International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Series G

Supplement 63

(02/2018)

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

ITU-T G.989.3 TC layer operating in ITU-T G.987.3 or ITU-T G.9807.1 TC layer mode

ITU-T G-series Recommendations – Supplement 63

International Telecommunication Union

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
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.

Supplement 63 to ITU-T G-series Recommendations

ITU-T G.989.3 TC layer operating in ITU-T G.987.3 or ITU-T G.9807.1 TC layer mode

Summary

Supplement 63 to ITU-T G-series Recommendations describes how a flexible ITU-T G.989.3 transmission convergence (TC) layer implementation can be used to support an ITU-T G.987.3 or ITU-T G.9807.1 passive optical network (PON).

ITU-T G.989.3 was largely derived from ITU-T G.987.3. The ITU-T G.9807.1 Appendix C TC layer specification was derived from ITU-T G.989.3, with ITU-T G.9807.1 Appendix II describing this derivation in detail. ITU-T G.9807.1 also specifies that an ITU-T G.9807.1 compliant optical line terminal (OLT) will interwork with an ITU-T G.987.3 compliant optical network terminal (ONT).

It should be evident from this chain of derivation that a flexible TC layer implementation that supports ITU-T G.989.3 can support an ITU-T G.9807.1 or ITU-T G.987.3 operation. This Supplement describes the implementation flexibility required.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T G Suppl. 63	2018-02-09	15	11.1002/1000/13587

Keywords

NG-PON2, TC layer, XG-PON, XGS-PON.

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

Compliance with this publication is voluntary. However, the publication may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the publication 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 publication is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this publication 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 publication development process.

As of the date of approval of this publication, ITU had not received notice of intellectual property, protected by patents, which may be required to implement this publication. 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/.

Table of Contents

Supplement 63 to ITU-T G-series Recommendations

ITU-T G.989.3 TC layer operating in ITU-T G.987.3 or ITU-T G.9807.1 TC layer mode

1 Scope

This Supplement describes next generation passive optical network 2 (NG-PON2) optical line termination (OLT) transmission convergence (TC) layer functioning as either a 10-Gigabit-capable symmetric passive optical network (XGS-PON) TC layer or as a 10-Gigabit passive optical network (XG-PON) TC layer. In general terms, this is accomplished by disabling wavelength channel management and tuning functionality. A consideration for the ITU-T G.989.3 TC layer specification is interworking between ITU-T G.989.3 OLT and ITU-T G.987.3 optical network units (ONUs). This feature of [ITU-T G.989.3] also figures into its use as a basis for [ITU-T G.9807.1], XGS-PON. While XGS-PON describes dual rate functionality in which a modified ITU-T G.989.3 TC layer is used to support both ITU-T G.9807.1 XGS-PON ONUs (from [ITU-T G.989.3]) and ITU-T G.987.3 XG-PON ONUs, this Supplement will address the direct use of the ITU-T G.989.3 TC layer to support XGS-PON and XG-PON operations, and the implementation flexibility required to achieve this goal.

2 References

[ITU-T G.984.3] Recommendation ITU-T G.984.3 (2014), *Gigabit-capable passive optical networks (GPON): Transmission convergence layer specification*.

[ITU-T G.987.3] Recommendation ITU-T G.987.3 (2014), *10-Gigabit-capable passive optical networks (XG-PON): Transmission convergence (TC) layer specification*.

[ITU-T G.989] Recommendation ITU-T G.989 (2015), *40-Gigabit-capable passive optical networks (NG-PON2): Definitions, abbreviations and acronyms*.

[ITU-T G.989.3] Recommendation ITU-T G.989.3 (2015), *40-Gigabit-capable passive optical networks (NG-PON2): Transmission convergence layer specification*.

[ITU-T G.9807.1] Recommendation ITU-T G.9807.1 (2016), *10-Gigabit-capable symmetric passive optical network (XGS-PON)*.

3 Definitions

3.1 Terms defined elsewhere

This Supplement uses terms defined in [ITU-T G.989].

3.2 Terms defined in this Supplement

None.

4 Abbreviations and acronyms

This Supplement uses abbreviations and acronyms defined in [ITU-T G.989].

5 General interrelationships between ITU-T G.987.3, ITU-T G.9807 and ITU-T G.989.3

An NG-PON2 OLT TC layer implementation that is also intended for use in XGS-PON or XG-PON applications must be flexible with respect to:

– single wavelength vs multiple wavelength per passive optical network (PON);

– provisioning of PON-ID/operation control (OC) body;
– for XG-PON operation, support for upstream (US) 10G operation;
– ONU-ID assignment restrictions;
– Alloc-ID assignment restrictions;
– Port-ID assignment restrictions;
– physical layer operations, administration and maintenance (PLOAM) provisioning: support for PLOAM messaging as specified by target application;
– ONU activation state behaviour support for each target application.

Several general statements may be made about the relationship between [ITU-T G.989.3] and [ITU-T G.987.3]:

– the terms "OLT CT," "CT," "channel termination," and "channel termination entity" should be understood to be equivalent to "OLT" in the context of XG-PON;
– the terms "TWDM" and "TWDM PON" should be considered to be equivalent to "XG-PON" in the context of XG-PON;
– the container "FS payload" is equivalent to "XGTC payload" of XG-PON;
– the container "FS frame" is equivalent to "XGTC frame" of XG-PON;
– the container "FS header" is equivalent to "XGTC header" of XG-PON;
– the upstream container "FS trailer" is equivalent to upstream "XGTC trailer" of XG-PON;
– the downstream container "FS trailer" does not exist in XG-PON, but this has been accounted for in the specification of [ITU-T G.989.3]. The ITU-T G.989.3 forced switch (FS) body cannot end with a short idle, so the FS trailer appears to an ITU-T G.987.3 TC layer as a short idle and is discarded;
– any reference to tuning is not used for XG-PON;
– any reference to channel management and auxiliary management and control channel (AMCC) is not used for XG-PON;
– for XG-PON, the in-band PLOAM transportation channel is the only PLOAM channel and it is mandatory;
– any reference to wavelength division multiplexing (WDM), multiple time and wavelength division multiplexing (TWDM) channels, multiple wavelengths, multiple channels, channel signaling, switching between channels and channel handover is not used for XG-PON;
– any reference to Channel_Profile, System_Profile, Calibration_Request, Adjust_Tx_Wavelength, Tuning_Control, Protection_Control, Change_Power_Level, Power_Consumption_Inquire, Rate_Control, Tuning_Response, Power_Consumption_Report, Rate_Response PLOAM messages is not used for XG-PON;
– any reference to wavelength calibration, wavelength calibration accuracy, wavelength tuning characteristics and wavelength tuning is not used for XG-PON;
– any reference to point-to-point (PtP) or PtP WDM PON is not used for XG-PON.

6 Specific interrelationships between ITU-T G.987.3, ITU-T G.9807 and ITU-T G.989.3

Specific details about the relationship between [ITU-T G.989.3] and XG-PON are given in the following clauses, referenced from [ITU-T G.989.3]. Appendix II of [ITU-T G.9807.1] has a similar breakdown of the relationship between [ITU-T G.989.3] and [ITU-T G.9807.1].

– for the purposes of XG-PON compatibility, references to [ITU-T G.989.2] are replaced by references to [ITU-T G.987.2];

– in clause 6.1.5.2 of [ITU-T G.989.3], NG2SYS ID is not used; it is part of the unused System_Profile PLOAM;

– in clause 6.1.5.3 of [ITU-T G.989.3], PON-ID was limited to 32 bits of the 51 bit PON-ID field in [ITU-T G.987.3]. The [ITU-T G.987.3] PON-ID field was free-form. [ITU-T G.989.3] defined 23 of these bits. In both [ITU-T G.989.3] and [ITU-T G.987.3], these bits reflect stable state information. It is recommended for forward compatibility that especially the protocol flag (P flag) be set per [ITU-T G.989.3] to identify whether the 51-bit field is set per [ITU-T G.989.3] or [ITU-T G.987.3]. DSWLCH should be set to all zeros.

– the upstream wavelength channel ID (UWLCH ID) should be set to all zeros for XG-PON;

– in Table 6-1 of [ITU-T G.989.3]:

  • for XG-PON, only the row with 9.95328 Gbit/s in downstream and 2.48832 Gbit/s in upstream applies.

– in Table 6-2 of [ITU-T G.989.3]:

  • for XG-PON, only the row with 9.95328 Gbit/s in downstream and 2.48832 Gbit/s in upstream applies.

– in Table 6-4 of [ITU-T G.989.3]:

  • for XG-PON, 1021 and 1022 are assignable, however, for interworking it is unnecessary for an ITU-T G.989.3 OLT to assign these ONU-IDs. Recommend 1021 and 1022 remain unused.

– in Table 6-5 of [ITU-T G.989.3]:

  XG-PON uses 0-1022 as default Alloc-ID. NG-PON2 uses 0-1020. Recommend using NG-PON2 default Alloc-ID range for NG-PON2:

  • Alloc-ID=1021 shall not be used for the NG-PON interworking with XG-PON
  • Alloc-ID=1022 shall not be used for the NG-PON interworking with XG-PON

  vAlloc-ID=1023 shall be used for serial number acquisition with XG-PON ONUs

– in Table 6-6 of [ITU-T G.989.3]:

  XG-PON uses 1023-65534 as assignable encapsulation method (XGEM) Port-ID;

  NG-PON2 uses 1021-65534 as assignable XGEM Port-ID;

  recommend using XG-PON default range for NG-PON2:

  • XGEM port values 1021 and 1022 shall not be assigned to XG-PON ONUs.

7 Resource allocation and quality of service

Clause 7 of [ITU-T G.989.3] is functionally equivalent to clause 7 of [ITU-T G.987.3].

8 Transmission convergence framing sublayer

Clause 8 of [ITU-T G.989.3] interworks with [ITU-T G.987.3] with the following exceptions:

– [ITU-T G.987.3] only supports downstream 9.95328 Gbit/s and 2.48832 Gbit/s upstream operation.

Note, [ITU-T G.987.3] does not recognize the downstream FS trailer introduced in clause 8.1 of [ITU-T G.989.3]. The ITU-T G.989.3 definition of idle XGEM generation requires that a short idle XGEM frame is avoided at the end of the FS payload section. The XG-PON ONU therefore interprets the downstream FS trailer (bit interleaved parity (BIP)) as a short idle XGEM frame, which it ignores.

9 Encapsulation method

Clause 9 of [ITU-T G.989.3] supports interworking with [ITU-T G.987.3]. Clause 9.1.4 describes the ITU-T G.989.3 special handling of Idle XGEM frames that enables ITU-T G.987.3 ONUs to ignore the downstream (DS) FS trailer.

10 PHY adaptation sublayer

Clause 10 of [ITU-T G.989.3] supports interworking with [ITU-T G.987.3] given the following.

– for compatibility with XG-PON, downstream forward error correction (FEC) is mandatory and always on;

– the PON-ID in [ITU-T G.987.3] is called the OC body in [ITU-T G.989.3]. Full compatibility with [ITU-T G.989.3] requires this 51-bit field be made available to the OLT as a free form field:

  • it is recommended that the OC-body definition from [ITU-T G 989.3] be followed. In that case, for compatibility with XG-PON, DS FEC flag = 1 (enabled), P flag = 1, R = 0 and C = 0, the 32-bit PON-ID can be provisioned in the same way as in [ITU-T G.989.3], TOL can be interpreted in the same way as in [ITU-T G.989.3] (see clause 10.1.1.1.3 of [ITU-T G.989.3]);

  • the ITU-T G.987.3 definition of the OC-body / PON-ID can be used, with the exception that the P flag bit as defined in [ITU-T G.989.3] should be set to 0.

11 PLOAM messaging channel

PLOAM messaging described in clause 11 of [ITU-T G.989.3] supports [ITU-T G.987.3] given:

– the following clauses in [ITU-T G.989.3] are not used: 11.2.6.3 through to 11.2.6.8, 11.3.3.10 through to 11.3.3.18 (and associated PLOAM messages in Table 11-2), 11.3.4.6 through to 11.3.4.8 (and associated PLOAM messages in Table 11-3);

– clause 11.2.1, ONU-ID considerations described above;

– clause 11.3.1, code points 0x12 and below. Definitions are supersets of those used by ITU-T G.987.3 ONUs;

– clause 11.3.1, code points 0x13 and higher are not used by ITU-T G.987.3 ONUs;

– clause 11.3.2, code points 0x10 and below. Definitions are supersets of those defined in [ITU-T G.987.3];

– clause 11.3.2, code points 0x11 and higher are not used;

– clause 11.3.3.1, Table 11-4, repeat count (byte 17) is 5 bits for XG-PON ONUs:

  • octet 5, bit F should be set to 0;

  • octet 17 repeat count, only least significant 5 bits are valid, e.g., "000R RRRR".

– clause 11.3.3.2, Table 11-6:

  • octet 5-6, range restricted as noted previously in clause 6.1 (Table 6-4).

– clause 11.3.3.3, Table 11-7, set X=0 (in octet 5) and set Octets 10-17 to zero:

  • octets 10-40 are ignored by XG-PON ONU.

– clause 11.3.3.5, Table 11-9, octet 5: the value 0x3F is not allowed for XG-PON compatibility;

– clause 11.3.3.7, Table 11-11, octets 8-9 are not used and set to 0;

– clause 11.3.4.1, Table 11-24, octets 17-39 are ignored from XG-PON ONUs;

– clause 11.3.4.4, Table 11-27, octets 6 and 7 are ignored from XG-PON ONUs;

– clause 11.3.4.5, Table 11-28, octet 5. Following [ITU-T G.989.3] power savings state machine: activity_level = 0x01 or 0x02 can be either ignored or a response of Sleep_Allow message = OFF, or follows [ITU-T G.987.3] power savings state machine.

12 ONU activation

Clause 12 of [ITU-T G.989.3] supports interworking with XG-PON ONUs given the following:

– the terms "OLT CT," "CT," "channel termination," and "channel termination entity" should be understood to be equivalent to "OLT" in the context of XG-PON;

– the terms "TWDM" and "TWDM PON" should be considered to be equivalent to "XG-PON" in the context of XG-PON;

– the term "NG-PON2" should be understood to be equivalent to "XG-PON";

– any reference to tuning is not used for XG-PON;

– the activation cycle does not include learning of system or channel profiles or channel selection and verification. These elements are not used;

– the activation cycle does not include verification of any US or DS rate other than 2.5G US and 10G DS. See clause 6 of [ITU-T G.989.3];

– power leveling is not supported by XG-PON;

– any reference to channel management and AMCC is not used for XG-PON (e.g., Tables 12-1 and 12-3);

– any reference to inter-channel-termination protocol (ICTP) is not used for XG-PON;

– for XG-PON, the in-band PLOAM transportation channel is the only PLOAM channel and it is mandatory;

– any reference to wavelength division multiplexing, multiple TWDM channels, multiple wavelengths, multiple channels and switching between channels is not used for XG-PON;

– any reference to Channel_Profile PLOAM messages is not used for XG-PON;

– any reference to PtP is not used for XG-PON;

– the UWLCH ID shall be set to all zeros for XG-PON;

– timers TOZ, TO3, TO4 and TO5 are not used;

– states O8 and O9 are not used;

– channel termination (CT) protection mechanisms are unused, e.g., wavelength channel protection (WLCP);

– clause 12.1.5, PON-ID checks are not used;

– clause 12.1.6 is not used;

– clause 12.2 is not used;

– in Table 12-1:

  • references to unused states and unused timers are invalid and not used;

  • reference to unused PLOAM messages are invalid and not used;

  • references to tuning, channel acquisition, or channel profile management are invalid and not used;

  • substate O5-2 is not used.

– in Table 12-2, references to TOZ, TO3, TO4 and TOZ timers are invalid and not used;

– in Table 12-3:

  • unused states and references are removed from table;

    - unused timers and references are removed from table;
    - input downstream wavelength channel (DWLCH) "DWLCH ok to work" is not used;
    - input "DWLCH not appropriate" is not used;
    - AMCC alternative semantic is not used;
    - input "Calibration request" is not used;
    - input "Tuning request" is not used;
    - input "US Tuning confirmation" is not used;
    - input "System_Profile" is not used;
    - input "Channel_Profile" is not used;
    - input "Adjust_Tx_Wavelength" is not used;
    - input "Protection_Control" is not used.
- in Figure 12-1, ONU state diagram, is equivalent to XG-PON ONU state diagram once unused states, timers and inputs are removed;
- in Table 12-4, ONU state transition table, is equivalent to XG-PON ONU state diagram once unused states, timers and inputs are removed;
- in Table 12-5:
    - system profile, Channel profile and Protection PON-ID rows are unused;
    - parameter set columns VI and VII are unused.

13 OLT and ONU timing relationships

Clause 13 of [ITU-T G.989.3] supports interworking with XG-PON given the following:

- the fibre propagation delay calculation in [ITU-T G.989.3] clause 13.2.3.2 is affected for the specific XG-PON wavelengths;
- clause 13.3 of [ITU-T G.989.3] is not used.

14 Performance monitoring, supervision and defects

Clause 14 of [ITU-T G.989.3] supports interworking with XG-PON given the following:

- performance monitoring should not include learning of system or channel profiles or channel selection and verification. These elements are not applicable to XG-PON;
- clause 14-3 text of [ITU-T G.989.3] is not applicable;
- Table 14-1 of [ITU-T G.989.3] is applicable with these exceptions:
    - total received words protected by BIP-32 for each ONU is set to "N/A";
    - DS BIP-32 errors counts are N/A;
    - counts associated with TWDM channel behaviours are not used;
    - counts associated with unused counters TO3, TO4, or TO5 are not used;
    - conditional counts including used counters are treated as unconditional counts of those counters. E.g., loss of downstream synchronization (LODS) "LODS events resulting in ONU reactivation without synchronization being reacquired";
    - counts associated with unused PLOAM messages are unused;
    - counts associated with AMCC operation are unused;
    - counts associated with activation, but that has AMCC or explicit TWDM behaviors are unused;
    - Tuning Control PM is not used;

- Power Levelling PM is not used.

– Table 14-2 is used with these exceptions:
  - DOTXi is not used;
  - ALRFi is not used.

15 Security

Clause 15 of [ITU-T G.989.3] supports interworking with XG-PON.

16 Power management

Clause 16 of [ITU-T G.989.3] supports interworking with XG-PON given the following:

– to support XG-PON ONUs on the PON, the OLT is required to support all three power management modes from [ITU-T G.987.3];

– clauses 16.1.5 and 16.2 are not applicable to XG-PON.

17 Channel management

Clause 17 of [ITU-T G.989.3] is not applicable to XG-PON.

18 System protection

Clause 18 of [ITU-T G.989.3] is not applicable to XG-PON.

19 Rogue behaviour and its mitigation

[ITU-T G.989.3] clause 19 behavior is not addressed by [ITU-T G.987.3]. OLT specific actions to detect and mitigate rogue behaviors compliant with this clause and consistent with single wavelength XG-PON operation are acceptable.

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
Series G	**Transmission systems and media, digital systems and networks**
Series H	Audiovisual and multimedia systems
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	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

Printed in Switzerland
Geneva, 2018