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

Digital terminal equipments – General

SERIES Y: GLOBAL INFORMATION INFRASTRUCTURE, INTERNET PROTOCOL ASPECTS AND NEXT-GENERATION NETWORKS, INTERNET OF THINGS AND SMART CITIES

Internet protocol aspects – Transport

Flexible OTN long-reach interfaces

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Recommendation ITU-T G.709.3/Y.1331.3 (ex. G.709.flexo-lr/Y.1331.flexo-lr)

Flexible OTN long-reach interfaces

Summary

This Recommendation defines flexible OTN (FlexO) long-reach interfaces that support bonding (i.e. grouping) of multiple of these interfaces such that an OTUCn ($n \geq 1$) can be transferred via one or more optical tributary signals (OTSi) over one or more physical interfaces. The Recommendation specifies the frame structure for FlexO long reach interfaces using forward error correction codes with a higher coding gain than used in the FlexO short reach interfaces that are specified in G.709.1.

NOTE – In this first edition only a 100G FlexO long reach interface is specified. Other FlexO long reach interface specifications are for further study.

Keywords:

FlexO, OTN, FEC, long reach

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Flexible OTN long-reach interfaces

1 Scope

This Recommendation defines flexible OTN (FlexO) long-reach interfaces that support bonding (i.e. grouping) of multiple of these interfaces such that an OTUCn ($n \geq 1$) can be transferred via one or more optical tributary signals (OTSi) over one or more physical interfaces.

The optical parameters associated with FlexO long reach interfaces are provided by application codes, which will be in a future edition of [ITU G.698.2].

A FlexO long reach interface group complements the OTN functionality specified in [ITU G.709] and [ITU-T G.709.1] such as B100G OTUCn frame, ODUk/flex, optical interface bonding for short reach interfaces, FlexO interface group management and OTUCn (de)mapping into/from FlexO group payload area, with new functionalities supporting optical interface bonding for long reach interfaces.

This Recommendation provides specifications for new functionalities that are specific to FlexO long reach interface groups and refers to [ITU-T G.709], [ITU-T G.709.1], [ITU-T G.709.2] and [ITU-T G.798] for already existing functionalities. In addition, some introduction material for the addressed applications are included.

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.698.2] Recommendation ITU-T G.698.2 (2018), *Amplified multichannel dense wavelength division multiplexing applications with single channel optical interfaces.*

[ITU-T G.709] Recommendation ITU-T G.709/Y.1331 (2016), *Interfaces for the optical transport network.*

[ITU-T G.709.1] Recommendation ITU-T G.709.1/Y.1331.1 (2017), *Flexible OTN short-reach interface*.

[ITU-T G.709.2] Recommendation ITU-T G.709.2/Y.1331.2 (2018), *OTU4 long-reach interface.*

[ITU-T G.798] Recommendation ITU-T G.798 (2017), *Characteristics of optical transport network hierarchy equipment functional blocks.*

[ITU-T G.872] Recommendation ITU-T G.872 (2016), *Architecture of optical transport networks (OTN).*

[IEEE 802.3] IEEE Std. 802.3-2015, *IEEE Standard for Information Technology – Telecommunications and Information Exchange Between Systems – Local and Metropolitan Area Networks – Specific Requirements Part 3: Carrier Sense Multiple Access With Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.*

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3 Definitions

3.1 Terms defined elsewhere:

This Recommendation uses the following terms defined elsewhere:

3.1.1 Terms defined in [ITU-T G.709]:

– completely standardized OTUCn (OTUCn)

– optical data unit (ODUCn)

– optical payload unit (OPUCn)

– optical transport network (OTN)

– optical data unit k (ODUk)

– optical tributary signal assembly (OTSiA)

3.1.2 Terms defined in [ITU-T G.709.1]:

– FlexO

– FlexO-x

– FlexO-x-RS

– FlexO-x-RS interface

– FlexO-x-RS-m interface group

– FOICx.k-RS

– FOICx.k-RS lane.

3.1.2 Terms defined in [ITU-T G.709.2]:

– Base Block

3.1.3 Terms defined in [ITU-T G.975.1]:

– coding gain

– net coding gain.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 FlexO-x-SC: Information structure consisting of a FlexO-x plus Staircase FEC parity and overhead.

3.2.2 FlexO-x-SC interface: Refers to an individual member interface that is part of a FlexO-x-SC-m interface group.

3.2.3 FlexO-x-SC-m interface group: Refers to the group of m × FlexO-x-SC interfaces.

NOTE – The text may use "FlexO group" as short-hand for FlexO-x-SC-m interface group.

3.2.4 FOICx.k-SC: Refers to a FlexO-x-SC interface using k parallel FOICx.k-SC lanes.

NOTE – "FOICx.k" is the FlexO equivalent of "OTLk.m" for OTUk as defined in [ITU-T G.709].

3.2.5 FOICx.k-SC lane: Refers to an electrical/optical lane of a FlexO-x-SC.

3.2.6 FEC Block Group (FBG): Refers to a group of 1,305,430 contiguous bits in consecutive FlexO-x-SC rows which maps to five Base Blocks.

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4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AM Alignment Marker

B100G Beyond 100G

BCH Bose-Chaudhuri-Hocquengham

DWDM Dense Wavelength Division Multiplex

ED Error Decorrelator

EDI Error Decorrelator Interleaver

EDD Error Decorrelator De-interleaver

FBA FEC Block Alignment

FBG FEC Block Group

FEC Forward Error Correction

FlexO Flexible OTN information structure

FlexO-x FlexO interface information structure of order x

FlexO-x-SC FlexO interface signal of order x with Staircase FEC

FOI FlexO Interface

FOICx.k FlexO Interface of order Cx with k lanes

LR Long Reach

MOTU Multi-OTU

MOTUm Multi-OTU with management

NCG Net Coding Gain

NNI Network Node Interface

OCC Overhead Communication Channel

ODU Optical Data Unit

ODU*k* ODU order *k*

ODU*Cn* ODU order *Cn*

OSMC OTN synchronization messaging channel

OTN Optical Transport Network

OTSi Optical Tributary Signal

OTU Optical Transport Unit

SC FEC Staircase FEC

SOTU Single OTU

SOTUm Single-OTU with management

RS Reed Solomon

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5 Conventions

This Recommendation uses the following conventions defined in [ITU-T G.709]:

- k
- Cn
- m
- n

Transmission order: The order of transmission of information in all the diagrams in this Recommendation is first from left to right and then from top to bottom. Within each byte the most significant bit is transmitted first. The most significant bit (bit 1) is illustrated at the left in all the diagrams.

Value of reserved bit(s): The value of an overhead bit, which is reserved or reserved for future international standardization, shall be set to "0".

Value of non-sourced bit(s): Unless stated otherwise, any non-sourced bits shall be set to "0".

6 Introduction and applications

The FlexO long reach interface groups specified in this Recommendation provide a longer reach version of the FlexO short reach interface groups specified in [ITU-T G.709.1]. In order to mitigate the impairments of accumulated noise it uses FEC types with a higher coding gain than the FEC type deployed in FlexO short reach interfaces.

Example applications are shown in Appendix I.

This Recommendation specifies FlexO-x-<fec>-m interface groups, of which $x \geq 1$, $m \geq 1$ and <fec> represents a FEC with a net coding gain higher than the RS(544,514) FEC in FlexO-x-RS-m interface groups specified in [ITU-T G.709.1].

Edition 1.0 of this Recommendation specifies the (m × 100G) FlexO-1-SC-m interface group, with m = n.

NOTE – The FOI*Cx.k*-SC specified in this Recommendation is not envisaged to be reused on a system internal interface (i.e. a Module Framer Interface), instead such interface can deploy the FOI*Cx.k* as specified in [b-ITU-T G.sup58].

7 Structure and processes

This clause introduces the functions associated with a FlexO-x-SC-m interface group and the basic signal structure, processes and atomic functions.

7.1 FlexO-x-SC-m signal structure

The FlexO-x-SC-m interface group in this recommendation is only specified for long-reach applications. For short reach applications, refer to [ITU-T G.709.1]. The FlexO-x-SC-m interface group functional model is specified in [ITU-T G.872].

NOTE – The physical optical interface specifications are beyond the scope of this recommendation.

The information structure for FlexO-x-SC-m interface groups is represented by information containment relationships and information flows. The principal information containment relationship is shown in Figure 7-1.

One OTUCn signal (consisting of n OTUC instances) is mapped into the payload of n FlexO signals, each FlexO signal containing the bits of one OTUC signal. The n FlexO signals are mapped into m ($m = \lceil n/x \rceil$) FlexO-x-SC signals, each FlexO-x-SC signal containing "x" (frame/multi-frame aligned interleaved) FlexO signals ($x \geq 1$) plus FEC parity and FlexO-x-SC overhead. Each FlexO-

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x-SC signal is split into k FlexO-x-SC lane signals (FOI*Cx.k*-SC). The k lane signals are modulated onto one OTSi, which is transported via one media element.

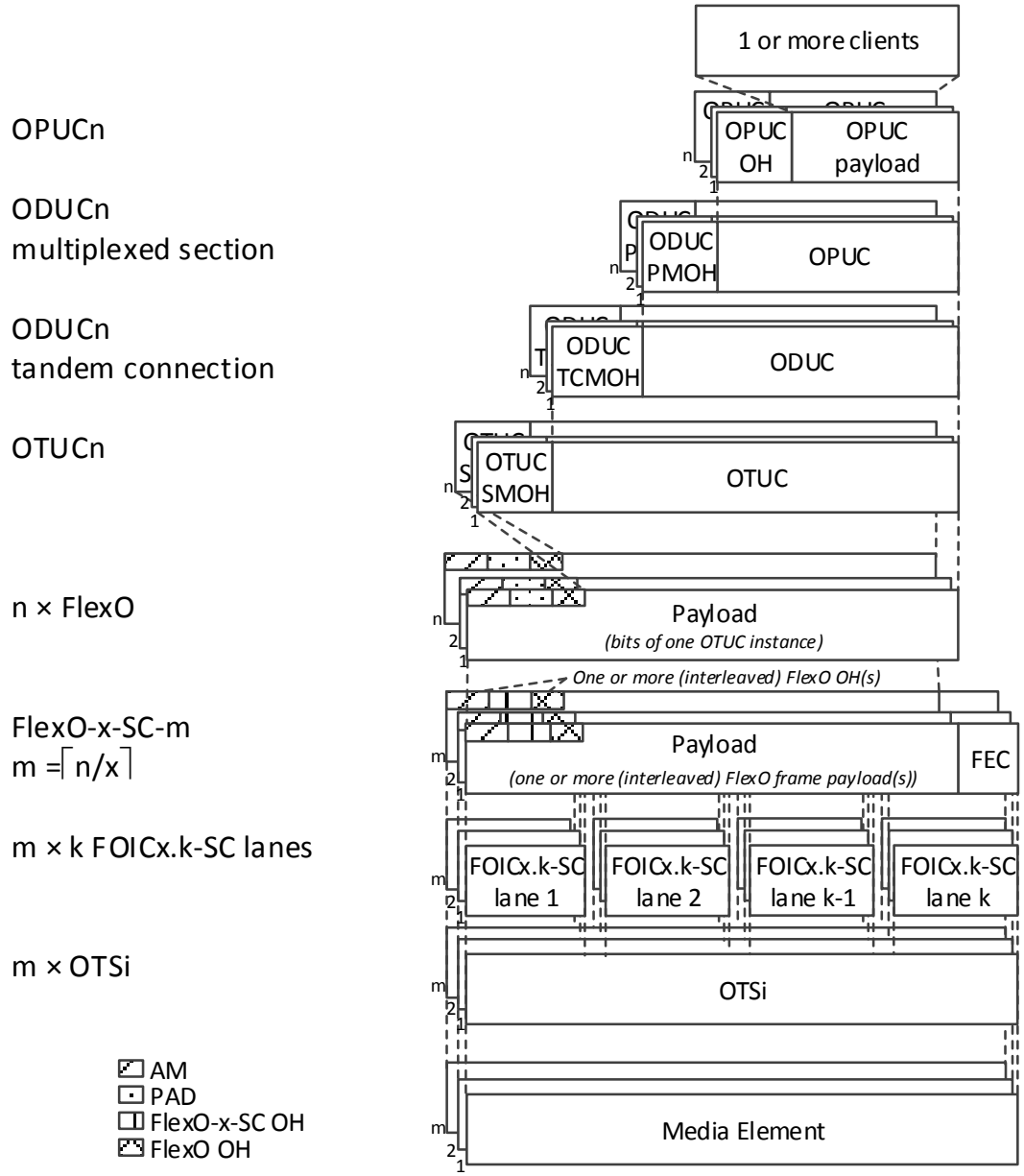

Figure 7-1 – FlexO-x-SC-m interface group principal information containment relationship

7.2 Processing and information flow

Functions and information flows are specified in [ITU G.798].

8 FlexO frame

Refer to clause 8 of [ITU-T G.709.1].

9 Alignment Markers, PAD and FlexO Overhead

Refer to clause 9 of [ITU-T G.709.1].

NOTE - G.709 excludes the use of a SOTUm to carry time synchronization information. This implies that the FlexO OSMC overhead is not applicable and reserved for the FlexO-x-F interface

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