

# ITU-T

TELECOMMUNICATION  
STANDARDIZATION SECTOR  
OF ITU

## **G.997.2** **Amendment 4** (12/2017)

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

Digital sections and digital line system – Metallic access  
networks

---

Physical layer management for G.fast transceivers  
**Amendment 4**

Recommendation ITU-T G.997.2 (2015) –  
Amendment 4

# ITU-T G-SERIES RECOMMENDATIONS

## TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

|  |                    |
|--|--------------------|
| INTERNATIONAL TELEPHONE CONNECTIONS AND CIRCUITS   | G.100–G.199        |
| 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        |
| COORDINATION OF RADIOTELEPHONY AND LINE TELEPHONY  | G.450–G.499        |
| TRANSMISSION MEDIA AND OPTICAL SYSTEMS CHARACTERISTICS   | G.600–G.699        |
| DIGITAL TERMINAL EQUIPMENTS  | G.700–G.799        |
| DIGITAL NETWORKS   | G.800–G.899        |
| DIGITAL SECTIONS AND DIGITAL LINE SYSTEM   | G.900–G.999        |
| General  | G.900–G.909        |
| Parameters for optical fibre cable systems   | G.910–G.919        |
| Digital sections at hierarchical bit rates based on a bit rate of 2048 kbit/s  | G.920–G.929        |
| Digital line transmission systems on cable at non-hierarchical bit rates   | G.930–G.939        |
| Digital line systems provided by FDM transmission bearers  | G.940–G.949        |
| Digital line systems   | G.950–G.959        |
| Digital section and digital transmission systems for customer access to ISDN   | G.960–G.969        |
| Optical fibre submarine cable systems  | G.970–G.979        |
| Optical line systems for local and access networks   | G.980–G.989        |
| <b>Metallic access networks</b>  | <b>G.990–G.999</b> |
| MULTIMEDIA QUALITY OF SERVICE AND PERFORMANCE – GENERIC AND USER-RELATED ASPECTS   | G.1000–G.1999      |
| TRANSMISSION MEDIA CHARACTERISTICS   | G.6000–G.6999      |
| DATA OVER TRANSPORT – GENERIC ASPECTS  | G.7000–G.7999      |
| PACKET OVER TRANSPORT ASPECTS  | G.8000–G.8999      |
| ACCESS NETWORKS  | G.9000–G.9999      |

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

# Recommendation ITU-T G.997.2

## Physical layer management for G.fast transceivers

### Amendment 4

#### Summary

Recommendation ITU-T G.997.2 specifies the physical layer management for fast access to subscriber terminals (G.fast) transmission systems. It specifies managed objects for configuration, fault, status, inventory and performance management.

Amendment 3 includes:

- A new annex for the management of remote power feeding (RPF).
- A new annex for the management of network termination (NT) software upgrades.
- A new annex for the management of Annex X and Annex T of [ITU-T G.9701].
- Updated managed objects to support new profiles 212a, 106c and 212c.
- Updated managed object to support additional international amateur radio (IAR) bands.

Corrigendum 3 includes:

- A correction to the maximal group size of the test parameters for 212 MHz profile.

Amendment 4 includes:

- Update to Annex A: Physical layer management for reverse power feeding (RPF) of remote access equipment
- Additional managed objects for support of impulse noise monitoring of ITU-T G.9701
- Additional managed objects for support of ANDEFTR of ITU-T G.9701
- Additional managed objects for support of RMCR of ITU-T G.9701

#### History

| Edition | Recommendation              | Approval   | Study Group | Unique ID*  |
|---------|-----------------------------|------------|-------------|---|
| 1.0     | ITU-T G.997.2               | 2015-05-22 | 15          | <a href="http://handle.itu.int/11.1002/1000/12375">11.1002/1000/12375</a> |
| 1.1     | ITU-T G.997.2 (2015) Cor. 1 | 2016-03-29 | 15          | <a href="http://handle.itu.int/11.1002/1000/12800">11.1002/1000/12800</a> |
| 1.2     | ITU-T G.997.2 (2015) Amd. 1 | 2016-05-07 | 15          | <a href="http://handle.itu.int/11.1002/1000/12555">11.1002/1000/12555</a> |
| 1.3     | ITU-T G.997.2 (2015) Amd. 2 | 2016-07-22 | 15          | <a href="http://handle.itu.int/11.1002/1000/12799">11.1002/1000/12799</a> |
| 1.4     | ITU-T G.997.2 (2015) Cor. 2 | 2016-12-22 | 15          | <a href="http://handle.itu.int/11.1002/1000/13067">11.1002/1000/13067</a> |
| 1.5     | ITU-T G.997.2 (2015) Amd. 3 | 2017-04-06 | 15          | <a href="http://handle.itu.int/11.1002/1000/13066">11.1002/1000/13066</a> |
| 1.6     | ITU-T G.997.2 (2015) Cor. 3 | 2017-08-13 | 15          | <a href="http://handle.itu.int/11.1002/1000/13311">11.1002/1000/13311</a> |
| 1.7     | ITU-T G.997.2 (2015) Amd. 4 | 2017-12-07 | 15          | <a href="http://handle.itu.int/11.1002/1000/13310">11.1002/1000/13310</a> |

#### Keywords

Distribution point unit, DPU, G.fast transceivers, management, performance monitoring.

\* To access the Recommendation, type the URL <http://handle.itu.int/> in the address field of your web browser, followed by the Recommendation's unique ID. For example, <http://handle.itu.int/11.1002/1000/11830-en>.

## FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). 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 received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at <http://www.itu.int/ITU-T/ipr/>.

© ITU 2018

All rights reserved. No part of this publication may be reproduced, by any means whatsoever, without the prior written permission of ITU.

## Table of Contents

|   |  | Page |
|---|--|------|
| 1 | Scope.....   | 1    |
| 2 | References.....  | 1    |
| 3 | Definitions .....  | 1    |
|   | 3.1 Terms defined elsewhere .....                                      | 1    |
|   | 3.2 Terms defined in this Recommendation.....                          | 1    |
| 4 | Abbreviations and acronyms .....                                       | 2    |
| 5 | Management architecture.....   | 4    |
| 6 | Network management protocol.....                                       | 5    |
| 7 | Managed objects .....  | 6    |
|   | 7.1 Line configuration objects .....                                   | 20   |
|   | 7.2 Channel configuration objects .....                                | 38   |
|   | 7.3 Data path configuration objects .....                              | 42   |
|   | 7.4 Line failures.....   | 42   |
|   | 7.5 Channel failures.....  | 43   |
|   | 7.6 Data path failures.....  | 43   |
|   | 7.7 Line performance monitoring objects .....                          | 43   |
|   | 7.8 Channel performance monitoring objects .....                       | 49   |
|   | 7.9 Data path performance monitoring objects .....                     | 51   |
|   | 7.10 Line test, diagnostics and status objects .....                   | 51   |
|   | 7.11 Channel test, diagnostics and status objects .....                | 65   |
|   | 7.12 Data path test, diagnostics and status objects .....              | 70   |
|   | 7.13 Inventory objects .....   | 70   |
|   | 7.14 Link State related managed objects .....                          | 73   |
| 8 | Procedures for performance monitoring functions .....                  | 74   |
|   | 8.1 Line transmission states.....                                      | 74   |
|   | 8.2 Threshold reports.....   | 75   |
|   | 8.3 Unavailable and available state filters .....                      | 76   |
|   | 8.4 TR1 filter .....   | 76   |
|   | 8.5 TR2 filter .....   | 76   |
|   | 8.6 Evaluation of TR1 .....  | 76   |
|   | 8.7 Evaluation of TR2 .....  | 76   |
|   | 8.8 Threshold report evaluation during transmission state changes..... | 77   |
|   | 8.9 Performance history storage in network elements.....               | 77   |
|   | 8.10 Register size.....  | 77   |
|   | 8.11 Parameter counts .....  | 77   |
|   | 8.12 Date/time-stamping of reports .....                               | 77   |
|   | 8.13 Inhibiting performance monitoring parameters.....                 | 78   |

|  | <b>Page</b> |
|--|-------------|
| Annex A – Physical layer management for reverse power feeding (RPF) of remote access equipment ..... | 79          |
| A.1 Scope .....  | 79          |
| A.2 References .....   | 79          |
| A.3 Definitions .....  | 79          |
| A.4 Abbreviations and acronyms .....   | 80          |
| A.5 DPU and NT management architecture .....   | 80          |
| A.6 Network management protocol .....  | 81          |
| A.7 DPU Northbound managed objects .....   | 85          |
| Annex B to Annex R .....   | 96          |
| Annex S – Management for network termination (NT) software upgrade process .....                     | 97          |
| S.1 Scope .....  | 97          |
| S.2 References .....   | 97          |
| S.3 Definitions .....  | 97          |
| S.4 Abbreviations and acronyms .....   | 97          |
| S.5 DPU management architecture .....  | 97          |
| S.6 Network management protocol .....  | 97          |
| S.7 Managed objects .....  | 97          |
| Annex T – Annex X and Annex T of ITU-T G.9701 – Managed objects .....                                | 102         |
| T.1 Overview of Annex X and Annex T of ITU-T G.9701 managed objects .....                            | 102         |
| T.2 Annex X and Annex T of [ITU-T G.9701] control objects .....                                      | 103         |
| T.3 Annex X and Annex T of ITU-T G.9701 status objects .....   | 104         |
| T.4 Annex X and Annex T of ITU-T G.9701 inventory objects .....                                      | 105         |
| Annex U to Annex W .....   | 106         |
| Annex X – Cross-layer link state objects .....   | 107         |
| X.1 Overview of cross-layer link state objects .....   | 107         |
| X.2 Cross-Layer Low power Mode Control .....   | 107         |
| Appendix I – Broadband Forum considerations on the FTTdp deployment scenario .....                   | 112         |
| Bibliography .....   | 113         |

# Recommendation ITU-T G.997.2

## Physical layer management for G.fast transceivers

### Amendment 4

*Editorial note: This is a complete-text publication. The modifications introduced by this amendment are shown in revision marks relative to Recommendation ITU-T G.997.2 (2015) plus its Cor.1 (2016), Cor.2 (2016), Amd.1 (2016), Amd.2 (2016), Amd.3 (2017) and Cor.3 (2017).*

#### 1 Scope

This Recommendation specifies the physical layer management for fast access to subscriber terminals (G.fast) transmission systems.

It specifies managed objects for configuration, fault, status, inventory and performance management. The list of managed objects applies at the distribution point unit-Northbound (DPU-NB) interface, relating to the "DPU-MIB" nomenclature used in [ITU-T G.9701]. The managed objects are defined to provide, at least, all the information necessary for translation into a YANG data model [b-IETF RFC 6020], although this does not exclude translation to other formats such as an abstract syntax notation one (ASN.1) (ITU-T X.680 series) management information base (MIB) description used in connection with the simple network management protocol (SNMP) [b-IETF RFC 1157]. The definition of the YANG data model for G.fast-managed objects is outside the scope of this Recommendation.

#### 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.

- [ITU-T G.994.1] Recommendation ITU-T G.994.1 (2012), *Handshake procedures for digital subscriber line transceivers*.
- [ITU-T G.9700] Recommendation ITU-T G.9700 (2014), *Fast access to subscriber terminals (G.fast) – Power spectral density specification*.
- [ITU-T G.9701] Recommendation ITU-T G.9701 (2014), *Fast access to subscriber terminals (G.fast) – Physical layer specification*.

#### 3 Definitions

##### 3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

**3.1.1 managed resource** [b-ITU-T M.3010]: The abstraction of those aspects of a telecommunication resource (logical or physical) required for telecommunications management.

##### 3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

**3.2.1 AdminStatus:** (Based on clause 12.1.1.7 of [ITU-T G.9701]) The AdminStatus represents the configured, desired state of the interface. The AdminStatus "up" is equivalent with the interface "enabled=true", where the desired link state is L0, L2.1N, L2.1B, or L2.2. The AdminStatus "down" is equivalent with the interface "enabled=false", where the desired link state is L3.

NOTE – The relation between the AdminStatus ("up" or "down") and the interface (enabled="true" or "false") is defined in the IETF YANG Data Model for Interface Management [b-IETF RFC 7223].

**3.2.2 anomaly:** A discrepancy between the actual and desired characteristics of an item.

The desired characteristic may be expressed in the form of a specification.

An anomaly may or may not affect the ability of an item to perform a required function.

**3.2.3 defect:** A limited interruption in the ability of an item to perform a required function. It may or may not lead to maintenance action depending on the results of additional analysis.

Successive anomalies causing a decrease in the ability of an item to perform a required function are considered a defect.

**3.2.4 empty array:** An array whose number of elements is zero.

**3.2.5 failure:** A termination of the ability of an item to perform a required function.

NOTE – After failure, the item has a fault. Analysis of successive anomalies or defects affecting the same item can lead to the item being considered as "failed".

**3.2.6 managed object:** The management view of a managed resource.

**3.2.7 DPU-NB interface:** The interface between the persistent management agent and the management entity of the distribution point unit.

## 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

|        |   |
|--------|---|
| ASN.1  | Abstract Syntax Notation one  |
| CV     | Code Violation  |
| CV-C   | Code Violation – Channel  |
| DPU    | Distribution Point Unit   |
| DPU-NB | DPU Northbound  |
| DRA    | Dynamic Resource Allocation   |
| ES     | Errored Second  |
| FAST   | Fast Access to Subscriber Terminals   |
| FE     | Far-End   |
| FRA    | Fast Rate Adaptation  |
| FTTdp  | Fibre To The distribution point   |
| FTTx   | Fibre To The x  |
| FTU    | FAST Transceiver Unit   |
| FTU-O  | FAST Transceiver Unit – Central office end (i.e., network operator end of the loop) |
| FTU-R  | FAST Transceiver Unit – Remote side (i.e., subscriber end of the loop)              |
| GDR    | Gamma Data Rate   |
| G.fast | fast access to subscriber terminals   |

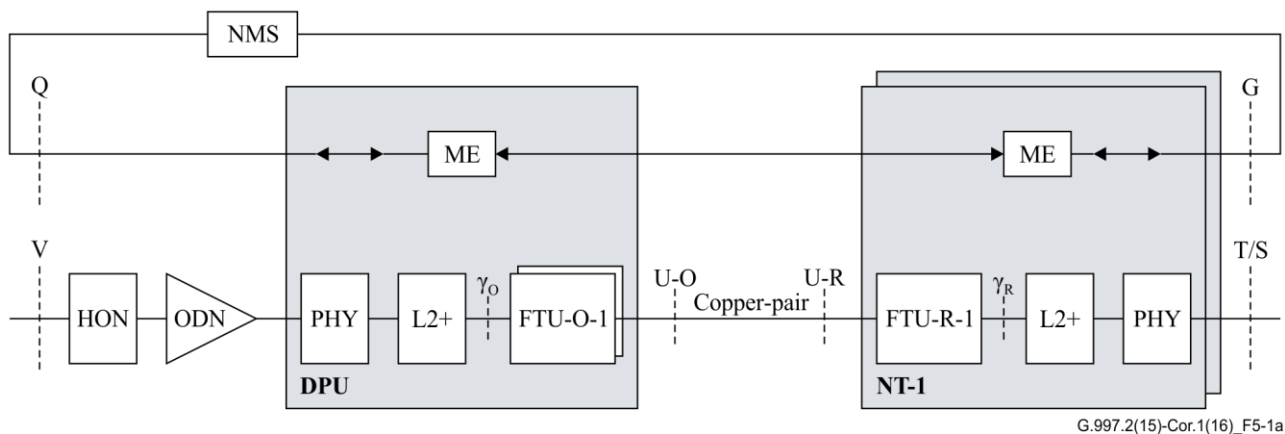


|        |  |
|--------|--|
| LOM    | Loss of Margin   |
| LOM-FE | Far-End Loss of Margin                                 |
| LOR    | Loss of RMC  |
| LOR-FE | Far-End Loss of RMC                                    |
| LORS   | LOR Second   |
| LOS    | Loss of Signal   |
| LOS-FE | Far-End Loss of Signal                                 |
| LOSS   | LOS Second   |
| LPR    | Loss of Power  |
| LPR-FE | Far-End Loss of Power                                  |
| MIB    | Management Information Base                            |
| MDU    | Multi-Dwelling Unit                                    |
| ME     | Management Entity                                      |
| NDR    | Net Data Rate  |
| NDRds  | downstream Net Data Rate                               |
| NDRus  | upstream Net Data Rate                                 |
| NE     | Network Element  |
| NMS    | Network Management System                              |
| NT     | Network Termination                                    |
| OLR    | On-Line Reconfiguration                                |
| OSS    | Operations Support Systems                             |
| PM     | Performance Monitoring                                 |
| PMA    | Persistent Management Agent                            |
| PMD    | Physical Media Dependent                               |
| PMS-TC | Physical Media Specific – Transmission Convergence     |
| PSD    | Power Spectral Density                                 |
| REIN   | Repetitive Electrical Impulse Noise                    |
| RMC    | Robust Management Channel                              |
| RPA    | RMC Parameter Adjustment                               |
| SES    | Severely Errored Second                                |
| SNMP   | Simple Network Management Protocol                     |
| SNR    | Signal-to-Noise Ratio                                  |
| SRA    | Seamless Rate Adaptation                               |
| TDD    | Time Division Multiplexing                             |
| TPS-TC | Transport Protocol Specific – Transmission Convergence |
| TR     | Threshold Report                                       |
| UAS    | UnAvailable Second                                     |

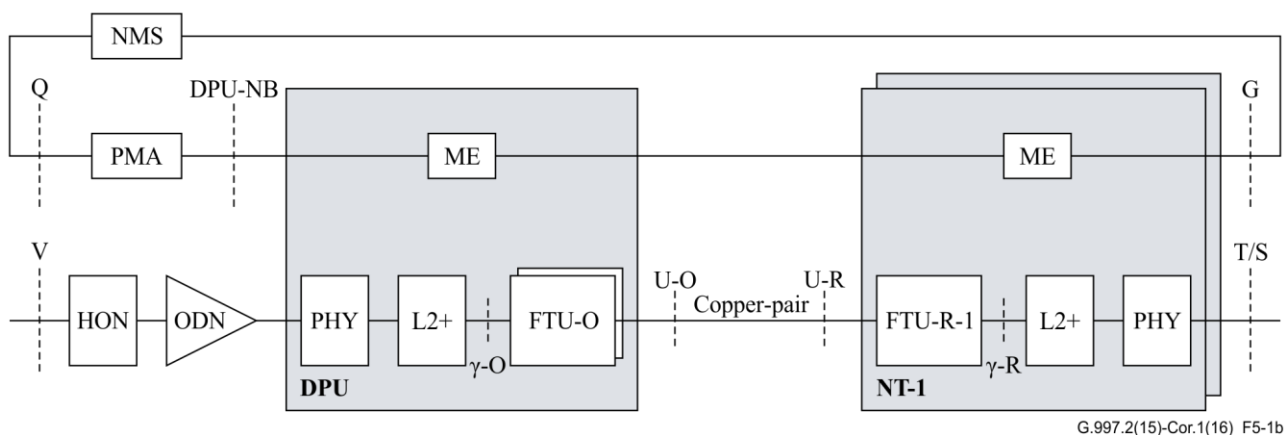
- U-O      Loop interface – Central office end  
U-R      Loop interface – Remote side (i.e., subscriber end of the loop)

## 5 Management architecture

The management of an access node (AN) or a distribution point unit (DPU) is performed by the network management system (NMS), passing management information over the Q reference point to each AN's management entity (ME) (see Figure 5-1a) or through a persistent management agent (PMA) to the each DPU's ME (see Figure 5-1b). The NMS may also monitor each G.fast transceiver unit – remote side (FTU-R) via the related network termination's (NT's) ME and G reference point. The connection between the ME functions at the AN or DPU and at the NT is established over management channels provided by the G.fast transceiver unit – central office ends (FTU-Os) and FTU-Rs via the copper pairs.



**Figure 5-1a – Reference model of traditional AN deployment  
(shown for line 1 in all N lines ( $N \geq 1$ ) connected to an AN)**



**Figure 5-1b – Reference model of FTTdp deployment with PMA and DPU  
(shown for line 1 in all N lines ( $N \geq 1$ ) connected to a DPU)**

Appendix I contains additional information regarding the Broadband Forum considerations on the fibre to the distribution point (FTTdp) deployment scenario (see also [b-BBF TR-301]).

The fundamental purpose of the PMA (see Appendix I) is to allow the operations support systems (OSS)/NMS to perform all operations on a given DPU whether or not that DPU is actually powered. This includes the following PMA functionality:

- firmware download and management;
- initial provisioning;
- configuration, including rate control;
- test and diagnostics;
- statistics gathering;
- event reporting;
- performance monitoring (PM) history beyond current and previous interval counters;
- management protocol translation between Q interface and the DPU-Northbound interface (DPU-NB interface).

Some of these operations have limited capabilities when the DPU is without power. For example, statistics gathering is limited to the history present in the PMA, since the current information is not available from the DPU.

The OSS/NMS also still needs to be able to ascertain the true power state of the DPU as a whole, and of each given line, for example for diagnostics purposes. It can choose to take into account the power state of a DPU for various processes, e.g., a new firmware download, but does not have to.

While distribution points are at locations where local power is typically not available, DPUs may also be deployed at locations where local powering or forward powering is available (e.g., in multi-dwelling unit (MDU) basements or in fibre to the x (FTTx) cabinets). In this case, a PMA could still exist as a separate entity to the DPU (if the DPU could still be unpowered at times).

[ITU-T G.9701] defines the interfaces between the FTU-O (which is part of the AN or DPU) and the FTU-R (which is part of the NT). This Recommendation specifies the physical layer management for fast access to subscriber terminals (G.fast) transmission systems as seen by the NMS (if the FTU-O is in an AN, see Figure 5-1a) and as seen by the PMA (if the FTU-O is in a DPU, see Figure 5-1b).

Clause 7 and 8 specifies managed objects for configuration, fault, test, diagnostics, status, and inventory management, and for performance monitoring. The list of managed objects applies at the DPU-NB interface shown in Figure 5-1b, relating to the "DPU-MIB" naming as used in [ITU-T G.9701]. The managed objects are defined to provide at least all the information necessary for translation into a YANG data model [b-IETF RFC 6020], although this does not exclude translation to other formats such as an ASN.1 (X.680 series) MIB description used in connection with SNMP [b-IETF RFC 1157].

The definitions of the managed objects defined in clause 7 provide the following information:

- description;
- type;
- unit;
- valid values;
- default value (for configuration objects only);
- reference.

The list of managed objects defined in clauses 7 and 8 also applies at the Q reference point shown in Figure 5-1a.

## 6 Network management protocol

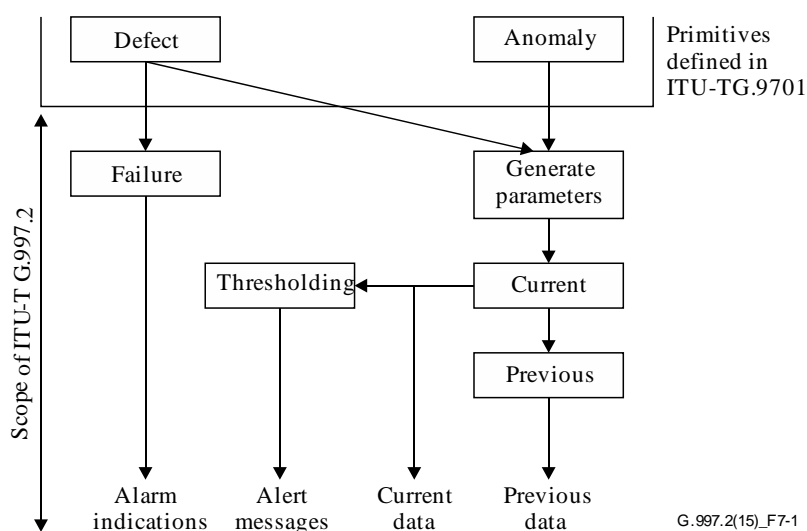
This Recommendation makes no presumption about which management protocol is used between the NMS and the AN (see Figure 5-1a) or between the PMA and the DPU (see Figure 5-1b) for transport of the G.fast-managed objects.

## 7 Managed objects

The list of managed objects contains six types of information:

- 1) configuration objects;
- 2) fault monitoring – failures (alarm indications);
- 3) fault monitoring – threshold crossing (alert messages);
- 4) performance monitoring objects (counters);
- 5) test, diagnostic and status objects;
- 6) inventory objects.

Figure 7-1 shows the in-service performance monitoring process. The primitives are specified in [ITU-T G.9701].



**Figure 7-1 – In-service performance monitoring process**

As [ITU-T G.9701] supports a DPU with up to 128 lines, provisioning every managed object for every G.fast port on the DPU may become burdensome. Therefore, the DPU configuration management (as defined in the Broadband Forum) defines G.fast configuration profiles, as well as a mechanism to associate these profiles to the individual ports. The definition of G.fast configuration profiles is outside the scope of this Recommendation. The allocation of the individual G.fast-managed objects (as defined in this Recommendation) to G.fast configuration profiles is addressed within the scope of the Broadband Forum.

NOTE – The "configuration profiles" are not the "Profiles" discussed in clause 6 of [ITU-T G.9701]. This clause uses the term "profile" for simplifying the configuration of [ITU-T G.9701] ports on a DPU in the field. Clause 6 of [ITU-T G.9701] is a discussion of a technique for defining the native capabilities (e.g., the particular subset of [ITU-T G.9701]) supported by a particular G.fast transceiver.

At the DPU-NB interface, a line is configured through the following information:

- line configuration objects (see Table 7-1) for the line;
- channel configuration objects (see Table 7-2) for the downstream channel;
- channel configuration objects (see Table 7-2) for the upstream channel;
- data path configuration objects (see Table 7-3) for the downstream data path;
- data path configuration objects (see Table 7-3) for the upstream data path.

Line configuration objects relate to the physical media dependent (PMD) sublayer and the robust management channel (RMC). Channel configuration objects relate to the bearer channel-related

aspects of the physical media specific – transmission convergence (PMS-TC) sublayer. Data path configuration objects relate to the transport protocol specific – transmission convergence (TPS-TC) sublayer.

At the DPU-NB interface, a line is monitored through the following information:

- line failures (see Table 7-4);
- channel failures (see Table 7-5);
- data path failures (see Table 7-6);
- line performance monitoring objects (see Table 7-7);
- channel performance monitoring objects (see Table 7-8) for the downstream channel;
- channel performance monitoring objects (see Table 7-8) for the upstream channel;
- data path performance monitoring objects (see Table 7-9) for the downstream data path;
- data path performance monitoring objects (see Table 7-9) for the upstream data path;
- line test, diagnostics and status objects (see Table 7-10);
- channel test, diagnostics and status objects (see Table 7-11) for the downstream channel;
- channel test, diagnostics and status objects (see Table 7-11) for the upstream channel;
- data path test, diagnostic and status objects (see Table 7-12) for the downstream channel;
- data path test, diagnostic and status objects (see Table 7-12) for the upstream channel;
- inventory objects (see Table 7-13).

As [ITU-T G.9701] supports a DPU with up to 128 lines, maintaining the performance monitoring and the test, diagnostic and status information for every line may become burdensome. Although access to all mandatory managed objects shall be supported at all times for all ports on the DPU at the DPU-NB interface towards the PMA (see Figure 5-1), the objects may not be maintained within the management entity of the DPU simultaneously for all lines at all times. Although reasonable performance shall be provided at the DPU-NB interface for access to the managed objects of any line, this Recommendation does not define specific performance requirements at this interface.

When the update request flag for a test parameter group (see clause 7.1.9) is set (its value is changed from 0 to 1), the parameters of the associated test parameter groups shall be updated in the DPU-MIB within the update time period specified in Table 7-0. The update request flag for the associated test parameter group is defined in the DPU-MIB and is independent of any autonomous update process in the system. The update request flag shall be reset (its value changed back to 0) by the DPU after the request parameter update is complete. The reset shall be within a period that is shorter than the reset time period specified in Table 7-0 to allow reception of another update request. The reset time period starts since the last time the update request flag was set (externally or by an autonomous process in the system). This applies only to the elements maintained in the DPU.

Test parameters and status parameters shall be updated in L0, L2.1N, L2.1B and L2.2 link states, unless explicitly stated differently in [ITU-T G.9701]. The GDRds/us and ATTGDRds/us shall be updated only in L0 state.

**Table 7-0 – Test parameter groups**

| Test parameter group (Note)   | Update time period | Reset time period |
|---|--------------------|-------------------|
| NE test parameter group 1 (NE-G1)   | 10 seconds         | 3 minutes         |
| FE test parameter group 1 (FE-G1)   | 15 seconds         | 3 minutes         |
| NE test parameter group 2 (NE-G2)   | 3 minutes          | 10 minutes        |
| FE test parameter group 2 (FE-G2)   | 3 minutes          | 10 minutes        |
| NOTE – The test parameters contained in each test parameter group are defined in Table 7-10 and Table 7-11. |                    |                   |

Tables 7-1 to 7-11 indicate the status of each managed object over the DPU-NB interface:

- R: Read only
- W: Write only
- R/W: Read and write
- (M): Mandatory
- (O): Optional

Entries in Tables 7-1 to 7-11 labelled with names containing the separator "/" represent multiple objects whose names are obtained by considering all combinations of the elements isolated with the separator. For example, the entry labelled with the name A/B\_C/D\_E/F represents eight objects with names A\_C\_E, A\_C\_F, A\_D\_E, A\_D\_F, B\_C\_E, B\_C\_F, B\_D\_E, B\_D\_F. Also, the entry labelled with the name Ads/us represents two objects with names Ads and Aus. Near-end (-NE) objects apply to the FTU-O, while far-end (-FE) objects apply to the FTU-R.

For each configuration managed object, a default value is defined. Configuring a managed object with a value different from the default may change the applicable valid values of other managed objects and therefore may require reconfiguration of these objects.

**Table 7-1 – Line configuration objects**

| Category/object  | Defined in clause: | DPU-NB interface |
|--|--------------------|------------------|
| <b><i>Profiles</i></b>   |                    |                  |
| [ITU-T G.9701] profiles enabling (PROFILES)                              | 7.1.0.1            | R/W (M)          |
| <b><i>Time division Duplexing (TDD)</i></b>                              |                    |                  |
| Symbol periods per TDD frame (MF)  | 7.1.1.1            | R/W (M)          |
| Symbol periods per TDD frame dedicated for downstream transmission (Mds) | 7.1.1.2            | R/W (M)          |
| Cyclic extension (CE)  | 7.1.1.3            | R/W (M)          |
| <b><i>Power and spectrum usage</i></b>                                   |                    |                  |
| MAXATPds   | 7.1.2.1            | R/W (M)          |
| MAXATPus   | 7.1.2.2            | R/W (M)          |
| CARMASKds  | 7.1.2.3            | R/W (M)          |
| CARMASKus  | 7.1.2.4            | R/W (M)          |
| MIBPSDMASKds   | 7.1.2.5            | R/W (M)          |
| MIBPSDMASKus   | 7.1.2.6            | R/W (M)          |
| RFIBANDS   | 7.1.2.7            | R/W (M)          |

**Table 7-1 – Line configuration objects**

| <b>Category/object</b>                 | <b>Defined in clause:</b> | <b>DPU-NB interface</b> |
|--|---------------------------|-------------------------|
| IARBANDS                               | 7.1.2.8                   | R/W (M)                 |
| UPBOPSDA                               | 7.1.2.9                   | R/W (M)                 |
| UPBOPSDB                               | 7.1.2.10                  | R/W (M)                 |
| UPBOKL                                 | 7.1.2.11                  | R/W (M)                 |
| UPBOKLF                                | 7.1.2.12                  | R/W (M)                 |
| UPBOKLREF                              | 7.1.2.13                  | R/W (M)                 |
| <b>Noise margins</b>                   |                           |                         |
| TARSNRMds                              | 7.1.3.1                   | R/W (M)                 |
| TARSNRMus                              | 7.1.3.2                   | R/W (M)                 |
| MAXSNRMus                              | 7.1.3.3                   | R/W (M)                 |
| MINSNRMds                              | 7.1.3.4                   | R/W (M)                 |
| MINSNRMus                              | 7.1.3.5                   | R/W (M)                 |
| <b>Seamless rate adaptation (SRA)</b>  |                           |                         |
| SRA-USNRMds                            | 7.1.4.1                   | R/W (M)                 |
| SRA-UTIMEds                            | 7.1.4.2                   | R/W (M)                 |
| SRA-USNRMus                            | 7.1.4.3                   | R/W (M)                 |
| SRA-UTIMEus                            | 7.1.4.4                   | R/W (M)                 |
| SRA-DSNRMds                            | 7.1.4.5                   | R/W (M)                 |
| SRA-DTIMEds                            | 7.1.4.6                   | R/W (M)                 |
| SRA-DSNRMus                            | 7.1.4.7                   | R/W (M)                 |
| SRA-DTIMEus                            | 7.1.4.8                   | R/W (M)                 |
| <b>Fast rate adaptation (FRA)</b>      |                           |                         |
| FRA-TIMEds                             | 7.1.5.1                   | R/W (M)                 |
| FRA-TIMEus                             | 7.1.5.2                   | R/W (M)                 |
| FRA-NTONESds                           | 7.1.5.3                   | R/W (M)                 |
| FRA-NTONESus                           | 7.1.5.4                   | R/W (M)                 |
| FRA-RTXUCds                            | 7.1.5.5                   | R/W (M)                 |
| FRA-RTXUCus                            | 7.1.5.6                   | R/W (M)                 |
| FRA-VENDISCds                          | 7.1.5.7                   | R/W (M)                 |
| FRA-VENDISCus                          | 7.1.5.8                   | R/W (M)                 |
| <b>Robust management channel (RMC)</b> |                           |                         |
| TARSNRM-RMCds                          | 7.1.6.1                   | R/W (M)                 |
| TARSNRM-RMCus                          | 7.1.6.2                   | R/W (M)                 |
| MINSNRM-RMCds                          | 7.1.6.3                   | R/W (M)                 |
| MINSNRM-RMCus                          | 7.1.6.4                   | R/W (M)                 |
| MAXBL-RMCds                            | 7.1.6.5                   | R/W (M)                 |
| MAXBL-RMCus                            | 7.1.6.6                   | R/W (M)                 |

**Table 7-1 – Line configuration objects**

| Category/object   | Defined in clause: | DPU-NB interface |
|---|--------------------|------------------|
| <b><i>Vectoring</i></b>   |                    |                  |
| FEXT cancellation enabling/disabling downstream (FEXT_TO_CANCEL_ENABLEds) | 7.1.7.1            | R/W (M)          |
| FEXT cancellation enabling/disabling upstream (FEXT_TO_CANCEL_ENABLEus)   | 7.1.7.2            | R/W (M)          |
| XLOG requested subcarrier group size (XLOGREQds)                          | 7.1.7.3            | R/W (O)          |
| XLOG requested disturber index (XLOGDREQds)                               | 7.1.3.4            | R/W (O)          |
| <b><i>Fast-retrain policy</i></b>   |                    |                  |
| LOS-PERSISTENCYds   | 7.1.8.1            | R/W (M)          |
| LOS-PERSISTENCYus   | 7.1.8.2            | R/W (M)          |
| LOM-PERSISTENCYds   | 7.1.8.3            | R/W (M)          |
| LOM-PERSISTENCYus   | 7.1.8.4            | R/W (M)          |
| LOR-PERSISTENCYds   | 7.1.8.5            | R/W (M)          |
| LOR-PERSISTENCYus   | 7.1.8.6            | R/W (M)          |
| REINIT_TIME_THRESHOLDds   | 7.1.8.7            | R/W (M)          |
| REINIT_TIME_THRESHOLDus   | 7.1.8.8            | R/W (M)          |
| LOW_ETR_THRESHOLDds   | 7.1.8.9            | R/W (M)          |
| LOW_ETR_THRESHOLDus   | 7.1.8.10           | R/W (M)          |
| <b><i>Update test parameters request</i></b>                              |                    |                  |
| UPDATE-NE-TEST  | 7.1.9.1            | R/W (M)          |
| UPDATE-FE-TEST  | 7.1.9.2            | R/W (M)          |
| <b><i>Low power modes</i></b>   |                    |                  |
| L2-TARSNRMds/us   | 7.1.10.1           | R/W (M)          |
| L2.1-MAXSNRMds/us   | 7.1.10.2           | R/W (M)          |
| L2-MAXPSDR  | 7.1.10.3           | R/W (M)          |
| L2.1-SRA-USNRMds  | 7.1.10.4           | R/W(M)           |
| L2.1-SRA-USNRMus  | 7.1.10.5           | R/W(M)           |
| L2.1-SRA-DSNRMds  | 7.1.10.6           | R/W(M)           |
| L2.1-SRA-DSNRMus  | 7.1.10.7           | R/W(M)           |
| <b><i><u>Impulse noise monitoring (INM)</u></i></b>                       |                    |                  |
| <u>INMIATds/us</u>  | <u>7.1.11.1</u>    | <u>R/W(M)</u>    |
| <u>INMIATSds/us</u>   | <u>7.1.11.2</u>    | <u>R/W(M)</u>    |
| <u>INMCCds/us</u>   | <u>7.1.11.3</u>    | <u>R/W(M)</u>    |
| <u>INM_INPEQ_FORMATds/us</u>  | <u>7.1.11.4</u>    | <u>R/W(M)</u>    |
| <u>BRGNds/us</u>  | <u>7.1.11.5</u>    | <u>R/W(M)</u>    |
| <u>INPEQ_SF</u>   | <u>7.1.11.6</u>    | <u>R/W(M)</u>    |



**Table 7-1 – Line configuration objects**

| Category/object                    | Defined in clause: | DPU-NB interface |
|------------------------------------|--------------------|------------------|
| <u>IAT_SF</u>                      | <u>7.1.11.7</u>    | <u>R/W(M)</u>    |
| <u>INM_ENABLE</u>                  | <u>7.1.11.8</u>    | <u>R/W(M)</u>    |
| <b><u>RMCR recovery (RMCR)</u></b> |                    |                  |
| <u>RMCR_LOR_TRIGGERds/us</u>       | <u>7.1.12.1</u>    | <u>R/W(M)</u>    |

**Table 7-2 – Channel configuration objects**

| Category/object                                    | Defined in clause: | DPU-NB interface |
|--|--------------------|------------------|
| <b><i>Data rate (downstream/upstream)</i></b>      |                    |                  |
| Maximum net data rate (NDR) (MAXNDR ds/us)         | 7.2.1.1            | R/W (M)          |
| Minimum expected throughput (MINETRds/us)          | 7.2.1.2            | R/W (M)          |
| Maximum gamma data rate (GDR) (MAXGDRds/us)        | 7.2.1.3            | R/W (M)          |
| Minimum gamma data rate (MINGDRds/us)              | 7.2.1.4            | R/W (M)          |
| <b><i>Retransmission (downstream/upstream)</i></b> |                    |                  |
| DELAYMAXds/us                                      | 7.2.2.1            | R/W (M)          |
| INPMIN_SHINEDs/us                                  | 7.2.2.2            | R/W (M)          |
| SHINERATIOds/us                                    | 7.2.2.3            | R/W (M)          |
| INPMIN_REINDs/us                                   | 7.2.2.4            | R/W (M)          |
| IAT_REINDs/us                                      | 7.2.2.5            | R/W (M)          |
| RNRATIOds/us                                       | 7.2.2.6            | R/W (M)          |
| RTX_TESTMODE                                       | 7.2.2.7            | R/W (M)          |
| <b>Low power modes</b>                             |                    |                  |
| L2.1-MAXNDRds/us                                   | 7.2.3.1            | R/W (M)          |
| L2.2-MAXNDR  | 7.2.3.2            | R/W (M)          |
| L2.1-MINETRds/us                                   | 7.2.3.3            | R/W (M)          |
| L2.2-MINETR  | 7.2.3.4            | R/W (M)          |
| L2.1-MINETR-EXITds/us                              | 7.2.3.5            | R/W (M)          |
| <b><i>Rate threshold (downstream/upstream)</i></b> |                    |                  |
| <u>LOW-ANDEFTR-THRESHOLDds/us</u>                  | <u>7.2.4.1</u>     | <u>R/W (M)</u>   |

**Table 7-3 – Data path configuration objects**

| Category/object | Defined in clause: | DPU-NB interface |
|-----------------|--------------------|------------------|
| TPS_TESTMODE    | 7.3.1              | R/W (M)          |
| DRA_TESTMODE    | 7.3.2              | R/W (M)          |

**Table 7-4 – Line failures**

| Category/object                         | Defined in clause: | DPU-NB interface |
|---|--------------------|------------------|
| <b><i>Near-end (FTU-O) failures</i></b> |                    |                  |
| Loss of signal (LOS)                    | 7.4.1.1            | R (M)            |
| Loss of margin (LOM)                    | 7.4.1.2            | R (M)            |
| Loss of RMC (LOR)                       | 7.4.1.3            | R (M)            |
| Loss of power (LPR)                     | 7.4.1.4            | R (M)            |
| <b><i>Far-end (FTU-R) failures</i></b>  |                    |                  |
| Far-end loss of signal (LOS-FE) failure | 7.4.2.1            | R (M)            |
| Far-end loss of margin (LOM-FE) failure | 7.4.2.2            | R (M)            |
| Far-end loss of RMC (LOR-FE) failure    | 7.4.2.3            | R (M)            |
| Far-end loss of power (LPR-FE) failure  | 7.4.2.4            | R (M)            |
| <b><i>Initialization failures</i></b>   |                    |                  |
| Line init (LINIT) failure               | 7.4.3.1            | R (M)            |

**Table 7-5 – Channel failures**

| Category/object                         | Defined in clause: | DPU-NB interface |
|---|--------------------|------------------|
| <b><i>Near-end (FTU-O) failures</i></b> |                    |                  |
|   |                    |                  |
| <b><i>Far-end (FTU-R) failures</i></b>  |                    |                  |
|   |                    |                  |

**Table 7-6 – Data path failures**

| Category/object                         | Defined in clause: | DPU-NB interface |
|---|--------------------|------------------|
| <b><i>Near-end (FTU-O) failures</i></b> |                    |                  |
|   |                    |                  |
| <b><i>Far-end (FTU-R) failures</i></b>  |                    |                  |
|   |                    |                  |

**Table 7-7 – Line performance monitoring objects**

| Category/object  | Defined in clause: | DPU-NB interface |
|--|--------------------|------------------|
| <b><i>Near-end (FTU-O)/Far-end (FTU-R) performance monitoring counters (current/previous 15 min/24 h interval)</i></b> |                    |                  |
| Measured time<br>(CURR/PREV_NE/FE_15/24_L_TIME)  | 7.7.1              | R (M)            |
| Invalid data flag<br>(PREV_NE/FE_15/24_L_INVALID)  | 7.7.2              | R (M)            |
| Time Stamp<br>(PREV_NE/FE_15/24_L_STAMP)   | 7.7.3              | R (M)            |
| LOS failure counter<br>(CURR/PREV_NE/FE_15/24_LOS)   | 7.7.4              | R (M)            |
| LOM failure counter<br>(CURR/PREV_NE/FE_15/24_LOM)   | 7.7.5              | R (M)            |
| LOR failure counter<br>(CURR/PREV_NE/FE_15/24_LOR)   | 7.7.6              | R (M)            |
| LPR failure counter<br>(CURR/PREV_NE/FE_15/24_LPR)   | 7.7.7              | R (M)            |
| ES counter<br>(CURR/PREV_NE/FE_15/24_ES)   | 7.7.8              | R (M)            |
| Severely errored second (SES) counter<br>(CURR/PREV_NE/FE_15/24_SES)   | 7.7.9              | R (M)            |
| LOSS counter<br>(CURR/PREV_NE/FE_15/24_LOSS)   | 7.7.10             | R (M)            |
| LOR second (LORS) counter<br>(CURR/PREV_NE/FE_15/24_LORS)  | 7.7.11             | R (M)            |
| Unavailable second (UAS) counter<br>(CURR/PREV_NE/FE_15/24_UAS)  | 7.7.12             | R (M)            |
| <b><i>Initialization performance monitoring counters (current/previous 15 min/24 h interval)</i></b>                   |                    |                  |
| Full inits counter<br>(CURR/PREV_15/24_FULL_INITS)   | 7.7.13             | R (M)            |
| Failed full inits counter<br>(CURR/PREV_15/24_FAILEDFULL_INITS)  | 7.7.14             | R (M)            |
| Fast inits counter<br>(CURR/PREV_15/24_FAST_INITS)   | 7.7.15             | R (M)            |
| Failed Fast inits counter<br>(CURR/PREV_15/24_FAILEDFAST_INITS)  | 7.7.16             | R (M)            |
| <b><i>Short interruption performance monitoring counters (current/previous 15 min/24 h interval)</i></b>               |                    |                  |
| LPR_INTRPT counter<br>(CURR/PREV_15/24_LPR_INTRPT)   | 7.7.17             | R (M)            |
| HRI_INTRPT counter<br>(CURR/PREV_15/24_HRI_INTRPT)   | 7.7.18             | R (M)            |
| SPONT_INTRPT counter<br>(CURR/PREV_15/24_SPONT_INTRPT)   | 7.7.19             | R (M)            |

**Table 7-7 – Line performance monitoring objects**

| Category/object   | Defined in clause: | DPU-NB interface |
|---|--------------------|------------------|
| <i>Near-end (FTU-O)/far-end (FTU-R) initiated OLR/FRA performance monitoring counters (current and previous 15 min/24 h interval)</i> |                    |                  |
| Successful bitswap counter<br>(CURR/PREV_NE/FE_15/24_BSW)   | 7.7.20             | R (M)            |
| Successful autonomous SRA counter<br>(CURR/PREV_NE/FE_15/24_SRA)  | 7.7.21             | R (M)            |
| Successful FRA counter<br>(CURR/PREV_NE/FE_15/24_FRA)   | 7.7.22             | R (M)            |
| Successful RPA counter (CURR/PREV_NE/FE_15/24_RPA)  | 7.7.23             | R (M)            |
| <i>Near-end (FTU-O) initiated TIGA performance monitoring counters (current and previous 15 min/24 h interval)</i>                    |                    |                  |
| Successful TIGA counter<br>(CURR/PREV_15/24_TIGA)   | 7.7.24             | R (M)            |
| Link State Usage (current and previous 15min/24h interval)  |                    |                  |
| L2.1N usage counter (CURR/PREV_15/24_L2.1N)   | 7.7.25             | R (M)            |
| L2.1B usage counter (CURR/PREV_15/24_L2.1B)   | 7.7.26             | R (M)            |
| L2.2 usage counter (CURR/PREV_15/24_L2.2)   | 7.7.27             | R (M)            |
| <i><u>Near-end (FTU-O)/Far-end (FTU-R) INM performance monitoring counters (current and previous 15 min/24 h interval)</u></i>        |                    |                  |
| <u>INM INPEQ histogram (CURR/PREV_NE/FE_15/24_INMINPEQ)</u>   | <u>7.7.28.1</u>    | <u>R(M)</u>      |
| <u>INM total measurement time (CURR/PREV_NE/FE_15/24_INMAME)</u>  | <u>7.7.28.2</u>    | <u>R(M)</u>      |
| <u>INM IAT histogram (CURR/PREV_NE/FE_15/24_INMIAT)</u>   | <u>7.7.28.3</u>    | <u>R(M)</u>      |
| <u>INM blank frame counter (CURR/PREV_NE/FE_15/24_INMBLFC)</u>  | <u>7.7.28.4</u>    | <u>R(M)</u>      |

**Table 7-8 – Channel performance monitoring objects**

| Category/object   | Defined in clause: | DPU-NB interface |
|---|--------------------|------------------|
| <i>Near-end (FTU-O)/far-end (FTU-R) performance monitoring counters (current/previous 15 min/24 h interval)</i> |                    |                  |
| Measured Time<br>(CURR/PREV_NE/FE_15/24_C_TIME)   | 7.8.1              | R (M)            |
| Invalid Data Flag<br>(PREV_NE/FE_15/24_C_INVALID)   | 7.8.2              | R (M)            |
| Time Stamp<br>(PREV_NE/FE_15/24_C_STAMP)  | 7.8.3              | R (M)            |
| CV counter<br>(CURR/PREV_NE/FE_15/24_CV)  | 7.8.4              | R (M)            |
| RTXUC counter<br>(CURR/PREV_NE/FE_15/24_RTXUC)  | 7.8.5              | R (M)            |

**Table 7-8 – Channel performance monitoring objects**

| Category/object  | Defined in clause: | DPU-NB interface |
|--|--------------------|------------------|
| RTXTX counter<br>(CURR/PREV_NE/FE_15/24_RTXTX)   | 7.8.6              | R (M)            |
| LANDEFTRS counter<br>(CURR/PREV_NE/FE_15/24_LANDEFTRS)   | 7.8.7              | R (M)            |
| ANDEFTRDS counter<br>(CURR/PREV_NE/FE_15/24_ANDEFTRDS)   | 7.8.8              | R (M)            |
| <i>Near-end(NE) and Far-end(FE) Rate parameters per time interval (current/previous 15 min/24 h time interval)</i>                                 |                    |                  |
| MINANDEFTR per time interval (MINANDEFTR_CURR/PREV_NE/FE_15/24)  | 7.8.9              | R (M)            |
| MAXANDEFTR per time interval (MAXANDEFTR_CURR/PREV_NE/FE_15/24)  | 7.8.10             | R (M)            |
| SUMANDEFTR per time interval (SUMANDEFTR_CURR/PREV_NE/FE_15/24)  | 7.8.11             | R (M)            |
| NOTE – The Measured Time, Invalid Data Flag and Time Stamp objects may have the same values as the respective line performance monitoring objects. |                    |                  |

**Table 7-9 – Data path performance monitoring objects**

| Category/object | Defined in clause: | DPU-NB interface |
|-----------------|--------------------|------------------|
|                 |                    |                  |

**Table 7-10 – Line test, diagnostic and status objects**

| Category/Object   | Defined in clause: | Test parameter group | DPU-NB Interface |
|---|--------------------|----------------------|------------------|
| <b>Profile</b>  |                    |                      |                  |
| G.9701 profile (PROFILE)  | 7.10.1.1           | Not applicable       | R (M)            |
| <b>Initialization</b>   |                    |                      |                  |
| Initialization success/failure cause (INITSFCAUSE)                    | 7.10.2.1           | Not applicable       | R (M)            |
| Initialization last transmitted downstream signal (INITLASTSSIGNALds) | 7.10.2.2           | Not applicable       | R (M)            |
| Initialization last received upstream signal (INITLASTSSIGNALus)      | 7.10.2.3           | Not applicable       | R (M)            |
| <b>Signal-to-noise ratio margin</b>                                   |                    |                      |                  |
| SNRMds  | 7.10.3.1           | Not applicable       | R (M)            |
| SNRMus  | 7.10.3.2           | Not applicable       | R (M)            |
| <b>Upstream power back-off</b>  |                    |                      |                  |
| UPBOKLE   | 7.10.4.1           | Not applicable       | R (M)            |
| UPBOKLE-R   | 7.10.4.2           | Not applicable       | R (M)            |
| <b>Actual aggregate transmit power</b>                                |                    |                      |                  |
| ACTATPDs  | 7.10.5.1           | FE-G1                | R (M)            |
| ACTATPus  | 7.10.5.2           | NE-G1                | R (M)            |

**Table 7-10 – Line test, diagnostic and status objects**

| Category/Object   | Defined in clause: | Test parameter group | DPU–NB Interface |
|---|--------------------|----------------------|------------------|
| <i>Actual transmit power spectrum density per sub-carrier</i> |                    |                      |                  |
| ACTPSDpsds  | 7.10.6.1           | FE-G1                | R (M)            |
| ACTPSDpsus  | 7.10.6.2           | NE-G1                | R (M)            |
| <i>Channel characteristics per sub-carrier</i>                |                    |                      |                  |
| HLOGMTds  | 7.10.1.1           | NE-G2                | R(M)             |
| HLOGGds   | 7.10.7.2           | NE-G2                | R(M)             |
| HLOGpsds  | 7.10.7.3           | NE-G2                | R(M)             |
| HLOGMTus  | 7.10.1.4           | NE-G2                | R (M)            |
| HLOGGus   | 7.10.7.5           | NE-G2                | R (M)            |
| HLOGpsus  | 7.10.7.6           | NE-G2                | R (M)            |
| <i>Signal-to-noise ratio per sub-carrier</i>                  |                    |                      |                  |
| SNRMTds   | 7.10.8.1           | FE-G1                | R (M)            |
| SNRGds  | 7.10.8.2           | FE-G1                | R (M)            |
| SNRpsds   | 7.10.8.3           | FE-G1                | R (M)            |
| SNRMTus   | 7.10.8.4           | NE-G1                | R (M)            |
| SNRGus  | 7.10.8.5           | NE-G1                | R (M)            |
| SNRpsus   | 7.10.8.6           | NE-G1                | R (M)            |
| <i>Quiet line noise per sub-carrier</i>                       |                    |                      |                  |
| QLNMTds   | 7.10.9.1           | FE-G2                | R (M)            |
| QLNGds  | 7.10.9.2           | FE-G2                | R (M)            |
| QLNpsds   | 7.10.9.3           | FE-G2                | R (M)            |
| QLNMTus   | 7.10.9.4           | NE-G2                | R (M)            |
| QLNGus  | 7.10.9.5           | NE-G2                | R (M)            |
| QLNpsus   | 7.10.9.6           | NE-G2                | R (M)            |
| <i>Active line noise per sub-carrier</i>                      |                    |                      |                  |
| ALNMT   | 7.10.10.1          | FE-G2                | R (M)            |
| ALNG  | 7.10.10.2          | FE-G2                | R (M)            |
| ALNps   | 7.10.10.3          | FE-G2                | R (M)            |
| <i>Low power modes</i>  |                    |                      |                  |
| L2.1-SNRMds   | 7.10.16.1          | Not applicable       | R(M)             |
| L2.1-SNRMus   | 7.10.16.2          | Not applicable       | R(M)             |
| L2.2-SNRMds   | 7.10.16.3          | Not applicable       | R(M)             |
| L2.2-SNRMus   | 7.10.16.4          | Not applicable       | R(M)             |
| L2-SNRM-RMCds   | 7.10.16.5          | Not applicable       | R(M)             |
| L2-SNRM-RMCus   | 7.10.16.6          | Not applicable       | R(M)             |
| <i>Bit allocation per sub-carrier on data symbols</i>         |                    |                      |                  |
| BITSpds   | 7.10.11.1          | Not applicable       | R (M)            |
| BITSpus   | 7.10.11.2          | Not applicable       | R (M)            |

**Table 7-10 – Line test, diagnostic and status objects**

| Category/Object                          | Defined in clause: | Test parameter group | DPU–NB Interface |
|--|--------------------|----------------------|------------------|
| <b><i>RMC</i></b>                        |                    |                      |                  |
| SNRM-RMCds                               | 7.10.12.1          | Not applicable       | R (M)            |
| SNRM-RMCus                               | 7.10.12.2          | Not applicable       | R (M)            |
| BITS-RMCpsds                             | 7.10.12.3          | Not applicable       | R (M)            |
| BITS-RMCpsus                             | 7.10.12.4          | Not applicable       | R (M)            |
| <b><i>Test parameter time stamps</i></b> |                    |                      |                  |
| STAMP-TEST-NE-G1                         | 7.10.13.1          | Not applicable       | R (M)            |
| STAMP-TEST-FE-G1                         | 7.10.13.2          | Not applicable       | R (M)            |
| STAMP-TEST-NE-G2                         | 7.10.13.3          | Not applicable       | R (M)            |
| STAMP-TEST-FE-G2                         | 7.10.13.4          | Not applicable       | R (M)            |
| <b><i>OLR time stamps</i></b>            |                    |                      |                  |
| STAMP-BSWds                              | 7.10.14.1          | Not applicable       | R (M)            |
| STAMP-BSWus                              | 7.10.14.2          | Not applicable       | R (M)            |
| STAMP-SRAds                              | 7.10.14.3          | Not applicable       | R (M)            |
| STAMP-SRAus                              | 7.10.14.4          | Not applicable       | R (M)            |
| STAMP-FRAds                              | 7.10.14.5          | Not applicable       | R (M)            |
| STAMP-FRAus                              | 7.10.14.6          | Not applicable       | R (M)            |
| STAMP-RPAds                              | 7.10.14.7          | Not applicable       | R (M)            |
| STAMP-RPAus                              | 7.10.14.8          | Not applicable       | R (M)            |
| STAMP-TIGA                               | 7.10.14.9          | Not applicable       | R (M)            |
| <b><i>Signal attenuation</i></b>         |                    |                      |                  |
| SATNds                                   | 7.10.15.1          | FE-G1                | R (M)            |
| SATNus                                   | 7.10.15.2          | NE-G1                | R (M)            |
| <b><i>Vectoring</i></b>                  |                    |                      |                  |
| XLOGDISTds                               | 7.10.17.1          | NE-G2                | R (O)            |
| XLOGBANDSds                              | 7.10.17.2          | NE-G2                | R (O)            |
| XLOGpsds                                 | 7.10.17.3          | NE-G2                | R (O)            |

**Table 7-11 – Channel test, diagnostic and status objects**

| Category/Object   | Defined in clause: | Test parameter group | DPU–NB Interface |
|---|--------------------|----------------------|------------------|
| <b><i>Actual data rates(downstream/upstream)</i></b>                  |                    |                      |                  |
| Net Data Rate (NDRds/us)  | 7.11.1.1           | Not applicable       | R (M)            |
| Expected Throughput (ETRds/us)  | 7.11.1.2           | Not applicable       | R (M)            |
| Gamma Data Rate (GDRds/us)  | 7.11.1.3           | Not applicable       | R (M)            |
| <b><i>Attainable data rates (downstream/upstream)</i></b>             |                    |                      |                  |
| Attainable net Data rate (ATTNDRds/us)                                | 7.11.2.1           | Not applicable       | R (M)            |
| Attainable Expected Throughput (ATTETRds/us)                          | 7.11.2.2           | Not applicable       | R (M)            |
| Attainable Gamma Data Rate (ATTGDRds/us)                              | 7.11.2.3           | Not applicable       | R (M)            |
| <b><i>Actual impulse noise protection (downstream/upstream)</i></b>   |                    |                      |                  |
| ACTINPds/us   | 7.11.3.1           | Not applicable       | R (M)            |
| ACTINP_REINds/us  | 7.11.3.2           | Not applicable       | R (M)            |
| <b><i>Actual framer setting (downstream/upstream)</i></b>             |                    |                      |                  |
| DTU–NFECds/us   | 7.11.4.1           | Not applicable       | R (M)            |
| DTU–RFECds/us   | 7.11.4.2           | Not applicable       | R (M)            |
| DTU–Qds/us  | 7.11.4.3           | Not applicable       | R (M)            |
| <b><i>Test parameters per time interval (downstream/upstream)</i></b> |                    |                      |                  |
| Error–free bits current 15 minutes (EFB–C15Mds/us)                    | 7.11.5.1           | Not applicable       | R (M)            |
| Error–free bits previous 15 minutes (EFB–P15Mds/us)                   | 7.11.5.2           | Not applicable       | R (M)            |
| Error–free bits current 24 hours (EFB–C24Hds/us)                      | 7.11.5.3           | Not applicable       | R (M)            |
| Error–free bits previous 24 hours (EFB–P24Hds/us)                     | 7.11.5.4           | Not applicable       | R (M)            |
| MINEFTR current15 minutes (MINEFTR_C15Mds/us)                         | 7.11.5.5           | Not applicable       | R (M)            |
| MINEFTR previous15 minutes (MINEFTR_P15Mds/us)                        | 7.11.5.6           | Not applicable       | R (M)            |
| MINEFTR current 24 hours(MINEFTR_C24Hds/us)                           | 7.11.5.7           | Not applicable       | R (M)            |
| MINEFTR previous 24 hours (MINEFTR_P24Hds/us)                         | 7.11.5.8           | Not applicable       | R (M)            |
| <b><i>Low power modes (downstream/upstream)</i></b>                   |                    |                      |                  |
| L2.1-NDRds/us   | 7.11.6.1           | Not applicable       | R(M)             |
| L2.2-NDRds/us   | 7.11.6.2           | Not applicable       | R(M)             |
| L2.1-ETRds/us   | 7.11.6.3           | Not applicable       | R(M)             |
| L2.2-ETRds/us   | 7.11.6.4           | Not applicable       | R(M)             |



**Table 7-12 – Data path test, diagnostic and status objects**

| Category/object | Defined in clause: | DPU-NB interface |
|-----------------|--------------------|------------------|
|                 |                    |                  |

**Table 7-13 – Inventory objects**

| Category/object                                 | Defined in clause: | DPU-NB interface |
|---|--------------------|------------------|
| <b><i>FTU related inventory</i></b>             |                    |                  |
| FTU-O ITU-T G.994.1 vendor ID (FTUO_GHS_VENDOR) | 7.13.1.1           | R (M)            |
| FTU-R ITU-T G.994.1 vendor ID (FTUR_GHS_VENDOR) | 7.13.1.2           | R (M)            |
| FTU-O version number (FTUO_VERSION)             | 7.13.1.3           | R (M)            |
| FTU-R version number (FTU-R VERSION)            | 7.13.1.4           | R (M)            |
| FTU-O self-test result (FTUO-SELFTEST)          | 7.13.1.5           | R (M)            |
| FTU-R self-test result (FTUR-SELFTEST)          | 7.13.1.6           | R (M)            |
| ITU-T G.9701 profile support (FTUO_PROFILES)    | 7.13.1.7           | R (M)            |
| ITU-T G.9701 profile support (FTUR_PROFILES)    | 7.13.1.8           | R (M)            |
| <b><i>System related inventory</i></b>          |                    |                  |
| DPU system vendor ID (DPU_SYSTEM_VENDOR)        | 7.13.2.1           | R (M)            |
| NT system vendor ID (NT_SYSTEM_VENDOR)          | 7.13.2.2           | R (M)            |
| DPU serial number (DPU_SYSTEM_SERIALNR)         | 7.13.2.3           | R (M)            |
| NT serial number (NT_SYSTEM_SERIALNR)           | 7.13.2.4           | R (M)            |
| VCE identifier (VCE_ID)                         | 7.13.2.5           | R (M)            |
| VCE port index (VCE_PORT_INDEX)                 | 7.13.2.6           | R (M)            |

**Table 7-14 – Link state objects**

| Category/Object   | Defined in clause: | DPU-NB  |
|---|--------------------|---------|
| Link State Test Configuration   |                    |         |
| Link State Force (LS-FORCED)  | 7.14.1.1           | R/W (M) |
| Link State Enabling (LS-ENABLE)   | 7.14.1.2           | R/W (M) |
| <b><i>Link state reporting</i></b>  |                    |         |
| Link State (LINK-STATE)   | 7.14.2.1           | R (M)   |
| Link State at update of near-end test parameter group 1 (LINK-STATE-TEST-NE-G1) | 7.14.2.2           | R (M)   |
| Link State at update of far-end test parameter group 1 (LINK-STATE-TEST-FE-G1)  | 7.14.2.3           | R (M)   |

## 7.1 Line configuration objects

### 7.1.0 Profiles

#### 7.1.0.1 ITU-T G.9701 profiles enabling (PROFILES)

**Description:** Defines for each profile whether operation according to that profile is allowed or disallowed.

**Type:** Array of PROFILEdescriptor[0...N-1] with N=5.

##### PROFILEdescriptor

**Type:** boolean.

**Valid values:** false (disallowed) and true (allowed).

##### Bit representation

- |   |                             |
|---|-----------------------------|
| 0 | [ITU-T G.9701] profile 106a |
| 1 | [ITU-T G.9701] profile 106b |
| 2 | [ITU-T G.9701] profile 212a |
| 3 | [ITU-T G.9701] profile 106c |
| 4 | [ITU-T G.9701] profile 212c |

**Default value:** All elements of the array set to true (All profiles allowed).

**Reference:** Clause 6 of [ITU-T G.9701].

#### 7.1.1 Time division duplexing (TDD)

##### 7.1.1.1 Number of symbol periods in a TDD frame (MF)

**Description:** Defines the total number of symbol periods in a TDD frame.

**Type:** 8-bit unsigned integer.

**Valid values:** 23 and 36.

**Default value:** 36.

**Reference:** Clause 10.5 of [ITU-T G.9701].

##### 7.1.1.2 Number of downstream symbol periods in a TDD frame (Mds)

**Description:** Defines the total number of symbol positions in a TDD frame allocated for downstream transmission. The total number of symbol positions in a TDD frame allocated for upstream transmission is calculated as  $M_{us} = M_F - 1 - M_{ds}$ .

**Type:** 8-bit unsigned integer.

**Valid values:** 10...32 (if MF=36) and 6...19 (if MF=23).

**Default value:** 28.

NOTE – If MF=23, a value different from the default value needs to be configured (see clause 7.1).

**Reference:** Clause 10.5 of [ITU-T G.9701].

##### 7.1.1.3 Cyclic extension (CE)

**Description:** Defines the cyclic extension ( $L_{CP}$ ) to be used.

**Type:** 8-bit unsigned integer.

**Unit:** N/64 samples, with N = index of highest supported downstream data-bearing sub-carrier as defined for the enabled profile (see Table 6-1 of [ITU-T G.9701]) plus one.

**Valid values:** 4, 8, 10, 12, 14, 16, 20, 24, 30 and 33.

**Default value:** 10.

**Reference:** Clause 10.4.4 of [ITU-T G.9701].

## **7.1.2 Power and spectrum usage**

### **7.1.2.1 Downstream maximum aggregate transmit power (MAXATPds)**

**Description:** Defines the maximum aggregate transmit power at the U-O2 reference point in the downstream direction during initialization and showtime (in dBm).

**Type:** 16-bit signed integer.

**Unit:** 0.1 dBm.

**Valid values:** -310...+310 (-31 to +31 dBm).

**Default value:** 40 (4 dBm).

**Reference:** Clause 7.3.2 of [ITU-T G.9701].

### **7.1.2.2 Upstream maximum aggregate transmit power (MAXATPus)**

**Description:** Defines the maximum aggregate transmit power at the U-R2 reference point in the upstream direction during initialization and showtime (in dBm).

**Type:** 16-bit signed integer.

**Unit:** 0.1 dBm.

**Valid values:** -310...+310 (-31 to +31 dBm).

**Default value:** 40 (4 dBm).

**Reference:** Clause 7.3.2 of [ITU-T G.9701].

### **7.1.2.3 Downstream sub-carrier masking (CARMASKds)**

**Description:** Defines the masked sub-carrier bands in the downstream direction. All sub-carriers within the band, i.e., with indices greater than or equal to the start sub-carrier index and less than or equal to the stop sub-carrier index, are masked, i.e., have a transmit power set to zero (linear scale).

**Type:** Array of CARMASKdescriptor[0...N-1], with  $N \leq 32$ .

#### **CARMASKdescriptor:**

**Type:** Record of a start sub-carrier index and a stop sub-carrier index.

#### **Sub-carrier index:**

**Type:** 16-bit unsigned integer.

**Valid values:** 0...4095 (sub-carrier index 0 to 4095).

**Default value:** Empty array (No masked sub-carriers).

**Reference:** Clause 6.3 of [ITU-T G.9700], and clause 7.3.1.3 of [ITU-T G.9701].

### **7.1.2.4 Upstream sub-carrier masking (CARMASKus)**

**Description:** Defines the masked sub-carrier bands in the upstream direction. All sub-carriers within the band, i.e., with indices greater than or equal to the start sub-carrier index and less than or equal to the stop sub-carrier index, have a transmit power set to zero (linear scale).

**Type:** Array of CARMASKdescriptor[0...N-1], with  $N \leq 32$ .

**CARMASKdescriptor:** See CARMASKds in clause 7.1.2.3.

**Default value:** Empty array (No masked sub-carriers).

**Reference:** Clause 6.3 of [ITU-T G.9700] and clause 7.3.1.3 of [ITU-T G.9701].

#### 7.1.2.5 Downstream PSD mask (MIBPSDMASKds)

**Description:** Defines the downstream power spectral density (PSD) mask applicable at the U-O2 reference point. Requirements for a valid MIBPSDMASKds are defined in clauses 7.3.1.1.2.1 and 7.3.1.1.2.2 of [ITU-T G.9701].

**Type:** Array of MIBPSDMASKdescriptor[0...N-1], with N=0 or  $2 \leq N \leq 32$ .

**PSDMASKdescriptor:**

**Type:** Record of a sub-carrier index and a PSD level.

**Sub-carrier index:**

**Type:** 16-bit unsigned integer.

**Valid values:** 0...4095 (sub-carrier index 0 to 4095).

**PSD level:**

**Type:** 8-bit unsigned integer.

**Unit:** -0.5 dBm/Hz.

**Valid values:** 0...255 (0 to -127.5 dBm/Hz).

**Default value:** Empty array (Limit PSD mask defined in [ITU-T G.9700]).

**Reference:** Clause 7.3.1.1 of [ITU-T G.9701].

#### 7.1.2.6 Upstream PSD mask (MIBPSDMASKus)

**Description:** Defines the upstream PSD mask applicable at the U-R2 reference point. Requirements for a valid MIBPSDMASKus are defined in clauses 7.3.1.1.2.1 and 7.3.1.1.2.2 of [ITU-T G.9701].

**Type:** Array of MIBPSDMASKdescriptor[0...N-1], with N=0 or  $2 \leq N \leq 32$ .

**PSDMASKdescriptor:** See MIBPSDMASKds in clause 7.1.2.5.

**Default value:** Empty array (Limit PSD mask defined in [ITU-T G.9700]).

**Reference:** Clause 7.3.1.1 of [ITU-T G.9701].

#### 7.1.2.7 RFI bands (RFIBANDS)

**Description:** Defines the bands where the PSD shall be reduced as specified in clause 7.3.1.2 of [ITU-T G.9701].

**Type:** Array of RFIBANDdescriptor[0...N-1], with  $N \leq 32$ .

**RFIBANDdescriptor:**

**Type:** Record of a start sub-carrier index and a stop sub-carrier index.

**Sub-carrier index:**

**Type:** 16-bit unsigned integer.

**Valid values:** 0...4095 (sub-carrier index 0 to 4095).

**Default value:** Empty array (No RFI bands, no PSD reduction).

**Reference:** Clauses 7.3.1.2 and 12.3.2.1.1 of [ITU-T G.9701].

#### 7.1.2.8 International amateur radio bands (IARBANDS)

**Description:** Defines for each international amateur radio (IAR) band whether transmit PSD reduction is enabled or disabled in that band.

**Type:** Array of IARBANDdescriptor[0...12].

**IARBANDdescriptor:**

**Type:** boolean.

**Valid values:** false (disabled) and true (enabled).

**Bit representation:**

|    |  |
|----|--|
| 0  | International amateur radio band 1800-2000 kHz     |
| 1  | International amateur radio band 3500-4000 kHz     |
| 2  | International amateur radio band 7000-7300 kHz     |
| 3  | International amateur radio band 10100-10150 kHz   |
| 4  | International amateur radio band 14000-14350 kHz   |
| 5  | International amateur radio band 18068-18168 kHz   |
| 6  | International amateur radio band 21000-21450 kHz   |
| 7  | International amateur radio band 24890-24990 kHz   |
| 8  | International amateur radio band 28000-29700 kHz   |
| 9  | International amateur radio band 50000-54000 kHz   |
| 10 | International amateur radio band 70000-70500 kHz   |
| 11 | International amateur radio band 144000-148000 kHz |
| 12 | International amateur radio band 5351.5-5366.5 kHz |

**Default value:** All elements of the array set to false (All IAR bands disabled, no PSD reduction).

**Reference:** Clauses 7.3.1.2 and 12.3.2.1.1 of [ITU-T G.9701], Tables 11.70.8 and 11.70.8.1 of [ITU-T G.994.1].

**7.1.2.9 Upstream power back-off reference PSD (UPBOPSDA)**

**Description:** Defines the parameter  $a$  for the UPBO reference PSD used to compute the upstream power back-off for the upstream frequency band.

**Type:** 16-bit unsigned integer.

**Unit:** 0.01 dBm/Hz.

**Offset:** 40 dBm/Hz.

**Valid values:** 0...4095 (40 to 80.95 dBm/Hz).

**Default value:** 0 (40 dBm/Hz).

**Reference:** Clause 7.3.1.4 of [ITU-T G.9701].

**7.1.2.10 Upstream power back-off reference PSD (UPBOPSDB)**

**Description:** Defines the parameter  $b$  for the UPBO reference PSD used to compute the upstream power back-off for the upstream frequency band.

**Type:** 16-bit unsigned integer.

**Unit:** 0.01 dBm/Hz.

**Valid values:** 0...4095 (0 to 40.95 dBm/Hz).

**Default value:** 0 (0 dBm/Hz).

**Reference:** Clause 7.3.1.4 of [ITU-T G.9701].

#### 7.1.2.11 Upstream electrical length (UPBOKL)

**Description:** Defines the electrical length  $kl_0$  (expressed in dB at 1 MHz).

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...1280 (0 to 128 dB).

**Default value:** 0 (0 dB)

**Reference:** Clause 7.3.1.4.2.1 of [ITU-T G.9701].

#### 7.1.2.12 Force electrical length (UPBOKLF)

**Description:** Defines whether or not the FTU-R is forced to use the electrical length  $kl_0 = \text{UPBOKL}$  to compute the UPBOMASK. If not forced, the FTUs determine the electrical length  $kl_0$ .

**Type:** boolean.

**Valid values:** false (not forced) and true (forced).

**Default value:** false (not forced).

**Reference:** Clause 7.3.1.4.2.1 of [ITU-T G.9701].

#### 7.1.2.13 UPBO reference electrical length per band (UPBOKLREF)

**Description:** Defines the UPBO reference electrical length  $kl_{0\_REF}$  used to compute the upstream power back-off for the Equalized FEXT UPBO method. If  $kl_{0\_REF} = 0$  (special value) then the Equal PSD UPBO method is used.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0 (special value) and 18...255 (1.8 to 25.5 dB).

**Default value:** 0 (special value).

**Reference:** Clause 7.3.1.4.2.2 of [ITU-T G.9701].

### 7.1.3 Noise margin

#### 7.1.3.1 Downstream target noise margin (TARSNRMds)

**Description:** Defines the downstream target noise margin for the channel initialization policy.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 60 (6 dB).

**Reference:** Clause 12.3.7 of [ITU-T G.9701].

#### 7.1.3.2 Upstream target noise margin (TARSNRMus)

**Description:** Defines the upstream target noise margin used in the channel initialization policy.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 60 (6 dB).

**Reference:** Clause 12.3.7 of [ITU-T G.9701].

### 7.1.3.3 Upstream maximum noise margin (MAXSNRMus)

**Description:** Defines the upstream maximum noise margin used in the channel initialization policy. The special value indicates there is no maximum bound for the upstream noise margin (i.e., the upstream maximum noise margin is infinite).

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB) and 511 (special value).

**Default value:** 511 (special value).

**Reference:** Clause 12.3.7 of [ITU-T G.9701].

### 7.1.3.4 Downstream minimum noise margin (MINSNRMds)

**Description:** Defines the downstream minimum noise margin the FTU-R receiver shall tolerate. If the downstream noise margin (SNRMds) falls below this level, a loss-of-margin (*lom*) defect occurs. Upon persistency of the *lom* defect, the FTU-R triggers a re-initialization (see clause 12.1.4.2 of [ITU-T G.9701]).

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 0 (0 dB).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

### 7.1.3.5 Upstream minimum noise margin (MINSNRMus)

**Description:** Defines the upstream minimum noise margin the FTU-O receiver shall tolerate. If the upstream noise margin (SNRMus) falls below this level, the FTU-O requests the FTU-R to increase the FTU-R transmit power. If an increase to FTU-R transmit power is not possible, a *lom* defect occurs. Upon persistency of the *lom* defect, the FTU-O triggers a re-initialization (see clause 12.1.4.2 of [ITU-T G.9701]).

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 0 (0 dB).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

## 7.1.4 Seamless rate adaptation

### 7.1.4.1 Downstream upshift noise margin (SRA-USNRMds)

**Description:** If the downstream noise margin (SNRMds) 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 (SRA-UTIMEds), the FTU-R autonomously attempts to increase the downstream net data rate (NDRds).

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 70 (7 dB).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

#### **7.1.4.2 Upstream upshift noise margin (SRA-USNRMus)**

**Description:** If the upstream noise margin (SNRMus) is above the upstream upshift noise margin and stays above that for more than the time specified by the upstream minimum upshift rate adaptation interval (SRA-UTIMEus), the FTU-O autonomously attempts to increase the upstream net data rate (NDRus).

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 70 (7 dB).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

#### **7.1.4.3 Downstream minimum time interval for upshift SRA (SRA-UTIMEds)**

**Description:** Defines the interval of time the downstream noise margin (SNRMds) should stay above the downstream upshift noise margin (SRA-USNRMds) before the FTU-R autonomously attempts to increase the NDRds.

**Type:** 16-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 0...16383 (0 to  $2^{14}-1$  s).

**Default value:** 8 (8 s).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

#### **7.1.4.4 Upstream minimum time interval for upshift SRA (SRA-UTIMEus)**

**Description:** Defines the interval of time the upstream noise margin (SNRMus) should stay above the upstream upshift noise margin (SRA-USNRMus) before the FTU-O autonomously attempts to increase the NDRus.

**Type:** 16-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 0...16383 (0 to  $2^{14}-1$  s).

**Default value:** 8 (8 s).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

#### **7.1.4.5 Downstream downshift noise margin (SRA-DSNRMds)**

**Description:** If the downstream noise margin (SNRMds) is below the downstream downshift noise margin and stays below that for more than the time specified by the downstream minimum downshift rate adaptation interval (SRA-DTIMEds), the FTU-R autonomously attempts to decrease the NDRds.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 50 (5 dB).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].



#### 7.1.4.6 Upstream downshift noise margin (SRA-DSNRMus)

**Description:** If the upstream noise margin (SNRMus) is below the upstream downshift noise margin and stays below that for more than the time specified by the upstream minimum downshift rate adaptation interval (SRA-DTIMEus), the FTU-O autonomously attempts to decrease the NDRus.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0..310 (0 to 31 dB).

**Default value:** 50 (5 dB).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

#### 7.1.4.7 Downstream minimum time interval for downshift SRA (SRA-DTIMEds)

**Description:** Defines the interval of time the downstream noise margin (SNRMds) should stay below the downstream downshift noise margin (SRA-DSNRMds) before the FTU-R autonomously attempts to decrease the NDRds.

**Type:** 16-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 0...16383 (0 to  $2^{14}-1$  s).

**Default value:** 2 (2 s).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

#### 7.1.4.8 Upstream minimum time interval for downshift SRA (SRA-DTIMEus)

**Description:** Defines the interval of time the upstream noise margin (SNRMus) should stay below the upstream downshift noise margin (SRA-DSNRMus) before the FTU-O autonomously attempts to decrease the NDRus.

**Type:** 16-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 0...16383 (0 to  $2^{14}-1$  s).

**Default value:** 2 (2 s).

**Reference:** Clause 12.3.4.2.1 of [ITU-T G.9701].

### 7.1.5 Fast rate adaptation

#### 7.1.5.1 Downstream FRA time window (FRA-TIMEds)

**Description:** Defines the duration of the time window used in the standard FRA triggering criteria (see clause 13.4.3.2 of [ITU-T G.9701]) for the downstream direction. The special value 0 indicates that vendor discretionary values for *fra-ntones*, *fra-rtx-uc*, and *fra-time* may be used in the downstream direction.

**Type:** 8-bit unsigned integer.

**Unit:** 1 logical frame length.

**Valid values:** 0 (special value) and (1...8 (if MF=36) or 1...12 (if MF=23)).

**Default value:** 8

**Reference:** Clause 13.3.1.1.1.1 of [ITU-T G.9701].

### 7.1.5.2 Upstream FRA time window (FRA-TIMEus)

**Description:** Defines the duration of the time window used in the standard FRA triggering criteria (see clause 13.4.3.2 of [ITU-T G.9701]) for the upstream direction. The special value 0 indicates that vendor discretionary values for *fra-ntones*, *fra-rtx-uc*, and *fra-time* may be used in the upstream direction.

**Type:** 8-bit unsigned integer.

**Unit:** 1 logical frame length.

**Valid values:** 0 (special value) and (1...8 (if MF=36) or 1...12 (if MF=23)).

**Default value:** 8.

**Reference:** Clause 13.3.1.1.1.1 of [ITU-T G.9701].

### 7.1.5.3 Downstream FRA minimum percentage of degraded tones (FRA-NTONESds)

**Description:** Defines the minimum percentage of loaded sub-carriers that are detected as degraded throughout a time window equal to FRA-TIMEds in order to arm the first FRA triggering criteria (see clause 13.3.1.1.1.5 of [ITU-T G.9701]) in the downstream direction. The special value 0 indicates that monitoring of the percentage of degraded sub-carriers is disabled.

**Type:** 8-bit unsigned integer.

**Valid values:** 0 and 1...100.

**Default value:** 50.

**Reference:** Clause 13.3.1.1.1.2 of [ITU-T G.9701].

### 7.1.5.4 Upstream FRA minimum percentage of degraded tones (FRA-NTONESus)

**Description:** Defines the minimum percentage of loaded sub-carriers (i.e., sub-carriers with  $b_i > 0$ ) that are detected as degraded throughout a time window equal to FRA-TIMEus in order to arm the first FRA triggering criteria (see clause 13.3.1.1.1.5 of [ITU-T G.9701]) in the upstream direction. The special value 0 indicates that monitoring of the percentage of degraded sub-carriers is disabled.

**Type:** 8-bit unsigned integer.

**Valid values:** 0 and 1...100.

**Default value:** 50.

**Reference:** Clause 13.3.1.1.1.2 of [ITU-T G.9701].

### 7.1.5.5 Downstream FRA number of uncorrectable DTU (FRA-RTXUCds)

**Description:** Defines the minimum number of *rtx-uc* anomalies received throughout a time window equal to FRA-TIMEds in order to arm the second FRA triggering criteria (see clause 13.3.1.1.1.5 of [ITU-T G.9701]) in the downstream direction. The special value 0 indicates that monitoring of the number of *rtx-uc* anomalies is disabled.

**Type:** 16-bit unsigned integer.

**Valid values:** 0 and 1...1023.

**Default value:** 150.

**Reference:** Clause 13.3.1.1.1.3 of [ITU-T G.9701].

### 7.1.5.6 Upstream FRA number of uncorrectable DTU (FRA-RTXUCus)

**Description:** Defines the minimum number of *rtx-uc* anomalies received throughout a time window equal to FRA-TIMEus in order to arm the second FRA triggering criteria (see clause 13.3.1.1.1.5 of

[ITU-T G.9701]) in the upstream direction. The special value 0 indicates that monitoring of the number of *rtx-uc* anomalies is disabled.

**Type:** 16-bit unsigned integer.

**Valid values:** 0 and 1...1023.

**Default value:** 150.

**Reference:** Clause 13.3.1.1.1.3 of [ITU-T G.9701].

#### **7.1.5.7 Downstream vendor discretionary FRA triggering criteria (FRA-VENDISCds)**

**Description:** Defines whether vendor discretionary FRA triggering criteria may be used (enabled) or not (disabled) in the downstream direction.

**Type:** boolean.

**Valid values:** false (disabled) and true (enabled).

**Default value:** false (disabled).

**Reference:** Clause 13.3.1.1.1.4 of [ITU-T G.9701].

#### **7.1.5.8 Upstream vendor discretionary FRA triggering criteria (FRA-VENDISCus)**

**Description:** Defines whether vendor discretionary FRA triggering criteria may be used (enabled) or not (disabled) in the upstream direction.

**Type:** boolean.

**Valid values:** false (disabled) and true (enabled).

**Default value:** false (disabled).

**Reference:** Clause 13.3.1.1.1.4 of [ITU-T G.9701].

### **7.1.6 Robust management channel**

#### **7.1.6.1 Downstream target noise margin for RMC (TARSNRM-RMCds)**

**Description:** Defines the downstream RMC noise margin (SNRM-RMCds) that the FTU-R receiver shall achieve, relative to the BER requirement, or better, to successfully complete initialization.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 60 (6 dB).

**Reference:** Clause 12.3.3.2.1 of [ITU-T G.9701].

#### **7.1.6.2 Upstream target noise margin (TARSNRM-RMCus)**

**Description:** Defines the upstream RMC noise margin (SNRM-RMCus) that the FTU-O receiver shall achieve, relative to the BER requirement, or better, to successfully complete initialization.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 60 (6 dB).

**Reference:** Clause 12.3.3.2.1 of [ITU-T G.9701].

### **7.1.6.3 Downstream minimum noise margin for RMC (MINSNRM-RMCds)**

**Description:** Defines the downstream minimum noise margin the FTU-R receiver tolerates for the RMC. If the downstream RMC noise margin (SNRM-RMCds) falls below this level, the FTU-R initiates the RMC parameter adjustment (RPA) procedure.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 0 (0 dB).

**Reference:** Clause 13.2.1.3 of [ITU-T G.9701].

### **7.1.6.4 Upstream minimum noise margin for RMC (MINSNRM-RMCus)**

**Description:** Defines the upstream minimum noise margin the FTU-O receiver tolerates for the RMC. If the downstream RMC noise margin (SNRM-RMCus) falls below this level, the FTU-O initiates the RPA procedure.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 0 (0 dB).

**Reference:** Clause 13.2.1.3 of [ITU-T G.9701].

### **7.1.6.5 Downstream maximum bitloading for RMC (MAXBL-RMCds)**

**Description:** Defines the maximum allowed bit-loading for the downstream RMC sub-carriers.

**Type:** 8-bit unsigned integer.

**Valid values:** 2...6.

**Default value:** 6.

**Reference:** Clause 12.3.3.2.1 of [ITU-T G.9701].

### **7.1.6.6 Upstream maximum bitloading for RMC (MAXBL-RMCus)**

**Description:** Defines the maximum allowed bit-loading for the upstream RMC sub-carriers.

**Type:** 8-bit unsigned integer.

**Valid values:** 2...6.

**Default value:** 6.

**Reference:** Clause 12.3.3.2.1 of [ITU-T G.9701].

## **7.1.7 Vectoring**

### **7.1.7.1 FEXT cancellation enabling/disabling downstream (FEXT\_TO\_CANCEL\_ENABLEDs)**

**Description:** Defines whether FEXT cancellation in the downstream direction from all the other vectored lines into the line in the vectored group is enabled or disabled.

**Type:** boolean.

**Valid values:** false (disabled) or true (enabled).

**Default value:** true (enabled).

**Reference:** Clause 11.4.3.1 of [ITU-T G.9701].

#### **7.1.7.2 FEXT cancellation enabling/disabling upstream (FEXT\_TO\_CANCEL\_ENABLE<sub>us</sub>)**

**Description:** Defines whether FEXT cancellation in the upstream direction from all the other vectored lines into the line in the vectored group is enabled or disabled.

**Type:** boolean.

**Valid values:** false (disabled) or true (enabled).

**Default value:** true (enabled).

**Reference:** Clause 11.4.3.1 of [ITU-T G.9701].

#### **7.1.7.3 XLOG requested subcarrier group size (XLOGGREQ<sub>ds</sub>)**

**Description:** This parameter is the requested lower bound on the value of XLOGG<sub>ds</sub> in the reporting of Xlogps<sub>ds</sub>.

**Type:** 8-bit signed integer.

**Unit:** 1 sub-carrier.

**Valid values:** 1, 2, 4, 8, 16, 32, and 64.

**Default value:** 1.

**Reference:** Clause 11.4.3.2 of [ITU-T G.9701].

#### **7.1.7.4 XLOG requested disturber index (XLOGDREQ<sub>ds</sub>)**

**Description:** This parameter is the requested value of the VCE\_port\_index (XLOGDIST<sub>ds</sub>) for the disturber line in the reporting of XLOGps<sub>ds</sub>.

**Type:** 16-bit unsigned integer.

**Valid values:** 1..65535.

**Default value:** 1.

**Reference:** Clause 11.4.3.2 of [ITU-T G.9701].

### **7.1.8 Fast-retrain policy**

#### **7.1.8.1 Downstream los defect persistency (LOS\_PERSISTENCY<sub>ds</sub>)**

**Description:** Defines the downstream *los* defect persistency for triggering a re-initialization (see clause 12.1.4.2) at the FTU-R receiver, as part of the fast-retrain policy.

**Type:** 8-bit unsigned integer.

**Unit:** 0.1 s.

**Valid values:** 1...20 (0.1 to 2 s).

**Default value:** 2 (0.2 s).

**Reference:** Clause 12.1.4.3.1 of [ITU-T G.9701].

#### **7.1.8.2 Upstream los defect persistency (LOS\_PERSISTENCY<sub>us</sub>)**

**Description:** Defines the upstream *los* defect persistency for triggering a re-initialization (see clause 12.1.4.2) at the FTU-O receiver, as part of the fast-retrain policy.

**Type:** 8-bit unsigned integer.

**Unit:** 0.1 s.

**Valid values:** 1...20 (0.1 to 2 s).

**Default value:** 2 (0.2 s).

**Reference:** Clause 12.1.4.3.1 of [ITU-T G.9701].

#### **7.1.8.3 Downstream *lom* defect persistency (LOM\_PERSISTENCYds)**

**Description:** Defines the downstream *lom* defect persistency for triggering a re-initialization (see clause 12.1.4.2) at the FTU-R receiver, as part of the fast-retrain policy.

**Type:** 8-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 2...20 (2 to 20 s).

**Default value:** 2 (2 s).

**Reference:** Clause 12.1.4.3.2 of [ITU-T G.9701].

#### **7.1.8.4 Upstream *lom* defect persistency (LOM\_PERSISTENCYus)**

**Description:** Defines the upstream *lom* defect persistency for triggering a re-initialization (see clause 12.1.4.2) at the FTU-O receiver, as part of the fast-retrain policy.

**Type:** 8-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 2...20 (2 to 20 s).

**Default value:** 2 (2 s).

**Reference:** Clause 12.1.4.3.2 of [ITU-T G.9701].

#### **7.1.8.5 Downstream *lor* defect persistency (LOR\_PERSISTENCYds)**

**Description:** Defines the downstream *lor* defect persistency for triggering a re-initialization (see clause 12.1.4.2) at the FTU-R receiver, as part of the fast-retrain policy.

**Type:** 8-bit unsigned integer.

**Unit:** 0.1 s.

**Valid values:** 1...20 (0.1 to 2 s).

**Default value:** 2 (0.2 s).

**Reference:** Clause 12.1.4.3.3 of [ITU-T G.9701].

#### **7.1.8.6 Upstream *lor* defect persistency (LOR\_PERSISTENCYus)**

**Description:** Defines the upstream *lor* defect persistency for triggering a re-initialization (see clause 12.1.4.2) at the FTU-O receiver, as part of the fast-retrain policy.

**Type:** 8-bit unsigned integer.

**Unit:** 0.1 s.

**Valid values:** 1...20 (0.1 to 2 s).

**Default value:** 2 (0.2 s).

**Reference:** Clause 12.1.4.3.3 of [ITU-T G.9701].

#### **7.1.8.7 Downstream re-initialization time threshold (REINIT\_TIME\_THRESHOLDds)**

**Description:** Defines the downstream threshold for the SES and eoc timeout conditions for declaring a High\_BER event (see clause 12.1.4.3.4) at the FTU-R receiver, as part of the fast-retrain policy.

**Type:** 8-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 5...31 (5 to 31 s).

**Default value:** 10 (10 s).

**Reference:** Clause 12.1.4.3.4 of [ITU-T G.9701].

#### **7.1.8.8 Upstream re-initialization time threshold (REINIT\_TIME\_THRESHOLD<sub>DUS</sub>)**

**Description:** Defines the upstream threshold for the SES and eoc timeout conditions for declaring a High\_BER event (see clause 12.1.4.3.4) at the FTU-O receiver, as part of the fast-retrain policy.

**Type:** 8-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 5...31 (5 to 31 s).

**Default value:** 10 (10 s).

**Reference:** Clause 12.1.4.3.4 of [ITU-T G.9701].

#### **7.1.8.9 Downstream low ETR threshold (LOW\_ETR\_THRESHOLD<sub>DS</sub>)**

**Description:** Defines the downstream threshold for the low ETR condition for declaring a High\_BER event (see clause 12.1.4.3.4) at the FTU-R receiver, as part of the fast-retrain policy. The special value 0 indicates that no High\_BER event is declared based on *ETR* being below the *ETR<sub>min</sub>*.

**Type:** 8-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 0 and 1...30 (1 to 30 s).

**Default value:** 20 (20 s).

**Reference:** Clause 12.1.4.3.4 of [ITU-T G.9701].

#### **7.1.8.10 Upstream low ETR threshold (LOW\_ETR\_THRESHOLD<sub>DUS</sub>)**

**Description:** Defines the upstream threshold for the low ETR condition for declaring a High\_BER event (see clause 12.1.4.3.4) at the FTU-O receiver, as part of the fast-retrain policy. The special value 0 indicates that no High\_BER event is declared based on *ETR* being below the *ETR<sub>min</sub>*.

**Type:** 8-bit unsigned integer.

**Unit:** 1 s.

**Valid values:** 0 and 1...30 (1 to 30 s).

**Default value:** 20 (20 s).

**Reference:** Clause 12.1.4.3.4 of [ITU-T G.9701].

### **7.1.9 Update test parameters**

#### **7.1.9.1 Update request flag for near-end test parameters (UPDATE-NE-TEST)**

**Description:** Forces an update of one or more of the near-end test parameter groups that can be updated during showtime. See introductory text to clause 7.

**Type:** Array of UPDATEREQUESTFLAGdescriptor[0..1].

**UPDATEREQUESTFLAGdescriptor:**

**Type:** boolean.

**Valid values:** false (no update forced) or true (update forced).

**Bit representation:**

- 0 Near-end test parameter group 1 (NE-G1)
- 1 Near-end test parameter group 2 (NE-G2)

**Default value:** All elements of the array set to false (no update forced).

**Reference:** Clause 11.1 of ITU-T G.9701.

### 7.1.9.2 Update request flag for far-end test parameters (UPDATE-FE-TEST)

**Description:** Forces an update of one or more of the far-end test parameter group that can be updated during showtime. See introductory text to clause 7.

**Type:** Array of UPDATEREQUESTFLAGdescriptor[0..1].

**UPDATEREQUESTFLAGdescriptor:** see clause 7.1.9.1.

**Bit representation:**

- 0 Far-end test parameter group 1 (FE-G1)
- 1 Far-end test parameter group 2 (FE-G2)

**Default value:** All elements of the array set to false (no update forced).

**Reference:** Clause 11.1 of [ITU-T G.9701].

### 7.1.10 Low power modes

#### 7.1.10.1 Target noise margin in L2 (L2-TARSNRMds/us)

**Description:** Defines the target noise margin used during the L2.1N, L2.1B and L2.2 link states.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0..310 (0 to 31 dB).

**Default value:** 60 (6 dB).

**Reference:** Clauses 13.4.1.5 and 13.4.2.5 of [ITU-T G.9701].

#### 7.1.10.2 Maximum noise margin in L2.1 (L2.1-MAXSNRMds/us)

**Description:** Defines the maximum noise margin allowed during the L2.1N and L2.1B link states.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0..310 (0 to 31 dB) and 511 (special value).

**Default value:** 511 (special value).

**Reference:** Clauses 13.4.1.5 and 13.4.2.5 of [ITU-T G.9701].

#### 7.1.10.3 Maximum PSD reduction in L2 (L2-MAXPSDR)

**Description:** Defines the maximum PSD reduction allowed during the L2.1N, L2.2B and L2.2 link states for both the upstream and downstream direction. The special value indicates there is no maximum bound for the PSD reduction (i.e., the maximum PSD reduction is infinite).

**Type:** 8-bit unsigned integer.



**Unit:** 1 dB.

**Valid values:** 0..10 (0 to 10 dB).

**Default value:** 0 (0 dB).

**Reference:** Clause 13.4.1.5 of [ITU-T G.9701].

#### **7.1.10.4 Downstream upshift noise margin in L2.1 (L2.1-SRA-USNRMds)**

**Description:** If the downstream noise margin in the L2.1N and L2.1B link states (L2.1-SNRMds) 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 (SRA-UTIMEds), the FTU-R autonomously attempts to increase the downstream net data rate in the L2.1 link state.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 70 (7 dB).

**Reference:** Clause 13.4.1.5 of [ITU-T G.9701].

#### **7.1.10.5 Upstream upshift noise margin in L2.1 (L2.1-SRA-USNRMus)**

**Description:** If the upstream noise margin in the L2.1N and L2.1B link states (L2.1-SNRMus) is above the upstream upshift noise margin and stays above that for more than the time specified by the upstream minimum upshift rate adaptation interval (SRA-UTIMEus), the FTU-O autonomously attempts to increase the upstream net data rate in the L2.1 link state.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 70 (7 dB).

**Reference:** Clause 13.4.1.5 of [ITU-T G.9701].

#### **7.1.10.6 Downstream downshift noise margin in L2.1 (L2.1-SRA-DSNRMds)**

**Description:** If the downstream noise margin in the L2.1N and L2.1B link states (L2.1-SNRMds) is below the downstream downshift noise margin and stays below that for more than the time specified by the downstream minimum downshift rate adaptation interval (SRA-DTIMEds), the FTU-R autonomously attempts to decrease the downstream net data rate in the L2.1 link state.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...310 (0 to 31 dB).

**Default value:** 50 (5 dB).

**Reference:** Clause 13.4.1.5 of [ITU-T G.9701].

#### **7.1.10.7 Upstream downshift noise margin in L2.1 (L2.1-SRA-DSNRMus)**

**Description:** If the upstream noise margin in the L2.1N and L2.1B link states (L2.1-SNRMus) is below the upstream downshift noise margin and stays below that for more than the time specified by the upstream minimum downshift rate adaptation interval (SRA-DTIMEus), the FTU-O autonomously attempts to decrease the upstream net data rate in the L2.1 link state.

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0..310 (0 to 31 dB).

**Default value:** 50 (5 dB).

**Reference:** Clause 13.4.1.5 of [ITU-T G.9701].

#### **7.1.11 INM configuration objects**

The following configuration objects are defined to control the impulse noise monitor in the receive direction in the FTU. A downstream impulse noise monitor applies to the FTU-R, an upstream impulse noise monitor applies to the FTU-O.

##### **7.1.11.1 INM inter arrival time offset (INMIATods/us)**

**Description:** Defines the inter arrival time offset per direction that the FTU receiver shall use to determine in which bin of the inter arrival time histogram the IAT is reported.

**Type:** 8-bit unsigned integer.

**Unit:** One IAT time unit (see clause 7.1.11.7).

**Valid values:** 3...511.

**Default value:** 3

**Reference:** Clause 11.4.4.7.2.1 of [ITU-T G.9701].

##### **7.1.11.2 INM inter arrival time step (INMIATSds/us)**

**Description:** Defines the inter arrival time step per direction that the FTU receiver shall use to determine in which bin of the inter arrival time histogram the IAT is reported.

**Type:** 8-bit unsigned integer.

**Unit:** One IAT time unit (see clause 7.1.11.7).

**Valid values:** 0...7.

**Default value:** 1.

**Reference:** Clause 11.4.4.7.2.2 of [ITU-T G.9701].

##### **7.1.11.3 INM cluster continuation value (INMCCds/us)**

**Description:** Defines the cluster continuation value per direction that the FTU receiver shall use in the cluster indication process.

**Type:** 8-bit unsigned integer.

**Unit:** One DMT symbol.

**Valid values:** 1...255.

**Default value:** 1.

**Reference:** Clause 11.4.4.7.2.3 of [ITU-T G.9701].

##### **7.1.11.4 INM equivalent INP format (INM\_INPEQ\_FORMATds/us)**

**Description:** Defines the way the scale is configured for the INM\_INPEQ histogram

**Type:** enumeration

**Valid values:** 0, 1.

0        Linear scale

1        Logarithmic scale

**Default value:** 0 (linear scale).

**Reference:** Clause 11.4.4.7.2.4 of [ITU-T G.9701].

#### **7.1.11.5 DTU cluster bridging (BRGNds/us)**

**Description:** Defines per direction whether the FTU receiver shall use bridging in the determination of the DTU cluster size.

**Type:** Boolean.

**Valid values:** False (disabled), True (enabled).

**Default value:** False (disabled).

**Reference:** Clause 11.4.4.7.2.5 of [ITU-T G.9701].

#### **7.1.11.6 INPEQ Time Unit Scaling Factor (INPEQ\_SF)**

**Description:** Defines time unit scaling factor for the line that the FTU receivers shall use for reporting INPEQ.

**Type:** 8-bit unsigned integer.

**Valid values:** 4, 8, 12.

**Default value:** 12.

**Reference:** Clause 11.4.4.7.2.6 of [ITU-T G.9701].

#### **7.1.11.7 IAT time unit scaling factor (IAT\_SF)**

**Description:** Defines the time unit scaling factor for the line that the FTU receivers shall use for reporting IAT. One IAT time unit is defined as ST DMT symbols.

**Type:** 8-bit unsigned integer.

**Valid values:** 4, 8, 12.

**Default value:** 12.

**Reference:** Clause 11.4.4.7.2.7 of [ITU-T G.9701].

#### **7.1.11.8 INM enable (INM\_ENABLE)**

**Description:** Defines whether the INM functionality is enabled or disabled.

**Type:** Boolean

**Valid values:** False (disabled), True (enabled).

**Default value:** False (disabled).

**Reference:** Clause 11.4.4.7 of [ITU-T G.9701].

#### **7.1.12 RMCR configuration objects**

**The following configuration objects are defined to control the RMCR procedure in the receive direction in the FTU.**

##### **7.1.12.1 RMCR *lor* persistency trigger (RMCR\_LOR\_TRIGGERds/us)**

**Description:** Defines the persistency period of a *lor* defect before the RMC is declared severely degraded. The value 0 is a special value that indicates that the RMCR procedure is disabled. It can only be set to 0 in one direction if the value is also set to 0 in the opposite direction.

**Type:** 8-bit unsigned integer.

**Unit:** 50 ms.

**Valid values:** 0 (disabled), 1(50 ms), ..., 20 (1000 ms)

**Default value:** (0disabled)

**Reference:** Clause 13.3.1.2.1 of [ITU-T G.9701].

## **7.2 Channel configuration objects**

### **7.2.1 Data rates**

#### **7.2.1.1 Maximum net data rate (MAXNDRds/us)**

**Description:** Defines the value of the maximum NDR (see clause 11.4.2.2 of [ITU-T G.9701]).

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967295 (0 to  $2^{32}-1$  kbit/s).

**Default value:** 4294967295 (4294967295 kbit/s).

**Reference:** Clause 11.4.2.2 of [ITU-T G.9701].

#### **7.2.1.2 Minimum expected throughput (MINETRds/us)**

**Description:** Defines the value of the minimum expected throughput (see clause 11.4.2.1 of [ITU-T G.9701]).

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967295 (0 to  $2^{32}-1$  kbit/s).

**Default value:** 0 (0 bit/s).

**Reference:** Clause 11.4.2.1 of [ITU-T G.9701].

#### **7.2.1.3 Maximum gamma data rate (MAXGDRds/us)**

**Description:** Defines the maximum value of the gamma data rate (GDR) (see clause 7.11.1.3). The GDR shall not exceed MAXGDR at the start of showtime and during showtime.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967295 (0 to  $2^{32}-1$  kbit/s).

**Default value:** 4294967295 (4294967295 kbit/s).

**Reference:** None.

#### **7.2.1.4 Minimum gamma data rate (MINGDRds/us)**

**Description:** Defines the minimum value of the GDR (see clause 7.11.1.3). The GDR may be less than MINGDR. If the GDR is less than MINGDR at initialization or when GDR becomes less than MINGDR during showtime, a threshold crossing alert occurs.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967295 (0 to  $2^{32}-1$  kbit/s).

**Default value:** 0 (0 bit/second).

**Reference:** None.

## 7.2.2 Retransmission

### 7.2.2.1 Maximum delay (DELAYMAXds/us)

**Description:** Defines the maximum allowed delay for retransmission (see clause 9.8 of [ITU-T G.9701]). The ITU-T G.9701 control parameter *delay\_max* is set to the same value as the maximum delay (see clause 11.4.2.3 of [ITU-T G.9701]).

**Type:** 32-bit unsigned integer.

**Unit:** 0.25 ms.

**Valid values:** 4..64 (1 to 16 milliseconds).

**Default value:** 40 (10 ms).

**Reference:** Clause 11.4.2.3 of [ITU-T G.9701].

### 7.2.2.2 Minimum impulse noise protection against SHINE (INPMIN\_SHINEds/us)

**Description:** Defines the minimum impulse noise protection against SHINE (see clause 9.8 of [ITU-T G.9701]). The ITU-T G.9701 control parameter *INP\_min\_shine* is set to the same value as the minimum impulse noise protection against SHINE (see clause 11.4.2.4 of [ITU-T G.9701]).

**Type:** 16-bit unsigned integer.

**Unit:** 1 symbol period.

**Valid values:** 0...520 (0 to 520 symbol periods).

**Default value:** 0 (0 symbol periods).

**Reference:** Clause 11.4.2.4 of [ITU-T G.9701].

### 7.2.2.3 SHINE ratio (SHINERATIOds/us)

**Description:** Defines the *SHINEratio* that is used in the definition of the expected throughput rate (*ETR*) (see clause 9.8 of [ITU-T G.9701]). The ITU-T G.9701 control parameter *SHINEratio* is set to the same value as the SHINE ratio (see clause 11.4.2.5 of [ITU-T G.9701]).

**Type:** 8-bit unsigned integer.

**Unit:** 0.001.

**Valid values:** 0...100 (0 to 0.1).

**Default value:** 0 (0).

**Reference:** Clause 11.4.2.5 of [ITU-T G.9701].

### 7.2.2.4 Minimum impulse noise protection against REIN (INPMIN\_REINds/us)

**Description:** Defines the minimum impulse noise protection against repetitive electrical impulse noise (REIN) (see clause 9.8 of [ITU-T G.9701]). The ITU-T G.9701 control parameter *INP\_min\_rein* is set to the same value as the minimum impulse noise protection against REIN (see clause 11.4.2.6 of [ITU-T G.9701]).

**Type:** 8-bit unsigned integer.

**Unit:** 1 symbol period.

**Valid values:** 0...63 (0 to 63 symbol periods).

**Default value:** 0 (0 symbol periods).

**Reference:** Clause 11.4.2.6 of [ITU-T G.9701].

#### 7.2.2.5 REIN inter-arrival time (IAT\_REINds/us)

**Description:** Defines the REIN inter-arrival time (see clause 9.8 of [ITU-T G.9701]). The ITU-T G.9701 control parameter *iat\_rein\_flag* is set to the same value as the REIN inter-arrival time (see clause 11.4.2.7 of [ITU-T G.9701]).

**Type:** enumeration.

**Valid values:** 0 (100 Hz), 1 (120 Hz), 2 (300 Hz), and 3 (360 Hz).

**Default value:** 0 (100 Hz).

**Reference:** Clause 11.4.2.7 of [ITU-T G.9701].

#### 7.2.2.6 Minimum Reed-Solomon RFEC/NFEC ratio (RNRATIOds/us)

**Description:** Defines the minimal required ratio, RFEC/NFEC, of Reed-Solomon code parameters. The ITU-T G.9701 control parameter *rnratio* is set to the same value as the minimum Reed-Solomon RFEC/NFEC ratio (see clause 11.4.2.8 of [ITU-T G.9701]).

**Type:** 8-bit unsigned integer.

**Unit:** 1/32.

**Valid values:** 0...8 (0 to 1/4).

**Default value:** 0 (0).

**Reference:** Clause 11.4.2.8 of [ITU-T G.9701].

#### 7.2.2.7 RTX-TC testmode (RTX\_TESTMODE)

**Description:** Defines whether the retransmission testmode defined in clause 9.8.3.1.2 of [ITU-T G.9701] is enabled or disabled in the upstream and downstream directions. The RTX\_TESTMODE setting may be changed during showtime. When changed, it shall take effect on the line within 2 s without re-initialization.

**Type:** boolean.

**Valid values:** false (disabled) or true (enabled).

**Default value:** false (disabled).

**Reference:** Clause 9.8.3.1.2 of [ITU-T G.9701].

### 7.2.3 Low power modes

#### 7.2.3.1 Maximum net data rate in L2.1 (L2.1-MAXNDRds/us)

**Description:** Defines the value of the maximum net data rate allowed during the L2.1N and L2.1B link states.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bits/second.

**Valid values:** 0..4294967295 (0 to  $2^{32}-1$  kbit/s).

**Default value:** 4294967295 (4294967295 kbit/second).

**Reference:** Clause 13.4.1.5 of [ITU-T G.9701].

#### 7.2.3.2 Maximum net data rate in L2.2 (L2.2-MAXNDR)

**Description:** Defines the value of the maximum net data rate allowed during the L2.2 link state for both the upstream and downstream direction.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bits/second.

**Valid values:** 0..4294967295 (0 to 232-1 kbit/s).

**Default value:** 4294967295 (4294967295 kbit/second).

**Reference:** Clause 13.4.2.5 of [ITU-T G.9701].

### **7.2.3.3 Minimum expected throughput in L2.1 (L2.1-MINETRds/us)**

**Description:** Defines the value of the minimum expected throughput allowed during the L2.1N and L2.1B link states.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bits/second.

**Valid values:** 0..4294967295 (0 to 232-1 kbit/s).

**Default value:** 0 (0 bits/second).

**Reference:** Clause 13.4.1.5 of [ITU-T G.9701].

### **7.2.3.4 Minimum expected throughput in L2.2 (L2.2-MINETR)**

**Description:** Defines the value of the minimum expected throughput allowed during the L2.2 link state for both the upstream and downstream direction.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bits/second.

**Valid values:** 0..4294967295 (0 to  $2^{32}$ -1 kbit/s).

**Default value:** 0 (0 bits/second).

**Reference:** Clause 13.4.2.5 of [ITU-T G.9701].

### **7.2.3.5 Minimum expected throughput after exit from L2.1 (L2.1-MINETR-EXITds/us)**

**Description:** Defines the value of the minimum expected throughput allowed after exit from the L2.1N to the L0 link state.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bits/second.

**Valid values:** 0..4294967295 (0 to  $2^{32}$ -1 kbit/s).

**Default value:** 0 (0 bits/second).

**Reference:** Clause 13.4.1.5 of [ITU-T G.9701].

## **7.2.4 Rate threshold**

### **7.2.4.1 "landeftr" defect threshold (LOW-ANDEFTR-THRESHOLDds/us)**

**Description:** Defines the value of the low all-NOI data error-free throughput rate threshold (see clause 11.3.1.3 of [ITU-T G.9701]).

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967295 (0 to  $2^{32}$ -1 kbit/s).

**Default value:** 0 (0 kbit/s).

**Reference:** Clause 11.3.1.3 of [ITU-T G.9701].

### 7.3 Data path configuration objects

#### 7.3.1 TPS-TC testmode (TPS\_TESTMODE)

**Description:** Defines whether the TPS-TC testmode defined in clause 8.3.1 of [ITU-T G.9701] is enabled or disabled in the upstream and downstream directions. The TPS\_TESTMODE setting may be changed during showtime. When changed, it shall take effect on the line within 2 s without re-initialization.

**Type:** boolean.

**Valid values:** false (disabled) or true (enabled).

**Default value:** false (disabled).

**Reference:** Clause 8.3.1 of [ITU-T G.9701].

#### 7.3.2 DRA testmode (DRA\_TESTMODE)

**Description:** Defines whether the dynamic resource allocation (DRA) testmode defined in clause 9.8.3.1.2 of [ITU-T G.9701] is enabled or disabled in the upstream and downstream directions. The DRA\_TESTMODE setting may be changed during showtime. When changed, it shall take effect on the line within 2 s without re-initialization.

**Type:** boolean.

**Valid values:** false (disabled) or true (enabled).

**Default value:** false (disabled).

**Reference:** Clause 9.8.3.1.2 of [ITU-T G.9701].

### 7.4 Line failures

Any failure defined in this clause shall be conveyed by the DPU over the DPU-NB interface and may be conveyed by the NT over the T-/S-interface after it is detected.

The near-end failure detections shall be provided at the DPU and may be provided at the NT.

The far-end failure detections shall be provided at the DPU (NT is at the far-end), and may be provided at the NT (DPU is at the far-end).

#### 7.4.1 Near end failures

The LOS, LOR, and LOM failures are mutually exclusive and reflect the reason cause of the triggered re-initialization. If no LOS, LOR, or LOM failure is declared, then the re-initialization is triggered by a High\_BER event (see clause 12.1.4 of [ITU-T G.9701]).

##### 7.4.1.1 Loss-of-signal (LOS) failure

A LOS failure is declared when a re-initialization is triggered by a persistent near-end *los* defect. A LOS failure is cleared immediately at the start of showtime in the receiving direction.

##### 7.4.1.2 Loss-of-RMC (LOR) failure

A LOR failure is declared when a re-initialization is triggered by a persistent near-end *lor* defect. A LOR failure is cleared immediately at the start of showtime in the receiving direction.

##### 7.4.1.3 Loss-of-margin (LOM) failure

A LOM failure is declared when a re-initialization is triggered by a persistent near-end *lom* defect. A LOM failure is cleared immediately at the start of showtime in the receiving direction.



#### **7.4.1.4 Loss of power failure**

A LPR failure is declared after  $2.5 \pm 0.5$  s of contiguous near-end *lpr* primitive presence. An LPR failure is cleared after  $10 \pm 0.5$  s of no near-end *lpr* primitive presence.

#### **7.4.2 Far-end failures**

##### **7.4.2.1 Far-end loss of signal failure**

A LOS-FE failure is declared when a re-initialization is triggered with a far-end *los* defect present. A LOS-FE failure is cleared immediately at the start of showtime in the transmitting direction.

##### **7.4.2.2 Far-end loss of RMC failure**

A LOR-FE failure is declared when a re-initialization is triggered with a far-end *lor* defect present and no LOS-FE failure is present. A LOR-FE failure is cleared immediately at the start of showtime in the transmitting direction.

##### **7.4.2.3 Far-end loss of margin failure**

A LOM-FE failure is declared when a re-initialization is triggered with a far-end *lom* defect present and no LOS-FE failure is present and no LOR-FE failure is present. A LOM-FE failure is cleared immediately at the start of showtime in the transmitting direction.

##### **7.4.2.4 Far-end loss of power failure**

A LPR-FE failure is declared after the occurrence of a far-end *lpr* primitive followed by  $2.5 \pm 0.5$  s of contiguous near-end *los* defect. A LPR-FE failure is cleared after  $10 \pm 0.5$  s of no near-end *los* defect.

#### **7.4.3 Initialization failures**

##### **7.4.3.1 Line initialization (LINIT) failure**

When the near-end transmitter enters the SILENT state and fails to reach the SHOWTIME state (after a vendor discretionary number of retries and/or within a vendor discretionary timeout), then an initialization failure occurs. An initialization failure cause and last successful transmitted state are reported (see clause 7.10.2).

#### **7.5 Channel failures**

No channel failures are defined.

#### **7.6 Data path failures**

No data path failures are defined.

#### **7.7 Line performance monitoring objects**

The line performance monitoring objects defined in Table 7-7 are subject to the rules defined in clause 8.

CURR/PREV means that the object may apply separately for the current interval and the previous interval, NE/FE means that the object may apply separately for network element (NE) and FE, and 15/24 means that the object may apply separately for 15 min and 24 h intervals.

##### **7.7.1 Measured Time (CURR/PREV\_NE/FE\_15/24\_L\_TIME)**

**Description:** Reports the amount of time, measured in seconds, that statistics for this interval have been counted.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...900 (for 15 min interval) and 0...86400 (for 24 h interval).

**Reference:** Clause 8.9.

#### **7.7.2 Invalid Data flag (PREV\_NE/FE\_15/24\_L\_INVALID)**

**Description:** Reports the validity of the corresponding PM data. Reported only with the previous interval PM counters.

**Type:** boolean.

**Valid values:** TRUE (PM data is incomplete or invalid) and FALSE (PM data is complete and valid).

**Reference:** Clause 8.9.

#### **7.7.3 Time Stamp (PREV\_NE/FE\_15/24\_L\_STAMP)**

**Description:** Reports the start date/time for this interval. Reported only with the previous interval PM counters.

**Type:** String (as defined in clause 8.12).

**Reference:** None.

#### **7.7.4 LOS failure counter (CURR/PREV\_NE/FE\_15/24\_LOS)**

**Description:** For NE, reports a count of the LOS failures defined in clause 7.4.1.1. For FE, reports a count of the LOS-FE failures defined in clause 7.4.2.1.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clauses 7.4.1.1 and 7.4.2.1.

#### **7.7.5 LOR failure counter (CURR/PREV\_NE/FE\_15/24\_LOR)**

**Description:** For NE, reports a count of the LOR failures defined in clause 7.4.1.2. For FE, reports a count of the LOR-FE failures defined in clause 7.4.2.2.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clauses 7.4.1.2 and 7.4.2.2.

#### **7.7.6 LOM failure counter (CURR/PREV\_NE/FE\_15/24\_LOM)**

**Description:** For NE, reports a count of the LOM failures defined in clause 7.4.1.3. For FE, reports a count of the LOM-FE failures defined in clause 7.4.2.3.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clauses 7.4.1.3 and 7.4.2.3.

#### **7.7.7 LPR failure counter (CURR/PREV\_NE/FE\_15/24\_LPR)**

**Description:** For NE, reports a count of the LPR failures defined in clause 7.4.1.4. For FE, reports a count of the LPR-FE failures defined in clause 7.4.2.4.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clauses 7.4.1.4 and 7.4.2.4.

#### **7.7.8 ES counter (CURR/PREV\_NE/FE\_15/24\_ES)**

**Description:** Reports the count of errored seconds (ESs). An ES is defined in clause 11.4.4.2 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...900 (15 min interval) and 0...86400 (24 h interval).

**Reference:** Clause 11.4.4.2 of [ITU-T G.9701].

#### **7.7.9 SES counter (CURR/PREV\_NE/FE\_15/24\_SES)**

**Description:** Reports the count of SESs. An SES is defined in clause 11.4.4.3 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...900 (15 min interval) and 0...86400 (24 h interval).

**Reference:** Clause 11.4.4.3 of [ITU-T G.9701].

#### **7.7.10 LOSS counter (CURR/PREV\_NE/FE\_15/24\_LOSS)**

**Description:** Reports the count of LOS seconds (LOSS). A LOSS is defined in clause 11.4.4.4 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...900 (15 min interval) and 0...86400 (24 h interval).

**Reference:** Clause 11.4.4.4 of [ITU-T G.9701].

#### **7.7.11 LORS counter (CURR/PREV\_NE/FE\_15/24\_LORS)**

**Description:** Reports the count of LORS. A LORS is defined in clause 11.4.4.5 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...900 (15 min interval) and 0...86400 (24 h interval).

**Reference:** Clause 11.4.4.5 of [ITU-T G.9701].

#### **7.7.12 UAS counter (CURR/PREV\_NE/FE\_15/24\_UAS)**

**Description:** Reports the count of unavailable seconds (UAS). An unavailable second (UAS) is defined in clause 11.4.4.6 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...900 (15 min interval) and 0...86400 (24 h interval).

**Reference:** Clause 11.4.4.6 of [ITU-T G.9701].

#### **7.7.13 Full inits counter (CURR/PREV\_15/24\_FULL\_INITS)**

**Description:** Reports a count of the full initialization primitives (full\_init). The full initialization primitive (full\_init) is defined in clause 11.3.1.5 of [ITU-T G.9701]. Reported only with the near-end PM counters.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.5 of [ITU-T G.9701].

#### **7.7.14 Failed full inits counter (CURR/PREV\_15/24\_FAILEDFULL\_INITS)**

**Description:** Reports a count of the failed full initialization primitives (*failedfull\_init*). The failed full initialization primitive (*failedfull\_init*) is defined in clause 11.3.1.5 of [ITU-T G.9701]. Reported only with the near-end PM counters.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.5 of [ITU-T G.9701].

#### **7.7.15 Fast inits counter (CURR/PREV\_15/24\_FAST\_INITS)**

**Description:** Reports a count of the fast initialization primitives (*fast\_init*). The fast initialization primitive (*fast\_init*) is defined in clause 11.3.1.5 of [ITU-T G.9701]. Reported only with the near-end PM counters.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.5 of [ITU-T G.9701].

#### **7.7.16 Failed fast inits counter (CURR/PREV\_15/24\_FAILEDFAST\_INITS)**

**Description:** Reports a count of the failed fast initialization primitives (*failedfast\_init*). The failed fast initialization primitive (*failedfast\_init*) is defined in clause 11.3.1.5 of [ITU-T G.9701]. Reported only with the near-end PM counters.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.5 of [ITU-T G.9701].

#### **7.7.17 LPR\_INTRPT counter (CURR/PREV\_15/24\_LPR\_INTRPT)**

**Description:** Reports a count of the loss-of-power interruption anomalies (*lpr\_intrpt*). The loss-of-power interruption anomaly (*lpr\_intrpt*) is defined in clause 11.3.1.1 of [ITU-T G.9701]. Reported only with the near-end PM counters.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.1 of [ITU-T G.9701].

#### **7.7.18 HRI\_INTRPT counter (CURR/PREV\_15/24\_HRI\_INTRPT)**

**Description:** Reports a count of the host-reinit interruption anomalies (*hri\_intrpt*). The host-reinit interruption anomaly (*hri\_intrpt*) is defined in clause 11.3.1.1 of [ITU-T G.9701]. Reported only with the near-end PM counters.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.1 of [ITU-T G.9701].

#### **7.7.19 SPONT\_INTRPT counter (CURR/PREV\_15/24\_SPONT\_INTRPT)**

**Description:** Reports a count of the spontaneous interruption anomalies (*spont\_intrpt*). The spontaneous interruption anomaly (*spont\_intrpt*) is defined in clause 11.3.1.1 of [ITU-T G.9701]. Reported only with the near-end PM counters.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.1 of [ITU-T G.9701].

#### **7.7.20 Successful bit swap counter (CURR/PREV\_NE/FE\_15/24\_BSW)**

**Description:** Reports a count of the successful bit swap primitives (*success\_BSW*). The successful bit swap primitive (*success\_BSW*) is defined in clause 11.3.1.6 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.6 of [ITU-T G.9701].

#### **7.7.21 Successful autonomous SRA (CURR/PREV\_NE/FE\_15/24\_SRA)**

**Description:** Reports a count of the successful autonomous SRA primitives (*success\_SRA*). The successful autonomous SRA primitive (*success\_SRA*) is defined in clause 11.3.1.6 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.6 of [ITU-T G.9701].

#### **7.7.22 Successful FRA counter (CURR/PREV\_NE/FE\_15/24\_FRA)**

**Description:** Reports a count of the successful FRA primitives (*success\_FRA*). The successful FRA primitive (*success\_FRA*) is defined in clause 11.3.1.6 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.6 of [ITU-T G.9701].

#### **7.7.23 Successful RPA counter (CURR/PREV\_NE/FE\_15/24\_RPA)**

**Description:** Reports a count of the successful RPA primitives (*success\_RPA*). The successful RPA primitive (*success\_RPA*) is defined in clause 11.3.1.6 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.6 of [ITU-T G.9701].

#### **7.7.24 Successful TIGA counter (CURR/PREV\_15/24\_TIGA)**

**Description:** Reports a count of the successful TIGA primitives (*success\_TIGA*). The successful TIGA primitive (*success\_TIGA*) is defined in clause 11.3.1.6 of [ITU-T G.9701]. Reported only with the near-end PM counters.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.6 of [ITU-T G.9701].

#### **7.7.25 L2.1N usage counter (CURR/PREV\_15/24\_L2.1N)**

**Description:** Reports the count of L2.1N link state seconds (L2.1NSs). An L2.1NS is defined in clause 12.1.1.1 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer

**Unit:** 1 second

**Valid values:** 0 .. 86400 (0 to 86400 s)

**Reference:** Clause 12.1.1.1 of [ITU-T G.9701]

#### **7.7.26 L2.1B usage counter (CURR/PREV\_15/24\_L2.1B)**

**Description:** Reports the count of L2.1B link state seconds (L2.1BSs). An L2.1BS is defined in clause 12.1.1.1 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer

**Unit:** 1 second

**Valid values:** 0 .. 86400 (0 to 86400 s)

**Reference:** Clause 12.1.1.1 of [ITU-T G.9701]

#### **7.7.27 L2.2 usage counter (CURR/PREV\_15/24\_L2.2)**

**Description:** Reports the count of L2.2 link state seconds (L2.2Ss). An L2.2S is defined in clause 12.1.1.1 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer

**Unit:** 1 second

**Valid values:** 0 .. 86400 (0 to 86400 s)

**Reference:** Clause 12.1.1.1 of [ITU-T G.9701]

### **7.7.28 INM performance monitoring objects**

#### **7.7.28.1 INM INPEQ histogram (CURR/PREV\_NE/FE\_15/24\_INMINPEQ)**

**Description:** Reports the count of the INMAINPEQ<sub>i</sub> anomalies occurring on the line during the accumulation period.

**Type:** Array of INPEQBINdescriptor[1..17]. The bin with index *i* shall include the count of INMAINPEQ<sub>i</sub> anomalies.

**INPEQBINdescriptor:**

– **Type:** 32-bit unsigned integer

– **Valid values:** 0...2<sup>32</sup>–1.

**Reference:** Clause 11.4.4.7.3.1 of [ITU-T G.9701].

#### **7.7.28.2 INM total measurement (CURR/PREV\_NE/FE\_15/24\_INMAME)**

**Description:** Reports the count of the INMAME anomalies occurring on the line during the accumulation period.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...2<sup>32</sup>–1.

**Reference:** Clause 11.4.4.7.3.2 of [ITU-T G.9701].

#### **7.7.28.3 INM IAT histogram (CURR/PREV\_NE/FE\_15/24\_INMIAT)**

**Description:** Reports the count of the INMAIAT<sub>i</sub> anomalies occurring on the line during the accumulation period.

**Type:** Array of IATBINdescriptor[0..7]. The bin with index *i* shall include the count of INMAIAT<sub>i</sub> anomalies.

**IATBINdescriptor:**

– **Type:** 32-bit unsigned integer

– **Valid values:**  $0 \dots 2^{32} - 1$ .

**Reference:** Clause 11.4.4.7.3.3 of [ITU-T G.9701].

**7.7.28.4 INM blank frame counter (CURR/PREV\_NE/FE\_15/24\_INMBLFCds/us)**

**Description:** Reports the count of the INMBLFC anomalies occurring on the line during the accumulation period.

**Type:** 32-bit unsigned integer.

**Valid values:**  $0 \dots 2^{32} - 1$ .

**Reference:** Clause 11.4.4.7.3.4 of [ITU-T G.9701].

**7.8 Channel performance monitoring objects**

The channel performance monitoring objects defined in Table 7-8 are subject to the rules defined in clause 8.

**7.8.1 Measured Time (CURR/PREV\_NE/FE\_15/24\_C\_TIME)**

**Description:** Reports the amount of time, measured in seconds, that statistics for this interval have been counted.

**Type:** 32-bit unsigned integer.

**Valid values:** 0...900 (for 15 min interval) and 0...86400 (for 24 h interval).

**Reference:** Clause 8.9.

**7.8.2 Invalid Data Flag (PREV\_NE/FE\_15/24\_C\_INVALID)**

**Description:** Reports the validity of the corresponding PM data. Reported only with the previous interval PM counters.

**Type:** boolean.

**Valid values:** TRUE (PM data is incomplete or invalid) and FALSE (PM data is complete and valid).

**Reference:** Clause 8.9.

**7.8.3 Time Stamp (PREV\_NE/FE\_15/24\_C\_STAMP)**

**Description:** Reports the start date/time for this interval. Reported only with the previous interval PM counters.

**Type:** String (as defined in clause 8.12).

**Reference:** None.

**7.8.4 CV counter (CURR/PREV\_NE/FE\_15/24\_CV)**

**Description:** Reports a count of the cyclic redundancy check anomalies (*crc*). The cyclic redundancy check anomaly (*crc*) is defined in clause 11.3.1.1 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.1 of [ITU-T G.9701].

### **7.8.5 Uncorrected DTU counter (CURR/PREV\_NE/FE\_15/24\_RTXUC)**

**Description:** Reports a count of the uncorrected DTU anomalies (*rtx-uc*). The uncorrected DTU anomaly (*rtx-uc*) is defined in clause 11.3.1.1 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.1 of [ITU-T G.9701].

### **7.8.6 Retransmitted DTU counter (CURR/PREV\_NE/FE\_15/24\_RTXTX)**

**Description:** Reports a count of the retransmitted DTU anomalies (*rtx-tx*). The retransmitted DTU anomaly (*rtx-tx*) is defined in clause 11.3.1.1 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...4294967295 (event counter).

**Reference:** Clause 11.3.1.1 of [ITU-T G.9701].

### **7.8.7 LANDEFTRS counter (CURR/PREV\_NE/FE\_15/24\_LANDEFTRS)**

**Description:** For NE, reports the count of LANDEFTRS seconds in downstream. For FE, reports the count of LANDEFTRS seconds in upstream. A LANDEFTRS second is defined in clause 11.4.4.8 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...900 (15 min interval) and 0...86400 (24 h interval).

**Reference:** Clause 11.4.4.8 of [ITU-T G.9701].

### **7.8.8 ANDEFTRDS counter (CURR/PREV\_NE/FE\_15/24\_ANDEFTRDS)**

**Description:** Reports the count of All NOI with Data symbols EFTR defined seconds (ANDEFTRDSs). An ANDEFTRDS is defined in clause 11.4.1.1.25 of [ITU-T G.9701].

**Type:** 32-bit unsigned integer.

**Valid values:** 0...900 (15 min interval) and 0...86400 (24 h interval).

**Reference:** Clause 11.4.1.1.25 of [ITU-T G.9701].

### **7.8.9 Minimum All NOI with Data symbols EFTR per time interval (MINANDEFTR\_CURR/PREV\_NE/FE\_15/24)**

**Description:** Reports the minimum All NOI with Data symbols EFTR (see clause 11.4.1.1.22 of [ITU-T G.9701]) over the associated time interval.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967295 (0 to  $2^{32}-1$  kbit/s).

**Reference:** Clause 11.4.1.1.22 of [ITU-T G.9701].

### **7.8.10 Maximum All NOI with Data symbols EFTR per time interval (MAXANDEFTR\_CURR/PREV\_NE/FE\_15/24)**

**Description:** Reports the maximum All NOI with Data symbols EFTR (see clause 11.4.1.1.23 of [ITU-T G.9701]) over the associated time interval.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.



**Valid values:** 0...4294967295 (0 to  $2^{32}-1$  kbit/s).

**Reference:** Clause 11.4.1.1.23 of [ITU-T G.9701].

### **7.8.11 Sum All NOI with Data symbols EFTR per time interval (SUMANDEFTR CURR/PREV NE/FE 15/24)**

**Description:** Reports the sum of All NOI with Data symbols EFTR bits (see clause 11.4.1.1.24 of [ITU-T G.9701]), divided by 65536, over the associated time interval. Note: SUMANDEFTR and ANDEFTRDS can be used to compute the mean of ANDEFTR.

**Type:** 32-bit unsigned integer.

**Unit:** 65536 bits.

**Valid values:** 0...4294967295 ((0 to  $(2^{32}-1)$ ) x  $2^{16}$  bits).

**Reference:** Clause 11.4.1.1.24 of [ITU-T G.9701].

## **7.9 Data path performance monitoring objects**

No data path performance monitoring objects are defined.

## **7.10 Line test, diagnostics and status objects**

### **7.10.1 Profile**

#### **7.10.1.1 ITU-T G.9701 profile (PROFILE)**

**Description:** Reports for each profile whether operation according to that profile is enabled or disabled. Only one profile can be enabled.

**Type:** Array of PROFILEDescriptor[0...N-1] with N=5.

#### **PROFILEDescriptor:**

**Type:** boolean.

**Valid values:** 0 (disabled) and 1 (enabled).

#### **Bit representation**

- 0 [ITU-T G.9701] profile 106a
- 1 [ITU-T G.9701] profile 106b
- 2 [ITU-T G.9701] profile 212a
- 3 [ITU-T G.9701] profile 106c
- 4 [ITU-T G.9701] profile 212c

**Reference:** Clause 6 of [ITU-T G.9701].

### **7.10.2 Initialization**

#### **7.10.2.1 Initialization success/failure cause (INITSFCAUSE)**

**Description:** Reports whether the last full or fast initialization procedure was successful. If the last initialization procedure was not successful, this parameter provides the reason.

**Type:** enumeration.

**Valid values:** 0...6.

- 0 Successful.
- 1 Configuration error.

This error occurs if the line cannot reach the L0 state due to a mismatch of configuration and FTU capabilities.

2 Configuration not feasible on the line.

This error occurs if the line cannot reach the L0 state due to a mismatch of configuration and line and noise characteristics.

3 Communication problem.

This error occurs, for example, due to corrupted messages or bad syntax messages or if no common mode can be selected in the ITU-T G.994.1 handshaking procedure or due to a timeout.

4 No far-end FTU detected.

This error occurs if the far-end FTU is not powered or not connected or if the line is too long to allow detection of a far-end FTU.

5 Any other or unknown initialization failure cause.

**Reference:** Clause 12.3.1 of [ITU-T G.9701].

#### **7.10.2.2 Initialization last transmitted downstream signal (INITLASTSIGNALds)**

**Description:** Reports the downstream signal count of the last transmitted initialization signal in the last full or fast initialization performed on the line. The downstream signal count is defined in clause 12.3.1 of [ITU-T G.9701].

**Type:** 8-bit unsigned integer.

**Valid values:** 0...21.

**Reference:** Clause 12.3.1 of [ITU-T G.9701].

#### **7.10.2.3 Initialization last received upstream signal (INITLASTSIGNALus)**

**Description:** Reports the upstream signal count of the last received initialization signal in the last full or fast initialization performed on the line. The upstream signal count is defined in clause 12.3.1 of [ITU-T G.9701].

**Type:** 8-bit unsigned integer.

**Valid values:** 0...10.

**Reference:** Clause 12.3.1 of [ITU-T G.9701].

### **7.10.3 Signal-to-noise ratio margin**

#### **7.10.3.1 Downstream signal-to-noise ratio margin (SNRMds)**

**Description:** Reports the signal-to-noise ratio margin (as defined in clauses 9.8.3.2 of [ITU-T G.9701] and 11.4.1.1.10 of [ITU-T G.9701]) in the downstream direction during the L0 link state. A first special value (−512) indicates that the signal-to-noise ratio margin is undetermined. A second special value (−511) indicates that the signal-to-noise ratio margin is less than or equal to −51.1 dB. A third special value (+511) indicates that the signal-to-noise ratio margin is greater than or equal to +51.1 dB.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** −512, −511, 511 (special values) and −510...+510 (−51.0 dB to +51.0 dB).

**Reference:** Clauses 9.8.3.2 and 11.4.1.1.10 of [ITU-T G.9701].

### **7.10.3.2 Downstream signal-to-noise ratio margin (SNRMus)**

**Description:** Reports the signal-to-noise ratio margin (as defined in clauses 9.8.3.2 of [ITU-T G.9701] and 11.4.1.1.10 of [ITU-T G.9701]) in the upstream direction during the L0 link state. The same special values as for SNRMDs are defined.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** -512, -511, +511 (special value) and -510...+510 (-51.0 dB to +51.0 dB).

**Reference:** Clauses 9.8.3.2 and 11.4.1.1.10 of [ITU-T G.9701].

### **7.10.4 Upstream power back-off**

#### **7.10.4.1 FTU-O estimated upstream power back-off electrical length (UPBOKLE)**

**Description:** Reports the electrical length that would have been sent from the FTU-O to the FTU-R if the electrical length was not forced by the DPU-MIB. If the electrical length is not forced by the DPU-MIB, then this object reports the final electrical length, as determined by the FTU-O (see clause 7.3.1.4.2.1 of [ITU-T G.9701]) and conveyed in the O-UPDATE initialization message (see clause 12.3.3.2.4 of [ITU-T G.9701]).

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...1280 (0 dB to 128 dB).

**Reference:** Clauses 7.3.1.4.2.1 and 12.3.3.2.3 of [ITU-T G.9701].

#### **7.10.4.2 FTU-R estimated upstream power back-off electrical length (UPBOKLE-R)**

**Description:** Reports the estimate of the electrical length, as determined by the FTU-R (see clause 7.3.1.4.2.1 of [ITU-T G.9701]) and conveyed in the R-MSG1 initialization message (see clause 12.3.3.2.3 of [ITU-T G.9701]).

**Type:** 16-bit unsigned integer.

**Unit:** 0.1 dB.

**Valid values:** 0...1280 (0 dB to 128 dB).

**Reference:** See clauses 7.3.1.4.2.1 and 12.3.3.2.3 of [ITU-T G.9701].

### **7.10.5 Actual aggregate transmit power**

#### **7.10.5.1 Downstream actual aggregate transmit power (ACTATPDs)**

**Description:** Reports the total amount of transmit power delivered by the FTU-O at the U-O2 reference point, at the instant of measurement. A first special value (-512) indicates that the transmit power is undetermined. A second special value (-311) indicates that the transmit power is less than or equal to -31.1 dBm. A third special value (+311) indicates that the transmit power is greater than or equal to +31.1 dBm.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** -512, -311, 311 (special values) and -310...310 (-31 dBm to +31 dBm).

**Reference:** Clause 11.4.1.2.6 of [ITU-T G.9701].

### 7.10.5.2 Upstream actual aggregate transmit power (ACTATP<sub>us</sub>)

**Description:** Reports the total amount of transmit power delivered by the FTU-R at the U-R2 reference point, at the instant of measurement. The same special values as for ACTATP<sub>ds</sub> are defined.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** -512, -311, 311 (special values) and -310...310 (-31 dBm to +31 dBm).

**Reference:** Clause 11.4.1.2.6 of [ITU-T G.9701].

### 7.10.6 Actual transmit PSD per sub-carrier

#### 7.10.6.1 Downstream actual transmit PSD per sub-carrier (ACTPSD<sub>psds</sub>)

**Description:** Reports the transmit PSD per sub-carrier delivered by the FTU-O at the U-O2 reference point as calculated by the VCE from the downstream ACTPSDREF-ps. A special value indicates that no transmit PSD value is available for the sub-carrier, or its transmit power is zero, or is out of the range to be represented.

**Type:** Array of PSDdescriptor[0...N-1], with N = index of highest supported downstream data-bearing sub-carrier as defined for the enabled profile (see Table 6-1 of [ITU-T G.9701]).

**PSDdescriptor:**

**Type:** 8-bit unsigned integer.

**Unit:** -0.5 dBm/Hz.

**Valid values:** 0...254 (0 to -127 dBm/Hz) and 255 (special value).

**Reference:** Clause 11.4.1.2.5 of [ITU-T G.9701].

#### 7.10.6.2 Upstream actual transmit PSD per sub-carrier (ACTPSD<sub>psus</sub>)

**Description:** Reports the transmit PSD per sub-carrier delivered by the FTU-R at the U-R2 reference point, as calculated by the VCE from the upstream ACTPSDREF-ps. A special value indicates that no transmit PSD value is available for the sub-carrier, or its transmit power is zero, or is out of the range to be represented.

**Type:** Array of PSDdescriptor[0...N-1], with N = index of highest supported upstream data-bearing sub-carrier as defined for the enabled profile (see Table 6-1 of [ITU-T G.9701]).

**PSDdescriptor:** See ACTPSD<sub>psds</sub> in clause 7.10.6.1.

**Reference:** Clause 11.4.1.2.5 of [ITU-T G.9701].

### 7.10.7 Channel characteristics function per sub-carrier (HLOG)

#### 7.10.7.1 Downstream HLOG measurement time (HLOGMT<sub>ds</sub>)

**Description:** Reports the number of symbols used to measure the downstream Hlog(f) values. The object is updated only in L0 link state.

**Type:** 16-bit unsigned integer.

**Unit:** 1 symbol.

**Valid values:** 0..65535.

**Reference:** Clause 11.4.1.2.1 of [ITU-T G.9701].

#### 7.10.7.2 Downstream HLOG sub-carrier group size (HLOGG<sub>ds</sub>)

**Description:** Reports the number of sub-carriers in any one sub-carrier group used to represent the downstream Hlog(f) values. The object is updated only in L0 link state.

**Type:** 8-bit unsigned integer.

**Unit:** 1 sub-carrier.

**Valid values:** 1, 2, 4, and 8.

**Reference:** Clause 11.4.1.2.1 of [ITU-T G.9701].

#### **7.10.7.3 Downstream HLOG(f) (HLOGpsds)**

**Description:** Reports the downstream Hlog(f) as one value per sub-carrier group. A first special value (1023) indicates that the Hlog(f) for this sub-carrier group is undetermined. A second special value (1022) indicates that no measurement could be done for this sub-carrier group because it is out of the MEDLEY set. A third special value (0) indicates that the Hlog(f) for this sub-carrier group is greater than or equal to +6.0 dB. A fourth special value (1020) indicates that the Hlog(f) for this sub-carrier group is less than or equal to −96.0 dB. The object is updated only in L0 link state.

**Type:** Array of HLOGdescriptor[0..N-1], where N = index of highest sub-carrier index in the MEDLEY set, divided by HLOGG, rounded to the higher integer.

**HLOGdescriptor:**

**Type:** 16-bit unsigned integer.

**Unit:** −0.1 dB.

**Offset:** 6 dB.

**Valid values:** 1..1019 (+5.9 to −95.9 dB) and 0,1020,1022,1023 (special values).

**Reference:** Clause 11.4.1.2.1 of [ITU-T G.9701].

#### **7.10.7.4 Upstream HLOG measurement time (HLOGMTus)**

**Description:** Reports the number of symbols used to measure the upstream Hlog(f) values.

**Type:** 16-bit unsigned integer.

**Unit:** 1 symbol.

**Valid values:** 0..65535.

**Reference:** Clause 11.4.1.2.1 of [ITU-T G.9701].

#### **7.10.7.5 Upstream HLOG sub-carrier group size (HLOGGus)**

**Description:** Reports the number of sub-carriers in any one sub-carrier group used to represent the upstream Hlog(f) values.

**Type:** 8-bit unsigned integer.

**Unit:** 1 sub-carrier.

**Valid values:** 1, 2 and 4.

**Reference:** Clause 11.4.1.2.1 of [ITU-T G.9701].

#### **7.10.7.6 Upstream HLOG(f) (HLOGpsus)**

**Description:** Reports the upstream Hlog(f) as one value per sub-carrier group. The same special values as for the HLOGpsds are defined. The object is updated only in L0 link state.

**Type:** Array of HLOGdescriptor[0..N-1], where N = index of highest sub-carrier index in the MEDLEY set, divided by HLOGG, rounded to the higher integer.

**HLOGdescriptor:**

**Type:** 16-bit unsigned integer.

**Unit:** −0.1 dB.

**Offset:** 6 dB.

**Valid values:** 1..1019 (+5.9 to −95.9 dB) and 0,1020,1022,1023 (special values).

**Reference:** Clause 11.4.1.2.1 of [ITU-T G.9701].

**7.10.8 Signal-to-noise ratio per sub-carrier (SNR)****7.10.8.1 Downstream signal-to-noise ratio PSD measurement time (SNRMTds)**

**Description:** Reports the number of symbols used to measure the downstream SNR(f) values.

**Type:** 16-bit unsigned integer.

**Unit:** 1 symbol.

**Valid values:** 0...65535.

**Reference:** Clause 11.4.1.2.2 of [ITU-T G.9701].

**7.10.8.2 Downstream SNR(f) sub-carrier group size (SNRGds)**

**Description:** Reports the number of sub-carriers in any one sub-carrier group used to represent the downstream SNR(f) values.

**Type:** 8-bit unsigned integer.

**Unit:** 1 sub-carrier.

**Valid values:** 1, 2, 4, and 8.

**Reference:** Clause 11.4.1.2.2 of [ITU-T G.9701].

**7.10.8.3 Downstream SNR(f) (SNRpsds)**

**Description:** Reports the downstream SNR(f) values. A special value indicates that no measurement could be done for this sub-carrier group because it is out of the downstream MEDLEY set or its transmit power is zero.

**Type:** Array of SNRdescriptor[0...N-1], where N = index of highest supported downstream data-bearing sub-carrier as defined for the enabled profile (see Table 6-1 of [ITU-T G.9701]), divided by SNRGds, rounded to the higher integer.

**SNRdescriptor:**

**Type:** 8-bit unsigned integer.

**Unit:** 0.5 dB.

**Offset:** −32 dB.

**Valid values:** 0...254 (−32 to 95 dB) and 255 (special value).

**Reference:** Clause 11.4.1.2.2 of [ITU-T G.9701].

**7.10.8.4 Upstream signal-to-noise ratio PSD measurement time (SNRMTus)**

**Description:** Reports the number of symbols used to measure the upstream SNR(f) values.

**Type:** 16-bit unsigned integer.

**Unit:** 1 symbol.

**Valid values:** 0...65535 (0 to  $2^{16}-1$  symbols).

**Reference:** Clause 11.4.1.2.2 of [ITU-T G.9701].

#### **7.10.8.5 Upstream SNR(f) sub-carrier group size (SNRGus)**

**Description:** Reports the number of sub-carriers in any one sub-carrier group used to represent the upstream SNR(f) values.

**Type:** 8-bit unsigned integer.

**Unit:** 1 sub-carrier.

**Valid values:** 1, 2, 4, and 8.

**Reference:** Clause 11.4.1.2.2 of [ITU-T G.9701].

#### **7.10.8.6 Upstream SNR(f) (SNRpsus)**

**Description:** Reports the upstream SNR(f) values. A special value indicates that no measurement could be done for this sub-carrier group because it is out of the upstream MEDLEY set or its transmit power is zero.

**Type:** Array of SNRdescriptor[0...N-1], where N = index of highest supported upstream data-bearing sub-carrier as defined for the enabled profile (see Table 6-1 of [ITU-T G.9701]), divided by SNRGds, rounded to the higher integer.

**SNRdescriptor:** See SNRpsds in clause 7.10.8.3.

**Reference:** Clause 11.4.1.2.2 of [ITU-T G.9701].

#### **7.10.9 Quiet line noise PSD per sub-carrier (QLN)**

##### **7.10.9.1 Downstream QLN measurement time (QLNMTds)**

**Description:** Reports the number of symbols used to measure the downstream QLN(f) values. The object is updated only in L0 link state.

**Type:** 16-bit unsigned integer.

**Unit:** 1 symbol.

**Valid values:** 0..65535.

**Reference:** Clause 11.4.1.2.3 of [ITU-T G.9701].

##### **7.10.9.2 Downstream QLN sub-carrier group size (QLNGds)**

**Description:** Reports the number of sub-carriers in any one sub-carrier group used to represent the downstream QLN(f) values. The object is updated only in L0 link state.

**Type:** 8-bit unsigned integer.

**Unit:** 1 sub-carrier.

**Valid values:** 1, 2, 4, and 8.

**Reference:** Clause 11.4.1.2.3 of [ITU-T G.9701].

##### **7.10.9.3 Downstream QLN(f) (QLNpsds)**

**Description:** Reports the downstream QLN(f) as one value per sub-carrier group. A first special value (255) indicates that the QLN(f) for this sub-carrier group is undetermined. A second special value (254) indicates that no measurement could be done for this sub-carrier group because it is out of the downstream MEDLEY set. A third special value (0) indicates that the QLN(f) for this sub-carrier group is greater than or equal to  $-35\text{dBm/Hz}$ . A fourth special value (251) indicates that the QLN(f) for this sub-carrier group is less than or equal to  $-160.5\text{ dBm/Hz}$ . The object is updated only in L0 link state.

**Type:** Array of QLNdescriptor[0..N-1], where N = index of highest sub-carrier index in the downstream MEDLEY set, divided by QLNGds, rounded to the higher integer.

**QLNdescriptor:**

**Type:** 8-bit unsigned integer.

**Unit:** -0.5 dBm/Hz.

**Offset:** -35 dBm/Hz.

**Valid values:** 1..250 (-35.5 to -160 dBm/Hz), 0, 251, 254, 255 (special values).

**Reference:** Clause 11.4.1.2.3 of [ITU-T G.9701].

#### **7.10.9.4 Upstream QLN measurement time (QLNMTus)**

**Description:** Reports the number of symbols used to measure the upstream QLN(f) values. The object is updated only in L0 link state.

**Type:** 16-bit unsigned integer.

**Unit:** 1 symbol.

**Valid values:** 0..65535.

**Reference:** Clause 11.4.1.2.3 of [ITU-T G.9701].

#### **7.10.9.5 Upstream QLN sub-carrier group size (QLNGus)**

**Description:** Reports the number of sub-carriers in any one sub-carrier group used to represent the upstream QLN(f) values. The object is updated only in L0 link state.

**Type:** 8-bit unsigned integer.

**Unit:** 1 sub-carrier.

**Valid values:** 1, 2, and 4.

**Reference:** Clause 11.4.1.2.3 of [ITU-T G.9701].

#### **7.10.9.6 Upstream QLN(f) (QLNpsus)**

**Description:** Reports the upstream quiet line noise PSD QLN(f) as one value per sub-carrier group. The same special values as for the QLNpsds are defined. The object is updated only in L0 link state.

**Type:** Array of QLNdescriptor[0..N-1], where N = index of highest sub-carrier index in the upstream MEDLEY set, divided by QLNGus, rounded to the higher integer.

**QLNdescriptor:** See clause 7.10.9.3.

**Reference:** Clause 11.4.1.2.3 of [ITU-T G.9701].

#### **7.10.10 Active line noise PSD per sub-carrier (ALN)**

##### **7.10.10.1 ALN measurement time (ALNMT)**

**Description:** Reports the number of symbols used to measure the ALN(f) values. The object is updated only in L0 link state.

**Type:** 16-bit unsigned integer.

**Unit:** 1 symbol.

**Valid values:** 0..65535.

**Reference:** Clause 11.4.1.2.4 of [ITU-T G.9701].



#### 7.10.10.2 ALN sub-carrier group size (ALNG)

**Description:** Reports the number of sub-carriers in any one sub-carrier group used to represent the ALN(f) values. The object is updated only in L0 link state.

**Type:** 8-bit unsigned integer.

**Unit:** 1 sub-carrier.

**Valid values:** 1, 2, 4, and 8.

**Reference:** Clause 11.4.1.2.4 of [ITU-T G.9701].

#### 7.10.10.3 ALN(f) (ALNps)

**Description:** Reports the ALN(f). A first special value (255) indicates that the ALN(f) for this sub-carrier is undetermined. A second special value (254) indicates that no measurement could be done for this sub-carrier because it is out of the downstream MEDLEY set. A third special value (0) indicates that the ALN(f) for this sub-carrier is greater than or equal to  $-35\text{dBm/Hz}$ . A fourth special value (251) indicates that the ALN(f) for this sub-carrier is less than or equal to  $-160.5\text{ dBm/Hz}$ . The object is updated only in L0 link state.

**Type:** Array of ALNdescriptor[0..N-1], where N = index of highest sub-carrier index in the downstream MEDLEY set, divided by ALNG, rounded to the higher integer.

**ALNdescriptor:**

**Type:** 8-bit unsigned integer.

**Unit:**  $-0.5\text{ dBm/Hz}$ .

**Offset:**  $-35\text{ dBm/Hz}$ .

**Valid values:** 1..250 ( $-35.5$  to  $-160\text{ dBm/Hz}$ ), 0, 251, 254 and 255 (special values).

**Reference:** Clause 11.4.1.2.4 of [ITU-T G.9701].

#### 7.10.11 Bit allocation per sub-carrier on data symbols

##### 7.10.11.1 Downstream bits allocation (BITSpsds)

**Description:** Reports the bit allocation values on data symbols in the normal operation interval (NOI) in the downstream direction.

**Type:** Array of BITSdescriptor[0...N-1], where N = index of highest supported downstream data-bearing sub-carrier as defined for the enabled profile (see Table 6-1 of [ITU-T G.9701]) plus one.

**BITSdescriptor:**

**Type:** 8-bit unsigned integer.

**Unit:** 1 bit.

**Valid values:** 0... 14.

**Reference:** Clause 10.2.1.4 of [ITU-T G.9701].

##### 7.10.11.2 Upstream bits allocation (BITSpsus)

**Description:** Reports the bit allocation values on data symbols in the normal operation interval (NOI) in the upstream direction.

**Type:** Array of BITSdescriptor[0...N-1], where N = index of highest supported upstream data-bearing sub-carrier as defined for the enabled profile (see Table 6-1 of [ITU-T G.9701]) plus one.

**BITSdescriptor:** See BITSpsds in clause 7.10.10.1.

**Reference:** Clause 10.2.1.4 of [ITU-T G.9701].

## **7.10.12 Robust Management Channel (RMC)**

### **7.10.12.1 Downstream signal-to-noise ratio margin for RMC(SNRM-RMCds)**

**Description:** Reports the signal-to-noise ratio margin (as defined in clause 11.4.1.1.11 of [ITU-T G.9701]) for the RMC in the downstream direction during the L0 link state. A first special value (−512) indicates that the signal-to-noise ratio margin is undetermined. A second special value (−511) indicates that the signal-to-noise ratio margin is less than or equal to −51.1 dB. A third special value (+511) indicates that the signal-to-noise ratio margin is greater than or equal to +51.1dB.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** −512, −511, +511 (special values) and −510...+510 (−51.0 dB to +51.0 dB).

**Reference:** Clause 11.4.1.1.11 of [ITU-T G.9701].

### **7.10.12.2 Upstream signal-to-noise ratio margin for RMC(SNRM-RMCus)**

**Description:** Reports the signal-to-noise ratio margin (as defined in clause 11.4.1.1.11 of [ITU-T G.9701]) for the RMC in the upstream direction during the L0 link state. The same special values as for SNRM-RMCds are defined.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** −512, −511, +511 (special values) and −510...+510 (−51.0 dB to +51.0 dB).

**Reference:** Clause 11.4.1.1.11 of [ITU-T G.9701].

### **7.10.12.3 Downstream bits allocation for RMC(BITS-RMCpsds)**

**Description:** Reports the bit allocation values on RMC sub-carriers in RMC symbols in the downstream direction.

**Type:** Array of BITSRMCdescriptor[0...N-1], where  $N \leq 512$ .

#### **BITSRMCdescriptor:**

**Type:** Record of a sub-carrier index and a bit allocation value.

#### **Sub-carrier index:**

**Type:** 16-bit unsigned integer.

**Valid values:** 0...4095 (sub-carrier index 0 to 4095).

#### **Bit allocation value:**

**Type:** 8-bit unsigned integer.

**Unit:** 1 bit.

**Valid values:** 0 and 2...6.

**Reference:** Clause 12.3.4.2.8 of [ITU-T G.9701].

### **7.10.12.4 Upstream bits allocation for RMC(BITS-RMCpsus)**

**Description:** Reports the bit allocation values on RMC sub-carriers in RMC symbols in the upstream direction.

**Type:** Array of BITSRMCdescriptor[0...N-1], where  $N$  = index of highest supported upstream data-bearing sub-carrier as defined for the enabled profile (see Table 6-1 of [ITU-T G.9701]) plus one.

**BITSRMCdescriptor:** See BITS-RMCpsds in clause 7.10.12.3.

**Reference:** Clause 12.3.4.2.7 of [ITU-T G.9701].

### **7.10.13 Test parameter time stamps**

#### **7.10.13.1 Date/time-stamping of near-end test parameter group 1 (STAMP-TEST-NE-G1)**

**Description:** Reports the date/time when the near-end test parameter group 1 that can change during showtime was last updated.

**Type:** string (as defined in clause 8.12)

**Reference:** Clause 11.1 of [ITU-T G.9701].

#### **7.10.13.2 Date/time-stamping of far-end test parameter group 1 (STAMP-TEST-FE-G1)**

**Description:** Reports the date/time when the far-end test parameter group 1 that can change during showtime was last updated.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.1 of [ITU-T G.9701].

#### **7.10.13.3 Date/time-stamping of near-end test parameter group 2 (STAMP-TEST-NE-G2)**

**Description:** Reports the date/time when the near-end test parameter group 2 that can change during showtime was last updated.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.1 of [ITU-T G.9701].

#### **7.10.13.4 Date/time-stamping of far-end test parameter group 2 (STAMP-TEST-FE-G2)**

**Description:** Reports the date/time when the far-end test parameter group 2 that can change during showtime was last updated.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.1 of [ITU-T G.9701].

### **7.10.14 On-line reconfiguration (OLR/FRA) time stamps**

#### **7.10.14.1 Date/time-stamping of last successful downstream bit swap operation (STAMP-BSWds)**

**Description:** Reports the date/time of the last successful FTU-R initiated bit swap execution that has modified the bits allocation.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.2.2.5 of [ITU-T G.9701].

#### **7.10.14.2 Date/time-stamping of last successful upstream bit swap operation (STAMP-BSWus)**

**Description:** Reports the date/time of the last successful FTU-O initiated bit swap execution that has modified the bits allocation.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.2.2.5 of [ITU-T G.9701].

#### **7.10.14.3 Date/time-stamping of last successful downstream autonomous SRA operation (STAMP-SRAds-)**

**Description:** Reports the date/time of the last successful FTU-R initiated autonomous SRA execution (excluding SRAs in response to TIGA) that has modified the bits allocation.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.2.2.5 of [ITU-T G.9701].

#### **7.10.14.4 Date/time-stamping of last successful upstream autonomous SRA operation (STAMP-SRAus-)**

**Description:** Reports the date/time of the last successful FTU-O initiated autonomous SRA execution that has modified the bits allocation.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.2.2.5 of [ITU-T G.9701].

#### **7.10.14.5 Date/time-stamping of last successful downstream FRA operation (STAMP-FRAds-)**

**Description:** Reports the date/time of the last successful FTU-R initiated FRA execution that has modified the bits allocation.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 13.3.1.1 of [ITU-T G.9701].

#### **7.10.14.6 Date/time-stamping of last successful upstream FRA operation (STAMP-FRAus-)**

**Description:** Reports the date/time of the last successful FTU-O initiated FRA execution that has modified the bits allocation.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 13.3.1.1 of [ITU-T G.9701].

#### **7.10.14.7 Date/time-stamping of last successful downstream RPA operation (STAMP-RPAds)**

**Description:** Reports the date/time of the last successful FTU-R initiated RPA execution that has modified the bits allocation for the RMC.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.2.2.5 of [ITU-T G.9701].

#### **7.10.14.8 Date/time-stamping of last successful upstream RPA operation (STAMP-RPAus)**

**Description:** Reports the date/time of the last successful FTU-O initiated RPA execution that has modified the bits allocation for the RMC.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.2.2.5 of [ITU-T G.9701].

#### **7.10.14.9 Date/time-stamping of last successful downstream TIGA operation (STAMP-TIGA)**

**Description:** Reports the date/time of the last successful FTU-O initiated TIGA execution.

**Type:** string (as defined in clause 8.12).

**Reference:** Clause 11.2.2.5 of [ITU-T G.9701].

### **7.10.15 Signal Attenuation (SATN)**

#### **7.10.15.1 Downstream signal attenuation (SATNds)**

**Description:** Reports the downstream SATN. A special value (1023) indicates that the value is undetermined. A second special value (0) indicates that the SATN is less than or equal to 0 dB. A third special value (1001) indicates that the SATN is greater than or equal to 100.1dB. The object is updated only in L0 link state.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** 1..1000 (0.1 dB to +100.0 dB), 0, 1001 and 1023 (special values).

**Reference:** Clause 11.4.1.2.7.1 of [ITU-T G.9701].

#### **7.10.15.2 Upstream signal attenuation (SATNus)**

**Description:** Reports the upstream SATN. The same special values as for SATNds are defined. The object is updated only in L0 link state.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** 0..1000 (0 dB to +100.0 dB) 0, 1001, and 1023 (special values).

**Reference:** Clause 11.4.1.2.7.2 of [ITU-T G.9701].

#### **7.10.16 Low power modes**

##### **7.10.16.1 L2.1 Downstream signal-to-noise ratio margin (L2.1-SNRMds)**

**Description:** Reports the signal-to-noise ratio margin (as defined in clauses 9.8.3.2 of [ITU-T G.9701] and 11.4.1.1.10 of [ITU-T G.9701]) in the downstream direction during the L2.1N and L2.1B link states. A first special value (−512) indicates that the signal-to-noise ratio margin is undetermined. A second special value (−511) indicates that the signal-to-noise ratio margin is less than or equal to −51.1 dB. A third special value (+511) indicates that the signal-to-noise ratio margin is greater than or equal to +51.1dB.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** −512, −511, +511 (special values) and −510...+510 (−51.0 dB to +51.0 dB).

**Reference:** Clauses 9.8.3.2 and 11.4.1.1.10 of [ITU-T G.9701].

##### **7.10.16.2 L2.1 Upstream signal-to-noise ratio margin (L2.1-SNRMus)**

**Description:** Reports the signal-to-noise ratio margin (as defined in clauses 9.8.3.2 of [ITU-T G.9701] and 11.4.1.1.10 of [ITU-T G.9701]) in the upstream direction during the L2.1N and L2.1B link states. The same special as for L2.1-SNRMds are defined.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** −512, −511, +511 (special values) and −510...+510 (−51.0 dB to +51.0 dB).

**Reference:** Clauses 9.8.3.2 and 11.4.1.1.10 of [ITU-T G.9701].

##### **7.10.16.3 L2.2 Downstream signal-to-noise ratio margin (L2.2-SNRMds)**

**Description:** Reports the signal-to-noise ratio margin (as defined in clauses 9.8.3.2 of [ITU-T G.9701] and 11.4.1.1.10 of [ITU-T G.9701]) in the downstream direction during the L2.2 link state. A first special value (−512) indicates that the signal-to-noise ratio margin is undetermined. A second special value (−511) indicates that the signal-to-noise ratio margin is less than or equal to −51.1 dB. A third special value (+511) indicates that the signal-to-noise ratio margin is greater than or equal to +51.1dB.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** -512, -511, +511 (special values) and -510...+510 (-51.0 dB to +51.0 dB).

**Reference:** Clauses 9.8.3.2 and 11.4.1.1.10 of [ITU-T G.9701].

#### **7.10.16.4 L2.2 Upstream signal-to-noise ratio margin (L2.2-SNRMus)**

**Description:** Reports the signal-to-noise ratio margin (as defined in clauses 9.8.3.2 of [ITU-T G.9701] and 11.4.1.1.10 of [ITU-T G.9701]) in the upstream direction during the L2.2 link state. The same special values as for L2.2-SNRMds are defined.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** -512, -511, +511 (special values) and -510...+510 (-51.0 dB to +51.0 dB).

**Reference:** Clauses 9.8.3.2 and 11.4.1.1.10 of [ITU-T G.9701].

#### **7.10.16.5 L2 Downstream signal-to-noise ratio margin for RMC (L2-SNRM-RMCds)**

**Description:** Reports the signal-to-noise ratio margin (as defined in clause 11.4.1.4 of [ITU-T G.9701]) for the RMC in the downstream direction during the L2.1N, L2.1B and L2.2 link state. A first special value (-512) indicates that the signal-to-noise ratio margin is undetermined. A second special value (-511) indicates that the signal-to-noise ratio margin is less than or equal to -51.1 dB. A third special value (+511) indicates that the signal-to-noise ratio margin is greater than or equal to +51.1dB.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** -512, -511, +511 (special values) and -510...+510 (-51.0 dB to +51.0 dB).

**Reference:** Clause 11.4.1.1.11 of [ITU-T G.9701].

#### **7.10.16.6 L2 Upstream signal-to-noise ratio margin for RMC (L2-SNRM-RMCus)**

**Description:** Reports the signal-to-noise ratio margin (as defined in clause 11.4.1.4 of [ITU-T G.9701]) for the RMC in the upstream direction during the L2.1N, L2.1B and L2.2 link state. The same special values as for L2-SNRM-RMCds are defined.

**Type:** 16-bit signed integer.

**Unit:** 0.1 dB.

**Valid values:** -512, -511, +511 (special values) and -510...+510 (-51.0 dB to +51.0 dB).

**Reference:** Clause 11.4.1.1.11 of [ITU-T G.9701].

#### **7.10.17 Downstream FEXT coupling coefficients (XLOG)**

##### **7.10.17.1 Downstream XLOG disturber index (XLOGDISTds)**

**Description:** Reports the VCE\_port\_index of the disturber line to which the XLOGpsds values apply. A special value 0 indicates that the requested VCE\_port\_index (XLOGDREQds) is invalid.

**Type:** 16-bit unsigned integer.

**Valid values:** 0 (special value) and 1..65535.

**Reference:** Clause 11.4.3.2 of [ITU-T G.9701].

##### **7.10.17.2 Downstream XLOG bandedges (XLOGBANDSds)**

**Description:** Defines the set of sub-carriers for which XLOGpsds is reported. For each band in which XLOGpsds is reported, XLOGBANDSds contains a triplet of (start\_subcarrier\_index, stop\_subcarrier\_index, group size). The XLOGpsds is reported for all sub-carriers in the band (start

and stop subcarrier inclusive) with index equal to start\_subcarrier\_index+m\*group\_size, with m integer. The object is updated only in L0 link state.

**Type:** Array of XLOGBANDSdescriptor[0...N-1], with  $1 \leq N \leq 8$  or empty if XLOGDISTds=0

**XLOGBANDSdescriptor:**

**Type:** Record of a start sub-carrier index, a stop sub-carrier index and a group size.

**Start sub-carrier index**

**Type:** 16-bit unsigned integer.

**Valid values:** 0...4095 (sub-carrier index 0 to 4095).

**Stop sub-carrier index:**

**Type:** 16-bit unsigned integer.

**Valid values:** 0...4095 (sub-carrier index 0 to 4095).

**Group size:**

**Type:** 8-bit unsigned integer.

**Valid values:** 1, 2, 4, 8, 16, 32, and 64.

**Reference:** Clause 11.4.1.2.9 of [ITU-T G.9701].

### 7.10.17.3 Downstream FEXT coupling (XLOGpsds)

**Description:** Reports the downstream Xlog(f) as one value per sub-carrier group. A first special value (255) indicates that the Xlog(f) for this sub-carrier group is undetermined. A second special value (254) indicates that no measurement could be done for this sub-carrier group. A third special value (0) indicates that the Xlog(f) for this sub-carrier group is greater than or equal to +40.0 dB. A fourth special value (251) indicates that the Xlog(f) for this sub-carrier group is less than or equal to -85.5 dB. The object is updated only in L0 link state.

**Type:** Array of XLOGdescriptor[0..N-1], with  $1 \leq N \leq 512$  or empty if XLOGDISTds=0.

**XLOGdescriptor:**

**Type:** 8-bit unsigned integer.

**Unit:** -0.5 dB.

**Offset:** 40 dB.

**Valid values:** 1...250 (39.5 to -85 dB) 0, 251, 254 and 255 (special values).

**Reference:** Clause 11.4.1.2.8 of [ITU-T G.9701].

## 7.11 Channel test, diagnostics and status objects

### 7.11.1 Actual data rates

#### 7.11.1.1 Net data rate (NDRds/us)

**Description:** Reports the NDR as defined in clause 11.4.1.1.1 of [ITU-T G.9701]. A special value ( $2^{32}-1$ ) indicates that the NDR is undetermined. The object is updated only in L0 link state.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-2$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** Clause 11.4.1.1.1 of [ITU-T G.9701].

### 7.11.1.2 Expected throughput (ETRds/us)

**Description:** Reports the expected throughput as defined in clause 11.4.1.1.3 of [ITU-T G.9701]. A special value ( $2^{32}-1$ ) indicates that the ETR is undetermined. The object is updated only in L0 link state.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-2$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** Clause 11.4.1.1.3 of [ITU-T G.9701].

### 7.11.1.3 Gamma Data Rate (GDRds/us)

**Description:** Reports the NDR as defined in clause 7.11.1.1, lowered by any throughput capability limitations remaining in the DRA or L2+ functions, assuming no user data is transmitted over all the other lines. A special value ( $2^{32}-1$ ) indicates that the GDR is undetermined. The object is updated only in L0 link state.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-2$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** None.

## 7.11.2 Attainable data rates

### 7.11.2.1 Attainable net data rate (ATTNDRds/us)

**Description:** Reports the attainable NDR as defined in clause 11.4.1.1.2 of [ITU-T G.9701]. A special value ( $2^{32}-1$ ) indicates that the attainable NDR is undetermined. The object is updated only in L0 link state.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-1$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** Clause 11.4.1.1.2 of [ITU-T G.9701].

### 7.11.2.2 Attainable expected throughput (ATTETRds/us)

**Description:** Reports the attainable expected throughput as defined in clause 11.4.1.1.4 of [ITU-T G.9701]. A special value ( $2^{32}-1$ ) indicates that the attainable expected throughput is undetermined. The object is updated only in L0 link state.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-2$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** Clause 11.4.1.1.4 of [ITU-T G.9701].

### 7.11.2.3 Attainable gamma data rate (ATTGDRds/us)

**Description:** Reports the attainable NDR (as defined in clause 7.11.2.1), lowered by any throughput capability limitations remaining in the DRA or L2+ functions, assuming no user data is transmitted over all the other Lines, and assuming MAXGDR (as defined in clause 7.2.1.3) is configured to its maximum valid value. A special value ( $2^{32}-1$ ) indicates that the attainable GDR is undetermined. The object is updated only in L0 link state.



**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-2$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** None.

### **7.11.3 Actual impulse noise protection**

#### **7.11.3.1 Actual INP against SHINE (ACTINPds/us)**

**Description:** Reports the actual INP against SHINE as defined in clause 11.4.1.1.4 of [ITU-T G.9701]. A special value indicates an actual INP against SHINE of 2047 symbols or higher.

**Type:** 16-bit unsigned integer.

**Unit:** 1 symbol.

**Valid values:** 0...2046 (0 to 2046 symbols) and 2047 (special value).

**Reference:** Clause 11.4.1.1.4 of [ITU-T G.9701].

#### **7.11.3.2 Actual INP against REIN (ACTINP\_REINds/us)**

**Description:** Reports the actual INP against REIN as defined in clause 11.4.1.1.5 of [ITU-T G.9701]. A special value indicates an actual INP against REIN of 63 symbols or higher.

**Type:** 8-bit unsigned integer.

**Unit:** 1 symbol.

**Valid values:** 0...62 (0 to 62 symbols) and 63 (special value).

**Reference:** Clause 11.4.1.1.5 of [ITU-T G.9701].

### **7.11.4 Actual framer settings**

#### **7.11.4.1 DTU FEC codeword length (DTU-NFECds/us)**

**Description:** Reports the DTU FEC codeword length as defined in clause 9.3 of [ITU-T G.9701].

**Type:** 8-bit unsigned integer.

**Unit:** 1 byte.

**Valid values:** 32..255 (32 to 255 bytes).

**Reference:** Clause 9.3 of [ITU-T G.9701].

#### **7.11.4.2 DTU FEC redundancy (DTU-RFECds/us)**

**Description:** Reports the DTU FEC codeword redundancy as defined in clause 9.3 of [ITU-T G.9701].

**Type:** 8-bit unsigned integer.

**Unit:** 1 byte.

**Valid values:** 2, 4, 6, 8, 10, 12, and 16 (2, 4, 6, 8, 10, 12, and 16 bytes).

**Reference:** Clause 9.3 of [ITU-T G.9701].

#### **7.11.4.3 Number of FEC codewords per DTU (DTU-Qds/us)**

**Description:** Reports the number of FEC codewords per DTU as defined in clause 9.3 of [ITU-T G.9701].

**Type:** 8-bit unsigned integer.

**Valid values:** 1...16.

**Reference:** Clause 9.3 of [ITU-T G.9701].

### **7.11.5 Test parameters per time interval**

#### **7.11.5.1 Error-free bits current 15 minutes (EFB-C15Mds/us)**

**Description:** Reports the number of error-free bits (see clause 11.4.1.1.6 of [ITU-T G.9701]) passed over the alpha reference point at the receiver, divided by 65536, in the current 15 min interval.

**Type:** 32-bit unsigned integer.

**Unit:** 65536 bits.

**Valid values:** 0...4294967295 (0 to  $2^{16} \times (2^{32} - 1)$  bits).

**Reference:** Clause 11.4.1.1.6 of [ITU-T G.9701].

#### **7.11.5.2 Error-free bits previous 15 minutes (EFB-P15Mds/us)**

**Description:** Reports the number of error-free bits (see clause 11.4.1.1.6 of [ITU-T G.9701]) passed over the alpha reference point at the receiver, divided by 65536, in the previous 15 min interval.

**Type:** 32-bit unsigned integer.

**Unit:** 65536 bits.

**Valid values:** 0...4294967295 (0 to  $2^{16} \times (2^{32} - 1)$  bits).

**Reference:** Clause 11.4.1.1.6 of [ITU-T G.9701].

#### **7.11.5.3 Error-free bits current 24 hours (EFB-C24Hds/us)**

**Description:** Reports the number of error-free bits (see clause 11.4.1.1.6 of [ITU-T G.9701]) passed over the alpha reference point at the receiver, divided by 65536, in the current 24 h interval.

**Type:** 32-bit unsigned integer.

**Unit:** 65536 bits.

**Valid values:** 0...4294967295 (0 to  $2^{16} \times (2^{32} - 1)$  bits).

**Reference:** Clause 11.4.1.1.6 of [ITU-T G.9701].

#### **7.11.5.4 Error-free bits previous 24 hours (EFB-P24Hds/us)**

**Description:** Reports the number of error-free bits (see clause 11.4.1.1.6 of [ITU-T G.9701]) passed over the alpha reference point at the receiver, divided by 65536, in the previous 24 h interval.

**Type:** 32-bit unsigned integer.

**Unit:** 65536 bits.

**Valid values:** 0...4294967295 (0 to  $2^{16} \times (2^{32} - 1)$  bits).

**Reference:** Clause 11.4.1.1.6 of [ITU-T G.9701].

#### **7.11.5.5 Minimum error-free throughput current 15 minutes (MINEFTR-C15Mds/us)**

**Description:** Reports the minimum error-free throughput (see clause 11.4.1.1.3 of [ITU-T G.9701]) over the current 15 min interval.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967295 (0 to  $2^{32} - 1$  kbit/s).

**Reference:** Clause 11.4.1.1.3 of [ITU-T G.9701].

#### **7.11.5.6 Minimum error-free throughput previous 15 minutes (MINEFTR-P15Mds/us)**

**Description:** Reports the minimum error-free throughput (see clause 11.4.1.1.3 of [ITU-T G.9701]) over the previous 15 min interval.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967295 (0 to  $2^{32}-1$  kbit/s).

**Reference:** Clause 11.4.1.1.3 of [ITU-T G.9701].

#### **7.11.5.7 Minimum error-free throughput current 24 hours (MINEFTR-C24Hds/us)**

**Description:** Reports the minimum error-free throughput (see clause 11.4.1.1.3 of [ITU-T G.9701]) over the current 24 h interval.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967295 (0 to  $2^{32}-1$  kbit/s).

**Reference:** Clause 11.4.1.1.3 of [ITU-T G.9701].

#### **7.11.5.8 Minimum error-free throughput previous 24 hours (MINEFTR-P24Hds/us)**

**Description:** Reports the minimum error-free throughput (see clause 11.4.1.1.3 of [ITU-T G.9701]) over the previous 24 h interval.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967295 (0 to  $2^{32}-1$  kbit/s).

**Reference:** Clause 11.4.1.1.3 of [ITU-T G.9701].

### **7.11.6 Low power modes**

#### **7.11.6.1 L2.1 Net data rate (L2.1-NDRds/us)**

**Description:** Reports the NDR in L2.1N and L2.1B link states as defined in clause 11.4.1.1.12 of [ITU-T G.9701]. A special value ( $2^{32}-1$ ) indicates that the NDR is undetermined. The object is updated only in L2.1N and L2.1B link states.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-2$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** Clause 11.4.1.1.12 of [ITU-T G.9701].

#### **7.11.6.2 L2.2 Net data rate (L2.2-NDRds/us)**

**Description:** Reports the NDR in L2.2 link state as defined in clause 11.4.1.1.13 of [ITU-T G.9701]. A special value ( $2^{32}-1$ ) indicates that the NDR is undetermined. The object is updated only in L2.2 link state.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-2$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** Clause 11.4.1.1.13 of [ITU-T G.9701].

#### **7.11.6.3 L2.1 Expected throughput (L2.1-ETRs/us)**

**Description:** Reports the expected throughput in L2.1N and L2.1B link state as defined in clause 11.4.1.1.14 of [ITU-T G.9701]. A special value ( $2^{32}-1$ ) indicates that the expected throughput is undetermined. The object is updated only in L2.1N and L2.1B link states.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-2$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** Clause 11.4.1.1.14 of [ITU-T G.9701].

#### **7.11.6.4 L2.2 Expected throughput (L2.2\_ETRs/us)**

**Description:** Reports the expected throughput in L2.2 link state as defined in clause 11.4.1.1.15 of [ITU-T G.9701]. A special value ( $2^{32}-1$ ) indicates that the expected throughput is undetermined. The object is updated only in L2.2 link state.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967294 (0 to  $2^{32}-2$  kbit/s) and 4294967295 ( $2^{32}-1$  special value).

**Reference:** Clause 11.4.1.1.15 of [ITU-T G.9701].

### **7.12 Data path test, diagnostics and status objects**

No data path test, diagnostics and status objects are defined.

### **7.13 Inventory objects**

#### **7.13.1 FTU related inventory**

##### **7.13.1.1 FTU-O ITU-T G.994.1 vendor ID (FTUO\_GHS\_VENDOR)**

**Description:** Reports the FTU-O [ITU-T G.994.1] vendor ID as inserted by the FTU-O in the [ITU-T G.994.1] CL message and as defined in clause 9.3.3.1 of [ITU-T G.994.1].

**Type:** string (8 binary octets).

**Reference:** Clause 9.3.3.1 of [ITU-T G.994.1].

##### **7.13.1.2 FTU-R ITU-T G.994.1 vendor ID (FTUR\_GHS\_VENDOR)**

**Description:** Reports the FTU-R [ITU-T G.994.1] vendor ID as inserted by the FTU-R in the [ITU-T G.994.1] CLR message and as defined in clause 9.3.3.1 of [ITU-T G.994.1].

**Type:** string (8 binary octets).

**Reference:** Clause 9.3.3.1 of [ITU-T G.994.1].

##### **7.13.1.3 FTU-O version number (FTUO\_VERSION)**

**Description:** Reports the FTU-O version number as inserted by the FTU-O in the embedded operations channel (see clause 11.2.2.10 of [ITU-T G.9701]). It is for version control and is vendor specific information.

**Type:** string (up to 16 binary octets).

**Reference:** Clause 11.2.2.10 of [ITU-T G.9701].

#### 7.13.1.4 FTU-R version number (FTUR\_VERSION)

**Description:** Reports the FTU-R version number as inserted by the FTU-R in the embedded operations channel (see clause 11.2.2.10 of [ITU-T G.9701]). It is for version control. It shall contain the FTU-R firmware version and the FTU-R model. Both shall be encoded in this order and separated by a space character, i.e., "<FTU-R firmware version><space><FTU-R model>".

**Type:** string (up to 16 ASCII characters).

**Reference:** Clause 11.2.2.10 of [ITU-T G.9701].

#### 7.13.1.5 FTU-O self-test result (FTUO\_SELFTEST)

**Description:** Reports the results from the most recent self-test procedure, initiated at power-up (see clause 12.1.2 of [ITU-T G.9701]). The first octet of the self-test result is 00<sub>hex</sub> if the self-test passed and 01<sub>hex</sub> if the self-test failed. The interpretation of the other octets is vendor discretionary and can be interpreted in combination with the FTU-O [ITU-T G.994.1] vendor ID and DPU system vendor ID.

**Type:** string (4 binary octets).

**Reference:** Clause 11.2.2.10 of [ITU-T G.9701].

#### 7.13.1.6 FTU-R self-test result (FTUR\_SELFTEST)

**Description:** Reports the results from the most recent self-test procedure, initiated either at power-up (see clause 12.1.2 of [ITU-T G.9701]) or by the perform self-test eoc command (see clause 12.2.2.6.1 of [ITU-T G.9701]). The first octet of the self-test result is 00<sub>hex</sub> if the self-test passed and 01<sub>hex</sub> if the self-test failed. The interpretation of the other octets is vendor discretionary and can be interpreted in combination with the FTU-R [ITU-T G.994.1] vendor ID and the NT system vendor ID.

**Type:** string (4 binary octets).

**Reference:** Clause 11.2.2.10 of [ITU-T G.9701].

#### 7.13.1.7 ITU-T G.9701 profile support (FTUO\_PROFILES)

**Description:** Reports for each profile whether the FTU-O supports operation according to that profile.

**Type:** Array of PROFILEdescriptor[0...N-1] with N=5.

**PROFILEdescriptor:**

**Type:** boolean.

**Valid values:** false (not supported) and true (supported).

**Bit representation**

- 0 [ITU-T G.9701] profile 106a.
- 1 [ITU-T G.9701] profile 106b.
- 2 [ITU-T G.9701] profile 212a.
- 3 [ITU-T G.9701] profile 106c.
- 4 [ITU-T G.9701] profile 212c.

**Reference:** Clause 6 of [ITU-T G.9701].

#### 7.13.1.8 ITU-T G.9701 profile support (FTUR\_PROFILES)

**Description:** Reports for each profile whether the FTU-R supports operation according to that profile.

**Type:** Array of PROFILEdescriptor[0...N-1] with N=5.

**PROFILEdescriptor:**

**Type:** boolean.

**Valid values:** false (not supported) and true (supported).

**Bit representation**

- 0 [ITU-T G.9701] profile 106a.
- 1 [ITU-T G.9701] profile 106b.
- 2 [ITU-T G.9701] profile 212a.
- 3 [ITU-T G.9701] profile 106c.
- 4 [ITU-T G.9701] profile 212c.

**Reference:** Clause 6 of [ITU-T G.9701].

**7.13.2 System related inventory****7.13.2.1 DPU system vendor ID (DPU\_SYSTEM\_VENDOR)**

**Description:** Reports the DPU system vendor ID as inserted by the FTU-O in the embedded operations channel (see clause 11.2.2.10 of [ITU-T G.9701]) and as defined in clause 9.3.3.1 of [ITU-T G.994.1].

**Type:** string (8 binary octets).

**Reference:** Clause 11.2.2.10 of [ITU-T G.9701].

**7.13.2.2 NT system vendor ID (NT\_SYSTEM\_VENDOR)**

**Description:** Reports the NT system vendor ID as inserted by the FTU-R in the embedded operations channel (see clause 11.2.2.10 of [ITU-T G.9701]) and as defined in clause 9.3.3.1 of [ITU-T G.994.1].

**Type:** string (8 binary octets).

**Reference:** Clause 11.2.2.10 of [ITU-T G.9701].

**7.13.2.3 DPU system serial number (DPU\_SYSTEM\_SERIALNR)**

**Description:** Reports the DPU serial number as inserted by the FTU-O in the embedded operations channel (see clause 11.2.2.10 of [ITU-T G.9701]). It is vendor specific information. The combination of DPU system vendor ID and DPU system serial number creates a unique number for each DPU.

**Type:** string (up to 32 ASCII characters).

**Reference:** Clause 11.2.2.10 of [ITU-T G.9701].

**7.13.2.4 NT system serial number (NT\_SYSTEM\_SERIALNR)**

**Description:** Reports the NT system serial number as inserted by the FTU-R in the embedded operations channel (see clause 11.2.2.10 of [ITU-T G.9701]). It shall contain the NT system serial number, the NT model and the NT firmware version. All shall be encoded in this order and separated by space characters, i.e., "<NT serial number><space><NT model><space><NT firmware version>". The combination of NT system vendor ID and NT system serial number creates a unique number for each NT.

**Type:** string (up to 32 ASCII characters).

**Reference:** Clause 11.2.2.10 of [ITU-T G.9701].

### 7.13.2.5 VCE ID (VCE\_ID)

**Description:** For the line in a vectored group, the VCE ID uniquely identifies the VCE that manages and controls the vectored group to which the line belongs. It consists of one octet and valid ranges are from 1 to 255. A special value means the line is not in a vectored group.

**Type:** 8-bit unsigned integer.

**Valid values:** 0 (special value) and 1..255.

**Reference:** Clause 11.4.6.1.1 of [ITU-T G.9701].

### 7.13.2.6 VCE port index (VCE\_PORT\_INDEX)

**Description:** For the line in a vectored group, the VCE port index is the physical index that uniquely identifies the VCE port to which the line is connected. It is an integer from 1 to the maximum number of lines supported by the VCE. The combination of VCE ID and VCE port index creates a unique identifier for each vectored FTU-O/-R.

**Type:** 16-bit unsigned integer.

**Valid values:** 0 (special value) and 1..65535.

**Reference:** Clause 11.4.6.1.2 of [ITU-T G.9701].

## 7.14 Link State related managed objects

### 7.14.1 Link State Configuration

#### 7.14.1.1 Link state forced (LS-FORCED)

**Description:** Forces the link to transition and to remain in the selected link state.

**Type:** enumeration

**Valid values:** 0 .. 4

- 0 No link state forced
- 1 L0 link state forced
- 2 L2.1N link state forced
- 3 L2.1B link state forced
- 4 L2.2 link state forced

**Default value:** 0 (no link state forced)

**Reference:** Clause 12.1.1.7.1 of [ITU-T G.9701].

#### 7.14.1.2 Link state enabling (LS-ENABLE)

**Description:** Selects the set of allowed low power mode states.

**Type:** enumeration

**Valid values:** 0 .. 3

- 0 L0 and L3 enabled (L2.1N, L2.1B, L2.2 disabled).
- 1 L0, L3 and L2.1N enabled (L2.1B, L2.2 disabled).
- 2 L0, L3, L2.1N and L2.1B enabled (L2.2 disabled).
- 3 L0, L3, L2.1N, L2.1B and L2.2 enabled.

**Default value:** 3 (L0, L3, L2.1N, L2.1B and L2.2 enabled)

**Reference:** Clause 12.1.1.7.2 of [ITU-T G.9701].

## **7.14.2 Link State Status Reporting**

### **7.14.2.1 Link state (LINK-STATE)**

**Description:** Reports the actual link state

**Type:** enumeration.

**Valid values:** 1..5

- 1 L0 link state
- 2 L2.1N link state
- 3 L2.1B link state
- 4 L2.2 link state
- 5 L3 link state

**Reference:** Clause 12.1.1.7.3 of [ITU-T G.9701].

### **7.14.2.2 Link state at update of near-end test parameter group 1 (LINK-STATE-TEST-NE-G1)**

**Description:** Report the link state during which near-end test parameters group 1 were updated.

**Type:** enumeration.

**Valid values:** 1..4.

- 1 L0 link state
- 2 L2.1N link state
- 3 L2.1B link state
- 4 L2.2 link state

**Reference:** Clause 12.1.1.7.3 of [ITU-T G.9701].

### **7.14.2.3 Link state at update of far-end test parameter group 1 (LINK-STATE-TEST-FE-G1)**

**Description:** Report the link state during which far-end test parameters group 1 were updated.

**Type:** enumeration.

**Valid values:** 1..4.

- 1 L0 link state
- 2 L2.1N link state
- 3 L2.1B link state
- 4 L2.2 link state

**Reference:** Clause 12.1.1.7.3 of [ITU-T G.9701].

## **8 Procedures for performance monitoring functions**

The functions described in this clause can be performed inside or outside the network element.

### **8.1 Line transmission states**

A line can be in one of two transmission states:



- 1) unavailable state;
- 2) available state.

The transmission state is determined from SES/non-SES data and the transceiver state SHOWTIME/non-SHOWTIME. The unavailable state is defined in clause 11.4.4.5 of [ITU-T G.9701]. A G.fast line is in the available state when it is not in the unavailable state.

## 8.2 Threshold reports

A threshold report (TR) is an unsolicited error performance report from a DPU over its DPU-NB interface with respect to either a 15-minute or 24-hour evaluation period. TRs can only occur when the concerned direction is in the available state. The performance counter thresholds are listed in Table 8-1 and Table 8-2. The TRs related to near-end and far-end ES, SES and UAS are mandatory and other TRs are optional. Threshold reports are not provided at the T/S-interface.

TR1s shall occur within 10 s after the 15 min threshold is reached or exceeded.

TR2s shall occur within 10 s after the 24 h threshold is reached or exceeded.

Entries in Tables 8-1 and 8-2 labelled with names containing the separator "/" represents multiple objects whose names are obtained by considering all combinations of the elements isolated with the separator. For example, the entry labelled with the name A/B\_C/D\_E/F represents eight objects with names A\_C\_E, A\_C\_F, A\_D\_E, A\_D\_F, B\_C\_E, B\_C\_F, B\_D\_E, B\_D\_F.

**Table 8-1 – Line performance counter thresholds**

| Category/object  | Counter defined in clause: | DPU-NB interface | T/S interface |
|--|----------------------------|------------------|---------------|
| <i>Near-end (FTU-O)/far-end (FTU-R) performance monitoring thresholds (15 min/24 h interval)</i> |                            |                  |               |
| THRESHOLD_NE/FE_15/24_ES   | 7.7.8                      | R/W (M)          | N/A           |
| THRESHOLD_NE/FE_15/24_SES  | 7.7.9                      | R/W (M)          | N/A           |
| THRESHOLD_NE/FE_15/24_LOSS   | 7.7.10                     | R/W (O)          | N/A           |
| THRESHOLD_NE/FE_15/24_LORS   | 7.7.11                     | R/W (O)          | N/A           |
| THRESHOLD_NE/FE_15/24_UAS  | 7.7.12                     | R/W (M)          | N/A           |
| <i>Initialization performance monitoring thresholds (15 min/24 h interval)</i>                   |                            |                  |               |
| THRESHOLD_15/24_FULL_INITS   | 7.7.13                     | R/W (O)          | N/A           |
| THRESHOLD_15/24_FAILEDFULL_INITS   | 7.7.14                     | R/W (O)          | N/A           |
| THRESHOLD_15/24_FAST_INITS   | 7.7.15                     | R/W (O)          | N/A           |
| THRESHOLD_15/24_FAILEDFAST_INITS   | 7.7.16                     | R/W (O)          | N/A           |
| <i>Short interruption performance monitoring thresholds (24 h interval)</i>                      |                            |                  |               |
| THRESHOLD_24_SPONT_INTRPT  | 7.7.19                     | R/W (O)          | N/A           |

**Table 8-2 – Channel performance monitoring thresholds**

| Category/object  | Counter defined in clause: | DPU-NB interface | T/S interface |
|--|----------------------------|------------------|---------------|
| <i>Near-end (FTU-O)/far-end (FTU-R) performance monitoring thresholds (15 min/24 h interval)</i> |                            |                  |               |
| THRESHOLD_NE/FE_15/24_CV   | 7.8.4                      | R/W (O)          | N/A           |
| THRESHOLD_NE/FE_15/24_RTXUC  | 7.8.6                      | R/W (O)          | N/A           |
| THRESHOLD_NE/FE_15/24_RTXTX  | 7.8.7                      | R/W (O)          | N/A           |

### 8.3 Unavailable and available state filters

The unavailable state filter is a rectangular sliding window with a default length of 10 s and a 1 s granularity of the slide. The length of the sliding window is configured through the REINIT\_TIME\_THRESHOLD line configuration object (see clauses 7.1.8.7 and 7.1.8.8).

The available state filter is also a rectangular sliding window with a default length of 10 s and a 1 s granularity of the slide. The length of the sliding window is configured through the REINIT\_TIME\_THRESHOLD line configuration object (see clauses 7.1.8.7 and 7.1.8.8).

### 8.4 TR1 filter

The TR1 filter is a 15 min rectangular fixed window. The start and end times for the 15 min rectangular fixed windows shall fall on the hour and at 15, 30 and 45 min after the hour.

### 8.5 TR2 filter

The TR2 filter is a 24 h rectangular fixed window. The start and end times for the 24 h rectangular fixed windows shall fall on a 15 min window boundary.

### 8.6 Evaluation of TR1

For second counters, the parameters are counted separately, second by second, over each 15 min rectangular fixed window period. The threshold values shall be programmable over the range 0 to 900 with default value 0. A value of 0 indicates that the threshold is disabled.

For event counters, the parameters are counted separately, one by one, over each 15 min rectangular fixed window period. The threshold values shall be programmable over the range 0 to the maximum value of the counter with default value 0. A value of 0 indicates that the threshold is disabled.

A threshold can be crossed at any second within the 15 min rectangular fixed window. As soon as a threshold is crossed, a TR1 as appropriate should be sent on the DPU-NB interface together with a date/time-stamp. Moreover, performance events should continue to be counted to the end of the current 15 min period, at which time the current parameter counts are stored in the history registers and the current parameter registers are reset to zero.

### 8.7 Evaluation of TR2

For second counters, the parameters are counted separately over each 24 h period. The threshold values shall be programmable over the range 0 to 86400 with default value 0. A value of 0 indicates that the threshold is disabled.

For event counters, the parameters are counted separately over each 24 h period. The threshold values shall be programmable over the range 0 to the maximum value of the counter with default value 0. A value of 0 indicates that the threshold is disabled.

The DPU shall recognize a 24 h threshold crossing within 15 min of its occurrence. The threshold crossing shall be given the date/time-stamp of the moment of recognition. A TR2 as appropriate should be sent to the NMS with the date/time-stamp. Moreover, performance events should continue to be counted to the end of the current 24 h period, at which time the parameter counts are stored in the history registers and the current parameter registers are reset to zero.

### **8.8 Threshold report evaluation during transmission state changes**

Care should be taken to ensure that threshold reports are correctly generated and parameter counters are correctly processed during changes in the transmission state. This implies that all threshold reports should be delayed by the length of the sliding window in the unavailable state filer (see clause 8.3).

### **8.9 Performance history storage in network elements**

Performance history storage at the DPU shall consist of the current and previous 15 min and 24 h parameter registers listed in clause 7. Support of performance history storage beyond the current and previous 15 min and 24 h parameter registers listed in clause 7 is not defined.

It is expected that the PMA at appropriate times pulls parameter register values from the DPU in order to store a performance history beyond the current and previous 15 min and 24 h parameter registers listed in clause 7.

As a minimum, a measured time and an invalid data flag shall be provided for each stored interval for each direction for each monitored transmission entity. For example, an invalid data flag is set to indicate that the data stored is incomplete or otherwise invalid when:

- the data has been accumulated over a period of time that is less than the nominal accumulation period duration;
- the data in the current interval is suspect because a terminal is restarted or a register is reset in the middle of an accumulation period;
- the data is incomplete in an accumulation period. For example, an incoming transmission failure or defect may prevent complete collection of far-end performance reports;
- the line is not configured (in which case the PM data and measured time are set to ZERO).

The invalid data flag is not set as a result of register saturation.

### **8.10 Register size**

The register size is 32 bits. When the maximum value of a register is reached, the register shall remain at that maximum value until it is reset, or the value is transferred or discarded, as described in this clause.

### **8.11 Parameter counts**

If the line is in AdminStatus="up", then performance monitoring counters shall be active, irrespective of the actual link state of the line.

If the line is in AdminStatus="down", then all performance monitoring counters shall be frozen, including the UAS counter.

All active parameter counts shall be actual (within a tolerance of 1 s) counts for the 15 min and 24 h filtering period.

### **8.12 Date/time-stamping of reports**

The date/time-stamping accuracy of reports, together with the method of maintaining the accuracy, is for further study.

The date/time-stamp is a string of ASCII characters formatted as "\d{4}-\d{2}-\d{2}T\d{2}:\d{2}:\d{2}(\.\d+)?"+ "(Z|[\+|-]\d{2}:\d{2})" (see [b-IETF RFC 6021] and [b-IETF RFC 3339]).

Equipment clock accuracy requirements are for further study.

### **8.13 Inhibiting performance monitoring parameters**

The accumulation of certain performance parameters is inhibited during certain periods. Inhibition of performance monitoring parameters is defined in clause 11.4.4.6 of [ITU-T G.9701].

## Annex A

### Physical layer management for reverse power feeding (RPF) of remote access equipment

(This annex forms an integral part of this Recommendation.)

#### A.1 Scope

This Annex specifies the physical layer management for reverse power feeding (RPF) of remote access equipment, e.g., DPUs containing digital subscriber line (DSL) or G.fast transmission systems, consisting of:

- The RPF operations, administration and maintenance (OAM) protocol between the NT ME (located in the network termination, see Figure 5-1 of [ITU-T G.9701]) and the DPU ME (located in the remote access equipment, like a DPU, see Figure 5-1 of [ITU-T G.9701]) (see clauses A.6.2.1 to A.6.2.4).
- The RPF indications and parameters exchanged between the NT ME and the DPU ME (see clauses A.6.2.1.1 and A.6.2.5, respectively);
- The RPF managed objects applicable at the Northbound interface of the remote access equipment, e.g., a DPU-NB interface towards an PMA (see clause A.7).

The RPF OAM protocol and the RPF parameters exchanged using the RPF OAM protocol relate to [ETSI TS 101 548]. The RPF OAM protocol consists of RPF OAM messages mapped as information payload on the [ITU-T G.9701] clear embedded operations channel (eoc) (see clause 11.2.2.4 of [ITU-T G.9701]).

NOTE – The RPF OAM messages defined in this annex may also be mapped as information payload on the [b-ITU-T G.993.2] clear eoc (see clause 11.2.3.8 of [b-ITU-T G.993.2]).

#### A.2 References

- [ETSI TS 101 548] ETSI Technical Specification 101 548 (2016), *Access, terminals, transmission and multiplexing (ATTM); European requirements for reverse powering of remote access equipment*.
- [IETF RFC 3986] IETF RFC 3986 (2005), *Uniform resource identifier (URI): Generic syntax*.

#### A.3 Definitions

None.

**A.3.1 broadband bypass:** Broadband bypass refers to the scenario whereby the DPU supports "Reverse Power Feed Architecture – No POTS with Broadband Bypass" (RPFA NOP-BB) as defined in clause 5.8 of [ETSI TS 101 548]. Or, alternatively, the scenario whereby the DPU supports Zero Touch-Remote Copper Reconfiguration defined in clause 7.4 of [ETSI TS 101 548] whereby exchange POTS is not present on the line, but where there is an overlay DSL service (i.e., "naked" or "dry" DSL).

**A.3.2 bypass mode:** Operational state of the POTS adapters or power splitter where there is a metallic connection to the exchange or to an ATA. And, specifically for RPFA-NOP-BB architecture option, the operational state of the stateless Switching Function (SF), whereby the non-ITU-T G.9701 xTU-R of the CPE is connected to an xTU-O of the CO/cabinet.

**A.3.3 normal mode:** Operational state of the POTS adapters or power splitter where there is no metallic connection to the exchange or to an ATA. And, specifically for RPFA-NOP-BB architecture option, the operational state of the stateless Switching Function (SF), whereby the FTU-R of the CPE is connected to the FTU-O of the DPU.

**A.3.4 POTS remote copper reconfiguration (RCR):** POTS RCR refers to the Scenario where POTS from the exchange may be provided to the subscriber and shall be disconnected by the DPU, prior to start-up of the DPU. Refer to clause 6.2.5.1 "PRP definition" of [ETSI TS 101 548].

#### **A.4 Abbreviations and acronyms**

ACM AC Mains

ATA Analogue Telephone Adapter

BBA Battery Backup Available

CPF Common Power Feed

DGL Dying Gasp Loss

IAR International Amateur Radio

IFN Intensity of current Feed Now

LLPF Last reverse power feeding line Loss of Power Failure

NTE Network Termination Equipment

OAM Operations, Administration and Maintenance

OHP Off-Hook Phone

PC Power Class

PE Power Extractor

POTS Plain Old Telephony Service

PRP PS Plain old telephony service Remote copper reconfiguration Protocol Power Splitter

PRP POTS RCR Protocol

PSE Power Source Equipment

RCR Remote Copper Reconfiguration

RCS ReConfiguration State

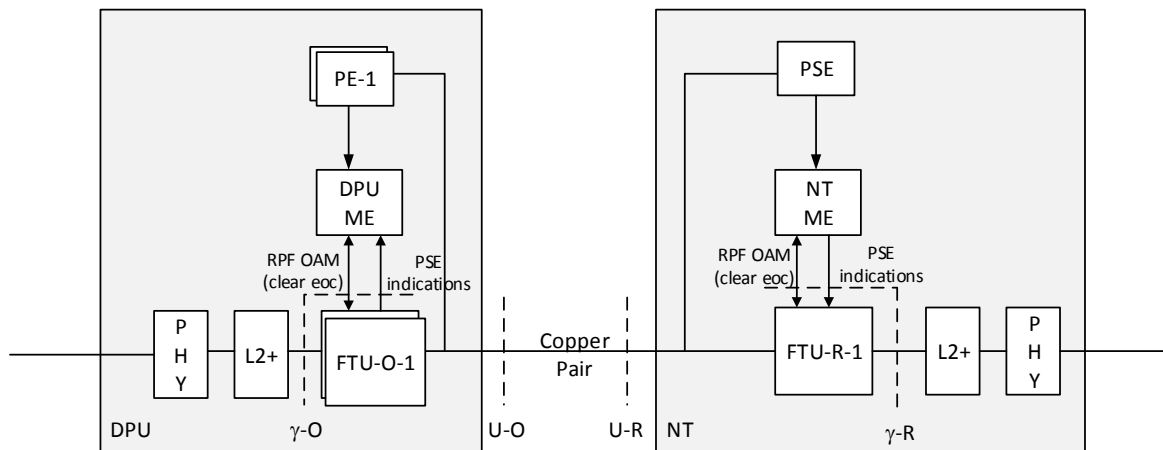
RPF Reverse Power Feeding

VoIP Voice over Internet Protocol

#### **A.5 DPU and NT management architecture**

This annex extends the reference model of DPU and NT management for the management of remote power feeding (RPF). See Figure A.1. On the FTU-O side, the DPU ME manages the power extractor (PE) and remotely manages the PSE. On the FTU-R side, the NT ME manages the power source equipment (PSE). In order to manage the PSE from the DPU-ME, two communication channels are used:

- A bi-directional channel using the clear eoc between the DPU ME and NT ME. This channel transports the RPF OAM messages.
- A low latency unidirectional channel using indicator bits over the RMC from the FTU-R to the FTU-O side. This channel transports PSE indications that are time sensitive.



**Figure A.1 – Reference model of DPU and NT management with RPF**

## **A.6 Network management protocol**

### **A.6.1 DPU Northbound management protocol**

This Annex makes no presumption about which management protocol is used between the PMA and the DPU for transport of the RPF-managed objects defined in clause A.7.

### **A.6.2 RPF OAM management protocol**

#### **A.6.2.1 RPF OAM message structure**

The structure of the RPF OAM message is shown in Table A.1. The message contains five fields. Each RPF OAM message shall be mapped on the information payload of the clear eoc of clause 11.2.2.4 of [ITU-T G.9701].

NOTE – The RPF OAM messages may also be mapped as information payload on the [b-ITU-T G.993.2] clear eoc (see clause 11.2.3.8 of [b-ITU-T G.993.2]).

**Table A.1 – RPF OAM message structure**

| Octet number | Length (octets) | Description                        |
|--------------|-----------------|------------------------------------|
| 1-2          | 2               | Type (1548 <sub>16</sub> for RPF)  |
| 3            | 1               | Subtype (03 <sub>16</sub> for OAM) |
| 4-5          | 2               | Flags (see clause A.6.2.1.1)       |
| 6            | 1               | Code (see clause A.6.2.1.2)        |
| 7-48         | 0-42            | Data (see clause A.6.2.2)          |

#### **A.6.2.1.1 RPF OAM flags field**

The flags field of the RPF OAM message as sent by the DPU ME to the NT ME is defined in Table A.2. The flags field shall be sent by the DPU ME as part of an RPF OAM parameter request message (see clause A.6.2.4).

**Table A.2 – RPF OAM flags field as sent by the DPU ME**

| Bit(s) | Name                      | Description                         |
|--------|---------------------------|-------------------------------------|
| 15-0   | Reserved for use by ITU-T | Reserved bits shall be set to zero. |

The flags field of the RPF OAM message as sent by the NT ME to the DPU ME is defined in Table A.3. The flags field shall be sent by the NT ME as part of an RPF OAM event notification message (see clause A.6.2.2) and as part of an RPF OAM parameter response message (see clause A.6.2.4).

NOTE – The RPF OAM flag fields in Table A.3 are consistent with the indications defined in clause 6.3 of [ETSI TS 101 548]. Alternatively, the PSE may send these indications to the PE using the means defined in clause 6.3 of [ETSI TS 101 548].

**Table A.3 – RPF OAM flags field as sent by the NT ME**

| Bit(s)   | Name                      | Description  |
|--|---------------------------|--|
| 15-5   | Reserved for use by ITU-T | Reserved bits shall be set to zero.  |
| 4  | PSE-DGL (dying gasp loss) | Set to ONE for indication of a PSE lost power dying gasp (see Note).<br>Set to ZERO otherwise.                                   |
| 3  | PSE-OHP (off-hook phone)  | Set to ONE for indication of a PSE Power Fail with off-hook phone during NORMAL OPERATIONS (see Note).<br>Set to ZERO otherwise. |
| 2  | PSE-BAT                   | Set to ONE for indication of a PSE operation on a battery.<br>Set to ZERO otherwise.   |
| 1  | PSE-ACM (AC mains)        | Set to ONE for indication of a PSE operation on mains power with no battery backup (BBA) available.<br>Set to ZERO otherwise.    |
| 0  | PSE-BBA                   | Set to ONE for indication of a PSE operating on mains power with BBA.<br>Set to ZERO otherwise.                                  |
| NOTE – When this indication occurs, the NT could lose power before the RPF OAM message has been sent. This indication may be sent through the RPF OAM message. This indication shall be sent through the power-related far-end primitive defined in clause 11.3.3.2 of [ITU-T G.9701]. |                           |  |

#### **A.6.2.1.2 RPF OAM code field**

The code field of the RPF OAM message is defined in Table A.4. This field identifies the message code.

**Table A.4 – RPF OAM code field**

| Code                               | Description               | Comment                                      | Source |
|------------------------------------|---------------------------|--|--------|
| 00 <sub>16</sub>                   | Reserved for use by ITU-T |  |        |
| 01 <sub>16</sub>                   | Event notification        | Alerts the DPU of RPF events                 | NT ME  |
| 02 <sub>16</sub>                   | Parameter request         | Requests one or more specific RPF parameters | DPU ME |
| 03 <sub>16</sub>                   | Parameter response        | Returns one or more specific RPF parameters  | NT ME  |
| 03 <sub>16</sub> -FF <sub>16</sub> | Reserved for use by ITU-T |  |        |



### A.6.2.2 RPF OAM event notification message

The RPF OAM event notification message is defined in Table A.5.

**Table A.5 – RPF OAM event notification message**

| Octets   | Description                                    |
|--|--|
| 2  | Type (1548 <sub>16</sub> for RPF)              |
| 1  | Subtype (03 <sub>16</sub> for OAM)             |
| 2  | Flags (see clause A.6.2.1.1)                   |
| 1  | Code (01 <sub>16</sub> for event notification) |
| 0-42   | Data (see Note)                                |
| NOTE – For this version of the RPF OAM protocol, the transmitter shall not send any data octets. For compatibility with future definition of data octets, the receiver shall ignore all data octets sent by the transmitter. |  |

### A.6.2.3 RPF OAM parameter request message

The RPF OAM parameter request message is defined in Table A.6.

**Table A.6 – RPF OAM parameter request message**

| Octets | Description  |
|--------|--|
| 2      | Type (1548 <sub>16</sub> for RPF)  |
| 1      | Subtype (03 <sub>16</sub> for OAM)   |
| 2      | Flags (see clause A.6.2.1.1)   |
| 1      | Code (02 <sub>16</sub> for managed object request)   |
| 3-42   | 1 to 14 parameter descriptors. Each descriptor consists of 3 octets (see tables of clause A.7): <ul style="list-style-type: none"><li>– Branch (1 octet)</li><li>– Leaf (2 octets)</li></ul> |

### A.6.2.4 RPF OAM parameter response message

The RPF OAM parameter response message is defined in Table A.7. A parameter response message shall be sent by the NT ME within 1 s of receipt of a parameter request message.

**Table A.7 – RPF OAM parameter response message**

| Octets | Description  |
|--------|--|
| 2      | Type (1548 <sub>16</sub> for RPF)  |
| 1      | Subtype (03 <sub>16</sub> for OAM)   |
| 2      | Flags (see clause A.6.2.1.1)   |
| 1      | Code (03 <sub>16</sub> for managed object response)  |
| 5-42   | A nonzero number of parameter containers. Each container is variable length (see tables of clause A.7): <ul style="list-style-type: none"><li>– Branch (1 octet)</li><li>– Leaf (2 octets)</li><li>– Width (1 octet)</li><li>– Value (<i>width</i> octets)</li></ul> |

### A.6.2.5 RPF OAM parameters

The RPF OAM parameters are defined in Table A.8. These parameters are exchanged through RPF OAM parameter request messages (see clause A.6.2.3) and RPF OAM parameter response messages (see clause A.6.2.4).

NOTE – The RPF OAM parameters in Table A.8 are consistent with clause 6.4 of [ETSI TS 101 548].

**Table A.8 – RPF OAM parameters**

| Name                                       | Branch                 | Leaf                     | Width                  | Definition   |
|--|------------------------|--------------------------|------------------------|--|
| <b>Status</b>                              |                        |                          |                        |  |
| RPF-IFN<br>(intensity of current feed now) | 04 <sub>16</sub>       | 0001 <sub>16</sub>       | 02 <sub>16</sub>       | Average current feed now at the UR-2P reference point, expressed in milliamperes, and represented as a 16 bit unsigned integer with valid values 0 to 400 mA. The averaging time window and accuracy are defined in [ETSI TS 101 548].   |
| <b>Diagnostics</b>                         |                        |                          |                        |  |
| <u>PSE-SUF</u>                             | <u>05<sub>16</sub></u> | <u>0001<sub>16</sub></u> | <u>01<sub>16</sub></u> | <u>Latest PSE Start-Up Failure indication, detected during "Start-Up". The octet is formatted as a bitmap, with a bit set to ONE if and only if the corresponding failure is detected. The bits are defined as follows (bit 0 lsb to bit 7 msb):</u><br><u>bit 0: ELC-0 (Open tip-to-ring);</u><br><u>bit 1: ELC-1 (Short tip-to-ring);</u><br><u>bit 2: ELC-2 (POTS Exchange (foreign) DC voltage)</u><br><u>bit 3: ELC-3 (Off-hook phone);</u><br><u>bit 4: Mismatch of the PSE RPF Class with the DPU RPF Class;</u><br><u>bit 5: Unknown;</u><br><u>bit 6: Set to ZERO, reserved for use by the ITU-T;</u><br><u>bit 7: Set to ZERO, reserved for use by the ITU-T.</u><br><u>No more than 1 bit shall be set to ONE in the field.</u> |
| <u>PSE-SDC</u>                             | <u>05<sub>16</sub></u> | <u>0002<sub>16</sub></u> | <u>01<sub>16</sub></u> | <u>Latest PSE Shutdown Cause indication, detected during "Normal Operation". The octet is formatted as a bitmap, with a bit set to ONE if and only if the corresponding cause applies. The bits are defined as follows (bit 0 lsb to bit 7 msb):</u><br><u>bit 0: ELC-0 (Open tip-to-ring);</u><br><u>bit 1: ELC-1 (Short tip-to-ring);</u><br><u>bit 2: ELC-3 (Off-hook phone);</u><br><u>bit 3: Overload time violation (Note 1);</u><br><u>bit 4: Maintain power signature violation (Note 2);</u><br><u>bit 5: Unknown;</u><br><u>bit 6: Set to ZERO, reserved for use by the ITU-T;</u><br><u>bit 7: Set to ZERO, reserved for use by the ITU-T.</u><br><u>No more than 1 bit shall be set to ONE in the field.</u>                   |
| <u>PSE-IE</u>                              | <u>05<sub>16</sub></u> | <u>0003<sub>16</sub></u> | <u>02<sub>16</sub></u> | <u>Injected energy by the PSE at U-R2P reference point, while PSE is in the "Normal Operations" state, expressed in units of mWh and represented as a 16-bit unsigned integer. Valid values range from 0mWh to 65535 mWh. The value shall wrap on overflow. The accuracy is defined in [ETSI TS 101 548] (Note 3).</u>   |

**Table A.8 – RPF OAM parameters**

| Name   | Branch                 | Leaf                     | Width                  | Definition  |
|--|------------------------|--------------------------|------------------------|---|
| <b><i>Inventory</i></b>  |                        |                          |                        |   |
| NTE-CPF<br>(network termination equipment - common power feed)   | 06 <sub>16</sub>       | 0001 <sub>16</sub>       | 01 <sub>16</sub>       | 00 <sub>16</sub> : PSE in physical entity separate from NT (not integrated).<br>01 <sub>16</sub> : PSE in same physical entity with NT (integrated).<br>Other values are reserved for use by ITU-T. |
| PSE-PC<br>(power class)  | 06 <sub>16</sub>       | 0002 <sub>16</sub>       | 01 <sub>16</sub>       | 01 <sub>16</sub> : Actual PSE-PC is SR1.<br>02 <sub>16</sub> : Actual PSE-PC is SR2.<br>03 <sub>16</sub> : Actual PSE-PC is SR3.<br>Other values are reserved for use by ITU-T.                     |
| <u>PSE-PRP</u>   | <u>06<sub>16</sub></u> | <u>0002<sub>16</sub></u> | <u>01<sub>16</sub></u> | <u>00<sub>16</sub> : PRP not supported;</u><br><u>01<sub>16</sub> : PRP supported;</u><br><u>Other values are reserved for use by ITU-T.</u>  |
| NOTE 1 – Overload time is defined in Table 35 of [ETSI TS 101 548].  |                        |                          |                        |   |
| NOTE 2 – Maintain power signature is defined in Table 37 of [ETSI TS 101 548].                                       |                        |                          |                        |   |
| NOTE 3 – The parameter PSE-IE is read by the DPU periodically to construct current and previous 15 min DPU counters. |                        |                          |                        |   |

## A.7 DPU Northbound managed objects

The list of managed objects contains six types of information:

- 1) configuration objects (see Table A.9);
- 2) fault monitoring – failures (alarm indications) (see Table A.10);
- 3) fault monitoring – threshold crossing (alert messages);
- 4) performance monitoring objects (counters) (see Table A.11);
- 5) test, diagnostic and status objects (see Tables A.12 and A.13);
- 6) inventory objects (see Table A.14).

**Table A.9 – RPF configuration objects**

| Category/object   | Defined in clause: | DPU-NB interface |
|---|--------------------|------------------|
| <b><i>Per line near-end (DPU) configuration objects</i></b>       |                    |                  |
| Power extraction when PSE on battery (PE-PEB)                     | A.7.1.1.1          | R/W (M)          |
| Service when PSE shutdown (FTU-SRV)                               | A.7.1.1.2          | R/W (M)          |
| <u>Forced ReConfiguration state (DPU-FRCS)</u>                    | <u>A.7.1.1.3</u>   | <u>R/W (M)</u>   |
| <u>Conditional Forced ReConfiguration state (DPU-CFRCS)</u>       | <u>A.7.1.1.4</u>   | <u>R/W (M)</u>   |
| <u>Conditional Forced ReConfiguration state time (DPU-CFRCST)</u> | <u>A.7.1.1.5</u>   | <u>R/W (M)</u>   |
| <u>Power extraction (PE-PWR)</u>                                  | <u>A.7.1.1.6</u>   | <u>R/W (M)</u>   |
| <b><i>Per line far-end (PSE) configuration objects</i></b>        |                    |                  |
|   |                    |                  |
| <b><i>Common near-end (DPU) configuration objects</i></b>         |                    |                  |
|   |                    |                  |

**Table A.10 – RPF failures and alarms**

| Category/object   | Defined in clause: | DPU-NB interface |
|---|--------------------|------------------|
| <b><i>Per line near-end (DPU) failures and alarms</i></b> |                    |                  |
| Loss of power alarm – unknown reason (PE-UKN)             | A.7.2.1.1          | R (M)            |
| ReConfiguration State Change alarm (DPU-RCSC)             | <u>A.7.2.1.2</u>   | <u>R (M)</u>     |
| PRP Error Status alarm (DPU-PRP-ERROR)                    | <u>A.7.2.1.3</u>   | <u>R (M)</u>     |
| Line Error Status alarm (DPU-LES)                         | <u>A.7.2.1.4</u>   | <u>R (O)</u>     |
| <b><i>Per line far-end (PSE) failures and alarms</i></b>  |                    |                  |
| Loss of power alarm – off-hook phone (PSE-OHP)            | A.7.2.2.1          | R (M)            |
| Loss of power alarm – PSE lost input power (PSE-DLG)      | A.7.2.2.2          | R (M)            |
| <b><i>Common near-end (DPU) failures and alarms</i></b>   |                    |                  |
| Loss of power failure – fault condition (DPU-LLPF)        | A.7.2.3.1          | R (M)            |
| Loss of power failure – insufficient power (DPU-MLPF)     | A.7.2.3.2          | R (M)            |
| Loss of power alarm – normal shutdown (DPU-LLPS)          | A.7.2.3.3          | R (M)            |

**Table A.11 – RPF performance monitoring objects**

| Category/object   | Defined in clause: | DPU-NB interface |
|---|--------------------|------------------|
| <b><i>Per line near-end (DPU) performance monitoring counters (current/previous 15 min/24 h interval)</i></b> |                    |                  |
| Measured Time (CURR/PREV_NE/FE_15_L_TIME)   | <u>A.7.3.1</u>     | <u>R (O)</u>     |
| Invalid Data flag (PREV_NE/FE_15_L_INVALID)   | <u>A.7.3.2</u>     | <u>R (O)</u>     |
| Time Stamp (PREV_NE/FE_15_L_STAMP)  | <u>A.7.3.3</u>     | <u>R (O)</u>     |
| DPU Extracted Energy counter (CURR/PREV_NE_15_EE)   | <u>A.7.3.4</u>     | <u>R (O)</u>     |
| <b><i>Per line far-end (PSE) performance monitoring counters (current/previous 15 min/24 h interval)</i></b>  |                    |                  |
| Measured Time (CURR/PREV_NE/FE_15_L_TIME)   | <u>A.7.3.1</u>     | <u>R (O)</u>     |
| Invalid Data flag (PREV_NE/FE_15_L_INVALID)   | <u>A.7.3.2</u>     | <u>R (O)</u>     |
| Time Stamp (PREV_NE/FE_15_L_STAMP)  | <u>A.7.3.3</u>     | <u>R (O)</u>     |
| PSE Injected Energy counter (CURR/PREV_FE_15_IE)  | <u>A.7.3.5</u>     | <u>R (O)</u>     |
| <b><i>Common near-end (DPU) performance monitoring counters (current/previous 15 min/24 h interval)</i></b>   |                    |                  |
|   |                    |                  |

**Table A.12 – RPF status objects**

| Category/object                                      | Defined in clause: | DPU-NB interface |
|--|--------------------|------------------|
| <b><i>Per line near-end (DPU) status objects</i></b> |                    |                  |
| Actual power class (PE-PC)                           | A.7.4.1.1          | R (M)            |
| Reverse power feeding state (PE-RPF)                 | A.7.4.1.2          | R (M)            |
| ReConfiguration State (DPU-RCS)                      | <u>A.7.4.1.3</u>   | <u>R (M)</u>     |
| PRP Error Status (DPU-PRP-ERROR)                     | <u>A.7.4.1.4</u>   | <u>R (M)</u>     |
| Line Error Status (DPU-LES)                          | <u>A.7.4.1.5</u>   | <u>R (M)</u>     |

**Table A.12 – RPF status objects**

| Category/object                              | Defined in clause: | DPU-NB interface |
|--|--------------------|------------------|
| <i>Per line far-end (PSE) status objects</i> |                    |                  |
| Actual power class (PSE-PC)                  | A.7.4.2.1          | R (M)            |
| Reverse power feeding state (PSE-RPF)        | A.7.4.2.2          | R (M)            |
| <i>Common near-end (DPU) status objects</i>  |                    |                  |
|  |                    |                  |

**Table A.13 – RPF diagnostics objects**

| Category/object                                    | Defined in clause: | DPU-NB interface |
|--|--------------------|------------------|
| <i>Per line near-end (DPU) diagnostics objects</i> |                    |                  |
|  |                    |                  |
| <i>Per line far-end (PSE) diagnostics objects</i>  |                    |                  |
| <u>Latest PSE Start-Up Failure cause (PSE-SUF)</u> | <u>A.7.5.2.1</u>   | <u>R (M)</u>     |
| <u>Latest PSE ShutDown Cause (PSE-SDC)</u>         | <u>A.7.5.2.2</u>   | <u>R (M)</u>     |
| <i>Common near-end (DPU) diagnostics objects</i>   |                    |                  |
|  |                    |                  |

**Table A.14 – RPF inventory objects**

| Category/object                                  | Defined in clause: | DPU-NB interface |
|--|--------------------|------------------|
| <i>Per line near-end (DPU) inventory objects</i> |                    |                  |
| <u>ReConfiguration Capability (DPU-RC)</u>       | <u>A.7.6.1.1</u>   | <u>R (M)</u>     |
| <i>Per line far-end (PSE) inventory objects</i>  |                    |                  |
| Integrated into NTE (NTE-CPF)                    | A.7.6.2.1          | R (M)            |
| Battery backup available (PSE-BBA)               | A.7.6.2.2          | R (M)            |
| <u>PRP Capability (PSE-PRP)</u>                  | <u>A.7.6.2.3</u>   | <u>R (M)</u>     |
| <i>Common near-end (DPU) inventory objects</i>   |                    |                  |
|  |                    |                  |

## **A.7.1 RPF configuration objects**

### **A.7.1.1 Per line near-end (DPU) configuration objects**

#### **A.7.1.1.1 Power extraction when PSE is on battery (PE-PEB)**

**Description:** Defines whether for the line, the PE is allowed to extract power from the line when the PSE-RPF is operating on battery power (see clause A.7.4.2.2) and sufficient power is available from one or more remaining RPF lines for normal operation of the DPU.

**Type:** boolean.

**Valid values:** false [only minimal power extraction, compliant with the maintain power signature current (see clause 7.5.2.2 of [ETSI TS 101 548]), allowed], true (power extraction allowed).

**Default value:** false (only minimal power extraction, compliant with the maintain power signature current, allowed).

**Reference:** Section 8.1 (R-22) of [b-BBF TR-301], clause 7.5.2.2 of [ETSI TS 101 548].

#### **A.7.1.1.2 Service when PSE shuts down (FTU-SRV)**

**Description:** Defines for the line, the FTU/L2+ action when the PSE is in shutdown (PSE-RPF, see clause A.7.4.2.2). Values NL0, ESO, and SRV are conditional on there being sufficient power from one or more remaining RPF lines available for normal operation of the DPU. If this condition is not met, value FL3 is applied instead.

**Type:** Enumeration.

Valid values: 0..3.

- 0 FL3: Force the line to the L3 link state (no service).
- 1 NL0: Force the line to an enabled low power link state (limited service).
- 2 ESO: Force the line to support emergency services only (all link states allowed).
- 3 SRV: No service limitations forced on the line (all link states allowed).

**Default value:** 0 (FL3 – no service).

**Reference:** Section 8.1 (R-26) of [b-BBF TR-301].

#### **A.7.1.1.3 Forced ReConfiguration state (DPU-FRCS)**

**Description:** Defines for the line, the Forced ReConfiguration state: either None, Normal or Bypass.

**Type:** Enumeration.

**Valid values:** 0..2.

- 0 None: No Forced ReConfiguration State. The DPU-FRCS configuration object has no effect on the line's ReConfiguration State.
- 1 Normal: The line is forced to enter and maintain Normal mode.
- 2 Bypass: The line is forced to enter and maintain Bypass mode. This command is ignored for a given line if this line is solely reverse powering the DPU or attempting to start-up the DPU.

**Default value:** 0 (None).

**Reference** Clauses 5.8 and 7.4 of [ETSI TS 101 548].

#### **A.7.1.1.4 Conditional Forced ReConfiguration State (DPU-CFRCS)**

**Description:** Defines for the line, the Conditional Forced ReConfiguration State, to be applied upon either enforcing no service on the line (i.e., FTU-SRV value FL3 is applied, see clause A.7.1.1.2) for a time period T (DPU-CFRCS-T, see clause A.7.1.1.5) or upon DPU shutdown.

**Type:** Enumeration.

**Valid values:** 0..1.

- 0 None: No Conditional Forced ReConfiguration State. The line maintains its current ReConfiguration State (see clause A.7.4.1.3).
- 1 Bypass: The line's ReConfiguration State is forced to Bypass mode.

**Default value:** 0 (None).

**Reference** Clauses 5.8 and 7.4 of [ETSI TS 101 548].

#### **A.7.1.1.5 Conditional Forced ReConfiguration State Time (DPU-CFRCST)**

**Description:** Defines the time period T to be used with configuration object DPU-CFRCS (see clause A.7.1.1.4).

**Type:** 8-bit unsigned integer.

Units: 1 second.

Valid values: 0..255.

Default value: 30 (30 seconds).

Reference Clause 5.8 of [ETSI TS 101 548].

#### **A.7.1.1.6 Power extraction (PE-PWR)**

Description: Defines whether or not power extraction from the line is allowed.

Type: Enumeration.

Valid values: 0..1.

0 Allowed: The PE may extract power from this line.

1 Not allowed: The PE should not extract more than 35 mA at U-O interface (excluding start-up transients) unless the given line is solely reverse powering the DPU or attempting to start-up the DPU.

Default value: 0 (Allowed).

Reference Clause 5.8 of [ETSI TS 101 548].

#### **A.7.1.2 Per line far-end (PSE) configuration objects**

No per-line far-end (PSE) configuration objects are defined.

#### **A.7.1.3 Common near-end (DPU) configuration objects**

No common near-end (DPU) configuration objects are defined.

### **A.7.2 RPF failures and alarms**

#### **A.7.2.1 Per line near-end (DPU) failures and alarms**

##### **A.7.2.1.1 Loss of power alarm – unknown reason (PE-UKN)**

If the PMA has enabled the PE-UKN alarm notification, the DPU shall autonomously send a PE-UKN alarm to the PMA when the PSE-RPF state (see clause A.7.4.2.2) becomes PSE-UKN.

##### **A.7.2.1.2 Reconfiguration State Change alarm (DPU-RCSC)**

If the PMA has enabled the DPU-RCSC alarm notification, the DPU shall autonomously send a Reconfiguration State Change (DPU-RCSC) alarm upon a state change of the line's Reconfiguration State (DPU-RCS, see clause A.7.4.1.3).

##### **A.7.2.1.3 PRP Error Status alarm (DPU-PRP-ERROR)**

If the PMA has enabled the DPU-PRP-ERROR alarm notification, the DPU shall autonomously send a PRP Error Status (DPU-PRP-ERROR) alarm upon the PRP Error Status (DPU-PRP-ERROR, see clause A.7.4.1.4) indicating an error condition on the line.

##### **A.7.2.1.4 Line Error Status alarm (DPU-LES)**

If the PMA has enabled the DPU-LES alarm notification and the DPU supports the Line Error Status object, the DPU shall autonomously send a Line Error Status (DPU-LES) alarm upon the Line Error Status (DPU-LES, see clause A.7.4.1.5) indicating an error condition on the line.

#### **A.7.2.2 Per line far-end (PSE) failures and alarms**

##### **A.7.2.2.1 Loss of power alarm – off-hook phone (PSE-OHP)**

If the PMA has enabled the PSE-OHP alarm notification, the DPU shall autonomously send a PSE-OHP alarm to the PMA when the PSE-RPF state (see clause A.7.4.2.2) becomes PSE-OHP.



#### **A.7.2.2.2 Loss of power alarm – PSE lost input power (PSE-DGL)**

If the PMA has enabled the PSE-DGL alarm notification, the DPU shall autonomously send a PSE-DGL alarm to the PMA when the PSE-RPF state (see clause A.7.4.2.2) becomes PSE-DGL.

#### **A.7.2.3 Common near-end (DPU) failures and alarms**

##### **A.7.2.3.1 Last reverse power feeding line loss of power failure (LLPF) – fault condition (DPU-LLPF)**

A DPU-LLPF failure is declared for the DPU when the DPU is about to shut down because the last RPF line has ceased providing power due to one of the following fault conditions:

- the PSE-RPF state (see clause A.7.4.2.2) becomes PSE-UKN;
- the PSE-RPF state (see clause A.7.4.2.2) becomes PSE-OHP.

If the PMA has enabled DPU-LLPF failure notification, the DPU shall autonomously indicate to the PMA when a DPU-LLPF failure is declared, thereby identifying the last RPF line that has ceased providing power and indicating for that line the PSE-RPF state (see clause A.7.4.2.2).

##### **A.7.2.3.2 Loss of power failure – insufficient power (DPU-MLPF)**

A DPU-MLPF failure is declared for the DPU when the DPU is about to shut down because one or more RPF lines have ceased providing power, each due to one of the following (fault) conditions:

- the PSE-RPF state (see clause A.7.4.2.2) becomes PSE-UKN;
- the PSE-RPF state (see clause A.7.4.2.2) becomes PSE-OHP.
- the PSE-RPF state (see clause A.7.4.2.2) becomes PSE-DGL,

If the PMA has enabled DPU-MLPF failure notification, the DPU shall autonomously indicate to the PMA when a DPU-MLPF failure is declared, thereby identifying the one or more RPF lines that have ceased providing power and indicating for those lines the PSE-RPF state (see clause A.7.4.2.2).

##### **A.7.2.3.3 Loss of power alarm – normal shutdown (DPU-LLPS)**

If the PMA has enabled the DPU-LLPS alarm notification, the DPU shall autonomously send a DPU-LLPS alarm to the PMA when the last RPF line has ceased providing power due to the following condition:

- the PSE-RPF state (see clause A.7.4.2.2) becomes PSE-DGL,

thereby identifying the last RPF line that has ceased providing power.

#### **A.7.3 RPF performance monitoring objects**

~~No RPF performance monitoring objects are defined.~~

##### **A.7.3.1 Measured Time (CURR/PREV\_NE/FE\_15\_L\_TIME)**

See clause 7.7.1.

##### **A.7.3.2 Invalid Data flag (PREV\_NE/FE\_15\_L\_INVALID)**

See clause 7.7.2.

##### **A.7.3.3 Time Stamp (PREV\_NE/FE\_15\_L\_STAMP)**

See clause 7.7.3.

##### **A.7.3.4 DPU Extracted Energy counter (CURR/PREV\_NE\_15\_EE)**

**Description:** Reports a count of the DPU extracted energy per line at U-O interface or at PSU input in current/previous 15 min interval, expressed in units of mWh. This PM object is optional. The accuracy is defined in [ETSI TS 101 548].



Type: 32-bit unsigned integer.

Valid values: 0...4294967295 (counter of mWh units).

Reference: None.

NOTE – The PMA can calculate the average extracted power over current 15 minute interval by the DPU at the U-O interface or at the PSU input by reading out the current 15 minute value and dividing it by the measured time in the current 15 minute interval.

#### **A.7.3.5 PSE Injected Energy counter (CURR/PREV FE 15 IE)**

**Description:** Reports a count of the PSE injected energy per line in current/previous 15 min interval, expressed in units of mWh. This PM object is optional. It is constructed by the DPU by reading the RPF OAM parameter PSE-IE (see clause A.6.2.5). It can only be supported in case the PSE is integrated in the NT (see clause A.7.6.2.1, PSE-NTE equals 1). The accuracy is defined in [ETSI TS 101 548].

Type: 32-bit unsigned integer.

Valid values: 0...4294967295 (counter of mWh units).

Reference: Clause 6.4 of [ETSI TS 101 548] and clause A.6.2.5.

NOTE – The PMA can calculate the average extracted power over current 15 minute interval by the DPU at the U-O interface or at the PSU input by reading out the current 15 minute value and dividing it by the measured time in the current 15 minute interval.

### **A.7.4 RPF status objects**

#### **A.7.4.1 Per line near-end (DPU) status objects**

##### **A.7.4.1.1 Actual power class (PE-PC)**

**Description:** Reports the actual PC of the PE for the line.

**Type:** Enumeration.

**Valid values:** 1 (SR1), 2 (SR2), and 3 (SR3).

**Reference:** Clause 7.2 of [ETSI TS 101 548].

##### **A.7.4.1.2 Reverse power feeding state (PE-RPF)**

**Description:** Reports the RPF state of the PE for the line.

**Type:** enumeration.

**Valid values:** 0 (not operational), 1 (in START-UP MODE) and 2 (in NORMAL OPERATIONS).

**Reference:** Clause 6.2.4 of [ETSI TS 101 548].

##### **A.7.4.1.3 ReConfiguration state (DPU-RCS)**

**Description:** Reports the ReConfiguration State for the line. A state change alarm shall be raised indicating a change of the line's Reconfiguration State (see clause A.7.2.1.2).

**Type:** Enumeration.

**Valid values:** 0 (Normal mode), 1 (Bypass mode).

**Reference:** Clause [A.3.1](#)

##### **A.7.4.1.4 PRP Error Status (DPU-PRP-ERROR)**

**Description:** Reports that the DPU has deduced a PRP related ERROR while the DPU **is** powered on. An alarm shall be raised upon the PRP Error Status indicating an error condition on the line.

**Type:** Enumeration

**Valid values:** 0..2

- |   |  |
|---|--|
| 0 | None: no error detected by DPU or PRP completed successfully.  |
| 1 | RPF Class Miss Match: DPU has decoded PRP disconnect trigger of a class that is not supported by the DPU for the given line. |
| 2 | POTS Reconnect trigger: POTS Reconnect trigger detected by DPU.  |

**Reference:** Clause 6.2.5 of [ETSI TS 101 548].

#### **A.7.4.1.5 Line error status (DPU-LES)**

**Description:** Reports an error condition for the line whereby the DPU is unable to draw continuous and sufficient power from the line. This status object is optional. If supported, an alarm shall be raised upon the Line Error Status indicating an error condition on the line.

**Type:** Enumeration.

**Valid values:** 0 (No error), 1 (Error).

**Reference:** None.

### **A.7.4.2 Per line far-end (PSE) status objects**

#### **A.7.4.2.1 Actual power class (PSE-PC)**

**Description:** Reports the actual PC of the PSE. Before the start-up protocol is successfully completed for the first time, the PC is undetermined.

**Type:** Enumeration.

**Valid values:** 0 (undetermined), 1 (SR1), 2 (SR2), and 3 (SR3).

**Reference:** Clause 7.2 of [ETSI TS 101 548].

#### **A.7.4.2.2 Reverse power feeding state (PSE-RPF)**

**Description:** Reports the RPF state of the PSE.

**Type:** enumeration.

**Valid values:** 0...5.

- |   |   |
|---|---|
| 0 | PSE-UKN: Shutdown for unknown reason <ul style="list-style-type: none"><li>– as initial state;</li><li>– when for the line the PE transitions to START-UP MODE after the PE detects loss of voltage, and has not received a PSE-DGL or PSE-OHP indication ( see clause A.6.2.1.1) from the PSE.</li></ul> |
| 1 | PSE-DGL: Shutdown with dying gasp (normal shutdown) <ul style="list-style-type: none"><li>– when for the line the PE transitions to START-UP MODE after the PE detects loss of voltage and has received a PSE-DGL indication (see clause A.6.2.1.1) from the PSE.</li></ul>                               |
| 2 | PSE-OHP: Shutdown with dying gasp with OHP <ul style="list-style-type: none"><li>– when for the line the PE transitions to START-UP MODE after the PE detects loss of voltage and has received a PSE-OHP indication (see clause A.6.2.1.1) from the PSE.</li></ul>  |
| 3 | PSE-PWR: Powered with unknown PSE powering method <ul style="list-style-type: none"><li>– when for the line the PE transitions to NORMAL OPERATIONS and it is yet unknown whether the PSE is battery or mains powered.</li></ul>  |

- 4      PSE-BAT: Battery powered
- when for the line the PE transitions to NORMAL OPERATIONS and the PE receives an indication that the PSE is trying to start up the DPU while powered on battery {plain old telephony service remote copper reconfiguration protocol power splitter (PRP PS) field, see clause 6.2.5.1 of [ETSI TS 101 548]};
  - when for the line the PE is in NORMAL OPERATIONS and the PE receives a PSE-BAT indication (see clause 6.2.2) from the PSE.
- 5      PSE-ACM: Mains powered
- when for the line the PE transitions to NORMAL OPERATIONS and the PE receives an indication that the PSE was trying to start up the DPU while powered on mains (PRP PS field, see clause 6.2.5.1 of [ETSI TS 101 548]);
  - when for the line the PE is in NORMAL OPERATIONS and the PE receives a PSE-ACM or PSE-BBA indication (see clause A.6.2.1.1) from the PSE.

**Reference:** Clauses 6.2.4, 6.2.5.1 and 6.3 of [ETSI TS 101 548] and clause A.6.2.1.1.

#### **A.7.4.3 Common near-end (DPU) status objects**

No common near-end (DPU) status objects are defined.

#### **A.7.5 RPF diagnostics objects**

~~No RPF diagnostics objects are defined.~~

##### **A.7.5.1 Per line near-end (DPU) diagnostics objects**

No per line near-end diagnostics objects are defined.

##### **A.7.5.2 Per line far-end (PSE) diagnostics objects**

###### **A.7.5.2.1 Latest PSE Start-Up Failure cause (PSE-SUF)**

**Description:** Reports the latest PSE Start-Up Failure indication, detected during "Start-Up".

**Type:** Enumeration.

**Valid values:** 0..7.

- 0      No failure;
- 1      ELC-0 (Open tip-to-ring);
- 2      ELC-1 (Short tip-to-ring);
- 3      ELC-2 (POTS Exchange (foreign) DC voltage)
- 4      ELC-3 (Off-hook phone) (Note);
- 5      Mismatch of the PSE RPF Class with the DPU RPF Class;
- 6      Unknown.
- 7      Failure other than off-hook (Note).

**Reference:** Clause 6.1.1 of [ETSI TS 101 548] and clause A.6.2.5.

NOTE – In case the PSE is not integrated in the NT and with POTS RCR (PRP) capability supported (i.e., NT-CPF equals 2 and PSE-PRP equals 2), this indication is deduced by the DPU from the "Last Start Up" (LSU) state 101<sub>2</sub> (see Table 20 of [ETSI TS 101 548]).

###### **A.7.5.2.2 Latest PSE ShutDown cause (PSE-SDC)**

**Description:** Reports the latest PSE ShutDown cause, detected during "Normal Operation".

**Type:** Enumeration.

**Valid values:** 0..6.

0 No PSE Shutdown yet;

1 ELC-0 (Open tip-to-ring);

2 ELC-1 (Short tip-to-ring);

3 ELC-3 (Off-hook phone);

4 Overload time violation as defined in Table 35 of [ETSI TS 101 548];

5 Maintain power signature violation as defined in Table 37 of [ETSI TS 101 548];

6 Unknown.

**Reference:** Clause 6.1.1 of [ETSI TS 101 548] and clause A.6.2.5.

### **A.7.5.3 Common near-end (DPU) diagnostics objects**

No common near-end (DPU) diagnostics objects are defined.

## **A.7.6 RPF inventory objects**

### **A.7.6.1 Per line near-end (DPU) inventory objects**

~~No per line near-end (DPU) inventory objects are defined.~~

#### **A.7.6.1.1 Reconfiguration capability (DPU-RC)**

**Description:** Reports the ReConfiguration capability for the line.

**Type:** Enumeration.

**Valid values:** 0 (None), 1 (Broadband Bypass), 2 (POTS RCR).

**Reference:** Clause 3.1 of [ETSI TS 101 548].

### **A.7.6.2 Per line far-end (PSE) inventory objects**

#### **A.7.6.2.1 Integrated into NT (NTE-CPF)**

**Description:** Reports whether the PSE is integrated into the NT, based on the RPF OAM parameter NTE-CPF (see clause A.6.2.5). Until the DPU ME receives an NTE-CPF indication for the first time, it is unknown whether the PSE is integrated into the NT.

**Type:** Enumeration.

**Valid values:** 0 (unknown), 1 (PSE not integrated into NT), 2 (PSE integrated into NT).

**Reference:** Clause A.6.2.5.

#### **A.7.6.2.2 Battery backup available (PSE-BBA)**

**Description:** Reports whether battery backup is available at the PSE, based on the PSE trying to start up the PE while powered on battery (PRP PS field, see clause 6.2.5.1 of [ETSI TS 101 548]) and on the PSE-BAT, PSE-ACM, and PSE-BBA indications (see clause 6.3 of [ETSI TS 101 548] and clause A.6.2.1.1). Until the PE receives the PRP PS field for the first time and until the PE or DPU ME receive a BAT, ACM, or BBA indication for the first time (whichever occurs first), it is unknown whether battery backup is available at the PSE.

**Type:** Enumeration.

**Valid values:** 0 (unknown), 1 (battery backup not available), 2 (BBA).

**Reference:** Clause 6.3 of [ETSI TS 101 548] and clause A.6.2.1.1.

#### **A.7.6.2.3 PRP capability (PSE-PRP)**

**Description:** Reports the PSE PRP capability. In case the PSE is integrated in the NT (i.e., NT-CPF equals 2), the PSE-PRP capability is communicated through RPF OAM from PSE to DPU (see clause A.6.2.5). In case the PSE is not integrated in the NT (i.e., NT-CPF equals 2), it is deduced by the DPU from successful PRP start-up, whereby the DPU shall assume that the PRP disconnect trigger is sent by the PSE that is currently providing reverse power to the DPU. Until the PE receives the PRP PS field (see clause A.6.2.5) for the first time, or until the first successful PRP start-up, the PSE PRP capability is unknown.

**Type:** Enumeration.

**Valid values:** 0 (unknown), 1 (PRP not supported), 2 (PRP supported).

**Reference:** Clause 6.2.5 of [ETSI TS 101 548] and clause A.6.2.5.

#### **A.7.6.3 Common near-end (DPU) inventory objects**

No common near-end (DPU) inventory objects are defined.

## **Annex B to Annex R**

Annexes B to R have been intentionally left blank.

## **Annex S**

### **Management for network termination (NT) software upgrade process**

(This annex forms an integral part of this Recommendation.)

*Editorial note: This annex was introduced by Amd.3 to ITU-T G.997.2, but is not shown in revision marks for readability purposes.*

#### **S.1 Scope**

This annex specifies the management of the NT software upgrade process defined in Annex S of [ITU-T G.9701]. Two images (0 and 1) are maintained by the software management function, so that one can be upgraded while the other is executing. These two images are managed separately using the managed objects defined in clause S.7.

#### **S.2 References**

This annex does not contain any additional references.

#### **S.3 Definitions**

This annex does not contain any additional definitions.

#### **S.4 Abbreviations and acronyms**

This annex does not contain any additional abbreviations and acronyms.

#### **S.5 DPU management architecture**

This annex does not modify the DPU management architecture defined in clause 5.

#### **S.6 Network management protocol**

This annex makes no presumption about which management protocol is used between the PMA and the DPU for transport of G.fast-managed objects.

#### **S.7 Managed objects**

The list of managed objects contains two types of information:

- 1) software image attributes;
- 2) software image configuration.

At the DPU-NB interface, the NT software upgrade process is managed through the information given in Table S.1.

When the software attribute update request flag for a software image (see clause S.7.1.1.7) is set (its value is changed from false to true), the attributes of the corresponding software image shall be updated in the DPU-MIB within 10 s. The update request flag shall be reset (its value changed back to false) by the DPU immediately after the request parameter update is complete.

Similarly, to request an action (activate, commit, or download) for an NT software image (0 or 1), the corresponding request flag (NT\_SW\_ACTIVATE0/1, NT\_SW\_COMMIT0/1, NT\_SW\_DOWNLOAD0/1) shall be set. The corresponding request flag shall be reset (its value changed back to false) by the DPU immediately after the requested action is complete and the result of the action is available in the DPU-MIB (NT\_SW\_ACTIVATE\_RES0/1, NT\_SW\_COMMIT\_RES0/1, NT\_SW\_DOWNLOAD\_RES0/1).

Table S.1 indicates the status of each managed object over the DPU-NB interface:

- R: Read only
- W: Write only
- R/W: Read and write
- (M): Mandatory
- (O): Optional

Entries in Table S.1 labelled with names containing the separator "/" represent multiple objects whose names are obtained by considering all combinations of the elements isolated with the separator. For example, the entry labelled with the name A0/1 represents two objects, for the two managed software images (0 and 1), with names A0 and A1.

**Table S.1 – NT software management objects**

| Category/object                     | Defined in clause | DPU-NB interface |
|-------------------------------------|-------------------|------------------|
| <i>Software image attributes</i>    |                   |                  |
| NT_SW_VERSION0/1                    | S.7.1.1.1         | R (M)            |
| NT_SW_COMMITTED0/1                  | S.7.1.1.2         | R (M)            |
| NT_SW_ACTIVE0/1                     | S.7.1.1.3         | R (M)            |
| NT_SW_VALID0/1                      | S.7.1.1.4         | R (M)            |
| NT_SW_PRODUCTCODE0/1                | S.7.1.1.5         | R (O)            |
| NT_SW_HASH0/1                       | S.7.1.1.6         | R (O)            |
| UPDATE_NT_SW_ATTR0/1                | S.7.1.1.7         | R/W (M)          |
| <i>Software image configuration</i> |                   |                  |
| NT_SW_ACTIVATE_COND0/1              | S.7.1.2.1         | R/W (O)          |
| NT_SW_ACTIVATE0/1                   | S.7.1.2.2         | R/W (M)          |
| NT_SW_ACTIVATE_RES0/1               | S.7.1.2.3         | R (M)            |
| NT_SW_COMMIT0/1                     | S.7.1.2.4         | R/W (M)          |
| NT_SW_COMMIT_RES0/1                 | S.7.1.2.5         | R (M)            |
| NT_SW_IMAGEFILE0/1                  | S.7.1.2.6         | R/W (M)          |
| NT_SW_DOWNLOAD0/1                   | S.7.1.2.7         | R/W (M)          |
| NT_SW_DOWNLOAD_RES0/1               | S.7.1.2.8         | R (M)            |

## **S.7.1 NT software management objects**

### **S.7.1.1 Software image attributes**

#### **S.7.1.1.1 Software image version (NT\_SW\_VERSION0/1)**

**Description:** Reports the version of the software image (see clause S.4.1 of [ITU-T G.9701]).

**Type:** string (14 binary octets).

**Reference:** Clause S.4.1 of [ITU-T G.9701].

#### **S.7.1.1.2 Software image committed (NT\_SW\_COMMITTED0/1)**

**Description:** Reports whether the associated software image is committed or uncommitted (see clause S.4.1 of [ITU-T G.9701]).

**Type:** boolean.



**Valid values:** false (uncommitted) and true (committed).

**Reference:** Clause S.4.1 of [ITU-T G.9701].

#### **S.7.1.1.3 Software image active (NT\_SW\_ACTIVE0/1)**

**Description:** Reports whether the associated software image is active or inactive (see clause S.4.1 of [ITU-T G.9701]).

**Type:** boolean.

**Valid values:** false (inactive) and true (active).

**Reference:** Clause S.4.1 of [ITU-T G.9701].

#### **S.7.1.1.4 Software image valid (NT\_SW\_VALID0/1)**

**Description:** Reports whether the associated software image is valid or invalid (see clause S.4.1 of [ITU-T G.9701]).

**Type:** boolean.

**Valid values:** false (invalid) and true (valid).

**Reference:** Clause S.4.1 of [ITU-T G.9701].

#### **S.7.1.1.5 Software product code (NT\_SW\_PRODUCTCODE0/1)**

**Description:** Reports the product code information of the software image (see clause S.4.1 of [ITU-T G.9701]).

**Type:** string (25 binary octets).

**Reference:** Clause S.4.1 of [ITU-T G.9701].

#### **S.7.1.1.6 Software image hash (NT\_SW\_HASH0/1)**

**Description:** Reports the MD5 hash of the software image (see clause S.4.1 of [ITU-T G.9701]).

**Type:** string (16 binary octets).

**Reference:** Clause S.4.1 of [ITU-T G.9701].

#### **S.7.1.1.7 Update request flag for software image attributes (UPDATE\_NT\_SW\_ATTR0/1)**

**Description:** Forces an update of the software image attributes, defined in clauses S.7.1.1.1 to S.7.1.1.6, of the corresponding software image to 0 or 1. See introductory text to clause S.7.

**Type:** boolean.

**Valid values:** false (no update forced) or true (update forced).

**Default value:** false (no update forced).

### **S.7.1.2 Software image configuration**

#### **S.7.1.2.1 Activate software conditions (NT\_SW\_ACTIVATE\_COND0/1)**

**Description:** Specifies the conditions under which the activation request for a software image shall be executed (see clauses S.7.1.2.2 and S.5.9 of [ITU-T G.9701]).

**Type:** enumeration.

**Valid values:** 0...2.

0      Activate image unconditionally.

1      Activate image only if no plain old telephony service/voice over Internet protocol (POTS/VoIP) calls are in progress.

2        Activate image only if no emergency call is in progress.

**Default value:** 0 (activate image unconditionally).

**Reference:** Clause S.5.9 of [ITU-T G.9701].

#### **S.7.1.2.2 Request activate software flag (NT\_SW\_ACTIVATE0/1)**

**Description:** Activate the downloaded software image (see clause S.5.9 of [ITU-T G.9701]). The flag shall be reset after the requested action is complete (see introductory text to clause S.7).

**Type:** boolean.

**Valid values:** false (no action) and true (activate software image).

**Default value:** false (no action).

**Reference:** Clause S.5.9 of [ITU-T G.9701].

#### **S.7.1.2.3 Result of activate software (NT\_SW\_ACTIVATE\_RES0/1)**

**Description:** Reports the results from the most recent activate software image action (see clause S.5.10 of [ITU-T G.9701] and the introductory text to clause S.7).

**Type:** enumeration.

**Valid values:** 0...6, and 256.

- 0        Command processed successfully.
- 1        Command processing error.
- 2        Command not supported.
- 3        Parameter error.
- 4        Reserved for use by ITU-T.
- 5        Unknown managed software image instance.
- 6        Device busy.
- 256     No result available.

**Reference:** Clause S.5.10 of [ITU-T G.9701].

#### **S.7.1.2.4 Request commit software flag (NT\_SW\_COMMIT0/1)**

**Description:** Commit the downloaded software image (see clause S.5.11 of [ITU-T G.9701]). The flag shall be reset after the requested action is complete (see introductory text to clause S.7).

**Type:** boolean.

**Valid values:** false (no action) and true (commit software image).

**Default value:** false (no action).

**Reference:** Clause S.5.11 of [ITU-T G.9701].

#### **S.7.1.2.5 Result of commit software (NT\_SW\_COMMIT\_RES0/1)**

**Description:** Reports the results from the most recent commit software image action (see clause S.5.12 of [ITU-T G.9701] and the introductory text to clause S.7).

**Type:** enumeration.

**Valid values:** 0...6, 256.

- 0        Command processed successfully.
- 1        Command processing error.
- 2        Command not supported.

- 3        Parameter error.
- 4        Reserved for use by ITU-T.
- 5        Unknown managed software image instance.
- 6        Device busy.
- 256     No result available.

**Reference:** Clause S.5.12 of [ITU-T G.9701].

#### **S.7.1.2.6 Location of software image file (NT\_SW\_IMAGEFILE0/1)**

**Description:** Defines the location of the software image file as Uniform Resource Identifier according to [IETF RFC 3986]. When a request software image download is initiated (see clause S.7.1.2.7), the image software image file is transferred from to the NT from the specified location.

**Type:** string (up to 256 ASCII characters).

#### **S.7.1.2.7 Request software image download (NT\_SW\_DOWNLOAD0/1)**

**Description:** Start the download of the software image file to the NT (see clause S.5.3 of [ITU-T G.9701]). The flag shall be reset after the requested action is complete (see introductory text to clause S.7).

**Type:** boolean.

**Valid values:** false (no action) and true (start download software image).

**Default value:** false (no action).

**Reference:** Clause S.5.3 of [ITU-T G.9701].

#### **S.7.1.2.8 Result of software image download (NT\_SW\_DOWNLOAD\_RES0/1)**

**Description:** Reports the results from the most recent software image download action (see clause S.5.8 of [ITU-T G.9701] and the introductory text to clause S.7).

**Type:** enumeration.

**Valid values:** 0...6, 256, 257.

- 0        Command processed successfully (CRC correct).
- 1        Command processing error (CRC incorrect, in addition to the normal criteria).
- 2        Command not supported.
- 3        Parameter error.
- 4        Reserved for use by ITU-T.
- 5        Unknown managed software image instance.
- 6        Device busy.
- 256     No result available.
- 257     Software image file could not be accessed at the specified location.

**Reference:** Clause S.5.8 of [ITU-T G.9701].

## Annex T

### Annex X and Annex T of ITU-T G.9701 – Managed objects

(This annex forms an integral part of this Recommendation.)

#### T.1 Overview of Annex X and Annex T of ITU-T G.9701 managed objects

Tables T.1, T.2 and T.3 give an overview of the managed objects used to manage the Annex X of [ITU-T G.9701] and the DTA cross-layer aspects specified in Annex T of [ITU-T G.9701]. Tables T.1, T.2 and T.3 use the same convention as that used in the tables of the managed object of clause 7. Support of Annex T is optional.

**Table T.1 – Annex X and Annex T of ITU-T G.9701 control objects**

| Category/object                                       | Defined in clause: | DPU-NB  |
|---|--------------------|---------|
| <i>DTA and Annex X management</i>                     |                    |         |
| Annex X operation mode (ANNEX_X_MODE)                 | T.2.1.1            | R/W (M) |
| DTA allowed (DTA_ALLOWED)                             | T.2.1.2            | R/W (M) |
| <i>DRA control</i>                                    |                    |         |
| Preferred Mds for DTA (DTA_PREF_Mds)                  | T.2.2.1            | R/W (M) |
| Maximum step size for DTA changes (DTA_SMAX)          | T.2.2.2            | R/W (M) |
| Minimum Mds for DTA (DTA_MIN_Mds)                     | T.2.2.3            | R/W (M) |
| Maximum Mds for DTA (DTA_MAX_Mds)                     | T.2.2.4            | R/W (M) |
| Minimum expected throughput for DTA (DTA_MINETRds/us) | T.2.2.5            | R/W (M) |
| Maximum net data rate for DTA (DTA_MAXNDRds/us)       | T.2.2.6            | R/W (M) |

**Table T.2 – Annex X and Annex T of ITU-T G.9701 status objects**

| Category/Object                             | Defined in clause: | DPU-NB |
|---|--------------------|--------|
| Annex X operation enabled (ANNEX_X_ENABLED) | T.3.1              | R(M)   |
| DTA enabled (DTA_ENABLED)                   | T.3.2              | R(M)   |

**Table T.3 – Annex X and Annex T of ITU-T G.9701 inventory objects**

| Category/Object                               | Defined in clause: | DPU-NB |
|---|--------------------|--------|
| FTU-O Annex X support (ANNEX_X_SUPPORT_FTU_O) | T.4.1              | R(M)   |
| FTU-R Annex X support (ANNEX_X_SUPPORT_FTU_R) | T.4.2              | R(M)   |
| FTU-O DTA support (DTA_SUPPORT_FTU_O)         | T.4.3              | R(M)   |

## **T.2 Annex X and Annex T of [ITU-T G.9701] control objects**

### **T.2.1 DTA and Annex X management**

#### **T.2.1.1 Annex X operation mode (ANNEX\_X\_MODE)**

**Description:** Determines whether Annex X operation of [ITU-T G.9701] is enabled.

**Type:** enumeration.

**Valid values:** 0, 1, 2.

0 AnnexX\_FORBIDDEN (Operation according to Annex X is not allowed).

1 AnnexX\_PREFERRED (Operation according to Annex X is preferred).

2 AnnexX\_FORCED (Operation according to Annex is forced).

**Default value:** 0 (AnnexX\_FORBIDDEN).

**Reference:** Clauses X.6.7.1 and T.2.1 of [ITU-T G.9701].

#### **T.2.1.2 DTA allowed (DTA\_ALLOWED)**

**Description:** Determines whether DTA is allowed.

**Type:** boolean.

**Valid values:** false (disallowed), true (allowed).

**Default value:** false (disallowed).

**Reference:** Clauses X.6.7.2 and T.2.2 of [ITU-T G.9701].

### **T.2.2 DRA control**

#### **T.2.2.1 Preferred Mds for DTA (DTA\_PREF\_Mds)**

**Description:** Provides the number of downstream symbol positions in a TDD frame requested by the DRA at the first opportunity upon entering showtime of a line on which DTA operation is enabled.

**Type:** 8-bit unsigned integer.

**Valid values:** 5...30 (if MF=36) and 5...17 (if MF=23).

**Default value:** 28.

NOTE – If MF=23, a value different from the default value needs to be configured (see 7.1).

**Reference:** Clause T.2.3 of [ITU-T G.9701].

#### **T.2.2.2 Maximum step size for DTA changes (DTA\_SMAX)**

**Description:** Defines the maximum step size for Mds requested by the DRA for a single DTA update.

**Type:** 8-bit unsigned integer.

**Valid values:** 1...25 (if MF=36) and 1...12 (if MF=23).

NOTE – If MF=23, a value different from the default value needs to be configured (see 7.1).

**Default value:** 25.

**Reference:** Clause T.2.4 of [ITU-T G.9701].

#### **T.2.2.3 Minimum Mds for DTA (DTA\_MIN\_Mds)**

**Description:** Provides the minimum number of downstream symbol positions Mds in a TDD frame that shall be requested by the DRA.

**Type:** 8-bit unsigned integer.

**Valid values:** 5...30 (if MF=36) and 5...17 (if MF=23).

**Default value:** 5.

**Reference:** Clause T.2.5 of [ITU-T G.9701].

#### **T.2.2.4 Maximum Mds for DTA (DTA\_MAX\_Mds)**

**Description:** Provides the maximum number of downstream symbol positions Mds in a TDD frame that shall be requested by the DRA.

**Type:** 8-bit unsigned integer.

**Valid values:** 5...30 (if MF=36) and 5...17 (if MF=23).

**Default value:** 30.

NOTE – If MF=23, a value different from the default value needs to be configured (see 7.1).

**Reference:** Clauses X.6.7.4 and T.2.6 of [ITU-T G.9701].

#### **T.2.2.5 Minimum expected throughput for DTA (DTA\_MINETRds/us)**

**Description:** Defines the value of the minimum expected throughput for DTA operation to constrain the dynamic range of Mds requested by the DRA.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967295 (0 to  $2^{32}-1$  kbit/s).

**Default value:** 0 (0 bit/s).

**Reference:** Clause T.2.7 of [ITU-T G.9701].

#### **T.2.2.6 Maximum net data rate for DTA (DTA\_MAXNDRds/us)**

**Description:** Defines the value of the maximum NDR for DTA operation.

**Type:** 32-bit unsigned integer.

**Unit:** 1000 bit/second.

**Valid values:** 0...4294967295 (0 to  $2^{32}-1$  kbit/s).

**Default value:** 4294967295 (4294967295 kbit/s).

**Reference:** Clauses X.6.7.5 and T.2.8 of [ITU-T G.9701].

### **T.3 Annex X and Annex T of ITU-T G.9701 status objects**

#### **T.3.1 Annex X operation enabled (ANNEX\_X\_ENABLED)**

**Description:** Indicates whether Annex X operation is enabled.

**Type:** boolean

**Valid values:** false (disabled), true (enabled)

**Reference:** Clause X.6.8.1 of [ITU-T G.9701].

#### **T.3.2 DTA enabled (DTA\_ENABLED)**

**Description:** Indicates whether DTA is enabled.

**Type:** boolean

**Valid values:** false (disabled), true (enabled)

**Reference:** Clause X.6.8.2 of [ITU-T G.9701].

## **T.4     Annex X and Annex T of ITU-T G.9701 inventory objects**

### **T.4.1   FTU-O Annex X support (ANNEX\_X\_SUPPORT\_FTU\_O)**

**Description:** Indicates whether Annex X is supported by the FTU-O.

**Type:** boolean.

**Valid values:** false (not supported), true (supported).

**Reference:** Clause X.7.1.1.1 of [ITU-T G.9701].

### **T.4.2     FTU-R Annex X support (ANNEX\_X\_SUPPORT\_FTU\_R)**

**Description:** Indicates whether Annex X is supported by the FTU-R.

**Type:** boolean.

**Valid values:** false (not supported), true (supported).

**Reference:** Clause X.7.1.2.1 of [ITU-T G.9701].

### **T.4.3     FTU-O DTA support (DTA\_SUPPORT\_FTU\_O)**

**Description:** Indicates whether DTA is supported by the FTU-O.

**Type:** boolean.

**Valid values:** false (not supported), true (supported).

**Reference:** Clause X.7.1.1.1 of [ITU-T G.9701].

## **Annex U to Annex W**

Annexes U to W have been intentionally left blank.



## Annex X

### Cross-layer link state objects

(This annex forms an integral part of this Recommendation.)

#### X.1 Overview of cross-layer link state objects

Table X.1 gives an overview of the managed objects used to manage the cross-layer functionality specified in Annex Z of [ITU-T G.9701]. It used the same convention as used in the tables of the managed object of the clause 7.

**Table X.1 – Cross-layer link state objects**

| Category/Object                              | Defined in clause: | DPU-NB  |
|--|--------------------|---------|
| <b><i>LRCC management</i></b>                |                    |         |
| Link State Control (LINK_STATE_CTRL)         | X.2.1.1            | R/W (O) |
| <b><i>L0 to L2.1 trigger criteria</i></b>    |                    |         |
| L0_L2.1N_TRIGR_THRESH_QAds/us                | X.2.2.1            | R/W (O) |
| L0_L2.1N_TRIGR_PERIOD_QAds/us                | X.2.2.2            | R/W (O) |
| L0_L2.1N_TRIGR_PERSIST_QAds/us               | X.2.2.3            | R/W (O) |
| <b><i>L2.1N to L0 trigger criteria</i></b>   |                    |         |
| L2.1N_L0_TRIGR_THRESH_QFds/us                | X.2.3.1            | R/W (O) |
| L2.1N_L0_TRIGR_PERSIST_QFds/us               | X.2.3.2            | R/W (O) |
| <b><i>L2.1B to L2.2 trigger criteria</i></b> |                    |         |
| L2.1B_L2.2_TRIGR_THRESH_QAds/us              | X.2.4.1            | R/W (O) |
| L2.1B_L2.2_TRIGR_PERIOD_QAds/us              | X.2.4.2            | R/W (O) |
| L2.1B_L2.2_TRIGR_PERSIST_QAds/us             | X.2.4.3            | R/W (O) |
| <b><i>L2.2 to L2.1B trigger criteria</i></b> |                    |         |
| L2.2_L2.1B_TRIGR_THRESH_QFds/us              | X.2.5.1            | R/W (O) |
| L2.2_L2.1B_TRIGR_PERSIST_QFds/us             | X.2.5.2            | R/W (O) |
| <b><i>Addition battery criteria</i></b>      |                    |         |
| L0_L2.1B_TRIGR_PERSIST_BAT                   | X.2.6.1            | R/W (O) |
| L2.1N_L2.1B_TRIGR_PERSIST_BAT                | X.2.6.2            | R/W (O) |
| L2.1B_L2.1N_TRIGR_PERSIST_BAT                | X.2.6.3            | R/W (O) |
| L2.2_L2.1N_TRIGR_PERSIST_BAT                 | X.2.6.4            | R/W (O) |

#### X.2 Cross-Layer Low power Mode Control

##### X.2.1 LRCC management

##### X.2.1.1 Link State Control (LINK\_STATE\_CTRL)

**Description:** Selects the operation mode for link state control

**Type:** enumeration

Valid values: 0,1

0 Vendor discretionary control

1 Control according to Annex Z of [ITU-T G.9701]

**Default value:** 0 (Vendor discretionary control)

**Reference:** Table Z.14 of [ITU-T G.9701]

## **X.2.2 L0 to L2.1N trigger criteria**

### **X.2.2.1 L0\_L2.1N\_TRIGR\_THRESH\_QAds/us**

**Description:** Defines the L0\_L2.1N bytes arriving trigger criteria for the L0 to L2.1N trigger criteria: the threshold for bytes arriving (QAD<sub>A</sub> or QAU<sub>A</sub> for downstream and upstream processing respectively) in trigger period L0\_L2.1N\_TRIGR\_PERIOD\_QA aggregated over all queues.

**Type:** 8-bit unsigned integer.

**Unit:** 1000 byte

**Valid values:** 1 .. 127 (1 to 127 kbytes)

**Default value:** 32 (32 kbytes)

**Reference:** Clause Z.6.2.3.1 of [ITU-T G.9701]

### **X.2.2.2 L0\_L2.1N\_TRIGR\_PERIOD\_QAds/us**

**Description:** Defines the period over which the bytes arriving (QAD<sub>A</sub> or QAU<sub>A</sub> for downstream and upstream processing respectively) metrics are accumulated for the L0 to L2.1N trigger criteria.

**Type:** 8-bit unsigned integer.

**Unit:** 1 millisecond

**Valid values:** 6 .. 255 (6 to 255 ms)

**Default value:** 255 (255 ms)

**Reference:** Clause Z.6.2.3.1 of [ITU-T G.9701]

### **X.2.2.3 L0\_L2.1N\_TRIGR\_PERSIST\_QAds/us**

**Description:** Defines the persistency guard time for the bytes arriving trigger criteria (QAD<sub>A</sub> or QAU<sub>A</sub> for downstream and upstream processing respectively), for the L0 to L2.1N trigger criteria.

**Type:** 16-bit unsigned integer.

**Unit:** 1 second

**Valid values:** 1 .. 4095 (1 to 4095 seconds)

**Default value:** 1200 (1200 seconds)

**Reference:** Clause Z.6.2.3.1 of [ITU-T G.9701]

## **X.2.3 L2.1N to L0 trigger criteria**

### **X.2.3.1 L2.1N\_L0\_TRIGR\_THRESH\_QFDs/us**

**Description:** Defines the L2.1N\_L0 queue fill trigger criteria: the threshold for queue fill (QFD<sub>A</sub> or QFU<sub>A</sub> for downstream and upstream processing respectively) aggregated over all queues.

**Type:** 16-bit unsigned integer.

**Unit:** 1 byte

**Valid values:** 64.. 65535 (bytes)

**Default value:** 32768 (bytes)

**Reference:** Clause Z.6.2.3.1 of [ITU-T G.9701]

#### **X.2.3.2 L2.1N\_L0\_TRIGR\_PERSIST\_QFds/us**

**Description:** Defines the persistency guard time for L2.1N to L0 trigger criteria.

**Type:** 8-bit unsigned integer.

**Unit:** 1 millisecond

**Valid values:** 0 .. 255 (0 to 255 ms)

**Default value:** 100 (100 ms)

**Reference:** Clause Z.6.2.3.1 of [ITU-T G.9701]

#### **X.2.4 L2.1B to L2.2 trigger criteria**

##### **X.2.4.1 L2.1B\_L2.2\_TRIGR\_THRESH\_QAds/us**

**Description:** Defines the L2.1B\_L2.2 bytes arriving trigger criteria for the L2.1B to L2.2 trigger criteria: the threshold for bytes arriving (QAD<sub>A</sub> or QAU<sub>A</sub> for downstream and upstream processing respectively) in trigger period L2.1B\_L2.2\_TRIGR\_PERIOD\_QA aggregated over all queues.

**Type:** 8-bit unsigned integer.

**Unit:** 1 byte

**Valid values:** 1.. 255 (1 to 255 bytes)

**Default value:** 1 (1 byte)

**Reference:** Clause Z.6.2.3.1 of [ITU-T G.9701]

##### **X.2.4.2 L2.1B\_L2.2\_TRIGR\_PERIOD\_QAds/us**

**Description:** Defines the period over which the bytes arriving (QAD<sub>A</sub> or QAU<sub>A</sub> for downstream and upstream processing respectively) metrics are accumulated for the L2.1B to L2.2 trigger criteria.

**Type:** 8-bit unsigned integer.

**Unit:** 1 millisecond

**Valid values:** 6 .. 255 (6 to 255 ms in step of 1 ms)

**Default value:** 6 (6 ms)

**Reference:** Clause Z.6.2.3.1 of [ITU-T G.9701]

##### **X.2.4.3 L2.1B\_L2.2\_TRIGR\_PERSIST\_QAds/us**

**Description:** Defines the persistency guard time for the L2.1B to L2.2 trigger criteria.

**Type:** 8-bit unsigned integer.

**Unit:** 1 second

**Valid values:** 0 .. 255 (0 to 255 s)

**Default value:** 1 (1 s)

**Reference:** Clause Z.6.2.3.1 of [ITU-T G.9701]

#### **X.2.5 L2.2 to L2.1B trigger criteria**

##### **X.2.5.1 L2.2\_L2.1B\_TRIGR\_THRESH\_QFds/us**

**Description:** Defines the L2.2\_L2.1B queue fill trigger criteria: the threshold for queue fill (QFD<sub>A</sub> or QFU<sub>A</sub> for downstream and upstream processing respectively) aggregated over all queues.

**Type:** 16-bit unsigned integer.

**Unit:** 1 byte

**Valid values:** 64 .. 65535 (64 to 65535 bytes)

**Default value:** 255 (255 bytes)

**Reference:** Clause Z.6.2.3.1 of [ITU-T G.9701]

#### **X.2.5.2 L2.2\_L2.1B\_TRIGR\_PERSIST\_QFds/us**

**Description:** Defines the persistency guard time for the L2.2 to L2.1B trigger criteria.

**Type:** 8-bit unsigned integer.

**Unit:** 10 milliseconds

**Valid values:** 1 .. 255 (10 to 2550 ms in step of 10 ms)

**Default value:** 60 (600 ms)

**Reference:** Clause Z.6.2.3.1 of [ITU-T G.9701]

#### **X.2.6 Additional battery (BAT) criteria**

##### **X.2.6.1 L0\_L2.1B\_TRIGR\_PERSIST\_BAT**

**Description:** Defines the persistency guard time for the L0 to L2.1B battery trigger criterion.

**Type:** 8-bit unsigned integer.

**Unit:** 1 millisecond

**Valid values:** 0 .. 255 (0 to 255 ms)

**Default value:** 1 (1 ms)

**Reference:** Clause Z.6.2.3.2 of [ITU-T G.9701]

##### **X.2.6.2 L2.1N\_L2.1B\_TRIGR\_PERSIST\_BAT**

**Description:** Defines the persistency guard time for the L2.1N to L2.1B battery trigger criterion.

**Type:** 8-bit unsigned integer.

**Unit:** 1 millisecond

**Valid values:** 0 .. 255 (0 to 255 ms)

**Default value:** 1 (1 ms)

**Reference:** Clause Z.6.2.3.2 of [ITU-T G.9701]

#### **X.2.6.3 L2.1B\_L2.1N\_TRIGR\_PERSIST\_BAT**

**Description:** Defines the persistency guard time for the L2.1B to L2.1N battery trigger criterion.

**Type:** 8-bit unsigned integer.

**Unit:** 1 millisecond

**Valid values:** 0 .. 255 (0 to 255 ms)

**Default value:** 1 (1 ms)

**Reference:** Clause Z.6.2.3.2 of [ITU-T G.9701]

#### **X.2.6.4 L2.2\_L2.1N\_TRIGR\_PERSIST\_BAT**

**Description:** Defines the persistency guard time for the L2.2 to L2.1N battery trigger criterion.

**Type:** 8-bit unsigned integer.

**Unit:** 1 millisecond

**Valid values:** 0 .. 255 (0 to 255 ms)

**Default value:** 1 (1 ms)

**Reference:** Clause Z.6.2.3.2 of [ITU-T G.9701]

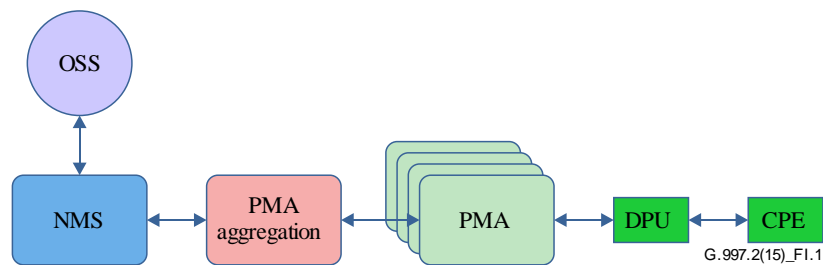
## Appendix I

### Broadband Forum considerations on the FTTdp deployment scenario

(This appendix does not form an integral part of this Recommendation.)

As the DPU is deployed closer to the customer premises, the number of ports on a DPU gets smaller and more DPUs are deployed throughout the network. Distribution points are at locations where local power is not available. In this case, the DPU may be reverse powered where the power comes from the customer premises, sharing the same copper pair with the data service, or the DPU may be forward powered where the power comes from a nearby network power node via copper pairs to the DPU from the network power node.

Reverse powering is one aspect of FTTdp that must be accounted for in the management architecture. Reverse powering of the DPU means that it can be powered down at any time without the network operator's advance knowledge or control. Most network management systems would treat such a spontaneous loss of power as a fault condition and raise an alarm, which is clearly not appropriate for FTTdp. This gave rise to the concept of a PMA, which acts as a management proxy for the DPU when it was unpowered. Figure I.1 shows the high-level PMA architecture as defined in the Broadband Forum



**Figure I.1 – High-level PMA architecture (source: Broadband Forum)**

In this architecture, there is a one to one correspondence between a PMA instance and the DPU it manages. These instances are then aggregated up to higher order management systems. This aggregation function may be realized as part of a PMA server that manages multiple DPUs, an intermediate system that aggregates PMAs residing on lower order systems, or as part of the NMS function.

The PMA uses NETCONF plus a Broadband Forum defined YANG model to manage the DPU. The definitions of the managed objects defined in clause 7 translate into YANG data model syntax (see [b-IETF RFC 6020]), for example as follows:

```
leaf <managed object name> {  
    description "<Description>";  
    type <Type> {  
        range "<Valid values>"; }  
    units "<Unit>";  
    default "<Default value>";  
    reference "<Reference>";  
}
```

## Bibliography

- [b-ITU-T G.993.2] Recommendation ITU-T G.993.2 (2015), *Very high speed digital subscriber line transceivers 2 (VDSL2)*.
- [b-ITU-T M.3010] Recommendation ITU-T M.3010 (2000), *Principles for a telecommunications management network*.
- [b-IETF RFC 1157] IETF RFC 1157 (1990), *A simple network management protocol (SNMP)*.
- [b-IETF RFC 3339] IETF RFC 3339 (2002), *Date and time on the Internet: Timestamps*.
- [b-IETF RFC 6020] IETF RFC 6020 (2010), *YANG – A data modelling language for the network configuration protocol (NETCONF)*.
- [b-IETF RFC 6021] IETF RFC 6021 (2010), *Common YANG data types*.
- [b-IETF RFC 7223] IETF RFC 7223 (2014), *A YANG Data Model for Interface Management*.
- [b-BBF TR-301] Broadband Forum TR-301 Issue 1 (2015), *Architecture and Requirements for Fiber to the Distribution Point*.







## SERIES OF ITU-T RECOMMENDATIONS

|                 |   |
|-----------------|---|
| Series A        | Organization of the work of ITU-T   |
| Series D        | Tariff and accounting principles and international telecommunication/ICT economic and policy issues   |
| Series E        | Overall network operation, telephone service, service operation and human factors   |
| Series F        | Non-telephone telecommunication services  |
| <b>Series G</b> | <b>Transmission systems and media, digital systems and networks</b>   |
| 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        | Environment and ICTs, climate change, e-waste, energy efficiency; 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, and associated measurements and tests   |
| 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, next-generation networks, Internet of Things and smart cities                               |
| Series Z        | Languages and general software aspects for telecommunication systems  |