1	Loss of Signal Seconds	Loss of Signal Seconds threshold crossing	2
2	Loss of Power Seconds	Loss of Power seconds threshold crossing	3
3	Errored Seconds	Errored seconds threshold crossing	4
4	Severely Errored Seconds	Severely Errored seconds threshold crossing	5
5	FEC Seconds	FEC Seconds threshold crossing	6
6	Unavailable Seconds	Unavailable Seconds threshold crossing	7
7-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data$_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.79 ADSL ATU-C channel performance monitoring history data

This managed entity represents the last completed 15-minute interval collected performance monitoring of the ATU-C – ATU-R ADSL channel as seen from the ATU-C.

Instances of this managed entity are created/deleted by the OLT after an instance of the corresponding Physical Path Termination Point ADSL UNI managed entity is created/deleted.

Relationships

One instance of this managed entity can exist for each instance of a Physical Path Termination Point ADSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The two most significant bits of the first byte are the Bearer Channel ID. The six least significant bits of the first byte are the slot ID (defined in 7.1.3). The second byte is the port ID with a value range from 0x01 to 0xFF (1 to 255): 0x01 is used for the leftmost/lowest port on a subscriber line card, 0x02 is used for the next right/upper port, and so forth. (R) (mandatory) (2 bytes)

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Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ ID: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Corrected blocks: This attribute is the count of all blocks received with errors that were corrected on this channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Uncorrected Blocks: This attribute is the count of all blocks received with uncorrectable errors on this channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Transmitted Blocks: This attribute is the count of all encoded blocks transmitted on this channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Received Blocks: This attribute is the count of all encoded blocks received on this channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Code Violations: This attribute is the count of CRC-8 anomalies in the bearer channel in the previous 15-minute interval. (R) (mandatory) (2 bytes)

Forward Error Corrections: This attribute is the count of FEC anomalies in the bearer channel in the previous 15-minute interval. (R) (mandatory) (2 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Get Current Data: Get the current value of one or more attributes.

Set: Set one or more attributes.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a Threshold Crossing Alert (TCA) has been detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. The event list for this entity is given in Table 24.

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Table 24/G.983.2 – Alarm list for ATU-C channel performance monitoring history data (reproduced from Table 7/G.983.10)

Number	Event	Description	Threshold data counter number (Note)
	Threshold Crossing Alert		
0	Corrected Blocks	Corrected Blocks threshold crossing	1
1	Uncorrected Blocks	Uncorrected Blocks threshold crossing	2
2	Code Violations	Code Violation threshold crossing	3
3	Forward Error Corrections	FEC threshold crossing	4
4-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold $Data_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.80 ADSL ATU-R channel performance monitoring history data

This managed entity represents the last completed 15-minute interval collected performance monitoring of the ATU-C – ATU-R ADSL channel as seen from the ATU-R.

Instances of this managed entity are created/deleted by the OLT after an instance of the corresponding Physical Path Termination Point ADSL UNI managed entity is created/deleted.

Relationships

One instance of this managed entity can exist for each instance of a Physical Path Termination Point ADSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The two most significant bits of the first byte are the Bearer Channel ID. The six least significant bits of the first byte are the slot ID (defined in 7.1.3). The second byte is the port ID with a value range from 0x01 to 0xFF (1 to 255): 0x01 is used for the leftmost/lowest port on a subscriber line card, 0x02 is used for the next right/upper port, and so forth. (R) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. (R) (mandatory) (1 byte)

Threshold $Data_{B\text{-}PON}$ ID: This attribute provides a pointer to an instance of the Threshold $Data_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Corrected blocks: This attribute is the count of all blocks received with errors that were corrected on this channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

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Uncorrected Blocks: This attribute is the count of all blocks received with uncorrectable errors on this channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Transmitted Blocks: This attribute is the count of all encoded blocks transmitted on this channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Received Blocks: This attribute is the count of all encoded blocks received on this channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Code Violations: This attribute is the count of CRC-8 anomalies in the bearer channel in the previous 15-minute interval. (R) (mandatory) (2 bytes)

Forward Error Corrections: This attribute is the count of FEC anomalies in the bearer channel in the previous 15-minute interval. (R) (mandatory) (2 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Get Current Data: Get the current value of one or more attributes.

Set: Set one or more attributes.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a Threshold Crossing Alert (TCA) has been detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. The event list for this entity is given in Table 25.

Table 25/G.983.2 – Alarm list for ATU-R channel performance monitoring history data (reproduced from Table 8/G.983.10)

Number	Event	Description	Threshold Data Counter Number (Note)
	Threshold Crossing Alert		
0	Corrected Blocks	Corrected Blocks threshold crossing	1
1	Uncorrected Blocks	Uncorrected Blocks threshold crossing	2
2	Code Violations	Code Violation threshold crossing	3
3	Forward Error Corrections	FEC threshold crossing	4
4-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data$_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.81 TC adaptor performance monitoring history data ADSL

This managed entity represents the last completed 15-minute interval collected performance monitoring of the ATU-C-ATU-R ATM Data Path.

Instances of this managed entity are created/deleted by the OLT after an instance of the corresponding Physical Path Termination Point ADSL UNI managed entity is created/deleted.

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Relationships

One instance of this managed entity can exist for each instance of a Physical Path Termination Point ADSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the ID of the Physical Path Termination Point ADSL UNI with which this ATU-R Channel Performance Monitoring History Data is associated. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. (R) (mandatory) (1 byte)

Threshold Data$_{\text{B-PON}}$ ID: This attribute provides a pointer to an instance of the Threshold Data$_{\text{B-PON}}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Near-end HEC violation count: The near-end HEC_violation_count performance parameter is a count of the number of occurrences of a near-end HEC anomaly in the ATM Data Path. (R) (mandatory) (2 bytes)

Near-end delineated total cell count (CD-P): The near-end delineated_total_cell_count performance parameter is a count of the total number of cells passed through the cell delineation and HEC function process operating on the ATM Data Path while in the SYNC state. (R) (mandatory) (4 bytes)

Near-end User total cell count: The near-end User_total_cell_count performance parameter is a count of the total number of cells in the ATM Data Path delivered at the V-C (for ATU-C) or T-R (for ATU-R) interface. (R) (mandatory) (4 bytes)

Near-end Idle Cell Bit Error Count: The near-end idle_bit_error_count performance parameter in a count of the number of bit errors in the idle cell payload received in the ATM Data Path at the near-end. (R) (mandatory) (2 bytes)

Far-end HEC violation count: The far-end HEC_violation_count performance parameter is a count of the number of occurrences of a far-end HEC anomaly in the ATM Data Path. (R) (mandatory) (2 bytes)

Far-end delineated total cell count: The far-end delineated_total_cell_count performance parameter is a count of the total number of cells passed through the cell delineation process and HEC function operating on the ATM Data Path while in the SYNC state. (R) (mandatory) (4 bytes)

Far-end User total cell count: The far-end User_total_cell_count performance parameter is a count of the total number of cells in the ATM Data Path delivered at the V-C (for ATU-C) or T-R (for ATU-R) interface. (R) (mandatory) (4 bytes)

Far-end Idle Cell Bit Error Count: The far-end idle_bit_error_count performance parameter is a count of the number of bit errors in the idle cell payload received in the ATM Data Path at the far-end. (R) (mandatory) (2 bytes)

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Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Get Current Data: Get the current value of one or more attributes.

Set: Set one or more attributes.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a Threshold Crossing Alert (TCA) has been detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. The event list for this entity is given in Table 26.

Table 26/G.983.2 – Alarm list for TC adaptor performance monitoring history data ADSL (reproduced from Table 9/G.983.10)

Number	Event	Description	Threshold data counter number (Note)
	Threshold Crossing Alert		
0	Near-end HEC violation	Near-end HEC violation count threshold crossing	1
1	Near-end Idle Cell Bit Error Count	Near-end Idle Cell Bit Error Count threshold crossing	2
2	Far-end HEC violation count	Far-end HEC violation count threshold crossing	3
3	Far-end Idle Cell Bit Error Count	Far-end Idle Cell Bit Error Count threshold crossing	4
4-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data$_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.82 Physical path termination point VDSL UNI

This managed entity represents the point at a VDSL connection in the ONU where physical paths terminate and physical path level functions (e.g., path overhead functions) are performed.

Instances of this managed entity shall be automatically created/deleted by the ONU upon the creation/deletion of a Subscriber Line Card of VDSL type.

If the Subscriber Line Card of VDSL type is a plug-in unit, the number of managed entities automatically created is the maximum number supportable by the Subscriber Line Card slot. This allows the creation of these managed entities before the unit is plugged-in.

Establishment of a "Physical Path Termination Point VDSL UNI"

The Physical Path Termination Point VDSL UNI is auto created when the Subscriber Line Card of type VDSL is created. On auto creation the three profile pointers within the Managed Entity are set to their default values of 0x00. However, the PPTP VDSL UNI must refer to three valid profiles before it can be operational.

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Relationships

One or more instances of this managed entity shall be contained in an instance of a Subscriber Line Card managed entity classified as VDSL type.

Extensions for VDSL using Single Carrier Modulation (SCM) and Multiple Carrier Modulation (MCM) are for further study.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The first byte is the slot ID (defined in 7.1.3). The second byte is the port ID with a value range from 0x01 to 0xFF (1 to 255): 0x01 is used for the leftmost/lowest port on a subscriber line card, 0x02 is used for the next right/upper port, and so forth. (R) (mandatory) (2 bytes)

Loopback Configuration: This attribute represents the loopback configuration of this physical interface. Value 0x00: no loopback; value 0x01: loopback2 ("Loopback2" refers to a loopback at the local VDSL modem). The OLT can execute a physical level loopback test after loopback is set. Upon autonomous instantiation, the value 0x00 is used. (R, W) (mandatory) (1 byte)

Administrative State: This attribute is used to activate (unlock: value 0x00) and deactivate (lock: value 0x01) the functions performed by instances of this managed entity. Selection of a default value for this attribute is outside the scope of this Recommendation as it is normally handled through supplier-operator negotiations. (R, W) (mandatory) (1 byte)

Operational State: This attribute indicates whether or not this managed entity is capable of performing its task. The operational state reflects the perceived ability to receive or to generate a valid signal. Valid values are enabled (0x00) and disabled (0x01). (R) (optional) (1 byte)

Availability State: This attribute indicates whether the hardware to support this UNI is available on the plugged in line card. Valid values are available(0), notAvailable(1), unknown(2). (R) (optional) (1 byte)

VDSL Line Coding Type: This data type is used as the syntax for the VDSL Line Code. Attributes with this syntax identify the line coding used. The three values are:

other(1) – none of the following;

mcm(2) – Multiple Carrier Modulation;

scm(3) – Single Carrier Modulation.

(R) (mandatory) (1 byte)

VDSL Line Type: Defines the type of VDSL physical line entity that exists, by defining whether and how the line is channelized. If the line is channelized, the value will be other than noChannel(1). This object defines which channel type(s) are supported. Defined values are:

noChannel(1) – no channels exist;

fastOnly(2) – only fast channel exists;

slowOnly(3) – only slow channel exists;

fastOrSlow(4) – either fast or slow channel exist, but only one at a time;

fastAndSlow(5) – both fast and slow channels exist.

(R) (mandatory) (1 byte)

ARC: This attribute is used to control alarm reporting from this managed entity. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

ARCInterval: This attribute provides a provisionable length of time. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

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VDSL Line Configuration Profile ID: This attribute provides a pointer to an instance of the VDSL Line Configuration Profile managed entity that contains the data necessary for initializing a VDSL MODEM. The value 0x00 is used to indicate that this ME does not point to a line configuration profile. The default value 0x00 is used when this ME is auto created. (R, W) (mandatory) (2 bytes)

VDSL Channel Configuration Profile ID: This attribute provides a pointer to an instance of the VDSL Channel Configuration Profile managed entity that contains the data necessary for channelizing a VDSL Connection. The value 0x00 is used to indicate that this ME does not point to a channel configuration profile. The default value 0x00 is used when this ME is auto created. (R, W) (mandatory) (2 bytes)

VDSL Band Plan Configuration Profile ID: This attribute provides a pointer to an instance of the VDSL Band Plan Configuration Profile managed entity that contains the data necessary to set up a VDSL Connection. The value 0x00 is used to indicate that this ME does not point to band plan configuration profile. The default value 0x00 is used when this ME is auto created. (R, W) (mandatory) (2 bytes)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

Attribute value change: This notification is used to report autonomous changes of attributes of this managed entity. The notification shall identify the attribute and its new value. The AVCs for this managed entity are given in Table 27.

Table 27/G.983.2 – AVC list for physical path termination point VDSL UNI (reproduced from Table 10/G.983.10)

Number	Attribute value change	Description
1-2	N/A	
3	OpState	Operational state
4-11	N/A	
12-16	Reserved	

Alarm: This notification is used to notify the management system when a failure has been detected or cleared. Both ONU and OLT should know the alarm list used by this entity. The alarms for this entity are given in Table 28.

Table 28/G.983.2 – Alarm list for physical path termination point VDSL UNI (reproduced from Table 11/G.983.10)

Number	Alarm	Description
0	NE_LOF	Near End (VTU-O) Loss of Framing
1	NE_LOS	Near End (VTU-O) Loss of Signal
2	NE_LOP	Near End (VTU-O) Loss of Power
3	NE_LOSQ	Near End (VTU-O) Loss of Signal Quality
4	NE_LOL	Near End (VTU-O) Loss of Link
5	FE_LOF	Far End (VTU-R) Loss of Framing

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Table 28/G.983.2 – Alarm list for physical path termination point VDSL UNI (reproduced from Table 11/G.983.10)

Number	Alarm	Description
6	FE_LOS	Far End (VTU-R) Loss of Signal
7	FE_LOP	Far End (VTU-R) Loss of Power
8	FE_LOSQ	Far End (VTU-R) Loss of Signal Quality
9-223	Reserved	
224-239	Vendor-specific alarms	Not to be standardized

7.3.83 VDSL VTU-O physical data

This managed entity represents the physical status of the VDSL Termination Unit (ONU) (VTU-O) in a VDSL connection in the ONU.

An instance of this managed entity shall be automatically created/deleted by the ONU upon the creation/deletion of a Subscriber Line Card of VDSL type.

Relationships

One or more instances of this managed entity shall be contained in an instance of a Subscriber Line Card managed entity classified as VDSL type.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The first byte is the slot ID. The second byte is the port ID with a value range from 0x01 to 0xFF (1 to 255). (R) (mandatory) (2 bytes)

Line Transmit Rate: Indicates the current VTU-O line transmit rate in kbit/s. This value will be less than or equal to the current attainable rate.

NOTE – 1 kbit/s = 1000 bit/s.

(R) (mandatory) (4 bytes)

Serial Number Part 1: The vendor-specific string that identifies the vendor equipment. It consists of up to 32 ASCII characters. This attribute contains the first 16 characters. (R) (mandatory) (16 bytes)

Serial Number Part 2: The vendor-specific string that identifies the vendor equipment. It consists of up to 32 ASCII characters. This attribute contains the second 16 characters. (R) (mandatory) (16 bytes)

Vendor ID: The vendor ID code is a copy of the binary vendor identification field expressed as readable characters in hexadecimal notation. (R) (mandatory) (16 bytes)

Version Number: The vendor-specific version number sent by this VTU as part of the initialization messages. It is a copy of the binary version number field expressed as readable characters in hexadecimal notation. (R) (mandatory) (16 bytes)

Current Status: Indicates current state of the VTU-O. This is a bit-map of possible conditions. The various bit positions are:

0 – noDefect – There are no defects on the line.

1 – lossOfFraming – VTU-O failure due to not receiving a valid frame.

2 – lossOfSignal – VTU-O failure due to not receiving signal.

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3 – lossOfPower – VTU-O failure due to loss of power.

4 – lossOfSignalQuality – Loss of Signal Quality is declared when the Noise Margin falls below the Minimum Noise Margin, or the bit-error-rate exceeds 10^{-7}.

5 – lossOfLink – VTU-O failure due to inability to link with peer VTU. Set whenever the transceiver is in the 'Warm Start' state.

6 – dataInitFailure – VTU-O failure during initialization due to bit errors corrupting startup exchange data.

7 – configInitFailure – VTU-O failure during initialization due to peer VTU not able to support requested configuration.

8 – protocolInitFailure – VTU-O failure during initialization due to incompatible protocol used by the peer VTU.

9 – noPeerVtuPresent – VTU-O failure during initialization due to no activation sequence detected from peer VTU.

(R) (mandatory) (2 bytes)

Current Output Power: Measured total output power transmitted by this VTU in steps of 0.1 dBm. This is the measurement that was reported during the last activation sequence. The effective range is 0 (0) to +16 (160) dBm. (R) (mandatory) (1 byte)

Current SNR Margin: Noise Margin as seen by this VTU with respect to its received signal in steps of 0.25 dB. The effective range is –31.75 (–127) to +31.75 (127) dB. (R) (mandatory) (1 byte)

Current Attenuation: Measured difference in the total power transmitted by the peer VTU and the total power received by this VTU. The effective range is 0 (0) to +63.75 (255) dB. (R) (mandatory) (1 byte)

Current Attainable Rate: Indicates the maximum currently attainable line transmit rate by the VTU-O in kbit/s. This value will be equal to or greater than the current line rate.

NOTE – 1 kbit/s = 1000 bit/s.

(R) (mandatory) (4 bytes)

Current Loop Length Estimate: Estimated loop length in feet assuming a 26 AWG (0.4 mm) loop. (R) (mandatory) (2 bytes)

Actions

Get: Get one or more attributes.

Notifications

None.

7.3.84 VDSL VTU-R physical data

This managed entity represents the physical status of the VDSL Termination Unit (Remote) (VTU-R) in a VDSL connection in the ONU.

An instance of this managed entity shall be automatically created/deleted by the ONU upon the creation/deletion of a Subscriber Line Card of VDSL type.

Relationships

One or more instances of this managed entity shall be contained in an instance of a Subscriber Line Card managed entity classified as VDSL type.

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Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The first byte is the slot ID. The second byte is the port ID with a value range from 0x01 to 0xFF (1 to 255). (R) (mandatory) (2 bytes)

Line Transmit Rate: Indicates the current VTU-R line transmit rate in kbit/s. This value will be less than or equal to the current attainable rate.

NOTE – 1 kbit/s = 1000 bit/s.

(R) (mandatory) (4 bytes)

Serial Number Part 1: The vendor-specific string that identifies the vendor equipment. This attribute contains the first 16 characters. (R) (mandatory) (16 bytes)

Serial Number Part 2: The vendor-specific string that identifies the vendor equipment. It consists of up to 32 ASCII characters. This attribute contains the second 16 characters. (R) (mandatory) (16 bytes)

Vendor ID: The vendor ID code is a copy of the binary vendor identification field expressed as readable characters in hexadecimal notation. (R) (mandatory) (16 bytes)

Version Number: The vendor-specific version number sent by this VTU as part of the initialization messages. It is a copy of the binary version number field expressed as readable characters in hexadecimal notation. (R) (mandatory) (16 bytes)

Current Status: Indicates current state of the VTU line. This is a bit-map of possible conditions. The various bit positions are:

0 – noDefect – There are no defects on the line.

1 – lossOfFraming – VTU failure due to not receiving a valid frame.

2 – lossOfSignal – VTU failure due to not receiving signal.

3 – lossOfPower – VTU failure due to loss of power.

4 – lossOfSignalQuality – Loss of Signal Quality is declared when the Noise Margin falls below the Minimum Noise Margin, or the bit-error-rate exceeds 10^{-7}.

(R) (mandatory) (1 byte)

Current Output Power: Measured total output power transmitted by this VTU in steps of 0.1 dBm. This is the measurement that was reported during the last activation sequence. The effective range is 0 (0) to +16 (160) dBm. (R) (mandatory) (1 byte)

Current SNR Margin: Noise Margin as seen by this VTU with respect to its received signal in 0.25 dB. The effective range is –31.75 (–127) to +31.75 (127) dB. (R) (mandatory) (1 byte)

Current Attenuation: Measured difference in the total power transmitted by the peer VTU and the total power received by this VTU. The effective range is 0 (0) to +63.75 (255) dB. (R) (mandatory) (1 byte)

Current Attainable Rate: Indicates the maximum currently attainable line transmit rate by the VTU-R in kbit/s. This value will be equal to or greater than the current line rate.

NOTE – 1 kbit/s = 1000 bit/s.

(R) (mandatory) (4 bytes)

Actions

Get: Get one or more attributes.

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Notifications

None.

7.3.85 VDSL channel data

This managed entity represents the physical status of the VDSL Fast and slow channels in a VDSL connection in the ONU.

An instance of this managed entity shall be automatically created/deleted by the ONU upon the creation/deletion of a Subscriber Line Card of VDSL type.

Relationships

One or more instances of this managed entity shall be contained in an instance of a Subscriber Line Card managed entity classified as VDSL type.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The first byte is the slot ID. The second byte is the port ID with a value range from 0x01 to 0xFF (1 to 255). (R) (mandatory) (2 bytes)

Current Interleave Delay Down: Downstream Interleave Delay for this channel in milliseconds. Interleave delay defines the mapping (relative spacing) between subsequent input bytes at the interleaver input and their placement in the bit stream at the interleaver output. Larger numbers provide greater separation between consecutive input bytes in the output bit stream allowing for improved impulse noise immunity at the expense of payload latency. (R) (mandatory) (1 byte)

Current Fast Payload Rate Down: Actual fast channel downstream data rate, in kbit/s.

NOTE – 1 kbit/s = 1000 bit/s.

(R) (mandatory) (4 bytes)

Current Slow Payload Rate Down: Actual slow downstream data rate, in kbit/s.

NOTE – 1 kbit/s = 1000 bit/s.

(R) (mandatory) (4 bytes)

Current Fast CRC Block Length Down: Indicates the length of the downstream fast channel data-block, in bytes, on which the CRC operates. (R) (mandatory) (2 bytes)

Current Slow CRC Block Length Down: Indicates the length of the downstream slow channel data-block, in bytes, on which the CRC operates. (R) (mandatory) (2 bytes)

Current Slow Burst Protect Down: Actual level of downstream impulse noise (burst) protection, in microseconds, for the slow channel. (R) (mandatory) (2 bytes)

Current Fast FEC Down: Actual downstream Forward Error Correction (FEC) redundancy, in percent, related overhead for the fast channel. (R) (mandatory) (1 byte)

Current Interleave Delay Up: Downstream Interleave Delay for this channel in milliseconds. Interleave delay applies only to the interleave (slow) channel and defines the mapping (relative spacing) between subsequent input bytes at the interleaver input and their placement in the bit stream at the interleaver output. Larger numbers provide greater separation between consecutive input bytes in the output bit stream allowing for improved impulse noise immunity at the expense of payload latency.

In the case where the interface type is fast, return a value of zero. (R) (mandatory) (1 byte)

Current Fast Payload Rate Up: Actual fast channel upstream data rate, in kbit/s.

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NOTE – 1 kbit/s = 1000 bit/s.

(R) (mandatory) (4 bytes)

Current Slow Payload Rate Up: Actual slow upstream data rate, in kbit/s.

NOTE – 1 kbit/s = 1000 bit/s.

(R) (mandatory) (4 bytes)

Current Fast CRC Block Length Up: Indicates the length of the upstream fast channel data-block, in bytes, on which the CRC operates. (R) (mandatory) (2 bytes)

Current Slow CRC Block Length Up: Indicates the length of the upstream slow channel data-block, in bytes, on which the CRC operates. (R) (mandatory) (2 bytes)

Current Slow Burst Protect Up: Actual level of upstream impulse noise (burst) protection, in microseconds, for the slow channel. (R) (mandatory) (2 bytes)

Current Fast FEC Up: Actual upstream Forward Error Correction (FEC) redundancy, in percent, related overhead for the fast channel. (R) (mandatory) (1 byte)

Actions

Get: Get one or more attributes.

Notifications

None.

7.3.86 VDSL line configuration profile

An instance of this managed entity represents a VDSL Line Configuration Profile supported on the ONU. Zero or more VDSL Physical Path Termination Points can reference an instance of a VDSL Line Configuration Profile managed entity.

Instances of this managed entity are created and deleted by the ONU on request of the OLT.

Relationships

Zero or more instances of this managed entity shall be contained in an ONU. One or more instances of this managed entity shall be contained in an ONU containing instances of Physical Path Termination Point VDSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. The value 0x00 is reserved. (R, W, Set-be-create) (mandatory) (2 bytes)

Down Rate Mode: Specifies the rate selection behaviour for the line in the downstream direction. manual(1) forces the rate to the configured rate, adaptAtInit(2) adapts the line based upon line quality. (R, W, Set-by-Create) (mandatory) (1 byte)

Up Rate Mode: Specifies the rate selection behaviour for the line in the upstream direction. manual(1) forces the rate to the configured rate, adaptAtInit(2) adapts the line based upon line quality. (R, W, Set-by-Create) (mandatory) (1 byte)

Down Max Power: Specifies the maximum aggregate downstream power level in the range 0 (0) to 14.5 dBm (58) in 0.25 dBm intervals. (R, W, Set-by-Create) (mandatory) (1 byte)

Up Max Power: Specifies the maximum aggregate upstream power level in the range 0 (0) to 14.5 dBm (58) in 0.25 dBm intervals. (R, W, Set-by-Create) (mandatory) (1 byte)

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Down Max SNR Margin: Specifies the maximum downstream Signal/Noise Ratio Margin in units of 0.25 dB, for a range of 0 (0) to 31.75 dB (127). (R, W, Set-by-Create) (mandatory) (1 byte)

Down Min SNR Margin: Specifies the minimum downstream Signal/Noise Ratio Margin in units of 0.25 dB, for a range of 0 (0) to 31.75 dB (127). (R, W, Set-by-Create) (mandatory) (1 byte)

Down Target SNR Margin: Specifies the target downstream Signal/Noise Ratio Margin in units of 0.25 dB, for a range of 0 (0) to 31.75 dB (127). This is the Noise Margin the transceivers must achieve with a BER of 10^{-7} or better to successfully complete initialization. (R, W, Set-by-Create) (mandatory) (1 byte)

Up Max SNR Margin: Specifies the maximum upstream Signal/Noise Ratio Margin in units of 0.25 dB, for a range of 0 (0) to 31.75 dB (127). (R, W, Set-by-Create) (mandatory) (1 byte)

Up Min SNR Margin: Specifies the minimum upstream Signal/Noise Ratio Margin in units of 0.25 dB, for a range of 0 (0) to 31.75 dB (127). (R, W, Set-by-Create) (mandatory) (1 byte)

Up Target SNR Margin: Specifies the target upstream Signal/Noise Ratio Margin in units of 0.25 dB, for a range of 0 (0) to 31.75 dB (127). This is the Noise Margin the transceivers must achieve with a BER of 10^{-7} or better to successfully complete initialization. (R, W, Set-by-Create) (mandatory) (1 byte)

Down PBO Control: Downstream power backoff (PBO) control for this line. For transceivers which do not support downstream PBO control, this object MUST be fixed at disabled(1). If auto(2) is selected, the transceiver will automatically adjust the power backoff. If manual(3) is selected, then the transceiver will use the Down PBO Level. (R, W, Set-by-Create) (mandatory) (1 byte)

Up PBO Control: Upstream power backoff (PBO) control for this line. For transceivers which do not support upstream PBO control, this object MUST be fixed at disabled(1). If auto(2) is selected, the transceiver will automatically adjust the power backoff. If manual(3) is selected, then the transceiver will use the Up PBO Level. (R, W, Set-by-Create) (mandatory) (1 byte)

Down PBO Level: Specifies the downstream backoff level to be used when Down PBO Control = manual(3). Valid range is 0 dB (0) to 40 dB (160) in 0.25 dB intervals. (R, W, Set-by-Create) (mandatory) (1 byte)

Up PBO Level: Specifies the upstream backoff level to be used when Up PBO Control = manual(3). Valid range is 0 dB (0) to 40 dB (160) in 0.25 dB intervals. (R, W, Set-by-Create) (mandatory) (1 byte)

Line Type: This parameter provisions the VDSL physical entity at start-up by defining whether and how the line will be channelized, i.e., which channel type(s) are supported. If the line is to be channelized, the value will be other than noChannel(1).

Defined values are:

noChannel(1) – no channels exist;

fastOnly(2) – only the fast channel exists;

slowOnly(3) – only the slow channel exists

fastOrSlow(4) – either the fast or the slow channel exists, but only one at a time;

fastAndSlow(5) – both fast and slow channels exist.

(R, W, Set-by-Create) (mandatory) (1 byte)

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Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

7.3.87 VDSL channel configuration profile

An instance of this managed entity represents a VDSL Channel Configuration Profile supported on the ONU. Zero or more VDSL Physical Path Termination Points can reference an instance of a VDSL Channel Configuration Profile managed entity.

Instances of this managed entity are created and deleted by the ONU on request of the OLT.

Relationships

Zero or more instances of this managed entity shall be contained in an ONU. One or more instances of this managed entity shall be contained in an ONU containing instances of Physical Path Termination Point VDSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. The value 0x00 is reserved. (R, Set-by-create) (mandatory) (2 bytes)

Down Rate Ratio: This attribute is the configured allocation ratio of excess downstream transmit bandwidth between fast and slow channels. Only applies when two channel mode and adaptAtInit are supported. Distribute bandwidth on each channel in excess of the corresponding Minimum Transmit Bit Rate so that:

$$\text{Rate Change Ratio} = [\text{Fast}/(\text{Fast} + \text{Slow})] \times 100$$

In other words, this value is the fast channel percentage. Valid range is 0 to 100. (R, W, Set-by-Create) (optional) (1 byte)

Up Rate Ratio: This attribute is the configured allocation ratio of excess upstream transmit bandwidth between fast and slow channels. Only applies when two channel mode and adaptAtInit are supported. Distribute bandwidth on each channel in excess of the corresponding Minimum Transmit Bit Rate so that:

$$\text{Rate Change Ratio} = [\text{Fast}/(\text{Fast} + \text{Slow})] \times 100$$

In other words, this value is the fast channel percentage. Valid range is 0 to 100. (R, W, Set-by-Create) (optional) (1 byte)

Down Slow Max Data Rate: Specifies the maximum downstream slow channel data rate in steps of 64 kbit/s. The maximum aggregate downstream transmit speed of the line can be derived from the sum of maximum downstream fast and slow channel data rates. (R, W, Set-by-Create) (mandatory) (2 bytes)

Down Slow Min Data Rate: Specifies the minimum downstream slow channel data rate in steps of 64 kbit/s. The minimum aggregate downstream transmit speed of the line can be derived from the sum of minimum downstream fast and slow channel data rates. (R, W, Set-by-Create) (mandatory) (2 bytes)

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Up Slow Max Data Rate: Specifies the maximum upstream slow channel data rate in steps of 64 kbit/s. The maximum aggregate upstream transmit speed of the line can be derived from the sum of maximum upstream fast and slow channel data rates. (R, W, Set-by-Create) (mandatory) (2 bytes)

Up Slow Min Data Rate: Specifies the minimum upstream slow channel data rate in steps of 64 kbit/s. The minimum aggregate upstream transmit speed of the line can be derived from the sum of minimum upstream fast and slow channel data rates. (R, W, Set-by-Create) (mandatory) (2 bytes)

Down Max Interleave Delay: Specifies the maximum interleave delay, in milliseconds, for the downstream slow channel. Valid range is 0 to 255 ms. (R, W, Set-by-Create) (mandatory) (1 byte)

Up Max Interleave Delay: Specifies the maximum interleave delay, in milliseconds, for the upstream slow channel. Valid range is 0 to 255 ms. (R, W, Set-by-Create) (mandatory) (1 byte)

Down Target Slow Burst: Specifies the target level of impulse noise (burst) protection, in microseconds, for the downstream slow channel. Valid range is 0 to 1275 µs. (R, W, Set-by-Create) (mandatory) (2 bytes)

Up Target Slow Burst: Specifies the target level of impulse noise (burst) protection, in microseconds, for the upstream slow channel. Valid range is 0 to 1275 µs. (R, W, Set-by-Create) (mandatory) (2 bytes)

Down Fast Max Data Rate: Specifies the maximum downstream fast channel data rate in steps of 64 kbit/s. (R, W, Set-by-Create) (mandatory) (2 bytes)

Down Fast Min Data Rate: Specifies the minimum downstream fast channel data rate in steps of 64 kbit/s. (R, W, Set-by-Create) (mandatory) (2 bytes)

Up Fast Max Data Rate: Specifies the maximum upstream fast channel data rate in steps of 64 kbit/s. (R, W, Set-by-Create) (mandatory) (2 bytes)

Up Fast Min Data Rate: Specifies the minimum upstream fast channel data rate in steps of 64 kbit/s. (R, W, Set-by-Create) (mandatory) (2 bytes)

Down Max Fast FEC: This parameter provisions the maximum level of Forward Error Correction (FEC) redundancy related overhead to be maintained, as a percentage, for the downstream fast channel. Valid range is 0 to 50 percent. (R, W, Set-by-Create) (optional) (1 byte)

Up Max Fast FEC: This parameter provisions the maximum level of Forward Error Correction (FEC) redundancy related overhead to be maintained, as a percentage, for the upstream fast channel. Valid range is 0 to 50 percent. (R, W, Set-by-Create) (optional) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

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7.3.88 VDSL band plan configuration profile

An instance of this managed entity represents a VDSL Band Plan Configuration Profile supported on the ONU. Zero or more VDSL Physical Path Termination Points can reference an instance of a VDSL Band Plan Configuration Profile managed entity.

Instances of this managed entity are created and deleted by the ONU on request of the OLT.

Relationships

Zero or more instances of this managed entity shall be contained in an ONU. One or more instances of this managed entity shall be contained in an ONU containing instances of Physical Path Termination Point VDSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. The value 0x00 is reserved. (R, Set-by-create) (mandatory) (2 bytes)

Band Plan: The VDSL band plan to be used for the line. bandPlan997(1) is to be used for G.993.1 Bandplan-B, ETSI Bandplan, ANSI Plan 997. bandPlan998(2) is to be used for G.993.1 Bandplan-A, ANSI Plan 998. bandPlanFx(3) is to be used for G.993.1 Bandplan-C. other(4) is to be used for non-standard band plans. If this object is set to bandPlanFx(3), then Band Plan FX MUST also be set. (R, W, Set-by-Create) (mandatory) (1 byte)

Band Plan FX: The frequency limit, in kHz, between bands D2 and U2 when the Band Plan is set to bandPlanFx(3). Valid range is 3 750 to 12 000 kHz. (R, W, Set-by-Create) (optional) (2 bytes)

Band Opt Usage: Defines the VDSL link use of the optional frequency range [25 kHz-138 kHz] (Opt). unused(1) indicates Opt is unused, upstream(2) indicates Opt usage is for upstream, downstream(3) indicates Opt usage is for downstream. (R, W, Set-by-Create) (mandatory) (1 byte)

Up PSD Template: The upstream PSD template to be used for the line. Here, templateMask1(1) refers to a notched mask that limits the transmitted PSD within the internationally standardized HAM (amateur Radio) radio bands, while templateMask2(2) refers to an unnotched mask. The masks themselves depend upon the applicable standard being used (Applicable Standard). (R, W, Set-by-Create) (mandatory) (1 byte)

Down PSD Template: The downstream PSD template to be used for the line. Here, templateMask1(1) refers to a notched mask that limits the transmitted PSD within the internationally standardized HAM (Handheld Amateur Radio) radio bands, while templateMask2(2) refers to an unnotched mask. The masks themselves depend upon the applicable standard being used (Applicable Standard). (R, W, Set-by-Create) (mandatory) (1 byte)

HAM Band Mask: The transmit power spectral density mask code, used to avoid interference with HAM (Handheld Amateur Radio) radio bands by introducing power control (notching) in one or more of these bands. Amateur radio band notching is defined in the VDSL spectrum as follows:

Band	Start frequency	Stop frequency
30 m	1 810 kHz	2 000 kHz
40 m	3 500 kHz	3 800 kHz (ETSI); 4000 kHz (ANSI)
80 m	7 000 kHz	7 100 kHz (ETSI); 7300 kHz (ANSI)
160 m	10 100 kHz	10 150 kHz

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Notching for each standard band can be enabled or disabled via this bit mask. Two custom notches may be specified. If customNotch1 is enabled, then both **Custom Notch 1 Start** and **Custom Notch 1 Stop** MUST be specified. If customNotch2 is enabled, then both **Custom Notch 2 Start** and **Custom Notch 2 Stop** MUST be specified. Valid bit values are defined as follows, all combinations are allowed:

customNotch1(0) – custom (region-specific) notch

customNotch2(1) – custom (region-specific) notch

amateurBand30m(2) – amateur radio band notch

amateurBand40m(3) – amateur radio band notch

amateurBand80m(4) – amateur radio band notch

amateurBand160m(5) – amateur radio band notch

(R, W, Set-by-Create) (mandatory) (1 byte)

Custom Notch 1 Start: Specifies the start frequency, in kHz, of custom HAM (Handheld Amateur Radio) notch 1. This field MUST be less than or equal to **Custom Notch 1 Stop**. Valid range is 0 to 65 535 kHz. (R, W, Set-by-Create) (optional) (2 bytes)

Custom Notch 1 Stop: Specifies the stop frequency, in kHz, of custom HAM (Handheld Amateur Radio) notch 1. This field MUST be greater than or equal to **Custom Notch 1 Start**. (R, W, Set-by-Create). Valid range is 0 to 65 535 kHz. (optional) (2 bytes)

Custom Notch 2 Start: Specifies the start frequency, in kHz, of custom HAM (Handheld Amateur Radio) notch 2. This field MUST be less than or equal to **Custom Notch 2 Stop**. Valid range is 0 to 65 535 kHz. (R, W, Set-by-Create) (optional) (2 bytes)

Custom Notch 2 Stop: Specifies the stop frequency, in kHz, of custom HAM (Handheld Amateur Radio) notch 2. This field MUST be greater than or equal to **Custom Notch 2 Start**. Valid range is 0 to 65 535 kHz. (R, W, Set-by-Create) (optional) (2 bytes)

Deployment Scenario: The VDSL line deployment scenario. When using fttCab(1), the VTU-C is located in a street cabinet. When using fttEx(2), the VTU-C is located at the central office. Changes to this value will have no effect on the transceiver. (R, W, Set-by-Create) (mandatory) (1 byte)

ADSL Presence: Indicates presence of ADSL service in the associated cable bundle/binder. none(1) indicates no ADSL service in the bundle, adslOverPots(2) indicates ADSL service over POTS is present in the bundle, adslOverISDN(3) indicates ADSL service over ISDN is present in the bundle. (R, W, Set-by-Create) (mandatory) (1 byte)

Applicable Standard: The VDSL standard to be used for the line. ansi(1) indicates ANSI standard, etsi(2) indicates ETSI standard, itu(3) indicates ITU standard, other(4) indicates a standard other than the above. (R, W, Set-by-Create) (mandatory) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

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7.3.89 VDSL VTU-O physical interface monitoring history data

This managed entity contains the last completed 15-minute interval collected statistic data for a VDSL physical interface.

Instances of this managed entity are created/deleted by the OLT after an instance of the Physical Path Termination Point VDSL UNI managed entity is created/deleted.

The performance management of the physical interfaces used by VDSL shall be supported. Failure/notifications should include threshold alerts for unacceptable performance (error) rates. Performance data should include transmission counts of Errored Seconds (ES), Severely Errored Seconds (SES) and Unavailable Seconds (UAS).

Relationships

One instance of this managed entity can exist for each instance of the Physical Path Termination Point VDSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The first byte is the slot ID. The second byte is the port ID with a value range from 0x01 to 0xFF (1 to 255). (R, W, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. The attribute counters are updated at the end of the interval. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ ID: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Loss of Framing Seconds: Count of seconds during this interval that there was Loss of Framing. (R) (mandatory) (2 bytes)

Loss of Signal Seconds: Count of seconds during this interval that there was Loss of Signal. (R) (mandatory) (2 bytes)

Loss of Power Seconds: Count of seconds during this interval that there was Loss of Power. (R) (mandatory) (2 bytes)

Loss of Link Seconds: Count of seconds during this interval that there was Loss of Link. (R) (mandatory) (2 bytes)

Errored Seconds: Count of Errored Seconds during this interval. An Errored Second is a one-second interval containing one or more CRC anomalies, or one or more LOS or LOF defects. (R) (mandatory) (2 bytes)

Severely Errored Seconds: Count of Severely Errored Seconds during this interval. (R) (mandatory) (2 bytes)

Unavailable Seconds: Count of Unavailable Seconds during this interval. (R) (mandatory) (2 bytes)

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Line Initializations: Count of the line initialization attempts during this interval. This count includes both successful and failed attempts. (R) (mandatory) (2 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Get Current Data: Get the current value of one or more attributes.

Set: Set one or more attributes.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a threshold crossing alert (TCA) is detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. Both ONU and OLT should know the event list used by this entity. The list of TCAs for this entity is given in Table 29.

Table 29/G.983.2 – Alarm list for VDSL VTU-O physical interface monitoring history data (reproduced from Table 12/G.983.10)

Number	Event	Description	Threshold data counter number (Note)
	Threshold Crossing Alert		
0	LOFS	Exceeds threshold	1
1	LOSS	Exceeds threshold	2
2	LOLS	Exceeds threshold	3
3	LOPS	Exceeds threshold	4
4	ES	Exceeds threshold	5
5	LI	Exceeds threshold	6
6	SES	Exceeds threshold	7
7	UAS	Exceeds threshold	8
8-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data$_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.90 VDSL VTU-R physical interface monitoring history data

This managed entity contains the last completed 15-minute interval collected statistic data for a VDSL physical interface.

Instances of this managed entity are created/deleted by the OLT after an instance of the Physical Path Termination Point VDSL UNI managed entity is created/deleted.

The performance management of the physical interfaces used by VDSL shall be supported. Failure/notifications should include threshold alerts for unacceptable performance (error) rates. Performance data should include transmission counts of Errored Seconds (ES), Severely Errored Seconds (SES) and Unavailable Seconds (UAS).

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Relationships

One instance of this managed entity can exist for each instance of the Physical Path Termination Point VDSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The first byte is the slot ID. The second byte is the port ID with a value range from 0x01 to 0xFF (1 to 255). (R, W, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. The attribute counters are updated at the end of the interval. (R) (mandatory) (1 byte)

Threshold Data$_{\text{B-PON}}$ ID: This attribute provides a pointer to an instance of the Threshold Data$_{\text{B-PON}}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set by-create) (mandatory) (2 bytes)

Loss of Framing Seconds: Count of seconds during this interval that there was Loss of Framing. (R) (mandatory) (2 bytes)

Loss of Signal Seconds: Count of seconds during this interval that there was Loss of Signal. (R) (mandatory) (2 bytes)

Loss of Power Seconds: Count of seconds during this interval that there was Loss of Power. (R) (mandatory) (2 bytes)

Loss of Link Seconds: Count of seconds during this interval that there was Loss of Link. (R) (mandatory) (2 bytes)

Errored Seconds: Count of Errored Seconds during this interval. An Errored Second is a one-second interval containing one or more CRC anomalies, or one or more LOS or LOF defects. (R) (mandatory) (2 bytes)

Severely Errored Seconds: Count of Severely Errored Seconds during this interval. (R) (mandatory) (2 bytes)

Unavailable Seconds: Count of Unavailable Seconds during this interval. (R) (mandatory) (2 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Get Current Data: Get the current value of one or more attributes.

Set: Set one or more attributes.

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Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a threshold crossing alert (TCA) is detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. Both ONU and OLT should know the event list used by this entity. The list of TCAs for this entity is given in Table 30.

Table 30/G.983.2 – Alarm list for VDSL VTU-R physical interface monitoring history data (reproduced from Table 13/G.983.10)

Number	Event	Description	Threshold data counter number (Note)
	Threshold Crossing Alert		
0	LOFS	Exceeds threshold	1
1	LOSS	Exceeds threshold	2
2	LOLS	Exceeds threshold	3
3	LOPS	Exceeds threshold	4
4	ES	Exceeds threshold	5
5	SES	Exceeds threshold	6
6	UAS	Exceeds threshold	7
7-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{\text{B-PON}}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.91 VDSL VTU-O channel performance monitoring history data

This managed entity contains the last completed 15-minute interval collected statistic data for both fast and slow VDSL channels, as seen from the VTU-O.

Instances of this managed entity are created/deleted by the OLT after an instance of the Physical Path Termination Point VDSL UNI managed entity is created/deleted.

Relationships

One instance of this managed entity can exist for each instance of the Physical Path Termination Point VDSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The first byte is the slot ID. The second byte is the port ID with a value range from 0x01 to 0xFF (1 to 255). (R, W, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last

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completed interval. The actual counters of this managed entity start counting directly. The attribute counters are updated at the end of the interval. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ ID: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set by-create) (mandatory) (2 bytes)

Fast Channel Corrected Blocks: This attribute is the count of all blocks received by the VTU-O with errors that were corrected on the fast channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Fast Channel Bad Blocks: This attribute is the count of all blocks received by the VTU-O with uncorrectable errors on the fast channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Fast Channel Transmitted Blocks: This attribute is the count of all blocks transmitted by the VTU-O on the fast channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Fast Channel Received Blocks: This attribute is the count of all blocks received by the VTU-O on the fast channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Slow Channel Corrected Blocks: This attribute is the count of all blocks received by the VTU-O with errors that were corrected on the slow channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Slow Channel Bad Blocks: This attribute is the count of all blocks received by the VTU-O with uncorrectable errors on the slow channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Slow Channel Transmitted Blocks: This attribute is the count of all blocks transmitted by the VTU-O on the slow channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Slow Channel Received Blocks: This attribute is the count of all blocks received by the VTU-O on the slow channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Get Current Data: Get the current value of one or more attributes.

Set: Set one or more attributes.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a threshold crossing alert (TCA) is detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. Both ONU and OLT should know the event list used by this entity. The list of TCAs for this entity is given in Table 31.

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Table 31/G.983.2 – Alarm list for VDSL VTU-O channel performance monitoring history data (reproduced from Table 14/G.983.10)

Number	Event	Description	Threshold data counter number (Note)
	Threshold Crossing Alert		
0	FCCB	Exceeds threshold	1
1	FCBB	Exceeds threshold	2
2	SCCB	Exceeds threshold	3
3	SCBB	Exceeds threshold	4
4-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.92 VDSL VTU-R channel performance monitoring history data

This managed entity contains the last completed 15-minute interval collected statistic data for both fast and slow VDSL channels, as seen from the VTU-R.

Instances of this managed entity are created/deleted by the OLT after an instance of the Physical Path Termination Point VDSL UNI managed entity is created/deleted.

Relationships

One instance of this managed entity can exist for each instance of the Physical Path Termination Point VDSL UNI.

Attributes

Managed Entity ID: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the physical position of the UNI. The first byte is the slot ID. The second byte is the port ID with a value range from 0x01 to 0xFF (1 to 255). (R, W, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. The attribute counters are updated at the end of the interval. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ ID: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set by-create) (mandatory) (2 bytes)

Fast Channel Corrected Blocks: This attribute is the count of all blocks received by the VTU-R with errors that were corrected on the fast channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

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Fast Channel Bad Blocks: This attribute is the count of all blocks received by the VTU-R with uncorrectable errors on the fast channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Fast Channel Transmitted Blocks: This attribute is the count of all blocks transmitted by the VTU-R on the fast channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Fast Channel Received Blocks: This attribute is the count of all blocks received by the VTU-R on the fast channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Slow Channel Corrected Blocks: This attribute is the count of all blocks received by the VTU-R with errors that were corrected on the slow channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Slow Channel Bad Blocks: This attribute is the count of all blocks received by the VTU-R with uncorrectable errors on the slow channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Slow Channel Transmitted Blocks: This attribute is the count of all blocks transmitted by the VTU-R on the slow channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Slow Channel Received Blocks: This attribute is the count of all blocks received by the VTU-R on the slow channel within the previous 15-minute interval. (R) (mandatory) (4 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Get Current Data: Get the current value of one or more attributes.

Set: Set one or more attributes.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a threshold crossing alert (TCA) is detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. Both ONU and OLT should know the event list used by this entity. The list of TCAs for this entity is given in Table 32.

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Table 32/G.983.2 – Alarm list for VDSL VTU-R channel performance monitoring history data (reproduced from Table 15/G.983.10)

Number	Event	Description	Threshold Data Counter Number (Note)
	Threshold Crossing Alert		
0	FCCB	Exceeds threshold	1
1	FCBB	Exceeds threshold	2
2	SCCB	Exceeds threshold	3
3	SCBB	Exceeds threshold	4
4-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{\text{B-PON}}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.3.93 Video return path service profile

Relationships

One instance of this managed entity may exist for each ONU. It is created automatically by the ONU on startup, if the ONU implements this service.

Please note that Annex A defines the transport methods required to support the video return path function. This includes providing a brief description of the relevant aspects of the two return path specifications supported (SCTE 55-1 [25] and 55-2 [26]). It also includes the formatting for carriage of the data over the B-PON data path.

Appendix VI presents three transparent ways to support the video return channel over a B-PON or other access system. The transparent aspect of the video return path is given only for information since it does not impact B-PON standardization.

Attributes

Managed Entity id: This attribute provides a unique number for the instance of this managed entity. This 2-byte number always has the value 0x00. (R) (mandatory) (2 bytes)

Administrative State: This attribute is used to activate (unlock: value 0x00) and deactivate (lock: value 0x01) the functions performed by instances of this managed entity. Selection of a default value for this attribute is outside the scope of this Recommendation as it is normally handled through supplier-operator negotiations. (R, W) (mandatory) (1 byte)

Operational State: This attribute indicates whether or not this managed entity is capable of performing its task. The operational state reflects the perceived ability to receive or to generate a valid signal. Valid values are enabled (0x00) and disabled (0x01). (R) (optional) (1 byte)

ARC: This attribute is used to control alarm reporting from this managed entity. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

ARCInterval: This attribute provides a provisionable length of time. See I.1.8 for a complete description. (R, W) (optional) (1 byte)

VRP Mode: This attribute specifies which format is being used for the VRP. These are defined by code-points:

0: Mode 1, SCTE 55-1 shall be used (256 kbit/s data rate, 62 byte PDUs, preceded by the unique word 0xCC CC CC 0). (mandatory)

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1: Mode 2, SCTE 55-2 shall be used (256 kbit/s data rate, 59 byte PDUs, preceded by the unique word 0xCC CC CC 0D). (optional)

2: Mode 2, SCTE 55-2 shall be used (1.544 Mbit/s data rate, 59 byte PDUs, preceded by the unique word 0xCC CC CC 0D). (mandatory)

3: Mode 2, SCTE 55-2 should be used (3.088 Mbit/s data rate, 59 byte PDUs, preceded by the unique word 0xCC CC CC 0D). (optional)

4-255: Reserved.

(R, W) (mandatory) (1 byte)

VRP Frequency lower bound: This attribute reports the ONU VRP tuning range lower bound, in units of Hertz. (R) (mandatory) (4 bytes)

VRP Frequency upper bound: This attribute reports the ONU VRP tuning range upper bound, in units of Hertz. (R) (mandatory) (4 bytes)

VRP Frequency used: This attribute reports the ONU VRP tuner frequency currently in use, in units of Hertz. (R, W) (mandatory) (4 bytes)

Mode 1 Physical Layer Configuration Mode: This attribute controls the physical layer configuration to be used in mode 1. The attribute is bit mapped, as follows:

Bit 15: DQPSK mode. 0 = "Default Mode", 1 = "Alternate Mode"

Bit 14-8: Reserved

Bit 7: Randomizer Stage 6 preload

Bit 6: Randomizer Stage 7 preload

Bit 5: Randomizer Stage 8 preload

Bit 4: Randomizer Stage 9 preload

Bit 3: Randomizer Stage 10 preload

Bit 2: Randomizer Stage 11 preload

Bit 1: Randomizer Stage 12 preload

Bit 0: Randomizer Stage 13 preload

(R, W) (mandatory) (2 bytes)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

Attribute value change: This notification is used to report autonomous changes of attributes of this managed entity. The notification shall identify its new value. The AVC list is given in Table 33.

Alarm: This notification is used to notify the management system when a failure has been detected or cleared. Both ONT and OLT should know the alarm list used by this entity. The alarm list for this entity is given in Table 34.

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Table 33/G.983.2 – AVC list for video return path service

Number	Attribute value change	Description
1	N/A	
2	OpState	Operational state of VRP Service
3-16	Reserved	

Table 34/G.983.2 – Alarm list for video return path service

Number	Event	Description
0	Frequency Mismatch	Frequency set by OLT is outside the capabilities of this ONU, or a frequency that is not on the standardized frequency plan
1-223	Reserved	
224-239	Vendor-specific alarms	Not to be standardized

7.3.94 Video return path statistics

Relationships

One instance of this managed entity may exist for each ONU. It is created by the OLT.

Attributes

Managed Entity id: This attribute provides a unique number for the instance of this managed entity. This 2-byte number always has the value 0x00. (R, Set-by-create) (mandatory) (2 bytes)

Interval End time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the attribute counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. The attribute counters are updated at the end of the interval. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ ID: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Rx Total bursts: This attribute reports the total number of bursts detected. (R) (optional) (4 bytes)

Rx Good bursts: This attribute reports the number of bursts that were detected and received correctly. (R) (optional) (4 bytes)

Rx FEC corrected bursts: This attribute reports the number of bursts that were detected with errors, but which were successfully corrected using FEC. (R) (optional) (4 bytes)

Rx Missed bursts: This attribute reports the number of bursts that were detected, but that were not received correctly (e.g., errors that are FEC uncorrectable). (R) (optional) (4 bytes)

Rx Min Power: This attribute reports the lowest power level of all bursts received in the current interval, in units of dBmV. (R) (optional) (1 byte)

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Rx Max Power: This attribute reports the highest power level of all bursts received in the current interval, in units of dBmV. (R) (optional) (1 byte)

Rx Current Power: This attribute reports the power level of the latest burst received, in units of dBmV. (R) (mandatory) (optional) (1 byte)

Rx FEC corrected Symbols: This attribute reports the number of symbols that were corrected through the use of FEC. It provides an indicator of the bit error rate of the link. (R) (optional) (4 bytes)

Actions

Set: Set one Threshold ID.

Get: Get one or more attributes.

Get current data: This action returns the current value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval. Support of this action is optional.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a Threshold Crossing Alert (TCA) has been detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold by the actual counter; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the actual counters are reset to 0x00. The event list for this entity is given in Table 35.

Table 35/G.983.2 – Alarm list for video return path statistics

Number	Event	Description	Threshold data counter number (Note)
	Threshold Crossing Alert		
0	Rx Total bursts	Rx Total bursts threshold crossing	1
1	Rx Good bursts	Rx Good bursts threshold crossing	2
2	Rx FEC corrected bursts	Rx FEC corrected bursts threshold crossing	3
3	Rx Missed bursts	Rx Missed bursts threshold crossing	4
4	Rx Min Power	Rx Min Power threshold crossing	5
5	Rx Max Power	Rx Max Power threshold crossing	6
6	Rx Current Power	Rx Current Power threshold crossing	7
7	Rx FEC corrected Symbols	Rx FEC corrected Symbols threshold crossing	8
8-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data$_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

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7.3.95 802.1p mapper service profile

This managed entity is used to associate the priorities of 802.1P priority tagged frames with a specific connection. Instances of this managed entity are created and deleted at the request of the OLT.

Relationships

One instance of this ME may be associated with zero or one instance of the PPTP UNI ME or the MAC bridge port configuration data ME.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. (R, Set-by-create) (mandatory) (2 bytes)

PPTP UNI Pointer: An instance identifier of the PPTP UNI that is associated with this 802.1p Priority Queue Mapper, in the case of direct 802.1p mapping. In the case of combined Bridging-mapping, this pointer is not used, and its value is set to 0xFFFF. (R, Set-by-create) (mandatory) (2 bytes)

Interwork TP Pointer (for P-Bit priority 0): This attribute represents a pointer to the Interworking Termination Point that is associated with P-Bit = 000 tagged frames. The value 0xFFFF is a null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Interwork TP Pointer (for P-Bit priority 1): This attribute represents a pointer to the Interworking Termination Point that is associated with P-Bit = 001 tagged frames. The value 0xFFFF is a null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Interwork TP Pointer (for P-Bit priority 2): This attribute represents a pointer to the Interworking Termination Point that is associated with P-Bit = 010 tagged frames. The value 0xFFFF is a null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Interwork TP Pointer (for P-Bit priority 3): This attribute represents a pointer to the Interworking Termination Point that is associated with P-Bit = 011 tagged frames. The value 0xFFFF is a null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Interwork TP Pointer (for P-Bit priority 4): This attribute represents a pointer to the Interworking Termination Point that is associated with P-Bit = 100 tagged frames. The value 0xFFFF is a null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Interwork TP Pointer (for P-Bit priority 5): This attribute represents a pointer to the Interworking Termination Point that is associated with P-Bit = 101 tagged frames. The value 0xFFFF is a null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Interwork TP Pointer (for P-Bit priority 6): This attribute represents a pointer to the Interworking Termination Point that is associated with P-Bit = 110 tagged frames. The value 0xFFFF is a null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Interwork TP Pointer (for P-Bit priority 7): This attribute represents a pointer to the Interworking Termination Point that is associated with P-Bit = 111 tagged frames. The value 0xFFFF is a null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Unmarked Frame Option: This attribute indicates how the ONT should handle Untagged Ethernet frames received across the associated Ethernet interface. Valid values include the following:

0: Convert from DSCP to 802.1p;

1: Tag frame to a certain value.

(R, W, Set-by-create) (mandatory) (1 byte)

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DSCP to P-Bit Mapping: This attribute is used in conjunction with the Unmarked Frame Option attribute. If unmarked frame option is 0, this attribute structure can be considered a bitmap that represents a sequence of 64 "3-bit" groupings. Each of the 64 groupings represents the possible value of the 6-bit DSCP field. Each of the "3-bit" groupings represents the "P-bit value" to which the associated DSCP value should be mapped. Once marked, the P-Bit marked frame will then be routed to the GEM Interwork Pointer as indicated by the P-Bit to Interwork Pointer mappings above.

(R, W, Set-by-create) (mandatory) (24 bytes)

Default P-Bit Marking: This attribute is used in conjunction with the Unmarked Frame Option attribute. If unmarked frame option is 1, this attribute contains the default P-Bit priority setting that will be applied to the frame. The P-Bit marked frame will then be routed to the GEM Interwork Pointer as indicated by the P-Bit to Interwork Pointer mappings above.

(R, W, Set-by-create) (mandatory) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

None.

7.3.96 $OLT_{B\text{-}PON}$

This optional managed entity identifies the OLT to which an ONT is connected.

The setting of this ME prompts the ONT to configure itself for operability with the OLT that has identified itself. If the OLT is operable with the ONT's default configuration then the setting of this ME is not required.

An instance of this managed entity is automatically created by the ONT after initialization and setup to the ONT's current configuration. Immediately following the startup phase, the OLT sets the ONT to the desired configuration.

Relationships

One instance of this managed entity is contained in the instance of the ONT managed entity.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. There is only one instance and it has the number 0x0000. (R) (mandatory) (2 bytes)

OLT Vendor id: This attribute identifies the OLT vendor that the ONT is interfacing with, and is the same format as the 4 most significant bytes of an ONT serial number as specified in ITU-T Rec. G.983.1. Upon autonomous instantiation, this attribute consists of all spaces. (R,W) (mandatory) (4 bytes)

Equipment ID: This attribute may be used to identify the specific type of OLT. In North America, this may be used for the equipment CLEI code. The default value of all spaces shall be used when Equipment ID information is not available or applicable to the OLT being represented. Upon autonomous instantiation, this attribute consists of all spaces. (R,W) (mandatory) (20 bytes)

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Version: This attribute identifies the version of the OLT as defined by the vendor. The default value of a printable value of "0" shall be used when version information is not available or applicable to the OLT being represented. Upon autonomous instantiation, this attribute consists of all spaces. (R,W) (mandatory) (14 bytes)

Actions

Set: Set one or more attributes.

Get: Get one or more attributes.

Notifications

None.

7.3.97 Multicast interworking VCC termination point

An instance of this managed entity represents a point in the ONT where the interworking of a service (e.g., IP) or underlying physical infrastructure (e.g., Ethernet) takes place. At this point, a bit stream is reconstructed from ATM cells.

Instances of this managed entity are created and deleted by the ONT on request of the OLT.

Establishment of connection

The multicast VCC TP is a special case of the ordinary VCC TP managed entity, whose purpose is specifically to manage the correspondence of IP multicast group addresses with the PON layer addresses. This is done via a new table attribute. The relationships that the ordinary VCC TP entity has would be maintained; however, the VP/VC network CTP would not reflect a normal connection per se, as the multicast VCC TP can represent many connections at once. So, the VP/VC network CTP object used in this case would not represent a circuit termination point, and would only be used to provide information on the traffic descriptors, priority queues, or performance management features.

The related VP/VC network CTP, Service Profile, and AAL profile entities must be created first. The multicast interworking VCC TP is then created with references to these entities.

Modes of operation

The default multicast operation of the PON is where all the multicast content streams are placed in one PON layer connection. This connection is then specified in the first entry of the MulticastAddressTable as set by the OLT. The single entry also specifies an all-inclusive IP multicast address range (e.g., 224.0.0.0 to 239.255.255.255). The ONT then filters the traffic based on either Ethernet MAC addresses or IP addresses. The VP/VC Network CTP ME has the VPI/VCI that supports all the multicast connections.

The optional multicast operation of the PON is where groups of one or more multicast content streams are carried over individual PON layer connections. In this case, the OLT sets as many table entries as desired for the multicasting control system. The ONT then filters the groups based on PON layer address. The ONT can also filter based on higher-layer addresses in a subsequent step. In this case, only one instance of VP/VC Network CTP ME is created by the request from OLT. Though this VP/VC Network CTP ME has only one VPI/VCI, ONT should regard this ME as the representative of those multicast VP/VC connections. Therefore, the traffic descriptors, priority queues, and performance management features for all the multicast connections are integrated into the VP/VC Network CTP ME.

Discovery of Multicast support

The OLT uses the multicast IW VCC TP entity as the means to discover the ONT's multicasting capability. This entity is mandatory if multicasting is supported by the ONT. Therefore, if the OLT

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attempts to create this entity on an ONT that does not support multicasting, the create command will fail. Furthermore, if the ONT does not support multiple multicasting groups, then the OLT's attempt to set multiple table entries will fail. The OLT will then have to make the necessary adjustments.

Relationships

One instance of this managed entity shall exist for each occurrence of transformation of ATM cells into a data stream where multicast interworking is desired. Note that the attributes "AAL Profile pointer" and "Service Profile pointer" imply relationships to these managed entities.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The value 0xFFFF is reserved. (R, Set-by-create) (mandatory) (2 bytes)

VCI Value: This attribute is not used. (R, Set-by-create) (mandatory) (2 bytes)

VP/VCNetworkCTP Connectivity Pointer: This attribute provides an instance identifier of the VP Network $CTP_{B\text{-}PON}$ or VC Network $CTP_{B\text{-}PON}$ that is associated with this Interworking VCC Termination Point. (R, Set-by-create) (mandatory) (2 bytes)

Interworking Option: This attribute identifies the type of non-ATM function that is being interworked; the option can be MAC Bridge LAN (0x01), IP Router (0x03), or 802.1p mapper (0x05). (R, Set-by-create) (mandatory) (1 byte)

Service Profile Pointer: This attribute provides the service profile type and a pointer to the instance of a service profile, such as the MAC Bridge Service Profile (if the interworking option = 0x01), IP Router Service Profile (if the interworking option = 0x03), or 802.1p mapper service profile (if interworking option = 0x05). (R, Set-by-create) (mandatory) (2 bytes)

AAL Profile Pointer: This attribute provides the AAL profile type and a pointer to an instance of AAL Profile such as AAL 5 $Profile_{B\text{-}PON}$ if the interworking option = 0x01, 0x03, 0x05. (R, Set-by-create) (mandatory) (2 bytes)

Interworking Termination Point pointer: This attribute is set to 0x0000, and not used. (R, Set-by-create) (mandatory) (2 bytes)

AAL Loopback configuration: This attribute is set to 0x0000 and not used. (R, W) (mandatory) (1 byte)

PPTP Counter: This attribute represents the number of instances of PPTP managed entities associated with this instance of the Interworking VCC Termination Point managed entity. If only one instance of a PPTP managed entity is associated with this instance of the Interworking VCC Termination Point managed entity, this attribute is set to 0x01. If multiple instances of PPTP managed entities are associated with this instance of the Interworking VCC Termination Point managed entity, this attribute is set to 0xZZ, where ZZ represents the number of associated PPTP instances. (R) (optional) (1 byte)

Operational State: This attribute indicates whether or not this managed entity is capable of performing its task. The operational state reflects the perceived ability to receive or to generate a valid signal. Valid values are enabled (0x00) and disabled (0x01). (R) (optional) (1 byte)

MulticastAddressTable: This attribute contains the mapping of IP multicast addresses to PON layer addresses. One entry provides the VPI/Port-ID value (2 bytes, right justified), VCI/spare value (2 bytes), IP multicast address start (4 bytes), and IP multicast address stop (4 bytes). An OMCI set message can carry a maximum of 2 entries at the same time. The first four bytes of each entry is treated as the index of the list, and a Set to a particular (VPI/Port-ID – VCI/spare) value will overwrite any existing entry with the same first four bytes. If the last eight bytes of a Set command are all zero, then that entry will be deleted from the list, as all-zero IP addresses

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are not valid multicast addresses. (R, W) (mandatory for one entry, optional for multiple entries) (N * 12 bytes, N is the number of entries in the list.)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes. Latch a snapshot (i.e., copy) of the current MulticastAddressTable and respond with the size of data (4 bytes) that should be obtained using the Get next command.

Get Next: Get the latched attribute values of the managed entity within the current snapshot.

Set: Set one or more attributes.

Notifications

Attribute value change: This notification is used to report autonomous changes of attributes of this managed entity. The notification shall identify the attribute and its new value. The list of AVCs for this managed entity is given in Table 36a.

Alarm: None.

Table 36a/G.983.2 – AVC list for interworking VCC termination point

Number	Attribute value change	Description
1-9	N/A	
10	OpState	Operational state of Interworking VCC Termination Point
11-16	Reserved	

Table 36b/G.983.2 – Alarm list for interworking VCC termination point

Number	Alarm	Description
0	End-to-end VC-AIS-LMIR	End-to-end VC-AIS receiving indication (optional)
1	End-to-end VC-RDI-LMIR	End-to-end VC-RDI receiving indication (optional)
2	End-to-end VC-AIS-LMIG	End-to-end VC-AIS generation indication (optional)
3	End-to-end VC-RDI-LMIG	End-to-end VC-RDI generation indication (optional)
4	Segment Loss of Continuity	Loss of continuity is detected when the Interworking VCC Termination Point is a segment end point (optional)
5	End-to-End Loss of Continuity	Loss of continuity is detected at the Interworking VCC Termination Point (optional)
6	CSA	Cell starvation alarm
7-223	Reserved	
224-239	Vendor-specific alarms	Not to be standardized

7.4 VP and VC MUX management

7.4.1 VP Network $CTP_{B\text{-}PON}$

This managed entity is used to represent the termination of VP links on an ONT. An instance of the ATM VP Cross-Connection (i.e., VP MUX in ONT) managed entity may be used to relate two

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instances of the VP Network $CTP_{B\text{-}PON}$ managed entity for point-to-point cross-connection (multipoint cross-connection is for further study).

Instances of the VP Network $CTP_{B\text{-}PON}$ managed entity will be created on demand of the OLT:

- as a consequence of action "create" on the VP Network $CTP_{B\text{-}PON}$ managed entity, or
- as a consequence of action "create complete connection" on the ATM VP Cross-Connection managed entity.

Instances of the VP Network $CTP_{B\text{-}PON}$ managed entity will be deleted on demand of the OLT:

- as a consequence of action "delete" on the VP Network $CTP_{B\text{-}PON}$ managed entity, or
- as a consequence of action "delete complete connection" on the ATM VP Cross-Connection managed entity.

Notice that a VP Network $CTP_{B\text{-}PON}$ can be deleted only when no ATM VP Cross-Connection or Interworking VCC Termination Point is associated with it. It is the responsibility of the OLT to make sure that the VP Network $CTP_{B\text{-}PON}$ meets this condition at the time when the OLT requests to delete it.

Note that this managed entity aggregates connectivity functionality from the network view and alarms from the network element view as well as artefacts from trails.

Relationships

Zero or more instances of the VP Network $CTP_{B\text{-}PON}$ managed entity shall exist for each instance of the TC $Adapter_{B\text{-}PON}$, PON TC Adapter or Interworking VCC Termination Point managed entity.

Relationship to Priority $Queue_{B\text{-}PON}$/Traffic Descriptor Profile Pointer: see attribute definition.

Relationship to UPC Disagreement Monitoring History $Data_{B\text{-}PON}$: one or zero implied in the managed entity id of UPC Disagreement Monitoring History $Data_{B\text{-}PON}$.

This managed entity is related to the ATM VP Cross-Connection managed entity through the Termination Point ANI/UNI side attributes of the ATM VP Cross-Connection managed entity.

Attributes

Managed Entity id: This attribute provides a number for each instance of this managed entity that is unique over all Network $CTP_{B\text{-}PON}$ MEs, of both VP and VC type. (R, Set-by-create) (mandatory) (2 bytes)

VPI Value: This attribute identifies the VPI value associated with the VP link being terminated. This value must be unique over any ANI or UNI. (R, Set-by-create) (mandatory) (2 bytes)

UNI/ANI Pointer: This attribute associates the VP Network $CTP_{B\text{-}PON}$ with the ANI (i.e., PON interface) or a UNI. It points to the connected ANI/UNI instance id.

NOTE – For the case using the multiplexing function of AAL 2 (i.e., multiple instances of UNI are associated with a VP Network $CTP_{B\text{-}PON}$ instance), this attribute is assigned a special value:

0x00XX will be used for pseudo slotIDs;

0xXX00 will be used for pseudo portIDs.

Therefore, 0x0000 will be used only for integrated interfaces (integrated type of ONT) that support multiple AAL 2 functions. (R, Set-by-create) (mandatory) (2 bytes)

Direction: This attribute specifies whether the VP link is used for UNI-to-ANI (value 0x01), ANI-to-UNI (value 0x02), or bidirectional (value 0x03) connection. (R, W, Set-by-create) (mandatory) (1 byte)

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Priority Queue Pointer for downstream: This attribute points to the instance of the Priority $Queue_{B\text{-}PON}$ used for this VP Network $CTP_{B\text{-}PON}$ in the downstream direction. Note that the value of this pointer is null when the VP Network $CTP_{B\text{-}PON}$ is at the ANI side. (R, Set-by-create) (mandatory) (2 bytes)

Traffic Management Pointer for upstream: This attribute points to the instance of the Priority $Queue_{B\text{-}PON}$ or T-CONT used for this VP Network $CTP_{B\text{-}PON}$ in the upstream direction. It is used when the UNI/ANI pointer indicates an ANI instance id. If the **Traffic Management Option** attribute in $ONT_{B\text{-}PON}$ is 0x00, then this pointer indicates the Priority Queue serving this VP CTP. If the **Traffic Management Option** attribute in $ONT_{B\text{-}PON}$ is 0x01, then this pointer indicates the T-CONT serving this VP CTP. (R, Set-by-create) (mandatory) (2 bytes)

Traffic Descriptor Profile Pointer: This attribute serves as a pointer to the instance of the Traffic Descriptor Profile managed entity that contains the traffic parameters used for this VP Network $CTP_{B\text{-}PON}$. This attribute is used when the **Traffic Management Option** attribute in $ONT_{B\text{-}PON}$ is 0x01. It applies to the UNI side VP Network $CTP_{B\text{-}PON}$ if UPC is used. In this case, this pointer points to a Traffic Descriptor managed entity.

When traffic shaping is used, it applies to the ANI side VP Network $CTP_{B\text{-}PON}$. In this case, this pointer points to a Traffic Descriptor Profile managed entity and the **Priority Queue Pointer for the upstream** attribute is null. (R, Set-by-create) (optional) (2 bytes)

See also Appendix IV.

UNI Counter: This attribute represents the number of instances of $UNI_{B\text{-}PON}$ managed entities associated with an instance of the VP Network $CTP_{B\text{-}PON}$ managed entity. If only one instance of a $UNI_{B\text{-}PON}$ managed entity is associated with an instance of the VP Network $CTP_{B\text{-}PON}$ managed entity, this attribute is set to 0x01. If multiple instances of $UNI_{B\text{-}PON}$ managed entities are associated with an instance of the VP Network $CTP_{B\text{-}PON}$ managed entity (i.e., in case of AAL 2 multiplexing), this attribute is set to 0xZZ, where ZZ represents the number of associated $UNI_{B\text{-}PON}$ instances. (R) (optional) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes of this managed entity.

Set: Set one or more attributes of this managed entity.

Notifications

Alarm: This notification is used to notify the management system for the ATM Layer Management Indication (LMI) when an alarm has been detected or cleared. The OLT should know the alarm list used by this entity. The alarm list for this entity is given in Table 37. See also Appendix III.

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Table 37/G.983.2 – Alarm list for VP network $CTP_{B\text{-}PON}$

Number	Alarm	Description
0	VP-AIS-LMIR	VP-AIS receiving indication (optional)
1	VP-RDI-LMIR	VP-RDI receiving indication (optional)
2	VP-AIS-LMIG	VP-AIS generation indication (optional)
3	VP-RDI-LMIG	VP-RDI generation indication (optional)
4	Segment Loss of Continuity	Loss of continuity is detected when the VP Network $CTP_{B\text{-}PON}$ is a segment end point (optional)
5	End-to-End Loss of Continuity	Loss of continuity is detected when the VP Network $CTP_{B\text{-}PON}$ supports an Interworking VCC Termination Point (optional)
6-223	Reserved	
224-239	Vendor-specific alarms	Not to be standardized

7.4.2 ATM VP cross-connection

For point-to-point ATM VP Cross-Connections, this managed entity is used to represent the Cross-Connect relationship between two VP Network $CTPs_{B\text{-}PON}$. For multipoint ATM VP Cross-Connections, which are optional, the use of this managed entity is for further study.

Instances of this managed entity shall be created and deleted by the OLT based on ATM connection set up.

Relationships

Zero or more instances of the ATM VP Cross-Connection managed entity shall exist for each instance of the $ONT_{B\text{-}PON}$ managed entity.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the instance identifier of the VP Network $CTP_{B\text{-}PON}$ at the ANI side of this ATM VP cross-connect. (R, Set-by-create) (mandatory) (2 bytes)

Termination Point ANI side: This attribute identifies the instance of the VP Network $CTP_{B\text{-}PON}$ managed entity that represents the cross-connected VP Network $CTP_{B\text{-}PON}$s on the ANI side. (R, Set-by-create) (mandatory) (2 bytes)

Termination Point UNI side: This attribute identifies the instance of the VP Network $CTP_{B\text{-}PON}$ managed entity that represents the cross-connected VP Network $CTP_{B\text{-}PON}$s on the UNI side. (R, Set-by-create) (mandatory) (2 bytes)

Operational State: This attribute indicates whether or not this managed entity is capable of performing its task. The operational state reflects the perceived ability to receive or to generate a valid signal. Valid values are enabled (0x00) and disabled (0x01). (R) (optional) (1 byte)

Administrative State: This attribute is used to "unlock" (value 0x00) and "lock" (value 0x01) the functions performed by instances of this managed entity. (R, W, Set-by-create) (mandatory) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

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Create complete connection: Create two instances of the VP Network $CTP_{B\text{-}PON}$ managed entity (ANI-side and UNI-side) and one instance of the ATM VP Cross-Connection managed entity.

Delete complete connection: Delete two instances of the VP Network $CTP_{B\text{-}PON}$ managed entity (ANI-side and UNI-side) and one instance of the ATM VP Cross-Connection managed entity.

Get: Get attributes of this managed entity.

Get complete connection: Get all attributes of a connection; this holds the attributes of two instances of the VP Network $CTP_{B\text{-}PON}$ managed entity (ANI-side and UNI-side) and the attributes of the corresponding ATM VP Cross-Connection managed entity.

Set: Set one or more attributes.

Notifications

Attribute value change: This notification is used to report autonomous changes of attributes of this managed entity. The notification shall identify its new value. The list of AVCs for this managed entity is given in Table 38.

Table 38/G.983.2 – AVC list for ATM VP cross-connection

Number	AVC	Description
1	N/A	
2	N/A	
3	OpState	Operational state
4	N/A	
5-16	Reserved	

7.4.3 VP PM history data

This managed entity is used to collect and report performance monitoring data associated with a VPC for the last completed 15-minute interval. The instances of this managed entity are created and deleted on request of the OLT. Note that these processes supersede the in-band PM OAM functions.

Relationships

Zero or more instances of this managed entity may exist for each instance of the VP Network $CTP_{B\text{-}PON}$ managed entity. If the instance is associated with the ANI-side VP CTP, then the performance of the downstream ATM flows is reported. If the instance is associated with the UNI-side VP CTP, then the performance of the upstream ATM flows is reported.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the Managed Entity id of the corresponding VP Network $CTP_{B\text{-}PON}$. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the actual counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. (R) (mandatory) (1 byte)

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Threshold Data$_{B\text{-}PON}$ id: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Lost C=0+1 Cells: This attribute measures background cell loss. It cannot distinguish between cells lost because of header bit errors, ATM-level header errors, cell policing, or buffer overflows. It records only loss of information independent of the priority of the cell. If the actual counter saturates, it remains on its maximum value. (R) (mandatory) (2 bytes)

Lost C = 0 Cells: This attribute measures background cell loss. It cannot distinguish between cells lost because of header bit errors, ATM-level header errors, cell policing, or buffer overflows. It records only loss of high priority cells. If the actual counter saturates, it remains on its maximum value. (R) (mandatory) (2 bytes)

Misinserted Cells: This attribute is used to measure occurrences of when a cell is misrouted to an active VP that is being monitored. If the actual counter saturates, it remains on its maximum value. (R) (mandatory) (2 bytes)

Transmitted C = 0 + 1 Cells: This attribute provides a count of all cells that are originated at a monitored connection by the transmitting end point (i.e., backward reporting is assumed). (R) (mandatory) (5 bytes)

Transmitted C = 0 Cells: This attribute provides a count of all high priority cells that are originated at a monitored connection by the transmitting end point (i.e., backward reporting is assumed). (R) (mandatory) (5 bytes)

Impaired Block: This severely errored cell block counter will be incremented whenever one of the following events takes place: the number of misinserted cells exceeds $M_{misinserted}$, the number of bipolar violations exceeds $M_{errored}$, or the number of lost cells exceeds M_{lost}. The values for $M_{misinserted}$, $M_{errored}$, and M_{lost} are set based on vendor-operator negotiation. (R) (mandatory) (2 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Get current data: This action returns the *current* value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes. Support of this action is optional.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a threshold crossing alert (TCA) is detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the counters are reset to 0x00. Both ONT and OLT should know the event list used by this entity, given in Table 39.

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Table 39/G.983.2 – Alarm list for VP PM history data

Number	Event	Description	Threshold data counter # (Note)
	Threshold Crossing Alert		
0	Lost CLP=0+ 1 Cells	Exceeds threshold	1
1	Lost CLP=0 Cells	Exceeds threshold	2
2	Misinserted Cells	Exceeds threshold	3
3	Impaired Blocks	Exceeds threshold	4
4-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.4.4 VC network $CTP_{B\text{-}PON}$

This managed entity is used to represent the termination of VC links on an ONT. An instance of the ATM VC Cross-Connection (i.e., VC MUX in ONT) managed entity may be used to relate two instances of the VC Network $CTP_{B\text{-}PON}$ managed entity for point-to-point cross-connection (multipoint cross-connection is for further study).

Instances of the VC Network $CTP_{B\text{-}PON}$ managed entity will be created on demand of the OLT:

- as a consequence of action "create" on the VC Network $CTP_{B\text{-}PON}$ managed entity, or
- as a consequence of action "create complete connection" on the ATM VC Cross-Connection managed entity.

Instances of the VC Network $CTP_{B\text{-}PON}$ managed entity will be deleted on demand of the OLT:

- as a consequence of action "delete" on the VC Network $CTP_{B\text{-}PON}$ managed entity, or
- as a consequence of action "delete complete connection" on the ATM VC Cross-Connection managed entity.

Notice that a VC Network $CTP_{B\text{-}PON}$ can be deleted only when no ATM VC Cross-Connection or Interworking VCC Termination Point is associated with it. It is the responsibility of the OLT to make sure that the VC Network $CTP_{B\text{-}PON}$ meets this condition at the time when the OLT requests to delete it.

Note that this managed entity aggregates connectivity functionality from the network view and alarms from the network element view as well as artefacts from trails.

Relationships

Zero or more instances of the VC Network $CTP_{B\text{-}PON}$ managed entity shall exist for each instance of the TC $Adapter_{B\text{-}PON}$, PON TC Adapter or Interworking VCC Termination Point managed entity.

Relationship to Priority $Queue_{B\text{-}PON}$ /Traffic Descriptor Profile Pointer: see attribute definition.

Relationship to UPC Disagreement Monitoring History $Data_{B\text{-}PON}$: one or zero implied in the managed entity id of UPC Disagreement Monitoring History $Data_{B\text{-}PON}$.

This managed entity is related to the ATM VC Cross-Connection managed entity through the Termination Point ANI/UNI side attributes of the ATM VC Cross-Connection managed entity.

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Attributes

Managed Entity id: This attribute provides a number for each instance of this managed entity that is unique over all Network $CTP_{B\text{-}PON}$ MEs, of both VP and VC type. (R, Set-by-create) (mandatory) (2 bytes)

VPI Value: This attribute identifies the VPI value associated with the VC link being terminated. (R, Set-by-create) (mandatory) (2 bytes)

VCI Value: This attribute identifies the VCI value associated with the VC link being terminated. The combination of VPI and VCI values must be unique over any ANI or UNI. (R, Set-by-create) (mandatory) (2 bytes)

UNI/ANI Pointer: This attribute associates the VC Network $CTP_{B\text{-}PON}$ with the ANI (i.e., PON interface) or a UNI. It points to the connected ANI/UNI instance id.

NOTE – For the case using the multiplexing function of AAL 2 (i.e., multiple instances of UNI are associated with a VC Network $CTP_{B\text{-}PON}$ instance), this attribute is assigned a special value:

- 0x00XX will be used for pseudo slotIDs;
- 0xXX00 will be used for pseudo portIDs.

Therefore, 0x0000 will be used only for integrated interfaces (integrated type of ONT) that support multiple AAL 2 functions. (R, Set-by-create) (mandatory) (2 bytes)

Direction: This attribute specifies whether the VC link is used for UNI-to-ANI (value 0x01), ANI to-UNI (value 0x02), or bidirectional (value 0x03) connection. (R, W, Set-by-create) (mandatory) (1 byte)

Priority Queue Pointer for downstream: This attribute points to the instance of the Priority $Queue_{B\text{-}PON}$ used for this VC Network $CTP_{B\text{-}PON}$ in the downstream direction. Note that the value of this pointer is null when the VC Network $CTP_{B\text{-}PON}$ is at the ANI side. (R, Set-by-create) (mandatory) (2 bytes)

Traffic management Pointer for upstream: This attribute points to the instance of the Priority $Queue_{B\text{-}PON}$ or T-CONT used for this VC Network $CTP_{B\text{-}PON}$ in the upstream direction. It is used when the UNI/ANI pointer indicates an ANI instance id. If the **Traffic Management Option** attribute in $ONT_{B\text{-}PON}$ is 0x00, then this pointer indicates the Priority Queue serving this VC CTP. If the **Traffic Management Option** attribute in $ONT_{B\text{-}PON}$ is 0x01, then this pointer indicates the T-CONT serving this VC CTP. (R, Set-by-create) (mandatory) (2 bytes)

Traffic Descriptor Profile Pointer: This attribute serves as a pointer to the instance of the Traffic Descriptor Profile managed entity that contains the traffic parameters used for this VC Network $CTP_{B\text{-}PON}$. This attribute is used when the **Traffic Management Option** attribute in $ONT_{B\text{-}PON}$ is 0x01. It applies to the UNI side VC Network $CTP_{B\text{-}PON}$ if UPC is used. In this case, this pointer points to a Traffic Descriptor managed entity.

When traffic shaping is used, it applies to the ANI side VC Network $CTP_{B\text{-}PON}$. In this case, this pointer points to a Traffic Descriptor Profile managed entity and the **Priority Queue Pointer for the upstream** attribute is null. (R, Set-by-create) (optional) (2 bytes)

See also Appendix IV.

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes of this managed entity.

Set: Set one or more attributes of this managed entity.

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Notifications

Alarm: This notification is used to notify the management system for the ATM Layer Management Indication (LMI) when an alarm has been detected or cleared. The OLT should know the alarm list used by this entity. The alarm list for this entity is given in Table 40. See also Appendix III. Note that in the case where an Interworking VCC Termination Point ME is directly associated with this CTP, these alarms are suppressed on the CTP.

Table 40/G.983.2 – Alarm list for VC network $CTP_{B\text{-}PON}$

Number	Alarm	Description
0	VC-AIS-LMIR	VC-AIS receiving indication (optional)
1	VC-RDI-LMIR	VC-RDI receiving indication (optional)
2	VC-AIS-LMIG	VC-AIS generation indication (optional)
3	VC-RDI-LMIG	VC-RDI generation indication (optional)
4	Segment Loss of Continuity	Loss of continuity is detected when the VC Network $CTP_{B\text{-}PON}$ is a segment end point (optional)
5	End-to-End Loss of Continuity	Loss of continuity is detected when the VC Network $CTP_{B\text{-}PON}$ supports an Interworking VCC Termination Point (optional)
6-223	Reserved	
224-239	Vendor-specific alarms	Not to be standardized

7.4.5 ATM VC cross-connection

For point-to-point ATM VC Cross-Connections, this managed entity is used to represent the cross-connect relationship between two VC Network $CTP_{B\text{-}PON}$s. For multipoint ATM VC Cross-Connections, which are optional, the use of this managed entity is for further study.

Instances of this managed entity shall be created and deleted by the OLT based on ATM connection set up.

Relationships

Zero or more instances of the ATM VC Cross-Connection managed entity shall exist for each instance of the $ONT_{B\text{-}PON}$ managed entity.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is directly associated with the instance identifier of the VC Network $CTP_{B\text{-}PON}$ at the ANI side of this ATM VC cross-connect. (R, Set-by-create) (mandatory) (2 bytes)

Termination Point ANI side: This attribute identifies the instance of the VC Network $CTP_{B\text{-}PON}$ managed entity that represents the cross-connected VC Network $CTP_{B\text{-}PON}$s on the ANI side. (R, Set-by-create) (mandatory) (2 bytes)

Termination Point UNI side: This attribute identifies the instance of the VC Network $CTP_{B\text{-}PON}$ managed entity that represents the cross-connected VC Network $CTP_{B\text{-}PON}$s on the UNI side. (R, Set-by-create) (mandatory) (2 bytes)

Operational State: This attribute indicates whether or not this managed entity is capable of performing its task. The operational state reflects the perceived ability to receive or to generate a valid signal. Valid values are enabled (0x00) and disabled (0x01). (R) (optional) (1 byte)

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Administrative State: This attribute is used to "unlock" (value 0x00) and "lock" (value 0x01) the functions performed by instances of this managed entity. (R, W, Set-by-create) (mandatory) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Create complete connection: Create two instances of the VC Network $CTP_{B\text{-}PON}$ managed entity (ANI-side and UNI-side) and one instance of the ATM VC Cross-Connection managed entity.

Delete complete connection: Delete two instances of the VC Network $CTP_{B\text{-}PON}$ managed entity (ANI-side and UNI-side) and one instance of the ATM VC Cross-Connection managed entity.

Get: Get attributes of this managed entity.

Get complete connection: Get all attributes of a connection; this holds the attributes of two instances of the VC Network $CTP_{B\text{-}PON}$ managed entity (ANI-side and UNI-side) and the attributes of the corresponding ATM VC Cross-Connection managed entity.

Set: Set one or more attributes.

Notifications

Attribute value change: This notification is used to report autonomous changes of attributes of this managed entity. The notification shall identify its new value. The list of AVCs for this managed entity is given in Table 41.

Table 41/G.983.2 – AVC list for ATM VC cross-connection

Number	AVC	Description
1	N/A	
2	N/A	
3	OpState	Operational state
4	N/A	
5-16	Reserved	

7.4.6 VC PM history data

This managed entity is used to collect and report performance monitoring data associated with a VCC for the last completed 15-minute interval. The instances of this managed entity are created and deleted on request of the OLT. Note that these processes supercede the in-band PM OAM functions.

Relationships

Zero or more instances of this managed entity may exist for each instance of the VC Network $CTP_{B\text{-}PON}$ managed entity. If the instance is associated with the ANI-side VP CTP, then the performance of the downstream ATM flows is reported. If the instance is associated with the UNI-side VP CTP, then the performance of the upstream ATM flows is reported.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the Managed Entity id of the corresponding VC Network $CTP_{B\text{-}PON}$. (R, Set-by-create) (mandatory) (2 bytes)

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Interval End Time: This attribute identifies the most recently finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the actual counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute is set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ id: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Lost C = 0 + 1 Cells: This attribute measures background cell loss. It cannot distinguish between cells lost because of header bit errors, ATM-level header errors, cell policing, or buffer overflows. It records only loss of information independent of the priority of the cell. If the actual counter saturates, it remains on its maximum value. (R) (mandatory) (2 bytes)

Lost C = 0 Cells: This attribute measures background cell loss. It cannot distinguish between cells lost because of header bit errors, ATM-level header errors, cell policing, or buffer overflows. It records only loss of high priority cells. If the actual counter saturates, it remains on its maximum value. (R) (mandatory) (2 bytes)

Misinserted Cells: This attribute is used to measure occurrences of when a cell is misrouted to an active VC that is being monitored. If the actual counter saturates, it remains on its maximum value. (R) (mandatory) (2 bytes)

Transmitted C = 0 + 1 Cells: This attribute provides a count of all cells that are originated at a monitored connection by the transmitting end point (i.e., backward reporting is assumed). (R) (mandatory) (5 bytes)

Transmitted C = 0 Cells: This attribute provides a count of all high priority cells that are originated at a monitored connection by the transmitting end point (i.e., backward reporting is assumed). (R) (mandatory) (5 bytes)

Impaired Block: This severely errored cell block counter will be incremented whenever one of the following events takes place: the number of misinserted cells exceeds $M_{misinserted}$, the number of bipolar violations exceeds $M_{errored}$, or the number of lost cells exceeds M_{lost}. The values for $M_{misinserted}$, $M_{errored}$, and M_{lost} are set based on vendor-operator negotiation. (R) (mandatory) (2 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes.

Set: Set one or more attributes.

Get current data: This action returns the *current* value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

Support of this action is optional.

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Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a threshold crossing alert (TCA) is detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the counters are reset to 0x00. Both ONT and OLT should know the event list used by this entity, given in Table 42.

Table 42/G.983.2 – Alarm list for VC PM history data

Number	Event	Description	Threshold data counter # (Note)
	Threshold Crossing Alert		
0	Lost CLP=0+ 1 Cells	Exceeds threshold	1
1	Lost CLP=0 Cells	Exceeds threshold	2
2	Misinserted Cells	Exceeds threshold	3
3	Impaired Blocks	Exceeds threshold	4
4-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{B\text{-}PON}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.5 Traffic management

7.5.1 Priority Queue$_{B\text{-}PON}$

This managed entity specifies the priority queue in the ONT that is used for the VP Network CTP$_{B\text{-}PON}$. All the Priority Queues used for the upstream traffic are created by the ONT after initialization. All the Priority Queues used for the downstream traffic are created/deleted by the ONT after the creation/deletion of the Subscriber Line Card.

The following assumption is made in order to simplify the queue management: the maximum number of priority queues supported by an ONT, Subscriber Line Card or PON IF Line Card is 32 (the maximum number is 256 in the case of DBA support). If *N* priority queues reside in the ONT, the Subscriber Line Card or PON IF Line Card, *N* Priority Queue$_{B\text{-}PON}$ managed entities will be automatically created by the ONT following the creation of the related equipment. Note that the OLT will find all the queues by reading the Priority Queue$_{B\text{-}PON}$ managed entity instances. If the OLT tries to retrieve a non-existing Priority Queue$_{B\text{-}PON}$, this will be indicated in the response from the ONT to the OLT.

One or more Priority Queue should be created in the PON IF Linecard in order to guarantee the backward compatibility with the G.983.2 ONT.

See also Appendix IV.

Priority queues can exist in the ONT core and subscriber line cards as well as PON IF Line Cards. Therefore the managed entity id definition is extended for DBA applications.

In order to have a flexible connection and configuration between the priority queues and Traffic Schedulers and T-CONT buffers new attributes are added for DBA applications.

Relationships

One or more instances of this managed entity shall be contained in the ONT$_{B\text{-}PON}$ managed entity to model the upstream direction if the **Traffic Management Option** attribute in ONT is 0x00.

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One or more instances of this managed entity shall be associated with the Subscriber Line Card managed entity as downstream Priority Queue$_{B\text{-}PON}$.

Attributes

Managed Entity id: Non-DBA definition: This attribute provides a unique number for each instance of this managed entity. The first byte is the slot id of the Subscriber Line Card or PON IF card with which this queue is associated. The second byte is the priority of this queue (0x00 indicates the highest priority, and 0x1F (31) the lowest).

DBA definition: This attribute provides a unique number for each instance of this managed entity. The first byte is the slot id of the Subscriber Line Card or PON IF card with which this queue is associated. For integrated Subscriber Line/PON IF interfaces, this byte can be associated with "pseudo" slot ids 0x00, 0x80 (128), respectively. If the ONT has upstream priority queues that are not associated with the PON IF card at the creation of this instance, the first byte of this priority queue is 0xFF. The second byte is the priority of this queue (0x00 indicates the highest priority, and 0xFF (255) the lowest). The second byte is numbered by the ONT itself.

In either definition, the priority rank of the queues applies on a per-port or per-T-CONT basis. Congestion on one port or T-CONT will not block traffic being delivered to other ports or T-CONTs. (R) (mandatory) (2 bytes)

Queue Configuration Option: This attribute identifies the buffer-partitioning policy. The value of 0x01 means that all the queues share one buffer size of Maximum Queue Size and the value 0x00 means that each queue uses its individual buffer size of Maximum Queue Size. (R) (mandatory) (1 byte)

Maximum Queue Size: This attribute specifies the maximum size of the queue. (R) (mandatory) (2 bytes)

Allocated Queue Size: This attribute identifies the allocated size of this queue. (R, W) (mandatory) (2 bytes)

Discard-cell-counter reset interval: This attribute represents the interval in milliseconds at which the counter resets itself. (R, W) (optional) (2 bytes)

Threshold value for discarded cells due to buffer overflow: The threshold for the number of cells discarded on this queue due to buffer overflow. (R, W) (optional) (2 bytes)

Back Pressure Operation: This attribute is used to activate (enable: value 0x00) or deactivate (disable: value 0x01) the functions of Back Pressure operation. Default value is 0x00. (R, W) (mandatory if Back Pressure supported) (2 bytes)

Back Pressure Time: This attribute indicates the time duration in which the customer terminal temporarily suspends sending data. This attribute presents the duration in microseconds. This attribute can be used as a pause time for Ether UNI. Values: 0x00000000 to 0xFFFFFFFF. Upon autonomous instantiation, the value 0x00000000 is used. (R, W) (mandatory if Back Pressure supported) (4 bytes)

Back Pressure occur Queue Threshold: This attribute identifies the threshold size of this queue to start sending Back Pressure signal. (R, W) (mandatory if Back Pressure supported) (2 bytes)

Back Pressure clear Queue Threshold: This attribute identifies the threshold size of this queue to stop sending Back Pressure signal. (R, W) (mandatory if Back Pressure supported) (2 bytes)

T-CONT buffer pointer: This attribute represents the T-CONT buffer instance that is directly associated with this priority queue. Upon autonomous instantiation this attribute consists of the 0x8000, 0x8100 or 0xYY00. 0xYY is the first byte of this Managed Entity id. (The default value should be decided in consideration of the backward compatibility.) It is used when this priority

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queue is contained by a T-CONT buffer directly, this pointer is null (0x0000) otherwise. (R, W) (mandatory if DBA supported) (2 bytes)

Traffic Scheduler pointer: This attribute represents the Traffic Scheduler instance that is directly associated with this priority queue. Upon autonomous instantiation this attribute is null (0x0000). This pointer is used when this priority queue is connected with a Traffic Scheduler. (R, W) (mandatory if DBA supported) (2 bytes)

Weight: This attribute represents weight for WRR. This weight is used by the Traffic Scheduler or T-CONT buffer (whose Policy is WRR) indicated by the Traffic Scheduler pointer or T-CONT buffer pointer, if present. Upon autonomous instantiation this attribute consists of the 0x01. (R, W) (mandatory if DBA supported) (1 byte)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

Attribute Value Change: This notification is used to report autonomous changes to the attributes of this managed entity. The notification shall identify the attribute that changed and its new value.

Threshold Crossing Alert: This notification is used to notify the management system when a threshold crossing alert (TCA) has been detected or cleared. Both ONT and OLT should know the event coding used by this entity. The event list for this entity is given in Table 43.

Table 43/G.983.2 – Alarm list for Priority Queue$_{B\text{-}PON}$

Number	Alarm	Description
	Threshold Crossing Alert	
0	Cell loss	Exceeds threshold
1-223	Reserved	
224-239	Vendor-specific alarms	Not to be standardized

7.5.2 Traffic descriptors

ATM transfer capabilities (ATCs) are defined in ITU-T Rec. I.371 [7]. These are Deterministic Bit Rate (DBR), Statistical Bit Rate (SBR), ATM Block Transfer with Delayed Transmission (ABT/DT), ATM Block Transfer with Immediate Transmission (ABT/IT), Available Bit Rate (ABR), and Guaranteed Frame Rate (GFR).

[B-9] has defined analogous Service Categories. These are Constant Bit Rate (CBR), Real-time Variable Bit Rate (rt-VBR), Non-Real-Time VBR (nrt-VBR), Unspecified Bit Rate (UBR), Available Bit Rate (ABR), and Guaranteed Frame Rate (GFR).

Both the ITU-T SBR ATC and the ATM Forum VBR service categories may be further subdivided into 3 categories. These are taken to be separate ATCs or Service Categories and are designated by adding the numeral 1, 2, or 3 to the VBR or SBR acronym. For VBR1 and SBR1, the cell loss ratio (CLR) performance objective is applied to the aggregate traffic in the connection. For VBR2 and SBR2, the CLR objectives are applied only to cells with the cell loss priority (CLP) bit set to 0x00, and there is no tagging of cells. For VBR3 and SBR3, the CLR objective is applied only to cells with the cell loss priority (CLP) bit set to 0x00, and there is tagging of cells.

The plausible approximate correspondence among ITU-T ATC and the service categories in [B-9] is shown in Table 44.

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Table 44/G.983.2 – Traffic descriptors

ITU	[B-9]	Traffic descriptor in G.983.2
DBR [1]	CBR	CBR/DBR Traffic Descriptor
DBR [U]	UBR	UBR Traffic Descriptor
SBR1 [2]	VBR1	SBR1/VBR1 Traffic Descriptor
SBR2 [1]/[3]	VBR2	SBR2/VBR2 Traffic Descriptor
SBR3 [3]	VBR3	SBR3/VBR3 Traffic Descriptor
ABR	ABR	ABR Traffic Descriptor
GFR	GFR	GFR Traffic Descriptor
ABT/DT ABT/IT		ABT/DT/IT Traffic Descriptor

The attribute value units used in the Traffic Descriptors in the following clauses are identical to the ones defined in ITU-T Rec. I.751 [9]. See also References [12] and [7] for a full discussion of traffic attributes.

Note carefully that all the traffic descriptor managed entities in an ONT must have a unique number, regardless of type.

7.5.2.1 DBR/CBR traffic descriptor

This managed entity specifies traffic and QoS parameters for upstream DBR/CBR virtual path connections.

Instances of this managed entity are created and deleted by the OLT.

Relationships

Zero or more instances of this managed entity may be contained in an instance of an $ONT_{B\text{-}PON}$ managed entity.

Each instance of this entity may be related to zero or more instances of VP Network $CTP_{B\text{-}PON}$ entities through their pointer attribute: Traffic Descriptor Profile Pointer.

Attributes

Managed Entity id: This attribute provides a number for each instance of this managed entity that is unique over all the traffic descriptors regardless of type. (R, Set-by-create) (mandatory) (2 bytes)

Service Category/ATC: Value 0x00 is used for DBR/CBR. (R, Set-by-create) (mandatory) (1 byte)

Peak Cell Rate: Peak Cell Rate for the CLP = 0 + 1 traffic flow. Unit is an integer number of cells/second. (R, Set-by-create) (mandatory) (4 bytes)

Cell Delay Variation Tolerance in relation to the PCR: Cell Delay Variation Tolerance in relation to the PCR for the CLP = 0 + 1 traffic flow. Unit is in microseconds. (R, Set-by-Create) (mandatory) (2 bytes)

CLR: Maximum permissible Cell Loss Ratio for the CLP = 0 + 1 traffic flow. (R, Set-by-create) (mandatory) (2 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

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Get: Get one or more attributes of this managed entity.

Notifications

None.

7.5.2.2 UBR traffic descriptor

This managed entity specifies traffic and QoS parameters for upstream UBR virtual path connections.

Instances of this managed entity are created and deleted by the OLT.

Relationships

Zero or more instances of this managed entity may be contained in an instance of an $ONT_{B\text{-}PON}$ managed entity.

Each instance of this entity may be related to zero or more instances of VP Network $CTP_{B\text{-}PON}$ entities through their pointer attribute: Traffic Descriptor Profile Pointer.

Attributes

Managed Entity id: This attribute provides a number for each instance of this managed entity that is unique over all the traffic descriptors regardless of type. (R, Set-by-create) (mandatory) (2 bytes)

Service Category/ATC: Value 0x01 is used for UBR/DBR[U]. (R, Set-by-create) (mandatory) (1 byte)

Peak Cell Rate: Peak Cell Rate for the CLP = 0 + 1 traffic flow. Unit is an integer number of cells/second. (R, Set-by-create) (mandatory) (4 bytes)

Cell Delay Variation Tolerance in relation to the PCR: Cell Delay Variation Tolerance in relation to the PCR for the CLP = 0 + 1 traffic flow. Unit is in microseconds. (R, Set-by-create) (mandatory) (2 bytes)

FrameDiscard: This boolean attribute allows the indication of frame-aware handling. If set to 'false', no special handling is requested. If set to 'true', then the ONU is requested to treat data for this connection as frames (e.g., AAL 5 CPCS_PDUs) rather than as individual cells. The treatment must be on a per-VC basis. While the precise implementation is equipment-specific, this treatment may for example involve discarding entire frames during congestion, rather than a few cells from many frames. (R, W, Set-by-create) (optional) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes of this managed entity.

Notifications

None.

7.5.2.3 SBR1/VBR1 traffic descriptor

This managed entity specifies traffic and QoS parameters for upstream SBR1/VBR1 virtual path connections.

Instances of this managed entity are created and deleted by the OLT.

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Relationships

Zero or more instances of this managed entity may be contained in an instance of an $ONT_{B\text{-}PON}$ managed entity.

Each instance of this entity may be related to zero or more instances of VP Network $CTP_{B\text{-}PON}$ entities through their pointer attribute: Traffic Descriptor Profile Pointer.

Attributes

Managed Entity id: This attribute provides a number for each instance of this managed entity that is unique over all the traffic descriptors regardless of type. (R, Set-by-create) (mandatory) (2 bytes)

Service Category/ATC: Value 0x02 is used for SBR1, value 0x03 is used for Real-time VBR1, and value 0x04 is used for Non Real-time VBR1. (R, Set-by-create) (mandatory) (1 byte)

Peak Cell Rate: Peak Cell Rate for the CLP = 0 + 1 traffic flow. Unit is an integer number of cells/second. (R, Set-by-create) (mandatory) (4 bytes)

Sustainable Cell Rate: Sustainable Cell Rate for the CLP = 0 + 1 traffic flow. Unit is an integer number of cells/second. (R, Set-by-create) (mandatory) (4 bytes)

Maximum Burst Size: Maximum Burst Size for the CLP = 0 + 1 traffic flow. Unit is an integer number of cells. (R, Set-by-create) (mandatory) (2 bytes)

Cell Delay Variation Tolerance in relation to the PCR: Cell Delay Variation Tolerance in relation to the PCR for the CLP = 0 + 1 traffic flow. Unit is in microseconds. (R, Set-by-create) (mandatory) (2 bytes)

Cell Delay Variation Tolerance in relation to the SCR: Cell Delay Variation Tolerance in relation to the SCR for the CLP = 0 + 1 traffic flow. Unit is in microseconds. (R, Set-by-create) (mandatory) (2 bytes)

CLR: Maximum permissible Cell Loss Ratio for the CLP = 0 + 1 traffic flow. (R, Set-by-create) (mandatory) (2 bytes)

FrameDiscard: This boolean attribute allows the indication of frame-aware handling. If set to 'false', no special handling is requested. If set to 'true', then the ONU is requested to treat data for this connection as frames (e.g., AAL 5 CPCS_PDUs) rather than as individual cells. The treatment must be on a per-VC basis. While the precise implementation is equipment-specific, this treatment may for example involve discarding entire frames during congestion, rather than a few cells from many frames. (R, W, Set-by-create) (optional) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes of this managed entity.

Notifications

None.

7.5.2.4 SBR2/VBR2 traffic descriptor

This managed entity specifies traffic and QoS parameters for upstream SBR2/VBR2 virtual path connections.

Instances of this managed entity are created and deleted by the OLT.

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Relationships

Zero or more instances of this managed entity may be contained in an instance of an $ONT_{B\text{-}PON}$ managed entity.

Each instance of this entity may be related to zero or more instances of VP Network $CTP_{B\text{-}PON}$ entities through their pointer attribute: Traffic Descriptor Profile Pointer.

Attributes

Managed Entity id: This attribute provides a number for each instance of this managed entity that is unique over all the traffic descriptors regardless of type. (R, Set-by-create) (mandatory) (2 bytes)

Service Category/ATC: Value 0x05 is used for SBR2, value 0x06 is used for real-time VBR2, and value 0x07 is used for non-real-time VBR2. (R, Set-by-create) (mandatory) (1 byte)

Peak Cell Rate: Peak Cell Rate for the CLP = 0 + 1 traffic flow. Unit is an integer number of cells/second. (R, Set-by-create) (mandatory) (4 bytes)

Sustainable Cell Rate: Sustainable Cell Rate for the CLP = 0 traffic flow. Unit is an integer number of cells/second. (R, Set-by-create) (mandatory) (4 bytes)

Maximum Burst Size: Maximum Burst Size for the CLP = 0 traffic flow. Unit is an integer number of cells. (R, Set-by-create) (mandatory) (2 bytes)

Cell Delay Variation Tolerance in relation to the PCR: Cell Delay Variation Tolerance in relation to the PCR for the CLP = 0 + 1 traffic flow. Unit is in microseconds. (R, Set-by-create) (mandatory) (2 bytes)

Cell Delay Variation Tolerance in relation to the SCR: Cell Delay Variation Tolerance in relation to the SCR for the CLP = 0 traffic flow. Unit is in microseconds. (R, Set-by-create) (mandatory) (2 bytes)

CLR: Maximum permissible Cell Loss Ratio for the CLP = 0 traffic flow. (R, Set-by-create) (mandatory) (2 bytes)

FrameDiscard: This boolean attribute allows the indication of frame-aware handling. If set to 'false', no special handling is requested. If set to 'true', then the ONU is requested to treat data for this connection as frames (e.g., AAL 5 CPCS_PDUs) rather than as individual cells. The treatment must be on a per-VC basis. While the precise implementation is equipment-specific, this treatment may for example involve discarding entire frames during congestion, rather than a few cells from many frames. (R, W, Set-by-create) (optional) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes of this managed entity.

Notifications

None.

7.5.2.5 SBR3/VBR3 traffic descriptor

This managed entity specifies traffic and QoS parameters for upstream SBR3/VBR3 virtual path connections.

Instances of this managed entity are created and deleted by the OLT.

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Relationships

Zero or more instances of this managed entity may be contained in an instance of an $ONT_{B\text{-}PON}$ managed entity.

Each instance of this entity may be related to zero or more instances of VP Network $CTP_{B\text{-}PON}$ entities through their pointer attribute: Traffic Descriptor Profile Pointer.

Attributes

Managed Entity id: This attribute provides a number for each instance of this managed entity that is unique over all the traffic descriptors regardless of type. (R, Set-by-create) (mandatory) (2 bytes)

Service Category/ATC: Value 0x08 is used for SBR3, value 0x09 is used for real-time VBR3, and value 0x0A is used for non-real-time VBR3. (R, Set-by-create) (mandatory) (1 byte)

Peak Cell Rate: Peak Cell Rate for the CLP = 0 + 1 traffic flow. Unit is an integer number of cells/second. (R, Set-by-create) (mandatory) (4 bytes)

Sustainable Cell Rate: Sustainable Cell Rate for the CLP = 0 traffic flow. Unit is an integer number of cells/second. (R, Set-by-create) (mandatory) (4 bytes)

Maximum Burst Size: Maximum Burst Size for the CLP = 0 traffic flow. Unit is an integer number of cells. (R, Set-by-create) (mandatory) (2 bytes)

Cell Delay Variation Tolerance in relation to the PCR: Cell Delay Variation Tolerance in relation to the PCR for the CLP = 0 + 1 traffic flow. Unit is in microseconds. (R, Set-by-create) (mandatory) (2 bytes)

Cell Delay Variation Tolerance in relation to the SCR: Cell Delay Variation Tolerance in relation to the SCR for the CLP = 0 traffic flow. Unit is in microseconds. (R, Set-by-create) (mandatory) (2 bytes)

CLR: Maximum permissible Cell Loss Ratio for the CLP = 0 traffic flow. (R, Set-by-create) (mandatory) (2 bytes)

FrameDiscard: This boolean attribute allows the indication of frame-aware handling. If set to 'false', no special handling is requested. If set to 'true', then the ONU is requested to treat data for this connection as frames (e.g., AAL 5 CPCS_PDUs) rather than as individual cells. The treatment must be on a per-VC basis. While the precise implementation is equipment-specific, this treatment may for example involve discarding entire frames during congestion, rather than a few cells from many frames. (R, W, Set-by-create) (optional) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes of this managed entity.

Notifications

None.

7.5.2.6 ABR traffic descriptor

This managed entity specifies traffic and QoS parameters for upstream ABR virtual path connections.

Instances of this managed entity are created and deleted by the OLT.

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Relationships

Zero or more instances of this managed entity may be contained in an instance of an $ONT_{B\text{-}PON}$ managed entity.

Each instance of this entity may be related to zero or more instances of VP Network $CTP_{B\text{-}PON}$ managed entities through their pointer attribute: Traffic Descriptor Profile Pointer.

Attributes

Managed Entity id: This attribute provides a number for each instance of this managed entity that is unique over all the traffic descriptors regardless of type. (R, Set-by-create) (mandatory) (2 bytes)

Service Category/ATC: Value 0x0B is used for ABR. (R, Set-by-create) (mandatory) (1 byte)

Peak Cell Rate: Peak Cell Rate for the CLP = 0 traffic flow. Unit is an integer number of cells/second. (R, Set-by-create) (mandatory) (4 bytes)

Cell Delay Variation Tolerance in relation to the PCR: Cell Delay Variation Tolerance in relation to the PCR for the CLP = 0 traffic flow. Unit is in microseconds. (R, Set-by-create) (mandatory) (2 bytes)

Minimum Cell Rate: Minimum Cell Rate for the CLP = 0 traffic flow. Unit is an integer number of cells/second. (R, Set-by-create) (mandatory) (4 bytes)

Initial Cell Rate: Rate at which a source should send initially and after an idle period. The unit is an integer number of cells/second. The value must not exceed PCR and is usually lower. (R, Set-by-create) (optional) (4 bytes)

Transient Buffer Exposure: These parameters are required for ABR traffic. (R, Set-by-create) (optional) (2 bytes)

Rate Decrease Factor: Controls the rate decrease that occurs when backward RM cells with CI = 1 are received. Allowed values are $1/2^k$, with k between 0 and 15. The coding of the attribute is according to the value of k. (R, Set-by-create) (optional) (1 byte)

Rate Increase Factor: Controls the rate increase that occurs when a backward RM cell is received with CI = 0 and NI = 0. Allowed values are $1/2^k$, with k between 0 and 15. The coding of the attribute is according to the value of k. (R, Set-by-create) (optional) (1 byte)

Fixed Round Trip Time: The sum of the fixed and propagation delays (in ms) from the source to the destination and back. (R, Set-by-create) (optional) (2 bytes)

Number RM: The maximum number of data cells a source may send for each forward RM cell. Allowed values are 2^k, where k is used as the code and is between 1 and 8. (R, Set-by-create) (optional) (1 byte)

Time RM: Upper bound on the time (in ms) between forward RM cells for an active source. Allowed values are computed as $100/2^k$, where k is used as the code and is between 0 and 7. The default is k = 0. (R, Set-by-create) (optional) (1 byte)

Cut-off Decrease Factor: Controls the rate decreases associated with lost or delayed backward RM cells. Allowed values are: $1/2^6$ (value 0x07), $1/2^5$ (value 0x06), $1/2^4$ (value 0x05), $1/2^3$ (value 0x04), $1/2^2$ (value 0x03), 1/2 (value 0x02), 0x01 (value 0x01) and 0x00 (value 0). (R, Set-by-create) (optional) (1 byte)

ACR Decrease Time Factor: Time permitted between sending RM cells before the rate decreases to ICR. The range is from 10 ms to 10.23 s in increments of milliseconds. (R, Set-by-create) (optional) (2 bytes)

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FrameDiscard: This boolean attribute allows the indication of frame-aware handling. If set to 'false', no special handling is requested. If set to 'true', then the ONU is requested to treat data for this connection as frames (e.g., AAL 5 CPCS_PDUs) rather than as individual cells. The treatment must be on a per-VC basis. While the precise implementation is equipment-specific, this treatment may for example involve discarding entire frames during congestion, rather than a few cells from many frames. (R, W, Set-by-create) (optional) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes of this managed entity.

Notifications

None.

7.5.2.7 ABT/DT/IT traffic descriptor

This managed entity specifies traffic and QoS parameters for upstream ABT/DT/IT virtual path connections.

Instances of this managed entity are created and deleted by the OLT.

Relationships

Zero or more instances of this managed entity may be contained in an instance of an $ONT_{B\text{-}PON}$ managed entity.

Each instance of this entity may be related to zero or more instances of VP Network $CTP_{B\text{-}PON}$ managed entities through its pointer attribute: Traffic Descriptor Profile Pointer.

Attributes

Managed Entity id: This attribute provides a number for each instance of this managed entity that is unique over all the traffic descriptors regardless of type. (R, Set-by-create) (mandatory) (2 bytes)

Service Category/ATC: Value 0x0C is used for ABT/DT; value 0x0D is used for ABT/IT. (R, Set-by-create) (mandatory) (1 byte)

Peak Cell Rate: Peak Cell Rate for the CLP = 0 + 1 traffic flow. Unit is an integer number of cells/second. (R, Set-by-create) (mandatory) (4 bytes)

Sustainable Cell Rate: Sustainable Cell Rate for the CLP = 0 + 1 traffic flow. Unit is an integer number of cells/second. (R, Set-by-create) (optional) (4 bytes)

Maximum Burst Size: Maximum Burst Size for the CLP = 0 + 1 traffic flow. Unit is an integer number of cells. (R, Set-by-create) (optional) (2 bytes)

Cell Delay Variation Tolerance in relation to the PCR: Cell Delay Variation Tolerance in relation to the PCR for the CLP = 0 + 1 traffic flow. Unit is in microseconds. (R, Set-by-create) (mandatory) (2 bytes)

Cell Delay Variation Tolerance in relation to the SCR: Cell Delay Variation Tolerance in relation to the SCR for the CLP = 0 + 1 traffic flow. Unit is in microseconds. (R, Set-by-create) (optional) (2 bytes)

Number RM: The maximum number of data cells a source may send for each forward RM cell. Allowed values are 2^k, where k is used as the code and is between 0x01 and 0x08. (R, Set-by-create) (optional) (1 byte)

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Time RM: Upper bound on the time between forward RM cells for an active source. Allowed values are computed as $100/2^k$, where k is used as the code and is between 0x00 and 0x07. The default is k = 0. (R, Set-by-create) (optional) (1 byte)

FrameDiscard: This boolean attribute allows the indication of frame-aware handling. If set to 'false', no special handling is requested. If set to 'true', then the ONU is requested to treat data for this connection as frames (e.g., AAL 5 CPCS_PDUs) rather than as individual cells. The treatment must be on a per-VC basis. While the precise implementation is equipment-specific, this treatment may for example involve discarding entire frames during congestion, rather than a few cells from many frames. (R, W, Set-by-create) (optional) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes of this managed entity.

Notifications

None.

7.5.2.8 GFR traffic descriptor

This managed entity specifies traffic and QoS parameters for upstream GFR virtual path connections.

Instances of this managed entity are created and deleted by the OLT.

Relationships

Zero or more instances of this managed entity may be contained in an instance of an $ONT_{B\text{-}PON}$ managed entity.

Each instance of this entity may be related to zero or more instances of VP Network $CTP_{B\text{-}PON}$ managed entities through their pointer attribute: Traffic Descriptor Profile Pointer.

Attributes

Managed Entity id: This attribute provides a number for each instance of this managed entity that is unique over all the traffic descriptors regardless of type. (R, Set-by-create) (mandatory) (2 bytes)

Service Category/ATC: Value 0x0E is used for GFR. (R, Set-by-create) (mandatory) (1 byte)

Peak Cell Rate: Peak Cell Rate for the CLP = 0 + 1 traffic flow. Unit is an integer number of cells/second. (R, Set-by-create) (mandatory) (4 bytes)

Sustainable Cell Rate: Sustainable Cell Rate for the CLP = 0 + 1 traffic flow. Unit is an integer number of cells/second. (R, Set-by-create) (optional) (4 bytes)

Maximum Burst Size: Maximum Burst Size for the CLP = 0 + 1 traffic flow. Unit is an integer number of cells. (R, Set-by-create) (optional) (2 bytes)

Cell Delay Variation Tolerance in relation to the PCR: Cell Delay Variation Tolerance in relation to the PCR for the CLP = 0 + 1 traffic flow. Unit is in microseconds. (R, Set-by-create) (mandatory) (2 bytes)

Cell Delay Variation Tolerance in relation to the SCR: Cell Delay Variation Tolerance in relation to the SCR for the CLP = 0 traffic flow. Unit is in microseconds. (R, Set-by-create) (optional) (2 bytes)

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Maximum Frame size: Maximum Frame size for GFR traffic. Unit is an integer number of cells. (R, Set-by-create) (optional) (2 bytes)

Minimum Cell Rate: Minimum Cell Rate for the CLP = 0 traffic flow. Unit is an integer number of cells/second. (R, Set-by-create) (mandatory) (4 bytes)

FrameDiscard: This boolean attribute allows the indication of frame-aware handling. If set to 'false', no special handling is requested. If set to 'true', then the ONU is requested to treat data for this connection as frames (e.g., AAL 5 CPCS_PDUs) rather than as individual cells. The treatment must be on a per-VC basis. While the precise implementation is equipment-specific, this treatment may for example involve discarding entire frames during congestion, rather than a few cells from many frames. (R, W, Set-by-create) (optional) (1 byte)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes of this managed entity.

Notifications

None.

7.5.2.9 UBR+ traffic descriptor

This managed entity specifies traffic and QoS parameters for upstream UBR+ virtual path connections. Instances of this managed entity are created and deleted by the OLT.

Relationships

Zero or more instances of this managed entity may be contained in an instance of an $ONT_{B\text{-}PON}$ managed entity. Each instance of this entity may be related to zero or more instances of VP Network $CTP_{B\text{-}PON}$ managed entities through their pointer attribute: Traffic Descriptor Profile Pointer.

Attributes

Managed Entity id: This attribute provides a number for each instance of this managed entity that is unique over all the traffic descriptors regardless of type. (R, Set-by-create) (mandatory) (2 bytes)

Service Category/ATC: Value 0x0F is used for UBR+ [U]. (R, Set-by-create) (mandatory) (1 byte)

Peak Cell Rate: Peak Cell Rate for the CLP = 0 + 1 traffic flow. Unit is an integer number of cells/second. (R, Set-by-create) (mandatory) (4 bytes)

Minimum Cell Rate: Minimum guaranteed cell rate. Unit is an integer number of cells/second. (R, Set-by-create) (mandatory) (4 bytes)

Cell Delay Variation Tolerance in relation to the PCR: Cell Delay Variation Tolerance in relation to the PCR for the CLP = 0 + 1 traffic flow. Unit is in microseconds. (R, Set-by-create) (mandatory) (2 bytes)

FrameDiscard: This boolean attribute allows the indication of frame-aware handling. If set to 'false', no special handling is requested. If set to 'true', then the ONU is requested to treat data for this connection as frames (e.g., AAL 5 CPCS_PDUs) rather than as individual cells. The treatment must be on a per-VC basis. While the precise implementation is equipment-specific, this treatment may for example, involve discarding entire frames during congestion, rather than a few cells from many frames. (R, W, Set-by-create) (optional) (1 byte)

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Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes of this managed entity.

Notifications

None.

7.5.3 This clause intentionally left blank

7.5.4 UPC Disagreement Monitoring History Data$_{B\text{-}PON}$

An instance of this managed entity is used to collect and report the last completed 15-minute interval data associated with UPC Disagreement Monitoring functions performed by the ONT on individual VP Network CTP$_{B\text{-}PON}$ or VC Network CTP$_{B\text{-}PON}$ managed entities in ONT$_{B\text{-}PON}$. The instances of this managed entity are created and deleted by the OLT.

Relationships

One instance of this managed entity may exist for each instance of a VP Network CTP$_{B\text{-}PON}$ or VC Network CTP$_{B\text{-}PON}$ managed entity instantiated at the UNI side.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. The assigned number is the same as the Managed Entity id of the corresponding VP Network CTP$_{B\text{-}PON}$ or VC Network CTP$_{B\text{-}PON}$. (R, Set-by-create) (mandatory) (2 bytes)

Interval End Time: This attribute identifies the most recent finished 15-minute interval. It is a cyclic counter (modulo 0xFF (256)) that is incremented each time a new interval is finished and the actual counters are updated. The value of this attribute is 0x00 during the first 15-minute interval that starts with the reception of the "synchronize time" action. The value is 0x01 during the first period after this, and so on. If this managed entity is created after the reception of the "synchronize time" action, the value of this attribute set equal to the number of the last completed interval. The actual counters of this managed entity start counting directly. (R) (mandatory) (1 byte)

Threshold Data$_{B\text{-}PON}$ id: This attribute provides a pointer to an instance of the Threshold Data$_{B\text{-}PON}$ managed entity that contains the threshold values for the performance monitoring data collected by this managed entity. The value 0x0000 is interpreted as a Null pointer. (R, W, Set-by-create) (mandatory) (2 bytes)

Discarded Cells due to UPC: This attribute provides a raw, thresholded count of the number of discarded cells due to combined CLP = 0 and CLP = 1 UPC policing. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (2 bytes)

Discarded CLP = 0 Cells due to UPC: This attribute provides a raw, thresholded count of the number of discarded CLP = 0 cells due to CLP = 0 only UPC policing. This counter is only present if CLP = 0 traffic is separately policed. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (2 bytes)

Tagged CLP = 0 Cells: This attribute provides a raw, unthresholded count of the number of cells that have been tagged. If the actual counter saturates, it remains on its maximum value. Default value is 0x00. (R) (mandatory) (2 bytes)

Successfully Passed Cells: This attribute provides a raw, unthresholded count of the number of cells that have been passed by the combined CLP=0+1 UPC policing. (R) (mandatory) (5 bytes)

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Successfully Passed CLP = 0 Cells: This attribute provides a raw, unthresholded count of the number of high priority cells that have been passed by the CLP=0 UPC policing. (R) (mandatory) (5 bytes)

Actions

Create: Create an instance of this managed entity.

Delete: Delete an instance of this managed entity.

Get: Get one or more attributes of this managed entity.

Set: Set one or more attributes of this managed entity.

Get current data: This action returns the *current* value of one or more actual counters associated with performance monitoring attributes and the value of the Interval End Time attribute representing the interval in which the request is made. The values in the specific counters are reset at the end of the interval.

NOTE – "Get" returns the statistical data stored in the attribute values; "Get current data" returns the real-time value of the actual counters associated with those attributes.

Support of this action is optional.

Notifications

Threshold Crossing Alert: This notification is used to notify the management system when a threshold crossing alert (TCA) is detected or cleared. The TCA change notification "on" will be sent at the crossing of the threshold; the TCA change notification "off" will be sent at the end of the 15-min period since that is when the counters are reset to 0x00. Both ONT and OLT should know the alarm list used by this entity, given in Table 45.

Table 45/G.983.2 – Alarm list for UPC disagreement monitoring history data $_{\text{B-PON}}$

Number	Alarm	Description	Threshold data counter # (Note)
	Threshold Crossing Alert		
0	Discarded Cells due to UPC	Exceeds threshold	1
1	Discarded CLP = 0 Cells due to UPC	Exceeds threshold	2
2-223	Reserved		
224-239	Vendor-specific alarms	Not to be standardized	
NOTE – This numbering is used with the associated Threshold Data $_{\text{B-PON}}$ managed entity. Threshold Data counter 1 indicates the 1st thresholded counter, etc.			

7.5.5 Traffic scheduler

An instance of this managed entity represents a logical object of some Traffic Scheduler to control upstream ATM cells. A Traffic Scheduler can accommodate ATM cells after priority queue or other Traffic Scheduler and transfer ATM cells toward the next Traffic Scheduler or T-CONT buffer.

Relationships

Zero or more instances of this managed entity are contained in an instance of the ONT managed entity.

Attributes

Managed Entity id: This attribute provides a unique number for each instance of this managed entity. This 2-byte number is associated with the physical capability that realizes the Traffic

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Scheduler. The first byte is the slot id of the PON IF card with which this Traffic Scheduler is associated. For integrated PON IF interfaces, this byte can be associated with "pseudo" slot id 0x80 (128). If the ONT has Traffic Schedulers that are not associated with the PON IF card at the creation of this instance, the first byte of this Traffic Scheduler is 0xFF. The second byte is the Traffic Scheduler id that is numbered by the ONT itself. The Traffic Scheduler id is numbered in ascending order with the range of 0x00 to 0xFF in each PON-IF Line Card or ONT core. (R) (mandatory) (2 bytes)

T-CONT Buffer pointer: This attribute represents the T-CONT Buffer instance that is directly associated with this Traffic Scheduler. Upon autonomous instantiation this attribute consists of the 0x8000, 0x8100 or 0xYY00. 0xYY is the first byte of this Managed Entity ID. (The default value should be decided in consideration of the backward compatibility.) This pointer is used when this Traffic Scheduler is contained by the T-CONT buffer directly, it is null (0x0000) otherwise. (R) (mandatory) (2 bytes)

Traffic Scheduler pointer: This attribute represents the Traffic Scheduler instance that serves this Traffic Scheduler. Upon autonomous instantiation this attribute is null (0x0000). This pointer is used when this Traffic Scheduler is connected to the another Traffic Scheduler, it is null otherwise. (The default value should be decided in consideration of the backward compatibility.) (R) (mandatory) (2 bytes)

Policy: This attribute represents scheduling policy. Valid values include but are not limited to "Null"(value 0x00), "HOL"(value 0x01) or "WRR"(value 0x02). Upon autonomous instantiation this attribute consists of the 0x00. (R) (mandatory) (1 byte)

Priority/Weight: This attribute represents priority for HOL scheduling or the weight for WRR scheduling. This value is used by the T-CONT buffer or Traffic Scheduler indicated by the T-CONT buffer pointer or Traffic Scheduler pointer. If the indicated pointer has Policy = HOL, then this value is interpreted as a priority (0x00 indicates the highest priority, and 0xFF (255) the lowest). If the indicated pointer has Policy = WRR, then this value is interpreted as a weight. Upon autonomous instantiation this attribute consists of the 0x00. (R, W) (mandatory) (1 byte)

Actions

Get: Get one or more attributes.

Set: Set one or more attributes.

Notifications

Attribute Value Change: This notification is used to report autonomous changes of attributes of this managed entity. The notification shall identify its new value.

8 ONT Management and Control Channel (OMCC)

An ATM connection shall be provisioned for the OMCC. ITU-T Rec. G.983.1 [3] specifies a PLOAM message that activates a VPI/VCI pair between the OLT and ONT processors. The VPI/VCI value for the management channel of each is programmed by the OLT using this message. The OMCCs of different ONTs should be assigned different VPIs. A grant flow must be allocated by the MAC layer of the OLT for upstream OMCC traffic of each ONT.

The following performance requirements related to the OMCC should be studied further with input from operators:

a) The cells carrying ONT management messages should be sent with cell loss priority CLP = 0.

b) The upstream traffic on each OMCC should not exceed x bandwidth, where x is based on the operator's requirement.

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c) An upstream OMCC cell should always be put in the high priority queue or be modelled with the CBR service category; the constraints on the downstream OMCC cells are out of the scope of the Recommendation as this is completely under control of the OLT.

d) Message Response Time: The system should support response times that do not exceed 1 s for the high priority protocol handling messages and 3 s for the low priority protocol handling messages.

9 ONT management and control protocol

9.1 ONT management and control protocol cell format

9.1.1 Introduction

Each ONT Management and Control Protocol packet is encapsulated directly in a single 53-byte ATM cell. The cell format is shown in Figure 41. The following clauses discuss the details.

ATM Header (5 bytes)	Transaction Correlation Identifier (2 bytes)	Message Type (1 byte)	Device Identifier (1 byte)	Message Identifier (3 bytes)	Message Contents (33 bytes)	AAL 5 Trailer (8 bytes)

Figure 41/G.983.2 – ONT management and control protocol cell format

9.1.2 ATM header

The header contains the VPI/VCI value of the OMCC for the addressed ONT (see clause 8).

The header PTI should equal 001. The CLP bit should equal 0.

The HEC should be calculated using the normal ATM CRC-8 polynomial.

9.1.3 Transaction correlation identifier

The Transaction Correlation Identifier is used to associate a request message with its response message. For request messages, the OLT selects any transaction identifier. A response message carries the transaction identifier of the message to which it is responding. The transaction identifier of event messages is 0x0000.

As explained in 9.2 Message Flow Control and Error Recovery, the most significant bit of the Transaction Correlation Identifier is used to indicate the priority of the message. The following coding will be used: 0 = low priority, 1 = high priority. The OLT decides whether a command should be executed with low or high priority.

The mechanism that the OLT uses to assign the rest of the bits of the Transaction Correlation Identifier in an acknowledged command is not standardized and is left to the implementers.

However, since the Transaction Correlation Identifier is used to match a command from the OLT to the ONT with a response from the ONT to the OLT, some care is required in the choice of the Transaction Correlation Identifier. The OLT must assign the Transaction Correlation Identifier in such a way that, whenever it sends a command with a Transaction Correlation Identifier that has been used before in another command to the same ONT, it is guaranteed with sufficiently high probability that no response for the first command will be received.

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9.1.4 Message type

The Message Type field is subdivided into four parts. These are given in Figure 42.

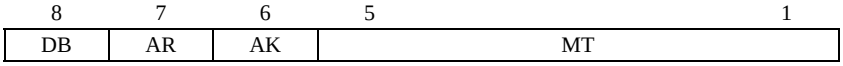


Figure 42/G.983.2 – Message type field subdivision

The most significant bit, bit 8, is reserved for the destination bit (DB). In the OMCI this bit is always 0.

Bit 7, Acknowledge Request (AR), is used to indicate whether or not the message requires an acknowledgement. If an acknowledgement is expected, this bit is set to "1". If no acknowledgement is expected, the coding of this bit is "0". Note that "acknowledge" means a response to an action request, not an acknowledgement at the link layer.

Bit 6, Acknowledgement (AK), is used to indicate whether or not this message is an acknowledgement to an action request. If a message is an acknowledgement, this bit is set to "1". If the message is not a response, this bit is set to "0".

Bit 5 to bit 1, Message Type (MT), are used to indicate the message type. Codes 0 to 3 are reserved for future use. Codes 4 to 31 are used by this Recommendation. Table 46 lists the message types that are defined.

Table 46/G.983.2 – OMCI message types

MT	Type	Purpose	AK	Inc MIB data sync.
4	Create	Create a managed entity instance with its attributes	yes	yes
5	Create complete connection	Create an ATM VP Cross-Connection and two associated VP Network $CTP_{B\text{-}PON}$s or create an ATM VC Cross-Connection and two associated VC Network $CTP_{B\text{-}PON}$s	yes	yes
6	Delete	Delete a managed entity instance	yes	yes
7	Delete complete connection	Delete an ATM VP Cross-Connection and two associated VP Network $CTP_{B\text{-}PON}$s or delete an ATM VC Cross-Connection and two associated VC Network $CTP_{B\text{-}PON}$s	yes	yes
8	Set	Set one or more attributes of a managed entity	yes	yes
9	Get	Get one or more attributes of a managed entity	yes	no
10	Get complete connection	Get all attributes of an ATM VP Cross-Connection and the attributes of the associated VP Network $CTP_{B\text{-}PON}$s	yes	no
11	Get all alarms	Latch the alarm statuses of all managed entities and reset the alarm message counter	yes	no
12	Get all alarms next	Get the alarm status of the next managed entity	yes	no
13	MIB upload	Latch the MIB	yes	no
14	MIB upload next	Get latched attributes of a managed entity instance	yes	no
15	MIB reset	Clear the MIB and reinitialize it to its default and reset the MIB data sync counter to 0	yes	no

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Table 46/G.983.2 – OMCI message types

MT	Type	Purpose	AK	Inc MIB data sync.
16	Alarm	Notification of an alarm	no	no
17	Attribute value change	Notification of an autonomous attribute value change	no	no
18	Test	Request a test on a specific managed entity	yes	no
19	Start software download	Start a software download action	yes	yes
20	Download section	Download a section of a software image	yes/no	no
21	End software download	End of a software download action	yes	yes
22	Activate software	Activate the downloaded software image	yes	yes
23	Commit software	Commit the downloaded software image	yes	yes
24	Synchronize Time	Synchronize the time between OLT and ONT	yes	no
25	Reboot	Reboot ONT, Subscriber Line Card or PON IF Line Card	yes	no
26	Get next	Get the latched attribute values of the managed entity within the current snapshot	yes	no
27	Test result	Notification of test result that is initiated by "Test"	no	no
28	Get current data	Get current counter value associated with one or more attributes of a managed entity	yes	no
NOTE – The "Download section" action is only acknowledged for the last section within a window. See Appendix I.2.15.				

9.1.5 Device identifier

For systems based on ITU-T Rec. G.983.1 [3], this field is defined as 0x0A.

9.1.6 Message identifier

The message identifier consists of three bytes. The first, most significant, byte of the message identifier field is used to indicate which managed entity is the target of the action specified in the message type. The maximum number of possible managed entities is thus 256. The least significant two bytes of this message identifier field are used to identify the managed entity instance. The maximum number of instances per managed entity is thus 65 536.

Table 47 gives the managed entities and their class values in the OMCI. Depending on the managed entity, there will be only one (e.g., $ONT_{B\text{-}PON}$) or several (e.g., VP Network $CTP_{B\text{-}PON}$) instances.

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Table 47/G.983.2 – Managed entity identifiers

Managed entity class value	Managed entity
1	$ONT_{B\text{-}PON}$
2	ONT Data
3	PON IF Line Cardholder
4	PON IF Line Card
5	Subscriber Line Cardholder
6	Subscriber Line Card
7	Software Image
8	$UNI_{B\text{-}PON}$
9	TC $Adapter_{B\text{-}PON}$
10	Physical Path Termination Point ATM UNI
11	Physical Path Termination Point Ethernet UNI
12	Physical Path Termination Point CES UNI
13	Logical N × 64 kbit/s Sub-port Connection Termination Point
14	Interworking VCC Termination Point
15	AAL 1 $Profile_{B\text{-}PON}$
16	AAL 5 $Profile_{B\text{-}PON}$
17	AAL 1 Protocol Monitoring History $Data_{B\text{-}PON}$
18	AAL 5 Protocol Monitoring History $Data_{B\text{-}PON}$
19	AAL 2 $Profile_{B\text{-}PON}$
20	(intentionally left blank)
21	CES Service $Profile_{B\text{-}PON}$
22	(intentionally left blank)
23	CES Physical Interface Monitoring History Data
24	Ethernet Performance Monitoring History Data
25	VP Network $CTP_{B\text{-}PON}$
26	ATM VP Cross-Connection
27	Priority $Queue_{B\text{-}PON}$
28	DBR/CBR Traffic Descriptor
29	UBR Traffic Descriptor
30	SBR1/VBR1 Traffic Descriptor
31	SBR2/VBR2 Traffic Descriptor
32	SBR3/VBR3 Traffic Descriptor
33	ABR Traffic Descriptor
34	GFR Traffic Descriptor
35	ABT/DT/IT Traffic Descriptor
36	UPC Disagreement Monitoring History $Data_{B\text{-}PON}$
37	(intentionally left blank)
38	ANI

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Table 47/G.983.2 – Managed entity identifiers

Managed entity class value	Managed entity
39	PON TC Adapter
40	PON Physical Path Termination Point
41	TC Adapter Protocol Monitoring History Data
42	Threshold Data$_{B\text{-}PON}$
43	Operator Specific
44	Vendor Specific
45	MAC Bridge Service Profile
46	MAC Bridge Configuration Data
47	MAC Bridge Port Configuration Data
48	MAC Bridge Port Designation Data
49	MAC Bridge Port Filter Table Data
50	MAC Bridge Port Bridge Table Data
51	MAC Bridge PM History Data
52	MAC Bridge Port PM History Data
53	Physical Path Termination Point POTS UNI
54	Voice CTP
55	Voice PM History Data
56	AAL 2 PVC Profile$_{B\text{-}PON}$
57	AAL 2 CPS Protocol Monitoring History Data$_{B\text{-}PON}$
58	Voice Service Profile AAL
59	LES Service Profile
60	AAL 2 SSCS Parameter Profile 1
61	AAL 2 SSCS Parameter Profile 2
62	VP PM History Data
63	Traffic Scheduler
64	T-CONT Buffer
65	UBR+ Traffic Descriptor
66	AAL 2 SSCS Protocol Monitoring History Data$_{B\text{-}PON}$
67	IP Port Configuration Data
68	IP Router Service Profile
69	IP Router Configuration Data
70	IP Router PM History Data 1
71	IP Router PM History Data 2
72	ICMP PM History Data1
73	ICMP PM History Data 2
74	IP Route Table
75	IP Static Routes
76	ARP Service Profile

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Table 47/G.983.2 – Managed entity identifiers

Managed entity class value	Managed entity
77	ARP Configuration Data
78	VLAN Tagging Operation Configuration Data
79	MAC Bridge Port Filter Preassign Table
80	Physical Path Termination Point ISDN UNI
81	(Reserved for Physical Path Termination Point HPNA UNI)
82	Physical Path Termination Point Video UNI
83	Physical Path Termination Point LCT UNI
84	VLAN Tagging Filter Data
85	$ONU_{B\text{-}PON}$
86	ATM VC Cross-Connection
87	VC Network $CTP_{B\text{-}PON}$
88	VC PM History Data
89	Ethernet Performance Monitoring History Data 2
90	Physical Path Termination Point Video ANI
91	Physical Path Termination Point 802.11 UNI
92	802.11 Station Management data 1
93	802.11 Station Management data 2
94	802.11 General Purpose Object
95	802.11 MAC&PHY Operation and Antenna Data
96	802.11 Counters
97	802.11 PHY FHSS DSSS IR Tables
98	Physical Path Termination Point ADSL UNI Part 1
99	Physical Path Termination Point ADSL UNI Part 2
100	ADSL Line Inventory and Status Data Part 1
101	ADSL Line Inventory and Status Data Part 2
102	ADSL Channel Downstream Status Data
103	ADSL Channel Upstream Status Data
104	ADSL Line Configuration Profile Part 1
105	ADSL Line Configuration Profile Part 2
106	ADSL Line Configuration Profile Part 3
107	ADSL Channel Configuration Profile
108	ADSL Subcarrier Masking Downstream Profile
109	ADSL Subcarrier Masking Upstream Profile
110	ADSL Downstream PSD Mask Profile
111	ADSL Downstream RFI Bands Profile
112	ADSL ATU-C Performance Monitoring History Data
113	ADSL ATU-R Performance Monitoring History Data
114	ADSL ATU-C Channel Performance Monitoring History Data

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Table 47/G.983.2 – Managed entity identifiers

Managed entity class value	Managed entity
115	ADSL ATU-R Channel Performance Monitoring History Data
116	TC Adaptor Performance Monitoring History Data ADSL
117	Physical Path Termination Point VDSL UNI
118	VDSL VTU-O Physical Data
119	VDSL VTU-R Physical Data
120	VDSL Channel Data
121	VDSL Line Configuration Profile
122	VDSL Channel Configuration Profile
123	VDSL Band Plan Configuration Profile
124	VDSL VTU-O Physical Interface Monitoring History Data
125	VDSL VTU-R Physical Interface Monitoring History Data
126	VDSL VTU-O Channel Performance Monitoring History Data
127	VDSL VTU-R Channel Performance Monitoring History Data
128	Video Return Path Service Profile
129	Video Return Path Statistics
130	802.1p mapper service profile
131	$OLT_{B\text{-}PON}$
132	Multicast Interworking VCC Termination Point
133-239	Reserved for future standardization
240-255	Vendor-Specific Entities, not to be standardized

9.1.7 Message contents

The layout of the message contents field is message specific. The detailed layout of all messages is given in Appendix II.

9.1.8 AAL 5-trailer

The eight bytes of this field are used as follows:

a) The CPCS-User-to-User-Indication (CPCS-UU) field is set to 0x00 at the transmitter and ignored at the receiver.

b) The CPCS Common Part Indication (CPCS-CPI) field is set to 0x00 at the transmitter and ignored at the receiver.

c) The length of the CPCS-SDU field is set to 0x0028.

d) The 32-bit CRC is as specified in ITU-T Rec. I.363.5 [6].

9.1.9 OMCI protocol limitations

Due to the arrangement of the messages, the OMCI imposes limits on the size of the message payloads. Table 48 lists the important limits for both B-PON and G-PON usages of the OMCI. To enable re-use of managed entities over both B-PON and G-PON, it is important that all MEs are defined such that they fit into the G-PON limits.

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Table 48/G.983.2 – OMCI protocol limitations

Item	Limited by	B-PON limit	G-PON limit
Total size of Set-by-Create Attributes (including ME ID)	Create	35	34
Size of (R) or (R,W) Simple Attribute	Get-Response	26	25
Size of (R) or (R,W) Table Entry	Set	31	30
Total size of a Get	Get-Response	26	25
Total size of a Get-current data	Get-Current Data Response	26	25

It is important that the OLT and ONT implementations take these limits into account. For example, it is very easy to form a 'get' command that asks the ONT to return more attributes than there is space in the Response message. Specifically, there is a known issue where the OLT and ONT may disagree on the maximum size limitation of the 'Get' response.

For the sake of maintaining backwards-compatibility, the behaviour when either the ONT or OLT utilizes a 30-byte message contents field is described:

Case 1. The OLT implements a maximum attribute space of 26 bytes, while the ONT implements a maximum attribute space of 30 bytes.

The OLT should not ask for attributes that exceed 26 bytes, so the ONT will just leave the extra space blank. Even in the case where the OLT asks for too many attributes, it will get an attribute mask that clarifies what is being sent and will ignore the attributes that extend beyond the 26 bytes.

Case 2. The OLT uses a maximum attribute space of 30 bytes, while the ONT uses a maximum attribute space of 26 bytes.

The OLT may ask for too many attributes, and the ONT can respond with however many attributes fit in its 26-byte attribute space. The OLT will get the appropriate attribute-present mask and will parse the attributes that were sent correctly. It will ask again later for those attributes that did not fit.

While this is the preferred behaviour, an alternate interpretation may be that the ONT would return a "parameter error" code when it receives a Get that does not fit in the Get Response. For the sake of interoperability, the expected behaviour between and OLT and ONT with different interpretations is provided below:

Case 1. The ONT reports a parameter error, and the OLT expects a partial list. If this happens, the OLT should react by simplifying its Get request. The ONT will then respond without an error.

Case 2. The ONT provides a partial list, while the OLT expects to get an error. The OLT will receive a normal message and will process it normally. The OLT should ask again for any attributes it did not get.

9.2 Message flow control and error recovery

The flow control/error recovery procedures for message exchange over the OMCC are based upon a simplex acknowledged transaction stop-and-wait mechanism that can easily be extended to support concurrent execution of multiple transaction requests of different priority levels. These flow-control procedures ensure that a low level acknowledged transaction request transmitted from the OLT has been properly received and processed to completion by the ONT before the next message of the same priority level is sent by the OLT. The stop-and-wait protocol uses the transaction correlation identifier field, retry counter(s), and applicable transaction request timer(s) to control the message flow rate while relying upon a CRC calculation to verify the data integrity of all received messages.

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A Transaction Request Timer T_i with expiration time $Tmax_i$ is started when a transaction request message of priority level "i" is sent to an ONT and is stopped upon receipt of an error-free acknowledgement message containing the same transaction correlation id value. If a valid acknowledgement message is not received by the OLT after timer T_i expires, the OLT resends the original transaction request message.

A retransmitted acknowledged transaction request message carries the same correlation ID as the original message. Each time an acknowledged transaction request message is retransmitted by the OLT, the transmitter increments the Retry Counter R_i (the counter associated with priority level "i" acknowledged transaction requests). When a retry counter R_i (initialized to 0x00 upon start-up) reaches the maximum retry value, $Rmax_i$, the transmitter stops retransmitting the message and declares an OMCC link state error.

Note that these timers (T_i) and retry counters (R_i) are only maintained within the OLT controller and do not exist within the ONT. Furthermore, the default threshold values for timer expiration ($Tmax_i$) and number of retries ($Rmax_i$) are not subject to standardization. It is suggested that the default threshold values of both Tmax and Rmax be independently configurable for each priority level. The default value for $Tmax_1$ (i.e., high priority threshold) should account for the typical message transmission delay plus the command message response time.

These flow control/error recovery procedures are illustrated in Figure 43 for a case where the OMCC link is not permanently broken. First the OLT sends an acknowledged transaction request (Message 1) with priority level 0. Subsequently (i.e., while Message 1 is still outstanding), the OLT issues an additional acknowledged transaction request (Message 2) with priority level 1. Both of these commands are received and executed with the associated response (acknowledgement messages) returned to the OLT by the ONT. The acknowledgement for Message 1 is received by the OLT in time, however the response to Message 2 is lost and never received. The OLT detects that something went wrong because timer T_1 expires, and the OLT therefore retransmits the original command (Message 2). Note that the ONT detects that this retransmitted command is identical to the last received command (for priority level 1) and therefore does not re-execute it. The ONT simply retransmits the original response from the previous execution of Message 2, which reaches the OLT in time. Finally, the OLT sends an acknowledged transaction request (Message 3) with priority level 0, but the message itself gets lost and is never properly received by the ONT. After the associated timer (T_0) expires, the OLT retransmits the command and now all goes well.

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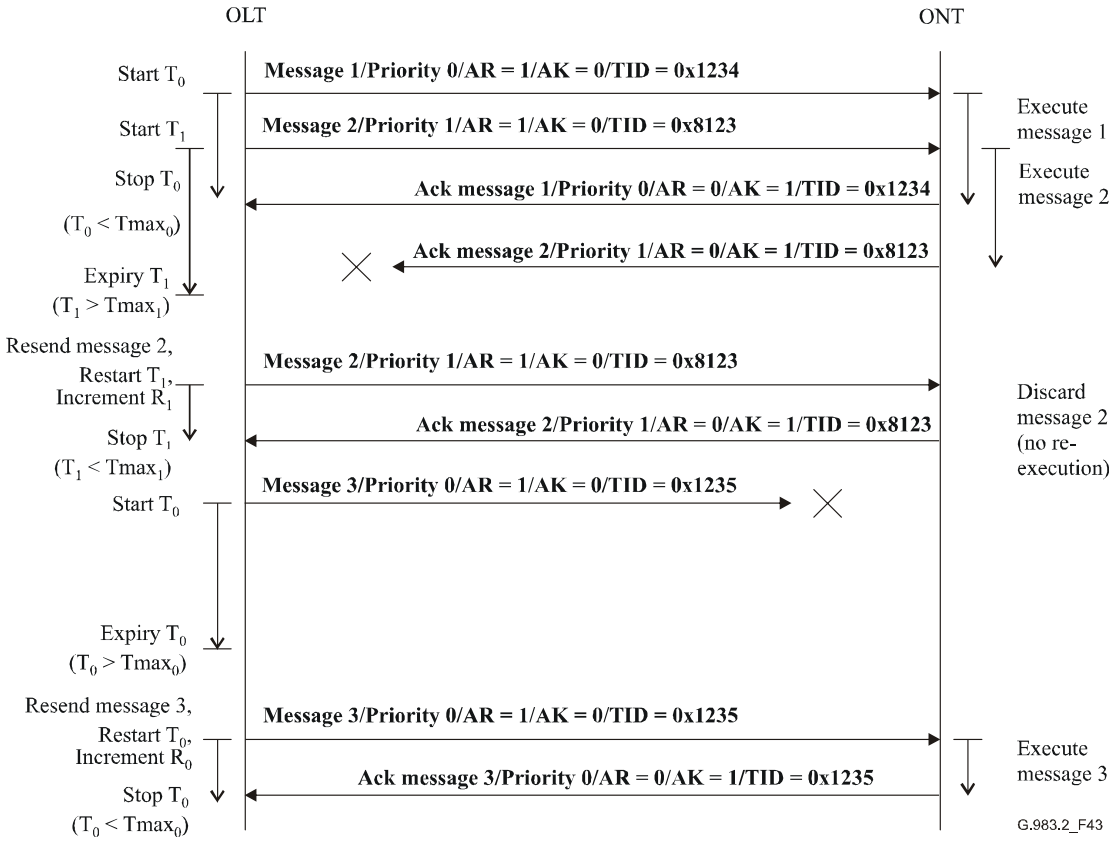


Figure 43/G.983.2 – Concurrent message exchange with error recovery

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A case where the OMCC link is effectively broken (down) is shown in Figure 44.

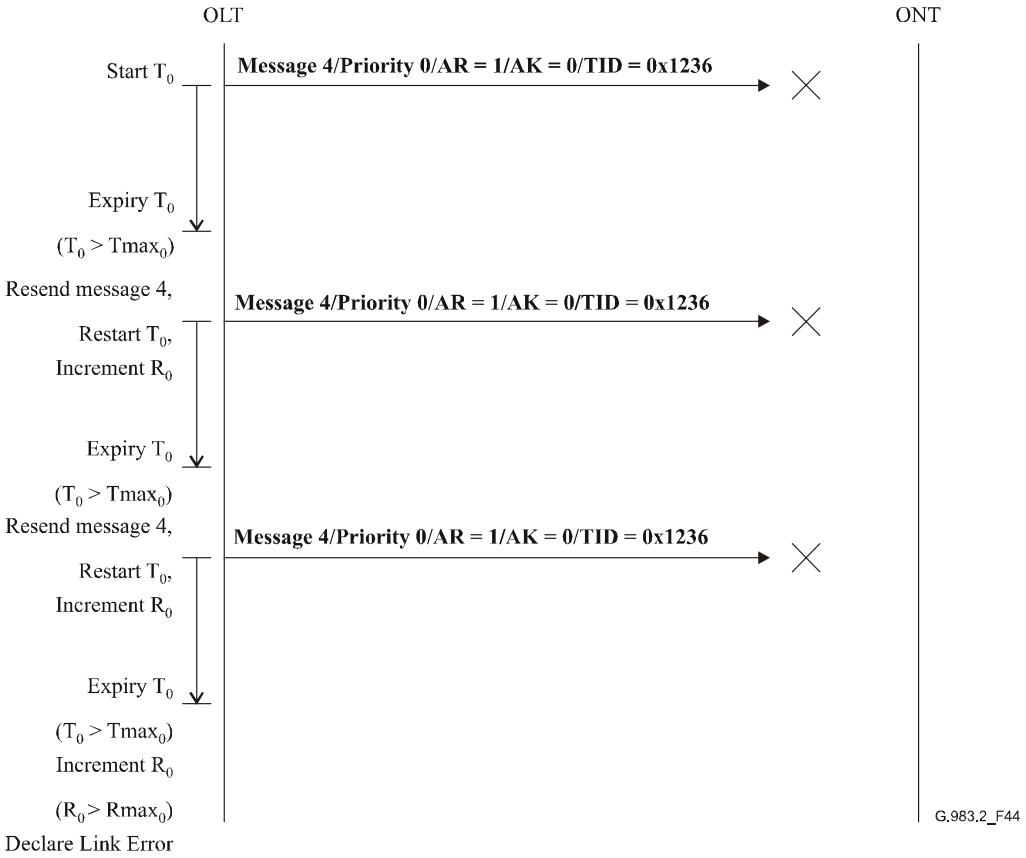


Figure 44/G.983.2 – OMCC link error detection

9.3 OMCI handling within the ONT

9.3.1 Prioritized protocol entities

This clause specifies the behaviour of the ONT more precisely than in the preceding clause with respect to the prioritized request mechanism of the OMCC.

Conceptually, the way the ONT handles the OMCC requests can be illustrated by referring to the dual priority level implementation example shown in Figure 45.

When the ONT receives an ATM cell via the VCC associated with the management channel, it shall calculate the CRC and compare it with the value found in the AAL 5 trailer. If the values do not match, the ONT shall discard the message. It is recommended that this event be logged by the ONT and possibly communicated to the OLT by some out-of-band mechanism but, as far as the protocol is concerned, the message is discarded silently.

Messages with a correct CRC are then placed into either of two distinct incoming FIFO-based message queues, according to the priority level (i.e., high or low) of the associated command. Note that the priority level of a given command is encoded using the most significant bit of the transaction correlation Identifier field. If the associated incoming message queue is already full, the ONT must simply discard the message. It is recommended that this event be logged by the ONT and possibly communicated to the OLT by some out-of-band mechanism but, as far as the protocol is concerned, the message is discarded silently.

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There are two distinct incoming command processing protocol entities (one associated with each priority level) that are used to service messages sequentially from an independently associated incoming FIFO queue. Each of these protocol entities can execute concurrently. If a message is a one-way command (i.e., an unacknowledged command), the protocol entity will simply have the command executed. If a message is an acknowledged command, the protocol entity must first look at the Transaction Correlation Identifier. If it is not equal to the Transaction Correlation Identifier of the last executed command with the same priority level, the protocol entity will have the command executed and place the response/acknowledgement (with identical Transaction Correlation Identifier) in the outgoing FIFO queue of the same priority level. If the Transaction Correlation Identifier is equal to that of the last executed command with the same priority level (i.e., the case where the controller retransmits a command due to lack of proper acknowledgement), the protocol entity will not actually have the command executed but simply will place the response from the last execution of that command in the outgoing FIFO queue (i.e., resend the previous acknowledgement response). It is assumed that in both cases, the command processing protocol entity for a given priority level will block until there is room in the associated outgoing FIFO queue for the response message.

In the other direction, requests by the applications to send autonomous event notifications will simply result in the corresponding messages being directed to an event notification protocol entity for transmission to the OLT. The event notification protocol entity will forward these event notification messages to the low priority outgoing FIFO queue. In this case as well, the event notification protocol entity will block until there is room in the low priority outgoing FIFO queue to hold the notification message. The CRC generator will remove messages from the outgoing FIFO queues using a strict priority discipline (i.e., the low-priority queue will only be serviced when the high-priority queue is empty), generate a CRC, append a properly-formatted AAL 5 trailer to the cell payload, and transmit the message to the OLT.

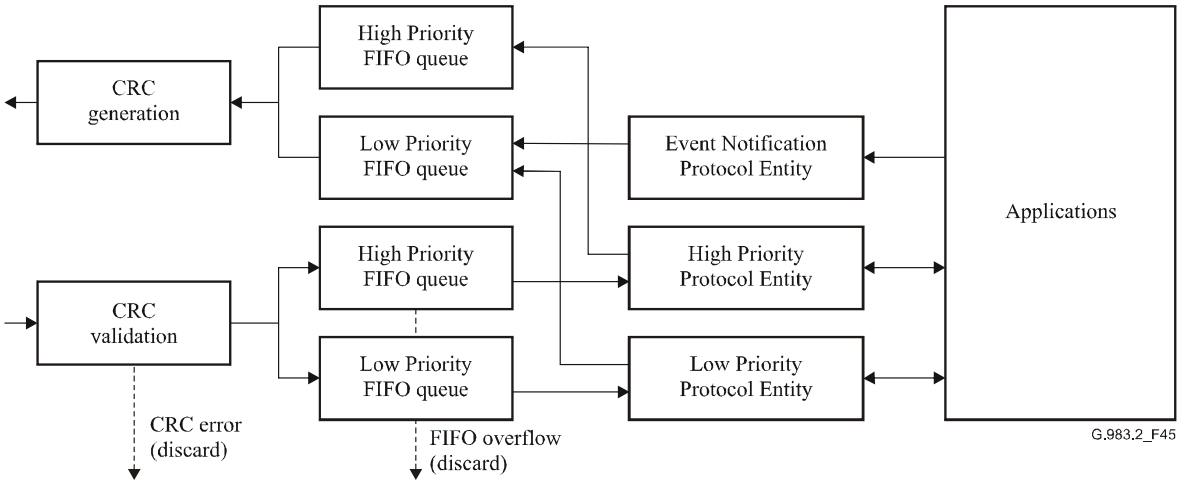


Figure 45/G.983.2 – Protocol entities within the ONT

9.3.2 Restrictions on the actions in relation to the protocol entities

To reduce the complexity and the amount of memory necessary in the ONT, the OLT is not allowed to issue a MIB Upload or a Software Download of a certain priority level while a similar action in the other priority level is in progress.

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Annex A

Transport of video return path service

A.1 Network overview

This Recommendation considers networks that use B-PON systems that include a video overlay. This system provides a bidirectional ATM transport service and a unidirectional video or data downstream broadcast or unicast service. If only broadcast video services are desired, then the only video transport required is the third wavelength, as shown in Figure A.1. The ONT converts the signals on the third wavelength to electrical signals on a coaxial output, suitable for video appliances such as televisions.

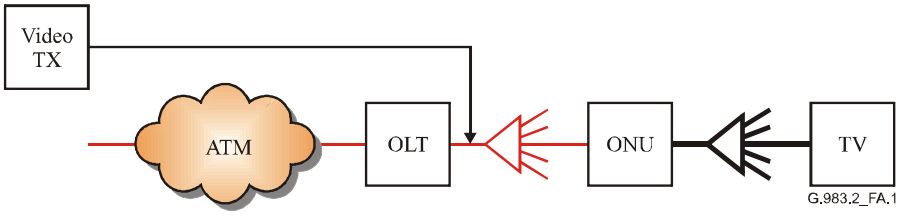


Figure A.1/G.983.2 – A B-PON with broadcast video only

In many cases, however, interactive video services are needed. In this case, the customer's video termination equipment (commonly referred to as a Set Top Box, or STB) needs connectivity back to the video control equipment in the central office. In the case of the B-PON system, this connectivity must be provided by the ONU and OLT. This scenario is depicted in Figure A.2. The connection begins in the STB, which transmits its information up the coaxial cables that connect it to the ONT. The ONT must receive this information, and adapt it to be carried on the B-PON in the form of an ATM connection. The OLT transports this connection through the network. At some point, the connection then terminates on the video control equipment.

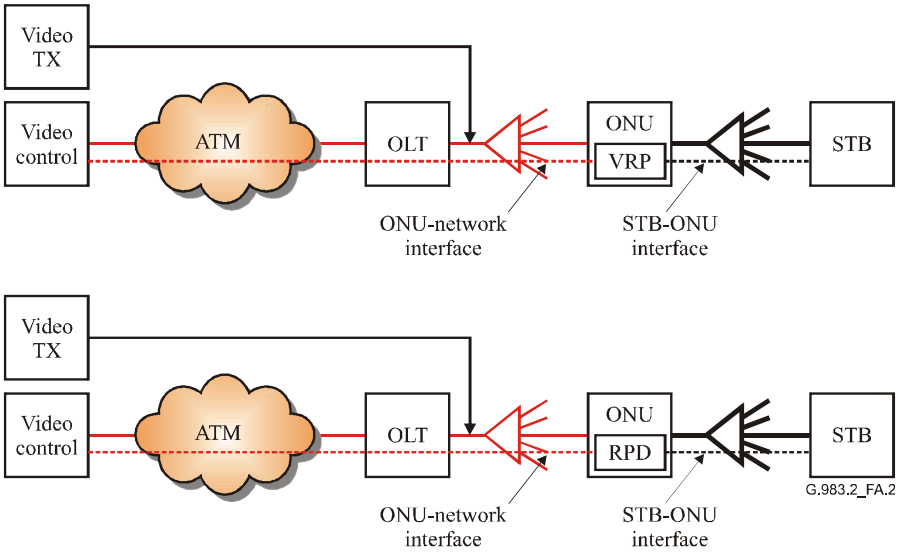


Figure A.2/G.983.2 – A B-PON with interactive video services

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Figure A.2 defines two interfaces that are important to interoperability. The STB-ONU interface is the first. This interface is defined by two standards: SCTE 55-1 and SCTE 55-2. These are peer standards that are mutually exclusive; that is, a system will run either one or the other, but not both at one time. Furthermore, each of these standards defines several grades of capability, one being chosen as the default (or basic practice). Clauses A.2 and A.4 clarify this interface for the purposes of providing the Video Return Path over B-PON.

The second important interface is the ONU-Network interface. This logical interface is an ATM connection that conducts the return path information back to the video equipment in the central office. The information must be formatted in a standardized way so that common control equipment can be used. The formatting depends on the particular return path interface being used. Clauses A.3 and A.5 define these formats.

Given the situation that there are two modes on both interfaces, it makes sense that the ONU has two modes of operation, denoted Mode 1 and Mode 2. Mode 1 corresponds to support of the SCTE 55-1 system, and Mode 2 corresponds to support of the SCTE 55-2 systems. The mode is set by the network operator during the initialization management of the video service.

A.2 Mode 1 STB-ONU Interface

The STB-ONU interface, in this case, is based on that from the commonly deployed SCTE 55-1 standard. The 55-1 standard defines all the aspects of the interactive video control system, while the STB-ONU interface herein described is only concerned with the upstream transmission of data. Therefore, we specify below which sections and sub-sections are relevant to the definition of the STB-ONU interface.

Relevant sections of SCTE 55-1 that apply to the STB-ONU interface:

5.2 PHYSICAL LAYER FOR RETURN-PATH TRANSMISSION

5.2.1 Return-Path Modem Description – A general explanation, Required.

5.2.2 RF Return Path Packet Format – Specifies the format of the upstream packet, Required.

Please note that the unique word specified in this section is given in standard QPSK notation, and not differential QPSK notation.

5.2.3 RF Return-Path Forward Error Correction – Specifies the code used for the FEC bytes, Optional.

Please note that while the FEC will be calculated by compliant STBs, the ONT's processing of the FEC is optional.

5.2.4 RF Return-Path Randomizer – Specifies the randomizer used in the upstream packets, Required.

Please note that the randomizer output is applied to the entire packet EXCEPT the unique word. Also, the programmable value of the randomizer seed to be used is given in the Video Return Path Service Profile Managed Entity.

5.2.5 RF Return Path Modulator – Specifies the physical layer to be used, Required.

Note that while the center frequency is specified to a wider range, in actual practice this frequency is limited from 8 to 12 MHz. Also, the DQPSK mode to be used is given in the Video Return Path Service Profile Managed Entity.

5.2.6 RF Return-Path Demodulator Specification – Specifies the physical layer to be used, Required.

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All other sections of SCTE 55-1 are not relevant to the STB-ONT interface. In particular, the extended practice (section 5.3) is explicitly not supported.

A.3 Mode 1 ONU-network interface

In mode 1, the ONU must forward the derandomized packet sequence field (1 byte) and the ATM data (53 bytes) intact to the video control system. The procedure to do this is:

1) Receive the DQPSK burst, and capture all 62 bytes of data and measure the power level of the burst relative to the nominal input power level for the receiver.
2) Exclusive OR the randomizer sequence with the received data.
3) (Optional) Calculate the FEC parity, compare with that received, and detect/correct errors. Discard cells that have uncorrectable errors.
4) Assemble the datagram to be forwarded, which is 56 bytes in length.
5) Encapsulate the datagram using AAL 5.
6) Forward the AAL 5 segments over an ATM Virtual Circuit allocated on the PON.

The structure of the incoming RF burst data and the outgoing ATM circuit data is shown in Figure A.3. The outgoing datagram is always 56 bytes in length, and is composed of a two byte Level Indication field, a one byte packet sequence field, and a 53 byte ATM data field. The unique word and FEC bytes are terminated in the ONU.

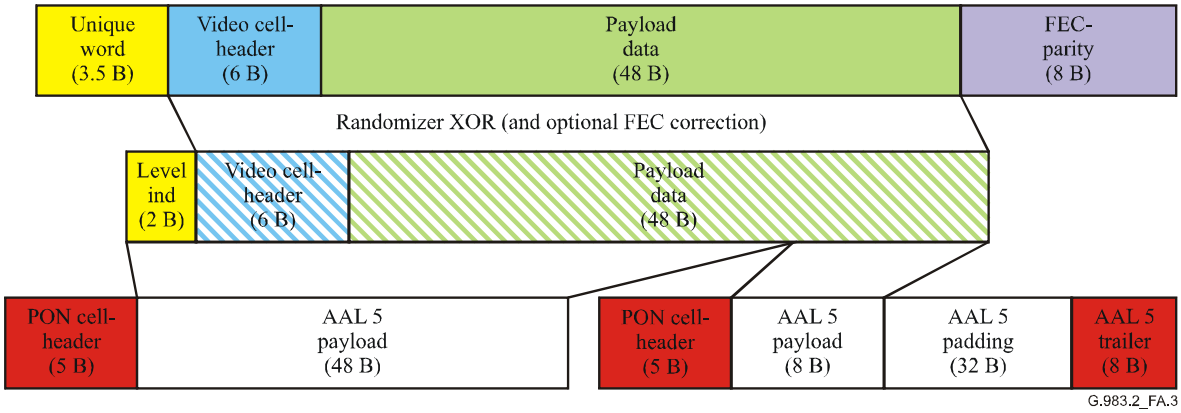


Figure A.3/G.983.2 – The transformation of a 55-1 formatted burst into ATM datagrams

The level indication field is formatted as: a1bb bbbb 0000 0000, where:

The bit 'a' is a detection indicator to be used if FEC is implemented in the ONT (if not, bit 'a' should be set to zero always), where:

a = 0 means burst was detected without errors;

a = 1 means a burst was detected with errors, but was corrected.

The '1' is a reserved bit.

The bits 'bbbbbb' are a power indication, containing the 2's complement representation of the measured power of this burst, in units of decibels relative to the nominal receive power of the equipment. For example, if the nominal receive power of the ONU is 10 dBmV, and a burst arrives with 17 dBmV, then bbbbbb=000111. If the same ONU receives a 7 dBmV burst, then bbbbbb=111101.

The "0000 0000" are all reserved bits.

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The ATM VC that carries the video return path data can be configured to provide a UBR service. The cell rate of the service can be calculated from the latency requirements of the 55-1 protocol and equipment implementation. Practical implementations of this protocol have round trip delay tolerances on the order of 100 ms. After this time, the STB will begin to re-transmit its upstream cells. One of the contributors of the delay will be the cell transmission time, which in our case is double the inverse cell rate.

For example, if 20 ms is allocated for cell transmission time, then the cell rate for the video return path connection should be made 2/20ms = 100 cps.

To summarize, the ONU-Network interface is 56 byte payloads (as defined above) encapsulated in AAL 5, carried in an ATM VC.

A.4 Mode 2 STB-ONU interface

The STB-ONU interface in this case is based on that from the commonly deployed SCTE 55-2 standard. The 55-2 standard defines all the aspects of the interactive video control system, while the STB-ONU interface herein described is only concerned with the upstream transmission of data. Therefore, we specify below which sections and subsections are relevant to the definition of the STB-ONU interface.

Relevant sections of SCTE 55-2 that apply to the STB-ONU interface:

2.2 Upstream Physical Interface Specification – A general explanation of the system, Required.

2.2.1 Quaternary Phase Shift Keying (QPSK) – A description of the physical layer used, Required.

Grade A 256 kbit/s is optional

Grade B 1.544 Mbit/s is required

Grade C 3.088 Mbit/s is optional

2.2.2 Coaxial Cable Impedance – A physical layer parameter, Required.

2.2.3 Time Division Multiple Access (TDMA), Optional.

2.2.4 Contention Based Access, Required.

All other sections of SCTE 55-2 are not relevant to the STB-ONT interface.

A.5 Mode 2 ONU-network interface

In mode 2, the ONU forwards the de-randomized and re-addressed ATM cells (53 bytes) to the video control system. The procedure to do this is:

1) Receive the QPSK burst, and capture all 59 bytes of data.
2) Exclusive OR the randomizer sequence with the received data.
3) (Required) Calculate the FEC parity, compare with that received, and detect/correct errors. Discard cells that have uncorrectable errors.
4) Perform a virtual circuit merge on all connections coming from the subtending STBs. Note that this merging function requires the ONU to queue all cells in a subtending VC until the end-of-packet indication is received. This maintains AAL 5 user payload frame delineation.
5) Forward the merged AAL 5 segments over an ATM Virtual Circuit allocated on the PON.

The structure of the incoming RF burst data and the outgoing ATM circuit data is shown in Figure A.4. The outgoing datagram is a 53-byte ATM cell. The cells have undergone a VC merge. The unique word and FEC bytes are terminated in the ONU.

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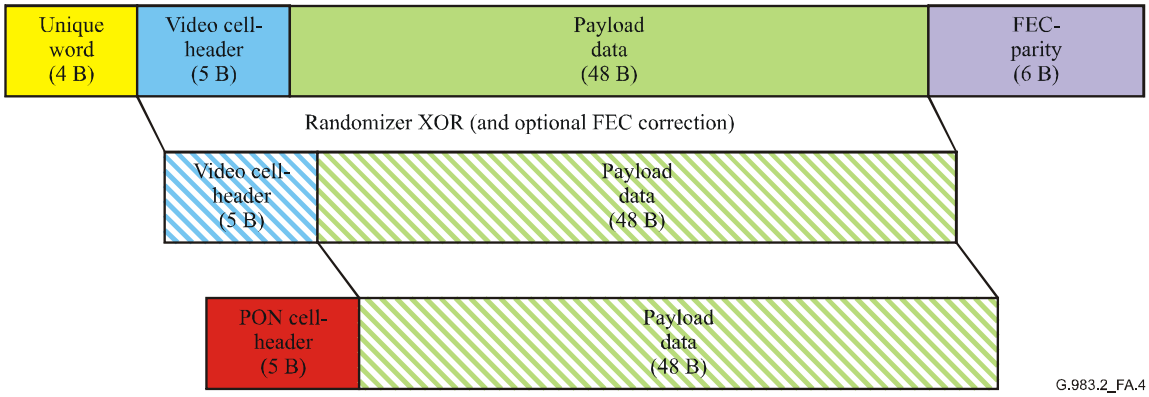


Figure A.4/G.983.2 – The transformation of a 55-2 formatted burst into ATM datagrams

The ATM VC that carries the video return path data can be configured to support the operator chosen QoS.

This method provides efficient bandwidth usage upstream since it maps the ATM payload from the STB onto the PON directly on a PON allocated VC.

To summarize, the ONU-Network interface is 53 byte cells, carrying AAL 5 encapsulated data, using a PON allocated ATM VC.

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Appendix I

OMCI common mechanisms and services

This appendix describes the common mechanisms of the OMCI, e.g., the MIB resynchronization, and the OMCI services, e.g., the equipment management or connection management.

I.1 Common mechanisms

The common mechanisms consist of:

a) MIB data sync increase.

b) MIB audit and resynchronization.

c) Alarm sequence number increase.

d) Alarm audit and resynchronization.

e) Get an attribute that is larger than the OMCI message contents field.

f) Create an instance of a managed entity with an attribute that is larger than the OMCI message contents field.

g) Reporting of test result.

h) Alarm Reporting Control.

These common mechanisms will be explained by the use of scenario diagrams.

I.1.1 MIB data sync increase

The MIB at the OLT and the instances of the managed entities in the ONT have to be synchronized at all times. This clause describes the means for achieving this. The "tool" used for this is the MIB data sync attribute of the ONT Data managed entity.

The MIB data sync attribute is a global 8-bit *sequence number*. When auditing the MIB in the ONT, the OLT requests this sequence number. If this number coincides with the corresponding sequence number in the OLT, no further action is needed, as the two MIBs, in ONT and OLT, are thought to be identical. If there is a discrepancy, the OLT either:

1) downloads its copy (including the MIB data sync) of the MIB to the ONT, or

2) uploads the MIB of the ONT, compares it with its own MIB, sends the necessary commands to the ONT to correct the differences and downloads its sequence number.

The ONT will be audited with respect to its MIB in three cases:

a) On loss and re-establishment of the OMCC.

b) Periodically, based on the operator's requirements.

c) On demand of the OpS.

On detecting a newly installed ONT, regardless of the sequence number of its MIB, the OLT will perform either a MIB audit followed by whatever modifications are required, or a MIB reset and ONT startup procedure (see I.2.1).

The MIB data sync counter will be incremented for the creation and deletion of managed entity instances that are the consequence of a command by the OLT. The MIB data sync counter will also be incremented for attribute value changes which are the consequence of a command by the OLT. The MIB data sync counter will be incremented once per executed command (see Figure I.1).

In contrast, the MIB data sync counter will not be incremented for autonomous creation and deletion of managed entity instances by the ONT itself. Neither will the MIB data sync counter be

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incremented for autonomous changes to attributes of managed entities within the ONT (see Figure I.2).

The order in which the OLT and the ONT will update their MIBs and increment the MIB data sync is not imposed. However, both the OLT and the ONT must locally update the MIB and increment the MIB data sync as one atomic action.

When incremented, the sequence number that follows 255 is 1. 0x00 is reserved for the following cases:

a) Default MIB with which the ONT left the factory.

b) An ONT which after (re-) initialization cannot restore its MIB.

In other words, a sequence number of 0 indicates that the ONT's MIB is not well defined, and therefore requires audit/reconfiguration.

Note that no mechanisms exist to detect that an autonomous attribute value change notification has been lost. Therefore, the OLT must regularly read the values of the attributes that can change their values autonomously.

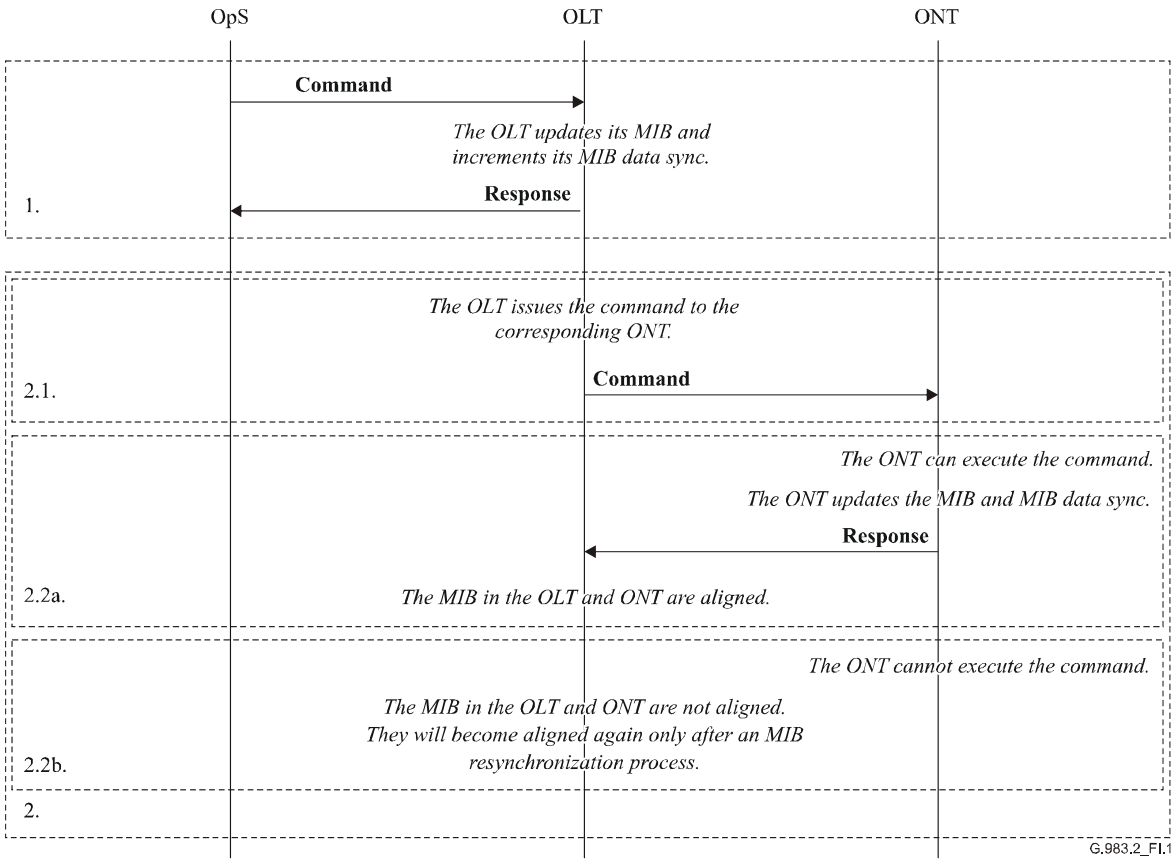


Figure I.1/G.983.2 – Increment of MIB data sync at ONT and OLT under OLT command

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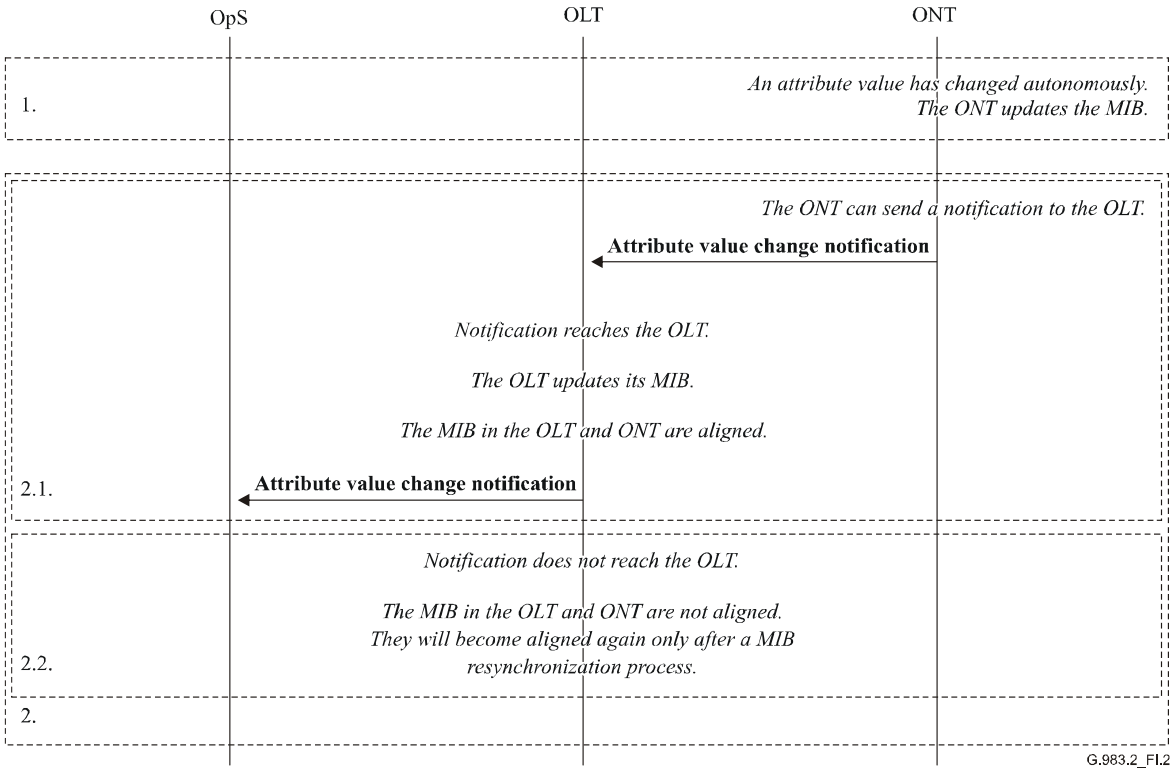


Figure I.2/G.983.2 – No increment of MIB data sync at ONT and OLT in case of autonomous attribute value changes

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I.1.2 MIB audit and resynchronization

Figure I.3 shows the scenario diagram of the MIB audit and MIB resynchronization process.

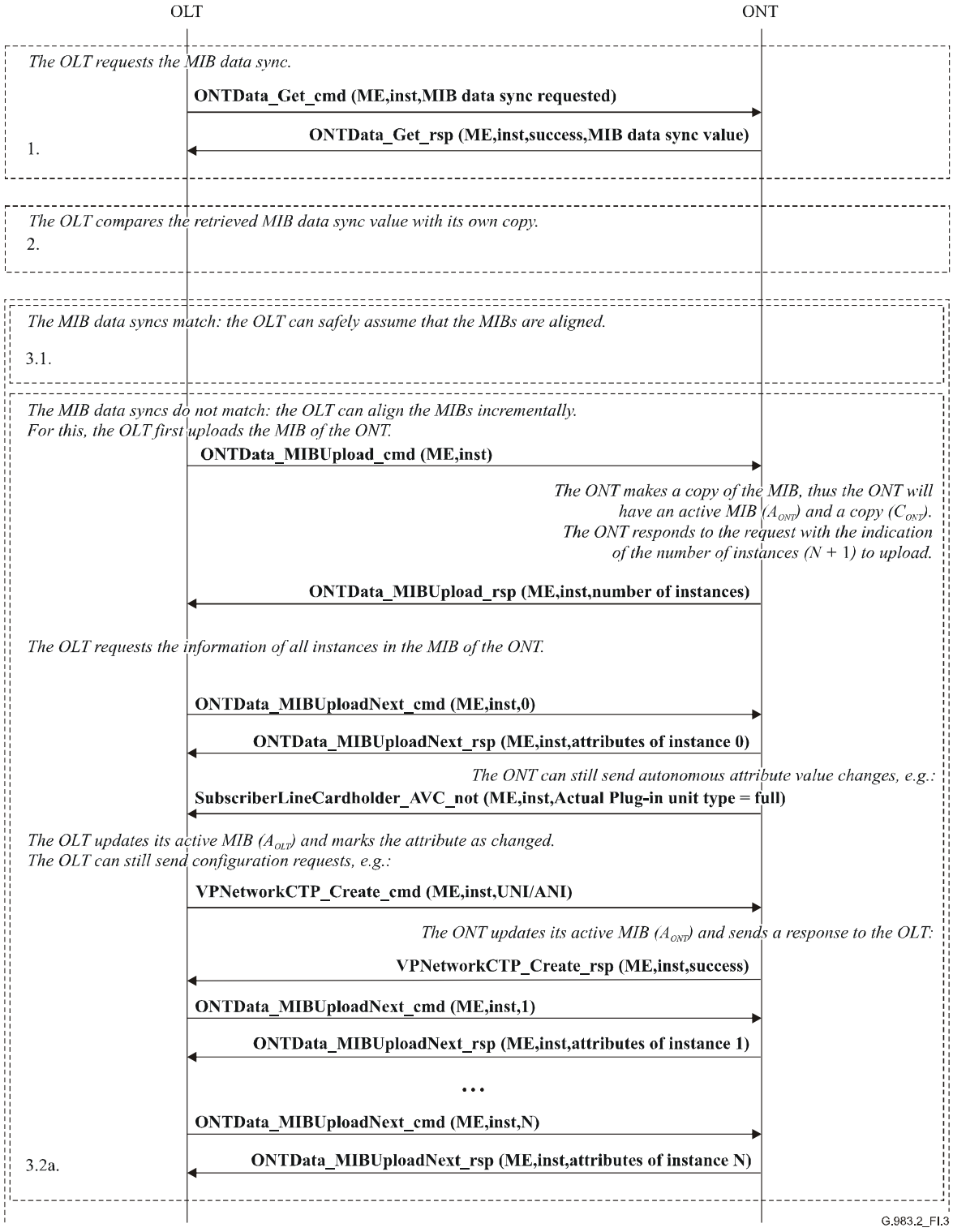


Figure I.3/G.983.2 – Audit and MIB resynchronization

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The OLT must issue as many MIBUploadNext requests as the number of instances given in the MIBUpload response. The maximum time between two MIBUploadNext requests is 1 minute. If the OLT does not send a MIBUploadNext request within this time after the previous MIBUploadNext request or after the MIBUpload start request, the ONT assumes the MIB upload to be terminated. The ONT can drop the copy of the MIB, and consider any MIBUploadNext requests to be out of range, as described in II.2.22.

I.1.3 Alarm sequence number increase

The ONT informs the OLT of alarm status changes by sending alarm status change notifications. Note that these notifications are sent in unacknowledged messages that carry an eight-bit alarm sequence number for the benefit of the OLT to detect loss of alarm notifications (see Figure I.4 and I.1.4). After a restart of the ONT, the alarm sequence number is reset so that the first alarm notification sent by the ONT will have an alarm sequence number equal to 1. The alarm message sequence number is incremented for each alarm notification and wraps around from 255 to 1. Consequently, an alarm notification with sequence number 0x00 will never be sent.

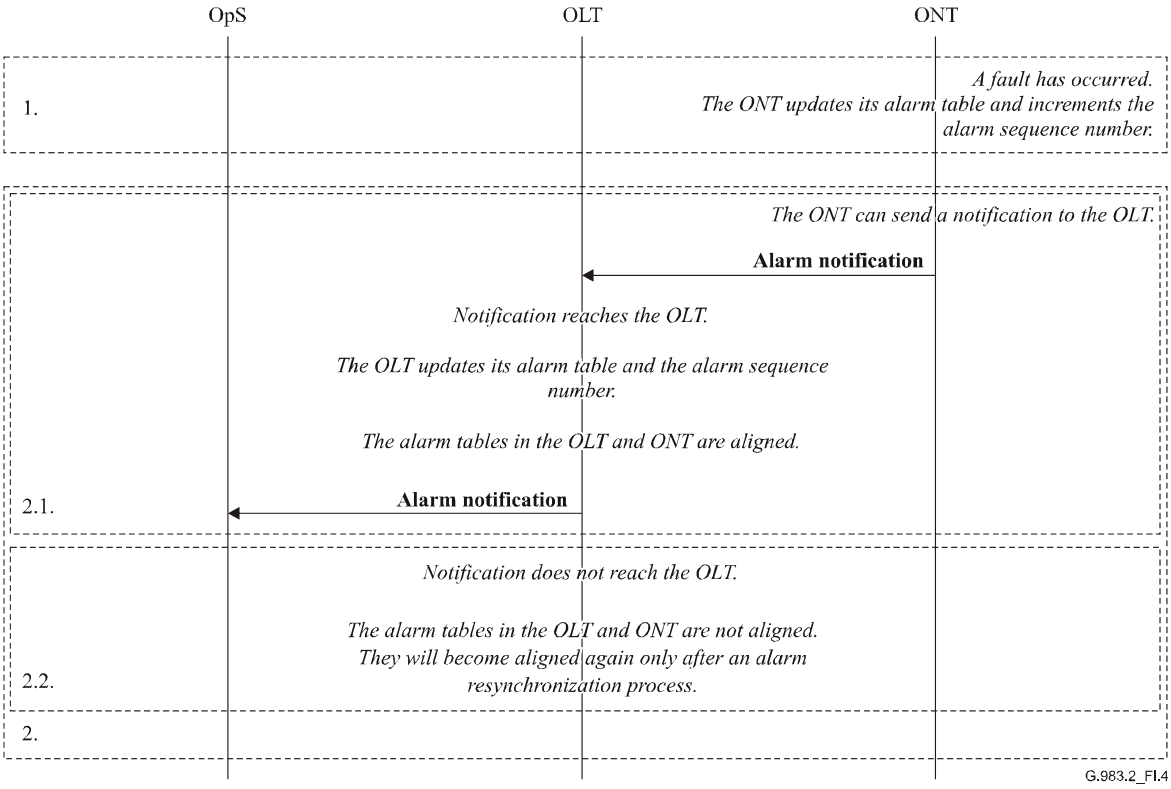


Figure I.4/G.983.2 – Increment of alarm sequence number at ONT and OLT

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I.1.4 Alarm audit and resynchronization

When the OLT detects a gap in the received sequence, as shown in Figure I.5, it asks the ONT for an alarm status report by sending a "Get All Active Alarms" command. Obviously, this command is acknowledged by a response that contains the number of managed entity instances that have outstanding alarms. The OLT will request the alarm status of all these managed entities instances via the "Get All Alarms Next" command. The OLT will compare these alarm statuses of all these instances with its own and will notify the network manager of the changes. The alarm sequence number is reset by the ONT when it receives the "Get All Active Alarms" request.

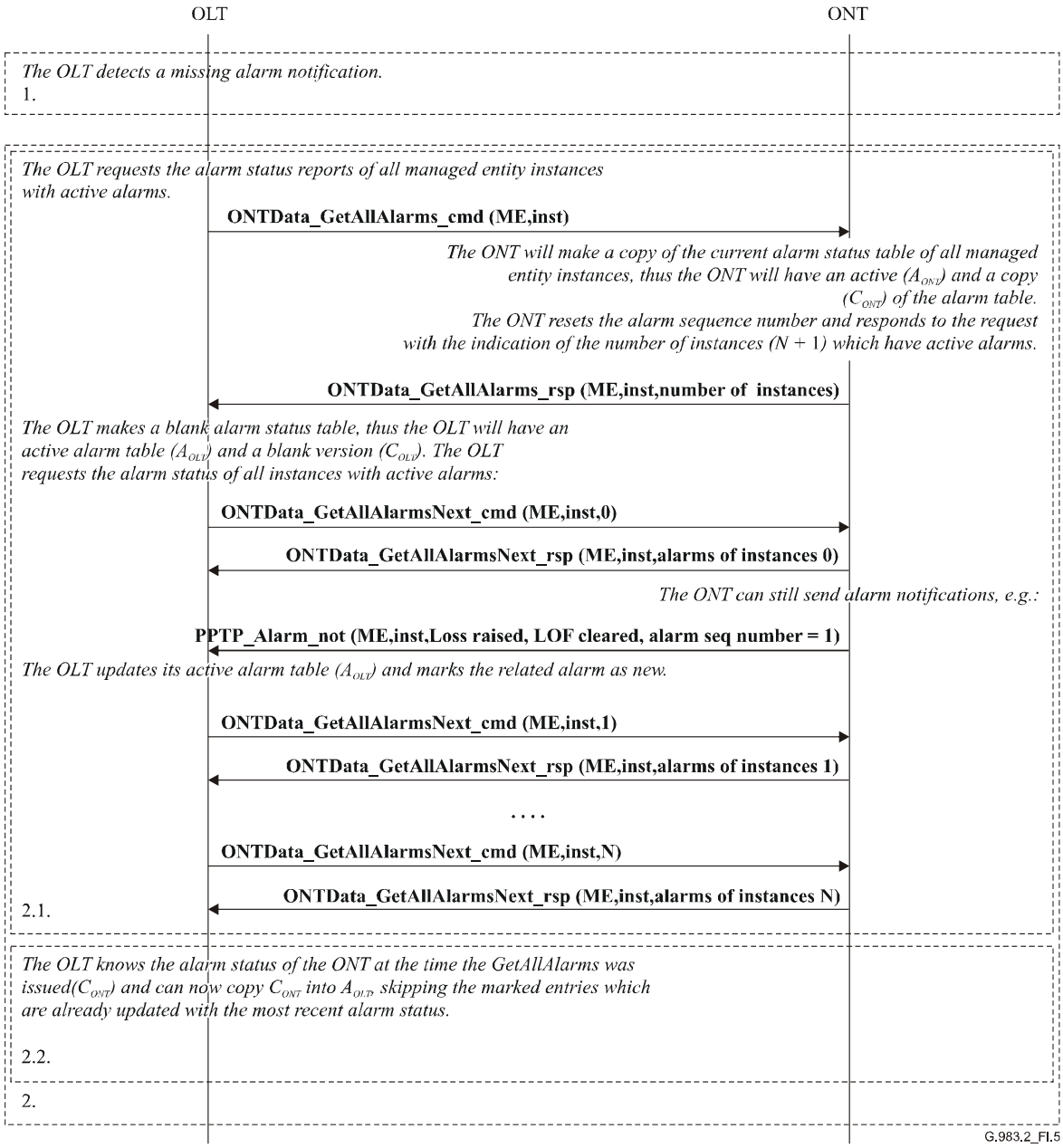


Figure I.5/G.983.2 – Audit and alarm resynchronization

The OLT must issue as many GetAllAlarmsNext requests as the number of instances given in the GetAllAlarms start response. The maximum time between two GetAllAlarmsNext requests is

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1 minute. If the OLT does not send a GetAllAlarmsNext request within this time after the previous GetAllAlarmsNext request or after the GetAllAlarms start request, the ONT assumes the alarm upload to be terminated. The ONT can drop the copy of the alarm table, and consider any GetAllAlarmsNext requests to be out of range, as described in II.2.18.

I.1.5 Get an attribute that is larger than the OMCI message contents field

Figure I.5-a shows the scenario diagram when the OLT gets an attribute that is larger than the OMCI message contents field (see 9.1.9 for limitations). The OLT asks the ONT for the size of the attribute by sending a "Get" command. In the Get response, the ONT uses 4 bytes to indicate the size of the data. This implies that the Get response message is formatted as if the oversized attribute had a size of 4 bytes. Then, the OLT will request the attribute data from the ONT via the appropriate number of "Get next" commands. This scenario is used for the MAC Filter Table attribute of MAC Bridge Port Filter Table Data managed entity and the Bridge Table attribute of the MAC Bridge Port Bridge Table Data managed entity.

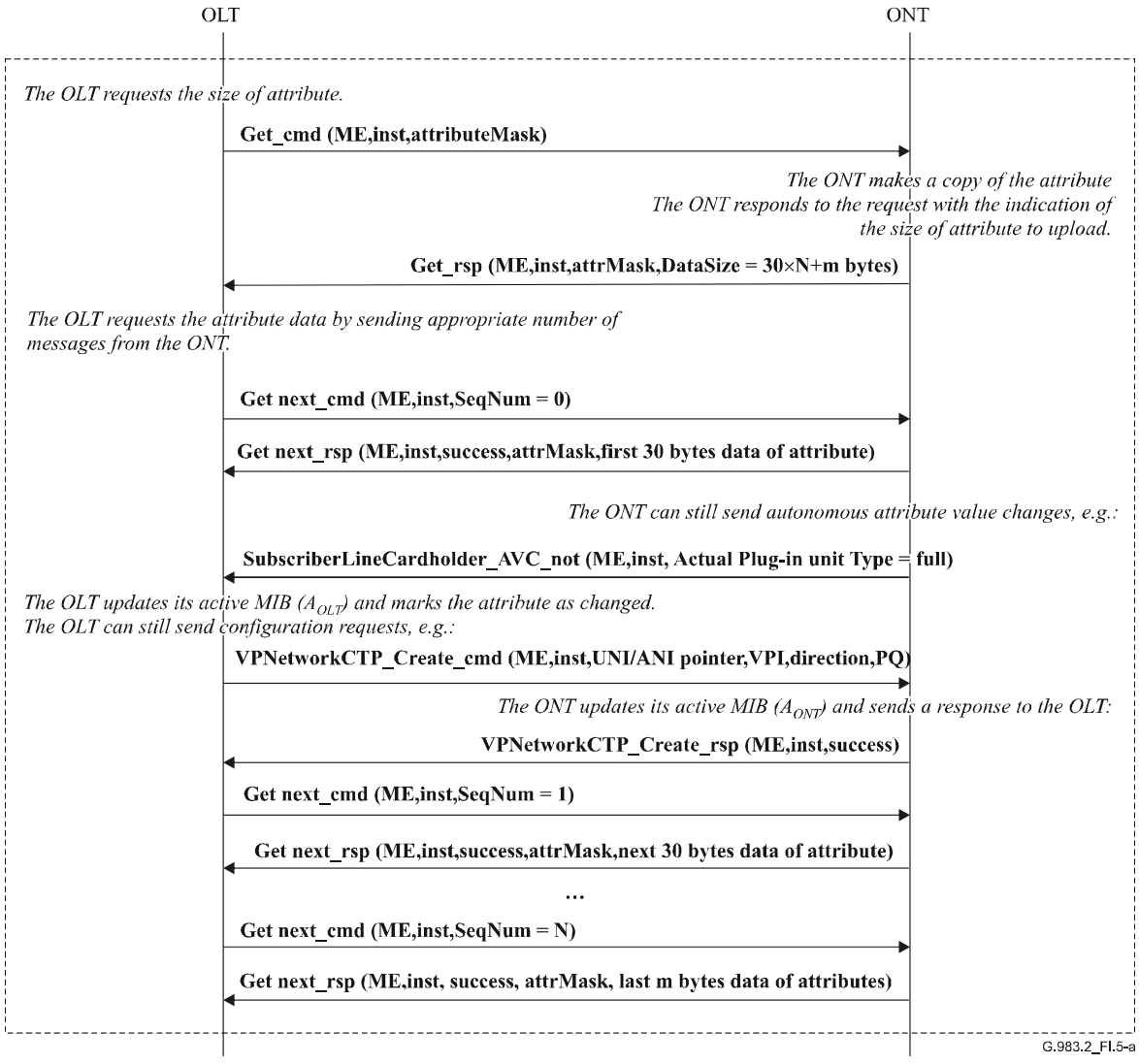


Figure I.5-a/G.983.2 – Get an attribute that is larger than the OMCI message field

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The OLT must issue as many "Get next" requests as needed to accommodate the size of the data indicated in the Get response. The maximum time between two "Get next" requests is 1 minute. If the OLT does not send a "Get next" request within this time after the previous "Get next" request or after the Get start request, the ONT assumes the Get attribute command has been terminated and can drop the copy of the attribute, and consider any GetNext requests to be out of range, as described in II.2.44. In addition, the OLT should not initiate simultaneous multiple get-next processes to any one ONT.

I.1.6 Create an instance of a managed entity with an attribute that is larger than the OMCI message contents field

Figure I.5-b shows the scenario diagram when the OLT creates an instance of a managed entity with an attribute that is larger than the OMCI message contents field (exactly 33 bytes). The OLT first creates an instance of the managed entity without attribute data by sending a "Create" command and then sets the attribute data by sending the appropriate number of "Set" commands. This scenario is useful for Threshold Data $_{\text{B-PON}}$ ME.

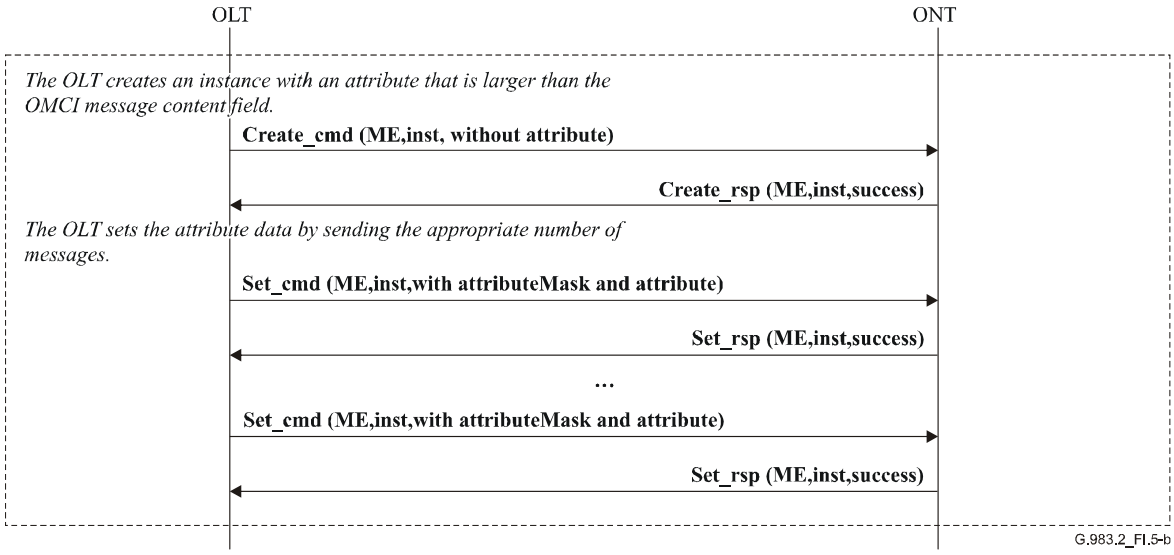


Figure I.5-b/G.983.2 – Create an instance of a managed entity with an attribute that is larger than the OMCI message field

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I.1.7 Report test result

Figure I.5-c shows the scenario diagram for when the OLT requests that the ONT perform a test. The OLT requests that the ONT starts testing by sending a "Test" command. This command is acknowledged by a "Test" response. Then, the ONT carries out the test. After the test is complete, the ONT reports the test result via a "Test result" notification message. This scenario is used for the "SelfTest" attribute of $ONT_{B\text{-}PON}$ managed entity or Subscriber Line Card managed entity. Moreover, this scenario may be useful for MLT tests or for additional tests that may be added in the future.

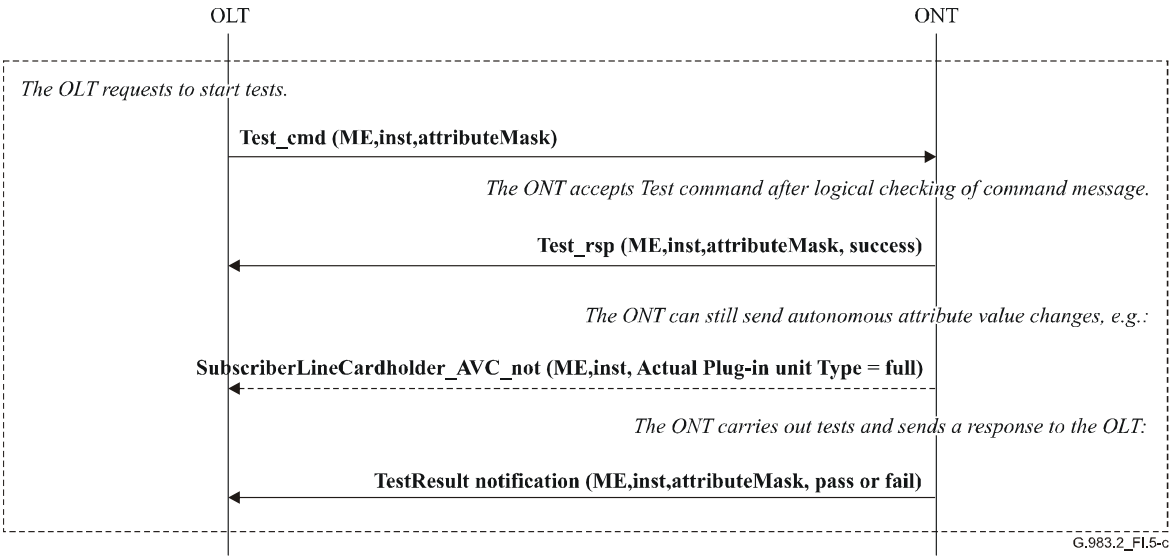


Figure I.5-c/G.983.2 – Reporting of test result

I.1.8 Alarm reporting control

Alarm Reporting Control allows for the suppression of alarms from physical path termination points, under the control of the management system. A complete description of ARC from a generic viewpoint is given in Amendment 3 (2001)/M.3100. The OMCI provides for ARC functions using two attributes of the PPTP, 'ARC' and 'ARC Interval'. These two attributes are described below

ARC:

This attribute allows the activation of Alarm Reporting Control (ARC) for this PPTP. The attribute works in concert with the ARC_interval attribute. A value of zero indicates disable, while a value of 1 indicates enable. The default value is disabled. When the ARC attribute is set to disabled, the PPTP is in the "ALM" state, as defined in Amendment 3 (2001)/M.3100. Alarms are reported normally in the ALM state. When the ARC attribute is set to enabled, then the PPTP is in the "NALM-QI" state, as defined in Amendment 3 (2001)/M.3100. Alarms are suppressed in this state.

The PPTP moves from the ALM state to the NALM-QI state when the OLT changes the ARC attribute to enabled. The PPTP moves from the NALM-QI state to the ALM state when either:

1) the PPTP is trouble free and the ARC_interval timer expires; or

2) the ARC attribute is set to disable by the OLT.

If the ARC_interval timer expires, the ONT will set the ARC attribute to disabled autonomously, and send an AVC to notify the OLT. Please refer to Amendment 3 (2001)/M.3100 for more extensive discussion of the behaviours of the state diagram.

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Note that the ARC_interval can assume normal timing values of 0 to 254 minutes. The value of 0 implies that a PPTP in the NALM-QI state will immediately transition to the ALM state upon detection of a problem-free state. An ARC_interval value of 255 has the special meaning of 'infinity'. This value means that the timer shall never expire, and the PPTP will stay in the NALM-QI state until the OLT sets the ARC attribute to disabled. This behaviour is equivalent to the "NALM" state, which is another generic behaviour of the ARC function in Amendment 3 (2001)/M.3100.

Note that there is no support for the "NALM-TI" subfunction in the OMCI system. (R,W) (optional) (1 byte)

ARC_interval:

This attribute defines the interval to be used with the ARC function for this PPTP. The values 0 through 254 give the duration in minutes for the NALM-QI timer. The special value 255 means that the timer never expires. The default value is zero. (R, W) (optional) (1 byte)

I.2 Common services

The common services consist of:

a) start-up phase of ONT;
b) on demand subscriber line card provisioning;
c) on demand subscriber line card de-provisioning;
d) plug-and-play subscriber line card provisioning;
e) plug-and-play subscriber line card de-provisioning;
f) ATM VP Cross-Connection or ATM VC Cross-Connection set-up;
g) ATM VP Cross-Connection or ATM VC Cross-Connection breakdown;
h) software image download;
i) software image changes;
j) MAC bridge service connection set-up;
k) MAC bridge service connection tear-down;
l) Addition of entities to MAC Filter Table;
m) Removal of entities from MAC Filter Table;
n) Voice service connection set-up; and
o) Voice service connection tear-down;
p) IP Router service connection set-up;
q) IP Router service connection tear-down;
r) Addition of entities to IP Static Routes;
s) Removal of entities from IP Static Routes;
t) Structured/Unstructured CES service connection set-up (ATM mode);
u) Structured/Unstructured CES service connection tear-down (ATM mode).

All the listed services will be explained by the use of scenario diagrams.

I.2.1 Start-up phase of ONT

The start-up phase of an ONT, from the OMCI point of view, belongs to one of two cases:

a) the ONT is "new" to the OLT; or
b) the OLT already "saw" this ONT at this PON.

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The details of start-up scenarios also vary for ONTs with different configuration options, e.g.,

a) ONT with cardholders at both PON IF and UNI;

b) ONT with integrated interfaces at both PON IF and UNI;

c) ONT with cardholders at PON IF and integrated interfaces at UNI; and

d) ONT with integrated interfaces at PON IF and cardholders at UNI.

Here the following scenarios will only show cases a) and b), from which the scenarios for cases c) and d) can be deduced.

NOTE – The preferred solution is that Subscriber Line Card and Subscriber Line Cardholder managed entities should always be modelled, regardless of whether or not the ONT has integrated interfaces.

Figure I.6 shows the start-up phase of a "new" ONT with Cardholders on both sides. Figure I.7 shows the start-up phase of a "new" ONT with integrated interfaces on both sides. Figure I.8 shows the start-up phase of an "old" ONT.

The behaviour of the ONT with respect to inserted Subscriber Line Cards during the start-up phase is not shown in the following figures. This behaviour is the subject of I.2.2.

Note that if attribute value changes do not arrive at the OLT, the OLT will not know the number of cardholders or integrated ports that reside in the ONT. The OLT can request the information of the newly created managed entity instances by a sequence of "Get" requests. If a "Get" request is issued on a non-existing instance, the response message to the OLT will indicate the error – Unknown managed entity instance.

In general, the AVCs shown in Figures I.6 and I.7 should be viewed as a partial method of ONT discovery. The OLT cannot rely on the receipt of AVCs to learn all ONT information, because not all managed entities or attributes issue AVCs, and because AVCs can be lost in transmission without an error being detected. Therefore, the OLT should audit any ONT immediately after a Reset is completed.

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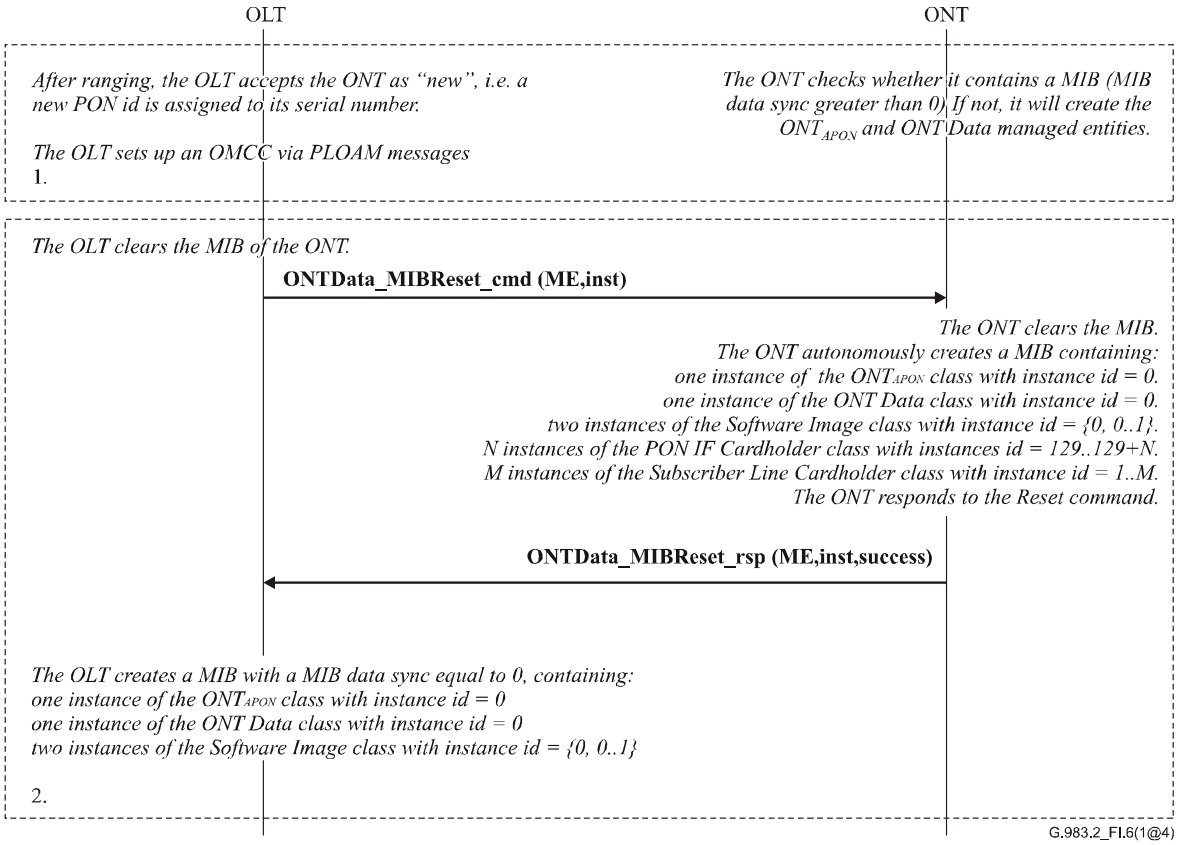


Figure I.6/G.983.2 – Start-up of a "new" ONT with Cardholders on both sides

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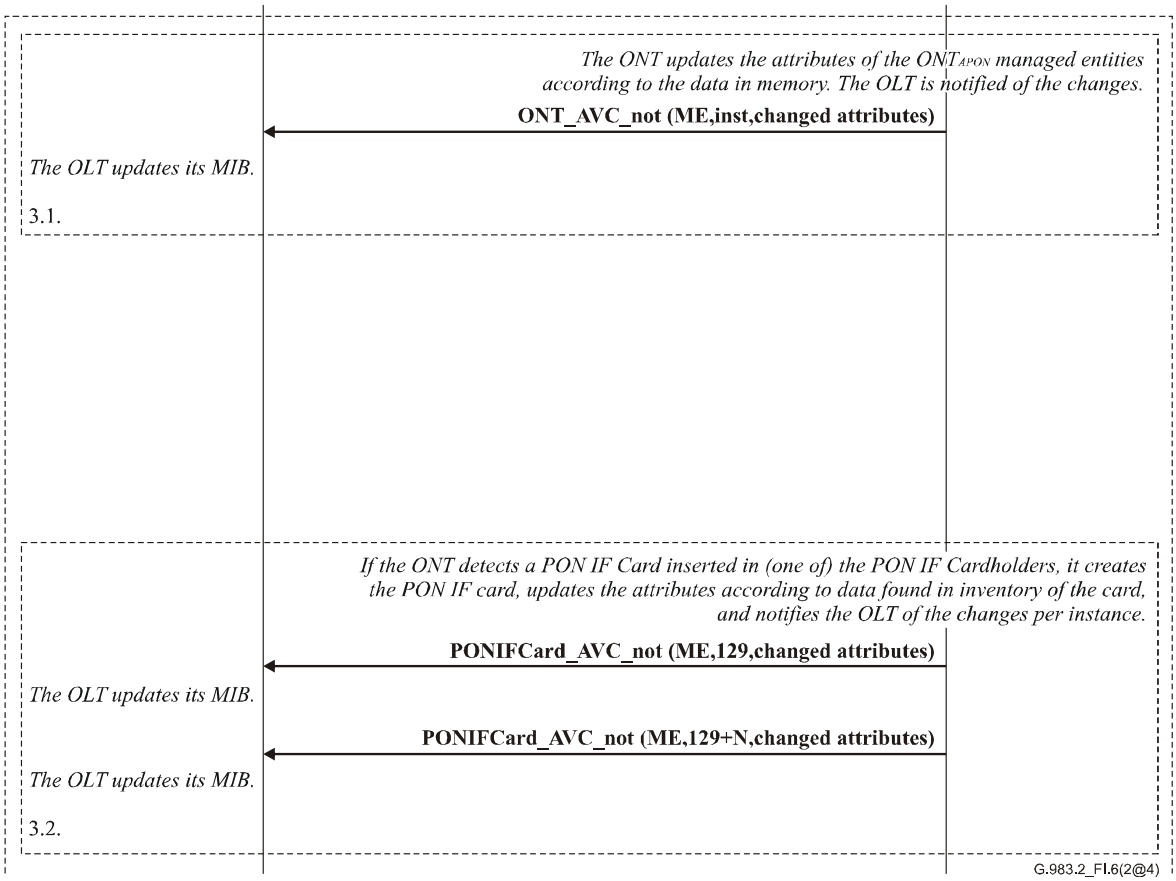


Figure I.6/G.983.2 – Start-up of a "new" ONT with Cardholders on both sides *(continued)*

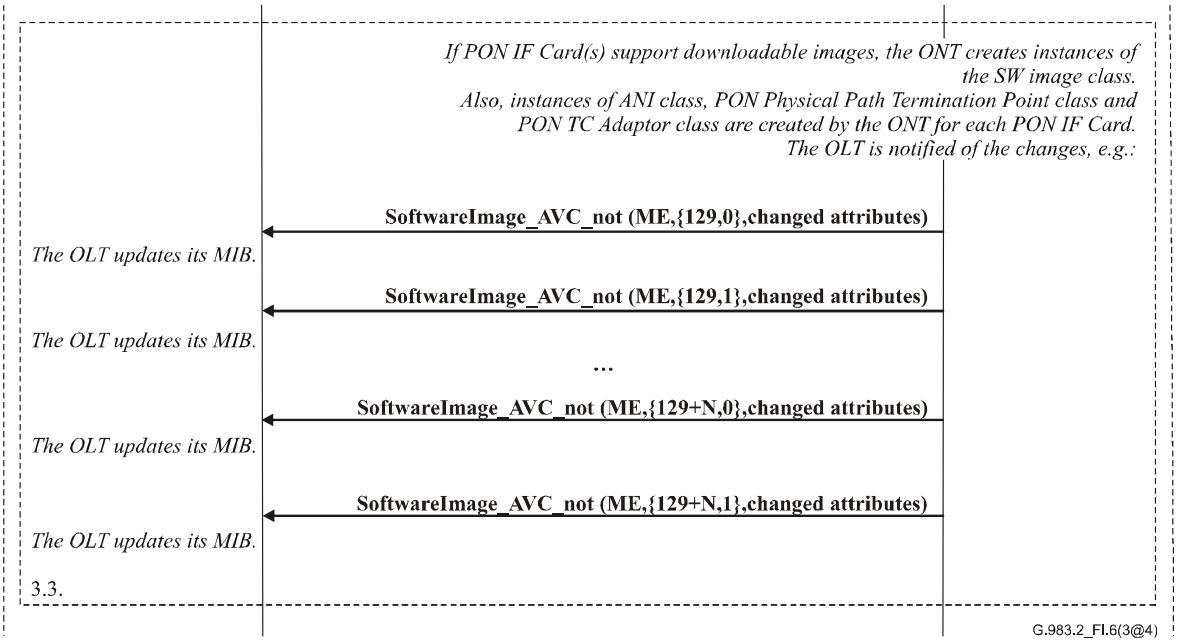


Figure I.6/G.983.2 – Start-up of a "new" ONT with Cardholders on both sides *(continued)*

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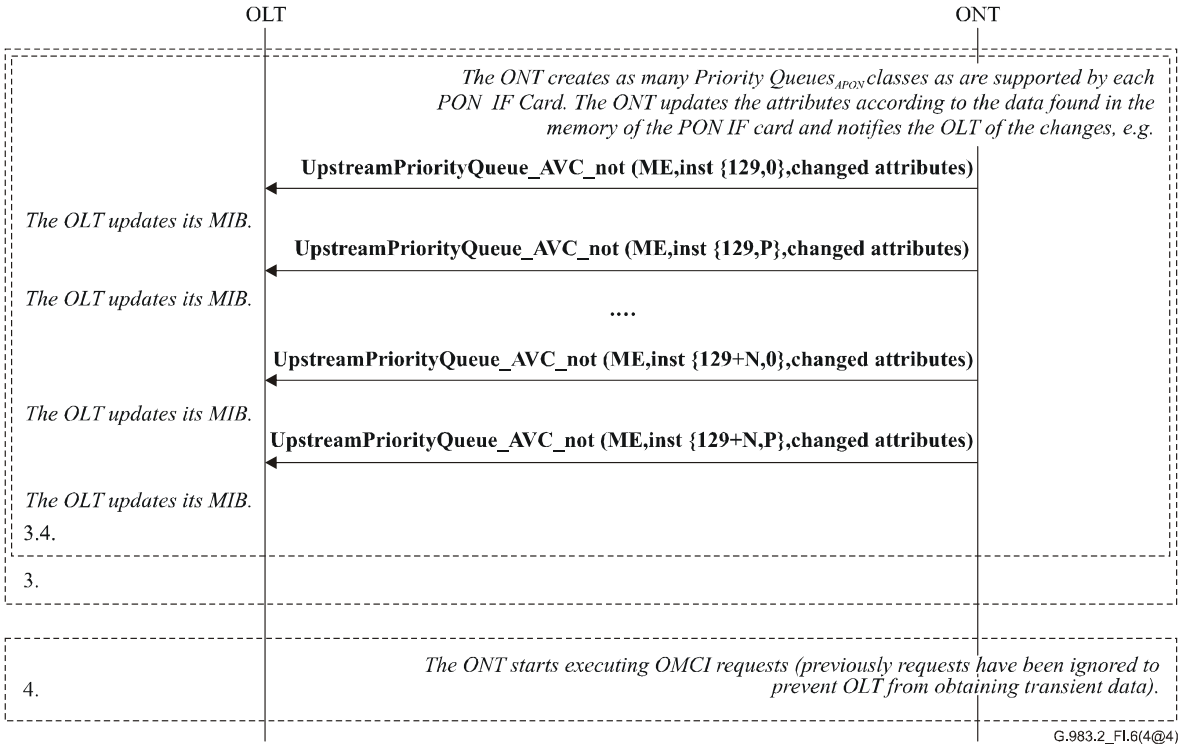


Figure I.6/G.983.2 – Start-up of a "new" ONT with Cardholders on both sides *(concluded)*

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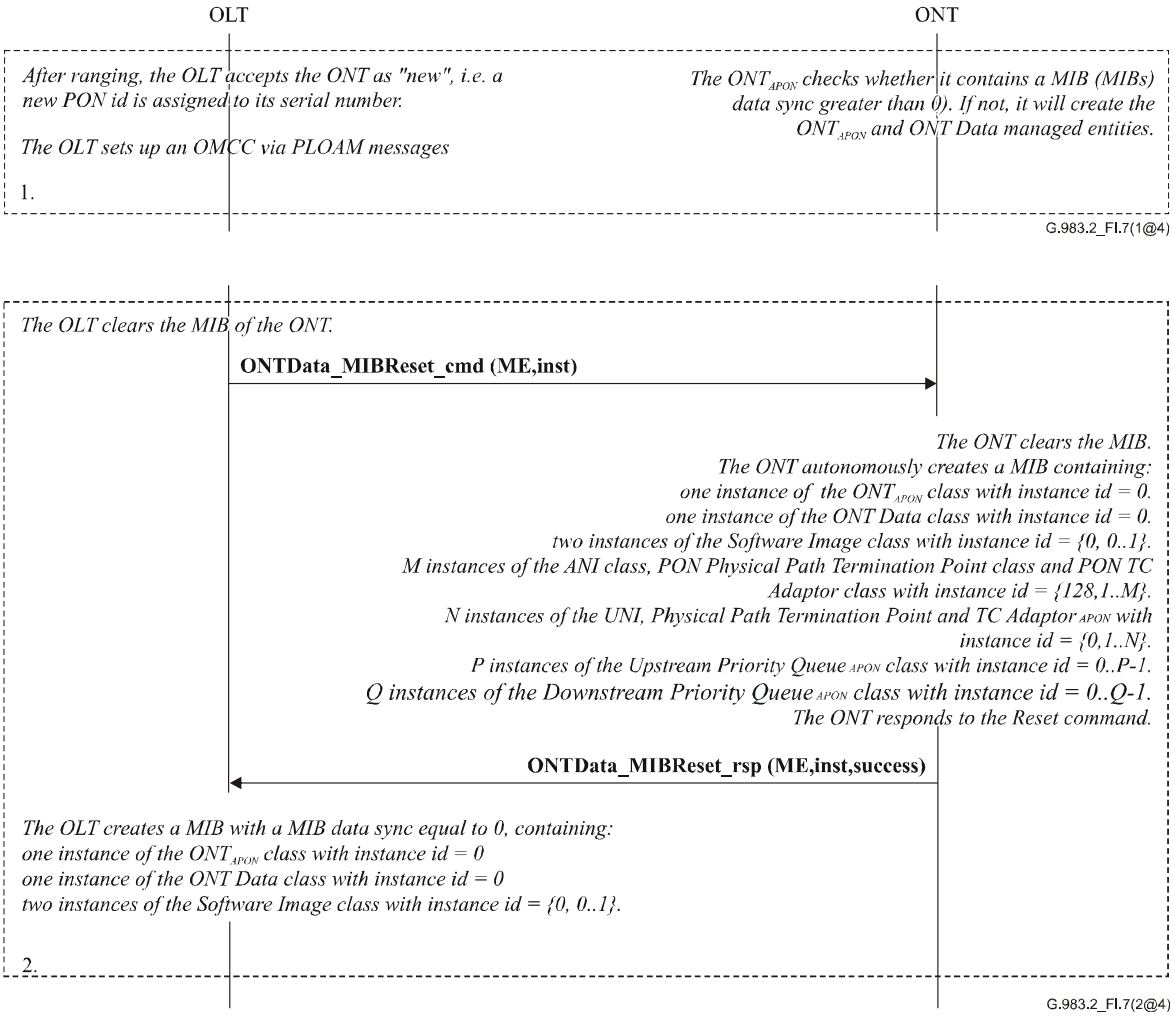


Figure I.7/G.983.2 – Start-up phase of a "new" ONT with integrated interfaces on both sides

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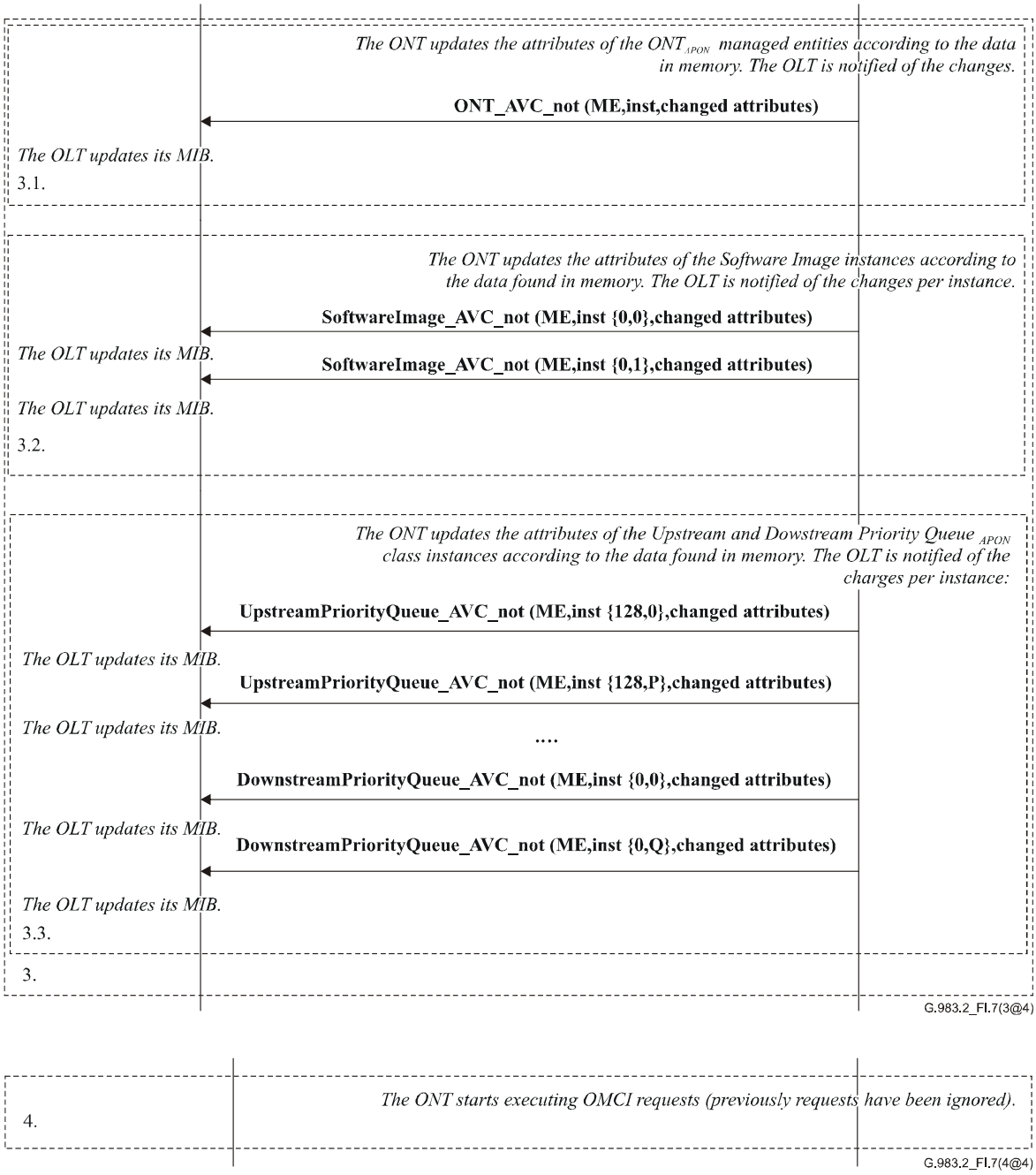


Figure I.7/G.983.2 – Start-up phase of a "new" ONT with integrated interfaces on both sides *(concluded)*

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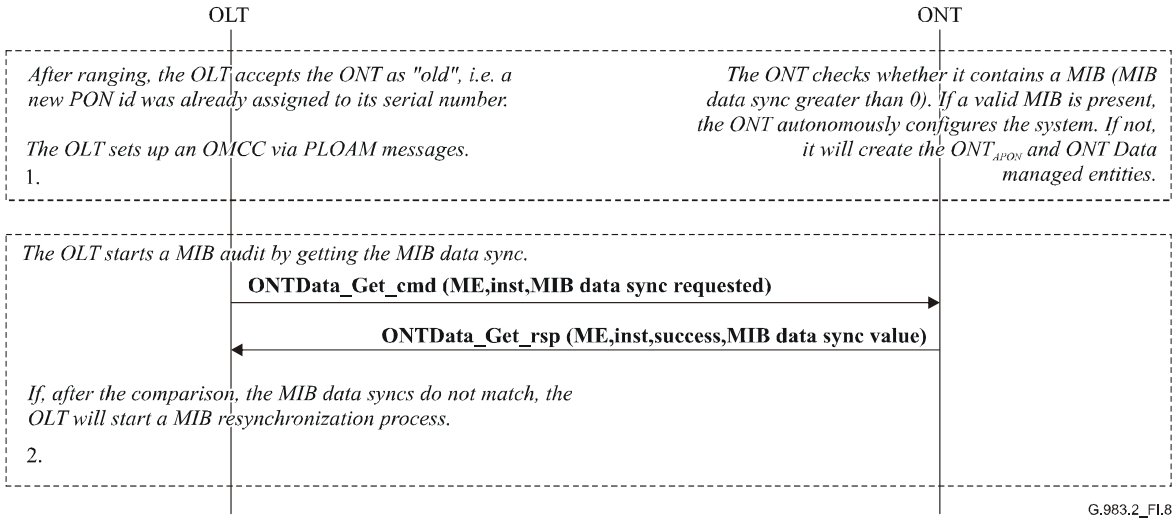


Figure I.8/G.983.2 – Start-up phase of an "old" ONT

I.2.2 Subscriber line card provisioning/deprovisioning

The provisioning and deprovisioning of Subscriber Line Card can be triggered in two ways:

a) On demand by the OpS;

b) Plug-and-play, triggered by the detection of the card insertion/removal.

However, this trigger of provisioning and deprovisioning is transparent to the ONT, i.e., the ONT is always responding to OLT provisioning and deprovisioning commands. The difference between plug-and-play mode and on-demand mode would reside in the OLT. For the on-demand mode, the OLT will provision (deprovision) the presence of the subscriber line card in the ONT when it has been provisioned (deprovisioned) by the operator; for the plug-and-play mode, the OLT will provision the slot to "plug-and-play" and further provision (deprovision) the presence of the subscriber line card in the ONT as soon as it has received a notification from the ONT that a line card has been plugged in (out).

I.2.3 On-demand subscriber line card provisioning

NOTE – It is possible to provision a subscriber line card while a subscriber line card of the same or of a different type is provisioned for the subscriber line cardholder. In case a subscriber line card of the same type is already provisioned, the provisioned command will have no effect. In case a subscriber line card of a different type is already provisioned, this subscriber line card will be automatically deprovisioned and only then will the system be configured according to the newly given plug-in unit type. Figure I.9 shows the scenario of provisioning an ATM LIM. Figure I.10 shows the scenario of provisioning a non-ATM LIM.

The cases below show the use of the attributes "Expected type" and "Sensed type" of the corresponding Physical Path Termination Point ATM/Ethernet/CES UNI.

Case 1

The subscriber linecard Holder or the ONT itself (the latter in case of integrated interfaces) only supports a specific type of interface. Notice that in the former case, the attribute "type" of the Subscriber Line Card managed entity will be equal to this type.

In this case, on creation of the Physical Path Termination Point managed entity instance, the attributes "Expected Plug-in Unit type" and "Actual Plug-in type" of the Subscriber Linecard Holder managed entity are both set equal to the specific interface type and the ONT sends attribute value change notifications to the OLT with the values of these attributes. It will not be possible for

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the OLT to change the value of the attribute "Expected Plug-in Unit type" later on (i.e., any attempt by the OLT to change the value of the attribute will be refused by the ONT).

Case 2

The subscriber linecard holder or the ONT itself (the latter in case of integrated interfaces) supports interfaces of different types.

In this case, on creation of the Physical Path Termination Point managed entity instance, the attribute "Expected Plug-in Unit type" is set to autosensing (0x00) and attribute "Actual Plug-in Unit type" is set to:

- inapplicable or unknown if the interface does not support autosensing or if the autosensing fails (actually, the coding is 0x00 in both cases);
- the sensed type if the interface supports autosensing and the autosensing was successful.

The ONT will send an attribute value change notification with the values of these attributes.

Later on, it will be possible for the OLT to change the value of attribute "Expected Plug-in Unit type" with the "Set" action. The value of attribute "Sensed type" will be set equal to the value of attribute "Expected type". Notice however that the ONT will only execute the "Set" action if the ONT supports the configured interface type.

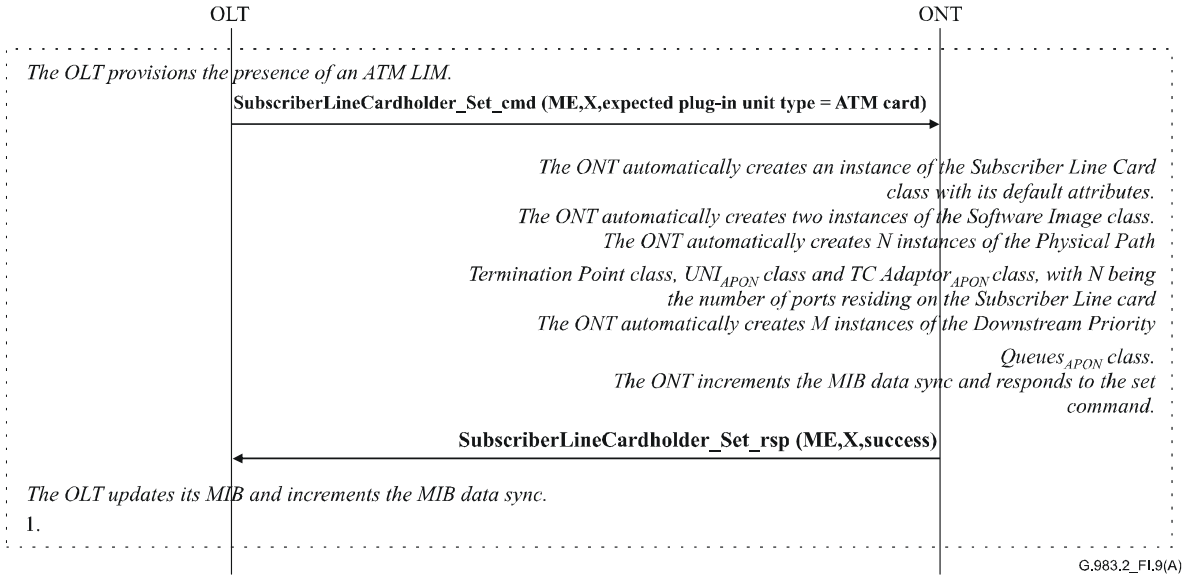


Figure I.9/G.983.2 – ATM subscriber line card provisioning

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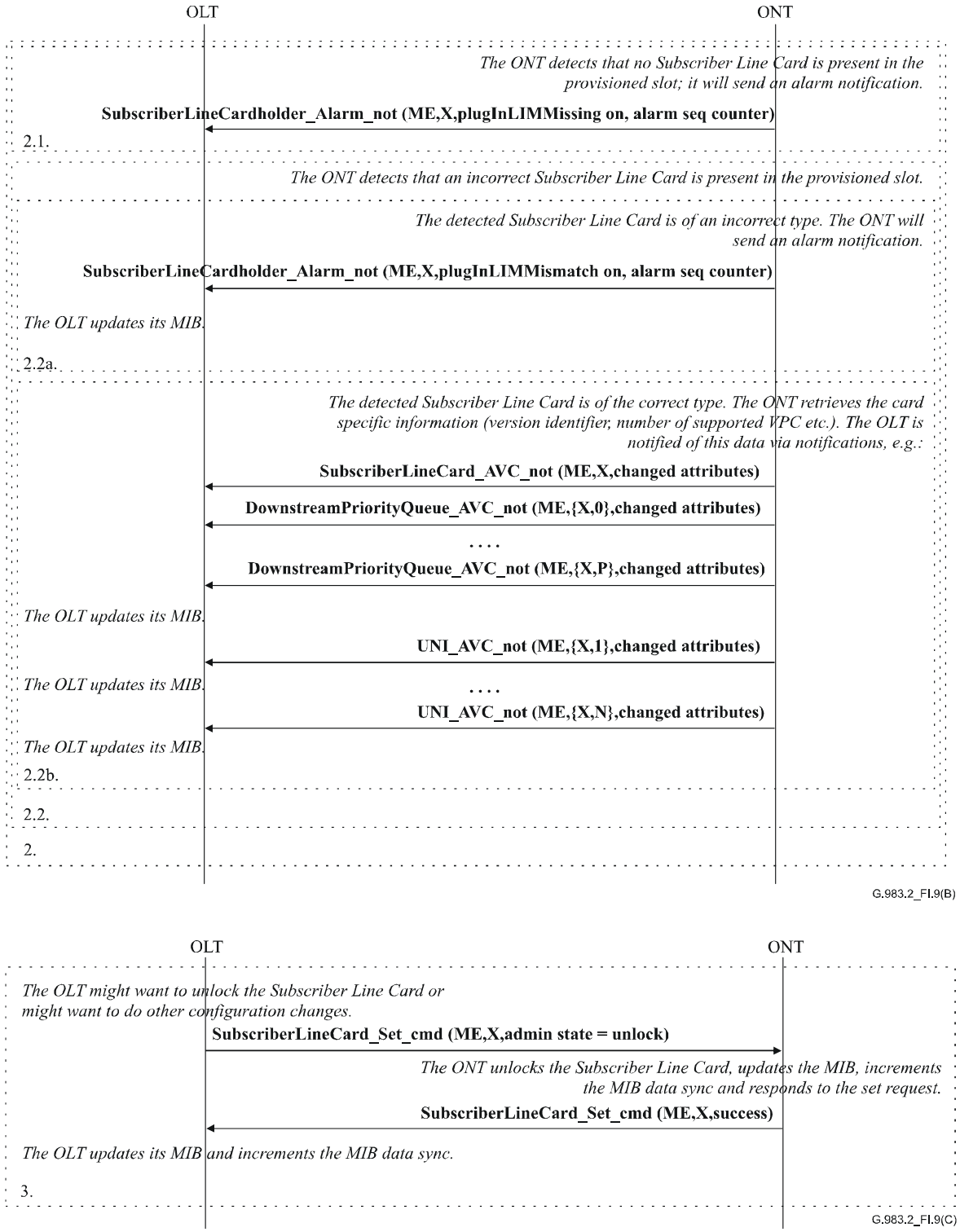
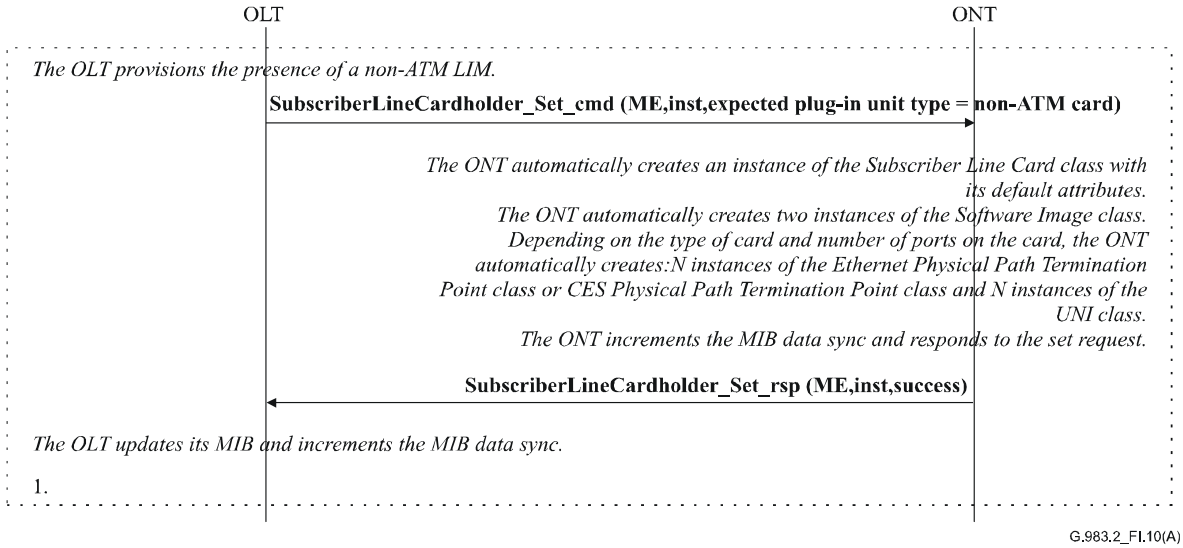


Figure I.9/G.983.2 – ATM subscriber line card provisioning *(concluded)*

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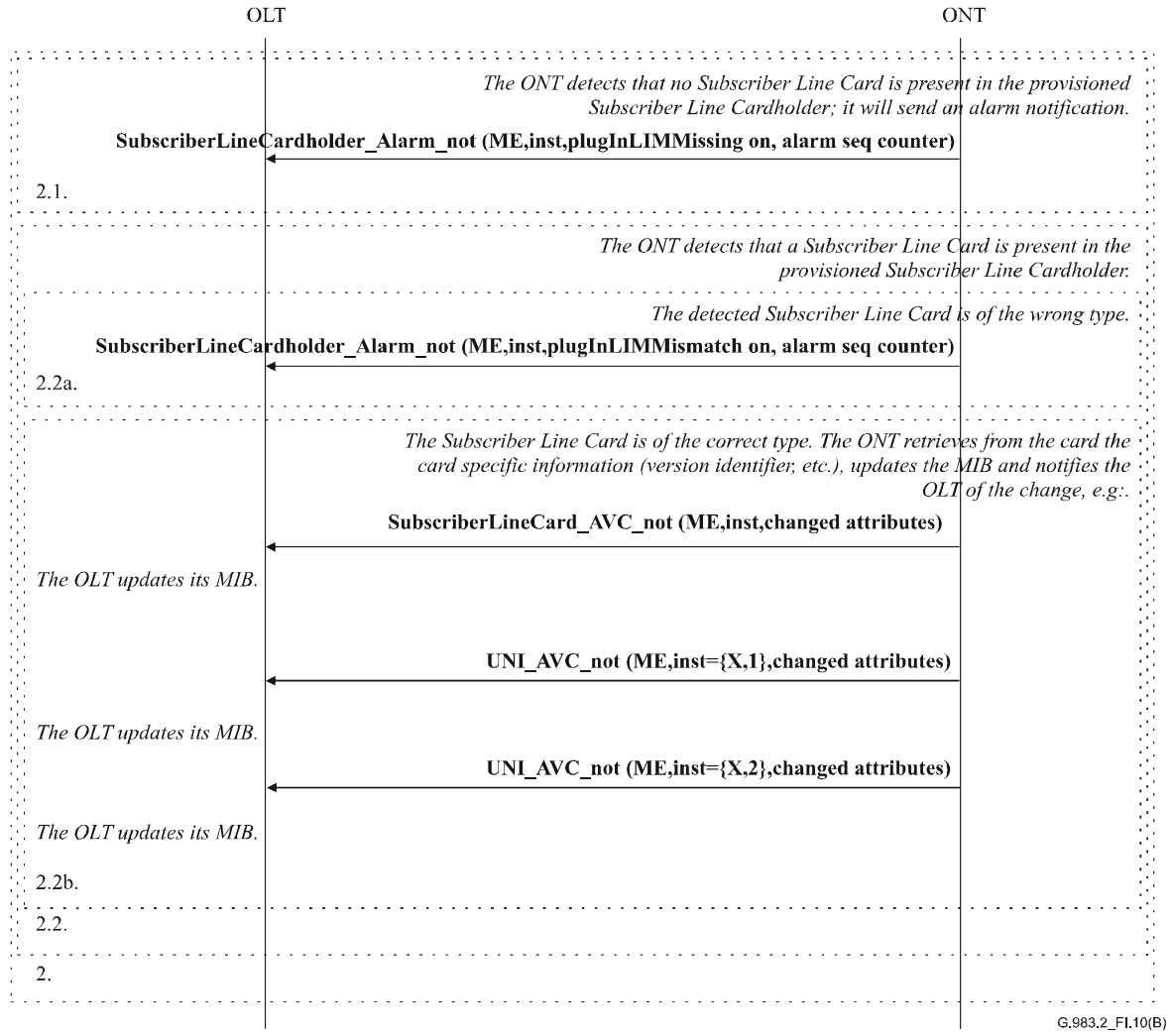


Figure I.10/G.983.2 – Non-ATM card subscriber line card provisioning

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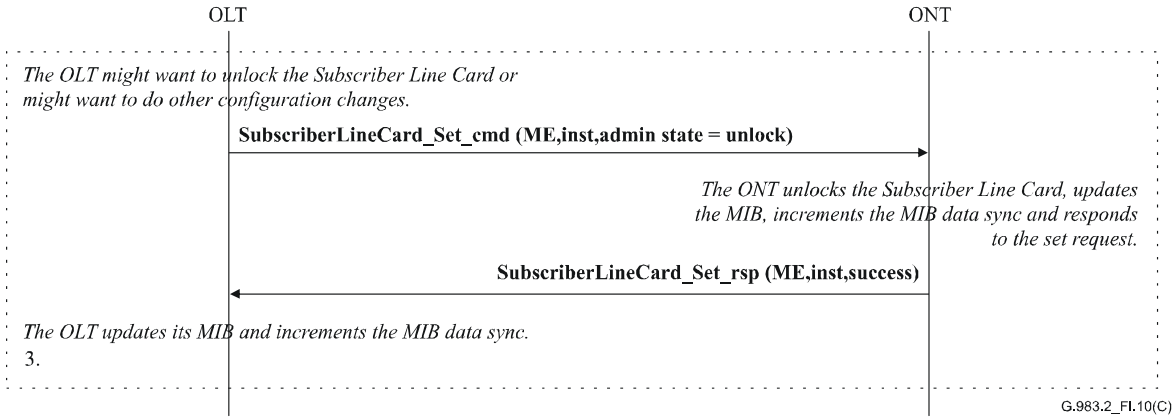


Figure I.10/G.983.2 – Non-ATM card subscriber line card provisioning *(concluded)*

I.2.4 On-demand subscriber line card deprovisioning

The ONT will delete from the MIB all managed entities that it automatically created during the provisioning of this subscriber line card. On the other hand, the OLT will be responsible for deleting all those managed entities that are associated with this card and were created by the OLT. Figure I.11 shows the process of deprovisioning a Subscriber Line Card.

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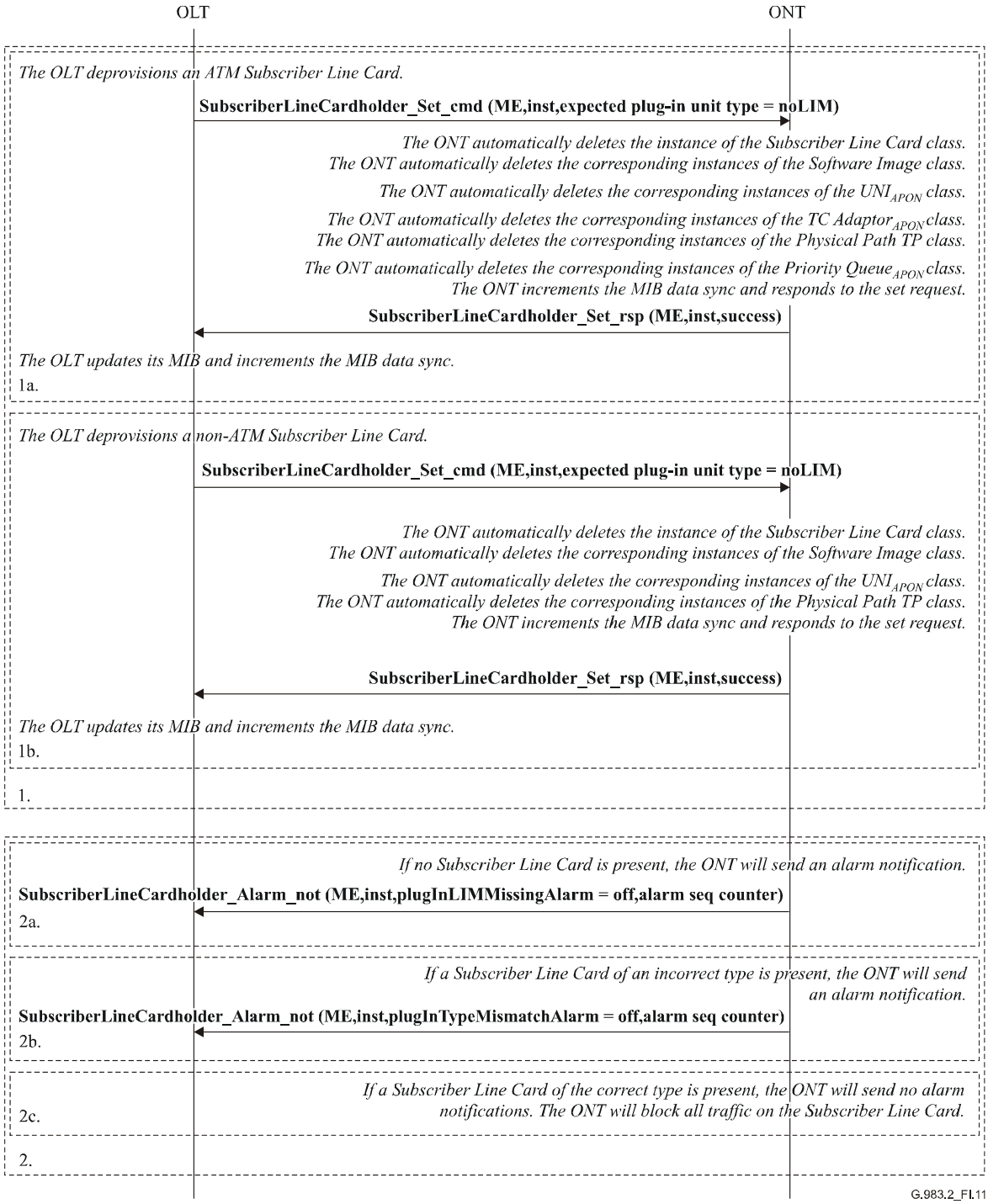


Figure I.11/G.983.2 – Subscriber line card deprovisioning

I.2.5 Plug-and-play subscriber line card provisioning

A subscriber line cardholder can be provisioned for a plug-and-play mode of operation (see also Figure 32). Figure I.12 shows the scenario for provisioning a slot for plug-and-play.

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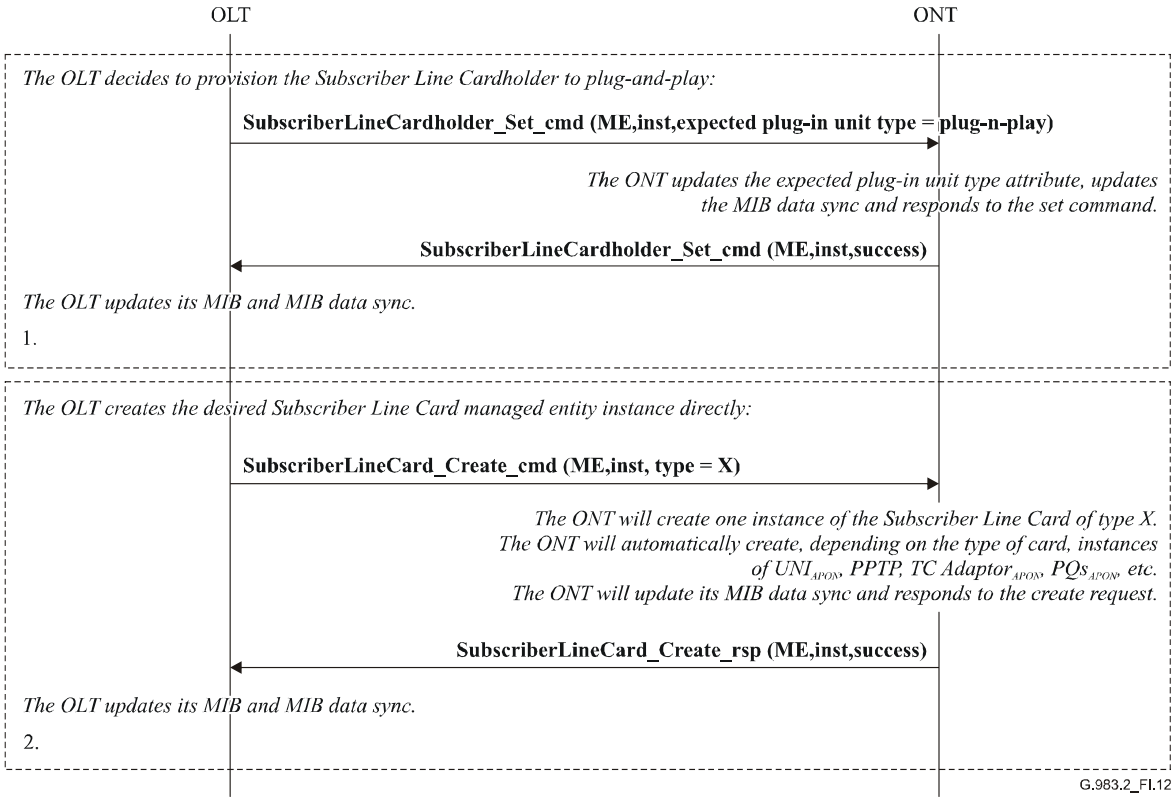


Figure I.12/G.983.2 – Plug-and-play subscriber line card provisioning

Not shown in the scenario diagram given above are the notifications of the ONT due to incorrectly inserted subscriber line cards. Figure 32 is given for this purpose.

I.2.6 Plug-and-play subscriber line card deprovisioning

When a subscriber line card is removed from a subscriber line cardholder, a notification will be send to the OLT. The OLT will deprovision the subscriber line cardholder upon receiving the notification (see Figure I.13).

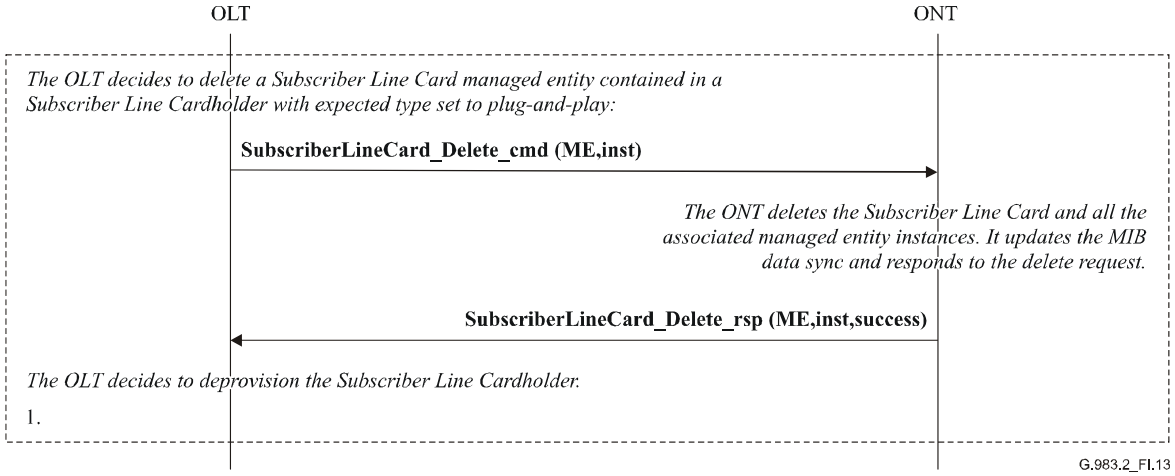


Figure I.13/G.983.2 – Plug-and-play subscriber line card deprovisioning

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I.2.7 ATM service set-up

The ATM connections within the ONT can be created in two ways: one consists of consecutively requesting the creation of two VP Network $CTP_{B\text{-}PON}$s and one ATM VP Cross-Connection (Figure I.14), whereas the other uses one request which will cause the simultaneous creation of two VP Network $CTP_{B\text{-}PON}$s and one ATM VP Cross-Connection (Figure I.15).

In the given figures for ATM service set-up, the assumption is made that Priority Queues are used. If Traffic Descriptors are used, the Traffic Descriptor managed entity instance for the requested service must be created first. Also, the OLT might want to create corresponding History Data managed entities for the connection.

These descriptions can be extended for use with VC cross-connections as well. For ATM service set-up and tear-down using VC cross-connections, replace "VP Network $CTP_{B\text{-}PON}$s" with "VC Network $CTP_{B\text{-}PON}$s" and "ATM VP Cross-Connection" with "ATM VC Cross-Connection".

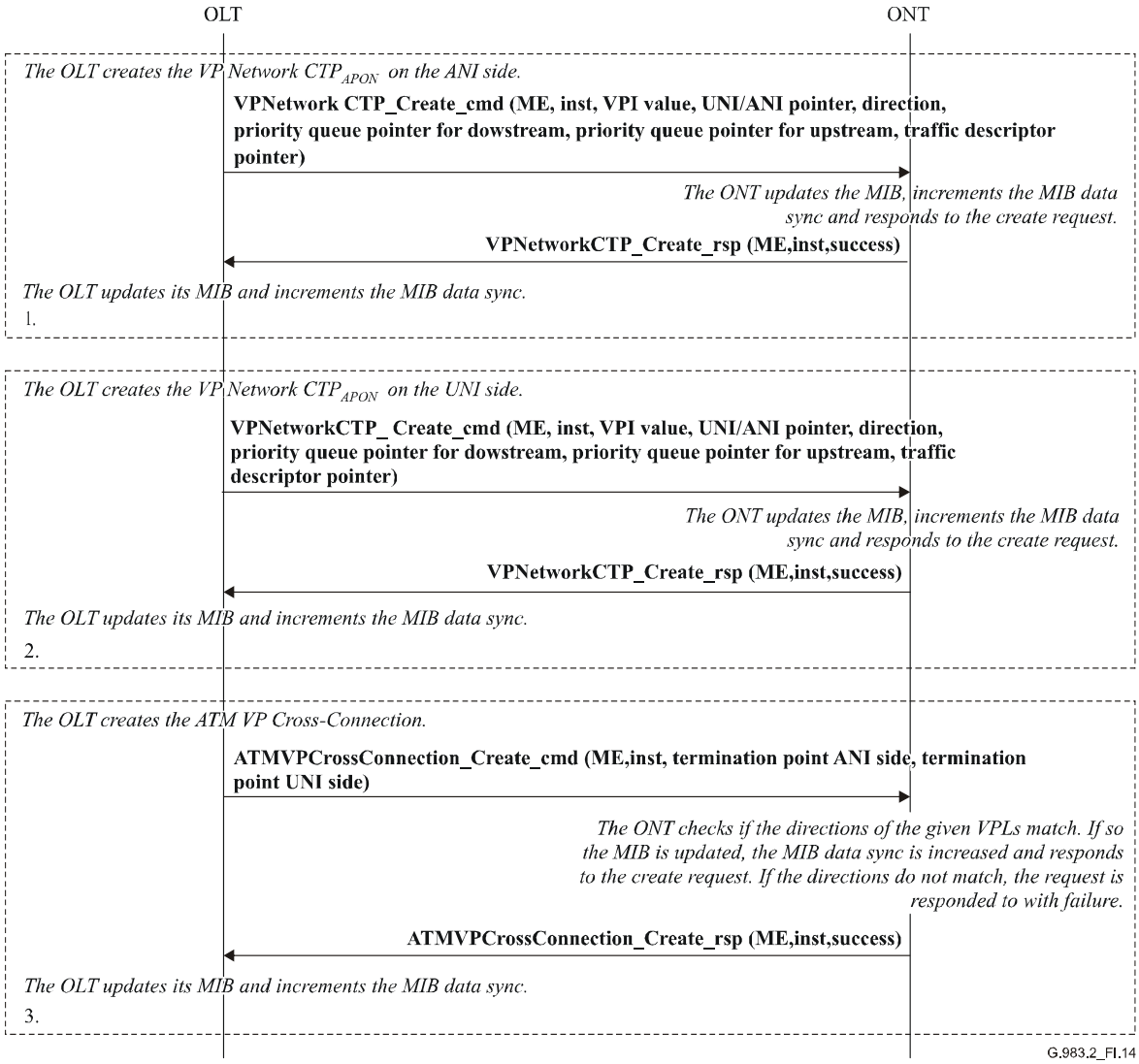


Figure I.14/G.983.2 – VP cross-connection set-up (alternative 1)

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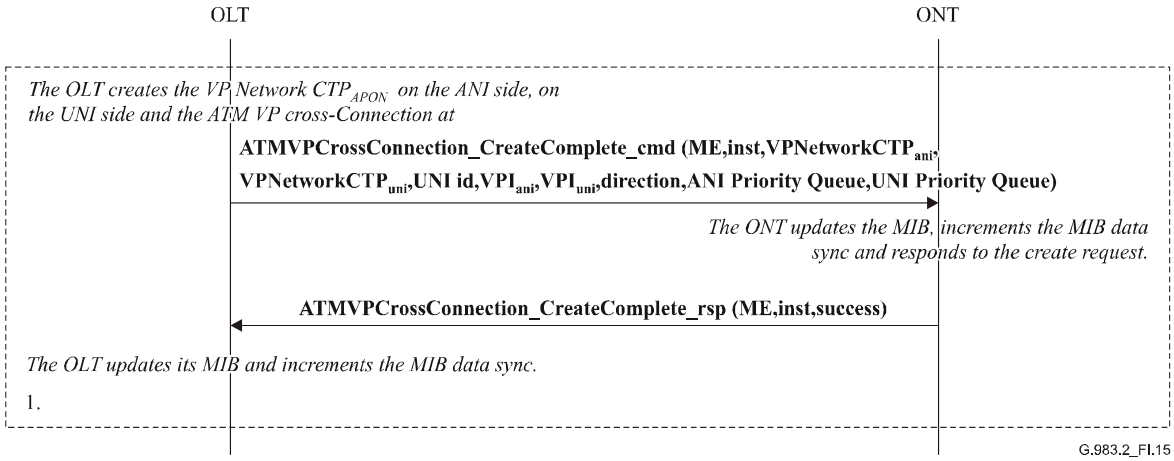


Figure I.15/G.983.2 – VP cross-connection set-up (alternative 2)

I.2.8 ATM service tear-down

The connections within the ONT can be deleted in two ways: one consists of consecutive deletion of the ATM VP Cross-Connection and the two VP Network CTP$_{B\text{-}PON}$s (Figure I.16), whereas the other uses one request to delete the ATM VP Cross-Connection and the two associated VP Network CTP$_{B\text{-}PON}$s (Figure I.17). The correct order of the deletion of the instances in the first alternative is under the control of the OLT. If applicable, the OLT must delete the corresponding History Data managed entities as well.

These descriptions can be extended for use with VC cross-connections as well. For ATM service set-up and tear-down using VC cross-connections, replace "VP Network CTP$_{B\text{-}PON}$s" with "VC Network CTP$_{B\text{-}PON}$s" and "ATM VP Cross-Connection" with "ATM VC Cross-Connection".

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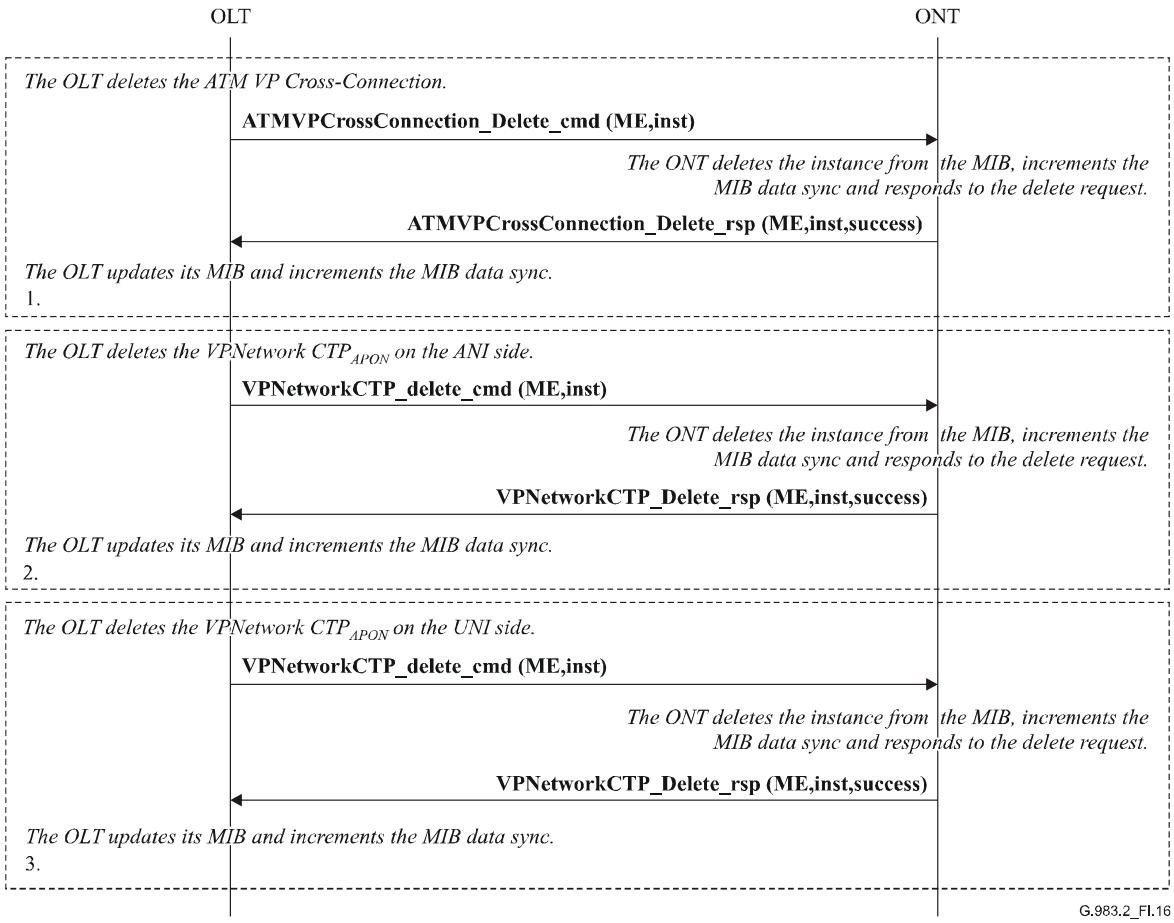


Figure I.16/G.983.2 – VP cross-connection deletion (alternative 1)

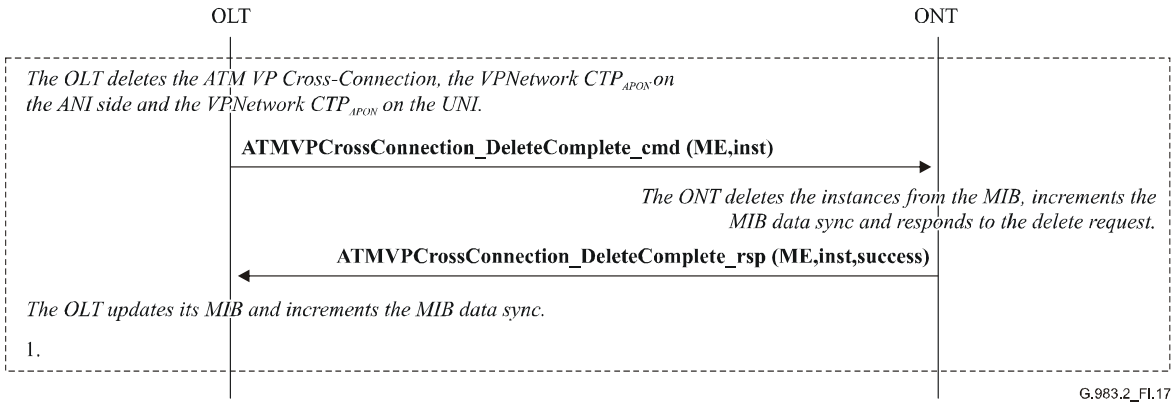


Figure I.17/G.983.2 – VP cross-connection deletion (alternative 2)

I.2.9 Structured CES service connection set-up

The following scenario of structured CES service connection set-up is given for an ONT with cross-connect functionality. For an ONT that does not model cross-connect functionality, the Interworking VCC Termination Point is directly associated with the VP/VC Network CTP$_{B\text{-}PON}$ on the ANI side.

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Figure I.18 shows the set-up of the first structured CES service on a Subscriber Line Card. Additional services on the same UNI interface, with their Interworking VCC Termination Points, AAL 1 Profile$_{B\text{-}PON}$s and CES Profile$_{B\text{-}PON}$s, can also share the same VP/VC Network CTP$_{B\text{-}PON}$.

Note that the AAL 1 and CES profiles can be shared among multiple Interworking VCC Termination Points. No creation of profiles is needed if the Interworking VCC Termination Point is pointing to an existing profile.

Also, the OLT might want to create corresponding History Data managed entities for the connection.

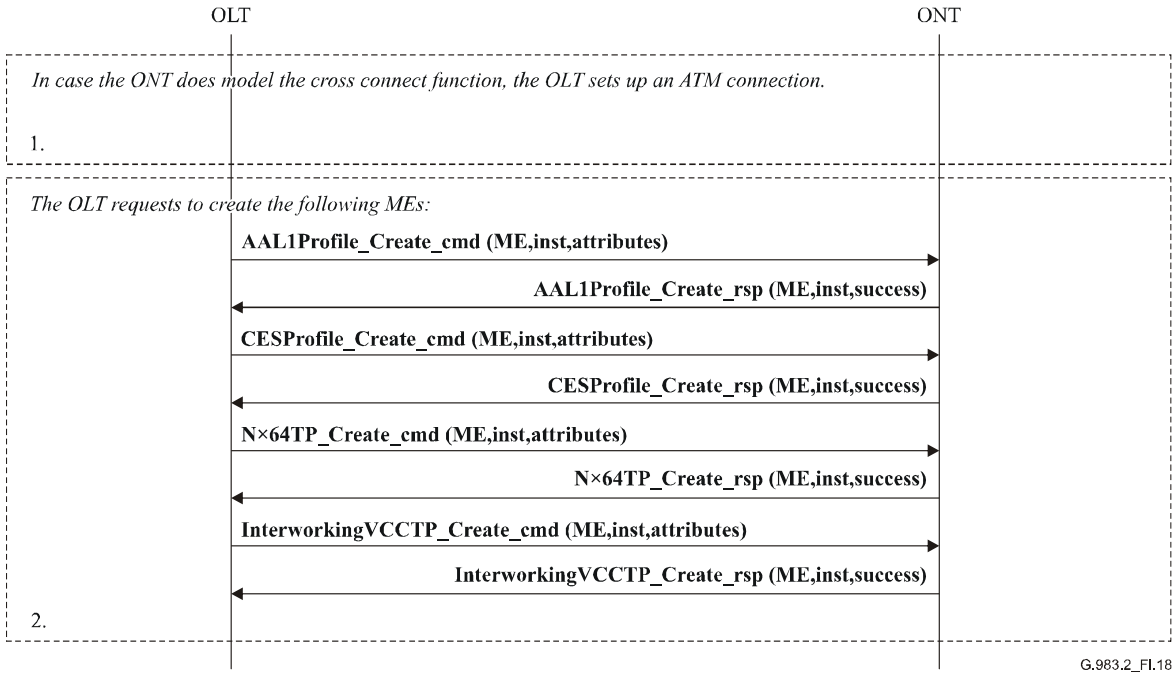


Figure I.18/G.983.2 – Connection set-up of a structured CES

I.2.10 Structured CES service connection tear-down

The following scenario, shown in Figure I.19, of structured CES service connection tear-down is given for an ONT with cross-connect functionality. For an ONT that does not model cross-connect functionality, the Interworking VCC Termination Point is directly associated with the VP/VC Network CTP$_{B\text{-}PON}$ on the ANI side.

Note that the AAL 1 and CES profiles can be shared among multiple Interworking VCC Termination Points. If there are more Interworking VCC Termination Points associated with these profile managed entities, the OLT may not request to delete them. This holds also for the ATM connection used: if more Interworking VCC Termination Points are associated with this connection (i.e., VP/VC Network CTP$_{B\text{-}PON}$), the ATM connection cannot be deleted.

If applicable, the OLT must delete the corresponding History Data managed entities as well.

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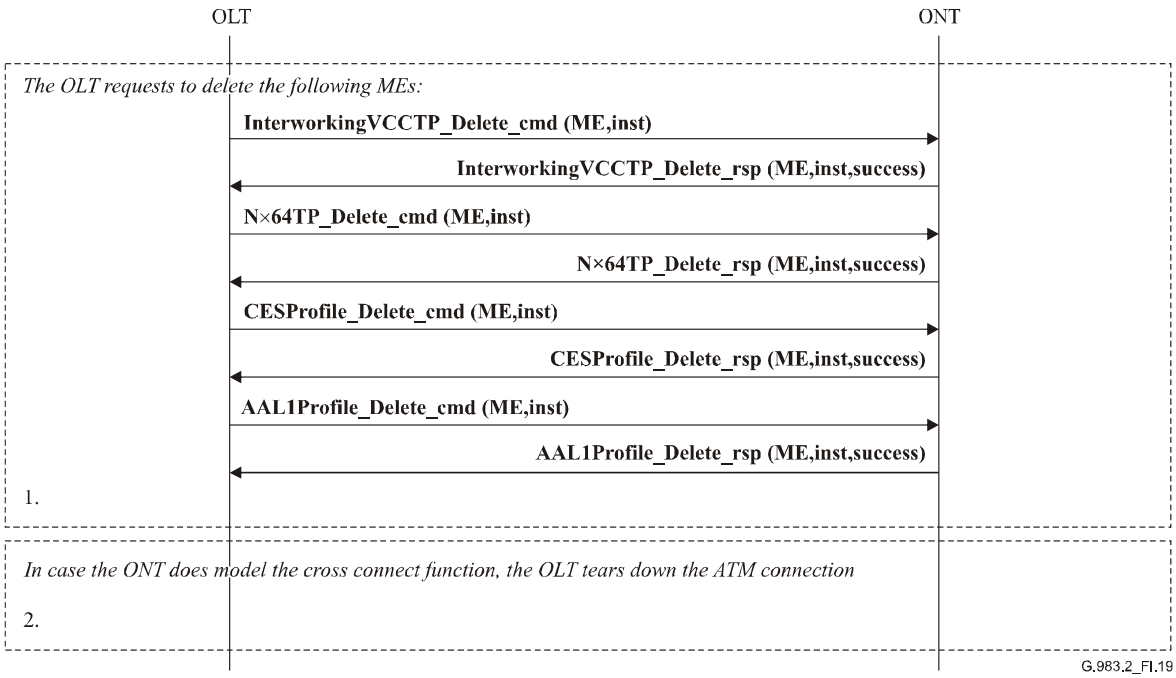


Figure I.19/G.983.2 – Connection tear-down of a structured CES

I.2.11 Unstructured CES service connection set-up

The following scenario, shown in Figure I.20, for unstructured CES service connection set-up, is given for an ONT with cross-connect functionality. For an ONT that does not model cross-connect functionality, the Interworking VCC Termination Point is directly associated with the VP/VC Network $CTP_{B\text{-}PON}$ on the ANI side.

Note that the AAL 1 and CES profiles can be shared among multiple Interworking VCC Termination Points. No creation of profiles is needed if the Interworking VCC Termination Point is pointing to an existing profile.

Also, the OLT might want to create corresponding History Data managed entities for the connection.

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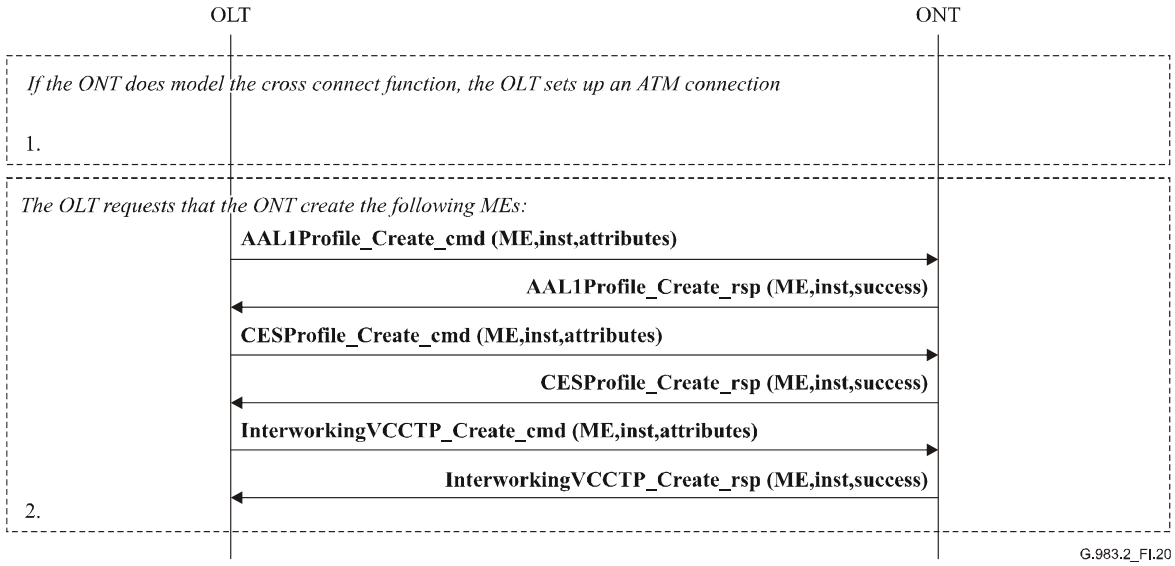


Figure I.20/G.983.2 – Connection set-up of an unstructured CES

I.2.12 Unstructured CES service connection tear-down

The following scenario, shown in Figure I.21, for an unstructured CES service connection tear-down is given for an ONT with cross-connect functionality. For an ONT that does not model cross-connect functionality, the Interworking VCC Termination Point is directly associated with the VP/VC Network $CTP_{B\text{-}PON}$ on the ANI side.

Note that the AAL 1 and CES profiles can be shared among multiple Interworking VCC Termination Points. If there are more Interworking VCC Termination Points associated with these profile managed entities, the OLT may not request to delete them. This holds also for the ATM connection used: if more Interworking VCC Termination Points are associated with this connection (i.e., VP/VC Network $CTP_{B\text{-}PON}$), the ATM connection cannot be deleted.

If applicable, the OLT must delete the corresponding History Data managed entities as well.

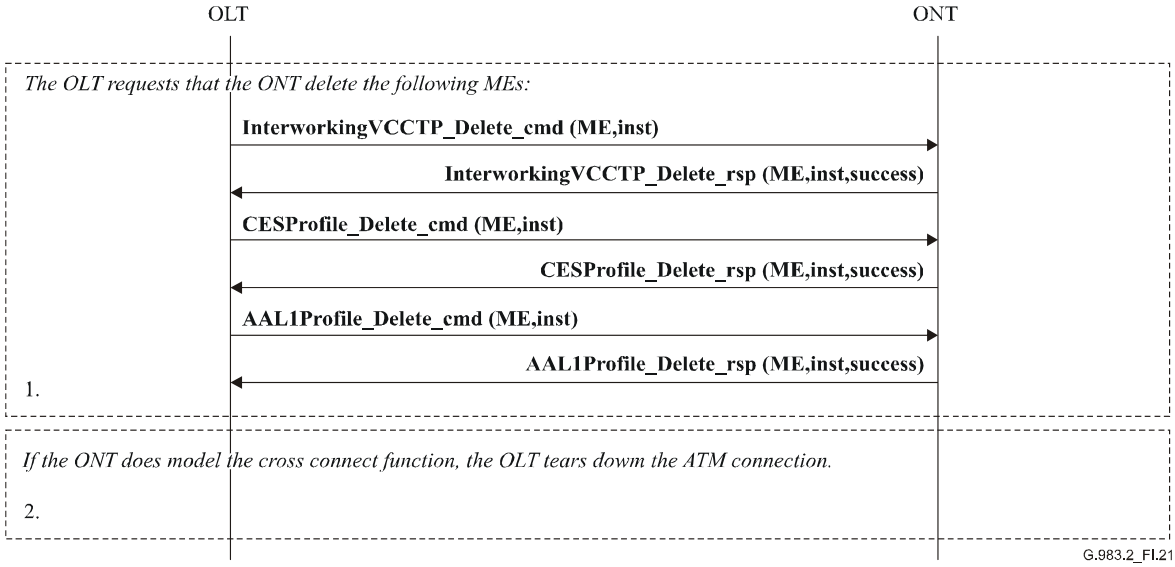


Figure I.21/G.983.2 – Connection tear-down of an unstructured CES

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I.2.13 This clause intentionally left blank

I.2.14 This clause intentionally left blank

I.2.15 Software image download

The download of a Software Image is based on a "segmented stop and wait" protocol; thus, the next segment can only be transmitted to the ONT if the previous segment is positively acknowledged. A Software Image segment (also named window) consists of one of more Software Image sections. Each section is transmitted in one OMCC message.

The number of sections in a segment is negotiated before the actual download. First the OLT proposes a segment size (not greater than 256). The ONT can propose a smaller segment size in the response. If the response indicates a smaller segment size, this is the size to be used in the download. Thus, an image segment consists of N image sections, with N being equal to the segment size. Only the last image section is acknowledged. If the ONT processed all sections of a segment properly, the acknowledgement will be positive, after which the OLT will download the next segment.

Note that the section numbering starts from 0 so that segments of precisely 8 kilobytes can be downloaded.

If an error occurred with a section of a segment (e.g., CRC error or missed section), the last section will be negatively acknowledged, which will result in an entire retransmission of the last segment.

When the last segment transferred is positively acknowledged, the OLT sends a CRC-32 to the ONT in the Software Image end download command. The ONT calculates the CRC-32 and compares it to the CRC received from the OLT. If they are equal, the image is considered valid. Figure I.22 gives the scenario for the software download.

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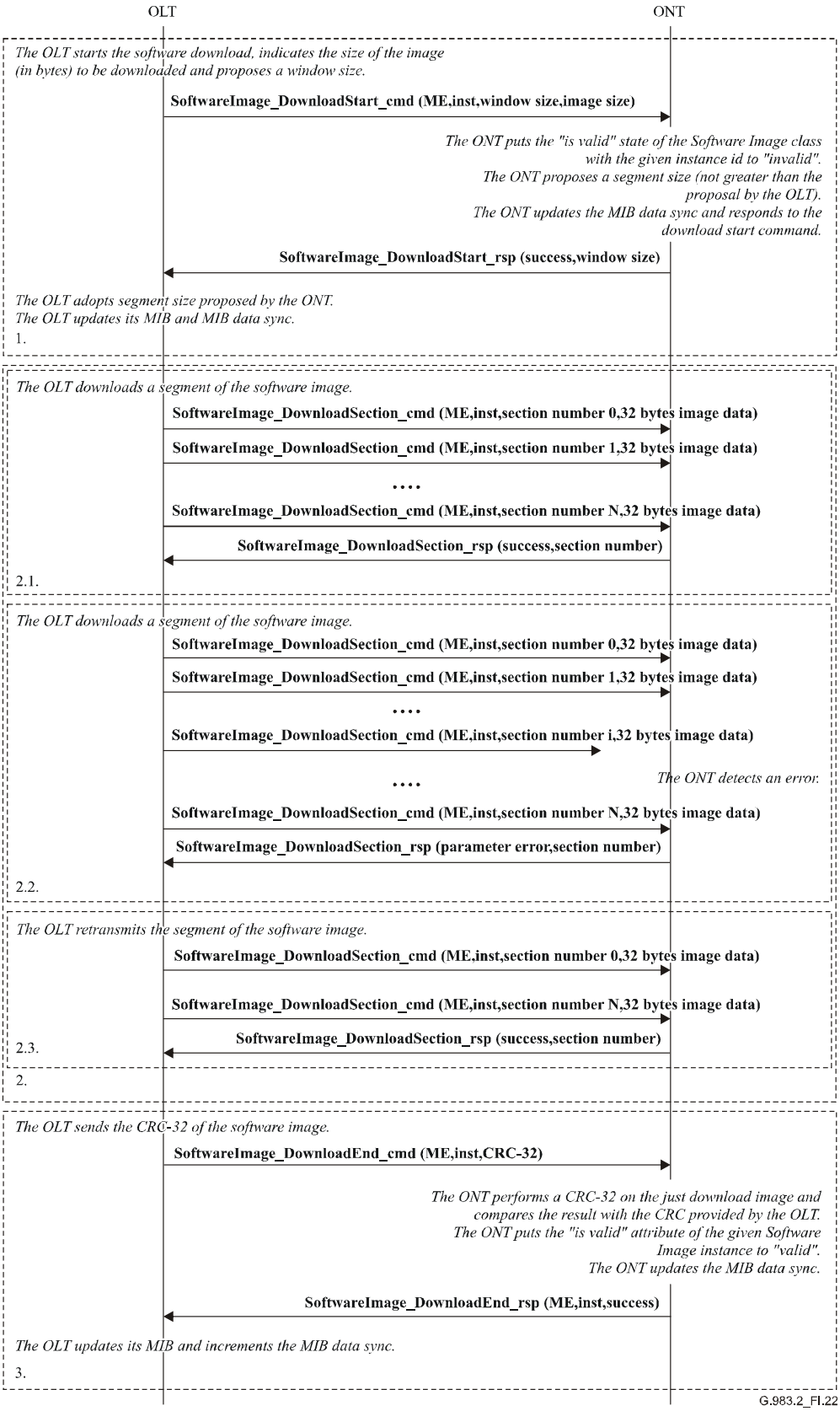


Figure I.22/G.983.2 – Software download

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I.2.16 Software image activate and commit

See Figure I.23.

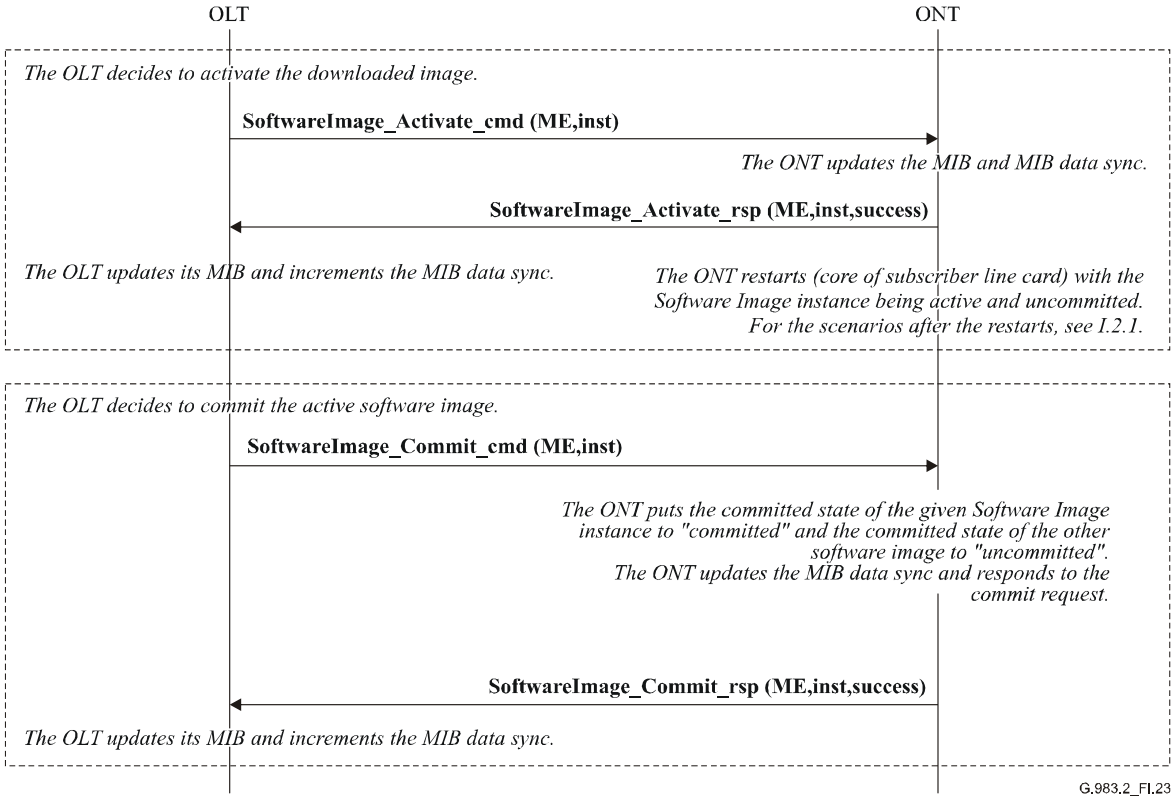


Figure I.23/G.983.2 – Software activate (above) and software commit (below)

I.2.17 MAC bridge service connection set-up

Figure I.24 shows the scenario for MAC bridge service connection set-up for an ONT with cross-connect functionality. For an ONT that does not model cross-connect functionality, the Interworking VCC Termination Point is directly associated with the VP Network $CTP_{B\text{-}PON}$ on the ANI side. Note that the AAL 5 $Profile_{B\text{-}PON}$ can be shared among multiple Interworking VCC Termination Points. No creation of profiles is needed if the Interworking VCC Termination Point points to an existing profile. Also, the OLT may want to create corresponding History Data managed entities for the connection.

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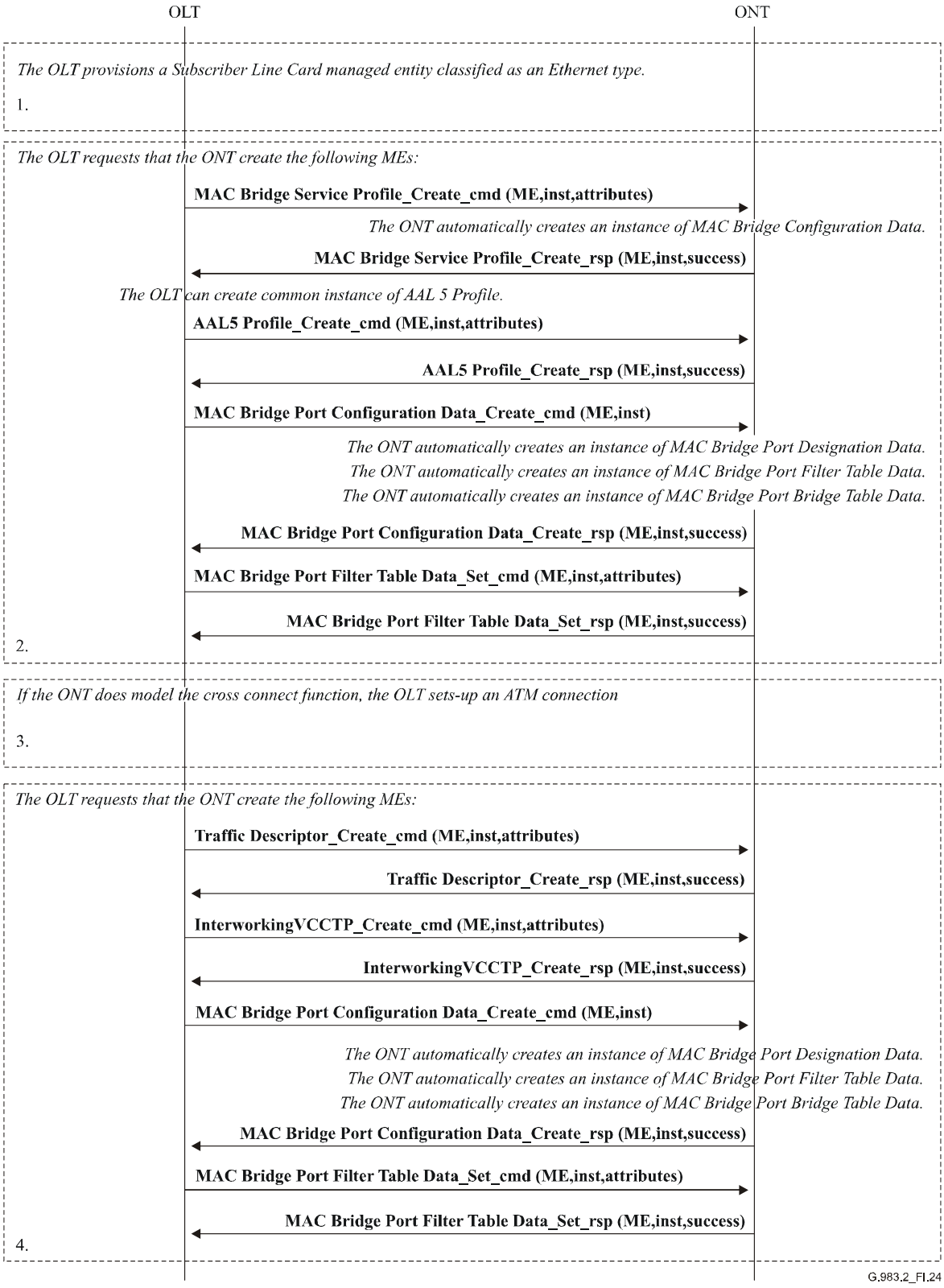


Figure I.24/G.983.2 – Connection set-up for MAC bridge service connection

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I.2.18 MAC bridge service connection tear-down

The following scenario, Figure I.25, depicts MAC bridge service connection tear-down for an ONT with cross-connect functionality. For an ONT that does not model cross-connect functionality, the Interworking VCC Termination Point is directly associated with the VP Network $CTP_{B\text{-}PON}$ on the ANI side. Note that the AAL 5 $Profile_{B\text{-}PON}$ can be shared among multiple Interworking VCC Termination Points. If there are more Interworking VCC Termination Points associated with this profile managed entity, the OLT may not request to delete it. This holds also for the ATM connection used: if more Interworking VCC Termination Points are associated to this connection (i.e., VP Network $CTP_{B\text{-}PON}$), the ATM connection cannot be deleted. If applicable, the OLT must delete the corresponding History Data managed entities as well.

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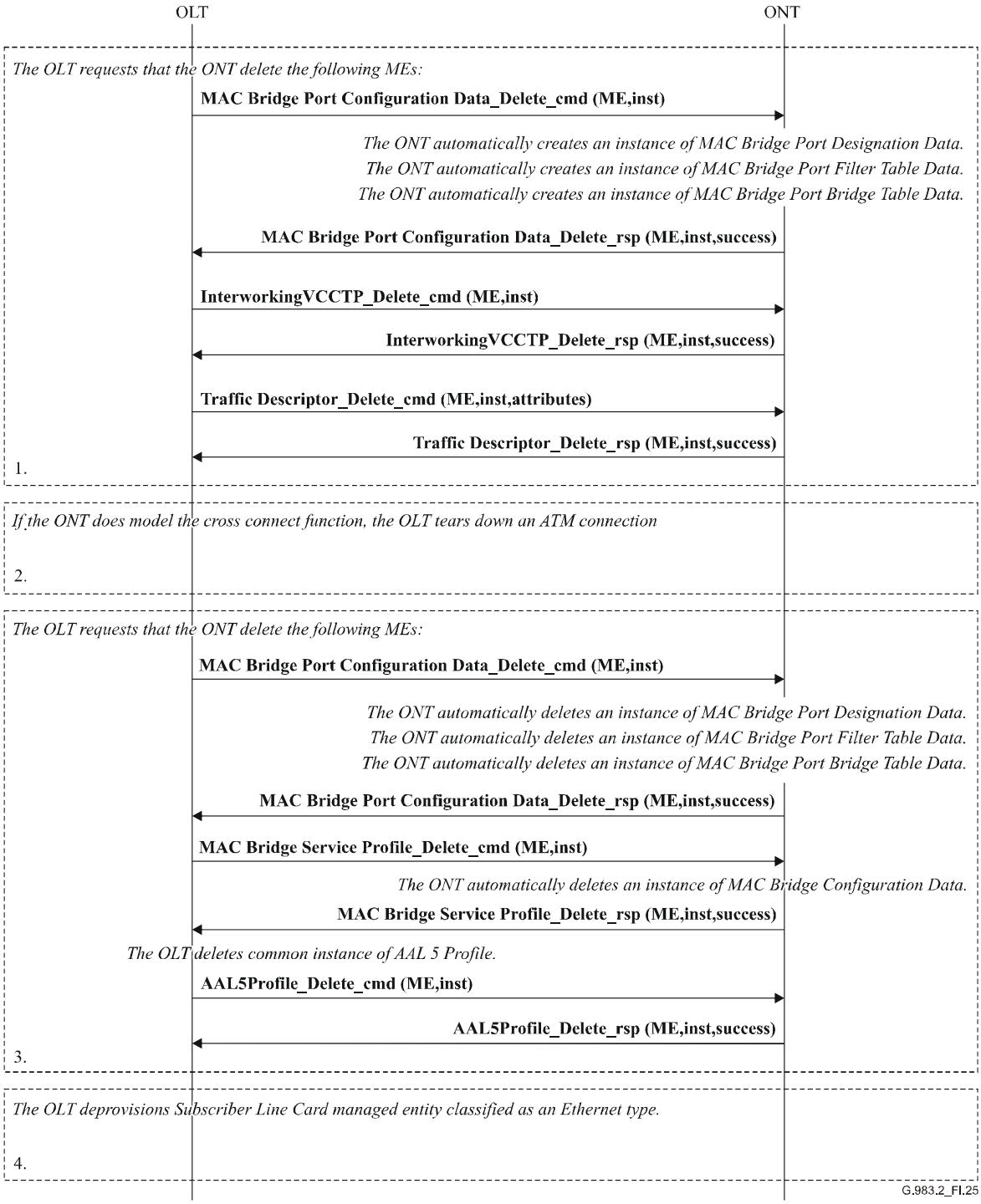


Figure I.25/G.983.2 – Connection tear-down for MAC bridge service connection

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I.2.19 Addition of entries on MAC filter table

The following scenario, Figure I.26, depicts addition of entries to the MAC Filter Table for an ONT.

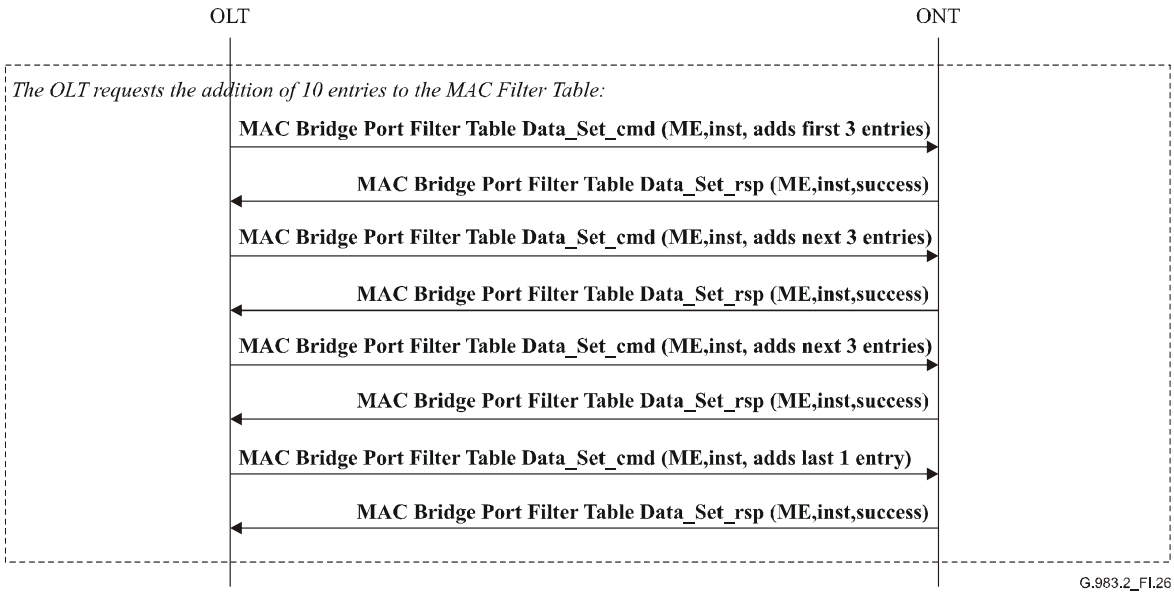


Figure I.26/G.983.2 – Addition of entries to the MAC filter table

I.2.20 Removal of entries from MAC filter table

The following scenario, Figure I.27, depicts the removal of entries from the MAC Filter Table for an ONT.

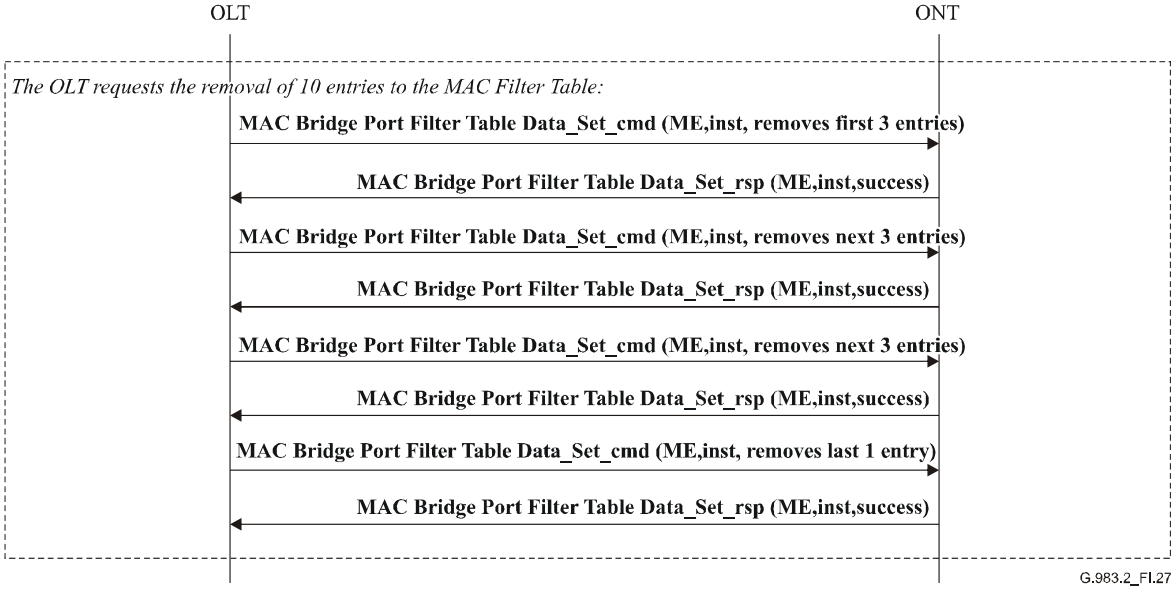


Figure I.27/G.983.2 – Removal of entries from MAC filter table

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I.2.21 Voice over AAL 2 service connection set-up

The following scenario, Figure I.28, depicts Voice over AAL 2 service connection set-up for an ONT with cross-connect functionality. For an ONT that does not model cross-connect functionality, the Interworking VCC Termination Point is directly associated with the VP Network $CTP_{B\text{-}PON}$ on the ANI side. Note that the Voice Service, LES Service, AAL 2 and AAL 2 PVC profiles can be shared among multiple Interworking VCC Termination Points. No creation of profiles is needed if the Interworking VCCTP points to an existing profile. Moreover, the SSCS Parameter1 and SSCS Parameter2 profiles can be shared among multiple AAL 2 $Profile_{B\text{-}PON}$s, so no creation of profiles is needed if the AAL 2 $Profile_{B\text{-}PON}$ points to an existing profile. Also, the OLT may want to create corresponding History Data managed entities for the connection.

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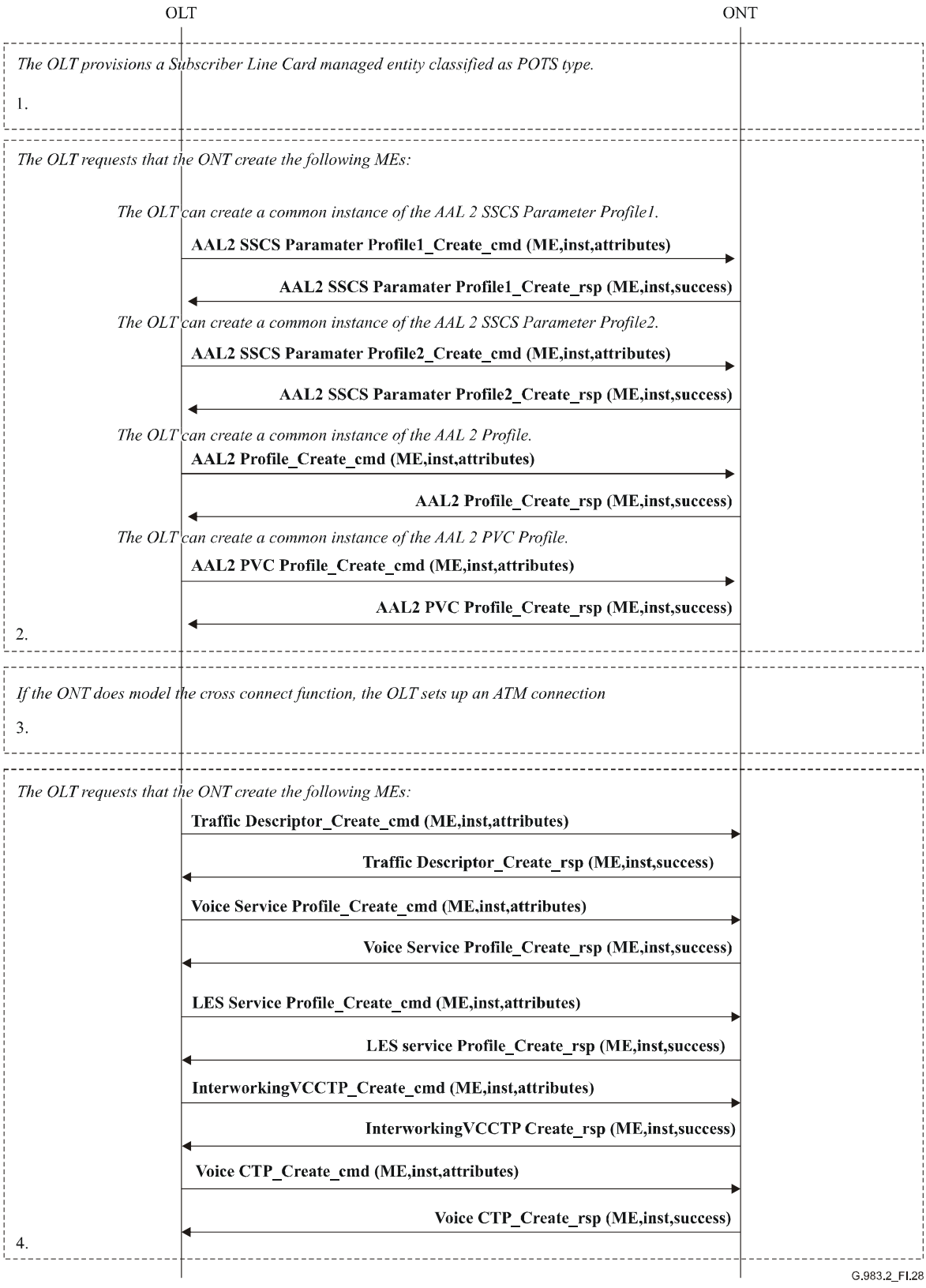


Figure I.28/G.983.2 – Connection set-up for voice over AAL 2 service connection

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I.2.22 Voice over AAL 2 service connection tear-down

The following scenario, Figure I.29, depicts the Voice over AAL 2 service connection tear-down for an ONT with cross-connect functionality. For an ONT that does not model cross-connect functionality, the Interworking VCC Termination Point is directly associated with the VP Network $CTP_{B\text{-}PON}$ on the ANI side. Note that the Voice Service, LES Service, AAL 2 and AAL 2 PVC profiles can be shared among multiple Interworking VCC Termination Points. If there are more Interworking VCC Termination Points associated with these profile managed entities, the OLT may not request to delete them. This holds also for the ATM connection used: if more Interworking VCC Termination Points are associated with this connection (i.e., VP Network $CTP_{B\text{-}PON}$), the ATM connection cannot be deleted. Moreover, the SSCS Parameter1 and SSCS Parameter2 profiles can be shared among multiple AAL 2 $Profiles_{B\text{-}PON}$. If there are more AAL 2 $Profiles_{B\text{-}PON}$ associated with these profile managed entities, the OLT may not request to delete them. If applicable, the OLT must delete the corresponding History Data managed entities as well.

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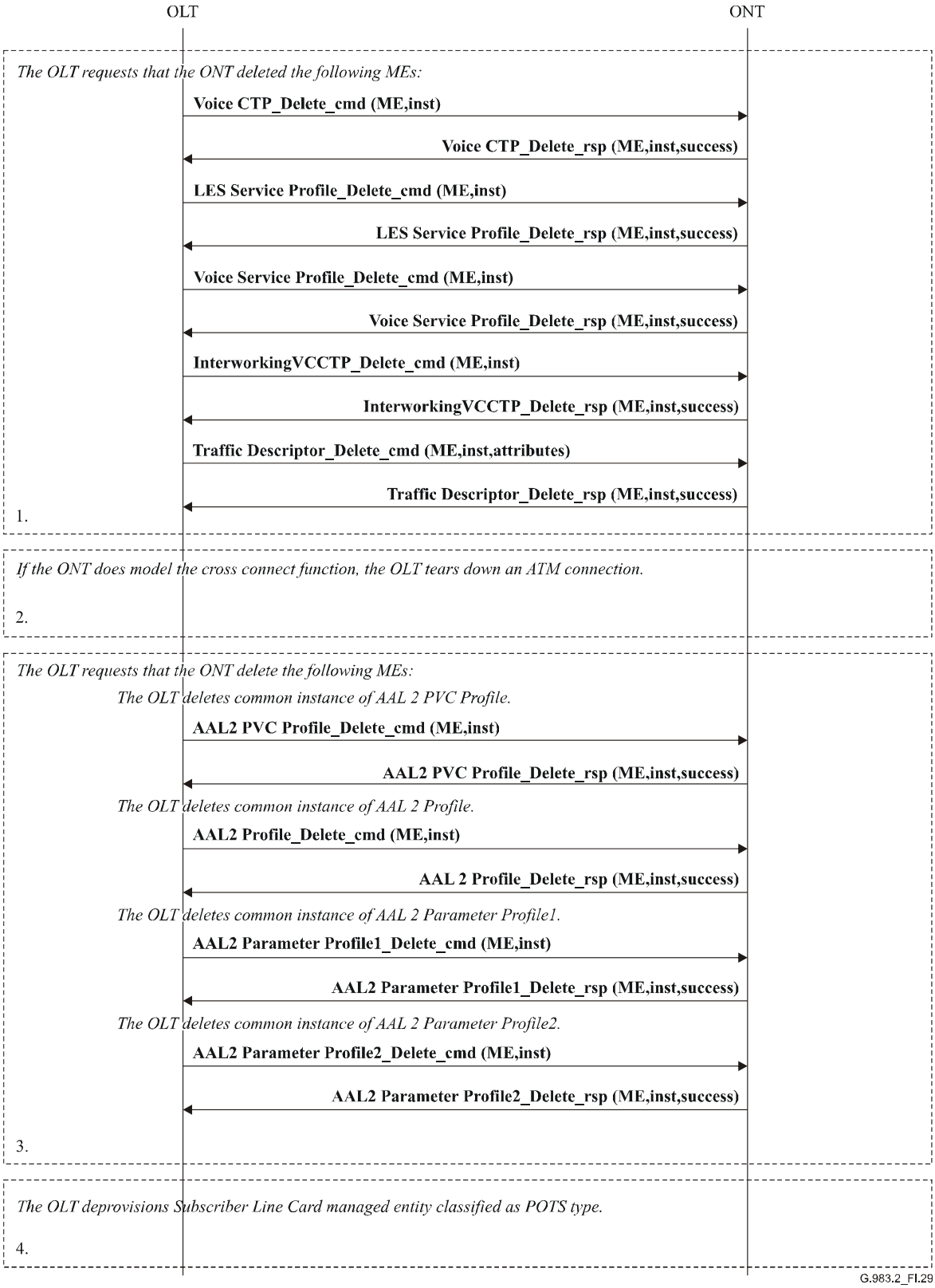


Figure I.29/G.983.2 – Voice over AAL 2 service connection tear-down

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I.2.23 Voice over AAL 1 service connection set-up

The following scenario, Figure I.30, for Voice over AAL 1 service connection set-up is given for an ONT with cross-connect functionality. For an ONT that does not model cross-connect functionality, the Interworking VCC Termination Point is directly associated with the VP Network $CTP_{B\text{-}PON}$ on the ANI side.

Note that the Voice Service and AAL 1 profiles can be shared among multiple Interworking VCC Termination Points. No creation of profiles is needed if the Interworking VCC Termination Point is pointing to an existing profile. Also, the OLT might want to create corresponding History Data managed entities for the connection.

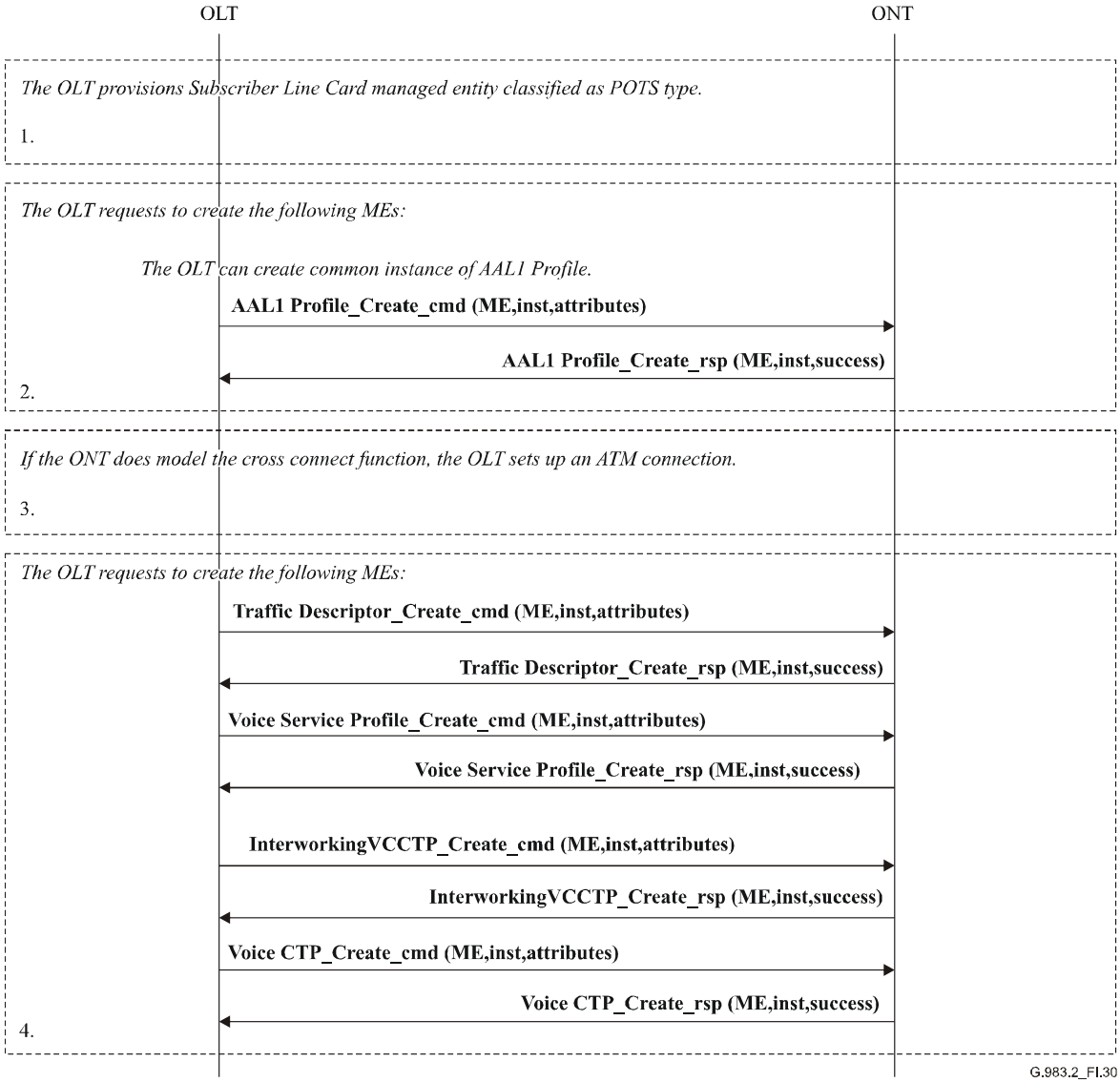


Figure I.30/G.983.2 – Connection set-up voice over AAL 1 service connection

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I.2.24 Voice over AAL 1 service connection tear-down

The following scenario, Figure I.31, for voice over AAL 1 service connection tear-down is given for an ONT with cross-connect functionality. For an ONT that does not model cross-connect functionality, the Interworking VCC Termination Point is directly associated with the VP Network $CTP_{B\text{-}PON}$ on the ANI side.

Note that the Voice Service and AAL 1 profiles can be shared among multiple Interworking VCC Termination Points. If there are more Interworking VCC Termination Points associated with these profile managed entities, the OLT may not request to delete them. This holds also for the ATM connection used: if more Interworking VCC Termination Points are associated with this connection (i.e., VP Network $CTP_{B\text{-}PON}$), the ATM connection cannot be deleted. If applicable, the OLT must delete the corresponding History Data managed entities as well.

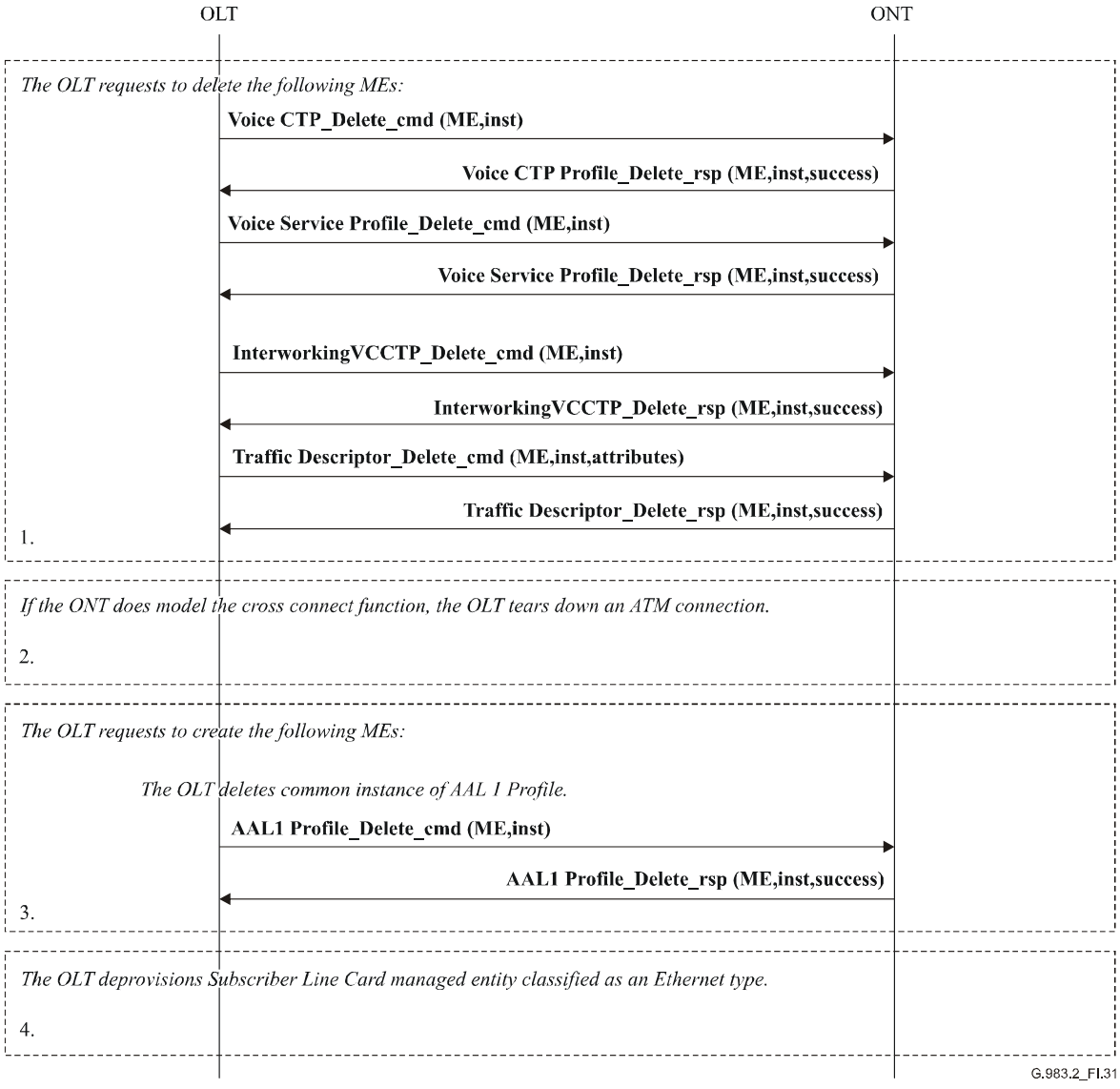


Figure I.31/G.983.2 – Connection tear-down for Voice over AAL 1 service connection

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I.2.25 IP Router service connection set-up

Figure I.32 shows the scenario for IP Router service connection set-up for an ONT with cross-connect functionality. For the case that an ONT does not model cross-connect function, the Interworking VCC Termination Point is directly associated to the VP Network $CTP_{B\text{-}PON}$ on the ANI side.

Note that the AAL 5 profile can be shared among multiple Interworking VCC Termination Points. No creation of profiles is needed if the Interworking VCCTP points to an existing profile. Moreover, the IP Router Service Profile and ARP Service Profile can be shared among multiple IP Port Configuration Data managed entities, so no creation of profiles is needed if the IP Port Configuration Data points to an existing profile.

The OLT also may want to create corresponding History Data managed entities for the connection.

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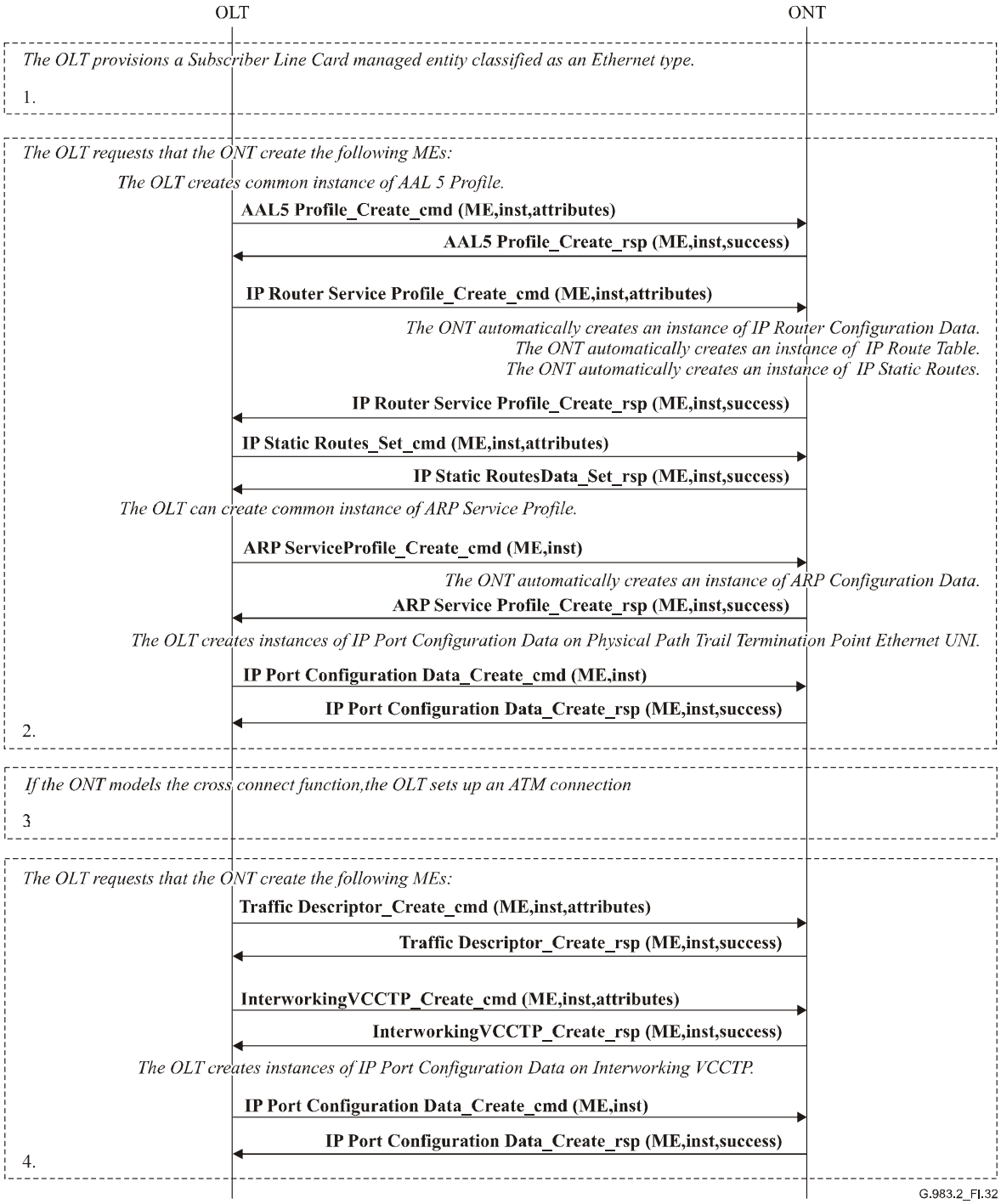


Figure I.32/G.983.2 – Connection set-up for IP router service connection

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I.2.26 IP router service connection tear-down

The following scenario, Figure I.33, depicts IP router service connection tear-down for an ONT with cross-connect functionality. For the case that an ONT does not model cross-connect function, the Interworking VCC Termination Point is directly associated to the VP Network $CTP_{B\text{-}PON}$ on the ANI side.

Note that the AAL 5 profile can be shared among multiple Interworking VCC Termination Points. If there are more Interworking VCC Termination Points associated with this profile managed entity, the OLT may not request to delete it. This holds also for the ATM connection used: if more Interworking VCC Termination Points are associated to this connection (i.e., VP Network $CTP_{B\text{-}PON}$), the ATM connection cannot be deleted. Moreover, the IP Router Service Profile and ARP Service Profile can be shared among multiple IP Port Configuration Data managed entities. If there are more IP Port Configuration Data managed entities associated with these profile managed entities, the OLT may not request to delete them.

If applicable, the OLT can delete the corresponding History Data managed entities as well.

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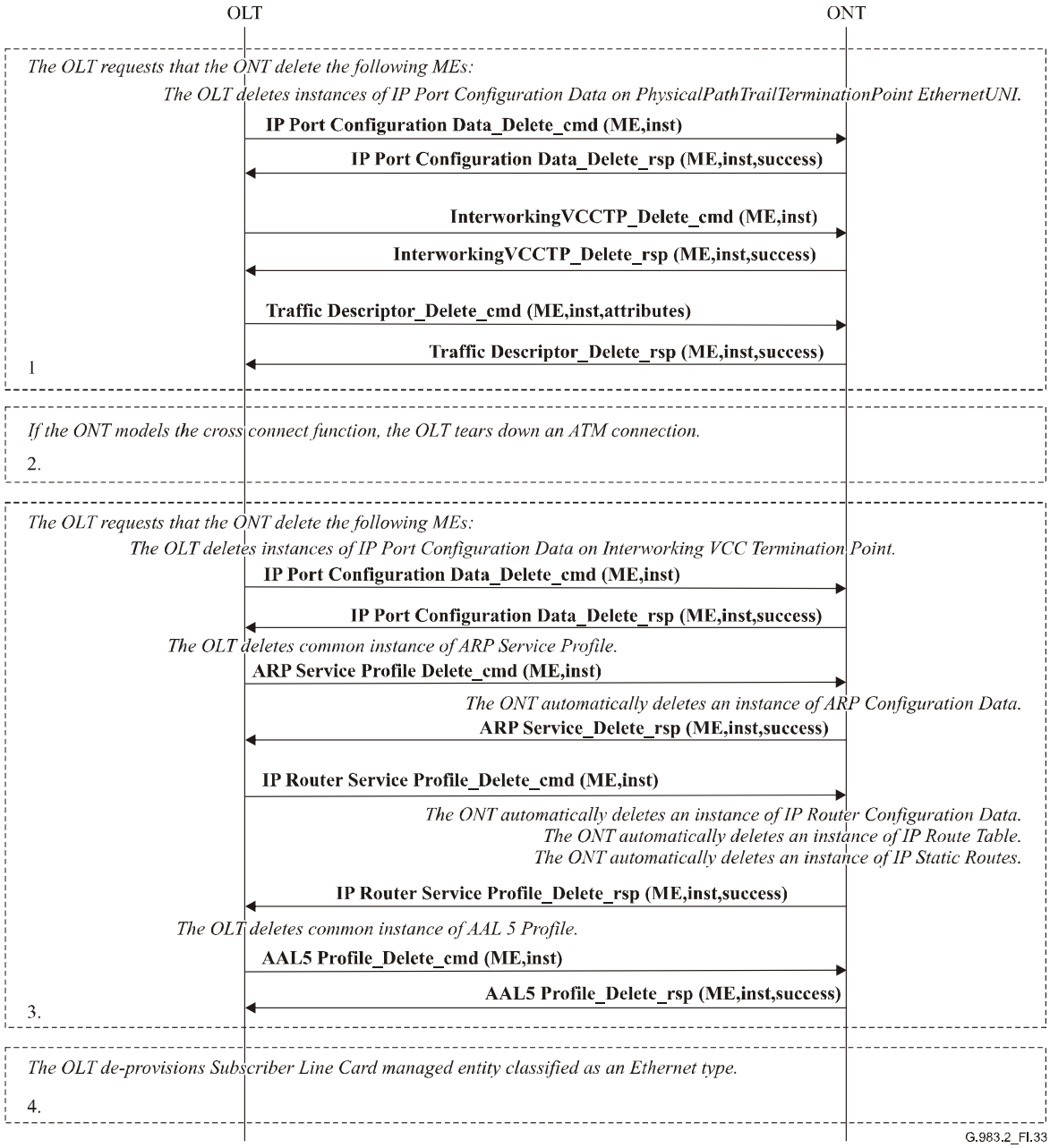


Figure I.33/G.983.2 – Connection tear-down for IP router service connection

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I.2.27 Addition of entries to IP static routes

The following scenario, Figure I.34, depicts addition of entities to the IP static routes managed entity for an ONT.

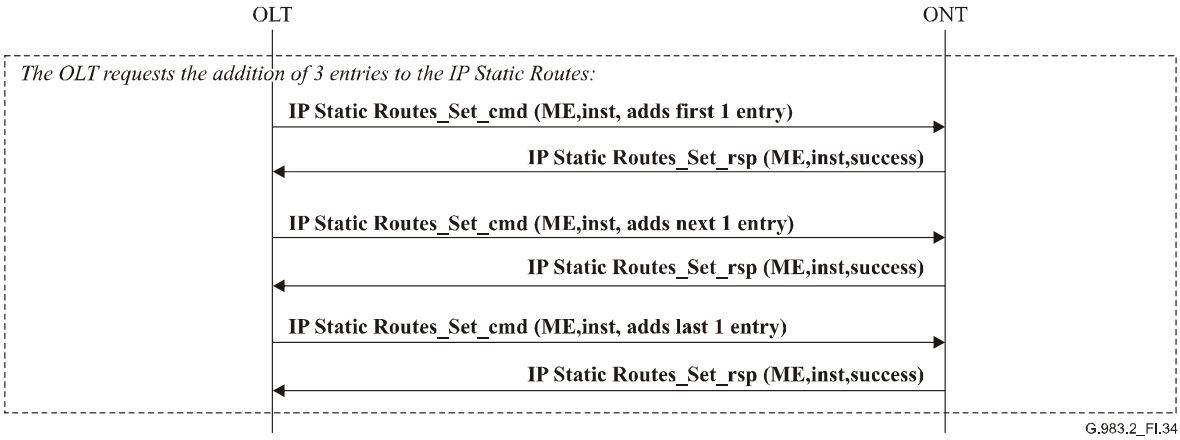


Figure I.34/G.983.2 – Addition of entities to the IP static routes

I.2.28 Removal of entries from IP static routes

The following scenario, Figure I.35, depicts the removal of entries from the IP static routes managed entity for an ONT.

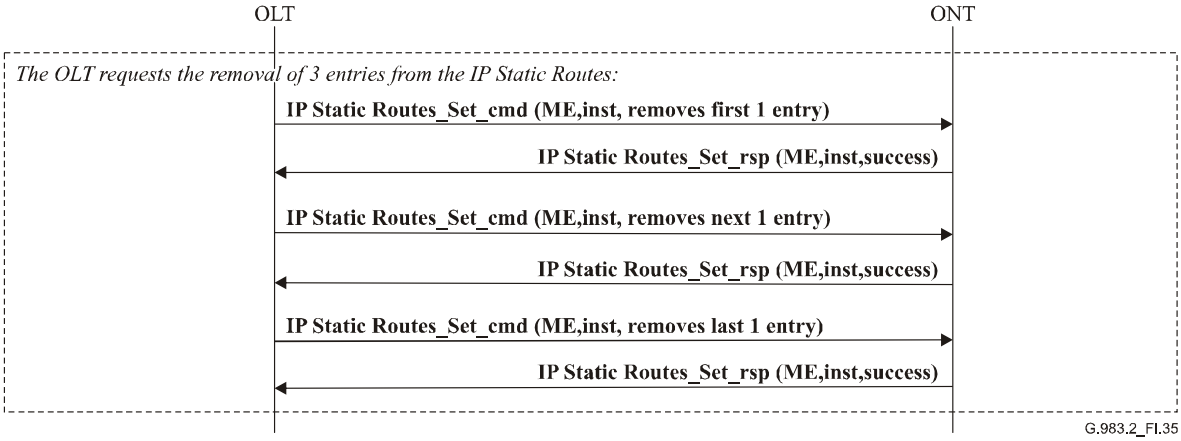


Figure I.35/G.983.2 – Removal of entries from IP static routes

I.3 Common services with PON protection

In cases where PON protection is implemented, some of the common service scenarios given in clause I.2 must be modified or augmented to accommodate the protection function. The following subclauses describe these cases.

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I.3.1 OMCC establishment – protection side ranged after start-up of working side

Figure I.36 shows the OMCI start-up sequence when only the working-side PON-LT is ranged during the initial phase. In the given figure, the assumption is made that the OLT and the ONT are both available for PON protection.

NOTE – When the OLT and the ONT do not support a common protection scenario (i.e., 1+1, 1:1 and extra traffic), the protection side is not used.

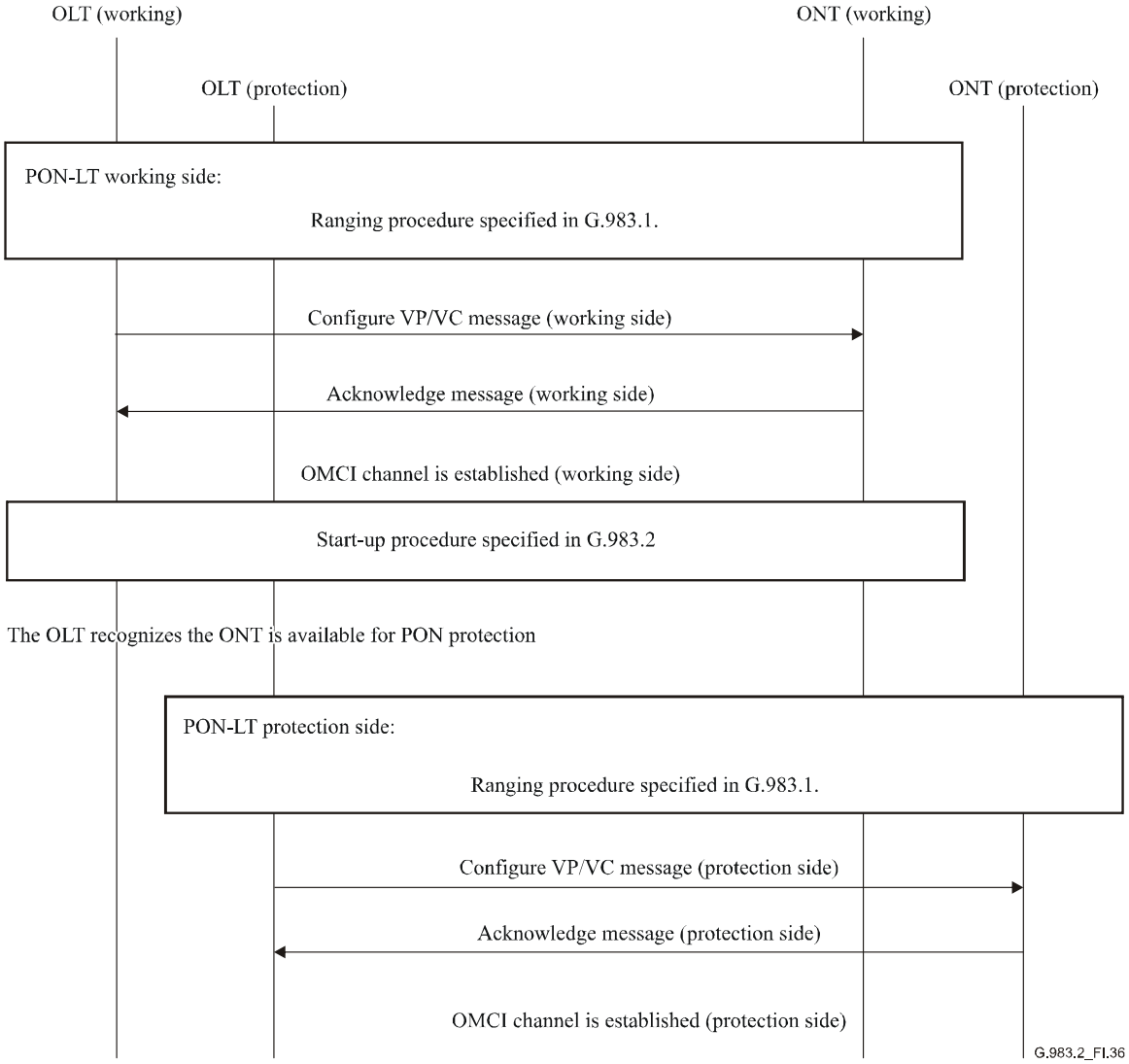


Figure I.36/G.983.2 – Start-up scenario for sequential ranging of working and protection sides

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I.3.2 OMCC establishment for simultaneous ranging of working and protection PON-LTs

Figure I.37 shows the OMCI start-up sequence when both working-side PON-LT and protection-side PON-LT are ranged simultaneously during the initial phase. In the given figure, the assumption is made that the OLT and the ONT are both available for PON protection.

NOTE – When the OLT and the ONT do not support a common protection scenario (i.e., 1+1, 1:1 and extra traffic), the protection side is not used.

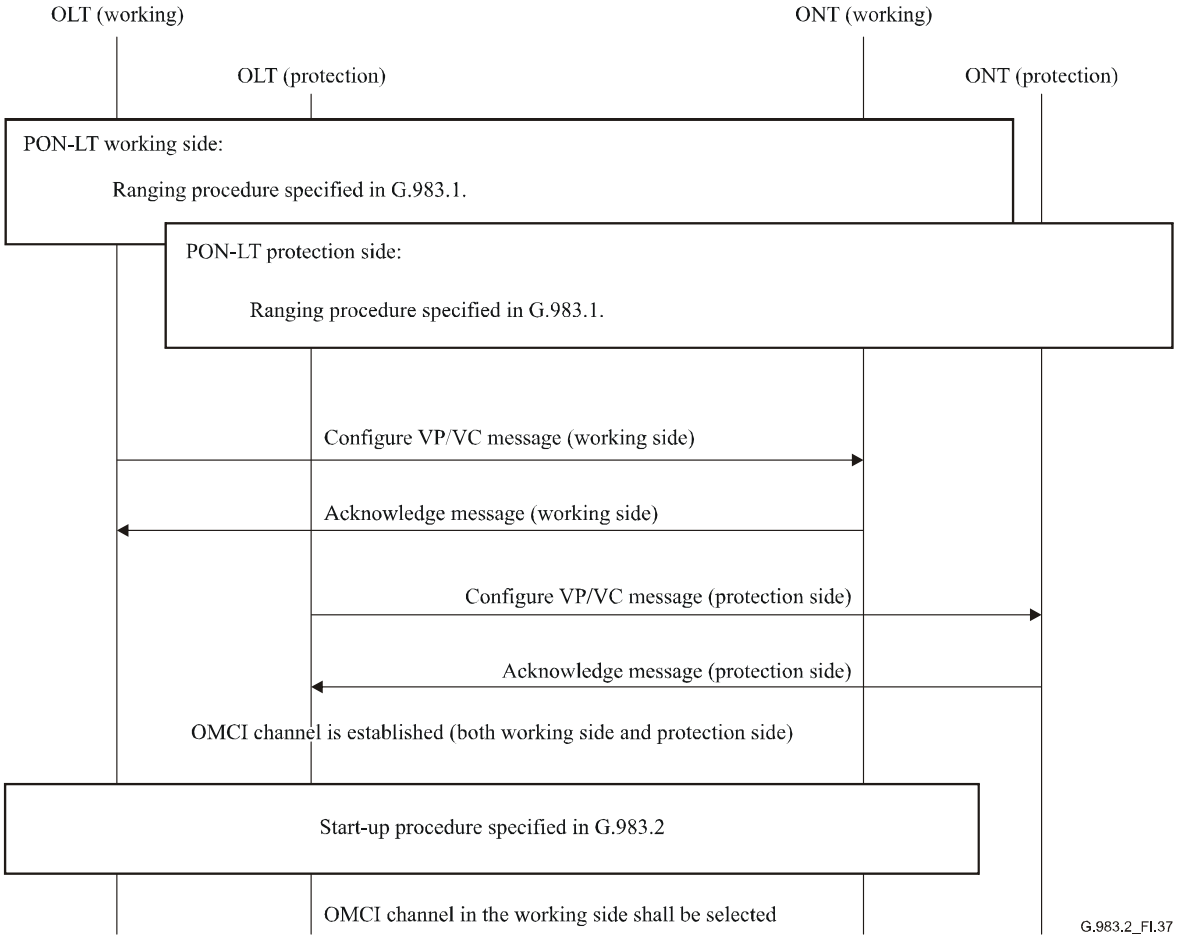


Figure I.37/G.983.2 – Start-up scenario for simultaneous ranging of working and protection sides

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I.3.3 VP configuration for the ONT defined as 1+1 model

Figure I.38 shows the VP configuration sequence for the 1+1 protection architecture.

NOTE – The same VPI/VCI for the OMCC should be used for both working and protection sides.

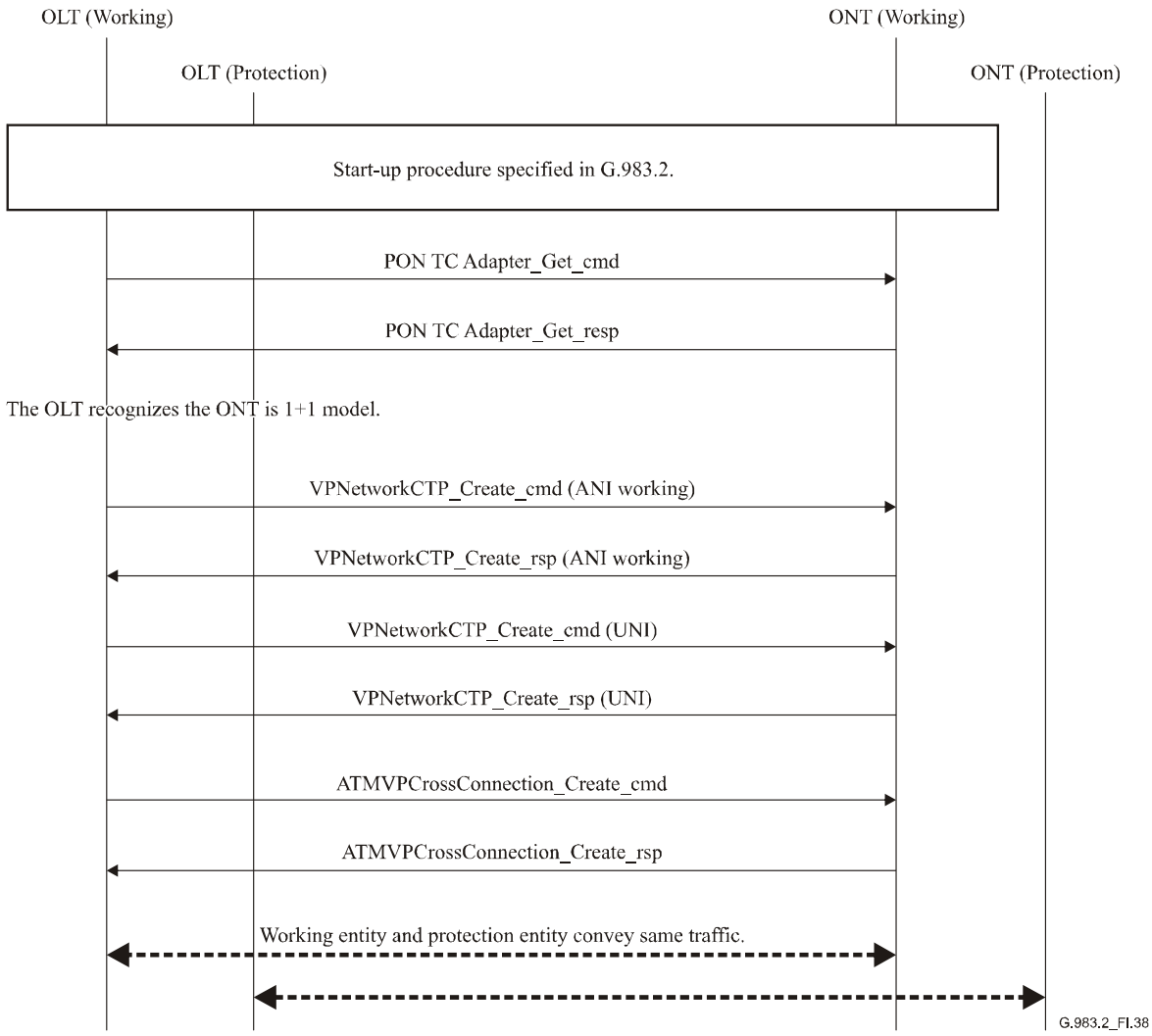


Figure I.38/G.983.2 – VP configuration for 1+1 ONT

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I.3.4 VP configuration for the ONT defined as 1:1 model

Figure I.39 shows the VP configuration sequence for the 1:1 protection architecture.

NOTE – The same VPI/VCI for the OMCC should be used for both working and protection sides.

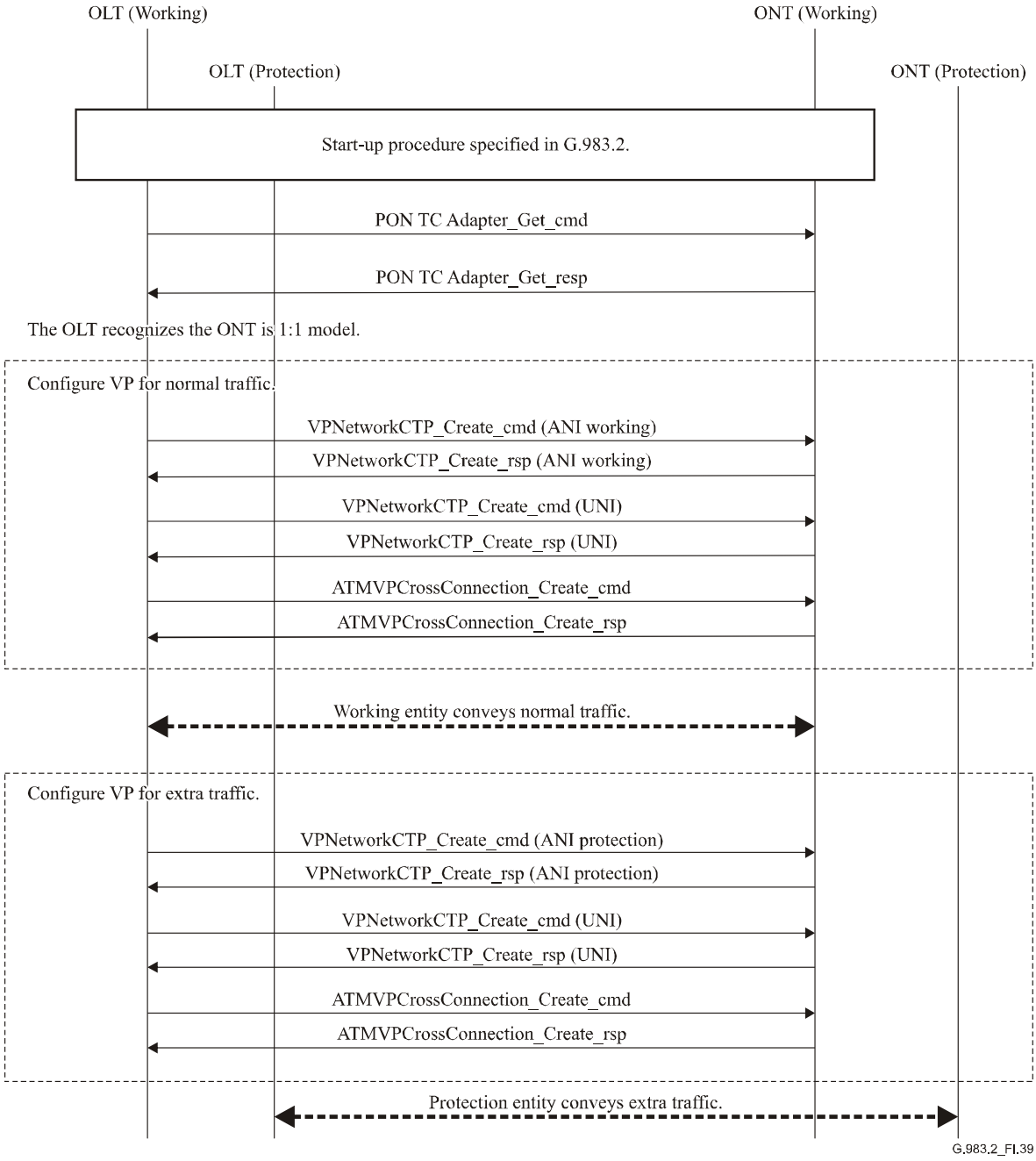


Figure I.39/G.983.2 – VP configuration for 1:1 ONT

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I.3.5 VP removal for 1+1 model ONT

Figure I.40 shows the VP removal sequence for the 1+1 protection architecture.

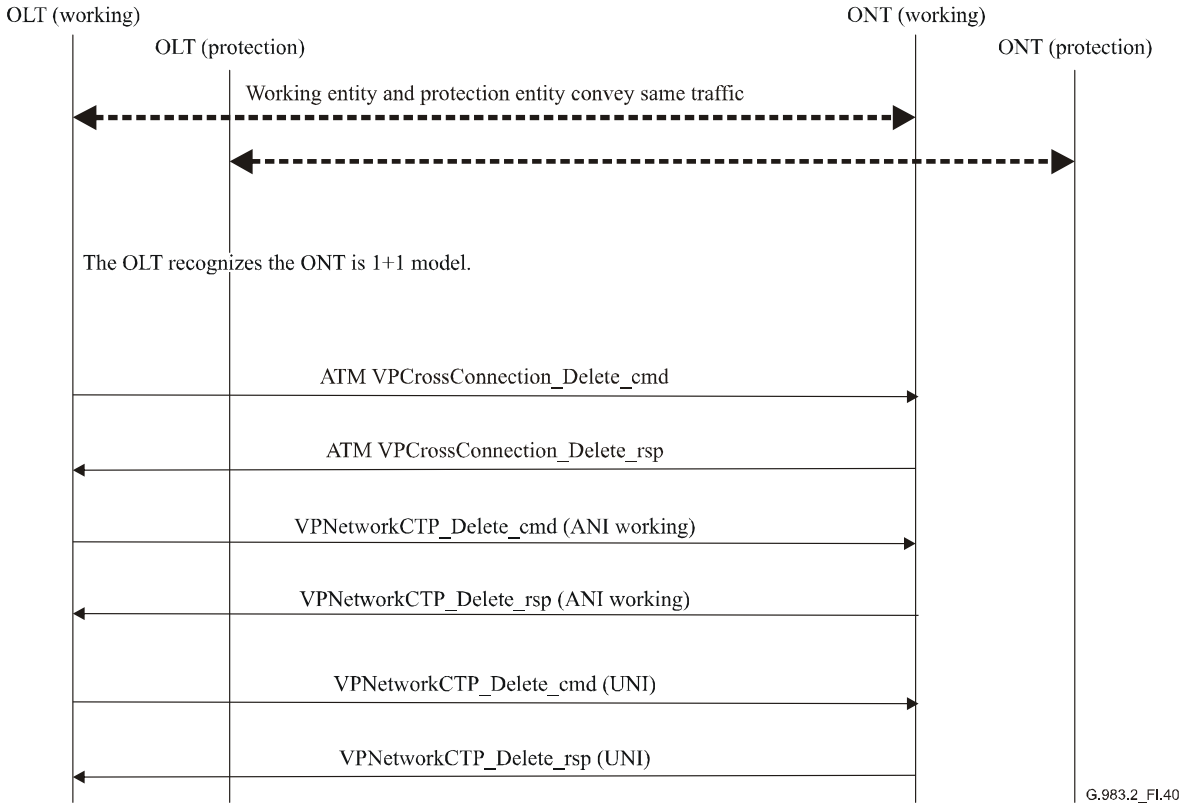


Figure I.40/G.983.2 – VP removal for 1+1 ONT

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I.3.6 VP removal for a 1:1 model ONT

Figure I.41 shows the VP removal sequence for the 1:1 protection architecture.

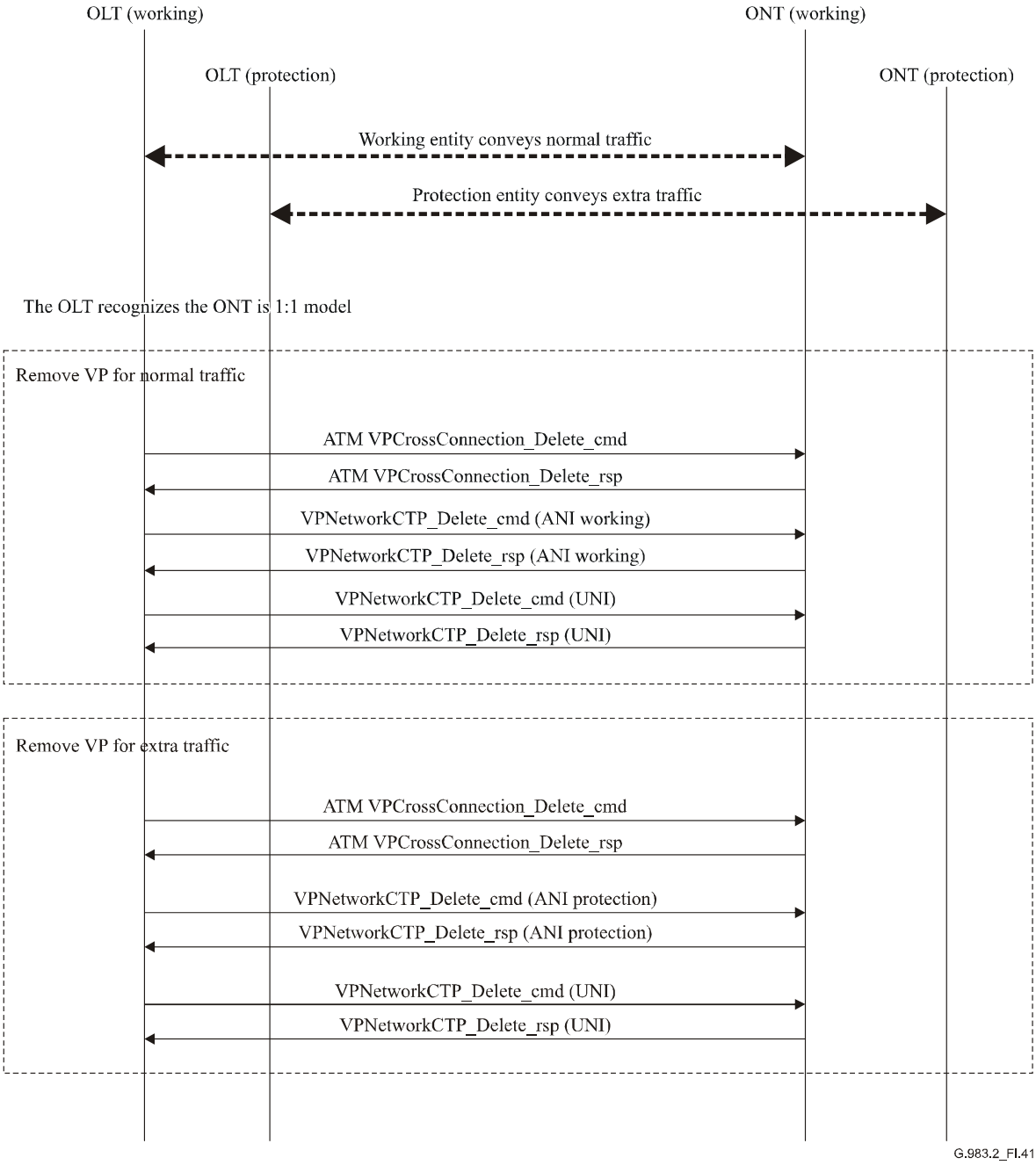


Figure I.41/G.983.2 – VP removal for 1:1 ONT

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I.3.7 Switch-over sequence for a 1+1 model ONT

Figure I.42 shows the switch-over sequence for the 1+1 protection architecture. In the given figure, the assumption is made that the working side's PON-LT detects Signal Fail (SF) or Signal Degrade (SD).

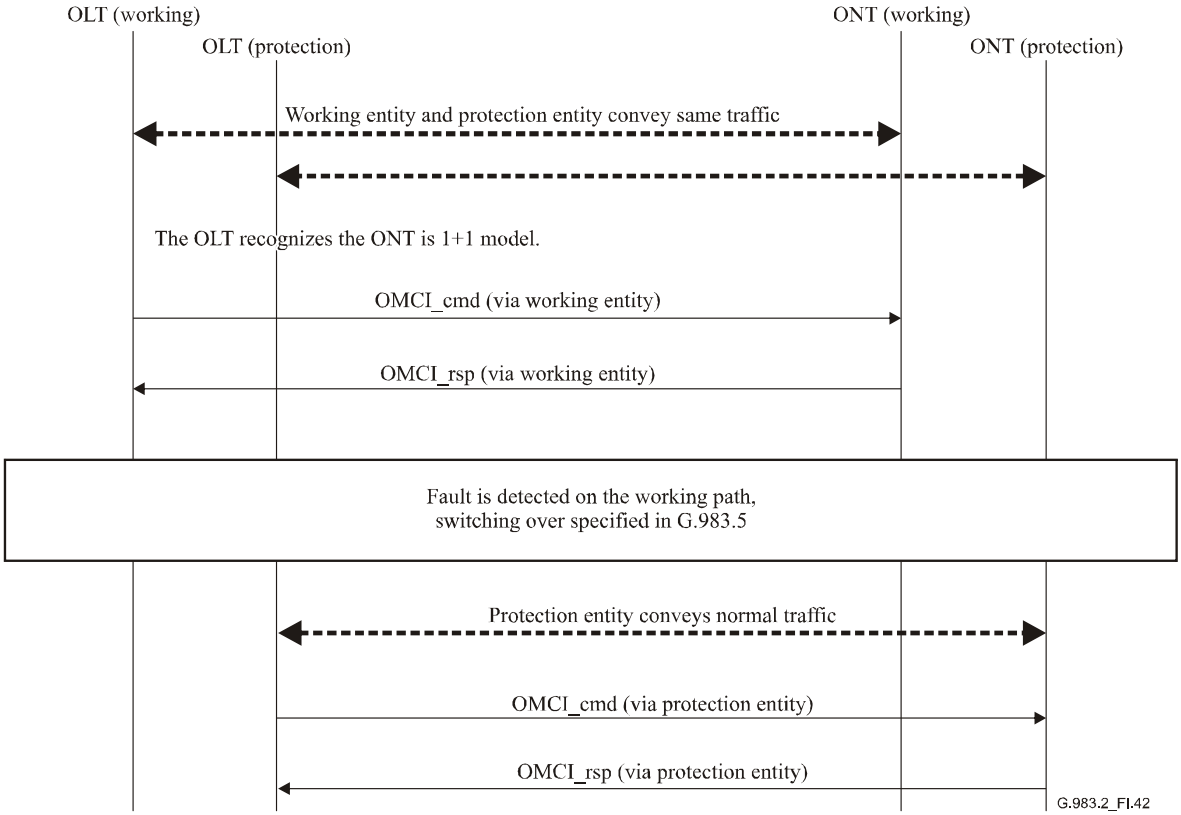


Figure I.42/G.983.2 – Switch-over sequence for 1+1 ONT

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I.3.8 Switch-over sequence for a 1:1 model ONT

Figure I.43 shows the switch-over sequence for the 1:1 protection architecture. In the given figure, the assumption is made that the working side's PON-LT detects Signal Fail (SF) or Signal Degrade (SD).

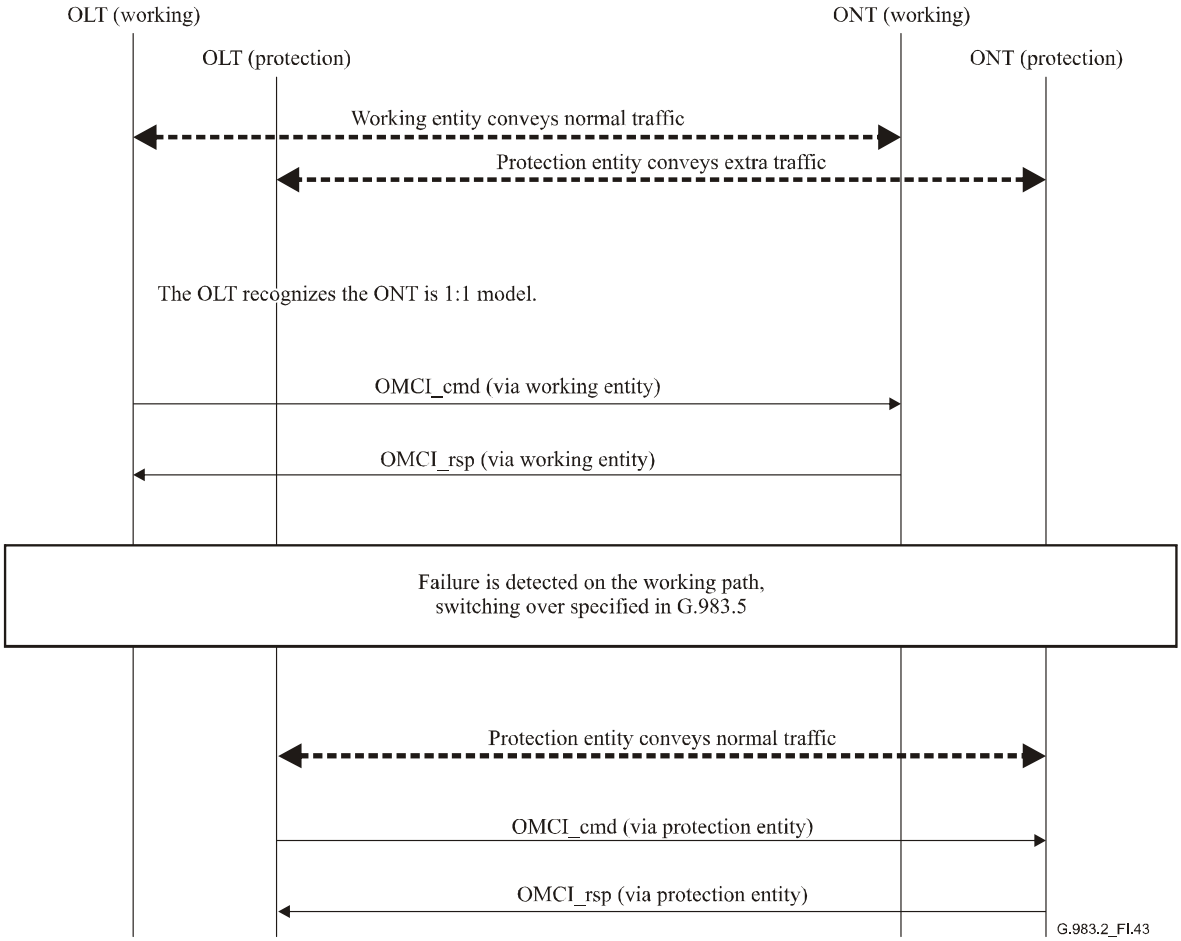


Figure I.43/G.983.2 – Switch-over sequence for 1:1 ONT

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I.4 Common services with DBA support

The following scenarios describe the initial discovery of the DBA function, and the creation and deletion of a T-CONT in the ONT.

I.4.1 Initial handshake

The scope of initial handshake is from ranging to acquisition of the information to be able to start the status reporting. Allocation of the divided_slot grant and data grants and T-CONT configuration is described in clause I.4.2.

Figure I.44 shows the initial handshake procedure.

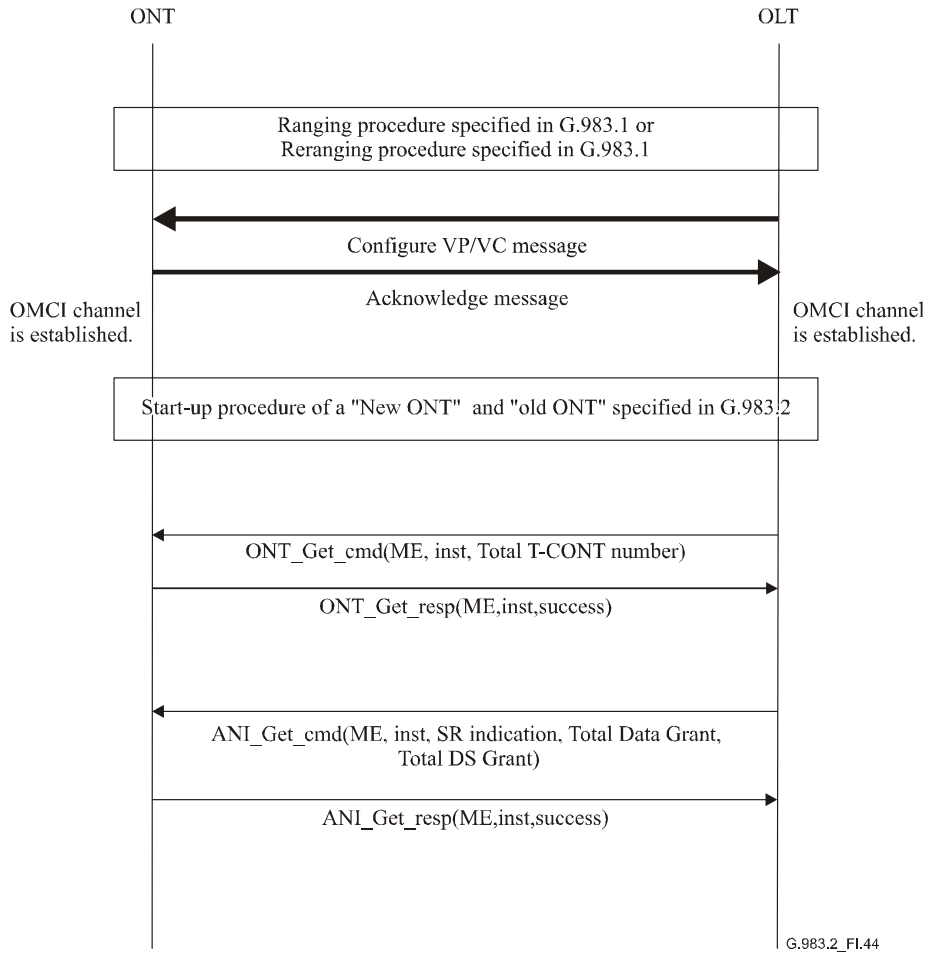


Figure I.44/G.983.2 – Initial handshake procedure

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I.4.2 Addition of T-CONT in an ONT

Figure I.45 shows the addition of T-CONT.

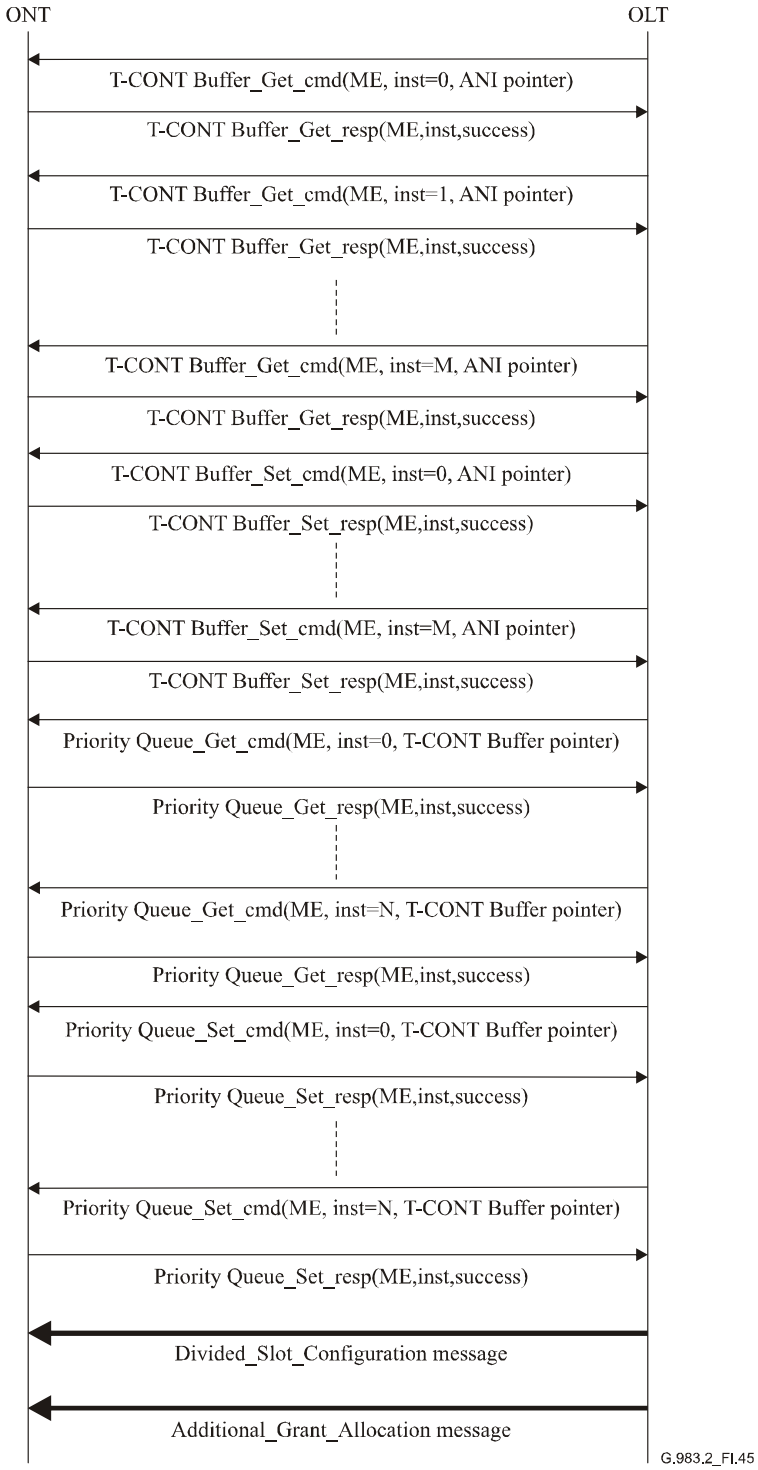


Figure I.45/G.983.2 – T-CONT addition procedure

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I.4.3 Deletion of T-CONT in an ONT

Figure I.46 shows the deletion of T-CONT.

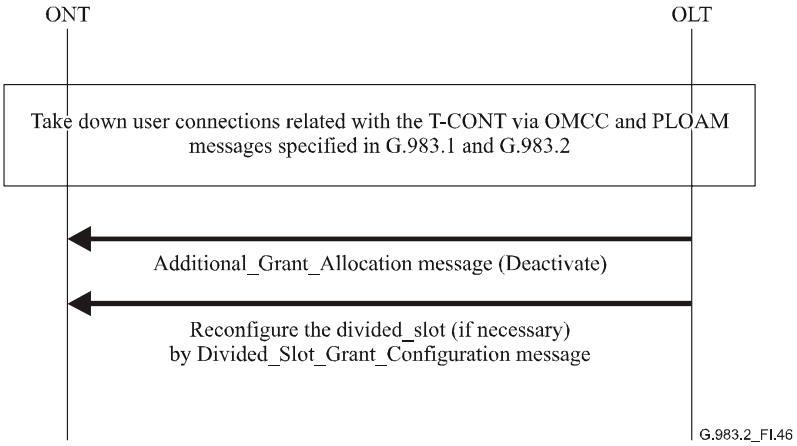


Figure I.46/G.983.2 – Deletion of T-CONT

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Appendix II

OMCI message set

II.1 General remarks

II.1.1 Message type identifier

In 9.1.4, the message types are given. This identifier is omitted in the message set below.

II.1.2 Entity class identifier

In 9.1.6, the entity class identifiers are given. This identifier is omitted in the message set below.

II.1.3 Result and reason

Responses to commands can indicate the result of the command. A value of "null" will indicate that the command was processed successfully. Non-null values will indicate the reason of the failure. If the result was "failure", the rest of the message contents will be filled with all 0x00s. The definition of each result and reason is as follows:

0) *command processed successfully*

   There are two functions for command processing: command interpretation and command execution. This result means that the received command, such as Get/Set/Test/Reboot, was properly interpreted by the ONT's command interpretation function without errors and that the interpreted command was successfully transferred to the ONT's command execution function.

1) *command processing error*

   This result means the command processing failed at the ONT due to some reason not described by items 3, 4, etc.

2) *command not supported*

   This result means that the message type indicated in Byte 8 is not supported by the ONT.

3) *parameter error*

   This result means that the command message received by the ONT was errored.

4) *unknown managed entity*

   This result means that the managed entity class indicated in Byte 10 is not supported by the ONT.

5) *unknown managed entity instance*

   This result means that the managed entity instance indicated in Bytes 11 and 12 does not exist in the ONT.

6) *device busy*

   This result means that the command could not be processed due to process-related congestion at the ONT.

7) *instance exists*

   This result means that the ONT already has a managed entity instance that corresponds to the one the OLT is attempting to create.

8) *Reserved*

9) *attribute(s) failed or unknown*

   This result means that an optional attribute is not supported by the ONT or that a mandatory/optional attribute could not be executed by the ONT, even if it is supported. In

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conjunction with this result, attribute masks are used to indicate which attributes failed or were unknown.

The following two kinds of attribute masks are used when this result/reason is raised:

– *optional attribute mask coding*, which indicates whether or not the optional attribute is supported. Bytes 14 and 15 are assigned to this mask.

– *attribute execution mask coding*, which indicates whether or not the mandatory/optional attribute was executed. Bytes 16 and 17 are assigned to this mask.

If one or more optional attributes are not supported by the ONT, the "optional attribute mask coding" for each *unsupported* optional attribute becomes 1 while the corresponding "attribute execution mask coding" remains 0.

If one or more mandatory or optional attributes were not executed by the ONT, the "optional attribute mask coding" remains 0, while the "attribute execution mask coding" becomes 1 for each *failed* attribute."

II.1.4 Get, get response and set messages

For an attribute mask, a bitmap is used in the "Get", "Get Current Data", "Get response", "Get Current Data Response", and "Set" messages. This bitmap indicates which attributes are requested (Get, Get Current Data) or provided (Get response, Get Current Data Response, and Set). The bitmap is composed as follows (see Table II.1):

Table II.1/G.983.2 – Attribute mask coding

Byte	Bit							
	8	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1	Attribute 1	Attribute 2	Attribute 3	Attribute 4	Attribute 5	Attribute 6	Attribute 7	Attribute 8
2	Attribute 9	Attribute 10	Attribute 11	Attribute 12	Attribute 13	Attribute 14	Attribute 15	Attribute 16

The attribute numbers correspond to the ordering of the attributes in clause 7. Note that the Managed Entity identifier, which is an attribute of each managed entity, has no corresponding bit in the attribute mask. Thus, the attributes are counted starting from the first attribute after the Managed Entity identifier.

II.1.5 Alarm notifications

The ONT will send this notification each time an alarm has changed status for the entity indicated in the message identifier. The message shows the status of *all* alarms of this entity. It is up to the OLT to determine which alarms changed status.

The maximum number of alarms that is supported by the OMCI is 240; thus, the alarm bitmap uses 30 bytes. The bitmap is composed as follows (see Table II.2):

Table II.2/G.983.2 – Alarm mask coding

Byte	Bit							
	8	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1	Alarm 0	Alarm 1	Alarm 2	Alarm 3	Alarm 4	Alarm 5	Alarm 6	Alarm 7
2	Alarm 8	Alarm 9	Alarm 10	Alarm 11	Alarm 12	Alarm 13	Alarm 14	Alarm 15
…								
30	Alarm 232	Alarm 233	Alarm 234	Alarm 235	Alarm 236	Alarm 237	Alarm 238	Alarm 239

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The alarm numbers correspond to the alarm coding in clause 7. Bits in the alarm bitmap that correspond to non-existing alarms shall always be set equal to "0". Bits that correspond to an existing alarm are set to a value of "0" to indicate that the corresponding alarm is cleared or a value of "1" to indicate that the alarm has been raised.

Alarm message sequence numbers can obtain values in the interval 1 to 255. Zero is excluded in order to make this counter similar to the MIB data sync counter.

II.1.6 Test, test response, and test result

The descriptions below indicate how Test, Test response, and Test result are related.

Test: This message is used to initiate either a self test or an MLT test (or additional tests defined in future).

Test response: This message is an immediate reaction to a Test message. The "Test response" message reports the ability of the ONT to run the required test, but it does not contain any specific results.

Test result: This message is used to report the result of either a self test (requested by the OLT) or a MLT test (or additional test defined in future). In the case of an AUTONOMOUS self test, the Test result notification is not used. Instead, notification is sent to the OLT via an alarm ONLY if the managed entity fails its autonomous self test.

A test on a particular managed entity instance is invoked by sending a Test message to this instance. Each managed entity that supports tests needs to have an action "Test" defined for it. The type of test that is invoked by a Test message depends on the managed entity.

The "Test response" message is an indication to the OLT that the test request is received and is being processed. The results of a requested test will be sent to the OLT via a specific "Test result" message.

The "Test response" message will be sent immediately after the Test message is received (i.e., within the normal response time). The transaction identifier of the "Test response" message is identical to the transaction identifier of the Test message that requested the test.

II.2 Message layout

II.2.1 Create

It should be noted that the message contents for the "Create" message apply only to attributes that are "Set-by-create". Thus, byte 13 begins with the attribute value for the first Set-by-create attribute and so forth. If the message contains attributes that are not supported by the ONT, the ONT will ignore the attributes, but it must allocate the space in the message to maintain delineation of the attribute fields.

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = create
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance

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Field	Byte	8	7	6	5	4	3	2	1	Comments
Message contents	13									attribute value of first Set-by-create attribute (size depending on the type of attribute)
										…
										attribute value of last Set-by-create attribute (size depending on the type of attribute)
	xx-45	0	0	0	0	0	0	0	0	padding

II.2.2 Create response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = create
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13	0	0	0	0	x	x	x	x	result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy 0111 = instance exists
	14-45	0	0	0	0	0	0	0	0	padding

II.2.3 Create complete connection

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = create complete connection
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13									MSB ani VP Network $CTP_{B\text{-}PON}$ or VC Network $CTP_{B\text{-}PON}$ instance
	14									LSB ani VP Network $CTP_{B\text{-}PON}$ or VC Network $CTP_{B\text{-}PON}$ instance

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Field	Byte	8	7	6	5	4	3	2	1	Comments
Message contents	15									MSB uni VP Network $CTP_{B\text{-}PON}$ or VC Network $CTP_{B\text{-}PON}$ instance
	16									LSB uni VP Network $CTP_{B\text{-}PON}$ or VC Network $CTP_{B\text{-}PON}$ instance
	17									MSB uni/ani pointer (= MSB corresponding uni instance)
	18									LSB uni/ani pointer (= LSB corresponding uni instance)
	19									MSB vpi ani side
	20									LSB VPI ani side
	21									MSB VPI uni side (= 0x00)
	22									LSB VPI uni side
	23	0	0	0	0	0	y	x	x	direction/VP-VC choice xx : 01 = uni-to-ani 10 = ani-to-uni 11 = bidirectional y : 0 = create VP CTPs 1 = create VC CTPs
	24									MSB priority queue pointer ani VP Network $CTP_{B\text{-}PON}$
	25									LSB priority queue pointer ani VP Network $CTP_{B\text{-}PON}$
	26									MSB priority queue pointer uni VP Network $CTP_{B\text{-}PON}$
	27									LSB priority queue pointer uni VP Network CTP
	28									padding
	29									padding
	30									MSB traffic descriptor profile pointer uni VP Network $CTP_{B\text{-}PON}$
	31									LSB traffic descriptor profile pointer uni VP Network $CTP_{B\text{-}PON}$
	32									MSB VCI ani side (if VC CTP)
	33									LSB VCI ani side (if VC CTP)
	34									MSB VCI uni side (if VC CTP)
	35									LSB VCI uni side (if VC CTP)
	36-45	0	0	0	0	0	0	0	0	padding

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II.2.4 Create complete connection response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = create complete connection
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13	0	0	0	0	x	x	x	x	result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy
	14-45	0	0	0	0	0	0	0	0	padding

II.2.5 Delete

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = delete
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13-45	0	0	0	0	0	0	0	0	padding

II.2.6 Delete response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK =1 bits 5-1: action = delete
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance

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Field	Byte	8	7	6	5	4	3	2	1	Comments
Message contents	13									result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy
	14-45	0	0	0	0	0	0	0	0	padding

II.2.7 Delete complete connection

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = delete complete connection
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13-45	0	0	0	0	0	0	0	0	padding

II.2.8 Delete complete connection response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = delete complete connection
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13	0	0	0	0	x	x	x	x	result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy
	14-45	0	0	0	0	0	0	0	0	padding

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II.2.9 Set

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = set
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13									MSB attribute mask
	14									LSB attribute mask
	15									attribute value of first attribute to set (size depending on the type of attribute)
										…
										attribute value of last attribute to set (size depending on the type of attribute)
	xx-45	0	0	0	0	0	0	0	0	padding

II.2.10 Set response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = set
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13	0	0	0	0	x	x	x	x	result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy 1001 = attribute(s) failed or unknown
	14									"optional attribute" mask (attributes 1-8), used with "1001" encoding: 0 = default 1 = unsupported attribute
	15									"optional attribute" mask (attributes 9-16), used with "1001" encoding: 0 = default 1 = unsupported attribute

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Field	Byte	8	7	6	5	4	3	2	1	Comments
Message contents	16									"attribute execution" mask (attributes 1-8), used with "1001" encoding: 0 = default 1 = failed attribute
	17									"attribute execution" mask (attributes 9-16), used with "1001" encoding: 0 = default 1 = failed attribute
	18-45	0	0	0	0	0	0	0	0	padding

II.2.11 Get

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = get
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13									MSB attribute mask
	14									LSB attribute mask
	15-45	0	0	0	0	0	0	0	0	padding

II.2.12 Get response

Note that the optional Attribute and Attribute Execution masks should always be assumed to be present, even if result code 0x1001 is not returned. There is a consideration of interoperability on this point. Some implementations do not assume the mask is always present (which is deprecated behaviour). Even in this case, it can be shown that no failure occurs.

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = get
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance

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Field	Byte	8	7	6	5	4	3	2	1	Comments
Message contents	13	0	0	0	0	x	x	x	x	result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy 1001 = attribute(s) failed or unknown
	14									MSB attribute mask
	15									LSB attribute mask
	16									attribute value of first attribute included (size depending on the type of attribute)
										…
										attribute value of last attribute included (size depending on the type of attribute)
	xx-41	0	0	0	0	0	0	0	0	padding
	42									"optional attribute" mask (attributes 1-8), used with "1001" encoding: 0 = default 1 = unsupported attribute
	43									"optional attribute" mask (attributes 9-16), used with "1001" encoding: 0 = default 1 = unsupported attribute
	44									"attribute execution" mask (attributes 1-8), used with "1001" encoding: 0 = default 1 = failed attribute
	45									"attribute execution" mask (attributes 9-16), used with "1001" encoding: 0 = default 1 = failed attribute

II.2.13 Get complete connection

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = get complete connection
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									Entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13-45	0	0	0	0	0	0	0	0	padding

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II.2.14 Get complete connection response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = get complete connection
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13	0	0	0	0	x	x	x	x	result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy
	14									MSB ani VP Network $CTP_{B\text{-}PON}$ or VC Network $CTP_{B\text{-}PON}$ instance
	15									LSB ani VP Network $CTP_{B\text{-}PON}$ or VC Network $CTP_{B\text{-}PON}$ instance
	16									MSB uni VP Network $CTP_{B\text{-}PON}$ or VC Network $CTP_{B\text{-}PON}$ instance
	17									LSB uni VP Network $CTP_{B\text{-}PON}$ or VC Network $CTP_{B\text{-}PON}$ instance
	18									MSB uni/ani pointer (= msb corresponding uni instance)
	19									LSB uni/ani pointer (= lsb corresponding uni instance)
	20									MSB VPI ani side
	21									LSB VPI ani side
	22									MSB VPI uni side (= 0x00)
	23									LSB VPI uni side
	24	0	0	0	0	0	y	x	x	direction/VP-VC choice xx : 01 = uni-to-ani 10 = ani-to-uni 11 = bidirectional y : 0 = create VP CTPs 1 = create VC CTPs
	25									MSB priority queue pointer ani VP Network $CTP_{B\text{-}PON}$
	26									LSB priority queue pointer ani VP Network $CTP_{B\text{-}PON}$

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Field	Byte	8	7	6	5	4	3	2	1	Comments
Message contents	27									MSB priority queue pointer uni VP Network $CTP_{B\text{-}PON}$
	28									LSB priority queue pointer uni VP Network $CTP_{B\text{-}PON}$
	29									padding
	30									padding
	31									MSB traffic descriptor profile pointer uni VP Network $CTP_{B\text{-}PON}$ or padding
	32									LSB traffic descriptor profile pointer uni VP Network $CTP_{B\text{-}PON}$ or padding
	33									MSB VCI ani side (if VC CTP)
	34									LSB VCI ani side (if VC CTP)
	35									MSB VCI uni side (if VC CTP)
	36									LSB VCI uni side (if VC CTP)
	37-45	0	0	0	0	0	0	0	0	padding

II.2.15 Get all alarms

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = get all alarms
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = ONT Data
	11	0	0	0	0	0	0	0	0	MSB entity instance
	12	0	0	0	0	0	0	0	0	LSB entity instance
Message contents	13-45	0	0	0	0	0	0	0	0	padding

II.2.16 Get all alarms response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = get all alarms
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = ONT Data
	11	0	0	0	0	0	0	0	0	MSB entity instance
	12	0	0	0	0	0	0	0	0	LSB entity instance
Message contents	13									MSB of the number of subsequent commands
	14									LSB of the number of subsequent commands
	15-45	0	0	0	0	0	0	0	0	padding

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II.2.17 Get all alarms next

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = get all alarms next
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = ONT Data
	11	0	0	0	0	0	0	0	0	MSB entity instance
	12	0	0	0	0	0	0	0	0	LSB entity instance
Message contents	13									MSB of the command sequence number
	14									LSB of the command sequence number
	15-45	0	0	0	0	0	0	0	0	padding

The command sequence numbers shall start from 0x00 onwards.

II.2.18 Get all alarms next response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = get all alarms next
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = ONT Data
	11	0	0	0	0	0	0	0	0	MSB entity instance
	12	0	0	0	0	0	0	0	0	LSB entity instance
Message contents	13									entity class on which the alarms are reported
	14									MSB entity instance on which the alarms are reported
	15									LSB entity instance on which the alarms are reported
	16-45	x	x	x	x	x	x	x	x	bitmap alarms

The bitmap that is used in the Get All Alarms Next response for a given managed entity class is identical to the bitmap that is used in the alarm notifications for that managed entity class.

In the case the ONT has received an Get All Alarms Next request message in which the command sequence number is out of range, the ONT shall respond with a message in which bytes 13 to 45 are all set to 0x00. This corresponds to a response with entity class 0x00, entity instance 0x0000, and bitmap all 0x00s.

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II.2.19 MIB upload

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = MIB upload
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = ONT Data
	11	0	0	0	0	0	0	0	0	MSB entity instance
	12	0	0	0	0	0	0	0	0	LSB entity instance
Message contents	13-45	0	0	0	0	0	0	0	0	padding

II.2.20 MIB upload response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = MIB upload
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = ONT Data
	11	0	0	0	0	0	0	0	0	MSB entity instance
	12	0	0	0	0	0	0	0	0	LSB entity instance
Message contents	13									MSB of the number of subsequent commands
	14									LSB of the number of subsequent commands
	15-45	0	0	0	0	0	0	0	0	padding

II.2.21 MIB upload next

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = MIB upload next
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = ONT Data
	11	0	0	0	0	0	0	0	0	MSB entity instance
	12	0	0	0	0	0	0	0	0	LSB entity instance
Message contents	13									MSB of the command sequence number
	14									LSB of the command sequence number
	15-45	0	0	0	0	0	0	0	0	padding

The command sequence numbers shall start from 0x00 onwards.

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II.2.22 MIB upload next response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = MIB upload next
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = ONT Data
	11	0	0	0	0	0	0	0	0	MSB entity instance
	12	0	0	0	0	0	0	0	0	LSB entity instance
Message contents	13									entity class of object
	14									MSB entity instance of object
	15									LSB entity instance of object
	16									MSB attribute mask
	17									LSB attribute mask
	18									value of first attribute (size depending on the type of the attribute)
										...
										value of the last attribute (size depending on the type of the attribute)
	xx-45	0	0	0	0	0	0	0	0	padding

If the ONT receives a MIB Upload Next request message in which the command sequence number is out of range, it shall respond with a message in which bytes 13 to 45 are all set to 0x00. This corresponds to a response with entity class 0x00, entity instance 0x0000, attribute mask 0x0000, and padding from byte 18 to byte 45.

Note that, if all attributes of a managed entity do not fit within one MIB Upload Next response message, the attributes will be split over several messages. The OLT can use the information in the attribute mask to determine which attribute values are reported in which MIB upload Next response message.

II.2.23 MIB reset

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = MIB reset
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = ONT Data
	11	0	0	0	0	0	0	0	0	MSB entity instance
	12	0	0	0	0	0	0	0	0	LSB entity instance
Message contents	13-45	0	0	0	0	0	0	0	0	padding

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II.2.24 MIB reset response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = MIB reset
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = ONT Data
	11	0	0	0	0	0	0	0	0	MSB entity instance
	12	0	0	0	0	0	0	0	0	LSB entity instance
Message contents	13	0	0	0	0	x	x	x	x	result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy
	14-45	0	0	0	0	0	0	0	0	padding

II.2.25 Alarm

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	0						DB = 0, AR = 0, AK = 0 bits 5-1: action = alarm
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13									alarm mask
										…
	42									alarm mask
	43-44	0	0	0	0	0	0	0	0	padding
	45									alarm sequence number

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II.2.26 Attribute value change

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	0						DB = 0, AR = 0, AK = 0 bits 5-1: action = attribute value change
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13									MSB attribute mask
	14									LSB attribute mask
	15									attribute value of first attribute changed (size depending on the type of attribute)
										...
										attribute value of last attribute changed (size depending on the type of attribute)
	xx-45	0	0	0	0	0	0	0	0	padding

II.2.27 Test

The format of the test message is specific to the target entity class. At present, two formats are defined. Future test extensions for a given entity class can be supported by adding additional encodings to presently unused bits or bytes. Future specification of tests for other entity classes may use an existing format or may define new formats for the test message. These extension mechanisms allow future tests to be supported without changing the principle of operation.

Format for ONTb-pon, ONUb-pon, subscriber line card, PON line card entity classes

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction indentifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = test
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									Entity class NOTE – This format applies to entity classes ONTb-pon, ONUb-pon, subscriber line card, PON line card.
	11									MSB entity instance
	12									LSB entity instance
	13	0	0	0	0	x	x	x	x	xxxx = select test 0111 = self test
	14-45	0	0	0	0	0	0	0	0	Padding

Format for POTS UNI and PPTP ISDN UNI entity classes

Note that a single message can be used to initiate multiple tests on a given ME if desired.

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Bytes 14-27 are used by the dial tone make-break test. A zero value for a timer causes the ONT to use its built-in defaults. As many as three dial tone frequencies can be specified, or omitted by setting their values to 0. Other fields are also omitted with the value 0, or controlled by flags. An ONT can support the dial tone test with internal defaults only, and is not required to support any of the attributes of bytes 14-27. Likewise, an ONT can use internal defaults for drop test, rather than the values given in bytes 28-37. The capabilities of an ONT are documented by the vendor and known through the administration's practices.

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction indentifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = test
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									Entity class NOTE – This format applies to entity classes PPTP POTS UNI and PPTP ISDN UNI.
	11									MSB entity instance
	12									LSB entity instance
	13	a	0	0	0	x	x	x	x	a – test mode 0 = normal; deny test if line busy 1 = forced mode xxxx = select test 0000 = all MLT tests 0001 = hazardous potential 0010 = foreign EMF 0011 = resistive faults 0100 = receiver off-hook 0101 = ringer 0110 = NT1 dc signature test 0111 = self test 1000 = dial tone make-break test
	14									DBDT timer T1 (slow dial tone threshold), in units of 0.1 seconds. Range 0.1 to 6.0 seconds.
	15									DBDT timer T2 (no dial tone threshold), in units of 0.1 seconds. Range 1.0 to 10.0 seconds.
	16									DBDT timer T3 (slow break dial tone threshold), in units of 0.1 seconds. Range 0.1 to 3.0 seconds.
	17									DBDT timer T4 (no break dial tone threshold), in units of 0.1 seconds. Range 1.0 to 3.0 seconds.
	18							d	p	DBDT control byte d: dialed digit 1 = dialed digit specified in byte 19 0 = use default digit p = pulse (1) or tone (0) dialing

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Field	Byte	8	7	6	5	4	3	2	1	Comments
Message identifier	19									Digit to be dialed, ASCII character in range "0"-"9", "*", "#".
	20-21									Dial tone frequency 1, in units of Hz
	22-23									Dial tone frequency 2, in units of Hz. 0 = unused (i.e., if only one tone is specified)
	24-25									Dial tone frequency 3, in units of Hz. 0 = unused (i.e., if only one or two tones are specified)
	26									Dial tone power threshold, absolute value, 0.1 dB resolution, range [–]0.1 to [–]25.3 dBm0. E.g., –13 dBm0 = 0x82. 0x00 = unspecified
	27									Idle channel power threshold, absolute value, 1 dB resolution, range [–]1 to [–]90 dBm0. 0x00 = unspecified
	28									DC hazardous voltage threshold, absolute value, volts 0x00 = unspecified
	29									AC hazardous voltage threshold, volts RMS 0x00 = unspecified
	30									DC foreign voltage threshold, absolute value, volts 0x00 = unspecified
	31									AC foreign voltage threshold, volts RMS 0x00 = unspecified
	32									Tip-ground and ring-ground resistance threshold, kΩ 0x00 = unspecified
	33									Tip-ring resistance threshold, kΩ 0x00 = unspecified
	34-35									Ringer equivalence minimum threshold, in 0.01 REN units 0x00 = unspecified
	36-37									Ringer equivalence maximum threshold, in 0.01 REN units 0x00 = unspecified
	38-45	0	0	0	0	0	0	0	0	Padding

II.2.28 Test response

If an ONT does not support all tests requested in byte 13 of the test message, it should not execute any test and should respond with result 0010, command not supported. If an ONT supports all of the requested tests but cannot support one or more of the explicitly specified threshold attributes, it should not execute any test and should respond with result 0011, parameter error. The test command could be re-issued with different thresholds or default thresholds, and would be expected to succeed.

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Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = test
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13	0	0	0	0	x	x	x	x	result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy
	14-45	0	0	0	0	0	0	0	0	padding

The Test response message is an indication to the OLT that the test request is received and is being processed.

II.2.29 Start software download

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = start software download
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = software image
	11									MSB entity instance 0 = $ONT_{B\text{-}PON}$ 1, 2, ..., 127 = UNI card 129, 130, ..., 255 = ANI card
	12	0	0	0	0	0	0	x	x	LSB entity instance 00 = first instance 01 = second instance
Message contents	13									window size – 1
	14-17									image size in bytes
	18-45	0	0	0	0	0	0	0	0	padding

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II.2.30 Start software download response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = start software download
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = software image
	11									MSB entity instance 0 = $ONT_{B\text{-}PON}$ 1, 2, ..., 127 = UNI card 129, 130, ..., 255 = ANI card
	12	0	0	0	0	0	0	x	x	LSB entity instance 00 = first instance 01 = second instance
Message contents	13	0	0	0	0	x	x	x	x	result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy
	14									window size – 1
	15-45	0	0	0	0	0	0	0	0	padding

II.2.31 Download section

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	x	0						DB = 0, AR = x, AK = 0 x = 0: no response expected (section within the window) x = 1: response expected (last section of a window) bits 5-1: action = sw download section
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = software image
	11									MSB entity instance 0 = $ONT_{B\text{-}PON}$ 1, 2, ..., 127 = UNI card 129, 130, ..., 255 = ANI card
	12	0	0	0	0	0	0	x	x	LSB entity instance 00 = first instance 01 = second instance
Message contents	13									download section number
	14-45									data

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II.2.32 Download section response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = sw download section
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = software image
	11									MSB entity instance 0 = $ONT_{B\text{-}PON}$ 1, 2, ..., 127 = UNI card 129, 130, ..., 255 = ANI card
	12	0	0	0	0	0	0	x	x	LSB entity instance 00 = first instance 01 = second instance
Message contents	13	0	0	0	0	x	x	x	x	result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy
	14									download section number
	15-45	0	0	0	0	0	0	0	0	padding

II.2.33 End software download

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = end software download
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = software image
	11									MSB entity instance 0 = $ONT_{B\text{-}PON}$ 1, 2, ..., 127 = UNI card 129, 130, ..., 255 = ANI card
	12	0	0	0	0	0	0	x	x	LSB entity instance 00 = first instance 01 = second instance
Message contents	13-16									CRC-32
	17-20									image size in bytes
	21-45	0	0	0	0	0	0	0	0	padding

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II.2.34 End software download response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = end software download
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = software image
	11									MSB entity instance 0 = $ONT_{B\text{-}PON}$ 1, 2, ..., 127 = UNI card 129, 130, ..., 255 = ANI card
	12	0	0	0	0	0	0	x	x	LSB entity instance 00 = first instance 01 = second instance
Message contents	13	0	0	0	0	x	x	x	x	result, reason 0000 = command processed successfully (CRC correct) 0001 = command processing error (CRC incorrect) 0010 = command not supported (not applicable) 0011 = parameter error (not applicable) 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy
	14-45	0	0	0	0	0	0	0	0	padding

II.2.35 Activate image

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = activate image
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = software image
	11									MSB entity instance 0 = $ONT_{B\text{-}PON}$ 1, 2, ..., 127 = UNI card 129, 130, ..., 255 = ANI card
	12	0	0	0	0	0	0	x	x	LSB entity instance 00 = first instance 01 = second instance
Message contents	13-45	0	0	0	0	0	0	0	0	padding

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II.2.36 Activate image response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = activate image
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = software image
	11									MSB entity instance 0 = $ONT_{B\text{-}PON}$ 1, 2, ..., 127 = UNI card 129, 130, ..., 255 = ANI card
	12	0	0	0	0	0	0	x	x	LSB entity instance 00 = first instance 01 = second instance
Message contents	13	0	0	0	0	x	x	x	x	result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy
	14-45	0	0	0	0	0	0	0	0	padding

II.2.37 Commit image

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = commit image
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = software image
	11									MSB entity instance 0 = $ONT_{B\text{-}PON}$ 1, 2, ..., 127 = UNI card 129, 130, ..., 255 = ANI card
	12	0	0	0	0	0	0	x	x	LSB entity instance 00 = first instance 01 = second instance
Message contents	13-45	0	0	0	0	0	0	0	0	padding

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II.2.38 Commit image response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = commit image
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class = software image
	11									MSB entity instance 0 = $ONT_{B\text{-}PON}$ 1, 2, ..., 127 = UNI card 129, 130, ..., 255 = ANI card
	12	0	0	0	0	0	0	x	x	LSB entity instance 00 = first instance 01 = second instance
Message contents	13	0	0	0	0	x	x	x	x	result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy
	14-45	0	0	0	0	0	0	0	0	padding

II.2.39 Synchronize time

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = synchronize time
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13-45	0	0	0	0	0	0	0	0	padding

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II.2.40 Synchronize time response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = synchronize time
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13									Result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy
	14-45	0	0	0	0	0	0	0	0	padding

II.2.41 Reboot

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR =1, AK = 0 bits 5-1: action = reboot
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13-45	0	0	0	0	0	0	0	0	padding

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II.2.42 Reboot response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = reboot
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13									result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy
	14-45									padding

II.2.43 Get next

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = get next
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13									MSB attribute mask
	14									LSB attribute mask
	15									MSB of the command sequence number
	16									LSB of the command sequence number
	17-45	0	0	0	0	0	0	0	0	padding

The command sequence numbers shall start from 0x00 onwards.

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II.2.44 Get next response

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK =1 bits 5-1: action = get next
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13	0	0	0	0	x	x	x	x	result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy
	14									MSB attribute mask
	15									LSB attribute mask
	16									attribute value of first attribute included (size depending on the type of attribute)
										…
										attribute value of last attribute included (size depending on the type of attribute)
	xx-45	0	0	0	0	0	0	0	0	padding

If the ONT receives a "Get next request" message in which the command sequence number is out of range, the ONT shall respond with a message in which bytes 13 to 45 are all set to 0x00. This corresponds to a response with entity class 0x00, entity instance 0x0000, attribute mask 0x0000, and padding from byte 16 to byte 45.

II.2.45 Test result

The test result message is used to report the result of a test. The transaction identifier of the test result message is identical to the transaction identifier of the test message that initiated the corresponding test.

Two formats are currently defined, one of which reports the result of a self test (any ME that supports self test), the other of which reports the results of a dial tone draw-break test (PPTP POTS UNI) or an MLT test (PPTP POTS UNI or PPTP ISDN UNI). If a new test for the presently-supported entities is defined in the future, the corresponding test results can be reported by extending the test result message layout. If a new test for other managed entity classes is defined in the future, a new test result message layout may be defined.

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Format for ONTb-pon, ONUb-pon, subscriber line card, PON line card entity classes

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	0						DB = 0, AR = 0, AK = 0 bits 5-1: action = test result
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class. NOTE – This message format pertains to ONTb-pon, ONUb-pon, subscriber line card, PON line card entity classes.
	11									MSB entity instance
	12									LSB entity instance
Message contents	13	0	0	0	0	0	0	0	0	Unused
	14	0	0	0	0	0	0	x	x	self test result: xx = 00: failed xx = 01: passed xx = 10: not completed
	15-45	0	0	0	0	0	0	0	0	padding

Format for POTS UNI and PPTP ISDN UNI entity classes

Byte 13 reports a summary MLT test result. The result for each test category is limited to the two values "test passed or was not executed" or "test failed." Bytes 15 and 16 report the results of a dial tone test.

Byte 14 reports the result of a self test. At present, self test is not supported for the POTS UNI and PPTP ISDN UNI entity classes, and this byte should be set to 0.

There are four possible outcomes for a given test – it can pass, fail, not be run, or not be recognized by the ONT. If an ONT does not support or recognize a given test, it is expected to deny the test request message. To avoid physical damage, an ONT may cease testing if a test fails, and thus some subsequent test will not be run. In addition, the ONT may support some but not all tests of a given suite, such as power measurements in the dial tone test sequence. The category summary in byte 13 includes two values. The value 1 indicates either that all tests in a category passed or that nothing in the category was tested, while 0 indicates that at least one test in the category failed. Further information appears in flags specific to each test results attribute to indicate whether each detailed test was run or not, whether it passed or failed and whether a measured result is reported or not.

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	0						DB = 0, AR = 0, AK = 0 bits 5-1: action = test result
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class. NOTE – This message format pertains to PPTP POTS UNI and PPTP ISDN UNI entity classes.
	11									MSB entity instance

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Field	Byte	8	7	6	5	4	3	2	1	Comments
Message identifier	12									LSB entity instance
Message contents	13	0	0	a	b	c	d	e	f	MLT drop test result: 0 = fail test a/b/c/d/e/f 1 = pass test, or test not run a/b/c/d/e/f a = hazardous potential b = foreign EMF c = resistive faults d = receiver off-hook e = ringer f = NT 1 dc signature test
	14	0	0	0	0	0	0	x	x	self test result: xx = 00: failed xx = 01: passed xx = 10: not completed
	15			b	b	b	d	d	d	Dial tone make-break flags: ddd – Dial tone draw = 000 test not run = 01m failed, could not draw = 10m slow draw = 11m passed bbb – Dial tone break = 000 test not run = 01m failed, could not break = 10m slow break = 11m passed m – measured value flag = 0 measurement not reported = 1 measurement reported
	16			a	a	a	b	b	b	Dial tone power flags: aaa – Quiet channel power bbb – Dial tone power See Note.
	17			a	a	a	b	b	b	Loop test DC voltage flags aaa – VDC, tip-ground bbb – VDC, ring-ground See Note.
	18			a	a	a	b	b	b	Loop test AC voltage flags aaa – VAC, tip-ground bbb – VAC, ring-ground See Note.
	19			a	a	a	b	b	b	Loop test resistance flags 1 aaa – Resistance, tip-ground bbb – Resistance, ring-ground See Note.

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Field	Byte	8	7	6	5	4	3	2	1	Comments
Message identifier	20			a	a	a	b	b	b	Loop test resistance flags 2 aaa – Resistance, tip-ring bbb – Ringer load test See Note.
	21									Time to draw dial tone, in 0.1 second units. Valid only if byte 15 ddd = xx1.
	22									Time to break dial tone, in 0.1 second units. Valid only if byte 15 bbb = xx1.
	23									Total dial tone power measurement, unsigned absolute value, 0.1 dB resolution, range 0 to [–]25.5 dBm0. Values above 0 dBm0 are reported as 0. Valid only if byte 16 bbb = xx1.
	24									Quiet channel power measurement, unsigned absolute value, 1 dB resolution, range 0 to [–]90 dBm0. Valid only if byte 16 aaa = xx1.
	25-26									Tip-ground DC voltage, 2's complement, resolution 1V. Valid only if byte 17 aaa = xx1.
	27-28									Ring-ground DC voltage, 2's complement, resolution 1V. Valid only if byte 17 bbb = xx1.
	29									Tip-ground AC voltage, Vrms. Valid only if byte 18 aaa = xx1.
	30									Ring-ground AC voltage, Vrms. Valid only if byte 18 bbb = xx1.
	31-32									Tip-ground DC resistance, kOhm. Infinite resistance: 0xffff. Valid only if byte 19 aaa = xx1.
	33-34									Ring-ground DC resistance, kOhm. Infinite resistance: 0xffff. Valid only if byte 19 bbb = xx1.
	35-36									Tip-ring DC resistance, kOhm. Infinite resistance: 0xffff. Valid only if byte 20 aaa = xx1.
	37									Ringer equivalence, in 0.1 REN units. Valid only if byte 20 bbb = xx1.
	38-45	0	0	0	0	0	0	0	0	padding

NOTE – Coding for 3 bit flag sets is as follows:

= 000 test not run
= 010 fail, measurement not reported
= 011 fail, measurement reported
= 110 pass, measurement not reported
= 111 pass, measurement reported

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II.2.46 Get current data

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	1	0						DB = 0, AR = 1, AK = 0 bits 5-1: action = get current data
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13									MSB attribute mask
	14									LSB attribute mask
	15-45	0	0	0	0	0	0	0	0	padding

II.2.47 Get current data response

Note that the optional Attribute and Attribute Execution masks should always be assumed to be present, even if result code 0x1001 is not returned. There is a consideration of interoperability on this point. Some implementations do not assume the mask is always present (which is deprecated behaviour). Even in this case, it can be shown that no failure occurs.

Field	Byte	8	7	6	5	4	3	2	1	Comments
Transaction identifier	6-7									
Message type	8	0	0	1						DB = 0, AR = 0, AK = 1 bits 5-1: action = get current data
Device identifier type	9	0	0	0	0	1	0	1	0	OMCI = 0x0A
Message identifier	10									entity class
	11									MSB entity instance
	12									LSB entity instance
Message contents	13	0	0	0	0	x	x	x	x	result, reason 0000 = command processed successfully 0001 = command processing error 0010 = command not supported 0011 = parameter error 0100 = unknown managed entity 0101 = unknown managed entity instance 0110 = device busy 1001 = attribute(s) failed or unknown
	14									MSB attribute mask
	15									LSB attribute mask
	16									attribute value of first attribute included (size depending on the type of attribute)
										…
										attribute value of last attribute included (size depending on the type of attribute)
	xx-41	0	0	0	0	0	0	0	0	padding

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Field	Byte	8	7	6	5	4	3	2	1	Comments
Message contents	42									"optional attribute" mask (attributes 1-8), used with "1001" encoding: 0 = default 1 = unsupported attribute
	43									"optional attribute" mask (attributes 9-16), used with "1001" encoding: 0 = default 1 = unsupported attribute
	44									"attribute execution" mask (attributes 1-8), used with "1001" encoding: 0 = default 1 = failed attribute
	45									"attribute execution" mask (attributes 9-16), used with "1001" encoding: 0 = default 1 = failed attribute

Appendix III

Support of F4/F5 maintenance flows in the ONT

III.1 General principle

The general principle regarding F4 and F5 maintenance flows in the ONT is to use the ITU-T Rec. I.610 [8] procedures wherever possible and to restrict the OMCI requirements to the strictly essential ones. The use of these procedures is largely independent of OMCI. The objective of this appendix is to clarify OMCI-related aspects.

III.2 Definition of the F4/F5 segment and end-to-end applicability

III.2.1 Support of F4/F5 maintenance flows with respect to ATM-UNIs

Segment F4 maintenance flow

The ONT always behaves as a Segment end point for the F4 segment maintenance flow towards the OLT.

The VP Network $CTP_{B\text{-}PON}$ located at the UNI side is by default the Segment end point.

End-to-end F4 maintenance flow

By definition the ONT is not involved.

Segment F5 and end-to-end F5 maintenance flows

By definition the ONT is not involved.

III.2.2 Support of F4/F5 maintenance flows with respect to non-ATM-UNIs

Segment F4 and end-to-end F4 maintenance flow

The ONT always behaves as a segment end point for the F4 Segment and End-to-end maintenance flow towards the OLT.

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The VP Network $CTP_{B\text{-}PON}$ that supports the Interworking VCC Termination Point is by default the Segment end point.

Segment F5 and end-to-end F5 maintenance flows

The ONT always behaves as a segment end point for the F5 Segment and End-to-end maintenance flow towards the OLT.

The Interworking VCC Termination Point is by default a Segment and End-to-end point.

III.3 OMCI support of F4/F5 flows in the ONT

III.3.1 OMCI support of AIS and RDI fault management

Report of End-to-end VP-AIS and VP-RDI, VC-AIS, VC-RDI receiving and generation alarms on the VP Network $CTP_{B\text{-}PON}$ and the Interworking VCC Termination Point respectively.

III.3.2 OMCI support of F4/F5 continuity check procedures

The activation and deactivation of the Continuity Check from the OLT as well as towards the OLT is done via in-band ITU-T Rec. I.610 [8] activation and deactivation procedures. OMCI supports the reporting of Loss of Continuity alarm on the VP Network $CTP_{B\text{-}PON}$ and the Interworking VCC Termination Point.

III.3.3 OMCI support of F4/F5 loopback procedures

The ONT supports loopback point functionality. The insertion of the loopback cell and the reporting of the loopback result are not required in the ONT. The OMCI supports setting of the loopback location identifier in selected PPTP entities described in 7.3.

III.3.4 OMCI support of F4/F5 performance monitoring

The OMCI provides performance monitoring support via the performance monitoring managed entities. Creation of a PM entity will activate the PM feature, and deletion of the entity will deactivate the monitoring. In-band control and reporting of the PM features is not supported.

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Appendix IV

Traffic management options

Depending on the trade-off between the complexity and the number of supported features, the ONT can have various traffic management options. Examples of traffic management implementation in the ONT are described in the following clauses. This appendix also indicates how the MIB defined in clause 7 is used for each implementation.

It should be pointed out that the ONT traffic management is not limited to these examples. ONT traffic management is likely a place where every vendor searches for a proprietary feature to give it a competitive advantage. However, every proprietary feature requires some kind of management that impacts the OMCI. In fact, it is difficult for the specification given in this Recommendation to keep up with the technological and feature innovations. It is envisioned that vendor-specific managed entities will be needed to manage the traffic management related functions in the ONT.

IV.1 Priority Queue$_{B\text{-}PON}$

When the focus is on low complexity implementation, the ONT uses the priority controlled upstream traffic method. In this case, the ONT has no traffic contract or QoS awareness. The ONT is configured by the OLT with a priority for each connection for both directions.

Theoretically, UPC is needed at every multiplexing point, including the ONT. A system with the UPC function has to monitor the traffic volume entering the network from all active VP/VC connections to ensure that the agreed parameters are not violated and to deploy a cell discard or tag policy. In the priority queue implementation, the UPC function is moved to the OLT, where it protects the core network. The PON is protected by the "UPC-like" MAC. The MAC manages all connections from an ONT as a whole. Essentially, the MAC isolates ONTs from each other.

As such, CPEs sharing one ONT may have to regulate their own connection streams to maintain quality. A CPE sending out more cells on one connection will do so at the expense of the other connections established at the same ONT.

OMCI requirements:

The traffic management option in the ONT$_{B\text{-}PON}$ managed entity is set to 0x00.

For the VP Network CTP$_{B\text{-}PON}$ at the ANI side:

Priority Queue Pointer for Upstream: using priority Queue$_{B\text{-}PON}$ managed entity id.

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IV.2 Clarification of ONT functional blocks

Figures IV.1 and IV.2 show the ONT functional blocks for the ATM UNI case and for the non-ATM UNI case.

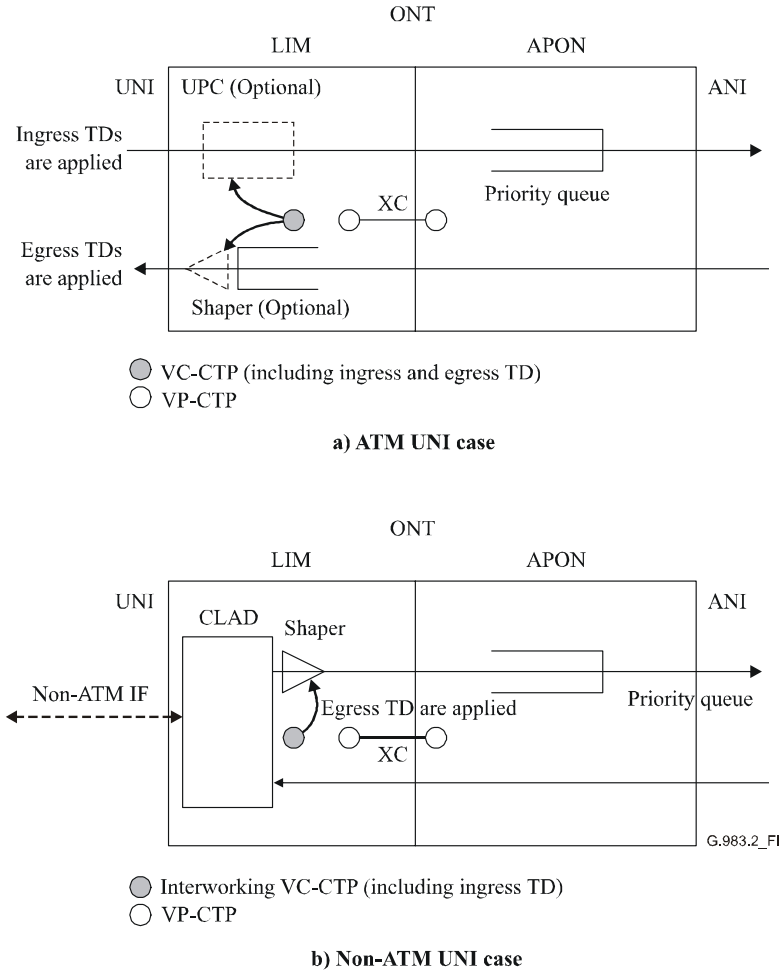
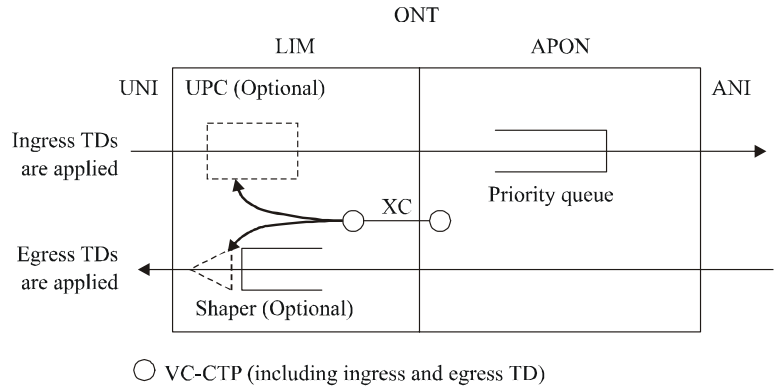
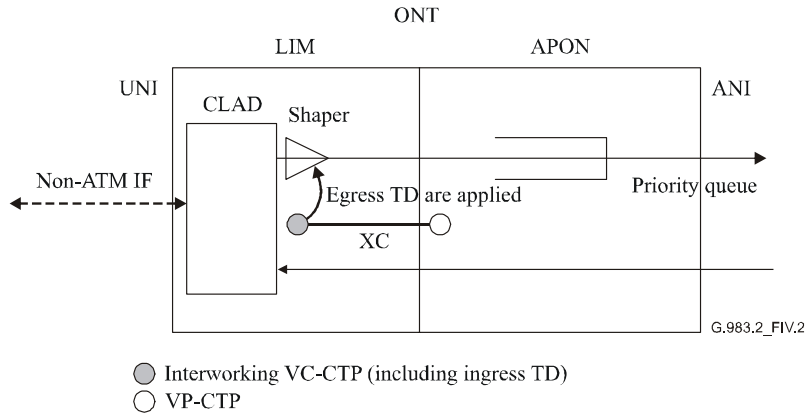


Figure IV.1/G.983.2 – ONT functional block diagrams for VC service

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a) ATM UNI case



b) Non-ATM UNI case

Figure IV.2/G.983.2 – ONT functional block diagrams for VP service

IV.3 An example of the traffic scheduler configuration

An example of the configuration of the Traffic Scheduler is proposed in Figure IV.3. This model consists of three stages, such as 2 delay control and 1 guaranteed rate control stages. A delay control stage can be worked by Head Of the Line (HOL) scheduling. A guaranteed rate control stage can be worked by WRR.

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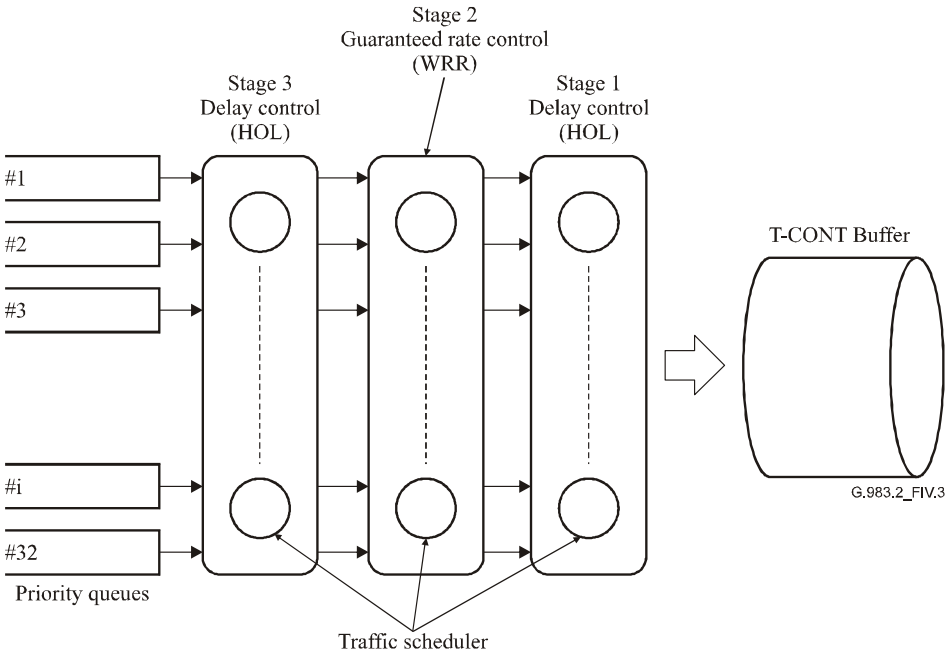


Figure IV.3/G.983.2 – Architectural model in ONT

There are two operations using the above model, such as delay prioritized and guaranteed prioritized policies. These configurations can be shown in Figures IV.4 and IV.5.

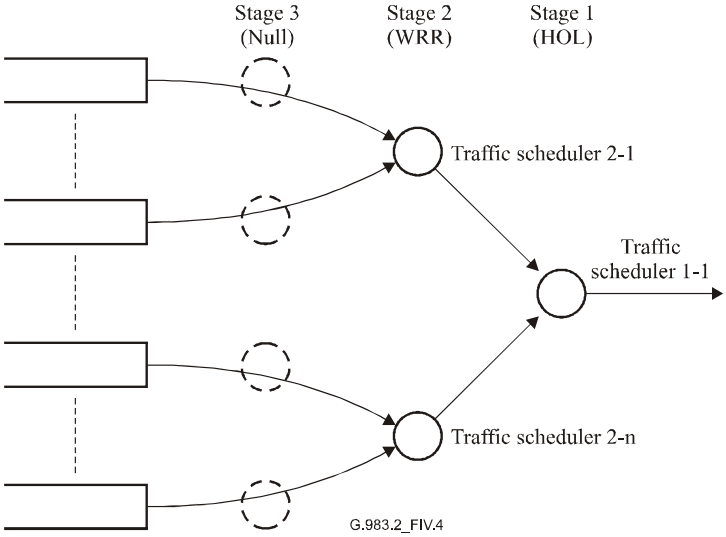


Figure IV.4/G.983.2 – Configuration of delay prioritized model

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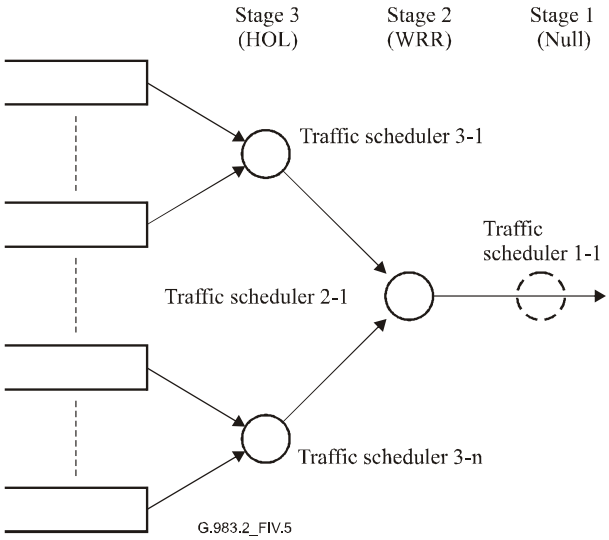


Figure IV.5/G.983.2 – Configuration of guaranteed rate prioritized model

Appendix V

MAC addresses and Ether types

Table V.1/G.983.2 – MAC address and Ether type for various protocols

#	Protocol	MAC address	Ether type	Standard
1	IPv4 Multicast	0x01005E000000 ~ 0x01005E7FFFFF	–	RFC 1700 [B-15]
2	IPv6 Multicast	0x333300000000 ~ 0x3333FFFFFFFF	–	RFC 2464 [B-16]
3	IPv4 Broadcast	0xFFFFFFFFFFFF	0x0800	RFC 1700 [B-15]
4	RARP	0xFFFFFFFFFFFF	0x8035	RFC 1700 [B-15]
5	IPX	0xFFFFFFFFFFFF	0x8137	RFC 1700 [B-15]
		0x09001BFFFFFF, 0x09004E000002	–	
6	NetBEUI	0x030000000001	–	
7	AppleTalk	0xFFFFFFFFFFFF	0x809B, 0x80F3	RFC 1700 [B-15]
		0x090007000000 ~ 0x0900070000FC, 0x090007FFFFFF	–	
8	Bridge Management Information	0x0180C2000000 ~ 0x0180C20000FF	–	IEEE 802.1D [13]
9	ARP	0xFFFFFFFFFFFF	0x0806	RFC 1700 [B-15]
10	PPPoE Broadcast	0xFFFFFFFFFFFF	0x8863	RFC 2516 [B-17]

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Appendix VI

Transparent support of video return path service

VI.1 Network overview

This clause considers support of the video return path. The following configurations are presented:

Configuration 1:

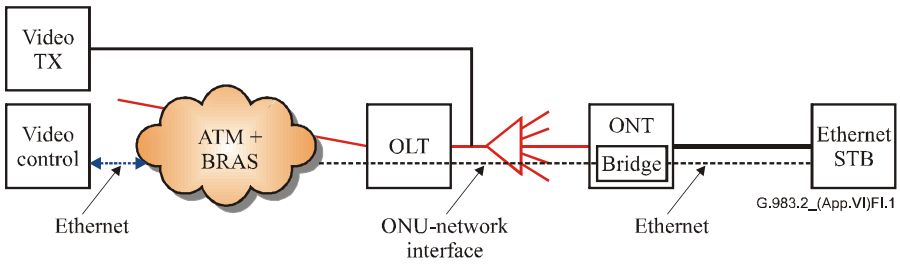


Figure VI.1/G.983.2 – A B-PON with ONT transparent support of interactive video services

In this type of configuration, the STB is Ethernet capable and can perform the TCP/IP protocols to configure itself and exchange information between the STB and the video control system.

The ONT transparently bridges the STB data to a BRAS which terminates the ATM layer and forwards the extracted Ethernet packets to the video control system.

This configuration requires no new B-PON Standardization

Configuration 2:

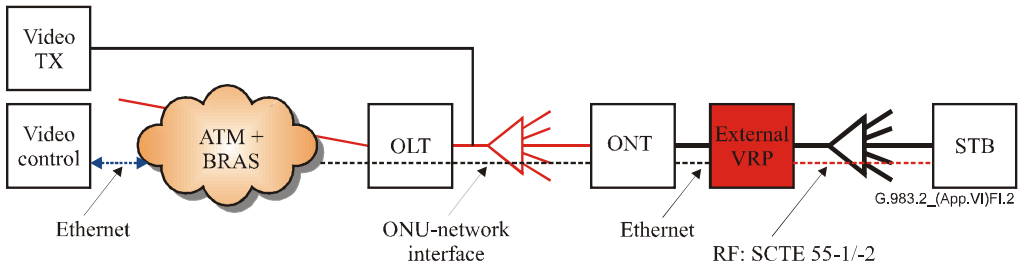


Figure VI.2/G.983.2 – A B-PON interactive video services with external VRP adaptation

In this configuration, the STB is compliant with SCTE 55-1/-2 and interfaces to an external VRP device that terminates the RF and performs the adaptation function from RF to Ethernet.

The interface between the ONT and the VRP device is Ethernet.

The ONT transparently bridges the STB data to a BRAS which terminates the ATM layer and forwards the extracted Ethernet packets to the video control system.

This configuration does not require new B-PON standardization.

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Configuration 3:

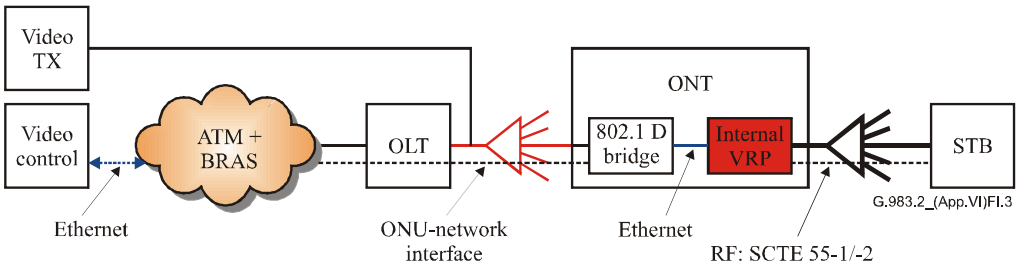


Figure VI.3/G.983.2 – A B-PON interactive video services with internal VRP adaptation

In this configuration, the STB is compliant with SCTE 55-1/-2 and interfaces to an internal VRP device that terminates the RF and performs the adaptation function from RF to Ethernet for input to the 802.1 D bridge in the ONT.

The ONT transparently bridges the STB data to a BRAS which terminates the ATM layer and forwards the extracted Ethernet packets to the video control system.

This configuration does not require new B-PON standardization.

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INTERNATIONAL TELECOMMUNICATION UNION

ITU-T G.983.3

(03/2001)

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Digital sections and digital line system – Optical line systems for local and access networks

A broadband optical access system with increased service capability by wavelength allocation

ITU-T Recommendation G.983.3

(Formerly CCITT Recommendation)

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For further details, please refer to the list of ITU-T Recommendations.

ITU-T Recommendation G.983.3

A broadband optical access system with increased service capability by wavelength allocation

Summary

This Recommendation defines new wavelength allocations to distribute ATM-PON signals and additional service signals simultaneously. New wavelength bands for additional services are made available by constraining the current ATM-PON downstream wavelength to a portion of downstream optical spectrum originally specified in ITU-T G.983.1. The new bands have potential to provide unidirectional and bidirectional services. The wavelength allocation defined in this Recommendation enables the distribution of video broadcast services or data services. The general optical characteristics of these services are taken into account. However, the detailed specifications of these services, such as modulation scheme, signal format, and so on are beyond the scope of this Recommendation.

Source

ITU-T Recommendation G.983.3 was prepared by ITU-T Study Group 15 (2001-2004) and approved under the WTSA Resolution 1 procedure on 15 March 2001.

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FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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NOTE – This Recommendation uses the term "ONU" to refer to both ONTs and ONUs. Any reference to ONUs includes ONTs as well within this Recommendation.

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ITU-T Recommendation G.983.3

A broadband optical access system with increased service capability by wavelength allocation

1 Scope

This Recommendation describes some extended functions for the ATM-PON system defined in ITU-T G.983.1.

This Recommendation describes the Broadband Passive Optical Network (BPON) system that uses wavelength division multiplexing techniques (WDM). These WDM techniques allow operators to provide additional services without disturbing the basic ATM-PON system.

This Recommendation defines new wavelength allocations to distribute ATM-PON signals and additional service signals simultaneously. New wavelength bands for additional services are made available by constraining the current ATM-PON downstream wavelength to a portion of downstream optical spectrum originally specified in ITU-T G.983.1. The new bands have potential to provide unidirectional and bidirectional services. The wavelength allocation defined in this Recommendation enables the distribution of video broadcast services or data services, and the general optical characteristics of these services are taken into account. However, the detailed specifications of these services, such as modulation scheme, signal format, and so on are beyond the scope of this Recommendation.

This Recommendation defines new reference points and optical interface parameters because of the new WDM and/or optical power splitter/combining functions needed at OLT and/or ONU sites.

However, the reference points and Optical Access Network (OAN) described in this Recommendation will remain compatible with the existing ITU-T G.982 and G.983.1.

This Recommendation also defines new environmental conditions required for the ONU equipment. These conditions are required for outside plant applications of the ATM-PON system.

This Recommendation describes the relevant differences from ITU-T G.983.1. However, sections that specify the TC layer are not included in this Recommendation, because they are not relevant to WDM enhancements. The specifications of the TC layer are given by other Recommendations, such as ITU-T G.983.1.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. References cited in ITU-T G.983.1 also apply to this Recommendation but are not reproduced here to avoid redundancy.

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3 Abbreviations

This Recommendation uses the following abbreviations:

AF	Adaptation Function
AM-VSB	Amplitude Modulation-Vestigial Side Band
APS	Automatic Protection Switching
ATM	Asynchronous Transfer Mode
BER	Bit Error Ratio
BIP	Bit Interleaved Parity
B-ISDN	Broadband Integrated Services Digital Network
BPON	Broadband Passive Optical Networks
CID	Consecutive Identical Digit
CNR	Carrier-to-Noise Ratio
CPE	Cell Phase Error
CRC	Cyclic Redundancy Check
DSL	Digital Subscriber Line
DWDM	Dense Wavelength Division Multiplexing
E/O	Electrical/Optical
E-OLT	Enhancement Band-Optical Line Termination
E-ONU	Enhancement Band-Optical Network Unit
FP-LD	Fabry-Perot Laser Diode
FTTB/C	Fibre to the Building/Curb
FTTCab	Fibre to the Cabinet
FTTH	Fibre to the Home
HEC	Header Error Control
IEC	International Electrotechnical Commission
ISDN	Integrated Services Digital Network
LAN	Local Area Network
LCD	Loss of Cell Delineation
LCF	Laser Control Field
LSB	Least Significant Bit
LT	Line Terminal
MAC	Media Access Control
MLM	Multi-Longitudinal Mode
MSB	Most Significant Bit
NRZ	Non Return to Zero
NT	Network Termination
O/E	Optical/Electrical

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OAM	Operation, Administration and Maintenance
OAN	Optical Access Network
ODF	Optical Distribution Frame
ODN	Optical Distribution Network
OLT	Optical Line Termination
ONT	Optical Network Termination
ONU	Optical Network Unit
OpS	Operations System
ORL	Optical Return Loss
PLOAM	Physical Layer OAM
PON	Passive Optical Network
PRBS	Pseudo-Random Bit Sequence
PST	PON Section Trace
PSTN	Public Switched Telephone Network
QAM	Quadrature Amplitude Modulation
QoS	Quality of Service
QPSK	Quadrature Phase Shift Keying
RAU	Request Access Unit
RIN	Relative Intensity Noise
RMS	Root Mean Square
RXCF	Receiver Control Field
SCM	Sub-Carrier Mulitiplexing
SDH	Synchronous Digital Hierarchy
SLM	Single-Longitudinal Mode
SN	Serial Number
SNI	Service Node Interface
TC	Transmission Convergence
TDMA	Time Division Multiple Access
UI	Unit Interval
UNI	User Network Interface
UPC	Usage Parameter Control
VC	Virtual Channel
VP	Virtual Path
VPI	Virtual Path Identifier
WDM	Wavelength Division Multiplexing
WF1	Wavelength division multiplexing and/or optical combining functions 1
WF2	Wavelength division multiplexing and/or optical splitting functions 2

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4 Definitions

This Recommendation defines the following terms:

4.1 diplex working: Bidirectional communication using a different wavelength for each direction of transmission over a single fibre.

4.2 duplex working: Bidirectional communication using the same wavelength for both directions of transmission over a single fibre.

4.3 logical reach: The logical reach is defined as the maximum length that can be achieved for a particular transmission system independent of optical budget.

4.4 Optical Access Network (OAN): The set of access links sharing the same network-side interfaces and supported by optical access transmission systems. The OAN may include a number of ODNs connected to the same OLT.

4.5 Optical Distribution Network (ODN): An ODN provides the optical transmission means from the OLT towards the users, and vice versa. It utilizes passive optical components.

4.6 Optical Line Termination (OLT): An OLT provides the network-side interface of the OAN, and is connected to one or more ODNs.

4.7 Optical Network Termination (ONT): An ONU used for FTTH and includes the User Port function.

4.8 Optical Network Unit (ONU): An ONU provides (directly or remotely) the user-side interface of the OAN, and is connected to the ODN.

4.9 user port function: The User Port Function (UPF) adapts the specific UNI requirements to the core and management functions. The AN may support a number of different accesses and user network interfaces which require specific functions according to the relevant interface specification and the access bearer capability requirements, i.e. bearers for information transfer and protocols.

4.10 verification: It is possible for a malicious user to masquerade as other ONU and use the network if the user knows that the ONU is power-off. Verification is a function to check whether the connected ONU is masqueraded by a malicious user.

4.11 Wavelength Division Multiplexing (WDM): Bidirectional multiplexing using different optical wavelength for up and downstream signals and multiplexing using different optical wavelength for Basic Band, Enhancement Band and Future Band signals.

4.12 basic band: Wavelength region allocated for the ATM-PON downstream capabilities.

4.13 enhancement band: Wavelength region allocated for new additional service capabilities, which include at least video services and Dense Wavelength Division Multiplexing (DWDM) services.

4.14 future band: Reserved wavelength region for future use.

4.15 E-OLT: OLT, which provides additional service capabilities including video services and DWDM services in Enhancement Band.

4.16 E-ONU: ONU, which provides additional service capabilities including video services and DWDM services in Enhancement Band.

4.17 WF1: WDM and/or optical combining/splitting functions, which separate/combine wavelength and/or split/combine optical power for ATM-PON transport service and additional services. It is located between ODN and the OLT.

4.18 WF2: WDM and/or optical combining/splitting functions, which separate/combine wavelength and/or split/combine optical power for ATM-PON transport service and additional services. It is located between ODN and the ONU.

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4.19 **WDM-L**: WDM, which separate/combine 1.3 µm region and 1.5 µm region, and is located in OLT side.

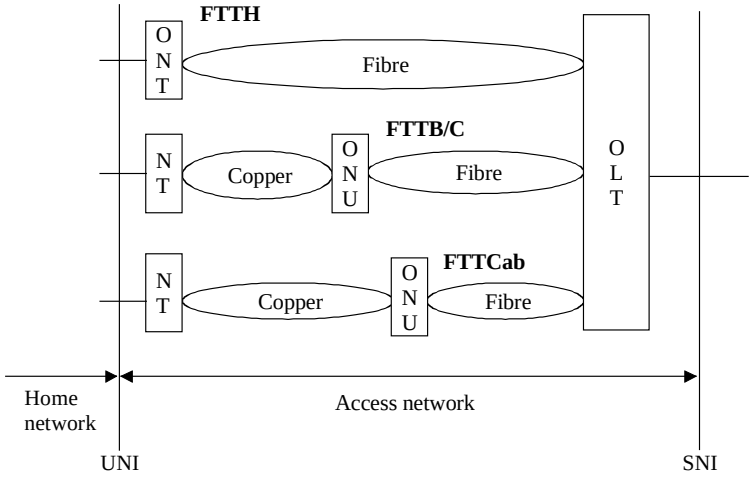
4.20 **WDM-N**: WDM, which separate/combine 1.3 µm region and 1.5 µm region, and is located in ONU side.

4.21 **BPON**: Broadband Passive Optical Network (BPON). BPONs are one-to-n broadband optical transmission systems. BPONs can transparently transport any type of data, for example voice, video, IP data, etc. The BPON is able to carry data regardless of the type of data link frame (i.e. not only native ATM but also HDL Ethernet frame, etc.).

5 Architecture of the optical access network

5.1 Network architecture

The optical section of a local access network system could be either a point-to-point, active, or passive point-to-multipoint architecture. Figure 1 shows the architectures considered, which range from Fibre to the Home (FTTH), through Fibre to the Building/Curb (FTTB/C) to Fibre to the Cabinet (FTTCab). The Optical Access Network (OAN) is common to all architectures shown in Figure 1, hence commonality in this system has the potential to generate large worldwide volumes. The FTTB/C and FTTCab network options are predominantly different only as a result of implementation, as a result they can be treated the same in this Recommendation.



ONU Optical Network Unit
ONT Optical Network Termination
OLT Optical Line Termination
NT Network Termination

Figure 1/G.983.3 – Network architecture

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5.1.1 FTTCab/C/B scenario

See 5.1.1/G.983.1.

5.1.2 FTTH scenario

FTTH; Fibre to the Home service drivers are similar to those of the previous scenarios and are determined by:

– Indoor ONUs can be considered, resulting in more favourable environmental conditions.

– Some changes of intermediate ONU may be required to upgrade access network capabilities to accommodate future evolution of broadband and multimedia services.

– Maintenance is easy, because it requires maintenance only for fibre systems, and all fibre systems are regarded as more reliable than hybrid fibre-metallic ones.

– FTTH is a driver for the development of advanced optoelectronics technologies. The greater volume in production of optical modules will also accelerate the reduction in cost.

When these factors can be fully exploited they may counterbalance a slightly higher per line cost. In that situation the FTTH scenario may be regarded as economically feasible even in the short term.

5.2 Reference configuration

The general reference configuration from ITU-T G.983.1 is shown in Figure 2a.

The specific reference configuration for this Recommendation is shown in Figure 2b which provides clarification of the new specification based on the revised wavelength allocation.

The ODN offers one or more optical paths between one OLT and one or more ONUs. Each optical path is defined between reference points S and R in a specific wavelength window. The two directions for optical transmission in the ODN are identified as follows:

– downstream direction for signals travelling from the OLT to the ONU(s);

– upstream direction for signals travelling from the ONU(s) to the OLT.

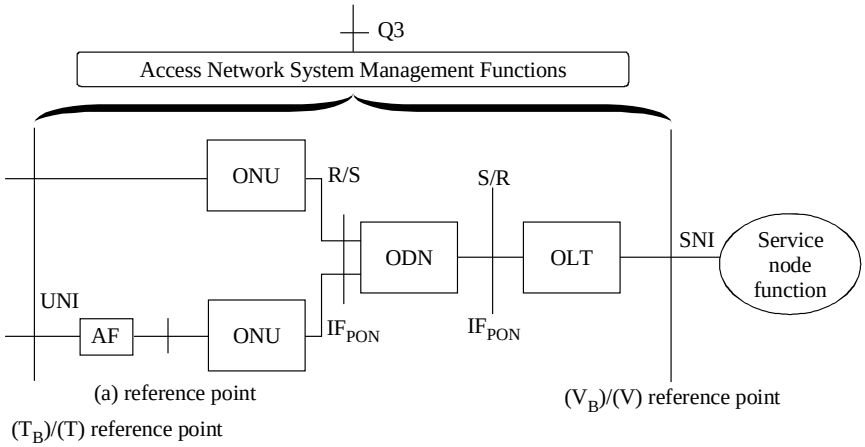
This clause describes the reference architecture for supporting Broadband transmission over a PON. This system consists of Optical Line Termination (OLT), Optical Network Unit (ONU), Wavelength division multiplexing and/or optical combining/splitting functions (WF1 and WF2) for the new wavelength allocation plan defined in this Recommendation and fibre cable which has a Passive Optical Network (PON) configuration with a passive optical splitter.

One fibre is passively split between multiple ONUs who share the capacity of one fibre. Because of the passive splitting, special actions are required with respect to privacy and security. Moreover, in the upstream direction a TDMA protocol is required.

WF1 and WF2 are used for separating/combining wavelengths and/or splitting/combining optical power for ATM-PON transport service and additional services such as video broadcast. These may be integrated into or provided as external optical component parts connected to the OLT and the ONU. Therefore, WF1 and WF2 could be regarded as a part of the OLT and the ONU. In the case of integration into the OLT or the ONU, reference points (c) and (e) in Figure 2b are regarded as internal reference points of the OLT and the ONU respectively.

Functionality required for WF1 and WF2 will vary depending upon the particular system configuration, regulations, service strategy, and geographic conditions for each telecom operator. These configurations based on scenarios by operators are described in Appendix II.

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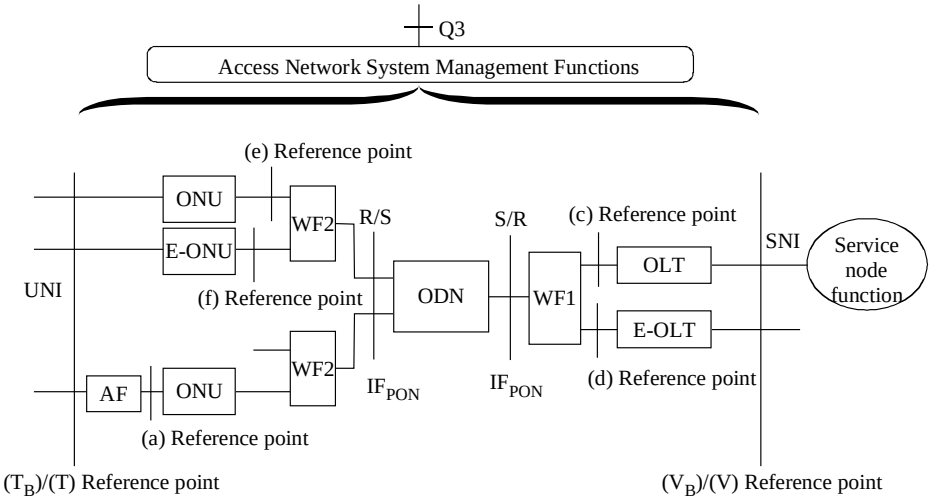


ONU	Optical Network Unit
ODN	Optical Distribution Network
OLT	Optical Line Termination
AF	Adaptation Function
S	Point on the optical fibre just after the OLT[Downstream]/ONU[Upstream] optical connection point (i.e. optical connector or optical splice).
R	Point on the optical fibre just before the ONU[Downstream]/OLT[Upstream] optical connection point (i.e. optical connector or optical splice).
(a)	Reference point – This reference point is added to differentiate the AF from the ONU.

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Figure 2a/G.983.3 – Reference configuration for an ATM based PON

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ONU	Optical Network Unit (which may include WF2 and/or E-ONU)
E-ONU	Optical Network Unit for Enhancement Band usage (which may be integrated into ONU)
ODN	Optical Distribution Network
OLT	Optical Line Termination (which may include WF1 and/or E-OLT)
E-OLT	Optical Line Termination for Enhancement Band usage (which may be integrated into OLT)
AF	Adaptation Function
WF1	Wavelength division multiplexing and/or optical power splitting/combining Function at OLT side
WF2	Wavelength division multiplexing and/or optical power splitting/combining Function at ONU side
S	Point on the optical fibre just after the OLT[Downstream]/ONU[Upstream] optical connection point (i.e. optical connector or optical splice), assuming that WF1 and WF2 are included in the OLT and the ONU respectively.
R	Point on the optical fibre just before the ONU[Downstream]/OLT[Upstream] optical connection point (i.e. optical connector or optical splice), assuming that WF1 and WF2 are included in the OLT and the ONU respectively.
(a)	Reference point – This reference point is added to differentiate the AF from the ONU.
(b)	Intentionally not used to avoid confusion with the index of broadband.
(c)	Reference point – This reference point is added to differentiate the WF1 from the OLT.
(d)	Reference point – This reference point is added to differentiate the WF1 from the E-OLT.
(e)	Reference point – This reference point is added to differentiate the WF2 from the ONU.
(f)	Reference point – This reference point is added to differentiate the WF2 from the E-ONU.

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Figure 2b/G.983.3 – Reference configuration for a Broadband PON

5.2.1 Service Node Interface

See ITU-T G.902.

5.2.2 Interface at the reference points S/R and R/S

This interface at the 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 the transmission between OLT and ONUs.

5.3 Functional blocks

See 5.3/G.983.1.

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5.4 ONU functional block

As an example, the FTTH ONU is active and decouples the access network delivery mechanism from the in-house distribution. The ONU consists of ODN interface, User Port, Transmission, Services, Customers Multiplexing (MUX)/demultiplexing functions and powering, which is described in Figure 3.

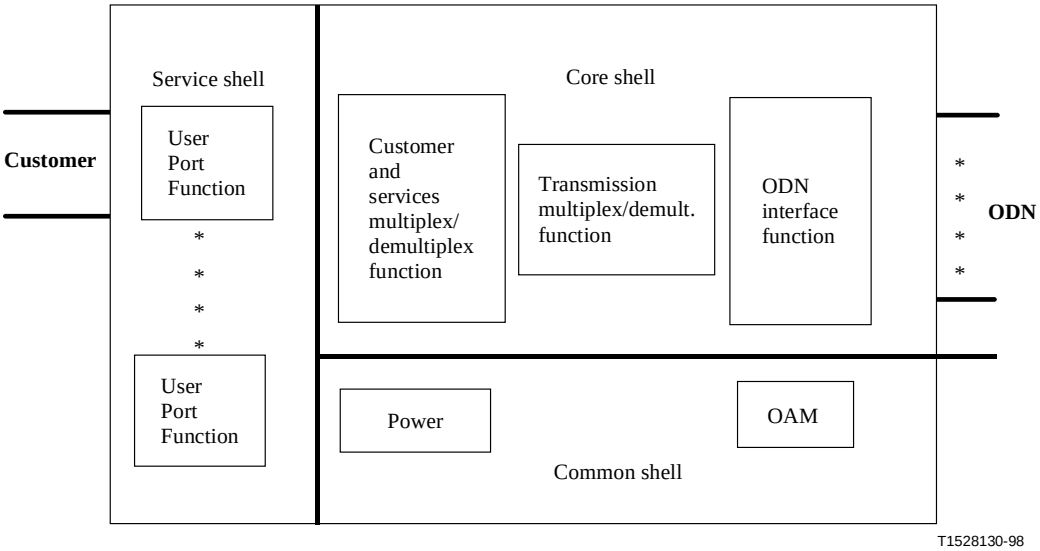


Figure 3/G.983.3 – Example of ONU functional blocks

5.4.1 Optical Distribution Network interface

The ODN interface handles the optoelectronic conversion process. The ODN interface extracts ATM cells from the downstream PON payload and inserts ATM cells into the upstream PON payload based on synchronization acquired from the downstream frame timing.

The ODN interface may handle the separation/combination of designated wavelengths and/or the optical splitter/combiner.

5.4.2 Multiplexing

Multiplexer (MUX) multiplexes service interfaces to ODN interface. Only valid ATM cells can be passed through the MUX, so many VPs can share the assigned upstream bandwidth effectively.

5.4.3 User Port

The User Port interfaces over UNI to a terminal. The User Port may handle inserting ATM cells into the upstream payload and extracting ATM cells from the downstream payload. In addition, the User Port may interface for video delivery and/or additional service from the OLT to customers.

5.4.4 ONU powering

ONU powering may be implementation dependent.

5.5 Optical Line Termination functional block

The OLT is connected to the switched networks via standardized interfaces (VB5.x, V5.x, NNI's). At the distribution side, it presents optical accesses according to the agreed requirements, in terms of bit rate, power budget, etc.

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The OLT consists of three parts: the service port function; ODN interface; and MUX for VP grooming (see Figure 4). This combination is not intended to preclude the Virtual Channel (VC) layer function in the OLT. VC layer function is for further study.

1) *Service port function*

The function interfaces to service nodes. The service port function may handle inserting ATM cells into the upstream SDH payload and extracting ATM cells from the downstream SDH payload. The function may be duplicated, then a protection switching function is necessary.

2) *MUX*

The MUX provides VP connections between the service port function and the ODN interface and different VPs are assigned to different services at IF_{PON}. Various information such as main contents, signalling, and OAM flows are exchanged by using VCs of the VP.

3) *ODN interface*

The ODN interface handles the optoelectronic conversion process. The ODN interface handles inserting ATM cells into the downstream PON payload and extracting ATM cells from the upstream PON payload. In addition, the ODN interface may handle the separation/combination of designated wavelengths and/or the optical splitter/combiner.

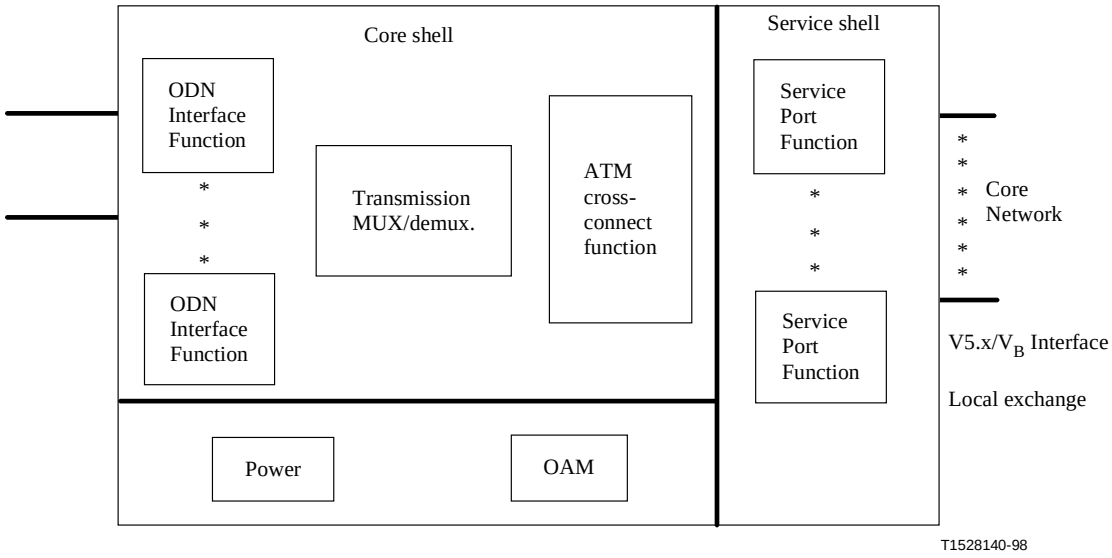


Figure 4/G.983.3 – Example of OLT functional blocks

5.6 Optical Distribution Network functional block

See 5.6/G.983.1.

6 Services

Such a high speed access system could provide the complete range of all currently known and new services being discussed for the residential subscribers and business customers. Here transmission system's service independence has to be regarded.

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These services cover a broad range of network requirements like bit rate, symmetry/asymmetry or delay, and range from video distribution, with varying degrees of interactivity, to electronic data transfer, LAN interconnection, transparent Virtual Paths, and so on.

What specific services should be provided is clearer to some operators than to others and depends heavily on the particular regulatory conditions of each operators' markets, as well as on the own markets potential. How these services are delivered in a cost effective way is a function not only of legal conditions, but also of factors including existing telecommunications infrastructure, dwelling distribution and residential and business customers mix.

In spite of this varied market background there are some features which have been perceived as common to all parties. They can be summarized as follows:

– some services require bit rates higher than those supported by PSTN and basic ISDN. These services are best delivered on fibre-based or fibre hybrid networks;

– as the services evolve and newer services are introduced, the bandwidth and management requirements will increase. This requires the access network to be flexible and easily upgradable;

– additional services, such as video distribution service overlaid ATM-PON, can be provided in an appropriate manner using the WDM scheme, where necessary. The choice of video modulation type will have an impact on the system requirements, but the video modulation system is beyond the scope of this Recommendation.

7 User Network Interface and Service Node Interface

The location of UNI and SNI is preliminary given in the reference configuration (see Table 1).

Other types of services such as video broadcast are for further study.

Table 1/G.983.3 – UNI and SNI

Service type	UNI standard	SNI standard
Defined in ITU-T G.982	ITU-T G.902	ITU-T G.902
– Digital broadband video system		ITU-T G.967.1
– Multimedia services	ITU-T I.432	ITU-T G.967.2
– VP leased line	IEEE 802.3	
– ATM SVC		

8 Optical network requirements

8.1 Layered structure of optical network

See 8.1/G.983.1.

8.2 Physical medium dependent layer requirements for the wavelength allocation

The wavelength of the ATM-PON downstream signal (single fibre system) is in the 1.5 µm band and that of the ATM-PON upstream signal is in the 1.3 µm band in ITU-T G.983.1. This Recommendation defines the new wavelength allocation to enable additional new services using the wavelength band defined in ITU-T G.983.1. The ATM-PON downstream wavelength band shall be compressed within the original 1.5 µm band and new wavelength bands shall be assigned for new additional services.

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Figure 5 and Table 2 define the new wavelength allocation. This reduces the ATM-PON downstream allocation currently defined in ITU-T G.983.1 to a portion of the available downstream optical spectrum. This portion for the ATM-PON shall be referred to as the "Basic Band". An additional wavelength band will then be made available and be referred to as the "Enhancement Band." Uses for the Enhancement Band include at least video services and Wavelength Division Multiplexing (WDM) services. A guardband separates the Basic Band from the Enhancement Band. The interference between signals in these two bands causes signal degradation to each other, which shall be kept negligible. Required isolation between these bands depends on optical power level, modulation scheme and so on. An example of WDM filters is described in Appendix III.

The specifications for Future L Band in the 1.5 µm band, and the "Reserved for Allocation by ITU-T" band in the Intermediate region, are for further study.

NOTE – Wavelengths in Enhancement Band may be used not only for downstream but also for upstream signal transmission in the WDM scheme.

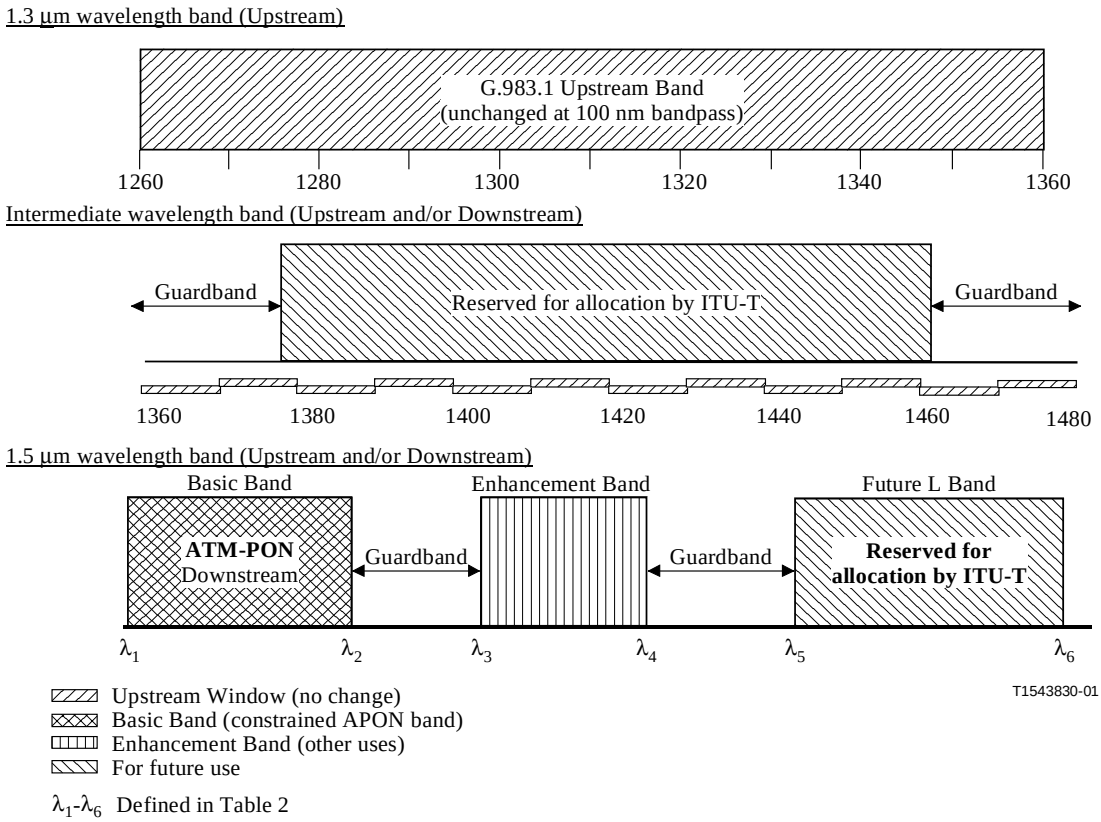


Figure 5/G.983.3 – Wavelength allocation

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Table 2/G.983.3 – Parameters for wavelength allocation in Figure 5

Items	Notation	Unit	Nominal value	Application examples
1.3 μm wavelength band				For use in ATM-PON upstream.
Lower limit	–	nm	1260	
Upper limit	–	nm	1360	
Intermediate wavelength band				For future use – Reserved band including guardbands for allocation by ITU-T.
Lower limit	–	nm	1360	
Upper limit	λ1	nm	1480	
Basic Band				For use in ATM-PON downstream.
Lower limit	λ1	nm	1480	
Upper limit	λ2	nm	1500	
Enhancement Band (Option 1)				For additional digital service use.
Lower limit	λ3	nm	1539	
Upper limit	λ4	nm	1565	
Enhancement Band (Option 2)				For video distribution service.
Lower limit	λ3	nm	1550	
Upper limit	λ4	nm	1560	
Future L Band				For future use – Reserved band for allocation by ITU-T.
Lower limit	λ5	nm	For further study	
Upper limit	λ6	nm		

NOTE 1 – The central frequencies in the Enhancement Band for DWDM application shall be based on the frequency grid given in ITU-T G.959.1 and G.692.

NOTE 2 – The value of isolation between the Basic Band signal and the Enhancement Band signal is not decided uniquely, because system configuration varies by regulations, service strategy, and geographic conditions as well as offered services in the Enhancement Band.

Here, isolation should be interpreted as both the ratio of leaked Basic Band signal to E-ONU or E-OLT from Basic Band signal and the ratio of leaked Enhancement Band signal to ONU or OLT from Enhancement Band signal at WF1 or WF2. Both types of isolation should be defined separately.

Common use of WDM filters is expected for cost reduction through large volume production. The isolation examples required in typical cases are described in Appendix III.

NOTE 3 – Isolation value recommended for between the Basic Band signal and the Enhancement Band signals (Option 1) is for further study.

NOTE 4 – Isolation value recommended for between the Basic Band signal and the Enhancement Band signals (Option 2) is for further study.

NOTE 5 – Applied filter has appropriate loss characteristics to achieve required isolation. However, loss characteristics outside the 1480-1580 nm range (e.g. in the future L Band) is for further study.

8.3 Physical medium dependent layer requirements for the ATM-PON

8.3.1 Digital signal nominal bit rate

The transmission line rate should be a multiple of 8 kHz. The target standardized system will have the following nominal line rates:

– Option 1: Symmetric 155.52 Mbit/s for FTTCab/C/B/H.

– Option 2: Asymmetric 155.52 Mbit/s upstream/622.08 Mbit/s downstream for FTTCab/C/B.

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Parameters to be defined are categorized by downstream and upstream, and nominal bit rate as shown in Table 3.

Table 3/G.983.3 – Relation between parameter categories and tables

Transmission direction	Nominal bit rate	Table
Downstream	155.52 Mbit/s	Table 4b (downstream, 155 Mbit/s)
	622.08 Mbit/s	Table 4c (downstream, 622 Mbit/s)
Upstream	155.52 Mbit/s	Table 4d (upstream, 155 Mbit/s)

All parameters are specified as follows, and shall be in accordance with Table 4a (ODN), Table 4b (downstream, 155 Mbit/s), Table 4c (downstream, 622 Mbit/s) and Table 4d (upstream, 155 Mbit/s). These tables will be globally referred to as Table 4 in this Recommendation unless more precision is needed. There are 6 kinds of ONUs and they are distinguished by bit rates of 155.52 Mbit/s and 622.08 Mbit/s and by optical path loss of Class A, Class B, and Class C (defined in ITU-T G.982). Some parameters described in Table 4 are described in Appendix I as examples for implementation.

The specification in Table 4 does not include the Maximum reflectance of equipment measured at transmitter wavelength and the Maximum reflectance of equipment measured at receiver wavelength for the E-ONU and E-OLT. Reflection from E-ONU and E-OLT may cause signal degradation in the ATM-PON transmission. The specifications for E-ONU and E-OLT reflectances at the 1.3 μm upstream and at the Basic Band downstream wavelengths are for further study.

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

All parameters are specified for IF_{PON} and relevant optical parameters for reference points of (c) and (e) in Figure 2b are described in Appendix V.

Attenuation range in the ODN may be reduced for some application area such as new-built field or limited area. In this case, required optical parameters will be relaxed and enhance applicability of optical modules compliant to ITU-T G.983.1. Appendix V also describes the example case of reduced attenuation range of the ODN.

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Table 4a/G.983.3 – Physical medium dependant layer parameters of ODN

Items	Unit	Specification
Fibre type	–	ITU-T G.652
Attenuation range (ITU-T G.982)	dB	Class A: 5-20 Class B: 10-25 Class C: 15-30
Differential optical path loss	dB	15
Maximum optical path penalty	dB	1
Max differential logical reach	km	20
Maximum fibre distance between S/R and R/S points	km	20
Minimum supported split ratio	–	Restricted by path loss and ONU addressing limits. PON with passive splitters (16 or 32 way split)
Bidirectional transmission	–	1-fibre WDM (2-fibre system is beyond the scope of this Recommendation)
Maintenance wavelength	nm	to be defined

Table 4b/G.983.3 – Optical interface parameters of 155 Mbit/s downstream direction for the Basic Band

Items	Unit	Specifications		
OLT Transmitter (optical interface O_{ld})				
Nominal bit rate	Mbit/s	155.52		
Operating wavelength	nm	1480-1500		
Line code	–	Scrambled NRZ		
Mask of the transmitter eye diagram	–	See Figure 6/G.983.1		
Maximum reflectance of equipment, measured at transmitter wavelength	dB	NA		
Minimum ORL of ODN at O_{ld} and O_{lu} (Notes 1 and 2)	dB	more than 32		
ODN Class		Class A	Class B	Class C
Mean launched power MIN	dBm	Note 4	Note 4	Note 4
Mean launched power MAX	dBm	Note 4	Note 4	Note 4
Launched optical power without input to the transmitter	dBm	NA		
Extinction ratio	dB	more than 10		
Tolerance to the transmitter incident light power	dB	more than –15		
If MLM Laser – Maximum RMS width	nm	1.8		
If SLM Laser – Maximum –20 dB width (Note 3)	nm	1		
If SLM Laser – Minimum side mode suppression ratio	dB	30		

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Table 4b/G.983.3 – Optical interface parameters of 155 Mbit/s downstream direction for the Basic Band *(concluded)*

Items	Unit	Specifications		
ONU Receiver (optical interface O_{rd})				
Maximum reflectance of equipment, measured at receiver wavelength	dB	less than –20		
Bit error ratio	–	less than 10^{-10}		
ODN Class		Class A	Class B	Class C
Minimum sensitivity	dBm	Note 4	Note 4	Note 4
Minimum overload	dBm	Note 4	Note 4	Note 4
Consecutive identical digit immunity	bit	more than 72		
Jitter tolerance	–	See Figure 9/G.983.1		
Tolerance to the reflected optical power	dB	less than 10		
NOTE 1 – The value of "minimum ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld}" should be more than 20 dB in optional cases which are described in Appendix I/G.983.1. NOTE 2 – The values on ONU transmitter reflectance for the case that the value of "minimum ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld}" is 20 dB are described in Appendix IV. NOTE 3 – Values of maximum –20 dB width, and minimum side mode suppression ratio are referred to in ITU-T G.957. NOTE 4 – Tentative parameters are described in Appendix I.				

Table 4c/G.983.3 – Optical interface parameters of 622 Mbit/s downstream direction for the Basic Band

Items	Unit	Specifications		
OLT Transmitter (optical interface O_{ld})				
Nominal bit rate	Mbit/s	622.08		
Operating wavelength	nm	1480-1500		
Line code	–	Scrambled NRZ		
Mask of the transmitter eye diagram	–	See Figure 6/G.983.1		
Maximum reflectance of equipment, measured at transmitter wavelength	dB	NA		
Minimum ORL of ODN at O_{lu} and O_{ld} (Notes 1 and 2)	dB	more than 32		
ODN Class		Class A	Class B	Class C
Mean launched power MIN	dBm	Note 4	Note 4	Note 4
Mean launched power MAX	dBm	Note 4	Note 4	Note 4
Launched optical power without input to the transmitter	dBm	NA		
Extinction ratio	dB	more than 10		
Tolerance to the transmitter incident light power	dB	more than –15		
If MLM Laser – Maximum RMS width	nm	NA		

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Table 4c/G.983.3 – Optical interface parameters of 622 Mbit/s downstream direction for the Basic Band *(concluded)*

Items	Unit	Specifications		
If SLM Laser – Maximum –20 dB width (Note 3)	nm	1		
If SLM Laser – Minimum side mode suppression ratio	dB	30		
ONU Receiver (optical interface O_{rd})				
Maximum reflectance of equipment, measured at receiver wavelength	dB	less than –20		
Bit error ratio	–	less than 10^{-10}		
ODN Class		Class A	Class B	Class C
Minimum sensitivity	dBm	Note 4	Note 4	Note 4
Minimum overload	dBm	Note 4	Note 4	Note 4
Consecutive identical digit immunity	bit	more than 72		
Jitter tolerance	–	See Figure 9/G.983.1		
Tolerance to the reflected optical power	dB	less than 10		
NOTE 1 – The value of "minimum ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld}" should be more than 20 dB in optional cases which are described in Appendix I/G.983.1. NOTE 2 – The values on ONU transmitter reflectance for the case that the value of "minimum ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld}" is 20 dB are described in Appendix IV. NOTE 3 – Values of maximum –20 dB width, and minimum side mode suppression ratio are referred to in ITU-T G.957. NOTE 4 – Tentative parameters are described in Appendix I.				

Table 4d/G.983.3 – Optical interface parameters of 155 Mbit/s upstream direction

Items	Unit	Specifications		
ONU Transmitter (optical interface O_{ru})				
Nominal bit rate	Mbit/s	155.52		
Operating wavelength	nm	1260-1360		
Line code	–	Scrambled NRZ		
Mask of the transmitter eye diagram	–	See Figure 7/G.983.1		
Maximum reflectance of equipment, measured at transmitter wavelength	dB	less than –6		
Minimum ORL of ODN at O_{ru} and O_{rd} (Notes 1 and 2)	dB	more than 32		
ODN Class		Class A	Class B	Class C
Mean launched power MIN	dBm	Note 4	Note 4	Note 4
Mean launched power MAX	dBm	Note 4	Note 4	Note 4
Launched optical power without input to the transmitter	dBm	less than Min sensitivity –10		
Extinction ratio	dB	more than 10		

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Table 4d/G.983.3 – Optical interface parameters of 155 Mbit/s upstream direction *(concluded)*

Items	Unit	Specifications		
Tolerance to the transmitter incident light power	dB	more than –15		
If MLM Laser – Maximum RMS width	nm	5.8		
If SLM Laser – Maximum –20 dB width (Note 3)	nm	1		
If SLM Laser – Minimum side mode suppression ratio	dB	30		
Jitter transfer	–	See Figure 8/G.983.1		
Jitter generation from 0.5 kHz to 1.3 MHz	UI p-p	0.2		
OLT Receiver (optical interface O_{lu})				
Maximum reflectance of equipment, measured at receiver wavelength	dB	less than –20		
Bit error ratio	–	less than 10^{-10}		
ODN Class		Class A	Class B	Class C
Minimum sensitivity	dBm	Note 4	Note 4	Note 4
Minimum overload	dBm	Note 4	Note 4	Note 4
Consecutive identical digit immunity	bit	more than 72		
Jitter tolerance	–	NA		
Tolerance to the reflected optical power	dB	less than 10		

NOTE 1 – The value of "minimum ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld}" should be more than 20 dB in optional cases which are described in Appendix I/G.983.1.

NOTE 2 – The values of ONU transmitter reflectance for the case that the value of "minimum ORL of ODN at point O_{ru} and O_{rd}, and O_{lu} and O_{ld}" is 20 dB are described in Appendix IV.

NOTE 3 – Values of maximum –20 dB width, and minimum side mode suppression ratio are referred to in ITU-T G.957.

NOTE 4 – Tentative parameters are described in Appendix I.

8.3.2 Physical media and transmission method

8.3.2.1 Transmission medium

This specification is based on the fibre described in ITU-T G.652.

8.3.2.2 Transmission direction

The signal is transmitted both upstream and downstream through the transmission medium.

8.3.2.3 Transmission methodology

Bidirectional transmission is accomplished by use of Wavelength Division Multiplexing (WDM) technique of 1310 nm region and Basic Band (1480-1500 nm) region wavelengths on a single fibre.

8.3.3 Bit rate

See 8.2.3/G.983.1.

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8.3.4 Line code

See 8.2.4/G.983.1.

8.3.5 Operating wavelength

8.3.5.1 Downstream direction

The operating wavelength range for the downstream direction on single fibre systems shall be 1480-1500 nm.

8.3.5.2 Upstream direction

The operating wavelength range for the upstream direction shall be 1260-1360 nm.

8.3.6 Transmitter at O_{ld} and O_{ru}

All parameters are specified as follows, and shall be in accordance with Table 4.

See the following clauses in ITU-T G.983.1 for each item:

8.2.6.1 for Source type;

8.2.6.2 for Spectral characteristics;

8.2.6.3 for Mean launched power;

8.2.6.3.1 for Launched optical power without input to the transmitter;

8.2.6.4 for Minimum extinction ratio;

8.2.6.6 for Mask of transmitter eye diagram;

8.2.6.6.1 for OLT transmitter; and

8.2.6.6.2 for ONU transmitter.

8.3.6.1 Maximum reflectance of equipment, measured at transmitter wavelength

Reflections from equipment (ONU/OLT) back to the cable plant are specified by the maximum permissible reflectance of equipment measured at O_{ld}/O_{ru}. It shall be in accordance with Table 4.

8.3.6.2 Tolerance to the reflected optical power

The specified transmitter performance must be met in the presence at S of the optical reflection level specified in Table 4.

8.3.7 Optical path between O_{ld}/O_{ru} and O_{rd}/O_{lu}

See the following clauses in ITU-T G.983.1 for each item:

8.2.7.2 for Minimum optical return loss of the cable plant at point R/S, including any connector; and

8.2.7.3 for Maximum discrete reflectance between points S and R.

8.3.7.1 Attenuation range

Three classes of attenuation ranges are being specified as defined in ITU-T G.982:

– 5-20 dB: Class A;

– 10-25 dB: Class B;

– 15-30 dB: Class C.

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Attenuation specifications are assumed to be worst-case values including losses due to splices, connectors, optical attenuators (if used) or other passive optical devices, and any additional cable margin to cover allowances for:

1) future modifications to the cable configuration (additional splices, increased cable lengths, etc.);
2) fibre cable performance variations due to environmental factors; and
3) degradation of any connector, optical attenuators (if used) or other passive optical devices between points S and R, when provided.

8.3.7.2 Dispersion

Systems considered limited by dispersion have maximum values of dispersion (ps/nm) specified in Table 4. These values are consistent with the maximum optical path penalties specified. They take into account the specified transmitter type, and the fibre dispersion coefficient over the operating wavelength range.

Systems considered limited by attenuation do not have maximum dispersion values specified and are indicated in Table 4 with the entry "NA" (not applicable).

8.3.8 Receiver at O_{rd} and O_{lu}

All parameters are specified as follows, and shall be in accordance with Table 4.

See the following clauses in ITU-T G.983.1 for each item:

8.2.8.1 for Minimum sensitivity;
8.2.8.2 for Minimum overload;
8.2.8.3 for Maximum optical path penalty;
8.2.8.5 for Differential optical path loss;
8.2.8.6 for Clock extraction capability;
8.2.8.7 for Jitter performance;
8.2.8.7.1 for Jitter transfer;
8.2.8.7.2 for Jitter tolerance;
8.2.8.7.3 for Jitter generation;
8.2.8.8 for Consecutive identical digit (CID) immunity;
8.2.8.9 for Tolerance to reflected power; and
8.2.8.10 for Transmission quality and error performance.

8.3.8.1 Maximum reflectance of receiver equipment, measured at receiver wavelength

Reflections from equipment (ONU/OLT) back to the cable plant are specified by the maximum permissible reflectance of equipment measured at O_{rd} and O_{lu}. It shall be in accordance with Table 4.

8.4 Physical medium dependent layer requirements for the Enhancement Band

Optical parameters, line code, modulation scheme and so on for the Enhancement Band are out of scope of this Recommendation.

However, reflection from ONU and OLT may cause signal degradation in the Enhancement Band services. Therefore the Maximum reflectance of equipment measured at transmitter wavelength and the Maximum reflectance of equipment measured at receiver wavelength for the ONU and the OLT should be specified in the Enhancement Band wavelength. The specification for reflectance of the ONU and OLT are for further study.

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9 Operations Administration and Maintenance (OAM) functionality

See clause 9/G.983.1.

10 Performance

See clause 10/G.983.1.

11 Environmental condition

For the OLT and indoor ONU, the conditions of IEC 60721-3-3 are recommended. For the outdoor ONU, the conditions of IEC 60721-3-4, with the expanded environmental range (4.1E) specified in ETS 300 019-1-4, are recommended.

The conditions of IEC 60801-2 and 60801-3 for electro magnetic compatibility are recommended.

Examples of the applied environmental conditions for the OLT and ONU temperature and relative humidity are described in Table 5. The other environmental conditions such as environmental pollutants and chemicals are for further study.

Table 5/G.983.3 – Examples of environmental conditions

Applied example	Temperature (C)		Relative humidity (%)		Remarks
	Normal	Short term	Normal	Short term	
OLT	5 to 40	0 to 50 (Note 1)	5 to 85	5 to 90 (Note 1)	IEC 60721-3-3 class 3k3
Indoor ONU	–5 to 45	–	5 to 95	–	IEC 60721-3-3 class 3k5
Outdoor ONU (Note 2)	–45 to 45 (Note 3)	–	8 to 100	–	ETS 300 019-1-4 class 4.1E

NOTE 1 – Option 1: short term refers to a period of not more than 72 consecutive hours and a total of not more than 15 days in one year.

Option 2: short term refers to a period of not more than 12 consecutive hours and a total of not more than four days in one year.

NOTE 2 – The environmental conditions for the ONU are environmental conditions outside the ONU enclosure, and assume that the ONU (including housing/cabinet) is provided by a single supplier and is located in a conventional indoor or outdoor setting. Environmental conditions for ONUs that are located in other settings (e.g. inside an operator-provided cabinet or a non-conditioned indoor environment such as an attic or garage) are for future study.

NOTE 3 – In many instances, network operators are willing to relax the low temperature requirement to –40 degrees.

12 Safety

Safety is defined in ITU-T G.983.1.

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APPENDIX I

Optical interface parameters examples for ODN

I.1 Introduction

Tentative optical parameters for ODN are described below (see Table 4) and are given in this Appendix I as examples for implementation. If appropriate parameters are approved and entered into Table 4, this Appendix will be removed.

I.2 Examples

Specified numerical values described in the following table indicate tentative values for items described in Table 4.

Table I.1/G.983.3 – Optical interface parameters of 155 Mbit/s downstream direction for the Basic Band

Items	Unit	Specifications		
OLT Transmitter (optical interface O_{ld})				
ODN Class		Class A	Class B	Class C
Mean launched power MIN	dBm	–7.5	–2.5	–0.5
Mean launched power MAX	dBm	–3	+2	+4
ONU Receiver (optical interface O_{rd})				
ODN Class		Class A	Class B	Class C
Minimum sensitivity	dBm	–28.5	–28.5	–31.5
Minimum overload	dBm	–8	–8	–11

Table I.2/G.983.3 – Optical interface parameters of 622 Mbit/s downstream direction for the Basic Band

Items	Unit	Specifications		
OLT Transmitter (optical interface O_{ld})				
ODN Class		Class A	Class B	Class C
Mean launched power MIN	dBm	–5.5	–0.5	–0.5
Mean launched power MAX	dBm	–1	+4	+4
ONU Receiver (optical interface O_{rd})				
ODN Class		Class A	Class B	Class C
Minimum sensitivity	dBm	–26.5	–26.5	–31.5
Minimum overload	dBm	–6	–6	–11

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Table I.3/G.983.3 – Optical interface parameters of 155 Mbit/s upstream direction

Items	Unit	Specifications		
ONU Transmitter (optical interface O_{ru})				
ODN Class		Class A	Class B	Class C (Note)
Mean launched power MIN	dBm	–7.5	–5.5	–3.5
Mean launched power MAX	dBm	0	+2	+4
OLT Receiver (optical interface O_{lu})				
ODN Class		Class A	Class B	Class C (Note)
Minimum sensitivity	dBm	–28.5	–31.5	–34.5
Minimum overload	dBm	–5	–8	–11
NOTE – The values proposed for the upstream Class C are best estimates. They are therefore subject to change in the future.				

APPENDIX II

Deployment scenarios

II.1 Introduction

It is assumed that various system configurations or scenarios will be introduced by telecom operators. These system configurations or scenarios are influenced by regulations, service strategy, and the geographic conditions for each telecom operator. These configurations include pure WDM-based overlays and those which rely on FDM techniques to separate the Basic Band and Enhancement Band signals.

Configuration examples are described below.

II.2 Configuration examples

II.2.1 Case 1: Reception of Basic Band only

If customers do not require additional services such as video service etc. over the Enhancement Band under the wavelength allocation of Figure 5, then two system configurations would be as shown in Figures II.1 and II.2. In the case of Figure II.1, the WDM blocking filter may be needed to prevent the signal in the Enhancement Band from reaching the ONU. In the case of Figure II.2, an FDM-based approach, newer version ONUs, which are equipped with an electrical bandsplit filter, are required.

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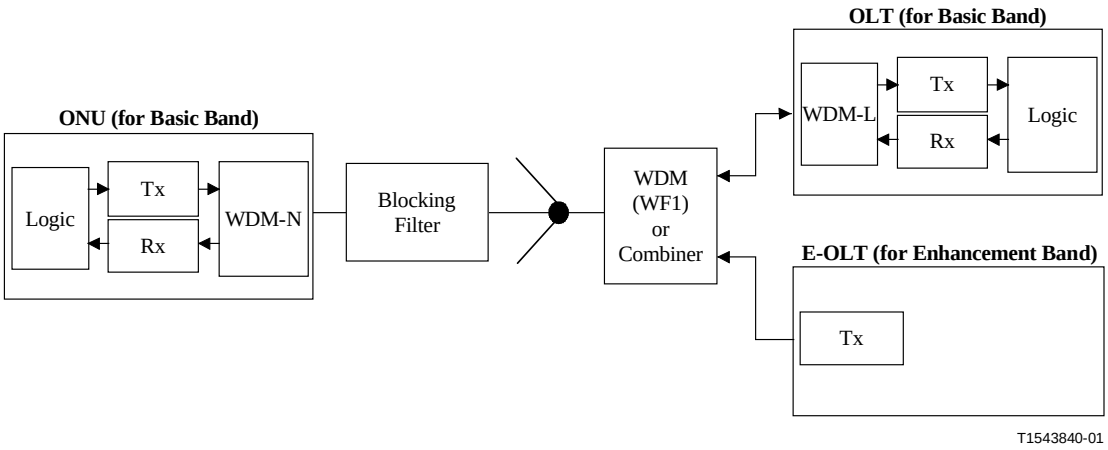


Figure II.1/G.983.3 – Reception of Basic Band only by blocking filter

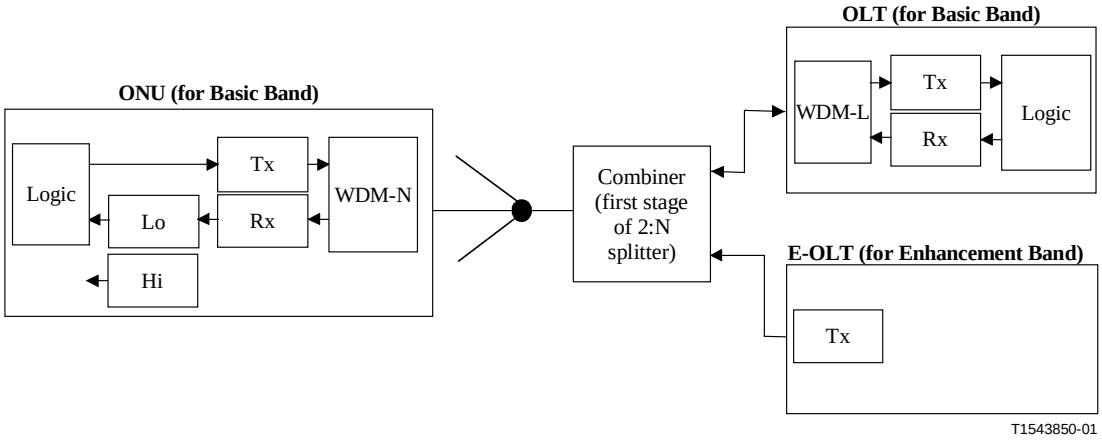


Figure II.2/G.983.3 – Reception of Basic Band only by FDM-based approach

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II.2.2 Case 2: Reception of Basic Band and Enhancement Band signals by separate ONUs

If operators provide both ATM-PON and additional services such as video service etc. in separate equipment modules, the WDM-based system configuration would be Figure II.3.

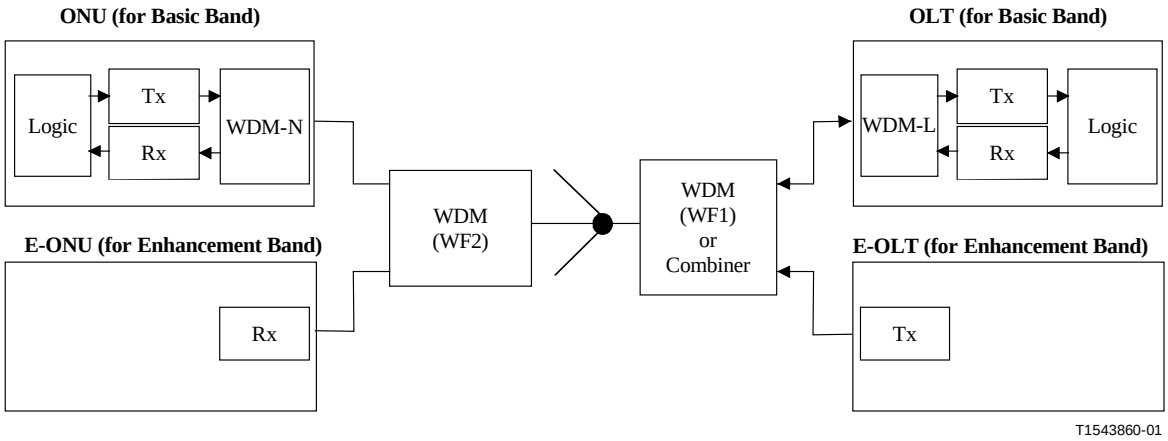


Figure II.3/G.983.3 – Reception of Basic Band and Enhancement Band signals by separate ONUs

II.2.3 Case 3: Reception of Basic Band and Enhancement Band signals by integrated ONUs

If operators provide both ATM-PON and additional services such as video service etc. in the same equipment, then two system configurations would be as shown in Figures II.4 and II.5. Figure II.4 shows a WDM-based approach. This type's ONUs are equipped with WDM filter. Figure II.5 shows FDM-based approach. This type's ONUs are equipped with electrical bandsplit filter.

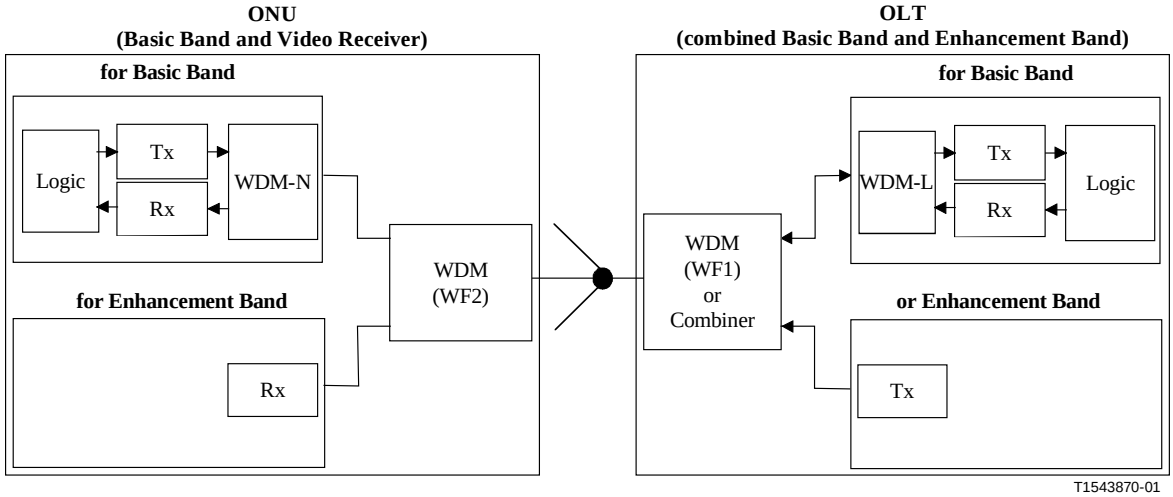


Figure II.4/G.983.3 – Reception of Basic Band and Enhancement Band signals by integrated ONUs (WDM-based approach)

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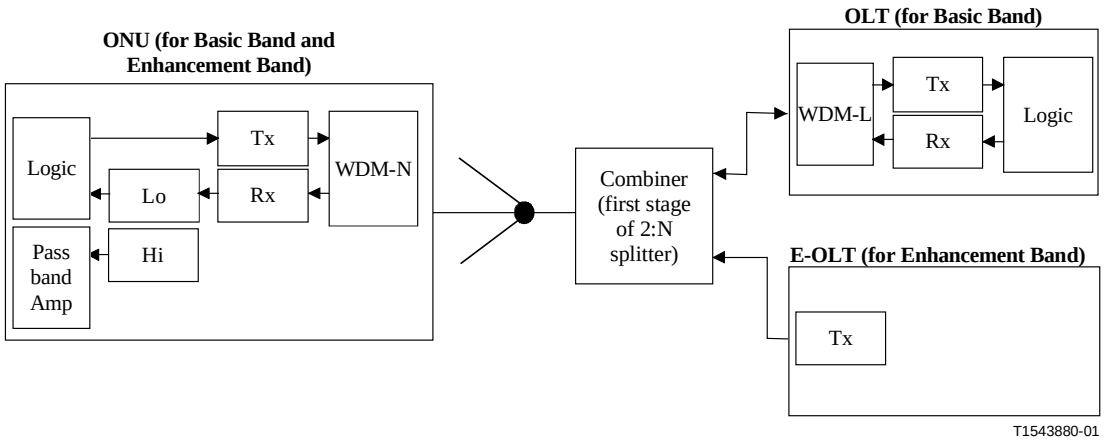


Figure II.5/G.983.3 – Reception of Basic Band and Enhancement Band signals by integrated ONUs (FDM-based approach)

II.2.4 Case 4: Arrangement of WDMs to minimize upstream path loss

This arrangement is aimed at minimizing the upstream path loss (at 1300 nm) when an Enhancement Band is added. In this case WDM-L and WDM-N separate the 1300 nm and 1500 nm bands and WF1 and WF2 split the 1500 nm band. This allows existing upstream transmitters and receivers to be used without a change in the end-to-end loss. The performance of WF1 and WF2 needs only to be specified in the 1500 nm band since 1300 nm signals are eliminated. It avoids the problem of near-end crosstalk when the Enhancement Band carries a downstream-only service. It avoids problems of reflections in the Basic Band being a problem to the Enhancement Band receivers. A disadvantage of this approach is that it is unsuitable for use with Basic Band electro-optic modules that incorporate G.983.1 WDMs.

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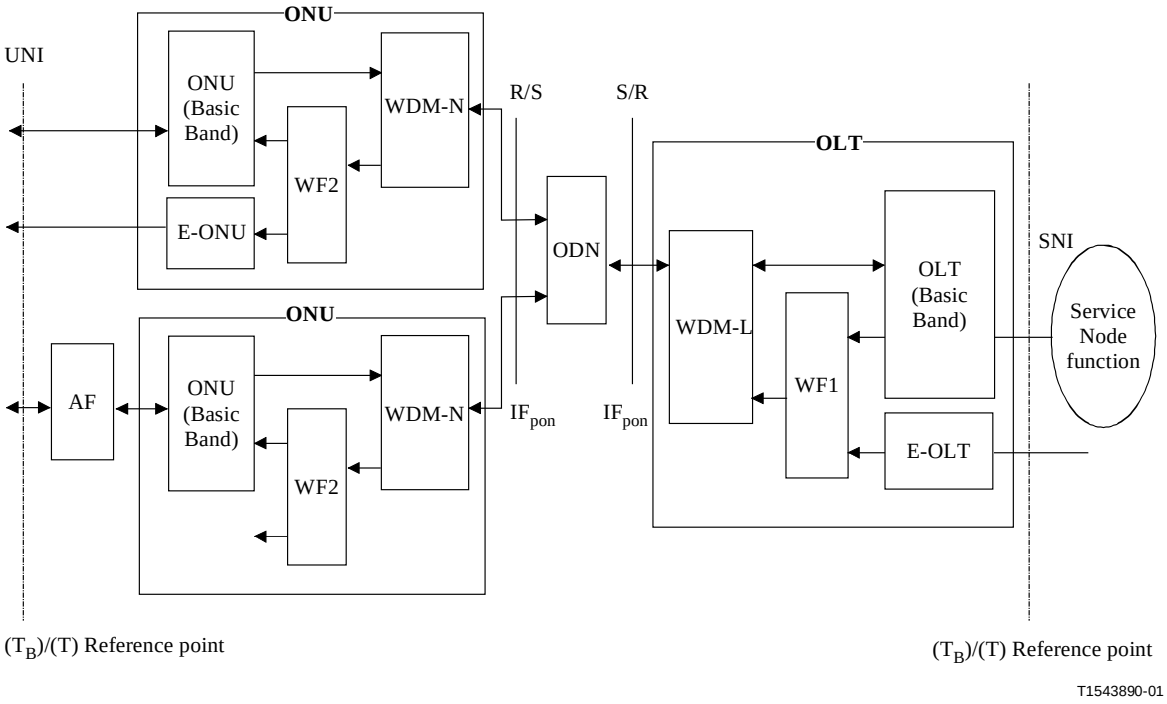


Figure II.6/G.983.3 – Arrangement of WDMs to minimize upstream path loss

II.2.5 Case 5: ODNs with reduced attenuation range for Enhancement Band

A problem for some operators arises when an existing Class C ODN is deployed. This is specified to have 30 dB path loss in both the 1300 and 1500 nm windows. Existing Basic Band transceivers will not have sufficient power budget when WDM components are added externally.

Case 4 could avoid this problem for the upstream path when the upstream and downstream transmitters and receivers are available as separate modules.

The downstream path will have additional losses for the WDMs in the 1500 nm band which could be as high as 1.5 dB at each end. This means that the 1500 nm transmitters and receivers need 3 dB extra power budget. One way of compensating this 3 dB is to apply a modified Class C, which takes into account the differential losses of the fibre in the 1300 and 1500 nm windows. The maximum loss at 1300 nm is 30 dB and the maximum loss at 1500 nm is 27 dB. Many existing Class C ODNs and all Class C with reduced attenuation range could meet a specification having less than 27 dB loss in the 1480-1580 nm band and less than 30 dB loss in the 1260-1360 nm band.

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II.2.6 Example in case of insufficiency of loss budget between E-ONU and E-OLT

In case of insufficiency of loss budget between E-ONU and E-OLT, it is possible to shorten the distance between E-ONU and E-OLT. Figure II.7 shows an example. In that case, output from E-OLT is inputted to second stage of splitter.

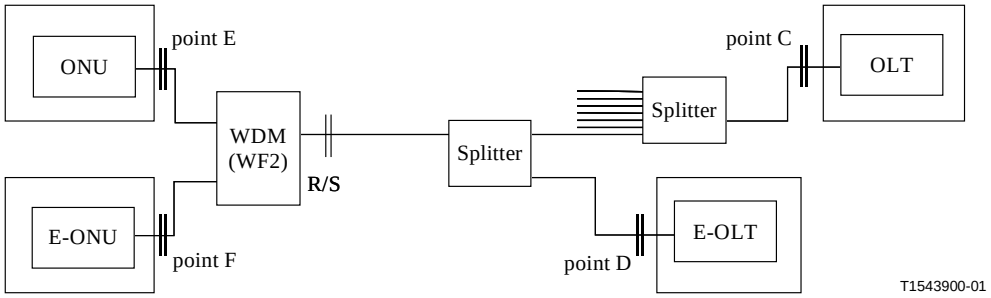


Figure II.7/G.983.3 – Arrangement in case of insufficiency of loss budget between E-ONU and E-OLT

APPENDIX III

Isolation between the Basic Band and the Enhancement Band

III.1 Introduction

The Enhancement Band can be used for many different types of services, such as video distribution and digital high bit-rate services.

Each service (characterized by modulation format or bit rate, the amount of carriers or amount of wavelengths) will require its own Enhancement Band receiver sensitivity and allowable cross-talk from the Basic Band signal.

These parameters, together with the total optical power in the Enhancement Band, will in turn determine the necessary isolation value at the Enhancement Band receiver from the Basic Band signal, and the necessary isolation value at the Basic Band receiver from the Enhancement Band signal.

In general, "Isolation" is defined as the loss difference between two wavelengths measured at the same port. Required Isolation for WDM filter such as WF1 and WF2 should be estimated considering reflections of equipment and/or ODN. The effect of reflections is described in Appendix IV.

This appendix provides some initial calculations of the optical characteristics of the Enhancement Band services. These are used to find example isolation values of the Basic Band from the Enhancement Band. Such examples may be useful to vendors in guiding their development efforts. However, the exact requirements of the isolation values, and the isolation required by the enhancement signals from the Basic Band depend on many factors that are out of the scope of this Recommendation. Any system design will need to do a complete accounting of all these factors to arrive at a complete optical isolation specification.

Isolation to be considered is schematically shown in Figure III.1.

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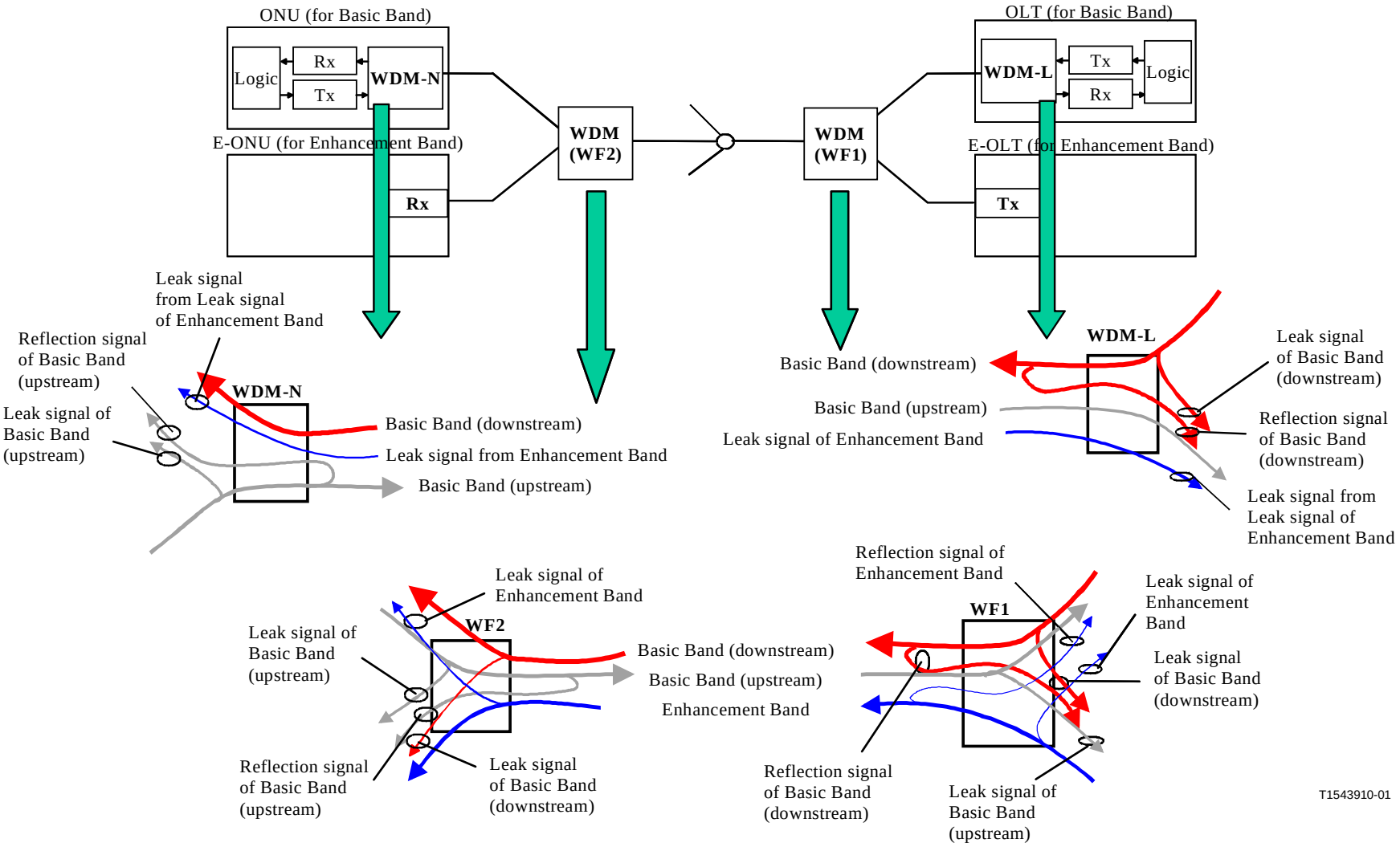


Figure III.1/G.983.3 – Isolation at WDM-L, WDM-N, WF1 and WF2

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The type of service and its characteristics will determine isolation performances of WF1 and WF2. As the optical power of the Basic Band signal will vary with the PON system class (A, B, C), the isolation values will also be different for the different ODN classes.

Out of the many different service and class scenarios, several isolation classes could then be defined.

The following tables illustrate several service scenarios. The scenarios have to be analysed for each PON Class.

The following notations are used in this appendix:

L_{ODN-BB} Optical loss of Basic Band in the ODN

L_{ODN-EB} Optical loss of Enhancement Band in the ODN

P_{BB} Optical power of Basic Band signal at the input to the ONU

P_{EB} Optical Power of Enhancement Band signal at the input to the E-ONU

F.F.S for further study

The following assumptions are taken for the examples:

– $L_{ODN-BB} = L_{ODN-EB}$.

– The allowable cross-talk at the Basic Band receiver [at reference points (c) and (e)] from the Enhancement Band signal is assumed to be at least 10 dB lower than the lowest Basic Band signal.

NOTE – This assumption should be modified to some higher value than 10 dB, for example to 13 dB, because the total optical noise to the receiver consists of multiple reflections as well as leak optical power. Permissible total noise may be 10 dB lower than the lowest signal level, but permissible noise power for each noise component is for further study. Therefore, the following are tentatively described on the assumption that each noise component be at least 10 dB lower than the signal.

– Assuming following WF1 and WF2 insertion losses: 0 dB – 1.5 dB.

III.2 Example for required isolation at Basic Band receiver from Enhancement Band signal

III.2.1 Video services

Required isolation depends on the minimum power required by the receiver to produce a usable signal plus the total amount of system tolerance (transmitter, fibre, and optical component loss variations). For subcarrier multiplexed video systems, the carrier-to-noise ratio (CNR) is given by Equation (III-1).

$$CNR = \frac{1}{2B} \cdot \frac{m^2}{RIN + \frac{2e}{i} + \frac{4kT}{i^2 R}} \qquad \text{(III-1)}$$

Here B is the channel bandwidth, m is the per-channel modulation index, RIN is the relative intensity noise of the transmitter, e is the charge of the electron, i is the detected photocurrent, kT is the Boltzman factor, and R is the receiver impedance. The assumed values for all these parameters are given in the following table:

RIN (dB/Hz)	–150.0
Receiver Temperature (K)	300.0
Receiver Impedance (Ω)	75.0
Receiver Responsivity (A/W)	0.85
RMS OMI	25%

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The required SNR depends on the signal format being considered. The values assumed here are given in the following table:

Channel Format	(dB)
QPSK	16
16-QAM	22
64-QAM	28
256-QAM	34
AM-VSB	44 (Note)
NOTE – The value given for AM-VSB is the CNR.	

The RMS optical modulation index (*OMI*), along with *N*, the number of channels, can be used to compute *m*, by using Equation (III-2). The responsivity is used to convert the photocurrent to optical power.

$$m = OMI\sqrt{\frac{2}{N}} \tag{III-2}$$

Equation (III-1) can be re-arranged as shown in Equation (III-3). This gives a quadratic in photocurrent, and the solution to this equation then can be converted into the required optical power, P_{EB}, at the point between the E-ONU and WF2, shown in Table III.1.

$$\left(RIN - \frac{m^2}{2B \cdot CNR}\right)i^2 + 2ei + \frac{4kT}{R} = 0 \tag{III-3}$$

Table III.1/G.983.3 – P_{EB}, minimal power of Enhancement Band signal at the input to the E-ONU

Transmission System	Carrier Format	Number of carriers	Carrier BW (MHz)	Required Power (dBm)
SCM	AM-VSB	40	4.5	–7.7
			6.5	–6.7
	QPSK	60	18	–18.3
	64-QAM	110	5.2	–13.6
			7.0	–13.0
	256-QAM	110	5.2	–10.5
			7.0	–9.8
FM Conversion	AM-VSB	40	4.5	–14.1
			6.5	–11.5
	64-QAM	110	5.2	–16.7
			7.0	–14.3
	256-QAM	110	5.2	–13.3
			7.0	–10.1

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The isolation values at WF2 (the ratio of leaked Enhancement Band signal to ONU from Enhancement Band signal at common port of WF2) are obtained from:

Isolation of WF2 = P_{EB} req + $R_{x\Delta}$ + $T_{x\Delta}$ – P_{BB} min + 13 dB,

where $R_{x\Delta}$ and $T_{x\Delta}$ are the dynamic range tolerances of the receiver and transmitter. We assume values of $R_{x\Delta}$ = 2 dB, and $T_{x\Delta}$ = 1 dB.

For example, if the minimum required enhancement power at the E-ONU receiver, P_{EB} req = –10 dBm and P_{BB} min = –30 dBm, then required isolation = 36 dB.

The resulting isolation at WF2 is specified in Table III.2. These are assuming that P_{BB} min = –30 dBm, which is true for class B equipment. Note that the above calculation assumes that the enhancement and Basic Band signals suffer the same insertion loss through WF2.

Table III.2/G.983.3 – Isolation requirements at Basic Band receiver from Enhancement Band

Transmission System	Carrier Format	Number of carriers	Carrier BW (MHz)	Required Isolation (dB)
SCM	AM-VSB	40	4.5	38.3
			6.5	39.3
	QPSK	60	18	27.7
	64-QAM	110	5.2	32.4
			7.0	33.0
	256-QAM	110	5.2	35.5
			7.0	36.2
FM Conversion	AM-VSB	40	4.5	31.9
			6.5	34.5
	64-QAM	110	5.2	29.3
			7.0	31.7
	256-QAM	110	5.2	32.7
			7.0	35.9

The isolation required at WF1 is driven by the reflections in the PON, which can be either –32 dB or –20 dB. The video transmitter will most likely be operating near the SBS limit of the fibre, implying a maximum launch power of +17 dBm. With a reflection loss of –20 dB, the reflection can be as high as –3 dBm. If the signal must be 13 dB higher than the interference, then the combined isolation of the WF1 and diplexer must be 40 dB. If PON reflectance of –32 dB is assumed, then the isolation of WF1 and diplexer must be 28 dB.

Note that the above isolations assume that the video and Basic Band signals overlap in electrical frequency. This is not necessarily true, and in some notable cases, such as the QPSK video, the video signal is entirely out of band. In these cases, the video signal only impairs the Basic Band signal via increased shot and relative intensity noise. This can reduce the required isolation greatly, in some cases to the point where no optical isolation is required at all.

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III.2.2 DWDM services

The provision of DWDM services over the PON will also place requirements on the isolation of filters WF1 and WF2. The starting point again is the sensitivities of the receivers that would be used for the DWDM upgrade. Table III.3 below gives the typical values for optical receivers, and also for the filters that are required to demultiplex the individual channels.

Table III.3/G.983.3 – The typical values for optical receivers and filters

Table a – Data Rate	SDH-1	SDH-4	GbE	SDH-16
Maximum overload (PIN photodiode) (dBm)	–8	–7	–6	–4
Minimum sensitivity (PIN photodiode) (dBm)	–36	–31	–25	–20
Maximum overload (APD) (dBm)	NA	–10	–9	–9
Minimum sensitivity (APD) (dBm)	NA	–38	–33	–29

Table b – Number of Channels	1	8	16	32
200 GHz Filter max loss (dB)	2	3.5	5	NA
100 GHz Filter Max loss (dB)	2.5	4.5	6.5	8.5
Basic/Enhancement Filter max loss (dB)	1	NA	NA	NA

By building hypothetical loss budgets using these numbers, one can derive the maximum launched powers (per channel) at both ends of the PON. The result depends on the speed and number of channels, as shown in Table III.4. Note that the upstream launch powers are higher than the downstream powers because the upstream channels must pass through the lossy multichannel WDM demultiplexer, while the downstream channels only pass through a single WDM filter.

Table III.4/G.983.3 – The maximal Tx power of Enhancement Band signal at IF_{PON}

a – just after the WF1 going downstream

	PIN (dBm)		APD (dBm)	
Channels	SDH-1	SDH-4	GbE	SDH-16
4	–4.5	0.5	–1.5	2.5
8	–4.5	0.5	–1.5	2.5
16	–4.0	1.0	–1.0	3.0

b – just after WF2 going upstream

	PIN (dBm)		APD (dBm)	
Channels	SDH-1	SDH-4	GbE	SDH-16
4	–2.0	3.0	1.0	4.8
8	–1.5	3.5	1.5	5.0
16	2.0	7.0	5.0	6.8

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The isolation values are obtained by first computing the maximum Enhancement Band power entering either WF1 or WF2. The two sources of this power are the forward path power (upstream in the case of WF1) and the reflection path power (downstream in the case of WF1). These powers are summed arithmetically, including the multiplier for the number of channels involved, and produce the interfering power. The worst case of this interfering power is then compared with the worst case of the Basic Band power. Their difference plus 13 dB is then the required isolation. The isolations for WF1 and WF2 are specified in Table III.5 assuming a class B PON. Note that the isolation stated for WF1 also includes whatever isolation that the diplexer provides inside the OLT, hence the actual isolation required of WF1 is actually less.

Table III.5/G.983.3 – Isolation requirements at Basic Band receiver from Enhancement Band

a – for WF1

	PIN (dB)		APD (dB)	
Channels	**SDH-1**	**SDH-4**	**GbE**	**SDH-16**
4	37.3	42.3	40.3	44.0
8	40.7	45.7	43.7	47.3
16	47.1	52.1	50.1	52.0

b – for WF2

	PIN (dB)		APD (dB)	
Channels	**SDH-1**	**SDH-4**	**GbE**	**SDH-16**
4	20.8	25.8	23.8	27.8
8	24.0	29.0	27.0	30.8
16	28.6	33.6	31.6	34.6

III.3 Example of isolation classes

Possible isolation classes for the ONU WF2 filter are shown in Table III.6. It would appear that 30 dB of isolation is sufficient for most all of the DWDM upgrades, and some of the video upgrades. Hence, this could define the first class of isolation. For exceptional cases of DWDM upgrade, or for many of the video upgrades, 40 dB of isolation is required. This could define the second class of isolation.

Table III.6/G.983.3 – Isolation Classes

		Guaranteed Isolation	
		at EB from BB (dB)	**at BB from EB (dB)**
Isolation Class	Case 1	F.F.S	30
	Case 2	F.F.S	40
	Case 3	F.F.S	F.F.S

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III.4 Deployment examples

This clause shows examples of WDM filters' characteristics such as power loss and isolation in deploying this system.

III.4.1 Model to be considered

Figure III.2 shows an example of model.

In order to calculate the value of isolation, the SNR of three receivers such as OLT-Rx, ONU-Rx and E-Rx should be considered. For that, each amount of interference optical power and the power of signal should be considered.

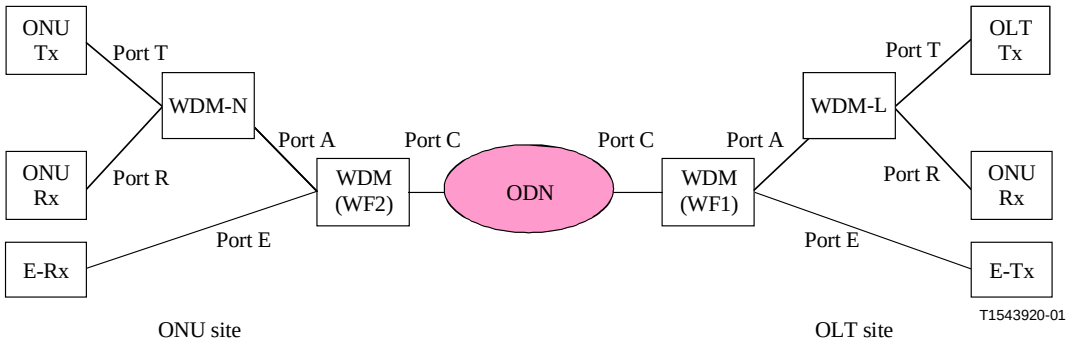
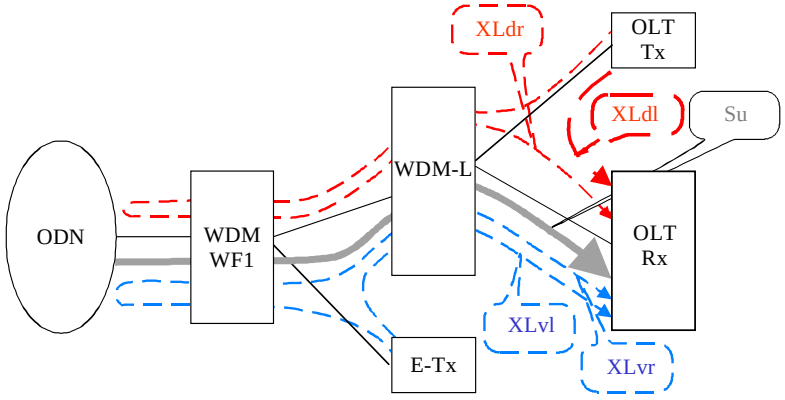


Figure III.2/G.983.3 – Model for calculation

III.4.1.1 SNR of OLT-Rx

Figure III.3 shows the noise signals received at OLT-Rx receiver.



Su	Basic Band Signal (upstream)
XL	Amount of interference optical power for OLT Receiver
XLdl	Leak signal of downstream
XLdr	Reflection signal of downstream
XLvl	Leak signal of video
XLvr	Reflection signal of video

Figure III.3/G.983.3 – Noise signals at OLT-Rx

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Then, amount of Interference optical power is given by Equation (III-4).

$$XL[dBm] = 10 \times \log(XL[mW]) \quad \text{(III-4)}$$

where:

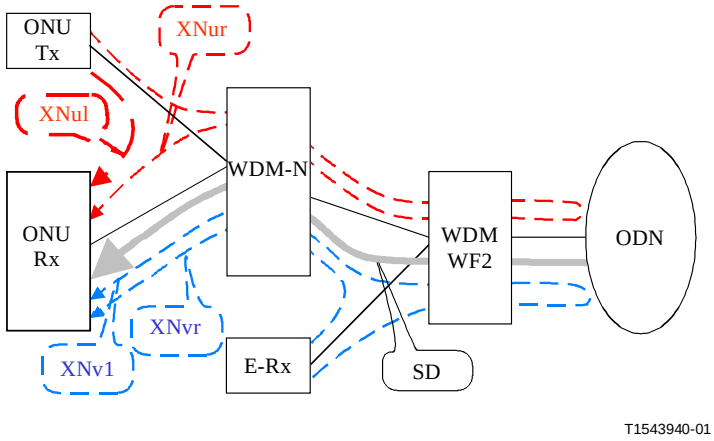
$$XL[mW] = XLdl[mW] + XLdr[mW] + XLvl[mW] + XLvr[mW]$$

So, if the reflected optical power is at least 10 dB lower than the signal power, then Equation (III-5) is satisfied.

$$Su[dBm] - XL[dBm] \geq 10[dB] \quad \text{(III-5)}$$

III.4.1.2 SNR of ONU-Rx

Figure III.4 shows the noise signals received at ONU-Rx receiver.



Sd	Basic Band (downstream)
XN	Amount of interference optical power for ONU Receiver
XNul	Leak signal of upstream
XNur	Reflection signal of upstream
XNvl	Leak signal of video
XNvr	Reflection signal of video

Figure III.4/G.983.3 – Noise signals at ONU-Rx

Then, amount of Interference optical power is given by Equation (III-6).

$$XN[dBm] = 10 \times \log(XN[mW]) \quad \text{(III-6)}$$

where:

$$XN[mW] = XNul[mW] + XNur[mW] + XNvl[mW] + XNvr[mW]$$

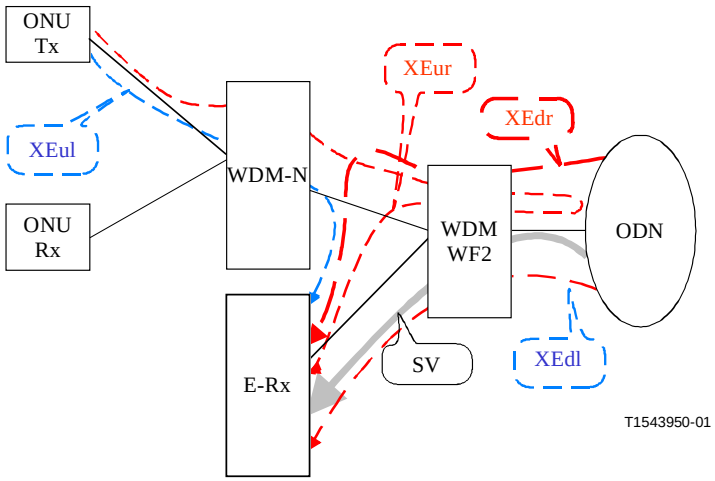
So, if the reflected optical power is at least 10 dB lower than the signal power, then Equation (III-7) is satisfied.

$$Sd[dBm] - XN[dBm] \geq 10[dB] \quad \text{(III-7)}$$

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III.4.1.3 SNR of E-Rx

Figure III.5 shows the noise signals received at E-Rx receiver.



Sv	Video signal
XE	Amount of interference optical power for E-ONU Receiver
XEul	Leak signal of upstream
XEur	Reflection signal of upstream
XEdl	Leak signal of downstream
XEdr	Reflection signal of downstream

Figure III.5/G.983.3 – Noise signals at E-Rx

Then, amount of Interference optical power (XE) is given by Equation (III-8).

$$XE[dBm] = 10 \times \log(XE[mW]) \quad \text{(III-8)}$$

where:

$$XE[mW] = XEul[mW] + XEur[mW] + XEdl[mW] + XEdr[mW]$$

So, Equation (III-9) is satisfied.

$$Sv[dBm] - XE[dBm] \geq (*)[dB] \quad \text{(III-9)}$$

(*) It depends on the specification of video signal. Refer to III.4.2.3.

III.4.2 In case of 64-QAM

– Assumption of the Basic Band signal

- 155 Mbit/s Class B

  Pout(ATM-OLT) = –2.5 to +2 [dBm] @ODN-I/F

  Pin(ATM-OLT) = –8 to –31.5 [dBm] @ODN-I/F

  Pout(ATM-ONU) = –5.5 to +2 [dBm] @ODN-I/F

  Pin(ATM-ONU) = –8 to –28.5 [dBm] @ODN-I/F
- All WDM insertion loss of through port for all wavelengths is 0 to 1.5 dB
- ORL of ODN is 32 dB, ORL of Equipment at receiver wavelength is 20 dB

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– Assumption of the 64-QAM signal:
  - 64-QAM modulation and 40 carriers for video (27.4 dB SNR is required)
    Pout(video) = +7 to +10 [dBm] @ODN I/F
    Pin(video) = 0 to –18 [dBm] @ODN I/F
  - Frequency Range: 54 MHz ~ 750 MHz
  - Carrier Spacing: 6 MHz
  - Required SNR: 28 dB

III.4.2.1 Calculation of OLT-Rx

Su [dBm] = –31.5 [dBm] – 1.5 [dB] – 1.5 [dB]

XLdl [dBm] = +2 [dBm] – LLTRd [dB]

XLdr [dBm] = +2 [dBm] – 32 [dB] – 0 [dB] – LLARd [dB]

XLvl [dBm] = +10 [dBm] – LWF1EAv [dB] – LLARv [dB]

XLvr [dBm] = +10 [dBm] – 32 [dB] – LWF1CAv [dB] – LLARv [dB]

From Equation III-4 and Equation III-5, an example of WDM characters are as follows:

LLTRd = 50 [dB] (Loss of downstream in WDM-L from Port T to port R)

LLARd = 20 [dB] (Loss of downstream in WDM-L from Port A to port R)

LWF1EAv = 50 [dB] (Loss of video in WDM-WF1 from Port E to port A)

LLARv = 20 [dB] (Loss of video in WDM-L from Port A to port R)

LWF1CAv = 20 [dB] (Loss of video in WDM-WF1 from Port C to port A)

III.4.2.2 Calculation of ONU-Rx

Sd [dBm] = –28.5 [dBm] – 1.5 [dB] – 1.5 [dB]

XNul [dBm] = +2 [dBm] – LNTRu [dB]

XNur [dBm] = +2 [dBm] – 32 [dB] – 0 [dB] – LNARu [dB]

XNvl [dBm] = (–18 [dBm] + 3 [dB]) – LWF2CAv [dB] – 0 [dB]

XNvr[dBm] = (–18 [dBm] + 3 [dB]) – 0 [dB] – 20 [dB] – LWF2EAv [dB] – 0 [dB]

3 [dB] = +10 [dBm] – (+7 [dBm])

From Equation III-6 and Equation III-7, examples of WDM characteristics are as follows:

LNTRu = 50 [dB] (Loss of upstream in WDM-N from Port T to port R)

LNARu = 20 [dB] (Loss of upstream in WDM-N from Port A to port R)

LWF2CAv = 29 [dB] (Loss of video in WDM-WF2 from Port C to port A)

LWF2EAv = 20 [dB] (Loss of video in WDM-WF2 from Port E to port A)

III.4.2.3 Calculation of E-Rx

S/X for video receiver requires 27.4 dB to transmit 40 carriers with –18 dBm received power. So, Equation (III-9 *bis*) is satisfied.

$$Sv[dBm] - XE[dBm] \geq 27.4\ dB \qquad \text{(III-9 } bis\text{)}$$

Sv [dBm] = –18 [dBm] – 1.5 [dB]

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XEul [dBm] = +2 [dBm] – LWF2AEu [dB]

XEur [dBm] = +2 [dBm] – 32 [dB] – LWF2CEu [dB]

XEdl [dBm] = (–27.5 [dBm] + 4.5 [dB]) – LWF2CEd [dB]

XEdr [dBm] = (–27.5 [dBm] + 4.5 [dB]) – 0 [dB] – 20 [dB] – LWF2AEd [dB]

$$4.5\ [dB] = +2\ [dBm] - (-2.5\ [dBm])$$

From Equation (III-8) and Equation (III-9 *bis*), examples of WDM characters are as follows:

LWF2AEu = 50 [dB] (Loss of upstream in WDM-WF2 from Port A to port E)

LWF2CEu = 31.5 [dB] (Loss of upstream in WDM-WF2 from Port C to port E)

LWF2CEd = 31.5 [dB] (Loss of downstream in WDM-WF2 from Port C to port E)

LWF2AEd = 20 [dB] (Loss of downstream in WDM-WF2 from Port A to port E)

III.4.3 Filter characteristics

From an estimation of III.4.2.1, III.4.2.2 and III.4.2.3, required filter characteristics are shown in Tables III.7 and III.8.

Table III.7/G.983.3 – Required filter characteristics (OLT side)

WF1					**WDM-L**				
	Port	**Wavelength**	**Min**	**Max**		**Port**	**Wavelength**	**Min**	**Max**
LWF1Acd	A→C	Down	0	1.5	LLTAd	T→A	Down	0	1.5
LWF1CAu	C→A	Up	0	1.5	LLARu	A→R	Up	–	1.5
LWF1CEv	C→E	Video	0	1.5	LLATv	A→T	Video	–	–
LWF1CEd	C→E	Down	–	–	LLARd	A→R	Down	20	–
LWF1CEu	C→E	Up	–	–	LLATu	A→T	Up	–	–
LWF1CAv	C→A	Video	20	–	LLARv	A→R	Video	20	–
LWF1AEd	A→E	Down	–	–	LLTRd	T→R	Down	50	–
LWF1AEu	A→E	Up	–	–	LLRTu	R→T	Up	–	–
LWF1EAv	E→A	Video	50	–	LLTRv	T→R	Video	–	–

Table III.8/G.983.3 – Required filter characteristics (ONU side)

WF2					**WDM-N**				
	Port	**Wavelength**	**Min**	**Max**		**Port**	**Wavelength**	**Min**	**Max**
LWF2Acu	A→C	Up	0	1.5	LNTAu	T→A	Up	0	1.5
LWF2CAd	C→A	Down	0	1.5	LNARd	A→R	Down	–	1.5
LWF2CEv	C→E	Video	0	1.5	LNARv	A→T	Video	0	–
LWF2CEu	C→E	Up	31.5	–	LNARu	A→R	Up	20	–

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Table III.8/G.983.3 – Required filter characteristics (ONU side) *(concluded)*

WF2					WDM-N				
	Port	**Wavelength**	**Min**	**Max**		**Port**	**Wavelength**	**Min**	**Max**
LWF2CEd	C→E	Down	31.5	–	LNATd	A→T	Down	–	–
LWF2CAv	C→A	Video	29	–	LNATv	A→R	Video	–	–
LWF2AEu	A→E	Up	50	–	LNTRu	T→R	Up	50	–
LWF2AEd	A→E	Down	20	–	LNRTd	R→T	Down	–	–
LWF2EAv	E→A	Video	20	–	LNTTv	T→R	Video	–	–

Isolation is defined as the loss difference between two wavelengths measured at the same port. Therefore, we can calculate "Isolation" using Tables III.7 and III.8.

Isolation at WDM-WF1: Isolate Basic Band upstream signal from Enhancement band signal.

LWF1CAv(min) [dB] – LWF1CAu(max) [dB] = 20 [dB] – 1.5 [dB] = **18.5 [dB]**

Isolation at WDM-WF2: Isolate Enhancement Band signal from Basic band upstream signal.

LWF2CEu(min) [dB] – LWF2CEv(max) [dB] = 31.5 [dB] – 1.5 [dB] = **30 [dB]**

Isolation at WDM-WF2: Isolate Enhancement Band signal from Basic Band downstream signal.

LWF2CEd(min) [dB] – LWF2CEv(max) [dB] = 31.5 [dB] – 1.5 [dB] = **30 [dB]**

Isolation at WDM-WF2: Isolate Basic Band downstream signal from Enhancement Band signal.

LWF2CAv(min) [dB] – LWF2CAd(max) [dB] = 29 [dB] – 1.5 [dB] = **27.5 [dB]**

APPENDIX IV

Effect of optical return loss of ODN

IV.1 Introduction

Each network model has its own optical return loss (ORL) of ODN and BPON is sensitive to the ORL of ODN. This appendix describes the relationship among some types of reflectance to be considered, WDM isolation of ONU and OLT, and ONU equipment reflectance for transmitter and receiver for each case that ORL of ODN is 32 dB and 20 dB.

The fundamental consideration has already been described in Appendix II/G.983.1. Similar consideration is applicable and extended for BPON ODN including effects by Enhancement Band, E-ONU, and E-OLT.

In the calculation of optical parameters, we assume that ONU and E-ONU equipment reflectance for receiver is –20 dB and OLT and E-OLT equipment reflectance for receiver is –20 dB. This appendix describes condition equations and calculation results for the reflectance, which restrict the parameters.

NOTE – Permissible total noise to the receiver, which consists of multiple reflections as well as leaked optical power, may be 10 dB lower than the lowest signal level. Since the permissible noise power for each noise component is for further study, thus the following clauses IV.2 and IV.3 are tentatively described on the assumption that each noise component be at least 10 dB lower than the signal. This assumption should be modified and interpreted to some higher value than 10 dB, for example to 13 dB, according to the permissible noise power assigned to each noise component such as reflections and leaked power.

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IV.2 Effect of ODN optical return loss in the Basic Band

IV.2.1 Reflectance model to be considered

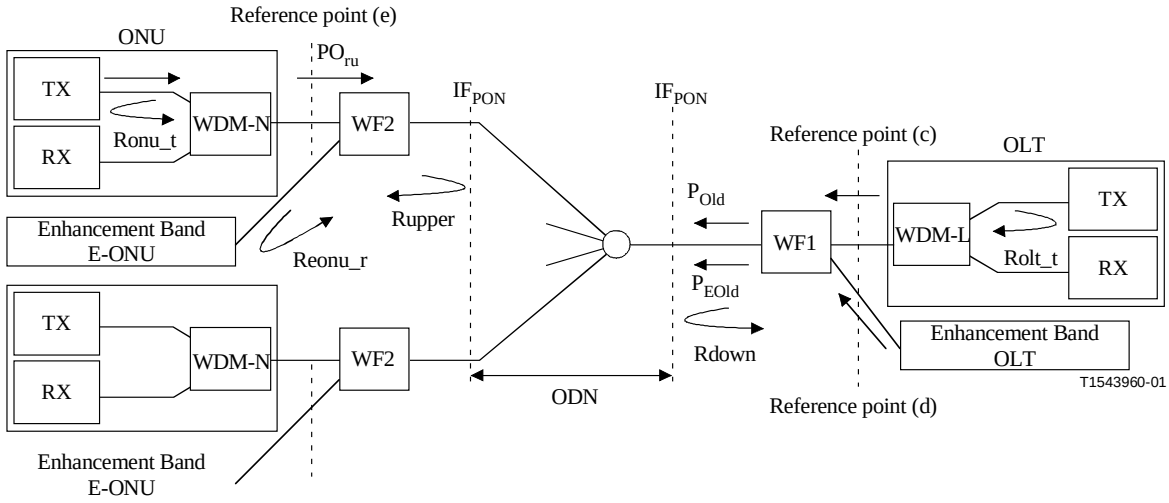


Figure IV.1/G.983.3 – Reflectance model to be considered

The following notations are used in this appendix:

P_{Oru_n}	Optical output power of ONU #n transmitter at O_{ru}
P_{Old}	Optical output power of OLT transmitter at O_{ld}
P_{EOld}	Optical output power of E-OLT transmitter at O_{ld}
Ronu_t	ONU transmitter equipment reflectance
Rolt_t	OLT transmitter equipment reflectance
Reonu_r	E-ONU receiver equipment reflectance
Rupper	ORL of ODN at O_{ru} and O_{rd}
Rdown	ORL of ODN at O_{ld} and O_{lu}
L_{ODN-BB}	Optical loss of Basic Band in the ODN
L_{ODN-EB}	Optical loss of Enhancement Band in the ODN
L_{WF1}	Insertion loss of WF1
L_{WF2}	Insertion loss of WF2
Iolt_t	WDM isolation for OLT transmitter
Iolt_r	WDM isolation for OLT receiver
Ionu_r	WDM isolation for ONU receiver
I_{WF1}	WF1 isolation for Basic Band
I_{WF2}	WF2 isolation for Basic Band

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These values are all treated as positive in this appendix.

The following assumptions are taken for the examples:

– $L_{ODN-BB} = L_{ODN-EB}$

– Minimum insertion loss for WF1 and WF2 is equal to 0 dB.

– Insertion loss between the port at reference point (c) and the port at IF_{PON} side of WF1 is identical for upstream/downstream 1.3 µm, and upstream/downstream 1.5 µm Basic Band wavelengths.

– Insertion loss between the port at reference point (e) and the port at IF_{PON} side of WF2 is identical for upstream/downstream 1.3 µm, and upstream/downstream 1.5µm Basic Band wavelengths.

IV.2.2 Influence of reflectance into ONU receiver

Figure IV.2 shows the path of reflected signal to be considered. Equation (IV-1) must be satisfied:

$$P_{Oru\_1} - Rupper - Ionu\_r < \text{(permissible interference optical power)} \quad \text{(IV-1)}$$

Assuming permissible interference optical power is equal to (minimum sensitivity –10 dB), permissible interference optical power = Pmin(A,B,C) – 10 dB. Pmin(A,B,C) means minimum sensitivity at reference point (e) for Class A, B, C described in Table V.1.

Then Ionu_r is estimated and summarized in Table IV.1.

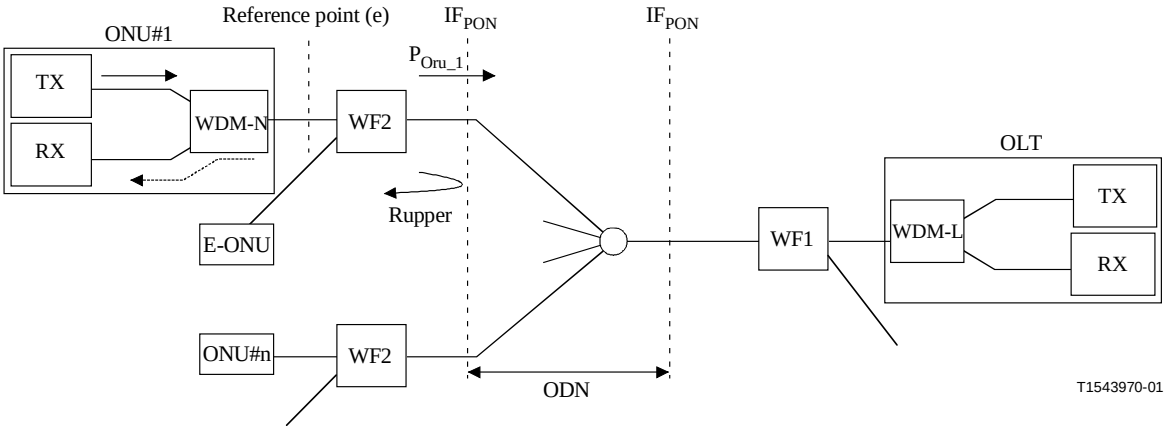


Figure IV.2/G.983.3 – Model for incidence into ONU receiver

IV.2.3 Influence of reflectance into OLT receiver (in the signal region)

The analysis for the influence of reflectance into OLT receiver is performed in two conditions; one is that the reflected signal overlaps the upstream burst signal region and the other is that the reflected signal is in the delay measurement window where there is no signal.

In the signal region, the following three cases are to be considered.

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IV.2.3.1 Case 1

Figure IV.3 shows the path of reflectance signals. Equation (IV-2) must be satisfied:

$$\text{(maximum difference of burst signal optical levels)} - \text{Rupper} - 2L_{WF2} - \text{Ronu\_t} < \text{(permissible interference optical power ratio)} \quad \text{(IV-2)}$$

Assuming permissible interference optical power ratio is −10 dB, we obtain the results (see Table IV.1). Here, loss of L_{WF2} is assumed as 0 dB to estimate the worst case.

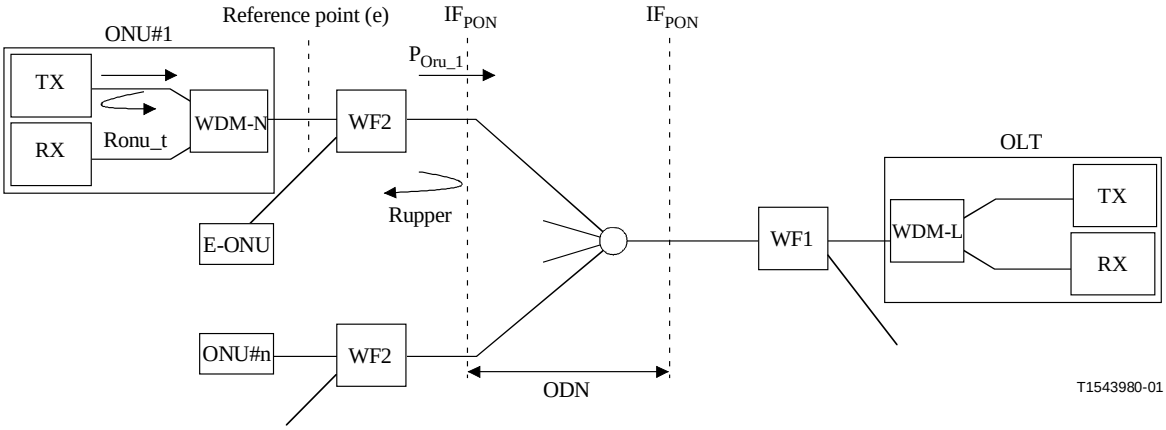


Figure IV.3/G.983.3 – Model 1 for incidence into OLT receiver

IV.2.3.2 Case 2

Figure IV.4 shows the path of reflectance signals. Equation (IV-3) must be satisfied:

$$\text{(maximum difference of burst signal optical levels)} - \text{Rolt\_t} - \text{Rdown} - 2L_{WF1} - 2\text{Iolt\_t} < \text{(permissible interference optical power)} \quad \text{(IV-3)}$$

Assuming permissible interference optical power is equal to −10 dB, we obtain the results (see Table IV.1). To estimate the worst case of Iolt_t, loss of L_{WF1} is assumed as 0 dB.

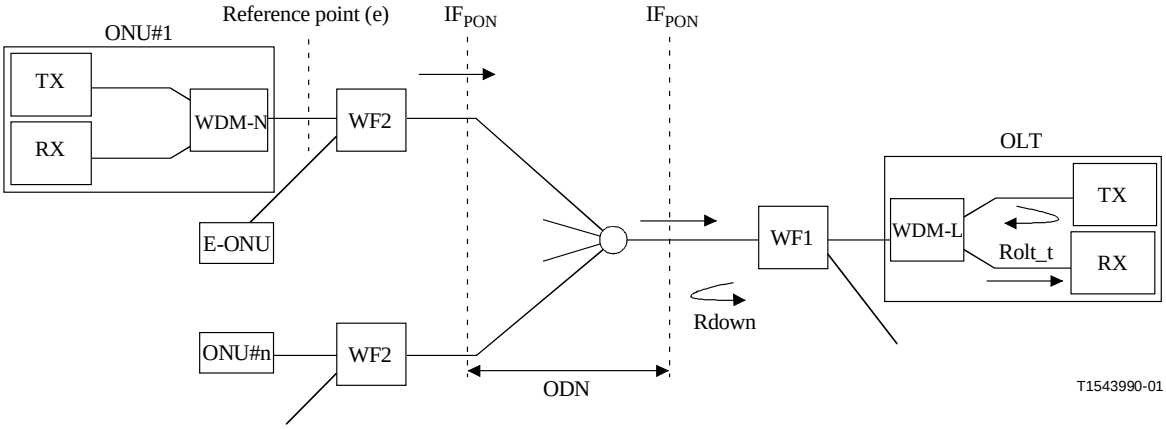


Figure IV.4/G.983.3 – Model 2 for incidence into OLT receiver

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IV.2.3.3 Case 3

Figure IV.5 shows the path of reflectance signals. Equation (IV-4) must be satisfied:

$$P_{Old} - Rdown - Iolt\_r < \text{(permissible interference optical power)} \quad \text{(IV-4)}$$

Assuming permissible interference optical power is equal to minimum sensitivity −10 dB, we obtain the results (see Table IV.1).

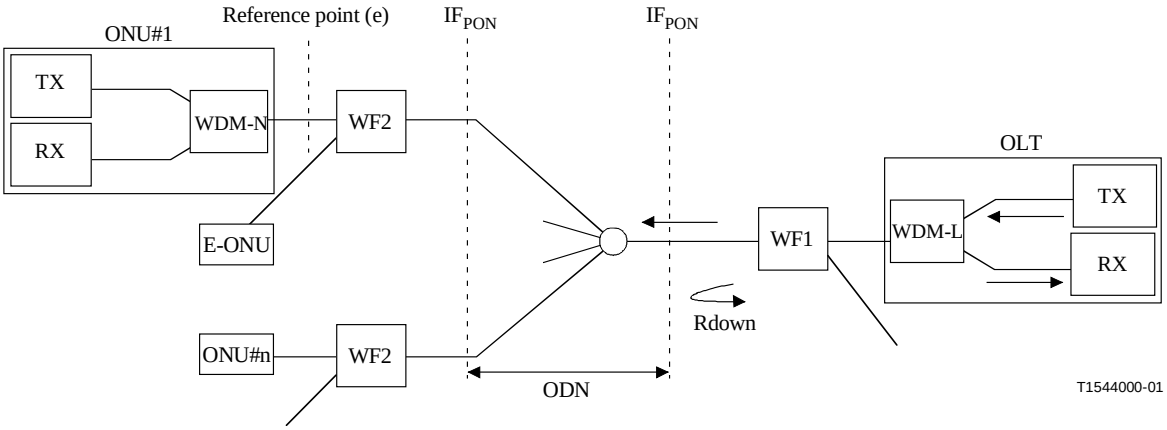


Figure IV.5/G.983.3 – Model 3 for incidence into OLT receiver

IV.2.4 Influence of reflectance into OLT receiver (in the no signal region)

In the no signal region, main cases of reflectance to be considered are the following two cases.

IV.2.4.1 Case 1

Figure IV.3 shows the path of reflectance signals. Equation (IV-5) must be satisfied:

$$P_{Oru\_n} - Rupper - 2L_{WF2} - Ronu\_t - \text{(minimum optical path attenuation)} < \text{(determination level as no signal)} \quad \text{(IV-5)}$$

Assuming determination level as no signal is equal to minimum sensitivity −10 dB, we obtain the results (see Table IV.1). To estimate the worst case of Ronu_t, loss of L_{WF2} is assumed as 0 dB.

IV.2.4.2 Case 2

Figure IV.5 shows the path of reflectance signals. Equation (IV-6) must be satisfied:

$$P_{Old} - Rdown - Iolt\_r < \text{(determination level as no signal)} \quad \text{(IV-6)}$$

Assuming determination level as no signal is equal to minimum sensitivity −10 dB, we obtain the results (see Table IV.1).

IV.2.5 Summary in effects of ODN optical return loss in the Basic Band

The calculation method mentioned above is available for the case that ODN reflectance is −20 dB. Table IV.1 shows the requirement for optical parameters when minimum ORL of ODN is 32 dB and 20 dB.

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WDM isolation parameter is implementation matter, and values concerning WDM isolation parameters in Table IV.1 are just informative. This appendix includes ONU and OLT equipment reflectance. Considering the characteristic of the WDM, Ronu_t is equal to the reflectance of ONU measured at transmitter wavelength.

When ORL of ODN is 32 dB, ONU transmitter equipment reflectance must be less than incident optical power. It shall be 6 dB, which is available in an ordinary FP-LD module.

In the case that ORL of ODN is 20 dB, ONU transmitter equipment reflectance must be less than 13.5 dB.

As mentioned above, maximum ONU transmitter equipment reflectance is sensitive to the value of ORL of ODN, which depends on the network built by the common carrier. In the case that ORL of ODN is 32 dB and 20 dB, values of equipment reflectance for ONU transmitter in Table IV.1 are applicable. In the other case, the appropriate value is derived by means of the calculation method mentioned above.

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Table IV.1/G.983.3 – Values for ONU transmitter equipment reflectance

Min ORL of ODN	Class	Optical parameters	Required characteristics					
			A[a)]	B[a)]	C[a)]	D[a)]	E[a)]	F[a)]
32 dB	A	WDM isolation for ONU receiver	6.5					
		WDM isolation for ONU transmitter						
		WDM isolation for OLT receiver				3.5		3.5
		WDM isolation for OLT transmitter			NA			
		Equipment reflectance for ONU transmitter		0.5			1.5	
	B	WDM isolation for ONU receiver	8.5					
		WDM isolation for ONU transmitter						
		WDM isolation for OLT receiver				11.5		11.5
		WDM isolation for OLT transmitter			NA			
		Equipment reflectance for ONU transmitter		0.5			1.5	
	C	WDM isolation for ONU receiver	13.5					
		WDM isolation for ONU transmitter						
		WDM isolation for OLT receiver				16.5		16.5
		WDM isolation for OLT transmitter			NA			
		Equipment reflectance for ONU transmitter		0.5			1.5	
20 dB	A	WDM isolation for ONU receiver	18.5					
		WDM isolation for ONU transmitter						
		WDM isolation for OLT receiver				15.5		15.5
		WDM isolation for OLT transmitter			3.3			
		Equipment reflectance for ONU transmitter		12.5			13.5	
	B	WDM isolation for ONU receiver	20.5					
		WDM isolation for ONU transmitter						
		WDM isolation for OLT receiver				23.5		23.5
		WDM isolation for OLT transmitter			3.3			
		Equipment reflectance for ONU transmitter		12.5			13.5	
	C	WDM isolation for ONU receiver	25.5					
		WDM isolation for ONU transmitter						
		WDM isolation for OLT receiver				28.5		28.5
		WDM isolation for OLT transmitter			3.3			
		Equipment reflectance for ONU transmitter		12.5			13.5	

a) A, B, C, D, E and F represent Equation (IV-1), Equation (IV-2), Equation (IV-3), Equation (IV-4), Equation (IV-5) and Equation (IV-6), respectively.

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IV.3 Influence of reflectance from Enhancement Band to Basic Band

IV.3.1 Influence of reflectance into OLT receiver from Enhancement Band

Service using Enhancement Band signals may degrade quality of the Basic Band (ATM-PON) service, and vice versa. Three types of reflection of Enhancement Band signals are considered. One is the reflection from the ODN, and the others are those from the E-ONU and the blocking filter.

IV.3.1.1 Case 1

Figure IV.6 shows the path of reflectance signals from ODN. Equation (IV-7) must be satisfied:

$$P_{EOld} - Rdown - Iolt\_r - I_{WF1} < \text{(determination level as no signal)} \quad \text{(IV-7)}$$

Assuming determination level as no signal is equal to minimum sensitivity −10 dB, we obtain the condition for I_{WF1}. Example for required isolation of I_{WF1} is shown in Table IV.2. Example conditions refer to Table IV.1 and Table V.1.

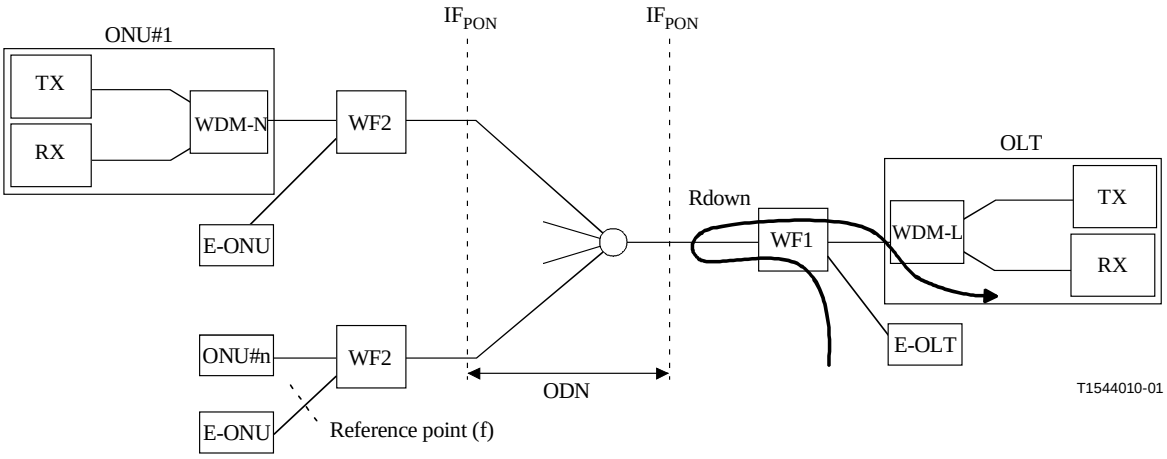


Figure IV.6/G.983.3 – Model 4 for incidence into OLT receiver

Table IV.2/G.983.3 – ORL versus Isolation at WF1

Min ORL of ODN	Class	Example conditions			Required I_{WF1} (dB)
		P_{Eold} (dBm)	Iolt_r (dB)	Pmin (dBm)	
32 dB	A	+16	3.5	–28.5	19
	B		11.5	–31.5	14
	C		16.5	–34.5	12
20 dB	A		15.5	–28.5	19
	B		23.5	–31.5	14
	C		28.5	–34.5	12

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IV.3.1.2 Case 2

Figure IV.7 shows the path of reflectance signals from E-ONU. Equation (IV-8) must be satisfied:

$$\Sigma (P_{EOld} - 2\,L_{ODN\text{-}EB} - Reonu\_r) - Iolt\_r - I_{WF1} < \text{(determination level as no signal)} \quad \text{(IV-8)}$$

Here, the first Σ (summation) denotes reflection from all connected E-ONUs. In other words,

$$P_{EOld} - 2\,L_{ODN\text{-}EB} - Reonu\_r + 10 \times LogN - Iolt\_r - I_{WF1} < \text{(determination level as no signal)}.$$

Here, N shows the number of connected E-ONUs.

Assuming determination level as no signal is equal to minimum sensitivity −10 dB, we obtain the condition for I_{WF1}. Example for required isolation of I_{WF1} is shown in Table IV.3. Minimum loss of ODN and appropriate number of N is assumed. Example conditions refer to Tables IV.1 and V.1.

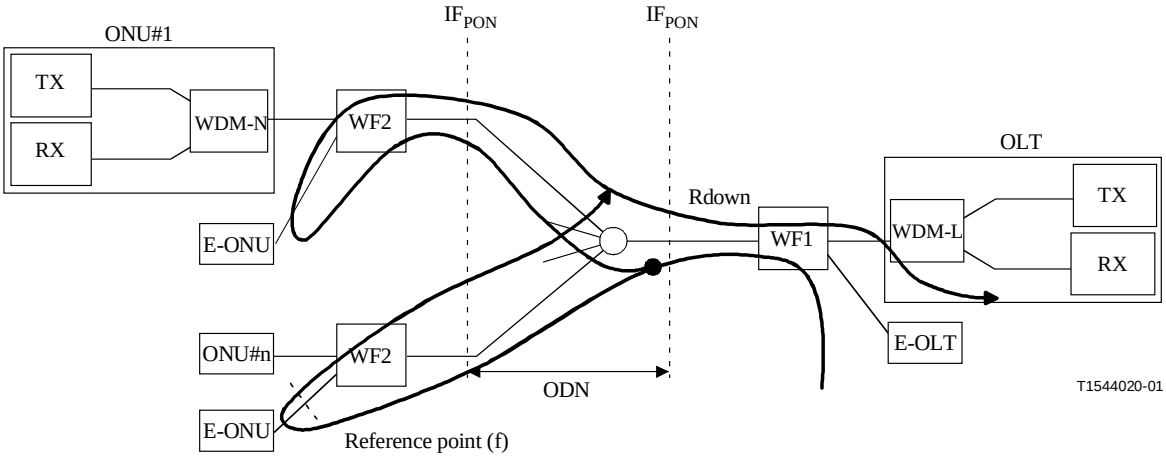


Figure IV.7/G.983.3 – Model 5 for incidence into OLT receiver

Table IV.3/G.983.3 – ORL versus Isolation at WF1

Min ORL of ODN	Assumption conditions							Required I_{WF1} (dB)
	ODN Class	Loss of ODN (dB)	No. of E-ONU N	P_{Eold} (dBm)	Iolt_r (dB)	Pmin (dBm)	Reonu_r (dB)	
32 dB	A	5	2	+16	3.5	–28.5	20	24
	B	10	8		11.5	–31.5		15
	C	15	32		16.5	–34.5		9
20 dB	A	5	2		15.5	–28.5		12
	B	10	8		23.5	–31.5		3
	C	15	32		28.5	–34.5		NA

IV.3.1.3 Case 3

Deployment scenarios described in Appendix II demonstrate configuration example of mixture in ONUs served by Basic Band only and ONUs served both by Basic Band and Enhancement Band. In this case, Blocking filters for Basic Band only users may be applied. Some type of Blocking filter may cause reflections to degrade signal quality.

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Figure IV.8 shows the path of reflection signals from Blocking filters. Equation (IV-9) must be satisfied:

$$\Sigma (P_{EOld} - 2\ L_{ODN\text{-}EB} - R_{WF2\_}r\ ) - Iolt\_r - I_{WF1} < \text{(determination level as no signal)} \quad \text{(IV-9)}$$

Here, $R_{WF2\_}r$ means the reflectance of the Blocking filter and the first Σ (summation) denotes reflection from all connected Blocking Filters. In other words,

$P_{EOld} - 2\ L_{ODN\text{-}EB} - R_{WF2\_}r + 10 \times LogN - Iolt\_r - I_{WF1} <$ (determination level as no signal).

Here, N shows the number of connected blocking filters.

Assuming determination level as no signal is equal to minimum sensitivity −10 dB, we obtain the condition for $R_{WF2\_}r$. An example for required reflectance of $R_{WF2\_}r$ is shown in Table IV.4. Minimum loss of ODN and appropriate number of N is assumed. Isolation of I_{WF1} is assumed to be larger value among those in Tables IV.2 and IV.3. Example conditions refer to Tables IV.1 and V.1.

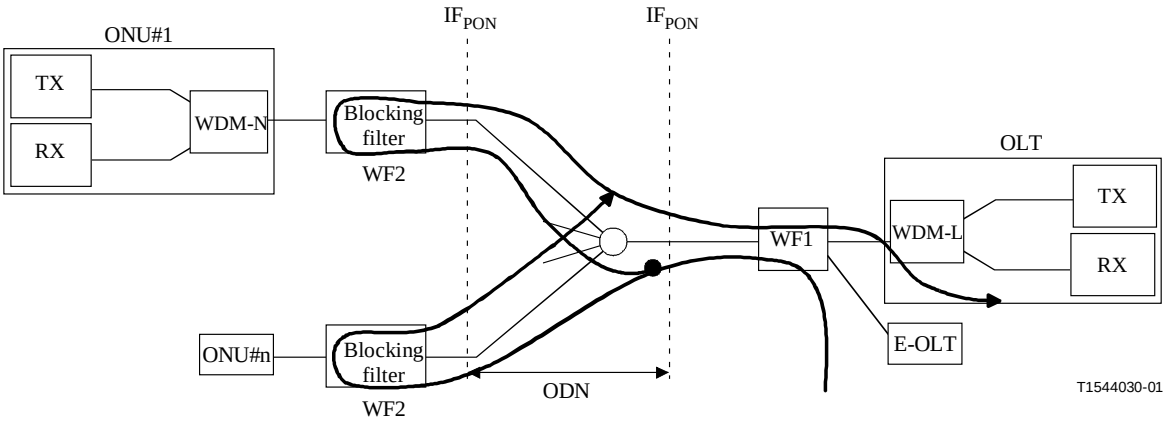


Figure IV.8/G.983.3 – Model 6 for incidence into OLT receiver

Table IV.4 – ORL versus Isolation at WF1

Min ORL of ODN	Assumption conditions							Required $R_{WF2\_}r$ (dB)
	ODN Class	Loss of ODN (dB)	No. of E-ONU N	P_{Eold} (dBm)	Iolt_r (dB)	Pmin (dBm)	I_{WF1} (dB)	
32 dB	A	5	2	+16	3.5	–28.5	24	20
	B	10	8		11.5	–31.5	15	20
	C	15	32		16.5	–34.5	12	17
20 dB	A	5	2		15.5	–28.5	19	13
	B	10	8		23.5	–31.5	14	9
	C	15	32		28.5	–34.5	12	5

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APPENDIX V

Optical parameters for reference point (c) and (e) and two example deployment cases

V.1 Introduction

The optical power parameters for reference points of (c) and (e) shown here are examples to guide implementation.

V.2 Optical level diagram examples

V.2.1 Case 1: ODN centric view of optical parameters

Optical parameters examples for IF_{PON} are assumed to be the same as those described in Appendix I and the attenuation range of the ODN is compliant to ITU-T G.982.

In this case, example optical power level diagrams are shown below:

WDM loss of WF1 = 0 dB to 1.5 dB, WDM loss of WF2 = 0 dB to 1.5 dB.

Optical path penalty of 1 dB is included at the reference points of R/S and S/R at IF_{PON}.

Table V.1/G.983.3 – Optical power level diagram (example)

	Ref.(e)		**IF_{PON} (O_{ru}, O_{rd})**		**ODN loss**		**IF_{PON} (O_{lu}, O_{ld})**		**Ref.(c)**	
Unit	**dBm**		**dBm**		**dB**		**dBm**		**dBm**	
Range	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Downstream										
155M Class A	–30	–8	–28.5	–8	5	20	–7.5	–3	–6	–3
155M Class B	–30	–8	–28.5	–8	10	25	–2.5	2	–1	2
155M Class C	–33	–11	–31.5	–11	15	30	–0.5	4	1	4
622M Class A	–28	–6	–26.5	–6	5	20	–5.5	–1	–4	–1
622M Class B	–28	–6	–26.5	–6	10	25	–0.5	4	1	4
622M Class C	–33	–11	–31.5	–11	15	30	–0.5	4	1	4
Upstream										
155M Class A	–6	0	–7.5	0	5	20	–28.5	–5	–30	–5
155M Class B	–4	2	–5.5	2	10	25	–31.5	–8	–33	–8
155M Class C	–2	4	–3.5	4	15	30	–34.5	–11	–36	–11

V.2.2 Case 2: Equipment centric view of optical parameters

Optical parameters for reference points of (c) and (e) are same as those specified in ITU-T G.983.1 and the attenuation range of the ODN is reduced from that in ITU-T G.982.

The purpose of this clause is to survey the BPON applicability of optical modules compliant to ITU-T G.983.1. Maximum variation of the attenuation range in the ODN is reduced in order to

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compensate for the extra dynamic range induced by WF1 and WF2. Applied ODN parameters are shown in Table V.2.

With regards to ODN Class A, optical parameters are not specified in ITU-T G.983.1, thus the case of Class A is not described.

Table V.2/G.983.3 – Physical medium dependant layer parameters of ODN

Items	Unit	Specification
Fibre type	–	ITU-T G.652
Attenuation range	dB	Reduced Class B with attenuation range: 10-22 Reduced Class C with attenuation range: 15-27
Differential optical path loss	dB	12
Maximum optical path penalty	dB	1
Max differential logical reach	km	20
Maximum fibre distance between S/R and R/S points	km	20
Minimum supported split ratio	–	Restricted by path loss and ONU addressing limits. PON with passive splitters (16 or 32 way split)
Bidirectional transmission	–	1-fibre WDM (2-fibre system is beyond the scope of this Recommendation)
Maintenance wavelength	nm	To be defined

In this case, example optical power level diagrams are shown below:

WDM loss of WF1 = 0 dB to 1.5 dB, WDM loss of WF2 = 0 dB to 1.5 dB.

Optical path penalty of 1 dB is included at the reference points of R/S and S/R at IF_{PON}.

Table V.3/G.983.3 – Optical power level diagram (example)

	Ref.(e)		**IF_{PON} (O_{ru}, O_{rd})**		**ODN loss**		**IF_{PON} (O_{lu}, O_{ld})**		**Ref.(c)**	
Unit	**dBm**		**dBm**		**dB**		**dBm**		**dBm**	
Range	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
Downstream										
155M reduced Class B	–30	–8	–28.5	–8	10	22	–5.5	2	–4	2
155M reduced Class C	–33	–11	–31.5	–11	15	27	–3.5	4	–2	4
622M reduced Class B	–28	–6	–26.5	–6	10	22	–3.5	4	–2	4
622M reduced Class C	–33	–11	–31.5	–11	15	27	–3.5	4	–2	4
Upstream										
155M reduced Class B	–4	2	–5.5	2	10	22	–28.5	–8	–30	–8
155M reduced Class C	–2	4	–3.5	4	15	27	–31.5	–11	–33	–11

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SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series B	Means of expression: definitions, symbols, classification
Series C	General telecommunication statistics
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	**Transmission systems and media, digital systems and networks**
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Telephone transmission quality, telephone installations, local line networks
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks and open system communications
Series Y	Global information infrastructure and Internet protocol aspects
Series Z	Languages and general software aspects for telecommunication systems

Geneva, 2001

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INTERNATIONAL TELECOMMUNICATION UNION

ITU-T G.983.4

(11/2001)

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Digital sections and digital line system – Optical line systems for local and access networks

A broadband optical access system with increased service capability using dynamic bandwidth assignment

ITU-T Recommendation G.983.4

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TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

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GENERAL CHARACTERISTICS COMMON TO ALL ANALOGUE CARRIER-TRANSMISSION SYSTEMS	G.200–G.299
INDIVIDUAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON METALLIC LINES	G.300–G.399
GENERAL CHARACTERISTICS OF INTERNATIONAL CARRIER TELEPHONE SYSTEMS ON RADIO-RELAY OR SATELLITE LINKS AND INTERCONNECTION WITH METALLIC LINES	G.400–G.449
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For further details, please refer to the list of ITU-T Recommendations.

ITU-T Recommendation G.983.4

A broadband optical access system with increased service capability using dynamic bandwidth assignment

Summary

This Recommendation specifies requirements for adding Dynamic Bandwidth Assignment (DBA) functionality to the Broadband Optical Access Systems defined in ITU-T Rec. G.983.1. The use of DBA functionality enables dynamic sharing of upstream bandwidth. This dynamic sharing uses upstream bandwidth more efficiently and enables additional services flexibility. This Recommendation captures specifications for DBA operation and for DBA-related communication between the OLT and the ONUs/ONTs.

Source

ITU-T Recommendation G.983.4 was prepared by ITU-T Study Group 15 (2001-2004) and approved under the WTSA Resolution 1 procedure on 29 November 2001.

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FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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ITU-T Recommendation G.983.4

A broadband optical access system with increased service capability using dynamic bandwidth assignment

1 Introduction

1.1 Scope

This Recommendation describes enhanced capabilities for flexible optical access networks based on ITU-T Rec. G.983.1. Specifically, this Recommendation describes the functions that extend ITU-T Rec. G.983.1 to enable Dynamic Bandwidth Assignment (DBA).

The requirements and specifications preserve backward compatibility and interoperability with the current G.983.1 systems, including management systems.

This Recommendation includes:

– Performances objectives (for example bandwidth assignment delay, maximum waiting time).

– Application functionality (for example dynamic bandwidth assignment for bursty traffic and for ONU/ONT aggregated traffic composed of different traffic classes).

– Fairness criteria and protocols (for example dynamic bandwidth assignment based on ONU/ONT status reporting, dynamic bandwidth assignment based on OLT monitoring, dynamic bandwidth assignment based on a combination of reporting and monitoring).

– Backwards compatibility and interoperability that allows legacy OLTs and ONUs/ONTs to operate in systems where DBA is employed.

It is anticipated that the introduction of DBA functionality into B-PON systems will increase efficiency and therefore lower the cost of providing broadband services.

1.2 Background

1.2.1 Bandwidth assignment in non-DBA G.983.1 systems

The current method for bandwidth assignment via grant control on ITU-T G.983.1 systems is described below.

ITU-T Rec. G.983.1 specifies a flexible access platform to provide broadband services through passive optical networks. It defines physical and link layer requirements. Traffic is conveyed in the passive optical network in the following frame formats.

The upstream traffic from the ONUs/ONTs to the OLT is transferred in a frame of 53 timeslots (cellslots). Each timeslot consists of three bytes of PON layer overhead and an ATM cell or a PLOAM cell. The upstream bandwidth is shared among the associated ONUs/ONTs. The OLT controls each upstream transmission from the ONUs/ONTs on a timeslot-by-timeslot basis. This is accomplished by sending data grants in downstream PLOAM cells.

PLOAM data grant cells are sent in the downstream direction to all ONUs/ONTs. The data grants are addressed to specific ONUs/ONTs and contain parameters that include the number of upstream data grants and the timeslots for the grants that are assigned to the individual ONU/ONT. Currently the grants are assigned in a static manner.

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1.2.2 Enhancing the bandwidth assignment on G.983.1 PON systems

In ITU-T Rec. G.983.1, the OLT grant generation and distribution are updated when a new connection is provisioned on a PON or an existing connection is removed from a PON. However, there are also other occasions when bandwidth is reassigned. Once the bandwidth is provisioned, the OLT will continuously send the assigned grants to the associated ONUs/ONTs; subsequently, the OLT will receive corresponding user cells in the upstream. This current granting mechanism is most efficient for real time traffic. For example, real time traffic (represented by circuit emulation services) is a typical application that is provided over an ATM DBR Class 1 service connection. This service will generate a well-behaved traffic pattern and can be readily accommodated using the static bandwidth assignment method.

However, ITU-T Rec. G.983.1 is intended to enable a wide range of broadband services, including those that do not have a constant bit rate. For example, the Internet connects to many bursty traffic sources, which are best accommodated by ATM SBR Class 2 or GFR, which have less rigid requirements on cell transfer delay and cell delay variation. Mapping these non-real-time services into a fixed bandwidth channel prevents the ONUs/ONTs on a PON from dynamically sharing the upstream PON bandwidth. For these non-real-time traffic types, the ability to assign bandwidth dynamically is expected to provide higher efficiency than the current static granting mechanisms.

1.2.3 Effectiveness of dynamic bandwidth assignment

A Dynamic Bandwidth Assignment (DBA) mechanism improves the efficiency of the PON upstream bandwidth by dynamically adjusting the bandwidth among the ONUs/ONTs in response to ONU/ONT bursty traffic requirements. The practical benefits of DBA are twofold. First, the network operators can add more subscribers to the PON due to more efficient bandwidth use. Second, the subscribers can enjoy enhanced services, such as those requiring bandwidth peaks that would extend beyond the traditional fixed allocation. A comparison between the current static mechanism and DBA is shown in Figure 1. Three ONUs/ONTs are represented and labelled No. 1, No. 2 and No. 3. ONU/ONT No. 1 requires constant bit rate traffic such as DBR Class 1, which is carried efficiently using the static bandwidth assignment method. ONU/ONT No. 2 and ONU/ONT No. 3, however, both have bursts of traffic; traffic from ONU/ONT No. 3 also has delay requirements. With static bandwidth allocation (shown in Figure 1 a)), traffic from ONU/ONT No. 2 would be lost and traffic from ONU/ONT No. 3 would be delayed. The efficiency of DBA is shown in Figure 1 b)), where ONU/ONT No. 3 is dynamically assigned enough bandwidth to carry its traffic burst, followed by ONU/ONT No. 2 being dynamically assigned sufficient bandwidth for its traffic.

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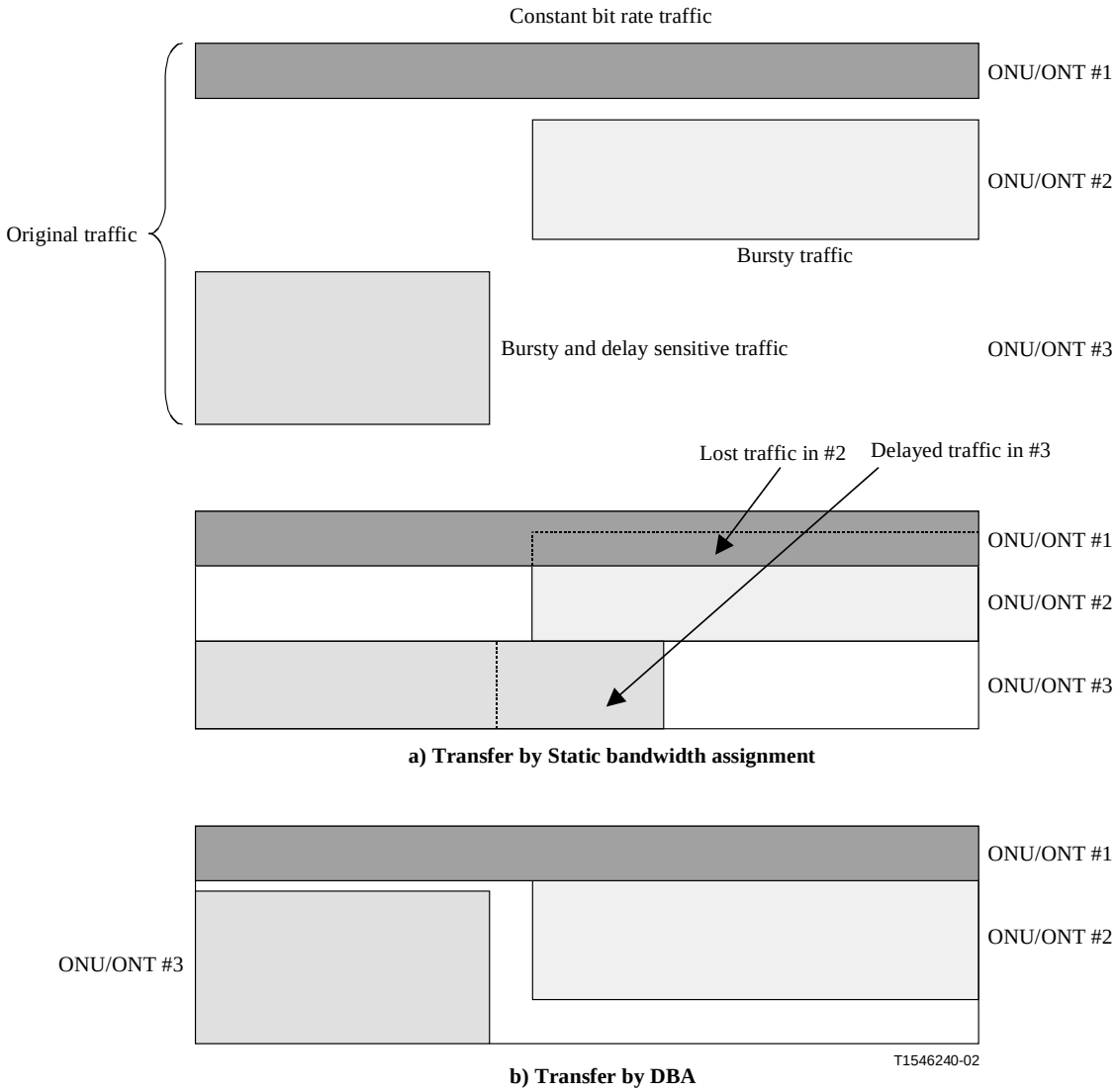


Figure 1/G.983.4 – Comparison between the current mechanism and DBA

1.2.4 General DBA approaches

Two different DBA mechanisms are summarized below.

Method one is referred to as "idle cell adjustment". In this approach, the OLT monitors the bandwidth used by each of the ONUs/ONTs. If the utilization exceeds a predefined threshold, then additional bandwidth will be assigned if it is available. In this approach, no bandwidth resources are needed for the ONU/ONT to report status; the OLT infers individual ONU/ONT bandwidth needs from the current utilization. However, a possible drawback of this approach would be slow reaction to ONUs/ONTs requesting upstream bandwidth.

Method two is called "buffer status reporting". ONUs/ONTs using this approach report the status of their buffers by using mini-slots. The OLT reassigns the bandwidth according to the ONU/ONT reports.

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1.2.5 Features and Migration scenarios for DBA

Other features of DBA include the ability to accommodate several Transmission Containers (T-CONTs) in one ONU/ONT. T-CONTs in an ONU/ONT can operate independently of one another. The DBA mechanism associates grant characteristics to a T-CONT type classification. This classification enables the PON to better handle traffic flows that have similar characteristics. This classification is not intended, in any way or form, to change the related ITU-T Recommendations concerning ATM services.

The introduction of DBA into a system can be broken down into several steps. In the first step, an OLT with DBA capability is installed into a system that previously had no DBA capability. With no DBA capability, the system ONUs/ONTs do not explicitly report their buffer status and are called Non-Status-Reporting ONUs/ONTs (NSR-ONUs/ONTs). The OLT can use the idle cell adjustment approach for DBA. Next, ONUs/ONTs with buffer status reporting capability – called Status Reporting ONUs/ONTs (SR-ONUs/ONTs) – can be installed and the OLT can use the buffer status reports to allocate bandwidth to the ONUs/ONTs. DBA must also operate in a mixed case of NSR-ONUs/ONTs and SR-ONUs/ONTs. Moreover, if we define multiple T-CONTs in one ONU/ONT, DBA can provide more complicated services.

1.2.6 Requirements for this Recommendation

This Recommendation is needed to ensure interoperability between OLTs and ONUs/ONTs where one or more OLTs and/or ONUs/ONTs on a PON use DBA functionality. The specifications, including the PON frame formats and existing PLOAM cell format and message types, are consistent with ITU-T Rec. G.983.1 whenever possible. Full compatibility is required between DBA-capable and non-DBA-capable elements. Specifically the following combinations must be supported:

– NSR-ONUs/ONTs must interoperate with non-DBA-OLTs (a non-DBA system).

– NSR-ONUs/ONTs must interoperate with DBA-OLTs (idle cell monitoring).

– SR-ONUs/ONTs must interoperate with non-DBA OLTs (by disabling ONU/ONT status reporting).

– SR-ONUs/ONTs must interoperate with DBA-OLTs (status reporting DBA or idle cell monitoring).

In addition, both non-DBA-OLTs and DBA-OLTs must be able to support a mixture of NSR-ONUs/ONTs and SR-ONUs/ONTs on the same PON. The detailed operations in these combinations are described in 8.3.5.10.5.

The following items are included in this Recommendation:

The method for reporting ONU/ONT status is defined for SR-ONUs/ONTs.

The definition of T-CONT types, including support for variable rate services.

Performance benchmarks are addressed for:

– ONU/ONT bandwidth request detection.

– ONU/ONT bandwidth request reporting.

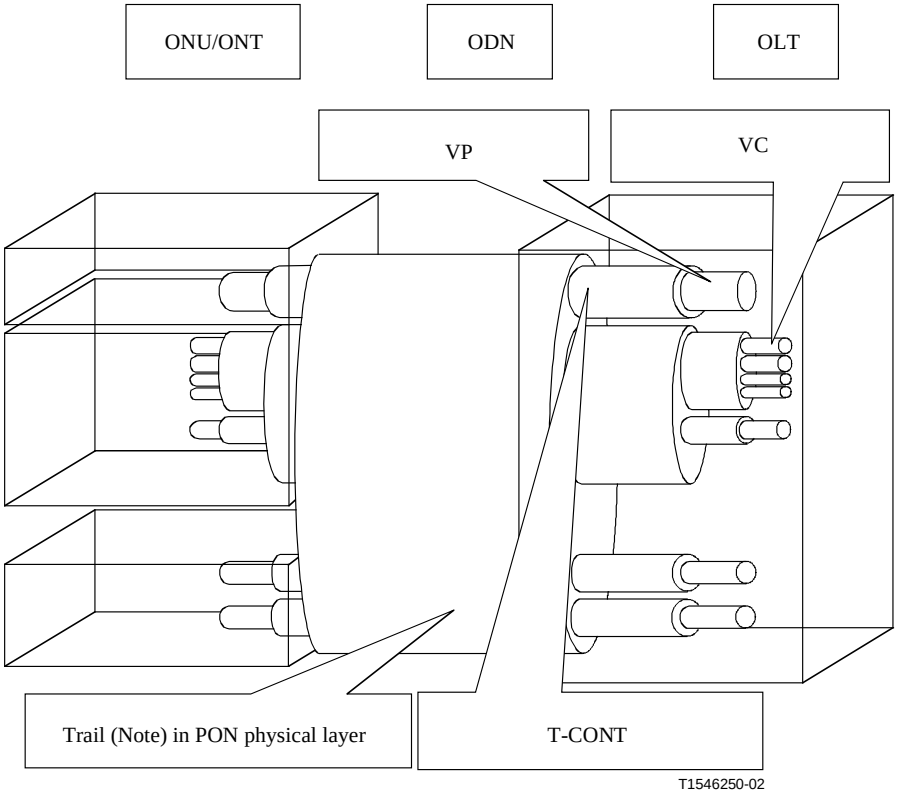
– OLT grant recalculation and distribution.

The number of types and definitions of T-CONTs are described.

1.2.7 Layered architecture

As previewed in ITU-T Rec. G.983.1, DBA is a Transmission Convergence layer function, not an ATM layer function. Figure 2 shows an example of the layered architecture.

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NOTE – Physical layer Trail includes the point to multi-points relationship between OLT and ONUs/ONTs

Figure 2/G.983.4 – The layer architecture in PON

1.3 Architectural Drawing

A single queue and multiple queues feeding a single T-CONT Buffer are shown in Figures 3 and 4.

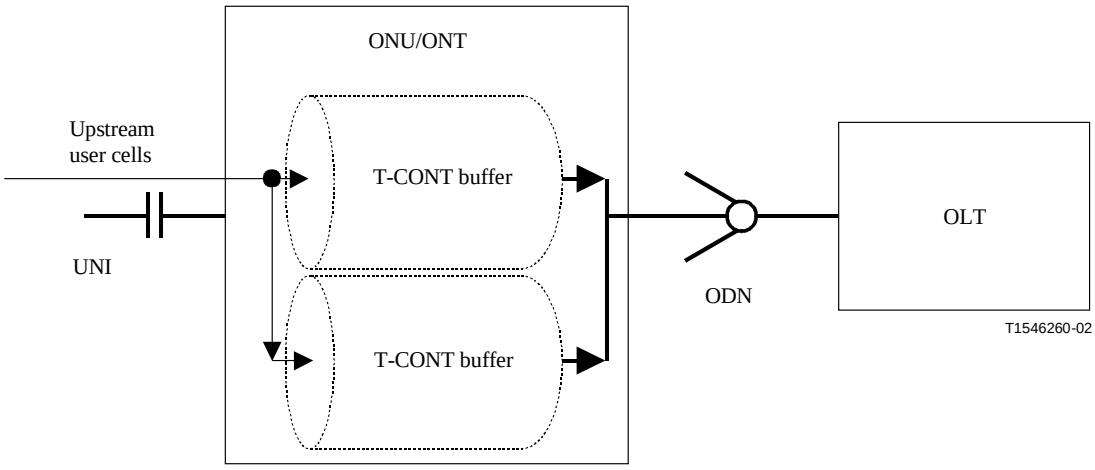


Figure 3/G.983.4 – Configurations of T-CONT buffers in one ONU/ONT

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In Figure 3, an ONU/ONT supports one or more T-CONT buffers that are the object of data grants by an OLT regardless of any internal mechanism as shown in Figure 4.

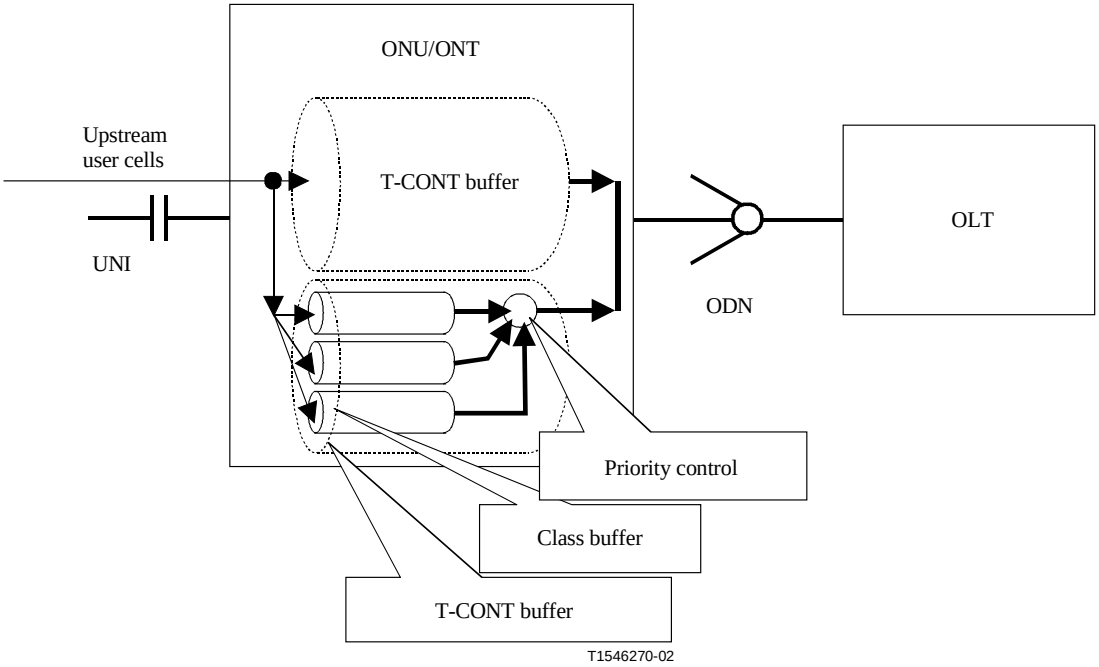


Figure 4/G.983.4 – An example of internal mechanisms in a T-CONT buffer

In Figure 4, some T-CONT buffers are serviced by an internal scheduler or some other mechanism in an upper layer (for example, the ATM layer). This figure shows one T-CONT buffer with no internal scheduler and one T-CONT buffer that consists of one or more traffic class buffers. In some applications, a priority control mechanism is used.

1.4 T-CONT priority hierarchy

The priority hierarchy for data grants to T-CONTs is shown in Figure 5.

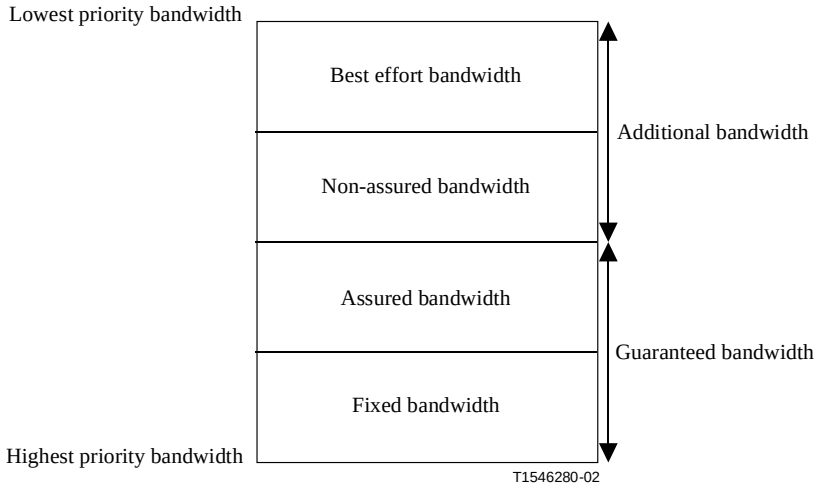


Figure 5/G.983.4 – Priority of bandwidth for grant allocation

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1.5 Objectives

When providing DBA functionality the following objectives should be observed.

Compatibility should be maintained with ITU-T Rec. G.983.1 and ITU-T Rec. G.983.2:

– A single PON will support both SR-ONUs/ONTs and NSR-ONUs/ONTs.

The cost to implement DBA should remain as low as possible:

– Cost includes the overall system.

– Strategies that add cost to all ONUs/ONTs (for example requiring excessively large memory buffers at the ONU/ONT) are less desirable.

Equipment from different vendors should interoperate.

ATM traffic contracts should be met for each ATM connection in all T-CONTs:

Grants from the OLT to the T-CONTs on a PON should be equitably distributed.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provision of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the mos recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

[1] ITU-T Recommendation G.652 (2000), *Characteristics of a single-mode optical fibre cable.*

[2] ITU-T Recommendation G.671 (2001), *Transmission characteristics of optical components and subsystems*.

[3] ITU-T Recommendation G.783 (2000), *Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks.*

[4] ITU-T Recommendation G.902 (1995), *Framework Recommendation on functional access networks (AN) – Architecture and functions, access types, management and service node aspects.*

[5] ITU-T Recommendation G.957 (1999), *Optical interfaces for equipments and systems relating to the synchronous digital hierarchy.*

[6] ITU-T Recommendation G.958 (1994), *Digital line systems based on the synchronous digital hierarchy for use on optical fibre cables.*

[7] ITU-T Recommendation G.982 (1996), *Optical access networks to support services up to the ISDN primary rate or equivalent bit rates.*

[8] ITU-T Recommendation G.983.1 (1998), *Broadband optical access systems based on Passive Optical Networks (PON).*

[9] ITU-T Recommendation G.983.2 (2000), *ONT management and control interface specification for ATM-PON.*

[10] ITU-T Recommendation I.321 (1991), *B-ISDN protocol reference model and its application.*

[11] ITU-T Recommendation I.326 (1995), *Functional architecture of transport networks based on ATM.*

[12] ITU-T Recommendation I.356 (2000), *B-ISDN ATM layer cell transfer performance.*

[13] ITU-T Recommendation I.361 (1999), *B-ISDN ATM layer specification.*

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[14] ITU-T Recommendation I.371 (2000), *Traffic control and congestion control in B-ISDN.*

[15] ITU-T Recommendation I.371.1 (2000), *Guaranteed frame rate ATM transfer capability.*

[16] ITU-T Recommendation I.432.1 (1999), *B-ISDN user-network interface – Physical layer specification: General characteristics.*

[17] ITU-T Recommendation I.610 (1999), *B-ISDN operation and maintenance principles and functions.*

[18] ITU-T Recommendation I.732 (2000), *Functional characteristics of ATM equipment.*

[19] ITU-T Recommendation I.751 (1996), *Asynchronous transfer mode management of the network element view.*

3 Abbreviations

This Recommendation uses the following abbreviations:

AF	Adaptation Function
AN	Access Network
APS	Automatic Protection Switching
ATC	ATM Transfer Capability
ATM	Asynchronous Transfer Mode
BER	Bit Error Ratio
BIP	Bit Interleaved Parity
B-ISDN	Broadband Integrated Services Digital Network
B-PON	Broadband Passive Optical Network
CID	Consecutive Identical Digit
CPE	Cell Phase Error
CRC	Cyclic Redundancy Check
DBA	Dynamic Bandwidth Assignment
DSL	Digital Subscriber Line
E/O	Electrical/Optical
FTTB/C	Fibre to the Building/Curb
FTTCab	Fibre to the Cabinet
FTTH	Fibre to the Home
HEC	Header Error Control
IEC	International Electrotechnical Commission
ISDN	Integrated Services Digital Network
LAN	Local Area Network
LCD	Loss of Cell Delineation
LCF	Laser Control Field
LSB	Least Significant Bit
LT	Line Terminal

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MAC	Media Access Control
MSB	Most Significant Bit
NSR	Non Status Reporting
NT	Network Termination
OAM	Operations Administration and Maintenance
OAN	Optical Access Network
ODF	Optical Distribution Frame
ODN	Optical Distribution Network
OLT	Optical Line Termination
ONT	Optical Network Termination
ONU	Optical Network Unit
OpS	Operations System
PLOAM	Physical Layer OAM
PON	Passive Optical Network
PRBS	Pseudo Random Bit Sequence
PST	PON Section Trace
PSTN	Public Switched Telephone Network
QoS	Quality of Service
RAU	Request Access Unit
RMS	Root Mean Square
SDH	Synchronous Digital Hierarchy
SN	Serial Number
SNI	Service Node Interface
SR	Status Reporting
TC	Transmission Convergence
T-CONT	Transmission Container
TDMA	Time Division Multiple Access
UI	Unit Interval
UNI	User Network Interface
UPC	Usage Parameter Control
VC	Virtual Channel
VCC	Virtual Channel Connection
VCI	Virtual Channel Identifier
VoD	Video-on-Demand
VP	Virtual Path
VPC	Virtual Path Connection

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VPG Virtual Path Group

VPI Virtual Path Identifier

WRR Weighted Round Robin

4 Definitions

This Recommendation defines the following terms:

4.1 additional bandwidth: Additional Bandwidth is the summation of Non-assured Bandwidth and Best Effort Bandwidth.

4.2 assured bandwidth: Assured Bandwidth is bandwidth that is always available to the ONU/ONT if the T-CONT buffer is expected to have cells to transmit. If the T-CONT buffer does not have cells to transmit, this bandwidth may be used by other T-CONTs. Assured Bandwidth is therefore able to participate in DBA.

4.3 best effort bandwidth: Best Effort Bandwidth is bandwidth that a T-CONT may be able to use if no higher-priority traffic consumes the bandwidth; there is no assurance or guarantee that the bandwidth will be available. Best Effort Bandwidth is able to participate in DBA.

4.4 broadband passive optical network (B-PON): B-PONs are one-to-many broadband optical transmission systems. B-PONs can transparently transport any type of data, for example voice, video, IP data, etc. The B-PON is able to carry data regardless of the type of data link frame (i.e. not only native ATM but also HDLC Ethernet frame, etc.).

4.5 churning: Churning is a function that can be applied to the downstream user data from an OLT to its ONUs/ONTs. Churning provides the necessary function of data scrambling and offers a low level of protection for data confidentiality. It is installed at the TC layer of the ATM-PON system and can be activated for point-to-point downstream connections.

4.6 data grant: A data grant is sent from an OLT to a T-CONT in an ONU/ONT and indicates permission for the T-CONT to transmit an upstream cell.

4.7 dynamic bandwidth assignment (**DBA)**: is the process by which ONUs/ONTs (and their associated T-CONTs) dynamically request upstream bandwidth (either implicitly or explicitly) and the method, through idle cell monitoring at OLT or buffer status reporting from ONUs/ONTs to OLT, the OLT reassigns upstream bandwidth accordingly.

4.8 DBA-OLT: An OLT that is able to provide DBA functionality on one or more PONs.

4.9 diplex working: Bidirectional communication using a different wavelength for each direction of transmission over a single fibre.

4.10 duplex working: Bidirectional communication using the same wavelength for both directions of transmission over a single fibre.

4.11 fixed bandwidth: Fixed Bandwidth is entirely reserved and cyclically allocated in order to achieve a low cell transfer delay. If a T-CONT is provisioned with Fixed Bandwidth and has no cells to send, grants associated with the Fixed Bandwidth are still sent from the OLT and consequently idle cells will be sent upstream from the ONU/ONT to the OLT.

4.12 guaranteed bandwidth: Guaranteed Bandwidth is the summation of Assured Bandwidth and Fixed Bandwidth.

4.13 logical reach: The logical reach is defined as the maximum length that can be achieved for a particular transmission system independent of optical budget.

4.14 maximum bandwidth: Maximum Bandwidth is the upper limit of bandwidth to be assigned to a T-CONT and is the sum of Guaranteed Bandwidth and the upper limit of Additional Bandwidth.

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4.15 mean signal transfer delay: The average upstream and downstream delay values between reference points "V" and "T" in Figure 7; a given value is determined by measuring round-trip delay, then dividing by 2.

4.16 non-DBA-OLT: An OLT that does not provide DBA services but conforms to the existing ITU-T Rec. G.983.1 and G.983.2.

4.17 non-assured bandwidth: Non-assured Bandwidth is a high priority variation of Additional Bandwidth that is assigned to T-CONTs with Assured Bandwidth. Non-assured bandwidth is able to participate in DBA.

4.18 Non-Status Reporting ONU/ONT (NSR-ONU/ONT): ONUs/ONTs that do not communicate their bandwidth needs and requirements to a DBA-OLT. All ONUs/ONTs conforming to ITU-T Recs. G.983.1 and G.983.2 but that do not report buffer status are NSR-ONUs/ONTs.

4.19 Optical Access Network (OAN): The set of access links sharing the same network-side interfaces and supported by optical access transmission systems. The OAN may include a number of ODNs connected to the same OLT.

4.20 Optical Distribution Network (ODN): An ODN provides the optical transport between the OLT and its associated ONUs/ONTs. It uses passive optical components.

4.21 Optical Line Termination (OLT): An OLT provides the network-side interface of the OAN, and is connected to one or more ODNs.

4.22 Optical Network Termination (ONT): An ONT provides the customer-side interface for the OAN, and is connected to one ODN. An ONT is used for FTTH and includes the User Port function. From a DBA point of view, ONT and ONU are identical and are represented by the term "ONU/ONT" in this Recommendation.

4.23 Optical Network Unit (ONU): An ONU provides (directly or remotely) the user-side interface of the OAN, and is connected to the ODN. From a DBA point of view, ONU and ONT are identical and are represented by the term "ONU/ONT" in this Recommendation.

4.24 QoS class: In the context of ATM services, QoS refers to a set of performance parameters that constitute the traffic contract between the subscriber equipment and the network. Examples of these performance parameters include, cell loss ratio, cell transfer delay, and cell delay variation tolerance. The parameters are used to define distinct QoS classes.

4.25 ranging: Ranging is a method of measuring the logical distance between each ONU/ONT and its associated OLT and determining the transmission timing such that upstream cells sent from different ONUs/ONTs on the same ODN do not collide.

4.26 service port function: The Service Port Function (SPF) adapts the requirements defined for a specific SNI to the common bearers handling function and selects the relevant information for treatment in the AN system management function.

4.27 Status Reporting ONU/ONT (SR-ONU/ONT): An ONU/ONT that reports the status of its T-CONT buffers to a DBA-OLT.

4.28 surplus bandwidth: Surplus Bandwidth is PON bandwidth not committed to Fixed Bandwidth or Assured Bandwidth or bandwidth reserved for special usage like OAM. Surplus Bandwidth is able to participate in DBA.

4.29 Transmission Containers (T-CONTs): T-CONTs are used for the management of upstream bandwidth allocation in the PON section of the Transmission Convergence layer. T-CONTs are primarily used to improve the upstream bandwidth use on the PON.

– T-CONTs carry ATM VPCs and VCCs and report their buffer status to their associated OLTs.

– T-CONTs dynamically receive grants from the OLT.

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– A single T-CONT can carry ATM traffic with various service classes and VCCs and/or VPCs.
– A T-CONT can accommodate one or more physical queues and aggregates them into a single logical buffer.
– A DBA-T-CONT status report summarizes the status of the logical buffer of that T-CONT.
– A T-CONT is a transport entity in the TC layer that transfers higher-layer information transparently from input to output.
– Information traversing a T-CONT is unchanged except where degradation occurs in the transfer process.
– A data grant is associated with one and only one T-CONT. T-CONTs physically occur in the ONU/ONT hardware and software.

See subclause 8.3.5.10.2 T-CONT types for detailed T-CONT definition and examples. This subclause also details the T-CONT sub-types.

4.30 Time Division Multiple Access (TDMA): Transmission technique that allocates specific timeslot(s) to each traffic source that shares a transmission medium.

4.31 user port function: The User Port Function (UPF) adapts the specific UNI requirements to the core and management functions. The AN may support a number of different accesses and user network interfaces which require specific functions according to the relevant interface specification and the access bearer capability requirements, i.e. bearers for information transfer and protocols.

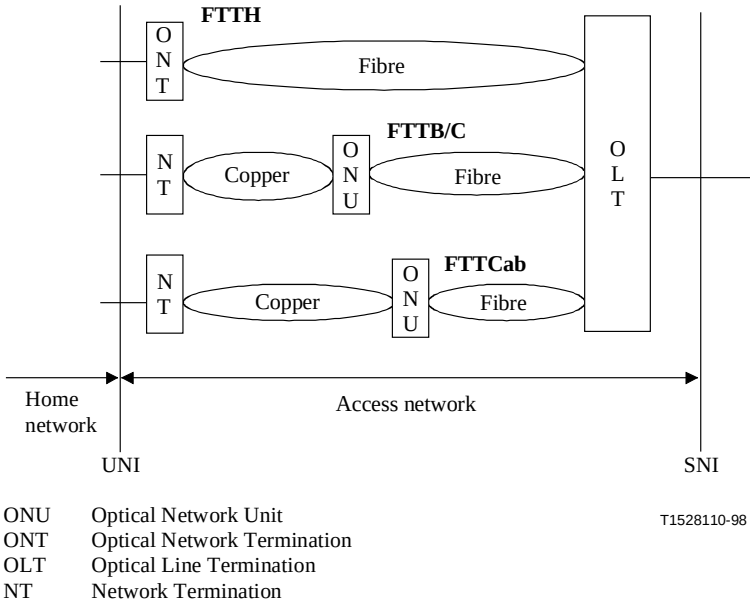
4.32 verification: It is possible for a malicious user to masquerade as another ONU/ONT and use the network if the user knows that the ONU/ONT is power-off. Verification is a function to check whether the connected ONU/ONT is masquerading.

5 Architecture of the optical access network

5.1 Network architecture

The optical section of a local access network system could be either point-to-point, point-to-multipoint, active, or passive. Figure 6 shows the architectures considered, which range from Fibre to the Home (FTTH), through Fibre to the Building/Curb (FTTB/C) to Fibre to the Cabinet (FTTCab). The Optical Access Network (OAN) is common to all architectures shown in Figure 6, hence commonality in this system has the potential to generate large worldwide volumes.

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ONU Optical Network Unit
ONT Optical Network Termination
OLT Optical Line Termination
NT Network Termination

Figure 6/G.983.4 – Network architecture

The FTTB/C and FTTCab network options are predominantly different only as a result of implementation, as a result they can be treated the same in this Recommendation. Protocols supported by ONTs on the fibre are the same as those supported by ONUs. In this Recommendation, ONU and ONT are represented as "ONU/ONT".

5.1.1 FTTCab/C/B scenario

Within this scenario the following service categories have been considered:

– Asymmetric broadband services (e.g. digital broadcast services, VoD, Internet, distance learning, telemedicine, etc.).

– Symmetric broadband services (e.g. telecommunication services for small business customers, teleconsulting, etc.).

– PSTN and ISDN. The access network must be able to provide, in a flexible way, the narrowband telephone services.

5.1.2 FTTH scenario

Fibre-to-the-Home service drivers are similar to those of the previous scenarios and include:

– Consideration of indoor ONUs/ONTs resulting from more favourable environmental conditions.

– No change of an existing ONU/ONT is required when upgrading access network capabilities to accommodate future evolution of broadband and multimedia services.

– Easier maintenance resulting from a passive fibre plant between the OLT and ONUs/ONTs, because fibre systems are regarded as more reliable than hybrid fibre-metallic systems.

– FTTH is a driver for the development of advanced optoelectronics technologies. The higher volumes associated with FTTH should help reduce the costs of optoelectronic components.

When these factors can be fully used they may counterbalance a slightly higher per line cost when compared to metallic alternatives. In this situation the FTTH scenario may be regarded as economically feasible even in the short term.

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5.1.3 DBA installations Scenario for FTTx

DBA can be installed for FTTx to increase availability of bandwidth by dynamically allocating all or part of the upstream bandwidth among the ONUs/ONTs. In short, DBA can provide higher performance for services in the FTTx systems specified in 5.1.1 and 5.1.2. DBA should allow the network to accommodate more users than in a non-DBA FTTx system. Bursty data applications should benefit significantly from DBA.

5.1.3.1 Compatibility between DBA and conventional systems specified in G.983.1

Systems and components that are controlled by DBA shall maintain backward compatibility and interoperability with existing systems that conform to ITU-T Rec. G.983.1. In particular, interoperability is required for the following combinations:

– A DBA-OLT can be replaced by a Non-DBA-OLT that supports NSR-ONUs/ONTs without modification of network design.

– A DBA-OLT shall be able to distinguish between NSR-ONUs/ONTs and SR-ONUs/ONTs without modification to the NSR-ONUs/ONTs.

– A DBA-OLT running in non-DBA mode shall have the same downstream capabilities and provide the same environment as a non-DBA-OLT. Detailed operations of combined configurations for OLTs and ONUs/ONTs are described in 8.3.5.10.5.

5.1.3.2 Interoperability in multi-vendor environment

Multi-vendor interoperability shall be required for all OLTs and ONUs/ONTs. The following requirements should be met:

– A DBA-OLT shall dynamically and fairly allocate bandwidth on a PON that includes NSR-ONUs/ONTs from different vendors.

– A DBA-OLT shall dynamically and fairly allocate bandwidth on a PON that includes SR-ONUs/ONTs from different vendors as long as these SR-ONUs/ONTs conform to the status reporting technique specified in this Recommendation.

– A DBA-OLT shall dynamically and fairly allocate bandwidth on a PON to any combinations of NSR-ONUs/ONTs and SR-ONUs/ONTs from different vendors.

5.2 Reference configuration

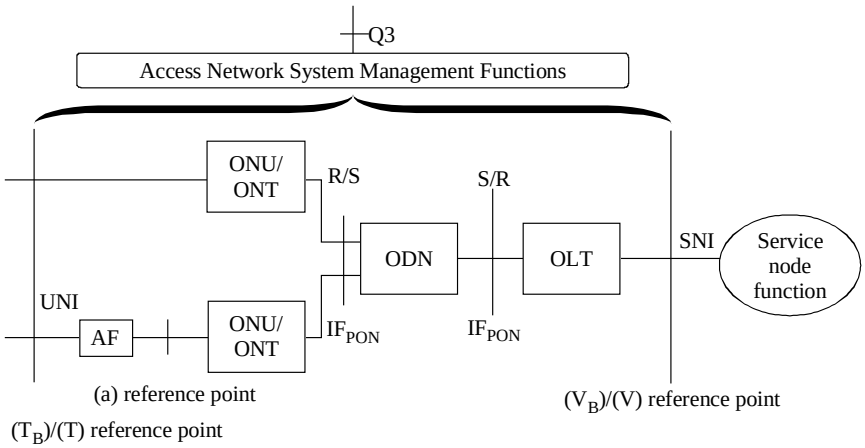
The reference configuration is shown in Figure 7.

The ODN offers one or more optical paths between one OLT and one or more ONUs/ONTs. Each optical path is defined between reference points S and R in a specific wavelength window. The two directions for optical transmission in the ODN are identified as follows:

– downstream direction is defined as the direction of flow of information from the OLT to the ONU/ONT(s);

– upstream direction is defined as the direction of flow of information from the ONU/ONT(s)to the OLT.

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(a)	Reference point – This reference point is added to differentiate the AF from the ONU
AF	Adaptation Function
ODN	Optical Distribution Network
OLT	Optical Line Termination
ONT	Optical Network Termination
ONU	Optical Network Unit
R	Point on the optical fibre just before the ONU/ONT[Downstream] or OLT[Upstream] optical point (i.e. optical connector or optical splice)
S	Point on the optical fibre just after the OLT[Downstream] or ONU/ONT[Upstream] optical point (i.e. optical connector or optical splice)

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Figure 7/G.983.4 – Reference configuration for an ATM based PON

The B-PON system consists of Optical Line Termination (OLT), Optical Network Unit/Optical Network Termination (ONU/ONT), fibre cable, and one or more passive optical splitter(s). Light from the OLT is passively split and distributed to multiple ONUs/ONTs on the ODN. Since each ONU/ONT receives all the information emanating downstream from the OLT, additional capabilities are required to provide privacy and security. In the upstream direction a Time-Division Multiple Access (TDMA) protocol is required.

5.2.1 Service node interface

See ITU-T Rec. G.902.

5.2.2 Interface at the reference points S/R and R/S

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 the transmission between OLT and ONUs/ONTs.

5.3 Functional blocks

5.3.1 Optical line termination

The optical line termination (OLT) interfaces to services nodes via the SNI and to the ONUs/ONTs via the ODN. The OLT is responsible for managing all the PON specific aspects of the ATM transport system. An ONU/ONT and its associated OLT provide transparent ATM transport service between the UNIs and the SNI over the PON. Both Non-DBA-OLTs and DBA-OLTs are covered in this Recommendation.

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5.3.1.1 Non-DBA-OLT

This type of OLT supports functions specified in ITU-T Rec. G.983.1.

5.3.1.2 DBA-OLT

A DBA-OLT is capable of assigning upstream bandwidth dynamically based on the service contracts of data traffic in the active T-CONTs, the requested bandwidth of the T-CONTs, and the available bandwidth upstream on the PON. In general, operations for DBA can be categorized into three approaches as follows:

In the first approach, a DBA-OLT updates allocated bandwidth depending on traffic monitoring in the DBA-OLT.

In the second case, the DBA-OLT updates allocated bandwidth based on reports from SR-ONUs/ONTs.

The third case, the DBA-OLT updates allocated bandwidth based on the combination of the traffic monitoring in the DBA-OLT and reports from SR-ONUs/ONTs.

5.3.2 Optical network unit/optical network termination

The ONU/ONT interfaces over the IF_{PON} to the OLT, and to the UNI. Together with the OLT, the ONU/ONT is responsible for providing transparent ATM transport service between the UNI and the SNI.

In this architecture, the ATM transport protocols at an IF_{PON} are described as consisting of Physical Media Dependent layer, Transmission Convergence layer, and ATM layer. This architecture is only intended to address the transport of ATM; further detail is contained in ITU-T Rec. I.732.

The Physical Media Dependent layer includes the modulation schemes for both the upstream and downstream channels (they may be different). It may be possible for the specification to allow for more than one type of Physical Media Dependent layer in a single direction.

The Transmission Convergence layer will be responsible for managing the distributed access to the upstream PON resource across the multiple ONUs/ONTs. This is a key protocol element and will directly affect the resulting ATM QoS.

The ATM protocols should see no change in the way they operate over the PON. Within both the OLT and the ONU/ONT functions performed at the ATM layer at both the OLT and ONU/ONT include cell relaying.

In this Recommendation, ONUs/ONTs are classified into two types: SR-ONU/ONT and NSR-ONU/ONT. These are defined in the following clauses.

5.3.2.1 NSR-ONU/ONT

NSR-ONUs/ONTs do not report T-CONT buffer status explicitly. ONUs/ONTs specified in ITU-T Rec. G.983.1 are NSR-ONUs/ONTs.

5.3.2.2 SR-ONU/ONT

An SR-ONU/ONT reports the status of its T-CONT buffers to the OLT.

5.3.3 Optical distribution network

The Optical Distribution Network provides the optical transport between the OLT and its associated ONUs/ONTs. It uses passive optical components.

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5.4 ONU/ONT functional block

As an example, the FTTH ONU/ONT is active and decouples the access network delivery mechanism from the in-house distribution. The ONU/ONT core consists of ODN interface, User Port, Transmission, Services and Customers Multiplexing (MUX)/demultiplexing functions and powering, see Figure 8.

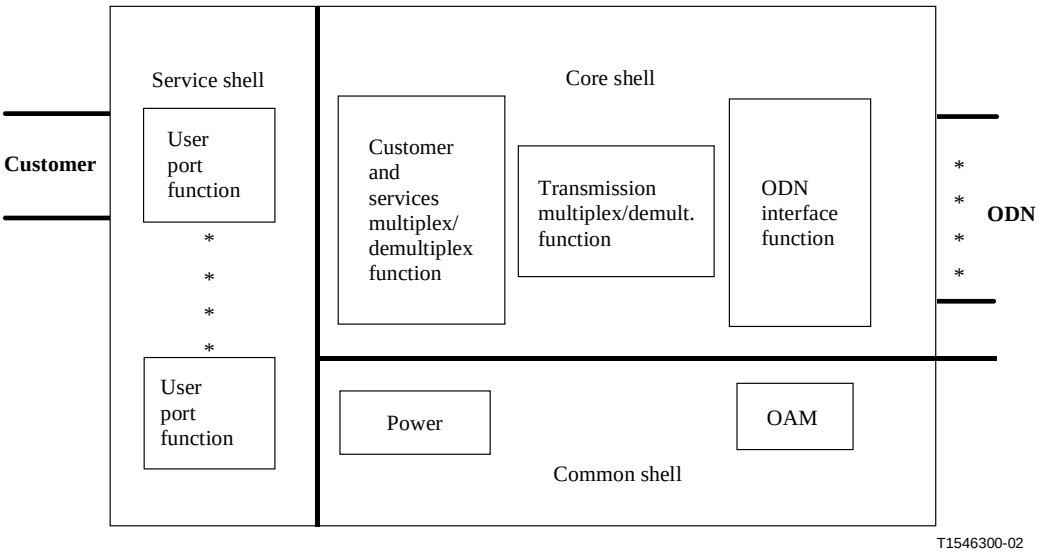


Figure 8/G.983.4 – Example of NSR-ONU/ONT functional blocks

5.4.1 NSR-ONU/ONT functional block

5.4.1.1 Optical Distribution Network interface

The ODN interface handles the optoelectronic conversion process. The ODN interface extracts ATM cells from the downstream PON payload and inserts ATM cells into the upstream PON payload based on synchronization acquired from the downstream frame timing. Moreover, if multiple T-CONTs exist in one ONU/ONT, these operations are invoked for every T-CONT.

5.4.1.2 Multiplexing

The multiplexer (MUX) multiplexes service interfaces to the ODN interface. Only valid ATM cells can be passed through the MUX, so many VPs can share the assigned upstream bandwidth effectively. Moreover, if multiple T-CONTs exist in one ONU/ONT, these operations are invoked for every T-CONT.

5.4.1.3 User port

The specific information is described in ITU-T Rec. G.983.1.

5.4.1.4 ONU/ONT powering

The specific information is described in ITU-T Rec. G.983.1.

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5.4.2 SR-ONU/ONT functional block

The FTTH ONU/ONT is active and decouples the access network delivery mechanism from the in-house distribution. The ONU/ONT core consists of the ODN interface, User Port, Transmission, Services and Customers Multiplexing (MUX)/demultiplexing functions, status reporting function, detecting function, and powering, see Figure 9.

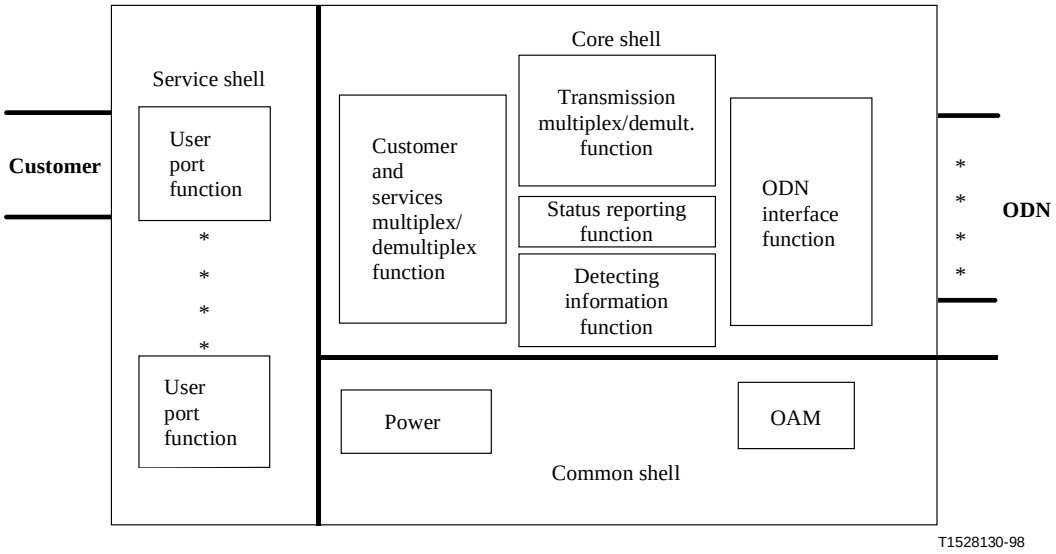


Figure 9/G.983.4 – Example of SR-ONU/ONT functional blocks

5.4.2.1 Optical Distribution Network interface

The ODN interface handles the optoelectronic conversion process. The ODN interface extracts ATM cells from the downstream PON payload and inserts ATM cells into the upstream PON payload based on synchronization acquired from the downstream frame timing. Moreover, if multiple T-CONTs exist in one ONU/ONT, these operations are invoked for every T-CONT.

5.4.2.2 Multiplexing

The multiplexer (MUX) multiplexes service interfaces to the ODN interface. Only valid ATM cells can be passed through the MUX, so many VPs can share the assigned upstream bandwidth effectively. Moreover, if multiple T-CONTs are contained in one ONU/ONT, these operations are invoked in every T-CONT.

5.4.2.3 User port

The specific information is described in ITU-T Rec. G.983.1.

5.4.2.4 ONU/ONT powering

The specific information is described in ITU-T Rec. G.983.1.

5.4.2.5 Reporting function

A DBA reporting function provides information indicating the bandwidth request status in every T-CONT to the DBA-OLT. Variations of the DBA reporting methods and format are described in 8.3.5.10.1.3.

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5.4.2.6 Detecting function

The SR-ONU/ONT is capable of performing the status detecting function by monitoring each T-CONT in the SR-ONU/ONT. The queue status of a T-CONT in the ONU/ONT can be detected using this function.

5.5 Optical Line Termination functional block

5.5.1 Non-DBA-OLT functional block

The OLT is connected to switched networks via standardized interfaces (VB5.x, V5.x, and NNI's). At the distribution side, it presents optical access according to the agreed requirements, in terms of bit rate, power budget, etc.

The OLT consists of four parts: the service port function; ODN interface; MUX for VP grooming, and static grant assignment (see Figure 10). This combination is not intended to preclude the Virtual Channel (VC) layer function in the OLT. VC layer function is for further study.

1) *Service port function*

   The function interfaces to service nodes. The service port function may handle inserting ATM cells into the upstream SDH payload and extracting ATM cells from the downstream SDH payload. The function may be duplicated, in which case the protection switching function is necessary.

2) *MUX*

   The MUX provides VP connections between the service port function and the ODN interface. Different VPs are assigned to different services at IF_{PON}. Various types of information such as bearer content, signalling, and OAM flows are exchanged by using VCs of the VP.

3) *ODN interface*

   The PON Line Terminal handles the optoelectronic conversion process. The ODN interface handles inserting ATM cells into the downstream PON payload and extracting ATM cells from the upstream PON payload. The difference in functional blocks between Non-DBA-OLT and DBA-OLT is the functionality of Media Access Control (MAC) in ODN interface. For a Non-DBA-OLT, the MAC assigns grants to each T-CONT contained in one ODN according to the T-CONT's contracted service.

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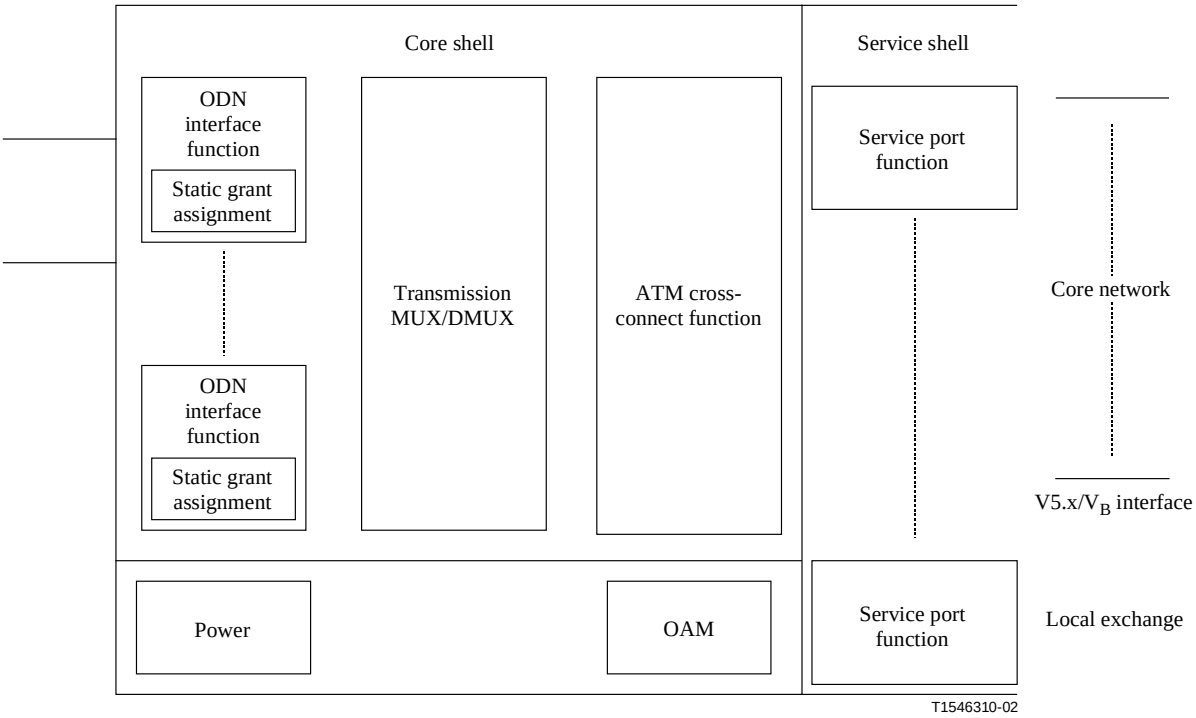


Figure 10/G.983.4 – Example of Non-DBA-OLT functional blocks

5.5.2 DBA-OLT functional block

The DBA-OLT shares many identical functional blocks with the Non-DBA-OLT (see Figure 11). In short, it is connected to the same networks via the same interfaces as the Non-DBA-OLT.

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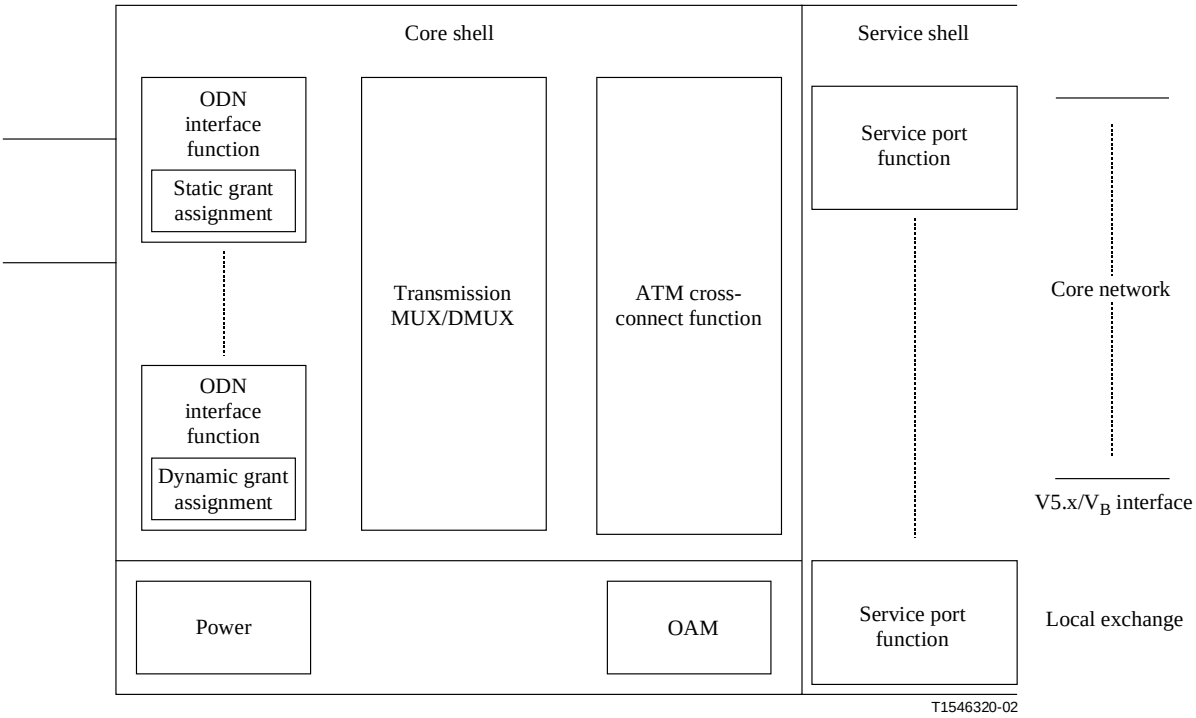


Figure 11/G.983.4 – Example of DBA-OLT functional blocks

The difference between the functional blocks of a Non-DBA-OLT and a DBA-OLT is grant assignment on the ODN interface. In a DBA-OLT, the MAC assigns grants to individual T-CONTs on one ODN statically and/or dynamically according to the contract of these T-CONTs and/or their bandwidth request status. Bandwidth request status is collected from ONU/ONT reports and/or OLT surveillance of incoming cells. Moreover, it may be recognized by other methods, for example, bandwidth request from network interfaces.

5.6 Optical distribution network functional block

In general, the Optical Distribution Network (ODN) provides the optical transport between the ONUs/ONTs and their associated OLT.

Individual ODNs may be combined and extended through the use of optical amplifiers (see ITU-T Rec. Rec. G.982).

5.6.1 Passive optical elements

The ODN consists of passive optical elements:

– single-mode optical fibres and cables;
– optical fibre ribbons and ribbon cables;
– optical connectors;
– passive branching components;
– passive optical attenuators;
– splices.

The specific information required to describe passive optical components is described in ITU-T Rec. G.671.

The specific information for optical fibres and cable is described in ITU-T Rec. G.652.

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5.6.2 Optical interfaces

In the context of the reference configuration, Figure 12 shows the generic physical configuration of an ODN.

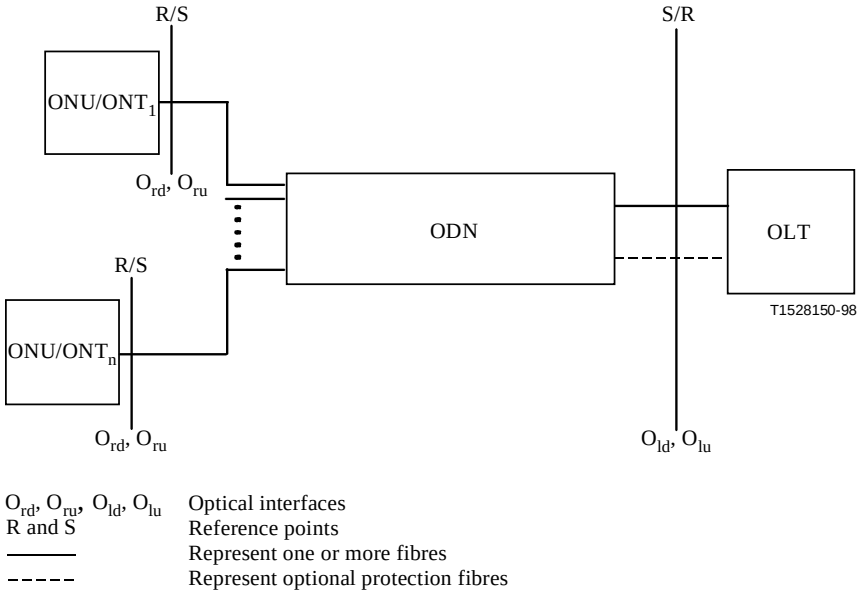


Figure 12/G.983.4 – Generic physical configuration of the Optical Distribution Network

The two directions for optical transmission in the ODN are identified as follows:

– downstream direction for signals travelling from the OLT to the ONU/ONT(s);

– upstream direction for signals travelling from the ONU/ONT(s) to the OLT.

Transmission in downstream and upstream directions can take place on the same fibre and components (duplex/diplex working) or on separate fibres and components (simplex working).

If additional connectors or other passive devices are needed for ODN rearrangement, they shall be located between S and R and their losses shall be taken into account in any optical loss calculation.

The ODN offers one or more optical paths between one OLT and one or more ONUs/ONTs. Each optical path is defined between reference points in a specific wavelength window.

The following optical interfaces are defined in Figure 12:

– O_{ru}, O_{rd} Optical interface at the reference point R/S between the ONU/ONT and the ODN for the upstream and downstream directions respectively.

– O_{lu}, O_{ld} Optical interfaces at the reference point S/R between the OLT and the ODN for the upstream and downstream directions respectively.

At the physical layer, the interfaces may require more than one fibre, e.g. for separation of transmission directions or different types of signals (services).

Specification of the optical interfaces (O_{ru}, O_{rd}, O_{lu}, O_{ld}) are defined in clause 8.

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The optical properties of the ODN shall enable the provisioning of any presently foreseeable service, without the need of extensive modifications to the ODN itself. This requirement has an impact on the properties of the passive optical components that constitute the ODN. A set of essential requirements, which have a direct influence on the optical properties of the ODN, are identified as follows:

– *optical wavelength transparency*: devices, such as optical branching devices, which are not intended to perform any wavelength-selective function, shall be able to support transmission of signals at any wavelength in the 1310 nm and 1550 nm regions;

– *reciprocity*: reversal of input and output ports shall not cause significant changes of the optical loss through the devices;

– *fibre compatibility*: all optical components shall be compatible with single-mode fibre as specified in ITU-T Rec. G.652.

5.6.2.1 Optical Distribution Network model loss calculations

This is described in ITU-T Rec. G.982.

5.6.2.2 Optical Distribution Network model loss calculation technique

This is described in ITU-T Rec. G.982.

6 Services

The high-speed access systems described in this Recommendation could provide the complete range of all currently known and new services being discussed for the residential subscribers and business customers. These services could include:

– Data communications, including LAN interconnection.

– Private Line services.

– Telephony.

– Entertainment video distribution and video conferencing.

– Electronic commerce and data transfer

These services imply a broad range of network requirements that include:

– bit rate;

– symmetry/asymmetry;

– delay;

– delay variation;

– transparent Virtual Paths;

– support for ATC/QoS.

In particular, even if DBA is installed to economize network resources, ATM services with any ATC/QoS over PON can be provided without degradation of criteria for quality as described in ITU-T Rec. I.356. Moreover, DBA produces benefits for carrying variable bit rate traffic, such as bursty traffic (e.g. SBR and GFR), which may be particularly useful for data communication and video communication.

What specific services should be provided differs among operators and depends heavily on the particular regulatory conditions in each operator's markets, as well as on market potential. How these services are delivered in a cost effective way is a function not only of legal conditions but also of factors including existing telecommunications infrastructure, dwelling distribution, customer density and residential/business customers mix.

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In spite of this varied market background there are some features that have been perceived as common to all parties. They can be summarized as follows:

– Some services require bit rates higher than those supported by PSTN and basic ISDN. These bit rates are best delivered on fibre based or fibre hybrid networks.

– As the services evolve and newer services are introduced the bandwidth and management requirements will increase. This requires the access network to be flexible and easily upgraded.

7 User network interface and service node Interface

The specific information is described in ITU-T Rec.G.983.1.

8 Optical network requirements

8.1 Layered structure of the optical network

Layering is based on ITU-T Rec. G.982. The ODN refers to the fibre distribution network based on passive optical splitter branching components. The OAN is the system between the "V" and "T" reference points (Figure 7). The ONU/ONT may have an adaptation function (AF), for digital subscriber line (DSL) transmission over copper to the customer. The OAN is managed as one element, through a Q3 management interface.

The protocol reference model is divided into physical medium, TC, and path layer (ITU-T Recs. G.902, I.326, and G.982). As an example an ATM-PON is shown in Table 1. In the ATM-PON network, path layer corresponds to the VP (Virtual Path) of the ATM layer.

Table 1/G.983.4 – Layered structure of ATM-PON Network

<table>
<tr><td colspan="3">Path layer</td><td>Refer to ITU-T Recs. I.732 and I.326</td></tr>
<tr><td rowspan="3">Transmission medium layer (Note)</td><td rowspan="2">TC layer</td><td>Adaptation</td><td>Refer to ITU-T Recs. I.732 and I.432</td></tr>
<tr><td>PON transmission</td><td>Ranging based on ITU-T Rec. G.983.1 and DBA
MAC
Cell slot allocation based on statistical bandwidth assignment and DBA
Detection of offered traffic load for DBA
Bandwidth allocation based on traffic contract and bandwidth request
Privacy and security
Frame alignment
Burst synchronization
Bit/byte synchronization</td></tr>
<tr><td colspan="2">Physical medium layer</td><td>E/O adaptation
Wavelength division multiplexing
Fibre connection</td></tr>
<tr><td colspan="4">NOTE – The transmission medium layer must provide the related OAM functions.</td></tr>
</table>

The TC layer is divided into PON transmission and adaptation sublayers, which correspond to the transmission convergence sublayer of the B-ISDN (Broadband Integrated Services Digital Network) in ITU-T Rec. I.321. The PON transmission sublayer terminates the required transmission function

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on the ODN. The PON specific functions are terminated by the PON transmission sublayer, and are not seen from the adaptation sublayer. The PON transmission sublayer includes MAC functions for cell slot allocation and bandwidth allocation. DBA is positioned as a part of the MAC functions in the PON transmission sublayer. As shown in Table 1, MAC provides cell slot allocation and bandwidth allocation according to the traffic contract based on ITU-T Rec. G.983.1. However, to support DBA, it provides these functions based on traffic load in addition to functions based on ITU-T Rec. G.983.1. Moreover, the Detection of Offered Traffic Load function is required to support the above-mentioned functions based on traffic load, which can be changed dynamically, for DBA. Additionally, Ranging in the PON transmission sublayer and some extensions of procedures in ITU-T Rec.G.983.1 are specified.

8.2 Physical medium dependent layer requirements for the ATM-PON

The specific information is described in ITU-T Rec. G.983.1.

8.3 Transmission convergence layer requirements for the ATM-PON

The specific information is described in ITU-T Rec. G.983.1.

8.3.1 Point-to-multipoint capacities for downstream and upstream

The specific information is described in ITU-T Rec. G.983.1.

8.3.2 Maximum payload capacities for downstream and upstream

The specific information is described in ITU-T Rec. G.983.1.

8.3.3 Downstream interface

The specific information is described in ITU-T Rec. G.983.1.

8.3.4 Upstream interface

The Physical Layer overhead includes: PLOAM cells, minislots for the MAC channel and overhead bytes which are added in front of each upstream ATM cell, PLOAM cell or minislot.

The transfer capacity for the 155.52 Mbit/s interface has an upper limit of 147.2 Mbit/s (155.52*53/56 Mbit/s). Some extra bandwidth is allocated by the OLT for the upstream PLOAM channel and the minislots for MAC channel. Mini-slots can be transferred from several ONUs/ONTs to the OLT synchronously. Bandwidth for minislots can be programmable according to reporting capability. For example, if a large amount of bandwidth is reserved for minislots, the OLT can receive and process the information that is sent by the ONUs/ONTs quickly, although bandwidth for other uses is reduced. This amount of bandwidth reserved for minislots should be determined by several factors, including network configuration, service guidelines and the implementation of OLTs and ONUs/ONTs. Moreover, the OLT can assign multiple minislots to an ONU/ONT in order to change the reporting frequency of any ONU/ONT. Therefore, the ONU/ONT must also manage the multiple minislots. Detailed examples are described in 8.3.5.10.1.3. The number of minislots assigned is also determined by multiple factors.

The upstream transfer capacity is shared between the ONUs/ONTs and/or T-CONTs based on their allocated upstream bandwidth.

8.3.5 Transport specific TC interface

8.3.5.1 Frame structure

The downstream interface structure for both 155.52 Mbit/s and 622.08 Mbit/s consists of a continuous stream of timeslots, each timeslot containing 53 octets of an ATM cell or a PLOAM cell.

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Every 28th timeslot a PLOAM cell is inserted. A downstream frame contains two such PLOAM cells and is 56 slots long for the 155 Mbit/s downstream case. For the 622 Mbit/s case, it contains eight PLOAM cells and is 224 slots long.

In the upstream direction the frame contains 53 timeslots of 56 bytes. The OLT requests an ONU/ONT to transmit an ATM cell via grants conveyed in downstream PLOAM cells. At a programmable rate, the OLT requests an ONU/ONT to transmit a PLOAM cell or a minislot. The upstream PLOAM rate depends on the required functionality contained in these PLOAM cells. These PLOAM cells may transfer information concerning the status of ONUs/ONTs in order to support DBA. The minimum PLOAM rate per ONU/ONT is one PLOAM cell every 100 ms. The OLT defines the bandwidth allocated to the upstream minislots. Although allocation of minislots can be programmable, several values will be recommended in order to obtain adequate performance.

The PLOAM cells are used to convey the Physical Layer OAM information. In addition, downstream PLOAM cells carry the grants used by the ONUs/ONTs for upstream access.

A divided_slot occupies a complete upstream timeslot, and contains a number of minislots from a set of ONUs/ONTs. The MAC protocol based on reporting status uses minislots to transfer to the OLT the status of the ONUs/ONTs in order to implement DBA. This serves as the mandatory method for reporting T-CONT status in SR-ONUs/ONTs. Therefore, since an OLT may expect reports from all of the SR-ONUs/ONTs on one physical interface with minimized time lag, divided_slots may be allocated consecutively to gather all of the reports within a short period.

The described frames, cells, bytes and bits are transmitted in the following order referring to their numbering: frames are transmitted in ascending order, cells within a frame are transmitted in ascending order, the bytes within a cell are transmitted in ascending order and within a byte, the most significant bit is transmitted first. The most significant bit in a byte is bit number 1 and the least significant bit is bit number 8, so for example the MSB of 0b10101010 is equal to 1.

8.3.5.1.1 Frame structure for symmetric PON

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.1.2 Frame structure for 622/155 Mbit/s PON

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.1.3 Time relation downstream – upstream frame

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.2 Physical layer cell identification

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.3 Downstream PLOAM structure

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.3.1 PLOAM cell termination

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.3.2 PLOAM identification

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.3.3 Frame synchronization

The specific information is described in ITU-T Rec. G.983.1.

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8.3.5.3.4 Synchronization field (SYNC1-SYNC2)

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.3.5 Grants

Each PLOAM cell is filled with 27 grants. These grants are used by the ONUs/ONTs for access to the upstream fibre. Per frame only 53 are needed. The 53 grants are mapped in the first two PLOAM cells of the downstream frame. All 53 grants are non-idle grants. The last grant of the second PLOAM cell is filled with an idle grant. The grant fields of the six remaining PLOAM cells for the 622 Mbit/s downstream case are all filled with idle grants and hence will not be used by the ONU/ONT. The length of a grant is 8 bits and the following types are defined in Table 2.

Table 2/G.983.4 – Specification of the grants

Type	Encoding	Definition
Data grant	Any value except 1111 1101 1111 1110 1111 1111	For indicating an upstream T-CONT-specific data grant. The value of the first data grant is assigned to the ONU/ONT during the ranging protocol using the grant_allocation message. The ONU/ONT can send an OMCI cell by this first assigned data grant to maintain backward compatibility with existing ONU/ONT specified in ITU-T Rec. G.983.1. Moreover the values of the additional data grant are assigned to the T-CONT in an operating state using the additional_grant_allocation message. The T-CONT can send a data cell by first or additional data grant. The ONU/ONT can send a data cell or an idle cell if no data cell is available.
PLOAM grant	Any value except 1111 1101 1111 1110 1111 1111	For indicating an upstream ONU/ONT-specific PLOAM grant. The value of the PLOAM grant is assigned to the ONU/ONT during the ranging protocol using the grant_allocation message. The ONU/ONT always sends a PLOAM cell in response to this grant.
Divided_slot grant	Any value except 1111 1101 1111 1110 1111 1111	For indicating an upstream group of ONU/ONT specific divided_slot grants. The OLT allocates the grant to a set of ONUs/ONTs using the Divided_slot_grant_configuration message. Each ONU/ONT of this set sends a minislot. The divided slot is used to report a queue length of the T-CONT to the OLT. The ONU/ONT processes one or more divided_slot grants up to the maximum specified by its Maximum_divided_slot_grants parameter.
Reserved grants	Any value except 1111 1101 1111 1110 1111 1111	In a future version of this Recommendation other grant types will be used for specific data grants (e.g. to address a specific ONU/ONT interface or QoS class).
Ranging grant	1111 1101	Used for the ranging process. The response to this grant is described in the ranging protocol.
Unassigned grant	1111 1110	For indicating an unused upstream slot.
Idle grant	1111 1111	For decoupling the downstream PLOAM rate from the upstream cell rate. These grants are ignored by the ONU/ONT.

The OLT shall be able to address 32 ONUs/ONTs at the same time on a PON. Optionally the OLT may address up to 64 ONUs/ONTs on a single PON.

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8.3.5.3.6 Grants protection

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.3.7 MESSAGE field

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.3.8 Bit Interleaved Parity (BIP)

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.4 Upstream PLOAM structure

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.4.1 PLOAM cell termination

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.4.2 PLOAM identification

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.4.3 MESSAGE field

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.4.4 Bit Interleaved Parity (BIP)

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.4.5 Laser Control Field (LCF)

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.4.6 Receiver Control Field (RXCF)

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.5 Divided _slots

An upstream slot can contain a divided_slot. The divided_slot fits into one upstream slot and contains a number of minislots coming from a set of ONUs/ONTs. The OLT assigns one divided_slot grant to this set of ONUs/ONTs for sending their minislots. The format of the divided_slot is shown in Figure 13.

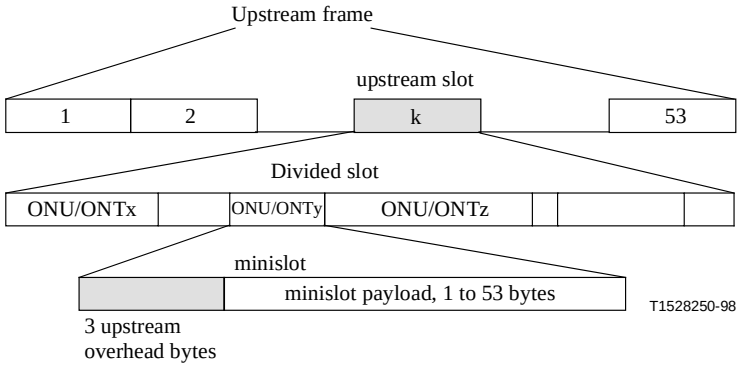


Figure 13/G.983.4 – Format of divided_slot

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The minislot is used to report the queue length of the T-CONT to the OLT in the case of SR-ONUs/ONTs.

The length of the minislot is an integral number of bytes, ranging from a minimum of 5 to a maximum of 56 bytes. Each minislot is composed of the physical layer overhead bytes, one or more T-CONT report bytes, and CRC-8 trailer.

NOTE – For exceptionally long minislots where the payload is greater than 15 bytes, additional CRC-8s must be inserted.

The three overhead bytes have the same definition as stated in Table 6/G.983.1.

The minislot payload is protected by a Cyclic Redundancy Check (CRC). The formula for generating the CRC polynomial for the minislot payload is:

$$g(x) = x^8 + x^2 + x + 1$$

8.3.5.6 Churning

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.7 Verification function

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.8 VP/VC for higher layer

The specific information is described in ITU-T Rec. G.983.1.

8.3.5.9 Duplex PON system

In the case of a duplex system where a redundant PON protects the active PON, protection switching will be activated by using specified messages in PLOAM cells. This sequence will require that the line numbers of the OLT must be exactly the same as those of the ONU/ONT. This line identifier is assigned to a transmitter based on the interconnection scheme of OLTs with ONUs/ONTs. The line identifier is sent to both the OLT and the ONU/ONT to check whether the received line identifier is the same as its own identifier. This is defined as the PON Section Trace (PST) message. Then individual equipment can verify that it is connected to the proper transmitter. If the received line number differs from the expected line number, the equipment generates an alarm, MIS (Link Mismatching) to notify the operator or user of the problem.

The PST messages include the K1 and K2 bytes as they are specified in ITU-T Rec. G.783 for performing Automatic Protection Switching.

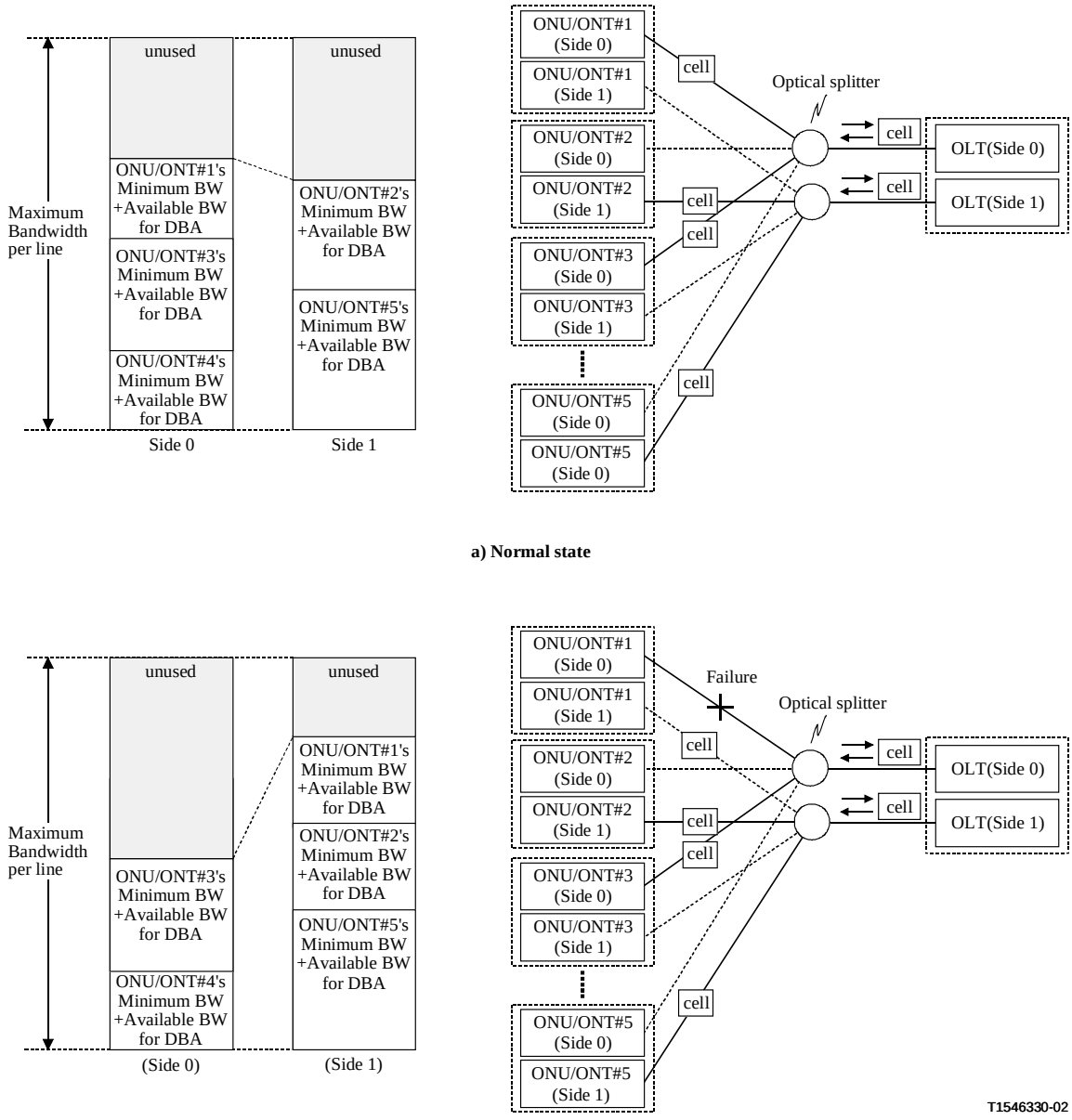
In case of an unprotected system, link mismatching is optional.

8.3.5.9.1 Relationship between DBA and protection functions

DBA has some impacts on protection functions in the cases of protection Types C and D as defined in Appendix IV/G.983.1. These impacts and outstanding operations in DBA will be discussed in the future. For Types A and B, DBA does not have any impact because each ONU/ONT has only one interface to the OLT. However, in the cases of Types C and D, some additional capabilities in DBA to support the protection functions may be specified, such as provisioned parameters, identification of T-CONTs, and grant allocation.

The typical example is shown in Figure 14. In this example, both side-0 and side-1 are used in the normal state as shown in Figure 14 a). When a failure occurs between the splitter and the ONU/ONT's working side, the other side's extra bandwidth is assigned for the ONU/ONT as shown in Figure 14 b).

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BW Bandwidth

Figure 14/G.983.4 – Relationship between DBA and protection function

8.3.5.10 MAC protocol

The MAC layer in the OLT needs specific information to fairly allocate bandwidth between ONUs/ONTs on a PON. The MAC protocol is also referred to as the DBA protocol if the OLT supports dynamic assignment of bandwidth in the upstream direction. The MAC protocol is implemented in the PON transmission part of the TC layer described in 8.1. As the MAC protocol, DBA should ensure transparency to higher layers, such as the ATM layer. In short, ATM cells should be transported through and across the PON in a completely transparent manner without any impact on ATC/QoS.

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When a DBA-OLT supports SR-ONUs/ONTs, the required information is mapped into the payload field of the minislot using the mandatory reporting method. An ONU/ONT is allowed to send this minislot after receiving a divided_slot grant. Specifically, the Divided_Slot_Grant_configuration message is used for this type of grant, and the length and offset of the upstream minislot are carried in the same message. The MAC also includes a bandwidth allocation function based on conventional static grant assignment according to the traffic contract.

8.3.5.10.1 DBA protocol

The DBA protocol consists of three strategies, referred to as NSR, SR, and Hybrid types. The NSR type strategy is invoked by monitoring traffic in the OLT. The SR type strategy is invoked by status reports sent from ONUs/ONTs to the OLT. The Hybrid strategy is invoked by both monitoring traffic in the OLT and processing in the OLT the status reports from ONUs/ONTs. This Recommendation does not specify detailed mechanisms or algorithms for these strategies, but rather requirements and the required interfaces at reference points IF_{PON} (S/R and R/S) are described (see clause 5.2). The detailed mechanisms and the scheme for how to combine NSR and SR types in the Hybrid strategy are out of scope for this Recommendation.

8.3.5.10.1.1 Working unit for DBA

The DBA protocol is executed on every T-CONT active in a SR-ONU/ONT. Operations and assigned resources among T-CONTs can be independent from each other. In short, one or more T-CONTs can be defined in one ONU/ONT, if all of the T-CONTs on the reference point S/R can be identified by grant codes specified in 8.3.5.3.5. T-CONTs do not interfere with each other.

8.3.5.10.1.2 DBA protocol with OLT monitoring

This clause describes how an OLT can collect the bandwidth request information from the T-CONTs in its associated ONUs/ONTs without using status reporting. The OLT inspects each incoming cell from a specific T-CONT in a predefined time frame. For example, the OLT calculates the utilization rate of the currently assigned bandwidth by monitoring the number of effective received cells from specific T-CONTs, and uses this value as the bandwidth request information.

These mechanisms are applied to cases where a DBA-OLT supports NSR-ONUs/ONTs and/or SR-ONUs/ONTs that may suspend reporting.

Moreover, if SR-ONUs/ONTs report status, the OLT can work based on monitoring results independently of these reports if the OLT concludes that the monitoring approach is more suitable for the current situation. For example, when the ONU/ONT reports are insufficient, the monitoring operation can be invoked.

8.3.5.10.1.3 DBA protocol with status reporting

This clause describes how an SR-ONU/ONT explicitly reports to its DBA-OLT PON interface. Since a number of ONUs/ONTs and their DBA T-CONTs may report queue lengths of T-CONT buffers, it is imperative to balance the amount of information with the upstream bandwidth consumption of these reports. Reporting methods and reported information are specified as follows.

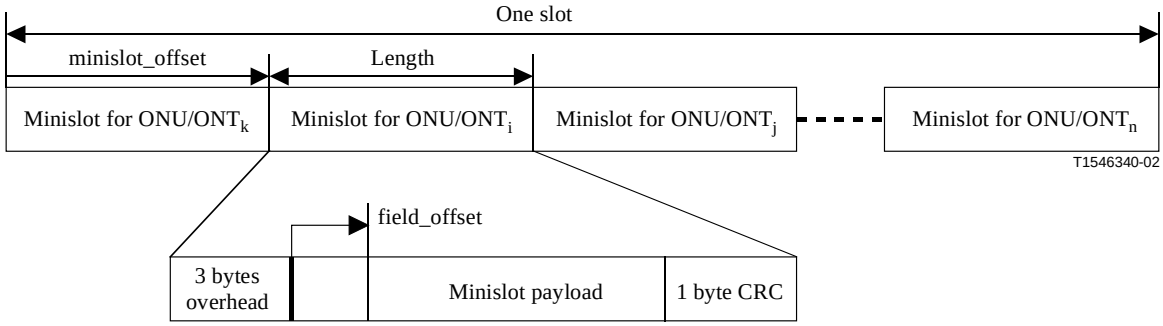
8.3.5.10.1.3.1 Reporting minislot format

Minislots contained in the divided_slot are specified using the mandatory status reporting method. The reporting cycle is one of the parameters that should be provisioned by the operators to obtain suitable performance.

Generally the OLT will generate divided_slot grants to request a queue length for the specified ONU/ONT according to the service requirements. When an ONU/ONT recognizes a divided_slot grant, the ONUs/ONTs can transfer information in a minislot in the divided_slot. This minislot contains the queue length for every T-CONT using non-linear coding and CRC-8.

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In this queue length reporting, fields in a divided_slot are identified by two offset values, minislot_offset and field_offset, as shown in Figure 15. The minislot_offset identifies the location of a minislot for the ONU/ONT. It is specified by a Divided_Slot_Grant_configuration message, which is one of the PLOAM messages and is mentioned in 8.3.8. The field_offset identifies the location of a T-CONT in the minislot, when two or more T-CONTs are specified in an ONU/ONT. It can be specified by the Additional_Grant_Allocation message. A minislot in a divided_slot can report queue length for up to 49 T-CONTs, if the default reported information described in 8.3.5.10.1.3.2 is used. However, if 50 or more T-CONTs are specified in an ONU/ONT, multiple divided_slots can be allocated to report the queue lengths. In this case, mapping between these slots and the reporting field for each T-CONT should be managed by the OLT. On the other hand, when the configuration of T-CONTs is changed and a T-CONT is deactivated, the queue length for this T-CONT should not be reported. In this case, the reporting field for this T-CONT is removed according to the procedures described in 8.6.3.



minislot_offset To identify the starting point for particular ONU/ONT minislot
field_offset To identify the starting point for particular TCONT within one ONU/ONT minislot

Figure 15/G.983.4 – Relationship between a divided_slot and minislots

8.3.5.10.1.3.2 Reported information

This clause describes reported information from SR-ONUs/ONTs using minislots. The reported information should not be limited by any DBA algorithms that are adopted or restricted by the set-up values of bandwidth types. Moreover, the bandwidth for any T-CONT should be adjustable to any value based on the reported information.

SR-ONUs/ONTs shall report the queue length of their T-CONTs using non-linear coding, when requested to do so by their OLT. The queue length is the sum of the total number of cells in all the class buffers that are connected to a particular T-CONT in an ONU/ONT. All equipment must support the format type, as shown in Figure 16.

The information conveyed in the minislot from the ONU/ONT should be protected by the CRC, and the information should be used only when the CRC check is correct.

Additional reported information may be useful. The additional reported information and the negotiation procedure to use additional reported information are described as an informative option in Appendix II. In Appendix II, standard reported information is dealt with as "default reporting field meaning" and the combination of standard reported information and additional reported information are dealt with as "optional report field meanings". Even if the OLT and the ONU/ONT have applied optional report field definitions in Appendix II, all OLTs and ONUs/ONTs must support the standard reported information definitions or "default reporting field meaning" in Appendix II.

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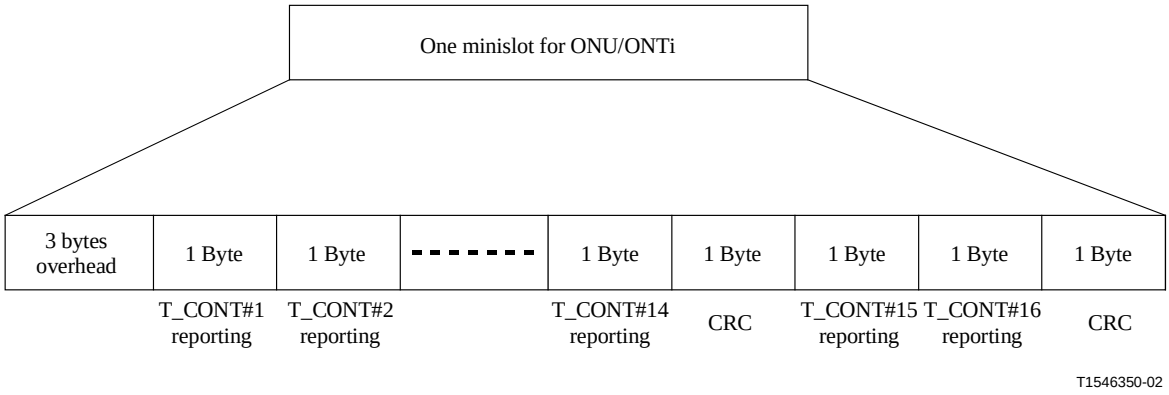


Figure 16/G.983.4 – The detailed minislot format for one ONU/ONT

One CRC is inserted for every 14 bytes of minislot payload at the ONU/ONT. The CRC shall be the remainder (modulo 2) of the division by the polynomial $x^8 + x^2 + x + 1$ into the report fields between the preceding CRC or the beginning of the minislot and the CRC itself. If the minislot payload is not evenly divisible into 14 byte segments, a CRC byte should be appended to the end of the minislot payload. An example of the detailed minislot format is shown in Figure 16. The maximum number of T-CONTs that can be supported in one minislot is 49 (the whole slot = 56 byte = 3 bytes overhead + 3 * 14 bytes (T-CONTs) + 3 bytes CRC + 7 T-CONTs + 1 CRC). This situation only happens when one complete slot is assigned to one ONU/ONT. This may be caused by one ONU/ONT having 49 or more activated T-CONTs.

8.3.5.10.1.3.3 Report field coding

The default minislot format is shown in Figure 16 in 8.3.5.10.1.3.2. The reported 1 byte queue length is the non-linear coded value of the actual number of cells in a T-CONT of a specific ONU/ONT. The mapping between the number of cells (the input), the 1 byte value (the code) and the decoded message (the output) is given in Table 3 as default code points. Note that the decoded output is effectively rounded up to the largest value that could have resulted in that particular code point. This property ensures that the coding error is always positive.

Table 3/G.983.4 –Non-linear coding for report field of minislot

Queue Length	Binary Input (ONU/ONT)	Coding of octet (minislot)	Binary Output (OLT)
0-127	00000000abcdefg	0abcdefg	00000000abcdefg
128-255	00000001abcdefx	10abcdef	00000001abcdef1
256-511	0000001abcdexxx	110abcde	0000001abcde111
512-1023	000001abcdxxxxx	1110abcd	000001abcd11111
1024-2047	00001abcxxxxxxx	11110abc	00001abc1111111
2048-4095	0001abxxxxxxxxx	111110ab	0001ab111111111
4096-8191	001axxxxxxxxxxx	1111110a	001a11111111111
>8191	001111111111111	11111110	011111111111111
Reserved	N/A	11111111	N/A

The code point described in Table 3 may be changed according to the service situation and the implementation of OLTs and ONUs/ONTs. However, alternative code points have not been specified in this Recommendation.

NOTE – The reserved value (0xFF) is used to indicate an unassigned report field.

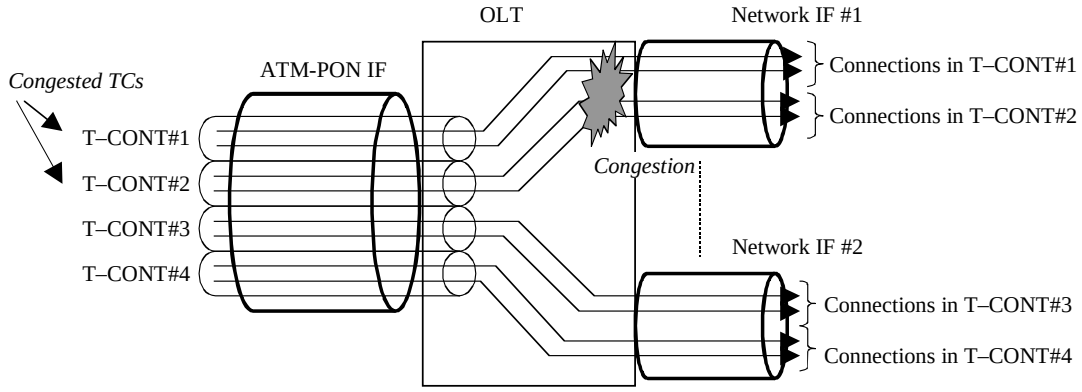
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8.3.5.10.1.4 DBA protocol with OLT monitoring and status reporting

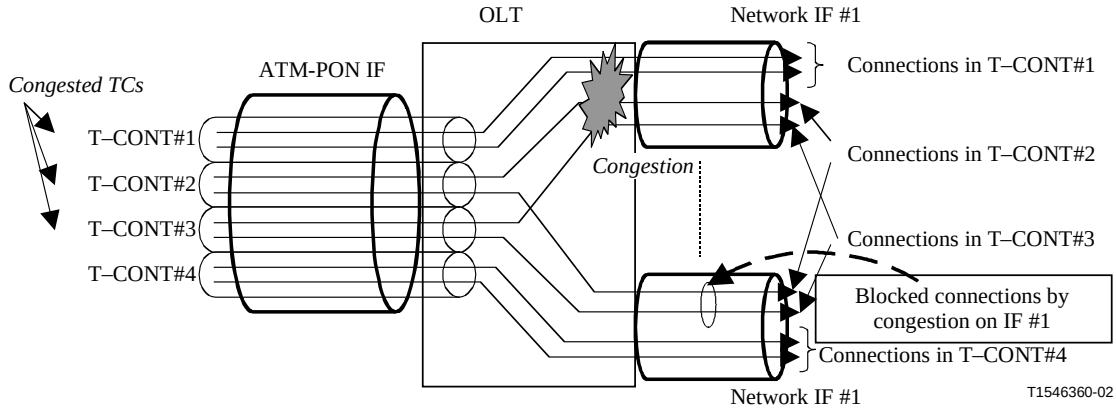
A DBA-OLT can combine NSR and SR strategies and then apply them to SR-ONUs/ONTs. For example, even if an SR-ONU/ONT reports status, the DBA-OLT is not required to use the information and may instead use cell monitoring results to update the bandwidth. The schemes for how to combine both types depend on the service situation and implementation. A DBA-OLT can select schemes based on either NSR or SR strategies, or the combination of NSR and SR strategies in every SR-ONU/ONT associated with one physical ATM-PON interface.

8.3.5.10.1.5 DBA and upstream congestion of the OLT NNI

As a future extension, the DBA protocol may operate based on not only the requested bandwidth of the T-CONTs and the available bandwidth of the upstream PON links but also the upstream congestion on the OLT NNIs as shown in Figure 17. The DBA-OLT could decrease the grants to T-CONTs carrying VPCs/VCCs that are congested upstream to their assured bandwidth level. The DBA-OLT could also intelligently control distribution of additional bandwidth available in the PON to an SR-ONU/ONT / T-CONT. In short, there are two congestion patterns such as a) and b) in Figure 17. In the first case, the bandwidth for T-CONTs included in the congested NNI may be reduced. However, in the second case, since the group that detected congestion on the network interface cannot band T-CONTs on ATM-PON physical links, blocking the upstream traffic carried by some T-CONTs may be caused as in Figure 17 (b). To avoid this blocking, some mechanisms and implementations can be studied. However, these are not included in this Recommendation.



a) Banded connections in every T–CONT on a network IF



b) Disbanded connections in every T–CONT on a network IF

Figure 17/G.983.4 – Configuration of T-CONTs on the network interface

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8.3.5.10.2 T-CONT types

This clause presents definitions of T-CONTs, their types and typical applications for each T-CONT type. DBA-OLTs shall support all T-CONT types. ONUs/ONTs can support all or some of them according to the services they support. Basically, T-CONT types are independent of applications, such as ATC/QoS specified in the ATM layer. In short, one T-CONT type can accommodate any ATC/QoS, and can contain multiple different classes. However, typical applications in each type are mentioned to make use of maximal effectiveness of DBA.

8.3.5.10.2.1 Definition of T-CONT

T-CONTs are essentially "pipes" that carry ATM VPs or VCs. Multiplexing of VPs and VCs having different ATC/QoS into one T-CONT is programmable. For example, the following scenarios can be assumed.

– one or more VPs with the same ATC/QoS mapped into one T-CONT (e.g. VP switching case).

– one or more VPs with the different ATC/QoS mapped into one T-CONT (e.g. VP switching case).

– one or more VPs banding VCs with the same ATC/QoS mapped into one T-CONT (e.g. VC switching case).

– one or more VPs banding VCs with the different ATC/QoS mapped into one T-CONT (e.g. VC switching case)

Note that one VP on the PON cannot be assigned to several T-CONTs in the current ATM-PON model specified in ITU-T Rec. G.983.1.

For the sake of convenience, T-CONTs can be classified into 5 types, which are T-CONT Type 1, T-CONT Type 2, T-CONT Type 3, T-CONT Type 4, and T-CONT Type 5.

Recommended supportability of ATC/QoS (or ATM Forum Service Category) in each T-CONT type is summarized in Table 4.

Table 4/G.983.4 – Relationship between ATC/QoS and T-CONT types

ITU	ATM Forum	T-CONT types				
ATC/QoS	Service category	1	2	3	4	5
DBR [1]	CBR	X				X
DBR [2]	VBR.1-nrt (SCR = PCR)	X	X	X		X
DBR [U]	UBR.1	X	X	X	X	X
SBR1 [1]	VBR.1-rt	X				X
SBR1 [2]	VBR.1-nrt	X	X	X		X
SBR1 [U]	UBR.1	X	X	X	X	X
SBR2 [3]	VBR.2-nrt	X	X	X		X
SBR2 [U]	UBR.1	X	X	X	X	X
SBR3 [3]	VBR.3-nrt	X	X	X		X
SBR3 [U]	UBR.2	X	X	X	X	X
ABT/DT [1], ABT/IT [1]	–	X				X
ABT/DT [2], ABT/IT [2]	–	X	X	X		X

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Table 4/G.983.4 – Relationship between ATC/QoS and T-CONT types

ABT/DT [U], ABT/IT [U]	–	X	X	X	X	X
ABR [3]	ABR	X	X	X		X
ABR [U]	ABR	X	X	X	X	X
GFR	GFR	X	X	X		X

8.3.5.10.2.2 Relationship among assigned bandwidth

Each T-CONT type is characterized by the kinds of assigned bandwidth types it supports. Before a description of T-CONT types, the relationship among assigned bandwidth is clarified as follows.

Assigned bandwidth consists of 4 types: Fixed bandwidth, Assured bandwidth, Non-assured bandwidth and Best-effort bandwidth (Maximum bandwidth can also be set in some cases).

Table 5/G.983.4 – Summary of assignable bandwidth

	Delay sensitive	**Assignment type**	**Applicable T-CONT types**				
			Type 1	**Type 2**	**Type 3**	**Type 4**	**Type 5**
Fixed	Yes	Provisioned	X				X
Assured	No	Provisioned		X	X		X
Non-assured	No	Dynamic			X		X
Best-effort	No	Dynamic				X	X
NOTE – In Types 3, 4 and 5, assignable bandwidth has the upper bound specified by Maximum bandwidth that should be provisioned for these types.							

In the table, Dynamic Assignment type represents additional bandwidth. Non-assured bandwidth is paired with Assured bandwidth. Non-assured bandwidth for each T-CONT that requests additional bandwidth is allocated in proportion to the Assured bandwidth for the T-CONT from the pool of surplus bandwidth. If Assured bandwidth is zero, Non-assured bandwidth is fairly allocated as well as Best-effort bandwidth. For example, T-CONTs which request additional bandwidth and do not have Assured bandwidth fairly share surplus bandwidth. Moreover, Assured bandwidth assignment to any T-CONTs should be guaranteed.

Assignable bandwidth can be prioritized as follows.

Priority 1 (Highest priority)	Fixed bandwidth
Priority 2	Assured bandwidth
Priority 3	Non-assured bandwidth
Priority 4 (Lowest priority)	Best effort bandwidth

In the bandwidth assignment, Fixed bandwidth is reserved first, including slot location to minimize delay and delay variation. Assured bandwidth is reserved next using the remaining bandwidth. Bandwidth that is still not reserved is released to the pool of surplus bandwidth for Non-assured bandwidth and Best effort bandwidth. Non-assured bandwidth has higher priority than Best effort bandwidth.

8.3.5.10.2.3 T-CONT Type 1

1) *Definition*

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T-CONT Type 1 is characterized by Fixed bandwidth only. For T-CONT Type 1, the bandwidth shall be exclusively and cyclically allocated with a fixed rate and controlled cell transfer delay.

Traffic descriptor for T-CONT Type 1: Fixed bandwidth: Provisioned

2) *Applications*

T-CONT Type 1 is able to accommodate any ATC/QoS. This T-CONT works in the same manner as the existing G.983.1 and G.983.2 Recommendations. Moreover, a Non-DBA-OLT is able to support any ATC/QoS as an application of T-CONT Type 1. DBA-OLTs accommodate real-time traffic as an application of this T-CONT type. DBA-OLTs always assign fixed bandwidth to connections on a T-CONT Type 1 regardless of whether there are cells to send or not. This T-CONT is not dynamically allocated and can be used to provide existing services (DS-1, E-1, J-1, etc). DBA-OLTs accommodate all of ATC/QoS classes in the ATM layer specified in ITU-T Recs. I.356 and I.371.

Mechanisms to transfer cells in the T-CONT and provisioning policies to guarantee QoS on the ATM level depend on the implementation of the ONU/ONT.

3) *Behaviours of multiplexed VPCs and VCCs in the ATM layer*

Multiple ATM connections are multiplexed into T-CONTs. Although configuration of T-CONT buffers depends on the implementation, Figure 18 illustrates an example of multiplexing DBR ATM connections using a typical implementation based on FIFO. As shown in Figure 18, though grants are allocated by a strict interval, CDV can be generated according to the behaviour of each ATM connection and/or contention among multiplexed connections.

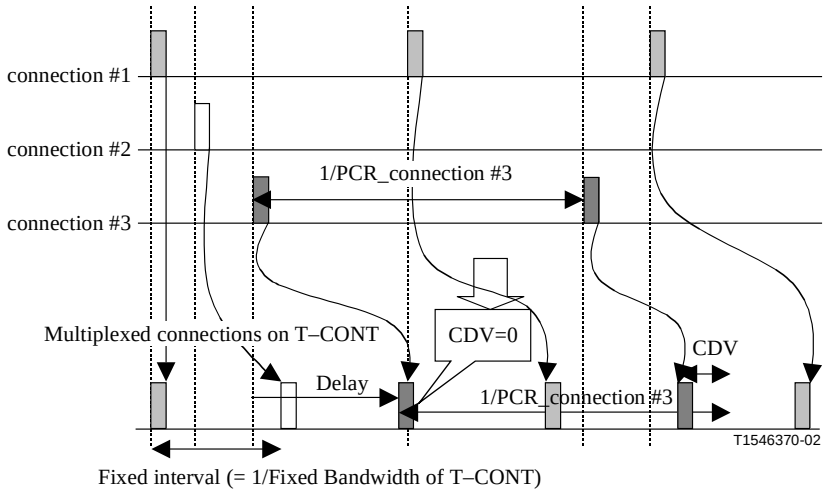


Figure 18/G.983.4 – Behaviours of multiplexed connections on T-CONT type 1

8.3.5.10.2.4 T-CONT Type 2

1) *Definition*

T-CONT Type 2 is characterized by Assured bandwidth only. Assured bandwidth means Fixed average bandwidth over some specified time interval. In traffic engineering, this bandwidth is distinguished from Fixed bandwidth in T-CONT Type 1 (Deterministic assignment) which is controlled for the short-term range from a delay-sensitive point of view. In short, although T-CONT Type 1 guarantees cell transfer delay and delay variation

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in addition to the transmission rate, T-CONT Type 2 guarantees the average transmission rate only. T-CONT Type 2 is supported only by DBA-OLTs.

Traffic descriptor for T-CONT Type 2: Assured bandwidth: Provisioned

2) *Application*

T-CONT Type 2 accommodates all ATC/QoS classes with the exception of class 1, that is non-real time service. The ATC/QoS in the ATM layer shown in Table 4 can be accommodated in this T-CONT type.

Mechanisms to transfer cells in the T-CONT and provisioning policies to guarantee QoS at the ATM level depend on the implementation of the ONU/ONT.

3) *Behaviours of multiplexed VPCs and VCCs in the ATM layer*

Multiple ATM connections are multiplexed into T-CONTs. Although configuration of T-CONT buffers depends on the implementation, Figure 19 illustrates an example of multiplexing DBR ATM connections using a typical implementation based on FIFO. As shown in Figure 19, since grants are allocated by interval with a variation, CDV for each ATM connection can be generated by such variation in addition to the behaviour of each ATM connection and/or contention among multiplexed connections.

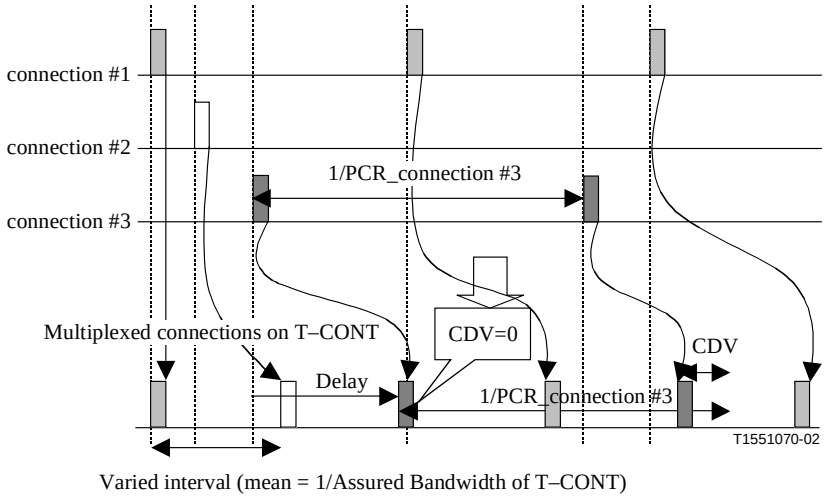


Figure 19/G.983.4 – Behaviours of multiplexed connections on T-CONT type 2

8.3.5.10.2.5 T-CONT Type 3

1) *Definition*

T-CONT Type 3 has Assured bandwidth and Non-assured bandwidth. T-CONT Type 3 shall be allocated bandwidth equivalent to its Assured bandwidth, only when it has cells at a rate equivalent to Assured bandwidth or more than Assured bandwidth. Non-assured bandwidth shall be allocated across all T-CONTs with Assured bandwidth that are requesting additional bandwidth in proportion to the Assured bandwidth of the individual T-CONTs on the PON, e.g. Weighted Round Robin method. The sum of the Assured bandwidth and Non-assured bandwidth allocated to this T-CONT should not exceed its Maximum bandwidth, which is a provisioned value.

Traffic descriptor for T-CONT Type 3:

Assured bandwidth: Provisioned

Non-assured bandwidth: Dynamic assignment

Maximum bandwidth: Provisioned

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2) *Application*

T-CONT Type 3 accommodates variable bit rate transmission having QoS classes with the exception of class 1, that is non-real time service. ATC/QoS in the ATM layer described in Table 4 can be accommodated in this T-CONT type.

Mechanisms to transfer cells in the T-CONT and provisioning policies to guarantee QoS on the ATM level depend on the implementation of the ONU/ONT.

3) *Behaviours of multiplexed VPCs and VCCs in the ATM layer*

Multiple ATM connections are multiplexed into T-CONTs. Although the configuration of T-CONT buffers depends on the implementation, Figure 20 illustrates an example of bandwidth assignment based on the characteristics of T-CONT type 3. As shown in Figure 20, behaviours can be divided into four parts: Phases 1, 2, 3, and 4. In stable phases, such as Phases 1 and 3, these behaviours are the same as the case of T-CONT type 2. Multiplexing behaviours in transition phases, such as Phases 2 and 4, are illustrated in Figures 21 and 22, respectively, in the case of DBR connections.

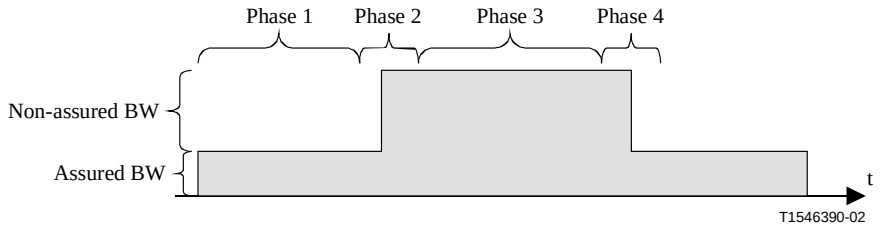


Figure 20/G.983.4 – Outline of bandwidth assignment in T-CONT type 3

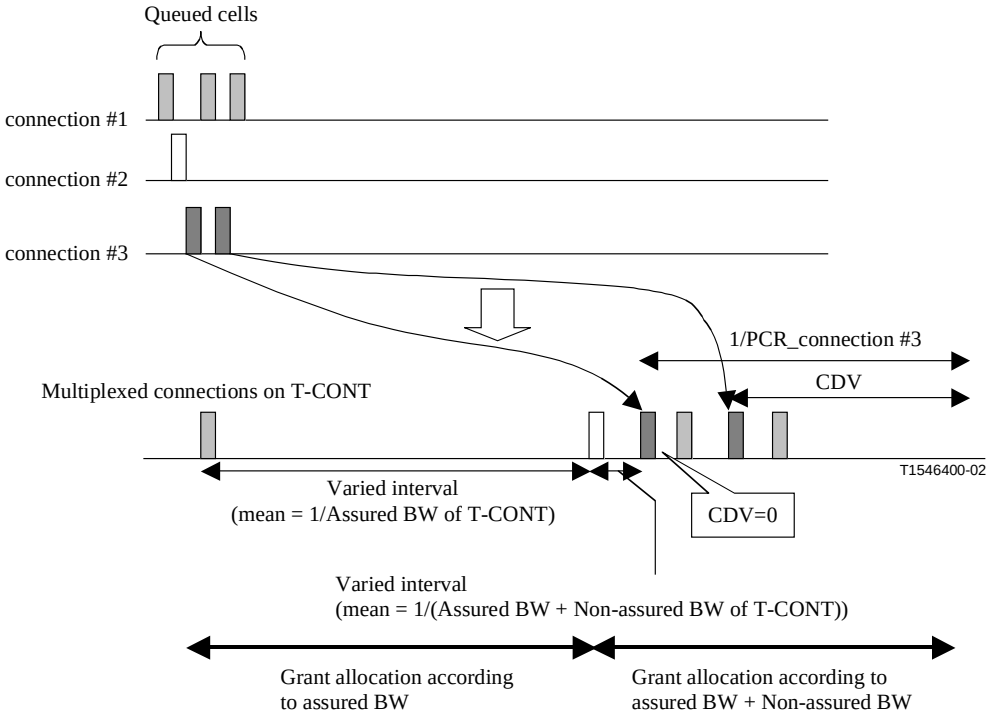


Figure 21/G.983.4 – Behaviour of multiplexed connections in Phase 2 in T-CONT type 3

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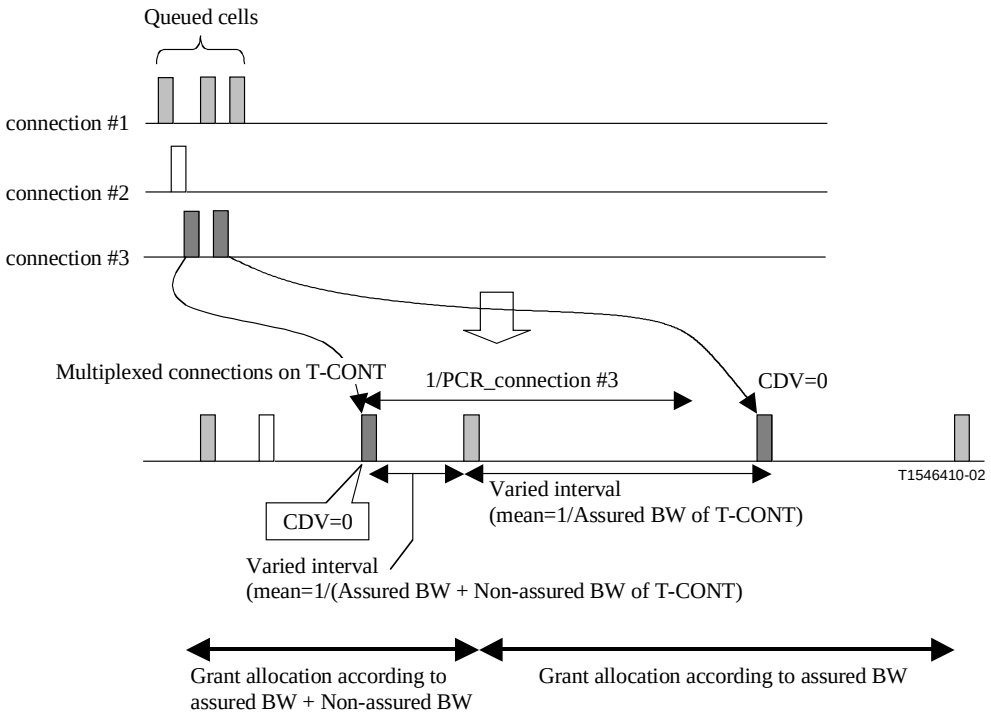


Figure 22/G.983.4 – Behaviour of multiplexed connections in Phase 4 in T-CONT type 3

8.3.5.10.2.6 T-CONT Type 4

1) *Definition*

T-CONT Type 4 has Best-effort bandwidth only and does not have any Guaranteed bandwidth. T-CONT Type 4 shall only use bandwidth that has not been allocated as Fixed bandwidth, Assured bandwidth or Non-assured bandwidth to T-CONTs in the PON. Best-effort bandwidth is allocated to each T-CONT Type 4 equally, e.g. based on the Round Robin method, up to the Maximum bandwidth.

Traffic descriptor for T-CONT Type 4:

Best-effort bandwidth: Dynamic assignment

Maximum bandwidth: Provisioned

2) *Application*

T-CONT Type 4 accommodates unspecified class as shown in Table 4.

Mechanisms to transfer cells in the T-CONT and provisioning policies to guarantee QoS on the ATM level depend on the implementation of the ONU/ONT.

3) *Behaviours of multiplexed VPCs and VCCs in the ATM layer*

Multiple ATM connections are multiplexed into T-CONTs. Although configuration of T-CONT buffers depends on the implementation, Figure 23 illustrates an example of bandwidth assignment based on the characteristics of T-CONT type 4. As shown in Figure 23, behaviours can be divided into four parts, such as Phases 1, 2, 3, and 4. In stable phases, such as Phases 1 and 3, these behaviours are the same as the cases of T-CONT types 2 and 3. Multiplexing behaviours in transition phases, such as Phases 2 and 4, are the same as the case of T-CONT type 3.

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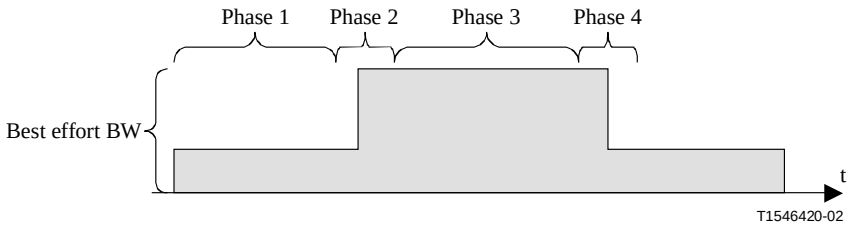


Figure 23/G.983.4 – Outline of bandwidth assignment in T-CONT type 4

8.3.5.10.2.7 T-CONT Type 5

1) *Definition*

T-CONT Type 5 is the super set of all of T-CONT types. T-CONT Type 5 may accommodate any ATC/QoS described in Table 4, and can be downgraded to one or more of the other T-CONT types. T-CONT Type 5 is characterized by the following descriptors.

Traffic descriptor for T-CONT Type 5:

Fixed bandwidth: Provisioned

Assured bandwidth: Provisioned

Non-assured bandwidth: Dynamic assignment

Best-effort bandwidth: Dynamic assignment

Maximum bandwidth: Provisioned

Assignment mechanisms depend on the implementation. For example, the following mechanisms can be assumed.

Step 1: Fixed bandwidth and Assured bandwidth are assigned.

Step 2: Non-assured bandwidth is assigned in proportion to Assured bandwidth.

Step 3: If additional bandwidth is still requested, Best-effort bandwidth is assigned up to the Maximum bandwidth.

2) *Application*

T-CONT type 5 can accommodate any application including real-time or resource-guaranteed applications. It can be applied to any ATC/QoS as shown in Table 4.

Mechanisms to transfer cells in the T-CONT and provisioning policies to guarantee QoS on the ATM level depend on the implementation of the ONU/ONT.

3) *Behaviours of multiplexed VPCs and VCCs in the ATM layer*

Multiple ATM connections are multiplexed into T-CONTs. Although configuration of T-CONT buffers depends on the implementation, Figure 24 illustrates an example of bandwidth assignment based on the characteristics of T-CONT type 5. As shown in Figure 24, behaviours can be divided into four parts: Phases 1, 2, 3, and 4. In stable Phases, such as Phases 1 and 3, these behaviours are shown in Figure 25. Multiplexing behaviours in transition phases, such as Phases 2 and 4, are the same as the cases of T-CONT type 3.

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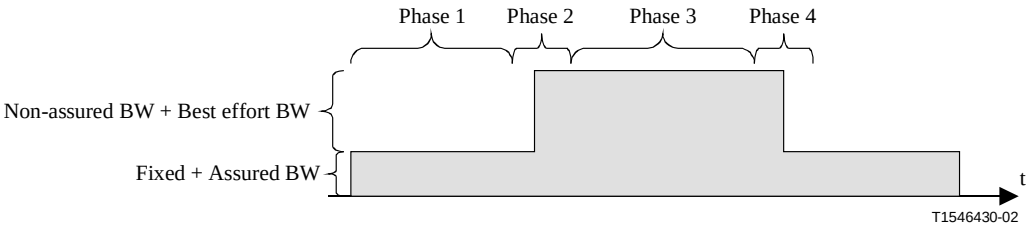


Figure 24/G.983.4 – Outline of bandwidth assignment in T-CONT type 5

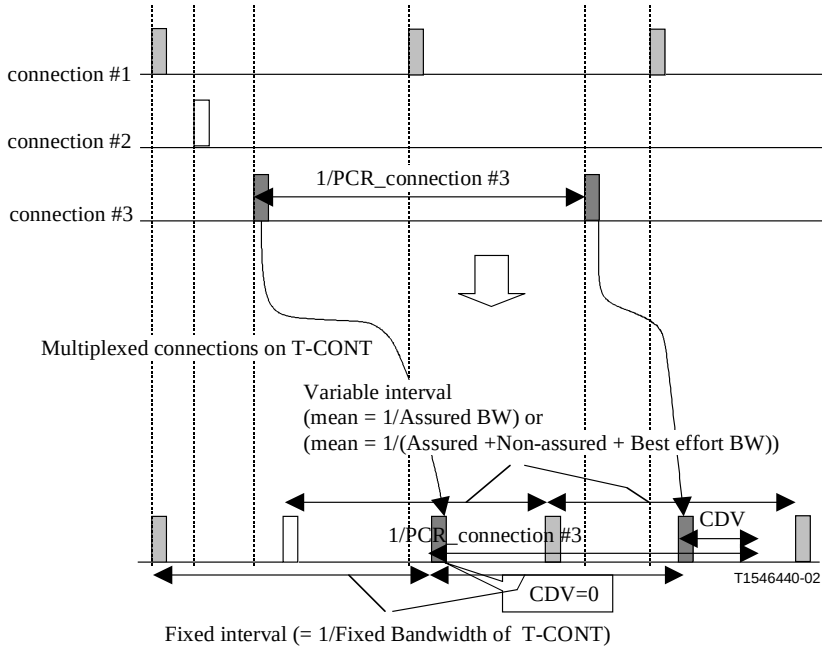
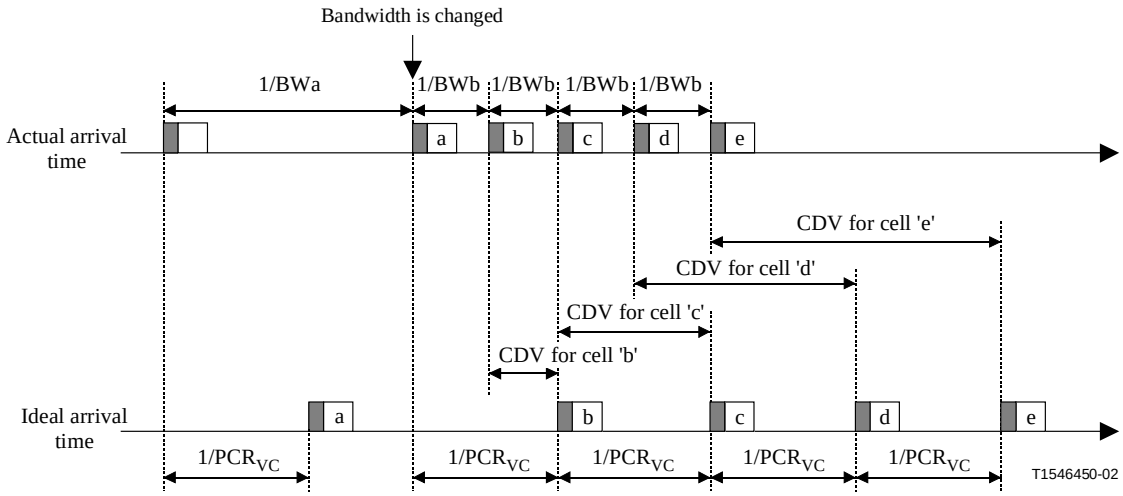


Figure 25/G.983.4 – Behaviour of multiplexed connections in Phases 1 and 3 in T-CONT type 5

8.3.5.10.2.8 Notes for traffic behaviours

When the PCR of a connection is smaller than the maximum bandwidth, implementing DBA may increase the CDV of the connection. Figure 26 shows a case of increasing CDV. In order to avoid cell discard by UPC, traffic descriptors for the T-CONT and the CDVT value for each connection should be considered carefully.

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In case of "BW_min ≤ BWa < PCR < BWb ≤ BW_max"

Figure 26/G.983.4 – CDV caused by DBA

8.3.5.10.3 Additional requirements for surplus bandwidth assignment

8.3.5.10.3.1 Surplus bandwidth sharing and fairness on an ONU/ONT

Surplus bandwidth in one ONU/ONT can be fairly shared with other DBA-T-CONTs in the same ONU/ONT and that can use surplus bandwidth (T-CONT type 3, T-CONT type 4 and T-CONT type 5). In short, one T-CONT working for T-CONT Types 3, 4 or 5 in one ONU/ONT can capture grants for surplus bandwidth which are then allocated to other T-CONTs in the ONU/ONT, if the other T-CONTs do not have transmission cells available. However, mechanisms to maintain a long-term balance of used grants among T-CONTs is for further study.

8.3.5.10.4 Requirements for grant allocation mechanisms

This clause specifies the requirements for grant allocation mechanisms and their backgrounds.

8.3.5.10.4.1 Grant assignment for fixed bandwidth

1) *Requirements*

This requirement is to restrict the fluctuation in the grant allocation interval to T-CONT Type 1 and the fixed bandwidth part of T-CONT Type 5 (this requirement is based on Peak-to-Peak CDV and maximum Cell Transfer Delay specified in ATM QoS parameters for Class 1). The maximum fluctuation of the interval between data grants in one T-CONT should take into account the following factors:

- the time of the ranging window;
- the number of T-CONT Type 1 and T-CONT Type 5 in the same PON-IF;
- one cell time for one PLOAM cell or Divided_slot;
- plus several cell times as margin.

2) *Background*

These T-CONTs are used for DBR [Class 1] the same as the existing G.983.1 and G.983.2 Recommendations. Therefore, the limitation on burst allocation is the same as that of the system in the existing G.983.1 and G.983.2 Recommendations. In short, grant assignment for fixed bandwidth in a T-CONT can emulate the T-CONT as a physical link without

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contention among T-CONTs. Therefore, although it can be applied to all ATC/QoS; time sensitive applications, such as Class 1, are the most suitable. For example, in the case of T-CONT type 1 which uses only fixed bandwidth, when the sum of the PCRs of all ATM connections in this T-CONT are less than the fixed bandwidth assigned to this T-CONT and each connection has no CDV, maximum Cell Transfer Delay (CTD) and CDV can be specified logically as follows (see Figure 27).

CTD<N*1/Fixed bandwidth

CDV<1/PCR for the target connection – 1/Fixed bandwidth,

where N is the number of multiplexing connections in one T-CONT.

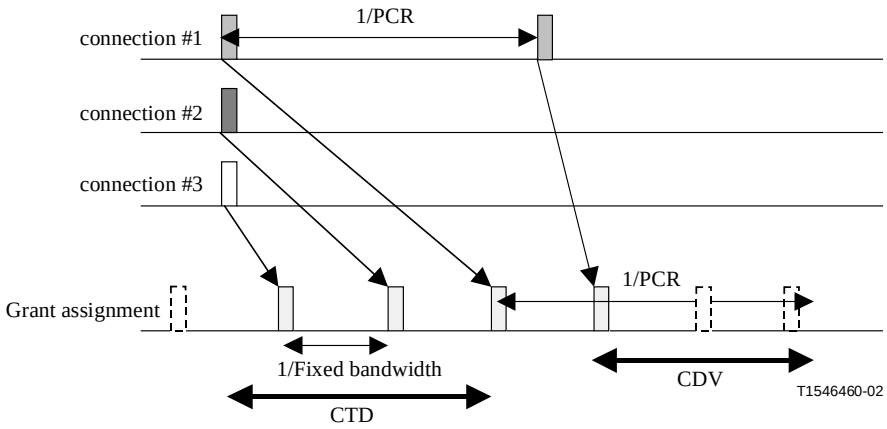


Figure 27/G.983.4 – CTD and CDV on T-CONT using only Fixed bandwidth

8.3.5.10.4.2 Grant assignment for other bandwidth

1) *Requirements*

This requirement is to restrict the fluctuation in the grant allocation interval in every T-CONT to comply with the CDVT specified in each VPC or VCC at the UPC.

2) *Background*

DBA should not cause cell loss by violating the CDVT at the UPC. Therefore, grant assignment should take this into account. There are two situations that may increase CDV. One is by burst grant assignment, and the other is by radical bandwidth update.

The first case can be illustrated by the following examples. Figure 28 shows comparison of grant assignment methods. Figure 28 a) shows the case of grant assignment as Fixed bandwidth assignment. Figure 28 b) shows burst assignment. Figure 29 shows examples of performance in each grant assignment method. These examples show cases where the utilization rate in one T-CONT is 0.8.

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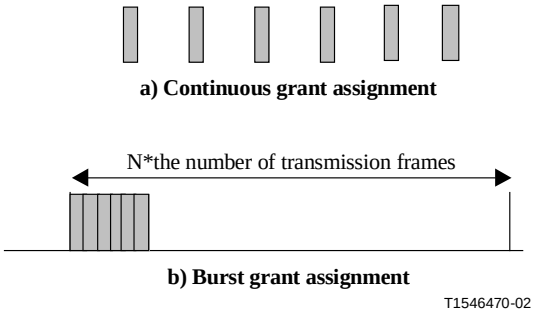


Figure 28/G.983.4 – Comparison between grant assignment methods

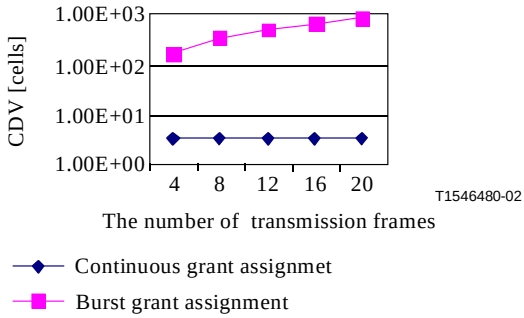


Figure 29/G.983.4 – Examples of performance in each grant assignment method

However, other methods to prevent the violation of CDVT, such as the new provisioning schemes for CDVT in the ATM-PON environment with DBA, may be required as future extensions.

8.3.5.10.4.3 Limitation of burst allocation for grant assignment

1) *Requirements*

The burst allocation for grants to T-CONTs shall be limited to within a few milliseconds, if the DBA-T-CONTs have enough traffic to use those grants.

2) *Backgrounds*

An excessively large burst allocation would result in discarded upstream cells by the UPC or would burden upstream shaping functions. Additionally, an excessively large burst allocation implies a long waiting time after the burst allocation. This causes large round trip times. TCP/IP Van-Jacobson slow start algorithm prevents very steep bandwidth ramp ups. The detailed criteria for the limitation of burst grant allocation and performance are under study.

8.3.5.10.5 Operations of grant assignment in combined environment

Table 6 presents operations concerning grant assignment for possible combinations of these OLTs and ONUs/ONTs when DBA functions are activated. It shows the bandwidth allocation schemes that may be used for each specific combination. The DBA enhancement should inherit the G.983.1 downstream frame format. OLTs and ONUs/ONTs from different equipment manufacturers should be interoperable based on Table 6.

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Table 6/G.983.4 – Operations of grant assignment

	NSR-ONU/ONT	SR-ONU/ONT	NSR-ONU/ONT and SR-ONU/ONT
Non-DBA-OLT	(non-DBA)	(non-DBA)	(non-DBA)
DBA-OLT	NSR-DBA	SR-DBA Or NSR-DBA	NSR-DBA for NSR-ONUs/ONTs and SR-DBA for SR-ONUs/ONTs Or NSR-DBA for both ONU/ONT types

The operation of NSR-DBA and SR-DBA described in this table are detailed in 8.3.5.10.1.2 and 8.3.5.10.1.3, respectively.

8.3.5.10.6 Target performance

This clause recommends some performance targets for the DBA protocol. The first two subclauses show performance targets that should be met regardless of input traffic or other variables. The remainder of this clause shows target performance for a standardized model for input traffic.

8.3.5.10.6.1 Waiting time

1) *Definition*

This is the waiting time for dynamic bandwidth allocation to a T-CONT with Assured bandwidth (T-CONT Types 2, 3, and 5) since the T-CONT buffer in the ONU/ONT receives new cells under the condition that it has not been allocated grants (See Figure 30).

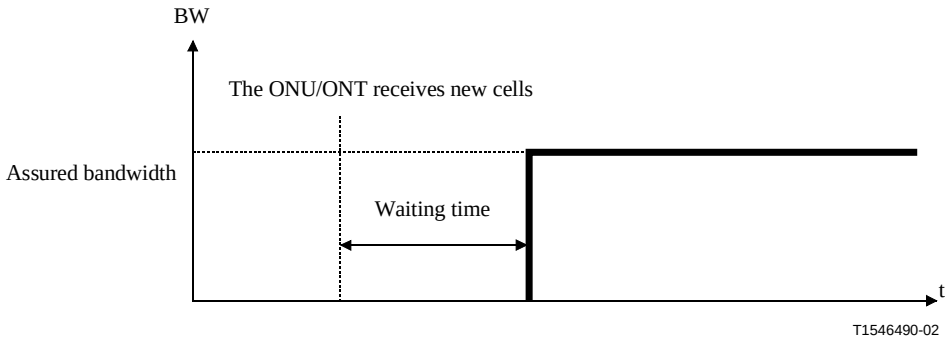


Figure 30/G.983.4 – Waiting time

2) *Target performance*

A few milliseconds shall be required (target of 2 ms).

3) *Background*

Longer waiting time means that greedier traffic gets more bandwidth. The waiting time should be kept short so that users generating less traffic are still allocated sufficient bandwidth. This requirement is related to allocation delay (based on reporting cycle, transmission delay, updating cycle of bandwidth allocation and so on) after rest time.

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8.3.5.10.6.2 Transition time

1) *Definition*

The transition time is defined as the time from an ONU/ONT's status change to a state where the ONU/ONT is consistently allocated the proper bandwidth (See Figure 31).

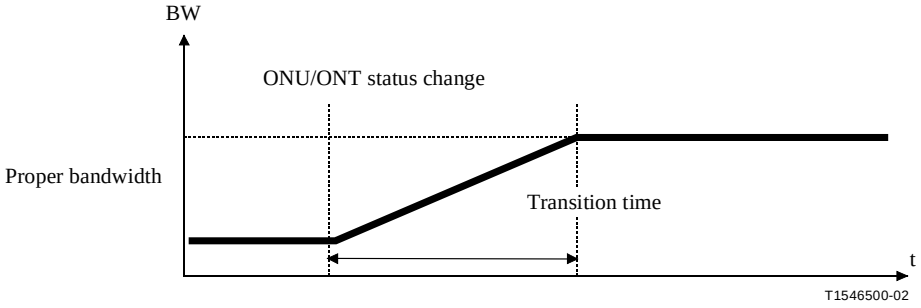


Figure 31/G.983.4 – Transition time

2) *Target performance*

Ten milliseconds shall be required (target of 6 ms).

3) *Background*

During transition time, bandwidth allocation is not fair. This requirement is related to the convergence time to achieve steady bandwidth allocation.

8.3.6 ATM specific TC functions

The specific information is described in ITU-T Rec. G.983.1.

8.3.7 OAM functions

The OAM functions that are installed in the ONU/ONT and OLT are shown in Figure 32. This figure also shows the notification signals between OLT and ONU/ONT. These signals are mapped into the message fields of the PLOAM cells. The general principles as defined in ITU-T Rec. I.610 can be applied to the PON. However, due to the point-to-multipoint nature of the physical medium, some notifications from OLT to ONU/ONT are obsolete principally due to the fact that the ONU/ONT is a slave to the OLT and the ONU/ONT is unable to do anything with these notifications.

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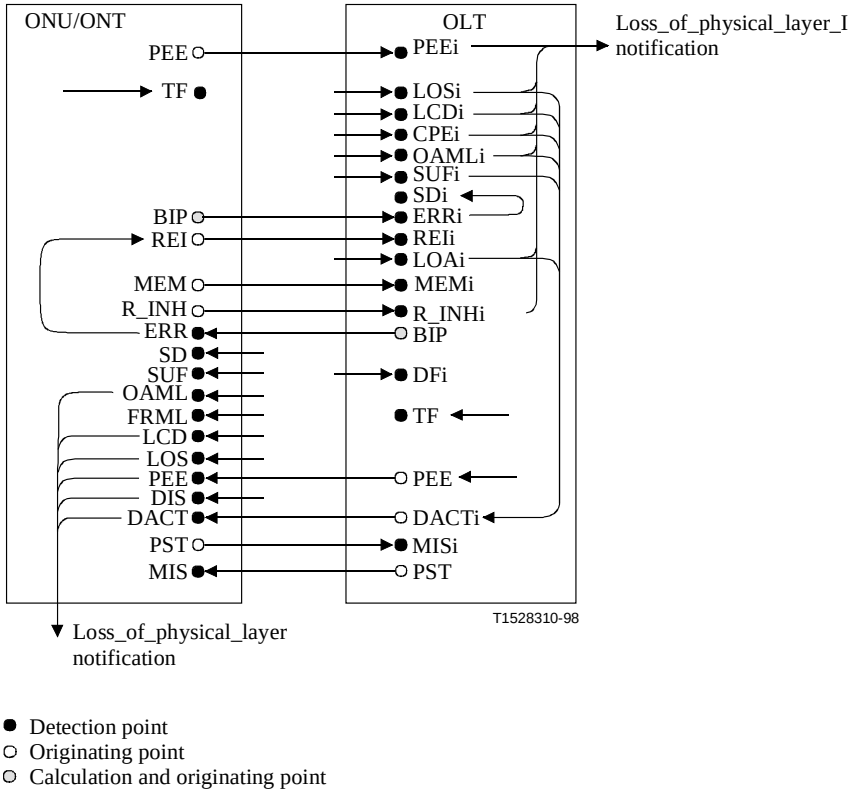


Figure 32/G.983.4 – OAM functions

When multiple T-CONTs are specified in the ONU/ONT, alarms in each T-CONT are merged and represented as alarms for the ONU/ONT accommodating these T-CONTs. Moreover, the specific alarm for divided_slots shall be defined to support SR-DBA. Figure 33 shows this alarm. This alarm is detected at the OLT and is described in 8.3.7.1.

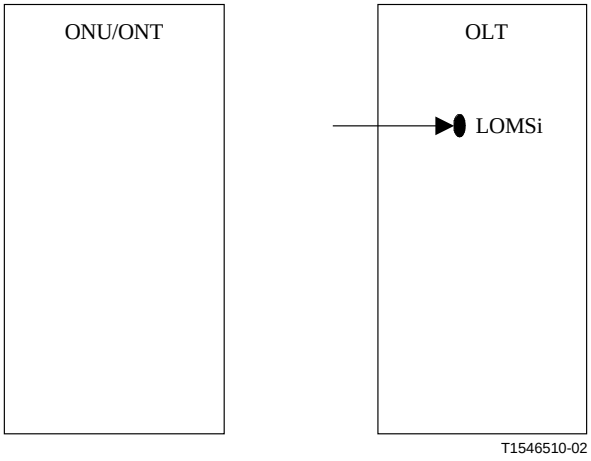


Figure 33/G.983.4 – OAM functions for divided_slot

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8.3.7.1 Items detected at OLT

This clause describes the items detected at the OLT. The items are captured in Table 7 and are listed according to type. Detail is provided for the detection conditions and associated actions as well as the cancellation conditions and associated actions.

Table 7/G.983.4 – Items detected at OLT

Type	**Description**	
	Detection conditions	*Actions*
	Cancellation conditions	*Actions*
TF	**Transmitter failure**	
	The OLT transmitter is declared in failure when there is no nominal backfacet photocurrent or when the drive currents go beyond the maximum specification.	
SUFi	**Startup failure of ONUi/ONTi**	
	The ranging of ONU/ONTi has failed n times (n = 2; refer to 8.4.4.3.3) while the OLT has received optical bursts from this ONU/ONT.	Send three times deactivate_PON_ID messages.
	The ONU/ONT is reranged successfully.	
PEEi	**Physical equipment error of ONUi/ONTi**	
	When the OLT receives a PEE from the ONU/ONT.	Generate Loss_of_physical_layer_I notification.
	When the OLT does not receive a PEE message from the ONUi/ONTi in three seconds.	Stop Loss_of_physical_layer_I notification.
LCDi	**Loss of cell delineation of ONUi/ONTi**	
	When eight consecutive invalid delimiters or invalid HECs from ONUi/ONTi are received.	Send three times deactivate_PON_ID messages. Generate Loss_of_physical_layer_I notification.
	When cell delineation for ONUi/ONTi is achieved in the operating state.	
OAMLi	**PLOAM cell loss for ONUi/ONTi**	
	When three consecutive PLOAM cells of ONUi/ONTi are missing.	Send three times deactivate_PON_ID messages. Generate Loss_of_physical_layer_I notification.
	When the OLT receives a PLOAM cell corresponding to its PLOAM grant in the Operating state.	
CPEi	**Cell phase error for ONUi/ONTi**	
	When the OLT is able to receive the correct delimiter and the received cell phase is beyond the limits and the corrective actions of the OLT do not solve the problem.	Send three times deactivate_PON_ID messages. Generate Loss_of_physical_layer_I notification.
	When the OLT receives a cell in the correct position in the operating state.	

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Table 7/G.983.4 – Items detected at OLT

	Description	
LOSi	**Loss of signal of ONUi/ONTi**	
	No valid optical signal at the O/E receiver received when expected for ONUi/ONTi during eight upstream sequential cells.	Send three times deactivate_PON_ID messages. Generate Loss_of_physical_layer_I notification.
	When the OLT receives a valid optical signal corresponding to its grant in the Operating state.	
LOAi	**Loss of acknowledge with ONUi/ONTi**	
	The OLT does not receive an acknowledge from ONUi/ONTi after a set of downstream messages that imply an upstream acknowledge.	Send three times deactivate_PON_ID messages. Generate Loss_of_physical_layer_I notification.
	When the OLT receives an acknowledge.	
DFi	**Deactivate failure of ONUi/ONTi**	
	The ONU/ONT does not react correctly after three DACT messages.	
	Cancelled by the operator.	
ERRi	**Block error detection of ONUi/ONTi**	
	The upstream received BIP8 is compared with the calculated BIP8 on the received stream. When there is a difference between them, the OLT issues ERRi.	
	ERRi should be renewed when the next upstream PLOAM cell is received at the OLT from ONUi/ONTi.	
SDi	**Signal degraded of ONUi/ONTi**	
	The number of differing bits is accumulated in Error_I during interval Tmeasure. The BER is defined as BER=Error_i/(BW*Tmeasure) where BW is the allocated upstream bandwidth. When the upstream BER of ONUi/ONTi becomes $\geq 10^{-5}$, this state is entered.	
	When the upstream BER of ONUi/ONTi becomes $<10^{-5}$, this state is cleared.	
REIi	**Remote error indication of ONUi/ONTi**	
	When the OLT receives a REI message it issues REIi.	
	ERRi should be renewed when the REI message is received at OLT from ONUi/ONTi.	

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Table 7/G.983.4 – Items detected at OLT

	Description	
MEMi	**Message_error message from ONUi/ONTi**	
	When the OLT receives an unknown message from ONUi/ONTi or received message_error message.	
	When the operator is informed.	
R-INHi	**Receive alarm inhibition of ONUi/ONTi**	
	When the OLT receives R-INH message from ONUi/ONTi, R-INHi is detected.	Ignore received alarms from this ONU/ONT. Generate Loss_of_physical_layer_I notification.
	When the OLT receives a PLOAM cell in the ranging process of ONUi/ONTi.	
MISi	**Link mismatch of ONUi/ONTi**	
	The OLT detects that the received PSTi and the transmitted PST are different.	
	The OLT detects that received PSTi and the transmitted PST are the same.	

Table 8 lists the items detected at the OLT that are specific to divided slots.

Table 8/G.983.4 – Specific items for divided_slots detected at OLT

Type	**Description**	
	Detection conditions	*Actions*
	Cancellation conditions	*Actions*
LOMSi	**Loss Of MiniSlot for ONUi/ONTi**	
	When eight consecutive minislots of ONUi/ONTi are missing.	
	When the OLT receives a minislot corresponding to its divided slot grant in the operating state.	

NOTE – Detailed specifications of detection and cancellation conditions are defined as follows.

Detection conditions:

– When one or more of following conditions is detected, LOMSi is generated.

– No valid optical signal at the O/E receiver received for ONUi/ONTi when expected during eight upstream sequential mini-slots.

– When eight consecutive invalid delimiters of mini-slots from ONUi/ONTi are received.

– When the OLT can receive the correct delimiter and the received mini-slot cell phase is beyond the limits and the corrective actions of the OLT do not solve the problem.

Cancellation conditions:

– When all of following conditions are recognized, LOMSi is cancelled.

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– When the OLT receives a valid optical signal corresponding to its mini-slot grant in the DBA operating state.

– When mini-slot cell delineation for ONUi/ONTi is achieved in the operating state.

– When the OLT receives a mini-slot cell in the correct position in the operating state.

8.3.7.2 Items detected at ONU/ONT

The specific information is described in ITU-T Rec. G.983.1.

8.3.8 Messages in the PLOAM channel

The specific information is described in ITU-T Rec. G.983.1.

8.3.8.1 Message definition

Message definitions for communication between the OLT and ONUs/ONTs are detailed in Table 9.

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Table 9/G.983.4 – Message definition

	Message Name	Function	Direction	Trigger	Number of times sent	Effect of receipt
1	No message	No message available when a PLOAM cell is transmitted.	OLT → ONU/ONT	Empty message queue.	–	Discard.
2	New_churning_key_rq	Requests a new churning key from the ONU/ONT.	OLT → ONU/ONT	OLT needs a new key for the churning mechanism.	1	ONU/ONT generates a new key and sends the key to the OLT with a new_churning_key message.
3	Upstream_RX_control	Instruct the ONU/ONT which pattern to fill in the RXCF part of the upstream PLOAM cell.	OLT → ONU/ONT	Each time a ranging process is started.	3	The ONU/ONT sets the upstream RXCF field of the upstream PLOAM cell.
4	Upstream_overhead	Instruct the ONU/ONT which overhead and pre-assigned equalization delay to use in the upstream direction.	OLT → ONU/ONT	Each time a ranging process is started.	3	The ONU/ONT sets the upstream overhead and the pre-assigned equalization delay.
5	Serial_number_mask	Provides a serial number and a mask masking a part of this serial number.	OLT → ONU/ONT	To find the serial number of a unique ONU/ONT.	1	If serial number and mask match the ONU/ONT's serial number, the ONU/ONT is enabled to react on ranging grants.
6	Assign_PON_ID	Links a free PON_ID number with the serial number also provided in this message.	OLT → ONU/ONT	When the OLT has found the serial number of a unique ONU/ONT.	3	The ONU/ONT with this serial number uses the returned PON_ID and will be addressed by this PON_ID.
7	Ranging_time	It indicates the value expressed in number of upstream bits that an ONU/ONT with the corresponding PON_ID must fill in into its equalization delay register.	OLT → ONU/ONT	When the OLT decides that the delay must be updated, see ranging protocol.	3	The ONU/ONT fills in the equalization delay register with this value.
8	Deactivate_PON_ID	It instructs an ONU/ONT with this PON_ID to stop sending upstream traffic and reset itself. It can also be a broadcast message.	OLT → ONU/ONT	When the LOSi, LCDi, OAMLi, LOAi, SUFi or CPEi are detected.	3	The ONU/ONT with this PON_ID switches off its laser and the PON_ID is discarded. It should be activated when the MPU is out of order.
9	Disable_serial_number	To disable an ONU/ONT with this serial number.	OLT → ONU/ONT	On command from the OpS.	3 or until no burst is detected.	Moves the ONU/ONT to the emergency stop state. The ONU/ONT cannot respond to grants.

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Table 9/G.983.4 – Message definition

10	Churning_key_update	To indicate to the ONU/ONT when the new churning key becomes valid. Priority level is 1.	OLT → ONU/ONT	When the OLT is ready to churn data for ONU/ONT with PON_ID.	3	The ONU/ONT switches to the new churning key 48*Tframe after the first update message. Send one acknowledge after each correctly received message.
11	Grant_allocation message	To allocate a data and PLOAM grant to an ONU/ONT.	OLT → ONU/ONT	After a PON_ID is allocated to the ONU/ONT, it needs a data and PLOAM grant for sending the upstream data and PLOAM cells.	3	The ONU/ONT stores the two grant types.
12	Divided_slot_grant_ configuration message	To allocate or deallocate a Divided_slot_grant to an ONU/ONT and identify the minislot length and offset position.	OLT → ONU/ONT	The OLT needs/no longer needs the service provided by the minislot.	3	The ONU/ONT sends the minislot after receiving this allocated divided_slot grant. If deallocated, it no longer reacts to this Divided_Slot_grant.
13	Configure_VP/VC	This message activates or deactivates a VP/VC in downstream and upstream for communication at the ATM layer.	OLT → ONU/ONT	When the OLT wants to set up or tear down a connection with the ONU/ONT, for example, for configuration of the UPC function, filling filtering tables or configuration of the interfaces of the ONU/ONT.	3	The ONU/ONT activates/deactivates these VP/VCs for the communication channel. Send one acknowledge after each correctly received message.
14	BER_interval	This defines the accumulation interval per ONU/ONT expressed in the number of downstream frames for the ONU/ONT counting the number of downstream bit errors. Same time-out as for Configure_VP/VC.	OLT → ONU/ONT	OpS defines this interval and can focus on one particular ONU/ONT.	3	The ONU/ONT starts a BER_interval timer and accumulates the downstream bit errors. Send one acknowledge after each correctly received message. The sequence number in the REI messages is reset.
15	PST message	To check the OLT-ONU/ONT connectivity in a redundant configuration and perform APS.	OLT → ONU/ONT	Send it at a certain rate.	1 time/second	ONU/ONT checks link number with own link number and generates a Link Mismatch MIS if different.
16	Physical_equipment_error message (PEE)	To indicate to the ONUs/ONTs that the OLT is unable to send both ATM cells and OMCC cells in the direction from ATM layer to TC layer.	OLT → ONU/ONT	When the OLT detects it cannot send both ATM cells and OMCC cells in the direction from ATM layer to TC layer.	1 time/second	System specific.

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Table 9/G.983.4 – Message definition

17	Churned_VP	To indicate to the ONUs/ONTs which VP/VC are churned or not.	OLT → ONU/ONT	When a new VP must be churned or not.	3	(Un)Mark this VP as churning. Send one acknowledge after each correctly received message.
18	Request_password message	Request the password from an ONU/ONT in order to verify it. The OLT has a local table of passwords for the connected ONUs/ONTs. If after a reranging, the password has changed, it will not activate this ONU/ONT.	OLT → ONU/ONT	After an ONU/ONT is ranged. This is optional.	1	Send the password message three times.
19	POPUP message	The OLT can request all connected ONUs/ONTs to restore their settings with the exception of the equalization delay and force the ONUs/ONTs to go from POPUP state to Operating standby state 3 (O7).	OLT → ONU/ONT	To speed up the reranging of a subset or all of the connected ONUs/ONTs.	3	The ONU/ONT restores the parameters it was using in operating state before it detected an LOS, LCD, OAML or FRML, with the exception of the equalization delay which is set to the pre-assigned equalization delay value.
20	Vendor_specific message	A number of Message_IDs are reserved for vendor specific messages.	OLT → ONU/ONT	Vendor specific.	Vendor specific.	Vendor specific.
21	No message	No message available when a PLOAM cell is transmitted.	OLT ← ONU/ONT	Empty message queue.		Discard.
22	New_churning_key	Contains a new key to be used on the downstream churned cells to this ONU/ONT. Priority level is 1.	OLT ← ONU/ONT	After the OLT request, the ONU/ONT fetches a new key and sends it to the OLT.	3 times	The OLT initializes the churning engine with this new key if it receives three consecutive identical keys and switches to the new key 48*Tframe after the first churning_key_update message.
23	Acknowledge	This is used by the ONU/ONT to indicate the reception of a downstream Configure_VP/VC, Churning_key_update, Churned_VP, BER_interval message or Additional_Grant allocation message. Priority is 1 for the acknowledge on the churning_key_update message. The priority level is 0 for the others. The time-out for the acknowledge is 300 ms.	OLT ← ONU/ONT	After receiving every correct corresponding downstream message.	1 time	The OLT is informed of good reception of the downstream message it was sending and performs the corresponding actions.

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Table 9/G.983.4 – Message definition

24	Serial_number_ONU/ONT	This message contains the serial number of an ONU/ONT.	OLT ← ONU/ONT	The ONU/ONT sends this message when in ranging mode and on receipt of a ranging grant or a PLOAM grant.	X (may be sent several times during the ranging protocol).	The OLT extracts the serial number and can assign a free PON_ID to this ONU/ONT.
25	Message_error message	This indicates that the ONU/ONT is unable to comply with a message from the OLT.	OLT ← ONU/ONT	When the ONU/ONT is unable to comply with a message contained in a downstream PLOAM cell.	3	Inform the operator.
26	REI (Remote Error Indication)	This contains the number of downstream BIP mismatches (one count per bit mismatch) counted during the BER_interval.	OLT ← ONU/ONT	When the BER_interval has expired.	1 time/BER_interval	The OLT can show the average BER in function of time for an ONU/ONT.
27	R-INH	Used to inform the OLT that the ONU/ONT will power-off in a normal manner. This is to prevent the OLT from issuing unnecessary alarm reports. Priority level is 2.	OLT ← ONU/ONT	The ONU/ONT generates this message when the power-off (such as the power switch off or the power cord extraction without battery backup) is activated in a normal operation.	At least 3 times	Discard any following alarms from this ONU/ONT. Inform OpS.
28	PST message	To check the OLT-ONU/ONT connectivity in a redundant configuration and perform APS.	OLT ← ONU/ONT	Send it at a certain rate.	1 time/second	OLT checks link number with own link number and generates a Link Mismatch MISi if different.
29	Physical_equipment_error	To indicate to the OLT that the ONU/ONT is unable to send both ATM cells and OMCC Cells in the direction from ATM layer to TC layer.	OLT ← ONU/ONT	When the ONU/ONT detects it cannot send both ATM cells and OMCC Cells in the direction from ATM layer to TC layer.	1 time/second	System specific
30	Password	Used to verify an ONU/ONT based on its password.	OLT ← ONU/ONT	When the OLT requests the password by the request_ password message.	3	If OLT receives three identical passwords, it is declared as valid. Further processing is system dependent.
31	Vendor_specific message	A number of Message_Ids are reserved for vendor specific messages.	OLT ← ONU/ONT	Vendor specific.	Vendor specific	Vendor specific.
32	Additional_Grant_allocation message	To allocate 2nd or additional data grants to ONU/ONT.	OLT → ONU/ONT	After a PON_ID is allocated to the ONU/ONT, it needs a data grant for sending the upstream data.	3	ONU/ONT has 2nd or additional data grant. Send one acknowledge after each correctly received message.

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8.3.8.2 Message formats

This clause defines the contents of messages in the previous clause .

8.3.8.2.1 Downstream message formats

This clause describes the downstream message formats.

The following messages are described in ITU-T Rec. G.983.1:

No message

Upstream_Rx_Control message

Upstream_overhead message

Ranging_time message

Serial_number_mask message

Assign_PON_ID message

Deactivate_PON_ID message

Disable_serial_number message

New_churning_key_request message

Churning_key_update message

Configure VP/VC message

Physical_equipment_error message

Request_password message

Churned_VP message

POPUP message

Vendor_specific message

PST message

BER_interval message

Additional messages are used to accommodate DBA. Given the ONU/ONT's DBA parameters, the OLT can then configure the ONU/ONT to recognize additional data grants, send reports containing T-CONT buffer status via the divided slot channel, and reconfigure the reporting of T-CONTs without interruption of the reporting service. The three messages in the PLOAM channel that are used to perform this are the Grant_allocation_message, the Additional_grant_allocation message, and the Divided_slot_configuration message. The formats of these messages are given below.

1) *Grant_allocation message*

   This message is applied to the first grant allocation. The format of this message is described in Table 10 and is the same as in ITU-T Rec. G.983.1.

2) *Additional_grant_allocation_message*

   A new message called Additional_grant_allocation message is defined as follows to address the grant assignment to T-CONTs. The message id is 32. This message is used for the DBA system. The original Grant_allocation message is only used initially during the ranging process. After that, the new Additional_grant_allocation message should be used to specify the divided slot grant, field offset, report type of this T-CONT, and grant. The format of this message is shown in Table 11.

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This message is sent to an ONU/ONT for each T-CONT inside the ONU/ONT. Each T-CONT is assigned a unique data grant. In other words, there is a one–to-one mapping between each data grant and each T-CONT. The T-CONT_ID is used to provide an extra layer of abstraction between the grant number and the T-CONT buffer in the ONU/ONT. These must always exist in a one-to-one mapping between an active T-CONT_ID and data grant. This abstraction allows for the grant number to be changed while maintaining the VP/VC configuration with the T-CONT_ID, which is likely to occur in reranging or provisioned scenarios.

3) *Divided_slot_grant_configuration message*

Divided_slot_grant_configuration message is unchanged from its definition in ITU-T Rec. G.983.1. For ease of reference, this message is shown in Table 12.

Table 10/G.983.4 – Grant_allocation message

Octet	Content	Description
35	PON_ID	Directed message to one ONU/ONT
36	0000 1010	Message identification "Grant_allocation"
37	dddd dddd	data grant allocated to the ONU/ONT with this PON_ID
38	0000 000a	a:1 = Activate data grant for this ONU/ONT a:0 = Deactivate data grant for this ONU/ONT
39	pppp pppp	PLOAM grant allocated to the ONU/ONT with this PON_ID
40	0000 000a	a:1 = Activate PLOAM grant for this ONU/ONT a:0 = Deactivate PLOAM grant for this ONU/ONT
41..46	0000 0000	Reserved
NOTE – Grant_allocation message is used for first data grant and is the same in ITU-T Rec. G.983.1.		

Table 11/G.983.4 – Additional_grant_allocation message

Octet	content	Description
35	PON_ID	Directed message to one ONU/ONT
36	0010 0000	Message identification for "Additional_grant_allocation"
37	dddd dddd	Data grant allocated to a T-CONT within the ONU/ONT with this PON_ID
38	0000 000a	a: 1 – Activate data grant for this T-CONT a: 0 – Deactivate data grant for this T-CONT
39	T-CONT_ID	The T-CONT_ID associated with this grant
40	DS_GR	Divided slot grant that this T-CONT will use to report status. 255 = no reporting for this T-CONT
41	RPT_type	Report type for this T-CONT 0 = default (1 byte, non-linear, total cells in buffer) Other values are for future use, described in Appendix II
42	FLD_offset	field_offset for this T-CONT. Within the range [0, 52]. field_offset = 0 means T-CONT report starts right after the 3 bytes of overhead within the minislot. Offsets include any CRC fields contained within the minislot, hence an offset of 14, 29, 44, or 52 is always invalid here.
43…46	0000 0000	Reserved

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Table 12/G.983.4 – Divided_Slot_Grant_configuration message

Octet	Content	Description
35	PON_ID	Directed message to one ONU/ONT
36	0000 1011	Message identification "Divided_slot_grant_configuration"
37	0000 000a	a:1 = Activate grant for this ONU/ONT a:0 = Deactivate grant for this ONU/ONT
38	DS_GR	Defines the grant value allocated to this ONU/ONT for sending a minislot. NOTE – the OLT can assign plural data grants.
39	LENGTH	Defines the length of the minislot payload in number of bytes.
40	OFFSET	Defines the offset of the start of the minislot in number of bytes from the start of an upstream cell slot. OFFSET = 0 means minislot starts at the first byte of the upstream slot.
41	Service_ID	Defines the service to be mapped into the minislot. 0000 0000 is used for the MAC protocol. Other values are for reserved for expansion.
42..46	0000 0000	Reserved

8.3.8.2.2 Upstream message formats

The specific information is described in ITU-T Rec. G.983.1.

8.3.9 Automatic protection switching

The specific information is described in ITU-T Rec. G.983.1.

8.4 Ranging method

8.4.1 Scope of the applied ranging method

The specific information is described in ITU-T Rec. G.983.1.

8.4.2 Features of ranging method for DBA

Basically, the ranging method for DBA is the same as that in ITU-T Rec. G.983.1 to maintain backward compatibility with the existing ONU/ONT specified in ITU-T Rec. G.983.1. Moreover, the ONU/ONT should accept Additional_grant_allocation messages when in an operating state in order to be sent multiple data grants by the OLT.

8.4.3 Phase relation specification between downstream and upstream

The specific information is described in 8.4.2/G.983.1.

8.4.4 Definition of messages used in the ranging protocol

The specific information is described in 8.4.3/G.983.1.

8.4.5 Ranging procedure

8.4.5.1 Overall ranging procedure

The specific information is described in ITU-T Rec. G.983.1.

8.4.5.2 Ranging procedure in the ONU/ONT

The specific information is described in ITU-T Rec. G.983.1.

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8.4.5.3 States of the ONU/ONT

The states and state transitions for the ONU/ONT are shown in Table 13. This table is similar to the state table found in Table 28/G.983.1 but includes an Additional_Grant_Allocation message.

8.4.5.4 Behaviour specification in the ONU/ONT

The ability to support multiple T-CONTs is achieved by allocating a new grant in the Operating state when the PON_ID matches its own PON_ID.

8.4.5.4.1 Message reception

The messages conveyed in the PLOAM cells from the OLT should be protected by the CRC, and the message receive-event should be generated when the CRC check is correct. In the case of a), c), d), and e) below, these messages are sent three times to ensure correct reception at the ONU/ONT. In these cases the message receive-event is generated after the message has been received correctly at least once.

a) *The receive-event of Upstream_overhead message*

The specific information is described in 8.4.4.2.2.1/G.983.1.

b) *The receive-event of Serial_number_mask message*

The specific information is described in 8.4.4.2.2.1/G.983.1.

c) *The receive-event of Assign_PON_ID message*

The specific information is described in 8.4.4.2.2.1/G.983.1.

d) *The receive-event of the Grant_allocation message*

The specific information is described in 8.4.4.2.2.1/G.983.1.

e) *The receive-event of Ranging_time message*

The specific information is described in 8.4.4.2.2.1/G.983.1.

f) *The receive-event of Deactivate_PON_ID message*

The specific information is described in 8.4.4.2.2.1/G.983.1.

g) *The receive-event of Disable_serial_number message*

The specific information is described in 8.4.4.2.2.1/G.983.1.

h) *The receive-event of POPUP message*

The specific information is described in 8.4.4.2.2.1/G.983.1.

i) *The receive-event of the Additional_grant_allocation message*

When the PON_ID in the Additional_Grant_allocation message matches its own PON_ID, an additional data grant is assigned and an acknowledgement is sent.

8.4.5.4.2 Grant reception

The specific information is described in ITU-T Rec. G.983.1.

8.4.5.4.3 Other events

The specific information is described in ITU-T Rec. G.983.1.

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Table 13/G.983.4 – The state diagram of the ONU/ONT

	Initial state (O1)	**Ranging standby state-1 (O2)**	**Ranging standby state-2 (O3)**	**Ranging standby state-3 (O4)**
Upstream_overhead message	–	extract overhead set pre-assigned delay Te ⇒ O3	–	–
Optical power set-up complete	–	–	timer TO1 start ⇒ O5	timer TO1 start ⇒ O5
Serial_number_mask message	–	–	match SN(valid bits)? ⇒ O4	unmatch SN(valid bits)? ⇒ O3
Assign_PON_ID message	–	–	–	–
Grant_allocation message	–	–	–	–
POPUP message	–	–	–	–
timer TO2 expire	–	–	–	–
timer TO1 expire	–	–	–	–
Ranging_time message	–	–	–	–
data grant	–	–	–	–
PLOAM grant	–	–	–	–
ranging grant	–	–	–	send PLOAM cell
Deactivate_PON_ID message (Note)	–	–	match PON_ID? ⇒ O2	match PON_ID? ⇒ O2
Disable_serial_number message	–	Match SN and enable = FFh? ⇒ O9	match SN and enable = FFh? ⇒ O9	match SN and enable = FFh? ⇒ O9
detect LOS or LCD or OAML or FRML	–	⇒ O1	⇒ O1	⇒ O1
clear LOS and LCD and OAML and FRML	⇒ O2	–	–	–
Additional_grant_allocation message	–	–	–	–

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Table 13/G.983.4 – The state diagram of the ONU/ONT

	Operating standby state-1 (O5)	**Operating standby state-2 (O6)**	**Operating standby state-3 (O7)**
Upstream_overhead message	–	–	–
Optical power set-up complete	–	–	–
Serial_number_mask message	match SN(valid bits)? ⇒ O6	unmatch SN(valid bits)? ⇒ O5	–
Assign_PON_ID message	match SN? → assign PON_ID	match SN? → assign PON_ID	–
Grant_allocation message	match PON_ID? → allocate data/PLOAM grant ⇒ O7	match PON_ID? → allocate data/PLOAM grant ⇒ O7	–
POPUP message	–	–	–
timer TO2 expire	–	–	–
timer TO1 expire	⇒ O3 (alarm SUF)	⇒ O3 (alarm SUF)	⇒ O3 (alarm SUF)
Ranging_time message	–	–	match PON_ID? → timer TO1 stop → set equalization delay ⇒ O8
data grant	–	–	–
PLOAM grant	–	–	send PLOAM cell
ranging grant	–	send PLOAM cell	–
Deactivate_PON_ID message (Note)	match PON_ID? → timer TO1 stop ⇒ O2	match PON_ID? → timer TO1 stop ⇒ O2	match PON_ID? → timer TO1 stop ⇒ O2
Disable_serial_number message	match SN and enable = FFh? → timer TO1 stop ⇒ O9	match SN and enable = FFh? → timer TO1 stop ⇒ O9	match SN and enable = FFh? → timer TO1 stop ⇒ O9
detect LOS or LCD or OAML or FRML	Timer TO1 stop ⇒ O1	timer TO1 stop ⇒ O1	timer TO1 stop ⇒ O1
clear LOS and LCD and OAML and FRML	–	–	–
Additional_grant_allocation message	–	–	–

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Table 13/G.983.4 – The state diagram of the ONU/ONT

	Operating state (O8)	**Emergency stop state-1 (O9)**	**POPUP state (O10)**
Upstream_overhead message	–	–	–
Optical power set-up complete	–	–	–
Serial_number_mask message	–		
Assign_PON_ID message	–	–	–
Grant_allocation message	–	–	–
POPUP message	–	–	Restore laser settings, Upstream_overhead, LCF and RXCF fields, Te, PON_ID, and Grant allocation, timer TO1 start ⇒ O7
timer TO2 expire	–	–	⇒ O1
timer TO1 expire	–	–	–
Ranging_time message	match PON_ID? → update equalization delay	–	–
data grant	send ATM cell	–	–
PLOAM grant	send PLOAM cell	–	–
ranging grant	–	–	–
Deactivate_PON_ID message (Note)	match PON_ID? ⇒ O2	–	–
Disable_serial_number message	match SN and enable = FFh? ⇒ O9	match SN and enable = 00h? or enable = 0Fh and SN irrelevant ⇒ O1	–
detect LOS or LCD or OAML or FRML	Start timer TO2 ⇒ O10	–	⇒ O10
clear LOS and LCD and OAML and FRML	–	–	–
Additional_grant_allocation message	match PON_ID? → allocate data grant and send acknowledge	–	–

NOTE – Receive-event of a broadcast Deactivate_PON_ID message (the 35th octet of PON_ID = 40h) is also assumed.
An ONU/ONT will leave the Operating state if a fault occurs or power is removed from the ONU/ONT.
Only maintenance signals of LOS, LCD, OAML, and FRML are considered in this state diagram.
"–" means no action for corresponding event.
PLOAM cell in the state of O4 should be transmitted in pre-assigned delay Te.
PON_ID and Grant allocation should be cleared or discarded when the state transitions to O1, O2, O3, and O9 occur, and pre-assigned delay Te should be cleared in transitions to O1 and O2.

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8.4.5.4.4 Ranging procedure in the OLT

The specific information is described in ITU-T Rec. G.983.1.

8.4.6 Ranging time requirements

The specific information is described in 8.4.5/G.983.1.

8.5 Handshake procedures

8.5.1 Overall handshake procedure

The typical model of class queues and T-CONTs in the ONU/ONT is shown in Figure 34. The procedures relating T-CONTs to grants are defined in this Recommendation; the procedures relating VPs to class queues are defined in ITU-T Rec. G.983.2, and the procedures relating queues to T-CONTs are defined in ITU-T Rec. G.983.7.

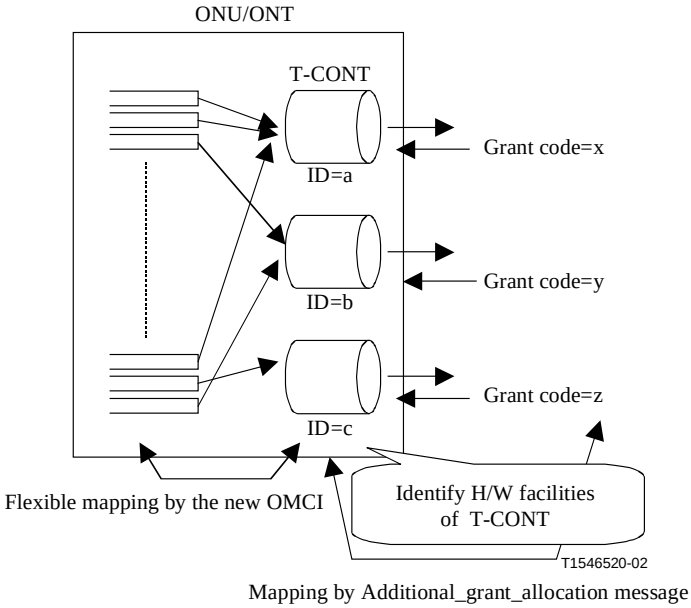


Figure 34/G.983.4 – Typical model of class queue and T-CONTs in the ONU/ONT

8.5.2 Negotiated parameters

To configure the additional data grants and divided slot reporting, the OLT must learn the capabilities of the ONU/ONT in question. This information shall be obtained using the OMCI channel. The detailed procedures of the information exchange are described in ITU-T Rec. G.983.7. The key parameters for the TC layer functions described here are listed in Table 14.

Table 14/G.983.4 – ONU/ONT parameters obtained via the DBA OMCI handshake

Parameter Name	Valid range
Maximum_data_grants	1..252
Maximum_divided_slot_grants	0..252
T-CONT_buffer_reporting_types	0..255

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The maximum_data_grants parameter can range from 1 (for an ONU/ONT with a single T-CONT) up to the theoretical maximum of 252 data grants (all the data grants on a PON with one ONU/ONT, although this is unlikely).

The maximum_divided_slot_grants parameter can range from 0 to 252. The minimum in this case (0) is for NSR-ONUs/ONTs. The cases of one or more divided_slot_grants are applied to SR-ONUs/ONTs. If operations of glitch-free reconfiguration specified in 8.6.2 are applied, two or more divided_slot_grants should be reserved. One of these divided_slot_grants cannot be used for real service, and should be used to step aside in transition of glitch-free operations according to 8.6.2. In SR-DBA, when glitch-free reconfiguration is not required, the case of one divided_slot_grant can be applicable. Moreover, if glitch-free operations that do not require one reserved divided_slot_grant besides operations in 8.6.2 are specified in the future, the case of one divided_slot_grants can be applicable even if glitch-free reconfiguration can be supported. The maximum is the same as for the data grants.

The T-CONT-buffer_reporting_types is a special code that indicates the kinds of reports that this ONU/ONT can perform. Only one code (0) is defined as a normative default, and this signifies that the ONU/ONT shall report the total number of cells in the T-CONT buffer. Other codes are described in Appendix II.

8.5.3 Detailed procedures

Figure 35 shows the handshake sequence between the OLT and the ONU/ONT.

Step 1 – Basic configuration of ONU/ONT

This procedure is specified in UIT-T Rec. G.983.1. A grant is allocated in the ranging procedure, although the ONU/ONT is assumed to be NSR for the moment.

Step 2 –The OLT gets the information about ONUs/ONTs

This procedure is specified in UIT-T Rec. G.983.7. The OLT gets the following DBA support information from ONU/ONT:

– The number of divided slot grants supported in this ONU/ONT.
– The number of T-CONTs supported in this ONU/ONT.
– The capability of T-CONT buffer reporting types for this ONU/ONT.

Step 3 – Allocating a Divided-slot grant to the ONU/ONT

If the ONU/ONT is able to report buffer status, the OLT sends "Divided_Slot_Grant_configuration message" to the ONU/ONT.

In this message the OLT specifies:

– The minislot grant for this ONU/ONT.
– The minislot length for this ONU/ONT.
– The minislot offset for this ONU/ONT.

Step 4 – Allocating a new data grant to the T-CONTs, or re-binding an existing data grant to a reporting field

The OLT sends Additional_grant_allocation message to the ONU/ONT. In this message the OLT specifies:

– The additional data grant for this ONU/ONT.
– The T-CONT ID associated with this data grant.

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– The minislot report type of this T-CONT.

– The divided slot grant for this T-CONT to use for reporting.

– The minislot field_offset for this T-CONT within the minislot.

After receiving this message, the ONU/ONT is able to associate the new or existing data grant to the appropriate minislot report field.

If the ONU/ONT has multiple T-CONTs (grants), then the OLT needs to send this message multiple times, once per T-CONT.

Step 5 –Configuration of user VPs

This procedure is specified in ITU-T Recs. G.983.1, G.983.2 and G.983.7. The class queue is related to the T-CONT by the OMCI message.

Step 6 – Status reporting

This is the actual transmission of minislot reports in response to divided slot grants, as described in this Recommendation.

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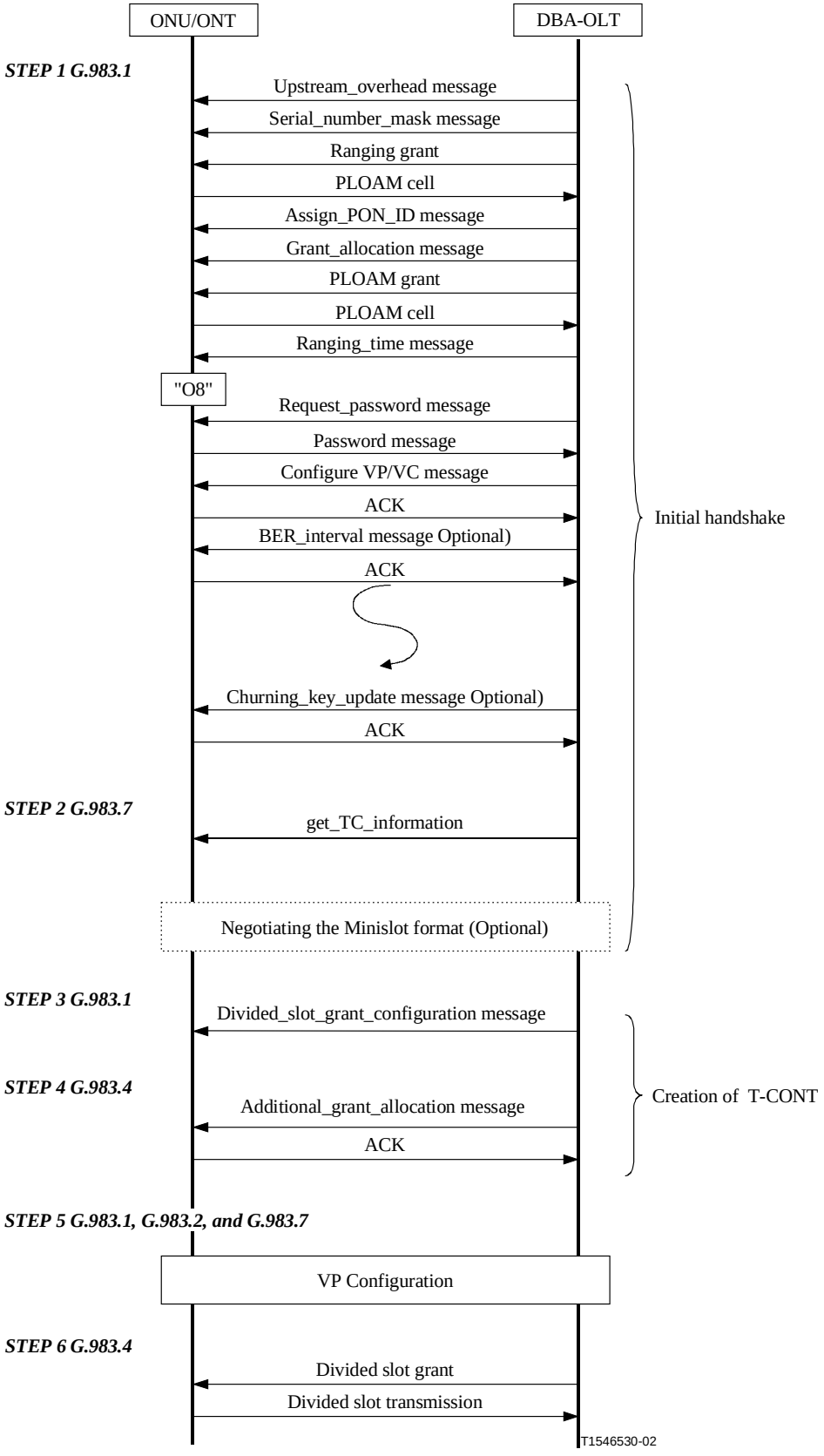


Figure 35/G.983.4 – The sequence between the OLT and the ONU/ONT

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8.6 Operations for creation and deletion of T-CONTs

8.6.1 Requirements for operations of T-CONT status change

T-CONTs on the ONU/ONT will be activated or deactivated according to user services in the operating status. In this situation the following requirements shall be met:

a) *Partial activation of T-CONTs in a single SR-ONU/ONT*

The OLT shall be able to activate individual T-CONTs in an SR-ONU/ONT as necessary. (R)

The number and configuration of T-CONTs is expected to vary from SR-ONU/ONT to SR-ONU/ONT. The number of T-CONTs activated for any SR-ONU/ONT may not be the maximum number of T-CONTs that particular SR-ONU/ONT is capable of physically supporting.

b) *The modification of the number of activated T-CONT in operating state (O8)*

In operating state (O8), the number of activated T-CONTs inside an individual ONU/ONT shall be able to be modified according to changes of user configuration, operational situation, etc. (R)

c) *Impact of addition or deletion of T-CONTs*

Addition or deletion of individual T-CONTs shall not affect other T-CONTs serviced by an individual ONU/ONT. (R)

Addition or deletion of individual T-CONTs or groups of T-CONTs shall not affect service to other T-CONTs served from an individual PON-IF board (or any other PON-IF board – this includes connections and ATM traffic).

The change of set-up values of one T-CONT shall not affect the other T-CONTs serviced by the same ONU/ONT and serviced by the same PON-IF board, their connections, nor their ATM traffic.

d) *Selection of T-CONT buffers*

Any T-CONT buffer shall be individually selectable to support operational requirements.

When a T-CONT number is mapped to a specific T-CONT buffer, the selection of the T-CONT number inside the ONU/ONT shall also be selected.

8.6.2 Operations for creation of T-CONTs

Reconfiguration of minislot reporting without impairments

Configuration and reconfiguration of the minislot reporting system shall not cause any data errors or omissions in the underlying MAC information. There are two major parts of configuration:

– Configuration of the divided slots,

– Configuration of the T-CONT reports within the minislots.

The divided slots are configured using the Divided_slot_grant_configuration message. The configuration of the divided slot has the properties that:

1) multiple ONUs/ONTs can be affected by a change;

2) the timing recovery at the OLT must be coordinated with the configuration, and

3) the CRC checking must be coordinated with the configuration. For these reasons, it is not practical to modify a divided slot configuration.

The only allowed operations are activate and deactivate. Specifically, for any divided slot grant/PON_ID combination, it may be illegal to send consecutive activating Divided_slot_grant_configuration messages with a different offset or size.

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For example, suppose an ONU/ONT has a divided slot configured that contains 4 report fields and then needs a fifth reporting field. It is not permissible to send a new configuration with a longer length, even if space exists in the divided slot. This is because the ONU/ONT will respond asynchronously to the new configuration, and the OLT will not know where to look for the trailing CRC. A similar problem occurs with changing the offset (start) of the minislot. The OLT will not know when to start looking for the start of the minislot. In either case, the OLT will not receive the information, and there will be a reporting impairment.

Therefore, to achieve a resizing or relocation of a minislot retransmission, the procedure will be to first create a new minislot, transfer the reporting functionality to this new minislot, and then delete the old minislot. Since an ONU/ONT can only transmit one minislot per divided slot grant, this implies that the new minislot must exist in another divided slot. This is not as restrictive as it sounds, because to achieve optimal packing of the variable sized minislots into the divided slots it will be necessary to move all the minislots contained in one divided slot to a new divided slot.

The configuration of the T-CONT reports within the minislots is mediated by the Additional_grant_allocation message. The fields in this message specify the current divided slot grant and offset to be used in reporting the T-CONT status. Note that this message can be sent in 3 cases:

Case 1: This is a new grant allocation.

Case 2: This is an existing grant deallocation.

Case 3: This is an existing grant, being reconfigured to report in a different minislot.

The first and second cases are clear, as they are the simple activate-deactivate pair, much like the use of the Grant_allocation message in ITU-T Rec. G.983.1. The third case is used to reconFigure an existing T-CONT report to a new minislot, offset combination. Thus, the behaviour of the ONU/ONT upon receiving an Additional_grant_allocation message containing a grant number that was previously allocated is as follows:

– Do not modify any of the traffic-affecting properties of the T-CONT.

– Change the minislot reporting association of that T-CONT to the newly specified one.

– Fill the now unused field in the old minislot with the idle code (0xFF).

No particular timing relationship between the receipt of the message and the change is assumed. The OLT will be able to determine which of the two fields is active by looking for the idle code. Note that case 3 of the Additional_grant_allocation message can be applied to the grant that was provisioned using the Grant_allocation_message during the ranging procedure. In this way, that initial grant can be made into whatever type of T-CONT is needed for service.

An illustration of the divided slot configuration and reconfiguration at creation of T-CONTs is given in Figure 36. The presumed sequence of this process is that the ONU/ONT is initially configured with 3 T-CONTs and then requires a fourth T-CONT. Note that in this sequence, steps 1-4 are the initial configuration, and steps 5-9 are the reconfiguration actions. The figure shows the contents of two minislots in divided slots No. 23 and No. 24 in the middle and right columns, respectively.

NOTE – When the minislot is first created, the unused fields are filled with the idle code (0xFF).

Note that between steps 1 and 9, the minislot with offset zero in divided_slot No. 23 is well defined. Its beginning is at offset 0, and it has a total length of 7 bytes; therefore, its only CRC is found at offset = 6. This CRC is calculated by the ONU/ONT on whatever the minislot contains (idle codes or real reports). Hence, the OLT calculates the CRC on the received sequence, no matter what step the configuration process is in. The same applies to the other minislot contained in divided_slot No. 24 from step 5 onward. This ensures that the lower layer processing at the OLT always has integrity.

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The approach being taken here is that the minislot transmission is exactly the right size for the number of T-CONTs being reported. This obviously requires a significant amount of messaging effort to maintain, and in many cases it will not reduce the bandwidth consumed by the minislots. A more efficient approach is to provision a modest but non-zero number of idle report fields for each ONU/ONT and utilize these as T-CONTs are provisioned and de-provisioned.

Also note that the interchange in Figure 36 only concerns one ONU/ONT's transmissions. So, while ONU/ONT 1 moves its minislot from divided slot No. 23 to No. 24, another ONU/ONT could perhaps move its minislot from yet another divided slot to divided slot No. 23. In this case, divided slot No. 23 would not be unscheduled (following step 10). By moving ONUs/ONTs back and forth between a given set of divided slot grants, much reconfiguration can be achieved without actually adding new divided slots or removing old ones. However, there is a limit to the reconfigurations possible in this piecewise reconfiguration, as gaps between odd-size minislots are bound to form. This problem is addressed by the process of divided slot configuration, described below.

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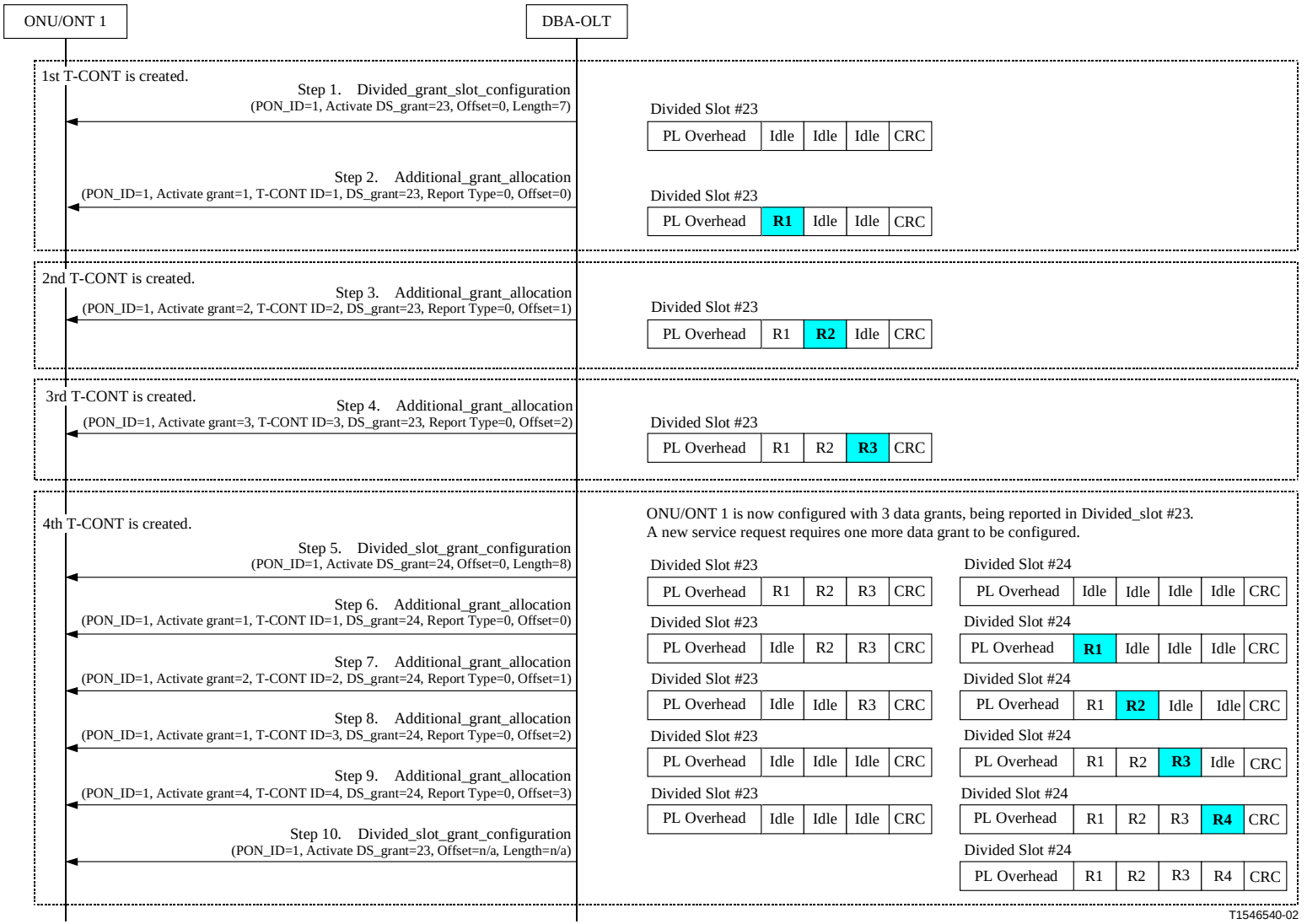


Figure 36/G.983.4 - Creation procedure of T-CONTs and glitch-free minislot transmission for one ONU/ONT

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8.6.3 Operations for deletion of T-CONTs

An illustration of the divided slot configuration and reconfiguration at deletion of a T-CONT is given in Figure 37. The presumed sequence of this process is that the ONU/ONT is initially configured with 4 T-CONTs and then no longer requires the 2nd and 4th T-CONTs. Note that in this sequence, steps 12-13 are the deletion actions, and steps 14-17 are the defragmentation action. The Figure shows the contents of two minislots in divided slots No. 23 and No. 24 in the middle and right columns, respectively.

Note that between steps 12 and 16, the minislot with offset zero in divided_slot No. 24 is well defined. Its beginning is at offset 0, and it has a total length of 8 bytes; therefore, its only CRC is found at offset = 7. This CRC is calculated by the ONU/ONT on whatever the minislot contains (idle codes or real reports). Hence, the OLT calculates the CRC on the received sequence, no matter what step the configuration process is in. This ensures that the lower layer processing at the OLT always has integrity.

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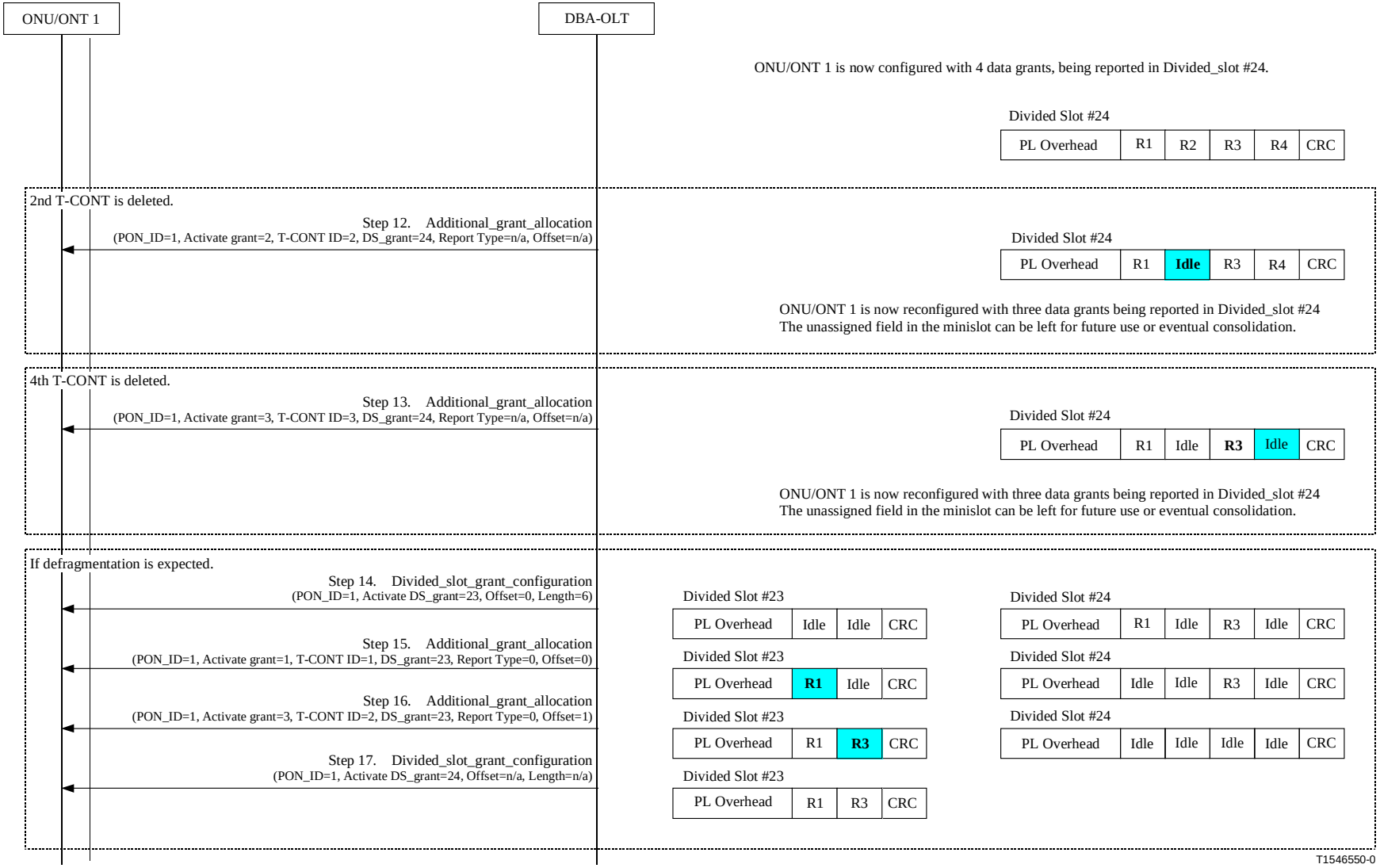


Figure 37/G.983.4 – Creation procedure of T-CONTs and glitch-free minislot transmission for one ONU/ONT

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8.6.4 Impact by T-CONT status change

As described in 8.6.2 and 8.6.3 and to avoid glitches, the OLT should reconfigure minislots without interruption of the reporting service.

Figure 38 describes in general terms the process of divided slot consolidation, where several ONUs/ONTs' minislots are reconfigured in order to fit them into a small number of divided slots.

Note that in the beginning case, two divided slots contain a number of poorly utilized and poorly spaced minislots. By a process of shifting each of these minislots into a more efficient version in a third minislot, all of the ONUs/ONTs can report in a single slot, and the two inefficient divided slots can be completely deconfigured and then taken out of the grant scheduler.

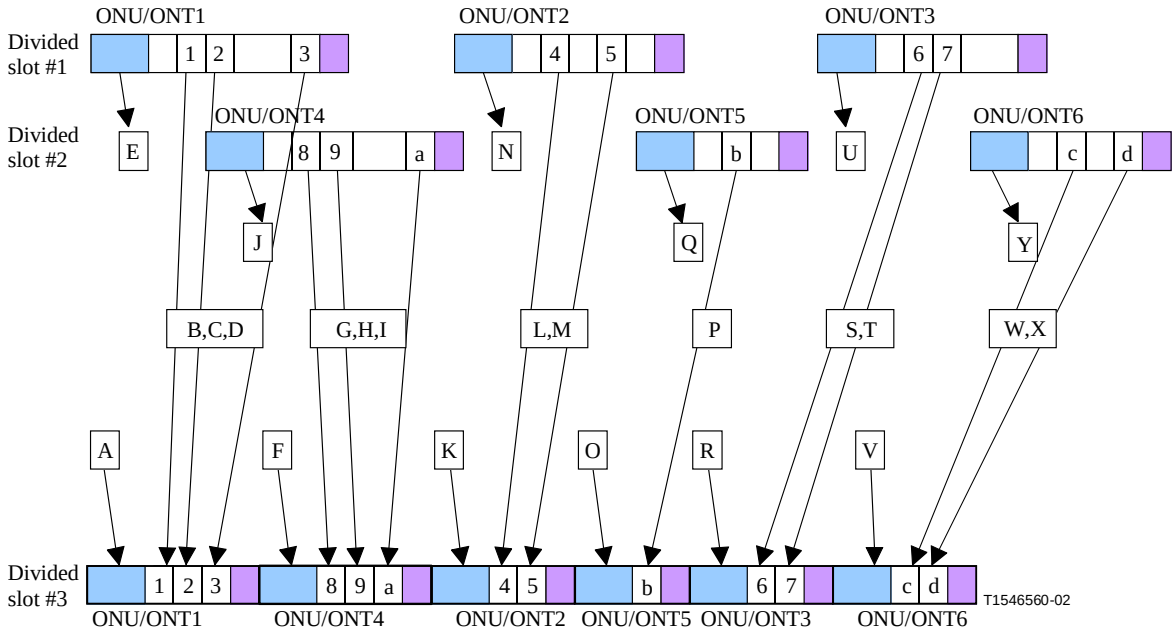


Figure 38/G.983.4 – An illustration of a bandwidth conserving reconfiguration of divided slots

List of the messages as indicated on the figure:

Divided_slot_configuration PONID=1, Activate DS_grant=3, Offset=0, Length=7

Additional_grant_allocation PONID=1, Activate grant=1, T-CONT_ID=1, DS_grant=3, Offset=0

Additional_grant_allocation PONID=1, Activate grant=2, T-CONT_ID=2, DS_grant=3, Offset=1

Additional_grant_allocation PONID=1, Activate grant=3, T-CONT_ID=3, DS_grant=3, Offset=2

Divided_slot_configuration PONID=1, Deactivate DS_grant=1, Offset=n/a, Length=n/a

Divided_slot_configuration PONID=4, Activate DS_grant=3, Offset=7, Length=7

Additional_grant_allocation PONID=4, Activate grant=8, T-CONT_ID=8, DS_grant=3, Offset=0

Additional_grant_allocation PONID=4, Activate grant=9, T-CONT_ID=9, DS_grant=3, Offset=1

Additional_grant_allocation PONID=4, Activate grant=a, T-CONT_ID=a, DS_grant=3, Offset=2

Divided_slot_configuration PONID=4, Deactivate DS_grant=2, Offset=n/a, Length=n/a

Divided_slot_configuration PONID=2, Activate DS_grant=3, Offset=14, Length=6

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Additional_grant_allocation PONID=2, Activate grant=4, T-CONT_ID=4, DS_grant=3, Offset=0

Additional_grant_allocation PONID=2, Activate grant=5, T-CONT_ID=5, DS_grant=3, Offset=1

Divided_slot_configuration PONID=2, Deactivate DS_grant=1, Offset=n/a, Length=n/a

Divided_slot_configuration PONID=5, Activate DS_grant=3, Offset=20, Length=5

Additional_grant_allocation PONID=5, Activate grant=b, T-CONT_ID=b, DS_grant=3, Offset=0

Divided_slot_configuration PONID=5, Deactivate DS_grant=2, Offset=n/a, Length=n/a

Divided_slot_configuration PONID=3, Activate DS_grant=3, Offset=25, Length=6

Additional_grant_allocation PONID=3, Activate grant=6, T-CONT_ID=6, DS_grant=3, Offset=0

Additional_grant_allocation PONID=3, Activate grant=7, T-CONT_ID=7, DS_grant=3, Offset=1

Divided_slot_configuration PONID=3, Deactivate DS_grant=1, Offset=n/a, Length=n/a

Divided_slot_configuration PONID=6, Activate DS_grant=3, Offset=31, Length=6

Additional_grant_allocation PONID=6, Activate grant=c, T-CONT_ID=c, DS_grant=3, Offset=0

Additional_grant_allocation PONID=6, Activate grant=d, T-CONT_ID=d, DS_grant=3, Offset=1

Divided_slot_configuration PONID=6, Deactivate DS_grant=2, Offset=n/a, Length=n/a

Remove Divided slot grants No. 1 and No. 2 from scheduler.

Note that this kind of full defragmentation of the divided slots is the fullest expression of the reconfiguration process. As mentioned previously, it is also possible to add and subtract individual minislots on an ONU/ONT by ONU/ONT basis, especially if the implementation chooses to configure minislots of a fixed size, since doing so avoids having unusable spaces in the divided slots.

Frequency of divided slot consolidation

The purpose of divided slot consolidation is the conservation of bandwidth. However, unless the consolidation results in a net reduction of the total number of divided slot grants in use, it will not result in any saved bandwidth. Hence, before any reconfiguration is attempted, it should be determined if one (or more) divided slots can be fully eliminated. If not, then reconfiguration can be delayed. This prevents needless message activity on the PON.

9 Operations Administration and Maintenance (OAM) functionality

The specific information is described in ITU-T Rec. G.983.1.

10 Performance

Performance of the ATM level specified in ITU-T Rec. I.356 should be guaranteed for any ATC/QoS. However, detailed performance in the network with DBA should be discussed as a future issue.

11 Environmental condition

The specific information is described in ITU-T Rec. G.983.1.

12 Safety

The specific information is described in ITU-T Rec. G.983.1.

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Appendix I

Algorithm for DBA

This appendix presents some recommended algorithms for a DBA protocol, such as bandwidth assignment and grant allocation in the OLT. Currently, many algorithms have been evaluated. After completion of performance evaluation and comparison among these algorithms from several points of view, these algorithms are introduced in this appendix.

DBA algorithms are classified into several parts as follows.

I.1 Algorithms for detecting ONU/ONT status for SR-ONU/ONT

To detect congestion in the T-CONT, we can monitor the queue length at the ONU/ONT. Monitoring queue length means counting the number of waiting cells for transmission on the PON link. These processes are invoked in every T-CONT.

Procedures

Step 1: The ONU/ONT monitors the queue length in every T-CONT buffer.

Step 2: The ONU/ONT receives the divided slot grants from the OLT.

Step 3: The ONU/ONT sends the total queue length information for every T-CONT.

I.2 Algorithms for monitoring cell streams at OLT from NSR-ONUs/ONTs

We can detect congestion on the PON link by monitoring the number of receiving cells at the OLT. We present the procedures of this mechanism as one example.

Procedures

Step 1: Monitor the number of received cells at the OLT in the fixed interval.

Step 2: Calculate the utilization rate (= used BW/Current assigned BW) by using the results of real time monitoring in Step 1.

Step 3: Recognize congestion by comparison between the utilization rate and thresholds.

Notice

NOTE – In Step 1, we should study the definition of monitored cells, such as idle cell monitoring, user cell monitoring, or used cell monitoring.

I.3 Algorithms to update bandwidth

When we calculate the updated bandwidth at the OLT, we can divide these mechanisms into three types, such as memory-less, stepwise increase, and stepwise increase and decrease. We can summarize these types as follows.

1) *Memory-less*

   When we detect congestion in a T-CONT, we allocate more resources to this group independent of previously allocated resources. We present the outline of this mechanism as follows and illustrate operations in Figure I.1.

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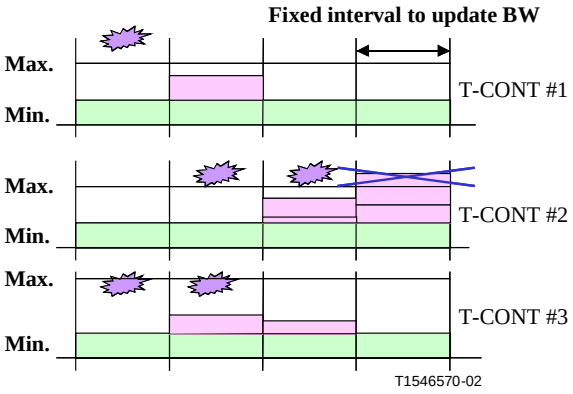


Figure I.1/G.983.4 – Operation in Memory-less bandwidth update

Notations

Max: maximum bandwidth for one B-PON physical interface

Max(i): maximum bandwidth for T-CONTi

Min(i): minimum bandwidth for T-CONTi

Old(i): allocated bandwidth for T-CONTi in the previous round

New(i): updated bandwidth for T-CONTi

SR(i): Shared bandwidth ratio for T-CONTi

C(i): Congestion status at T-CONTi

C(i)=1 if congestion for T-CONTi

C(i)=0 if non congestion for T-CONTi

Ad: Additional bandwidth for congested T-CONT

Procedures

```
If C(i)=0
      New(i)=Min(i)
If C(i)=1
      New(i)=SR(i)*(Max – sum(Min(j): for any j))+Min(i)
      If New(i)>Max(i)
         Ad=Ad+New(i)-Max(i)
         New(i)=Max(i)
```

For example, in these procedures, SR(i) can be specified as follows[1].

```
      SR(i)=Min(i)/sum(C(j)*Min(j): for any j)
```

[1] As the similar method, we present SR(i) as follows.

SR(i)=(Max(i)-Min(i))/sum(C(j)*(Max(j)-Min(j)): for any j)

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Moreover, we should determine the procedure of how to share "Ad" to congested grant groups that can accept additional bandwidth after assignment of bandwidth. In short, we should specify the maximum number of retry calculations for each grant group until convergence of updated bandwidth.

2) *Stepwise increase*

When we detect congestion in a T-CONT, we increase resources stepwise to this group based on previously allocated resources. We present the sample pseudo codes using the above notations and illustrate operations in Figure I.2.

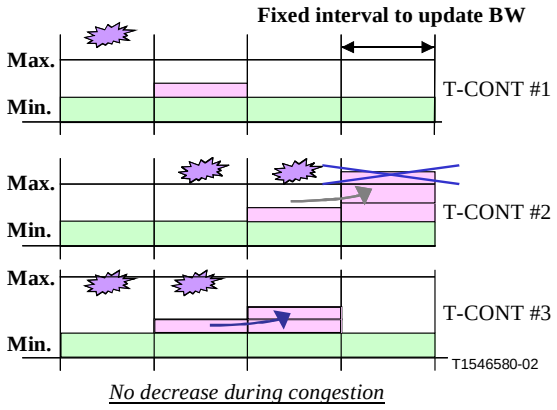


Figure I.2/G.983.4 – Operation in Stepwise increase bandwidth update

Procedures(1)

```
If C(i)=0
      New(i)=Min(i)
If C(i)=1
      New(i)=SR(i)*[Max – sum{(1-C(j))*Min(j): for any j}]+Old(i)
      If New(i)>Max(i)
         Ad=Ad+New(i)-Max(i)
         New(i)=Max(i)
```

For example, in these procedures, SR(i) can be specified as follows.

```
      SR(i)=Min(i)/sum(C(j)*Min(j): for any j)
```

Moreover, we can present another example of simplified procedures.

Procedures(2)

```
If C(i)=0
      New(i)=Min(i)
If C(i)=1
      New(i)=SR(i)*Old(i)+Old(i)
      If New(i)>Max(i)
         Ad=Ad+New(i)-Max(i)
         New(i)=Max(i)
      New(i)=min{New(i), New(i)/sum(New(j): for any j)*Max}
```


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In this case, SR(i) can be a constant value, which is similar to the Rate Decrease Factor in ABR behaviour.

3) *Stepwise increase and decrease*

When we recognize update of congestion in a T-CONT, we increase and decrease resources stepwise to this group based on previously allocated resources and illustrate operations in Figure I.3.

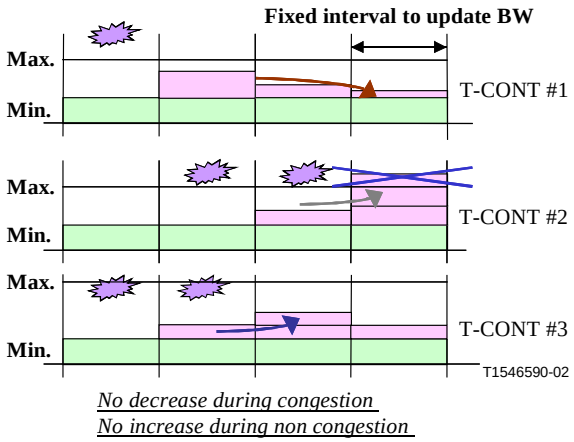


Figure I.3/G.983.4 – Operation in Stepwise increase and decrease bandwidth update

Procedures

```
If C(i)=0
      New(i)=Old(i)-SR(i)*Old(i)
      If New(i)<Min(i)
         Ad=Ad-(Min(i)-New(i))
         New(i)=Min(i)
If C(i)=1
      New(i)=Old(i)+SR(i)*Old(i)
      If New(i)>Max(i)
         Ad=Ad+New(i)-Max(i)
         New(i)=Max(i)
      New(i)=min{New(i), New(i)/sum(New(j): for any j)*Max}
```

For example, in these procedures, SR(i) can be a constant value to simplify these procedures. It looks like the Rate Increase or Decrease Factor in ABR behaviour.

I.4 Algorithms for grant assignment

Grants are assigned according to behaviours of each T-CONT type.

I.5 Control allowing for Upstream Congestion of the OLT NNI

For Further Study.

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Appendix II

Options for minislot format and negotiating procedures

II.1 Extended T-CONT reporting options

It has been shown that to support T-CONTs that contain both CLP = 0 and CLP = 1 cells, it is necessary to report multiple cell counts to the OLT to ensure bandwidth fairness. Full reporting of each queue is impractical, as it would require excessive minislot fields. Therefore, a more compact notation is needed. This clause outlines the optional extended reporting options.

II.1.1 Report type field

The reporting type appears in Octet 41 of the Additional_grant_allocation message. The defined values for this field are:

Field = 0: Default: The report has one field, which contains the non-linear coding of the total number of cells in the T-CONT buffer. Each T-CONT buffer reporting uses 1 byte. Support of this type is mandatory.

Field = 1: Two byte: The report has two fields, the first contains the non-linear coding of the total numbers of cells in T-CONT buffer that have PCR tokens (1 byte), and the second field contains the non-linear coding of the total number of cells in T-CONT buffer that have SCR tokens (1 byte). This type of reporting uses 2 bytes in total. This is suitable for T-CONT type 3 and type 5 reporting

Field = 2: Four byte: The report has four fields. The first contains the non-linear coding of total number of T-CONT No. 2 class cells that have PCR tokens (assured BW) (1 byte). The second field contains the non-linear coding of the total number of T-CONT No. 3 class cells that have SCR tokens (assured BW) (1 byte). The third field contains the non-linear coding of the total number of T-CONT No. 3 class cells that have PCR tokens (non-assured BW) (1 byte). The fourth field contains the non-linear coding of the total number of T-CONT No. 4 class cells that have PCR tokens (best effort BW) (1 byte). This type of reporting uses 4 bytes in total. This is suitable for T-CONT type 5 reporting.

Note that all reporting methods use the same non-linear coding for each subfield.

II.1.2 Reporting capability

The reporting capability determined in the DBA OMCI handshaking exchange indicates the reporting capabilities of the ONU/ONT. The defined values of this capability code are:

Code = 0: Default one byte reporting only is supported;

Code = 1: One byte and two byte reporting supported;

Code = 2: One byte and four byte reporting supported;

Code = 3: One, two, and four byte reporting supported.

Note that these codes basically specify a bit field that indicates support for the two optional reporting formats recommended in this appendix, allowing any combination of support. Note that all possible combinations include the normative one byte reporting method, ensuring interoperability over all ONU/ONT types.

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II.1.3 Usage of extended reporting types

The purpose of these extended reports is to give the OLT more information on the types of traffic waiting in the T-CONT buffer. Because the T-CONT buffer can contain multiple connections of multiple ATM service classes, a single cell count does not always give sufficient information on the traffic state of the T-CONT.

An example of the implementation of a T-CONT buffer that supports two-byte reporting is shown in Figure II.1. This shows a buffer that implements a weighted round robin type of scheduler, and each queue is policed using the standard dual-leaky bucket generic cell rate algorithm (GCRA). The derivation of the two cell counts to be sent in the two-byte report is shown to be the sum over all queues of the cells that have SCR tokens and PCR tokens, respectively. With these counts, the OLT DBA algorithm can send grants to those T-CONTs that have more SCR tokens first, ensuring fairness.

A similar process would be done to compute the four counts required for the four-byte reporting method, with the sums being taken over the groups of connections as listed for that mode.

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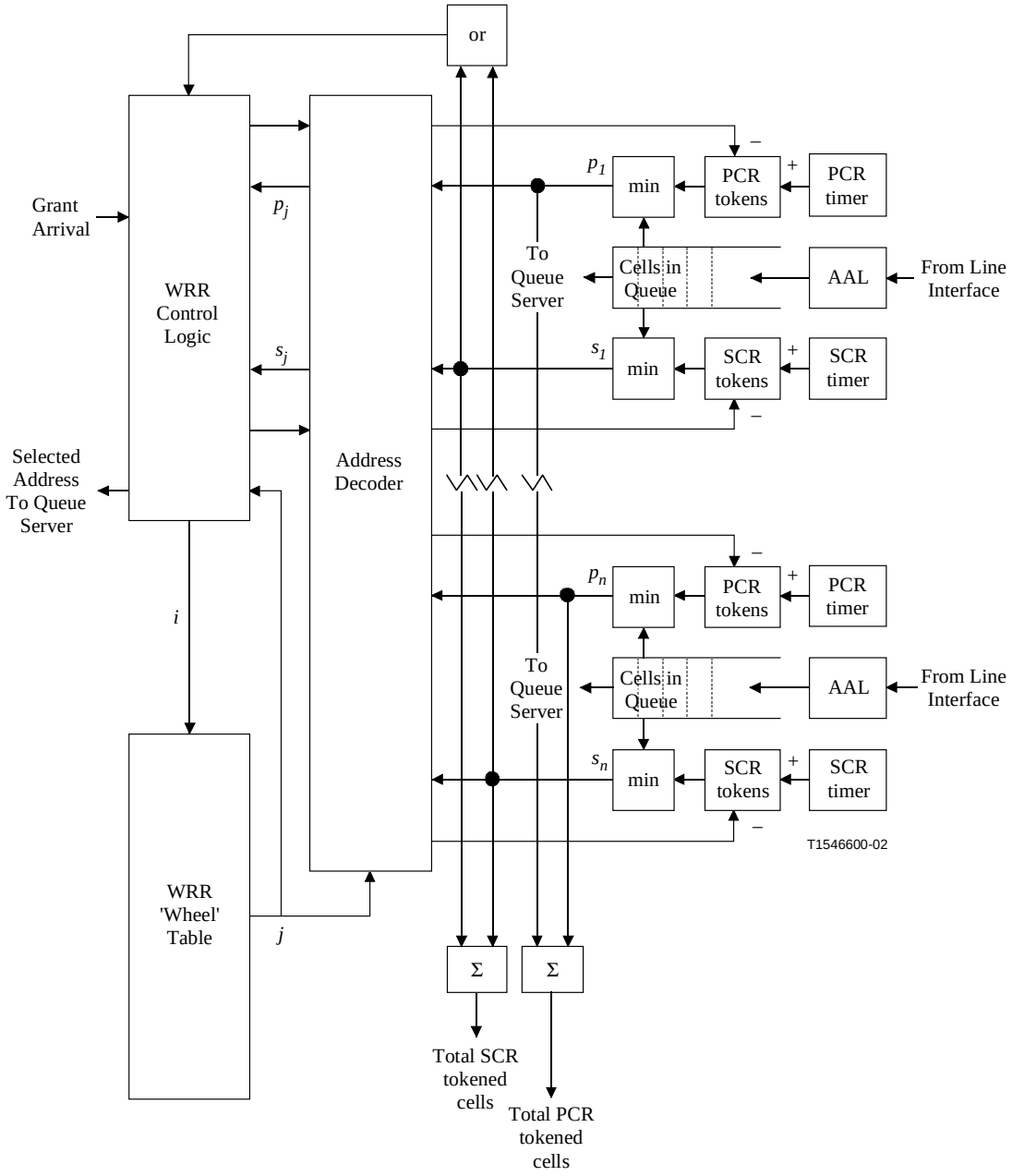


Figure II.1/G.983.4 – An implementation of a WRR dual-leaky bucket regulated scheduler

Note that the control logic is triggered by the arrival of a grant and then selects the next queue to be served based on: the weights configured in the 'wheel table', the availability of SCR and PCR tokens, and the presence of SCR tokenized cells in any queue. Also note that the occupancy of the multiple queues is summarized by calculating the total SCR and PCR tokenized cells.

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Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
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Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	TMN and network maintenance: international transmission systems, telephone circuits, telegraphy, facsimile and leased circuits
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Series O	Specifications of measuring equipment
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