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G.709/Y.1331

Amendment 1

(10/2012)

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 protocol aspects – Transport

Interfaces for the Optical Transport Network (OTN)

Amendment 1

CAUTION !

PREPUBLISHED RECOMMENDATION

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Amendment 1 to Recommendation ITU-T G.709/Y.1331 (2012)

Interfaces for the Optical Transport Network (OTN): Amendment 1

Summary

Amendment 1 to Recommendation ITU-T G.709/Y.1331 (2012) contains extensions related to the:

- addition of FC-1600 client signal (clauses 15.9.2.1.1, 17.9 and 17.9.2)
- addition of a reference to G.7714.1's use of PM, TCM6 and SM TTI fields and GCC0, GCC1, and GCC2 fields for discovery application (clauses 2, 15.7.2.1.1, 15.7.2.2, 15.8.2.1.1, 15.8.2.2.1 and 15.8.2.3)
- addition of a reference to G.873.2 and G.7714.1's allocation of the TCM6 field to monitor 3R'ed "optical paths (clauses 2, 15.8.2.2 and 15.8.2.2.6)
- addition of 3G-SDI information to Tables 7-9, 19-8, 19-9 and 19-10 (clauses 7.1, 19.6.1, 19.6.2 and 19.6.3)
- enhancement of the APS/PCC specification (clauses 2, 15.8.2.4)
- enhancement of the OTUk AIS Note (clause 16.4.1)
- addition of ODUflex(GFP) C_m and C_n values (clauses 19.6.1, 19.6.2, 19.6.3)
- extension of CPRI over OTN information (appendix VIII, Bibliography).

Amendment 1 to Recommendation ITU-T G.709/Y.1331 (2012)

Interfaces for the Optical Transport Network (OTN): Amendment 1

1 Introduction

This amendment contains extensions to the forth version (02/2012) of ITU-T Recommendation G.709/Y.1331, related to the:

- addition of FC-1600 client signal (clauses 15.9.2.1.1, 17.9 and 17.9.2)
- addition of a reference to G.7714.1's use of PM, TCM6 and SM TTI fields and GCC0, GCC1, and GCC2 fields for discovery application (clauses 2, 15.7.2.1.1, 15.7.2.2, 15.8.2.1.1, 15.8.2.2.1 and 15.8.2.3)
- addition of a reference to G.873.2 and G.7714.1's allocation of the TCM6 field to monitor 3R'ed "optical paths (clauses 2, 15.8.2.2 and 15.8.2.2.6)
- addition of 3G-SDI information to Tables 7-9, 19-8, 19-9 and 19-10 (clauses 7.1, 19.6.1, 19.6.2 and 19.6.3)
- enhancement of the APS/PCC specification (clauses 2, 15.8.2.4)
- enhancement of the OTUk AIS Note (clause 16.4.1)
- addition of ODUflex(GFP) C_m and C_n values (clauses 19.6.1, 19.6.2, 19.6.3)
- extension of CPRI over OTN information (appendix VIII, Bibliography).

2 Additions

2.1 Clause 2

Add to clause 2 the following reference:

[ITU-T G.7044] Recommendation ITU-T G.7044/Y.1347 (2011), *Hitless Adjustment of ODUflex(GFP) (HAO).*

[ITU-T G.7714.1] Recommendation ITU-T G.7714.1/Y.1705.1 (2010), *Protocol for automatic discovery in SDH and OTN networks.*

[ITU-T G.873.2] Recommendation ITU-T G.873.2 (2012), *ODUk Shared Ring Protection (SRP).*

2.2 Clause 7.1

Modify table 7-9 as follows:

Table 7-9 – Number of tributary slots required for ODUj into HO OPUk

	# 2.5G tributary slots		# 1.25G tributary slots			
LO ODU	**OPU2**	**OPU3**	**OPU1**	**OPU2**	**OPU3**	**OPU4**
ODU0	–	–	1	1	1	1
ODU1	1	1	–	2	2	2
ODU2	–	4	–	–	8	8
ODU2e	–	–	–	–	9	8
ODU3	–	–	–	–	–	31
ODUflex(CBR)				Note 1	Note 2	Note 3
- ODUflex(IB SDR)	–	–	–	3	3	2
- ODUflex(IB DDR)	–	–	–	5	5	4
- ODUflex(IB QDR)	–	–	–	-	9	8
- ODUflex(FC-400)	–	–	–	4	4	4
- ODUflex(FC-800)	–	–	–	7	7	7
- ODUflex(FC-1600)	–	–	–	–	12	11
- ODUflex(3G SDI) (2 970 000)	–	–	–	3	3	3
- ODUflex(3G SDI) (2 970 000/1.001)	–	–	–	3	3	3
ODUflex(GFP)	–	–	–	n	n	n

NOTE 1 – Number of tributary slots = Ceiling(ODUflex(CBR) nominal bit rate/(T×ODTU2.ts nominal bit rate) × (1+ODUflex(CBR) bit rate tolerance)/(1–HO OPU2 bit rate tolerance)).

NOTE 2 – Number of tributary slots = Ceiling(ODUflex(CBR) nominal bit rate/(T×ODTU3.ts nominal bit rate) × (1+ODUflex(CBR) bit rate tolerance)/(1–HO OPU3 bit rate tolerance)).

NOTE 3 – Number of tributary slots = Ceiling(ODUflex(CBR) nominal bit rate/(T×ODTU4.ts nominal bit rate) × (1+ODUflex(CBR) bit rate tolerance)/(1–HO OPU4 bit rate tolerance)).

NOTE 4 – T represents the transcoding factor. Refer to clauses 17.7.3, 17.7.4 and 17.7.5.

2.3 Clause 15.7.2.1.1

Modify text as follows:

For section monitoring, a one-byte trail trace identifier (TTI) overhead is defined to transport the 64-byte TTI signal specified in clause 15.2 or a discovery message as specified in [ITU-T G.7714.1].

The 64-byte TTI signal shall be aligned with the OTUk multiframe (see clause 15.6.2.2) and transmitted four times per multiframe. Byte 0 of the 64-byte TTI signal shall be present at OTUk multiframe positions 0000 0000 (0x00), 0100 0000 (0x40), 1000 0000 (0x80) and 1100 0000 (0xC0).

2.4 Clause 15.7.2.2

Modify text as follows:

Two bytes are allocated in the OTUk overhead to support a general communications channel or a discovery channel as specified in [ITU-T G.7714.1] between OTUk termination points.

This general communication channel is a clear channel and any format specification is outside of the scope of this Recommendation. These bytes are located in row 1, columns 11 and 12 of the OTUk overhead.

2.5 Clause 15.8.2.1.1

Modify text as follows:

For path monitoring, a one-byte trail trace identifier (TTI) overhead is defined to transport the 64-byte TTI signal specified in clause 15.2 or a discovery message as specified in [ITU-T G.7714.1].

The 64-byte TTI signal shall be aligned with the ODUk multiframe (see clause 15.6.2.2) and transmitted four times per multiframe. Byte 0 of the 64-byte TTI signal shall be present at ODUk multiframe positions 0000 0000 (0x00), 0100 0000 (0x40), 1000 0000 (0x80) and 1100 0000 (0xC0).

2.6 Clause 15.8.2.2

Modify text as follows:

Six fields of ODUk tandem connection monitoring (TCM) overhead are defined in row 2, columns 5 to 13 and row 3, columns 1 to 9 of the ODUk overhead; and six additional bits of tandem connection monitoring are defined in row 2, column 3, bits 1 to 6. TCM supports monitoring of ODUk connections for one or more of the following network applications (refer to [ITU-T G.805], ~~and~~ [ITU-T G.872], [ITU-T G.873.2] and [ITU-T G.7714.1]):

– optical UNI-to-UNI tandem connection monitoring; monitoring the ODUk connection through the public transport network (from public network ingress network termination to egress network termination);

– optical NNI-to-NNI tandem connection monitoring; monitoring the ODUk connection through the network of a network operator (from operator network ingress network termination to egress network termination);

– sublayer monitoring for linear 1+1, 1:1 and 1:n optical channel subnetwork connection protection switching, to determine the signal fail and signal degrade conditions;

– sublayer monitoring for optical channel data unit shared ring protection ~~ring~~ (SRP~~ring~~-1) protection switching as specified in [ITU-T G.873.2], to determine the signal fail and signal degrade conditions;

– sublayer monitoring for optical channel data unit connection passing through two or more concatenated ODUk link connections (supported by back-to-back OTUk trails), to provide a discovery message channel as specified in [ITU-T G.7714.1];

– monitoring an optical channel tandem connection for the purpose of detecting a signal fail or signal degrade condition in a switched optical channel connection, to initiate automatic restoration of the connection during fault and error conditions in the network;

– monitoring an optical channel tandem connection for, e.g., fault localization or verification of delivered quality of service.

<..>

2.7 Clause 15.8.2.2.1

Modify text as follows:

For each tandem connection monitoring field, one byte of overhead is allocated for the transport of the 64-byte trail trace identifier (TTI) specified in clause 15.2 or a discovery message as specified in [ITU-T G.7714.1] for TCM6.

The 64-byte TTI signal shall be aligned with the ODUk multiframe (see clause 15.6.2.2) and transmitted four times per multiframe. Byte 0 of the 64-byte TTI signal shall be present at ODUk multiframe positions 0000 0000 (0x00), 0100 0000 (0x40), 1000 0000 (0x80) and 1100 0000 (0xC0).

2.8 Clause 15.8.2.2.6

Modify text as follows:

Each TC-CMEP will be inserting/extracting its TCM overhead from one of the 6 TCM_i overhead fields and one of the 6 DMt_i fields. The specific TCM_i/DMt_i overhead field is provisioned by the network operator, network management system or switching control plane.

At a domain interface, it is possible to provision the maximum number (0 to 6) of tandem connection levels which will be passed through the domain. The default is three. These tandem connections should use the lower TCM_i/DMt_i overhead fields $TCM_1/DMt_1...TCM_{MAX}/DMt_{MAX}$. Overhead in TCM/DMt fields beyond the maximum (TCM_{max+1}/DMt_{max+1} and above) may/will be overwritten in the domain.

The TCM6 overhead field is assigned to monitor an ODUk connection which is supported by two or more concatenated ODUk link connections (supported by back-to-back OTUk trails). [ITU-T G.7714.1] specifies a discovery application which uses the TCM6 TTI SAPI field as discovery message channel. [ITU-T G.873.2] specifies an ODU SRP-1 protection application which uses the TCM6 field to monitor the status/performance of the ODU connection between two adjacent ODU SRP-1 nodes.

<..>

2.9 Clause 15.8.2.3

Modify text as follows:

Two fields of two bytes are allocated in the ODUk overhead to support two general communications channels or two discovery channels as specified in [ITU-T G.7714.1] between any two network elements with access to the ODUk frame structure (i.e., at 3R regeneration points).

These general communication channels are clear channels and any format specification is outside of the scope of this Recommendation. The bytes for GCC1 are located in row 4, columns 1 and 2, and the bytes for GCC2 are located in row 4, columns 3 and 4 of the ODUk overhead.

2.10 Clause 15.8.2.4

Update Table 15-6 and the paragraph below this table as follows:

Table 15-6 – Multiframe to allow separate APS/PCC for each monitoring level

MFAS bits 6 7 8	APS/PCC channel applies to connection monitoring level	Protection scheme using the APS/PCC channel (Note 1)
0 0 0	ODUk Path	ODUk SNC/Ne, ODUj CL-SNCG/I, Client SNC/I, ODU SRP-p
0 0 1	ODUk TCM1	ODUk SNC/S, ODUk SNC/Ns
0 1 0	ODUk TCM2	ODUk SNC/S, ODUk SNC/Ns
0 1 1	ODUk TCM3	ODUk SNC/S, ODUk SNC/Ns
1 0 0	ODUk TCM4	ODUk SNC/S, ODUk SNC/Ns
1 0 1	ODUk TCM5	ODUk SNC/S, ODUk SNC/Ns
1 1 0	ODUk TCM6	ODUk SNC/S, ODUk SNC/Ns, ODU SRP-1
1 1 1	ODUk server layer trail (Note 2)	ODUk SNC/I

NOTE 1 – An APS channel may be used by more than one protection scheme and/or protection scheme instance. In case of nested protection schemes, care should be taken when an ODUk protection is to be set up in order not to interfere with the APS channel usage of another ODUk protection on the same connection monitoring level, e.g., protection can only be activated if that APS channel of the level is not already being used.

NOTE 2 – Examples of ODUk server layer trails are an OTUk or an HO ODUk (e.g., an ODU3 transporting an ODU1).

For linear protection schemes, the bit assignments for these bytes and the bit-oriented protocol are given in [ITU-T G.873.1]. Bit assignment and byte-oriented protocol for ring protection schemes are ~~for further study~~given in [ITU-T G.873.2].

2.11 Clause 15.9.2.1.1

Modify Table 15-8 as follows:

Table 15-8 – Payload type code points

MSB 1 2 3 4	LSB 5 6 7 8	Hex code (Note 1)	Interpretation
0 0 0 0	0 0 0 1	01	Experimental mapping (Note 3)
0 0 0 0	0 0 1 0	02	Asynchronous CBR mapping, see clause 17.2
0 0 0 0	0 0 1 1	03	Bit synchronous CBR mapping, see clause 17.2
0 0 0 0	0 1 0 0	04	ATM mapping, see clause 17.3
0 0 0 0	0 1 0 1	05	GFP mapping, see clause 17.4
0 0 0 0	0 1 1 0	06	Virtual Concatenated signal, see clause 18 (Note 5)

Table 15-8 – Payload type code points

0 0 0 0	0 1 1 1	07	PCS codeword transparent Ethernet mapping: • 1000BASE-X into OPU0, see clauses 17.7.1 and 17.7.1.1 • 40GBASE-R into OPU3, see clauses 17.7.4 and 17.7.4.1 • 100GBASE-R into OPU4, see clauses 17.7.5 and 17.7.5.1
0 0 0 0	1 0 0 0	08	FC-1200 into OPU2e mapping, see clause 17.8.2
0 0 0 0	1 0 0 1	09	GFP mapping into Extended OPU2 payload, see clause 17.4.1 (Note 6)
0 0 0 0	1 0 1 0	0A	STM-1 mapping into OPU0, see clause 17.7.1
0 0 0 0	1 0 1 1	0B	STM-4 mapping into OPU0, see clause 17.7.1
0 0 0 0	1 1 0 0	0C	FC-100 mapping into OPU0, see clause 17.7.1
0 0 0 0	1 1 0 1	0D	FC-200 mapping into OPU1, see clause 17.7.2
0 0 0 0	1 1 1 0	0E	FC-400 mapping into OPUflex, see clause 17.9
0 0 0 0	1 1 1 1	0F	FC-800 mapping into OPUflex, see clause 17.9
0 0 0 1	0 0 0 0	10	Bit stream with octet timing mapping, see clause 17.6.1
0 0 0 1	0 0 0 1	11	Bit stream without octet timing mapping, see clause 17.6.2
0 0 0 1	0 0 1 0	12	IB SDR mapping into OPUflex, see 17.9
0 0 0 1	0 0 1 1	13	IB DDR mapping into OPUflex, see 17.9
0 0 0 1	0 1 0 0	14	IB QDR mapping into OPUflex, see 17.9
0 0 0 1	0 1 0 1	15	SDI mapping into OPU0, see 17.7.1
0 0 0 1	0 1 1 0	16	(1.485/1.001) Gbit/s SDI mapping into OPU1, see 17.7.2
0 0 0 1	0 1 1 1	17	1.485 Gbit/s SDI mapping into OPU1, see 17.7.2
0 0 0 1	1 0 0 0	18	(2.970/1.001) Gbit/s SDI mapping into OPUflex, see 17.9
0 0 0 1	1 0 0 1	19	2.970 Gbit/s SDI mapping into OPUflex, see 17.9
0 0 0 1	1 0 1 0	1A	SBCON/ESCON mapping into OPU0, see 17.7.1
0 0 0 1	1 0 1 1	1B	DVB_ASI mapping into OPU0, see 17.7.1
0 0 0 1	1 1 0 0	1C	FC-1600 mapping into OPUflex, see 17.9
0 0 1 0	0 0 0 0	20	ODU multiplex structure supporting ODTUjk only, see clause 19 (AMP only)
0 0 1 0	0 0 0 1	21	ODU multiplex structure supporting ODTUk.ts or ODTUk.ts and ODTUjk, see clause 19 (GMP capable) (Note 7)
0 1 0 1	0 1 0 1	55	Not available (Note 2)
0 1 1 0	0 1 1 0	66	Not available (Note 2)
1 0 0 0	x x x x	80-8F	Reserved codes for proprietary use (Note 4)
1 1 1 1	1 1 0 1	FD	NULL test signal mapping, see clause 17.5.1
1 1 1 1	1 1 1 0	FE	PRBS test signal mapping, see clause 17.5.2

Table 15-8 – Payload type code points

1 1 1 1	1 1 1 1	FF	Not available (Note 2)

NOTE 1 – There are ~~206~~ 205 spare codes left for future international standardization. Refer to Annex A of [ITU-T G.806] for the procedure to obtain one of these codes for a new payload type.

NOTE 2 – These values are excluded from the set of available code points. These bit patterns are present in ODUk maintenance signals.

NOTE 3 – Value "01" is only to be used for experimental activities in cases where a mapping code is not defined in this table. Refer to Annex A of [ITU-T G.806] for more information on the use of this code.

NOTE 4 – These 16 code values will not be subject to further standardization. Refer to Annex A of [ITU-T G.806] for more information on the use of these codes.

NOTE 5 – For the payload type of the virtual concatenated signal a dedicated payload type overhead (vcPT) is used, see clause 18.

NOTE 6 – Supplement 43 (02/2008) to the ITU-T G-series of Recommendations indicated that this mapping recommended using Payload Type 87.

NOTE 7 – Equipment supporting ODTUk.ts for OPU2 or OPU3 must be backward compatible with equipment which supports only the ODTUjk. ODTUk.ts capable equipment transmitting PT=21 which receives PT=20 from the far end shall revert to PT=20 and operate in ODTUjk only mode. Refer to [ITU-T G.798] for the specification.

2.12 Clause 15.9.2.2

Modify text as follows:

Seven bytes are reserved in the OPUk overhead for mapping and concatenation specific overhead. These bytes are located in rows 1 to 3, columns 15 and 16 and column 16 row 4. In addition, 255 bytes in the PSI are reserved for mapping and concatenation specific purposes.

The use of these bytes depends on the specific client signal mapping (defined in clauses 17 and 19), ~~and~~ the use of concatenation (see clause 18) and use of hitless adjustment of ODUflex(GFP) (see [ITU-T G.7044]).

2.13 Clause 16.4.1

Modify text as follows:

<..>

NOTE – OTUk-AIS is defined to support a future server layer application. OTN equipment should be capable to detect the presence of such signal within OTM-0.1, OTM-0.2, OTM-0.3 interface signals and within OChr interface signals (in an OTM-nr.m interface) carrying an OTU1, OTU2 or OTU3; it is not required to generate such signal.

2.14 Clause 17.9

Modify tables 17-14 and 17-15 as follows:

Table 17-14 – supra-2.488G CBR clients

Client signal	Nominal bit rate (kbit/s)	Bit rate tolerance (ppm)
FC-400	4 250 000	±100
FC-800	8 500 000	±100
FC-1600	14 025 000	±100
IB SDR	2 500 000	±100
IB DDR	5 000 000	±100
IB QDR	10 000 000	±100
3G SDI	2 970 000	± 10
3G SDI	2 970 000/1.001	± 10

Table 17-15 – Replacement signal for supra-2.488 Gbit/s clients

Client signal	Replacement Signal	Bit rate tolerance (ppm)
FC-400	NOS	±100
FC-800	NOS	±100
FC-1600	NOS	±100
IB SDR	For further study	±100
IB DDR	For further study	±100
IB QDR	For further study	±100
3G SDI	Generic-AIS	For further study

2.15 Clause 17.9.2

Add new clause as follows:

17.9.2 FC-1600

During a signal fail condition of the incoming FC-1600 signal (e.g., in the case of a loss of input signal), this failed incoming FC-1600 signal is replaced by a NOS primitive sequence as specified in [b-INCITS 470: FC-FS-3].

During signal fail condition of the incoming ODUflex signal (e.g., in the case of an ODUflex-AIS, ODUflex-LCK, ODUflex-OCI condition), NOS primitive sequence ordered sets as specified in [b-INCITS 470: FC-FS-3] are generated as a replacement signal for the lost FC-1600 signal.

2.16 Clause 19.6.1

Modify Table 19-8 as follows:

Table 19-8 – C_m and C_n (n=8) for ODUj into ODTU2.M

ODUj signal	M	m=8×M	Floor $C_{m,min}$ (note)	Minimum c_m	Nominal c_m	Maximum c_m	Ceiling $C_{m,max}$ (note)
ODU0	1	8	15167	15167.393	15168.000	15168.607	15169
ODUflex(GFP), n=1..8	n	8 × n	15227	15227.339	15229.167	15230.994	15231
~~**ODUflex(GFP), n=1..8**~~	~~n~~	~~8 × n~~	~~ODUflex(GFP) rate dependent~~				
ODUflex(CBR)	ODUflex(CBR) dependent						
- ODUflex(IB SDR)	3	24	10200	10200.928	10202.152	10203.376	10204
- ODUflex(IB DDR)	5	40	12241	12241.113	12242.582	12244.051	12245
- ODUflex(FC-400)	4	32	13006	13006.183	13007.744	13009.305	13010
- ODUflex(FC-800)	7	56	14864	14864.209	14865.993	14867.777	14868
- ODUflex(3G SDI) (2 970 000)	3	24	12118	12118.702	12120.156	12121.611	12122
- ODUflex(3G SDI) (2 970 000/1.001)	3	24	12106	12106.595	12108.048	12109.501	12110
			Floor $C_{8,min}$ (note)	Minimum c_8	Nominal c_8	Maximum c_8	Ceiling $C_{8,max}$ (note)
ODU0	1	8	15167	15167.393	15168.000	15168.607	15169
ODUflex(GFP), n=1..8	n	8 × n	ODUflex(GFP) see Table 19-8A~~rate dependent~~				
ODUflex(CBR)	ODUflex(CBR) dependent						
- ODUflex(IB SDR)	3	24	30602	30602.783	30606.456	30610.128	30611
- ODUflex(IB DDR)	5	40	61205	61205.566	61212.911	61220.257	61221
- ODUflex(FC-400)	4	32	52024	52024.731	52030.974	52037.218	52038
- ODUflex(FC-800)	7	56	104049	104049.462	104061.949	104074.437	104075
- ODUflex(3G SDI) (2 970 000)	3	24	36356	36356.106	36360.469	36364.833	36365
- ODUflex(3G SDI) (2 970 000/1.001)	3	24	36319	36319.786	36324.145	36328.504	36329

NOTE – Floor $C_{m,min}$, Floor $C_{n,min}$ (n=8), Ceiling $C_{m,max}$ and Ceiling $C_{n,max}$ (n=8) values represent the boundaries of ODUj/ODTU2.M ppm offset combinations (i.e. min. ODUj/max. ODTU and max. ODUj/min. ODTU). In steady state, given instances of ODUj/ODTU offset combinations should not result in generated C_n and C_m values throughout this range but rather should be within as small a range as possible. Under transient ppm offset conditions (e.g. AIS to normal signal), it is possible that C_n and C_m values outside the range $C_{n,min}$ to $C_{n,max}$ and $C_{m,min}$ to $C_{m,max}$ may be generated and a GMP demapper should be tolerant of such occurrences. Refer to Annex D for a general description of the GMP principles.

Add Table 19-8A as follows:

Table 19-8A –C_n (n=8) for ODUj (j=flex, ODU2.ts) into ODTU2.M

ODUj signal	M	m=8×M	Floor $C_{8,min}$ (note)	Minimum c_8	Nominal c_8	Maximum c_8	Ceiling $C_{8,max}$ (note)
ODUflex(GFP)	1	8	15227	15227.339	15229.167	15230.994	15231
ODUflex(GFP)	2	16	30454	30454.679	30458.334	30461.989	30462
ODUflex(GFP)	3	24	45682	45682.018	45687.501	45692.983	45693
ODUflex(GFP)	4	32	60909	60909.358	60916.667	60923.978	60924
ODUflex(GFP)	5	40	76136	76136.697	76145.834	76154.972	76155
ODUflex(GFP)	6	48	91364	91364.036	91375.001	91385.966	91386
ODUflex(GFP)	7	56	106591	106591.376	106604.168	106616.961	106617
ODUflex(GFP)	8	64	121818	121818.715	121833.335	121847.955	121848

2.17 Clause 19.6.2

Modify Table 19-9 as follows:

Table 19-9 – C_m and C_n (n=8) for ODUj into ODTU3.M

ODUj signal	M	m=8× M	Floor $C_{m,min}$ (note)	Minimum c_m	Nominal c_m	Maximum c_m	Ceiling $C_{m,max}$ (note)
ODU0	1	8	15103	15103.396	15104.000	15104.604	15105
ODU2e	9	72	14026	14026.026	14027.709	14029.392	14030
ODUflex(GFP), n=1..8, ODU2.ts	n	8 × n	15163	15163.089	15164.909	15166.729	15167
ODUflex(GFP), n=9..32, ODU3.ts	n	8 × n	15227	15227.339	15229.167	15230.994	15231
~~**ODUflex(GFP), n=1..32**~~	~~n~~	~~8 × n~~	~~ODUflex(GFP) rate dependent~~				
ODUflex(CBR)	ODUflex(CBR) dependent						
- ODUflex(IB SDR)	3	24	10157	10157.886	10159.105	10160.324	10161
- ODUflex(IB DDR)	5	40	12189	12189.463	12190.926	12192.389	12193
- ODUflex(IB QDR)	9	72	13543	13543.848	13545.473	13547.099	13548
- ODUflex(FC-400)	4	32	12951	12951.304	12952.859	12954.413	12955
- ODUflex(FC-800)	7	56	14801	14801.491	14803.267	14805.043	14806
- ODUflex(FC-1600)	12	96	14246	14246.435	14248.144	14249.854	14250
- ODUflex(3G SDI) (2 970 000)	3	24	12067	12067.568	12069.016	12070.465	12071
- ODUflex(3G SDI) (2 970 000/1.001)	3	24	12055	12055.513	12056.960	12058.406	12059

			Floor $C_{8,min}$ (note)	Minimum c_8	Nominal c_8	Maximum c_8	Ceiling $C_{8,max}$ (note)
ODU0	1	8	15103	15103.396	15104.000	15104.604	15105
ODU2e	9	72	126234	126234.232	126249.381	126264.532	126265
ODUflex(GFP), n=1..32	n	8 × n	ODUflex(GFP) ~~rate dependent~~see Tables 19-9A and 19-9B				
ODUflex(CBR)	ODUflex(CBR) dependent						
- ODUflex(IB SDR)	3	24	30473	30473.657	30477.314	30480.972	30481
- ODUflex(IB DDR)	5	40	60947	60947.314	60954.629	60961.943	60962
- ODUflex(IB QDR)	9	72	121894	121894.629	121909.258	121923.887	121924
- ODUflex(FC-400)	4	32	51805	51805.217	51811.434	51817.652	51818
- ODUflex(FC-800)	7	56	103610	103610.434	103622.869	103635.304	103636
- ODUflex(FC-1600)	12	96	170957	170957.217	170977.734	170998.251	170999
- ODUflex(3G SDI) (2 970 000)	3	24	36202	36202.705	36207.049	36211.394	36212
- ODUflex(3G SDI) (2 970 000/1.001)	3	24	36166	36166.538	36170.879	36175.219	36176

NOTE – Floor $C_{m,min}$, Floor $C_{n,min}$ (n=8), Ceiling $C_{m,max}$ and Ceiling $C_{n,max}$ (n=8) values represent the boundaries of ODUj/ODTU3.M ppm offset combinations (i.e. min. ODUj/max. ODTU and max. ODUj/min. ODTU). In steady state, given instances of ODUj/ODTU offset combinations should not result in generated C_n and C_m values throughout this range but rather should be within as small a range as possible. Under transient ppm offset conditions (e.g. AIS to normal signal), it is possible that C_n and C_m values outside the range $C_{n,min}$ to $C_{n,max}$ and $C_{m,min}$ to $C_{m,max}$ may be generated and a GMP demapper should be tolerant of such occurrences. Refer to Annex D for a general description of the GMP principles.

Add Tables 19-9A,B as follows:

Table 19-9A –C_n (n=8) for ODUj (j=flex, ODU2.ts) into ODTU3.M

ODUj signal	M	m=8×M	Floor $C_{8,min}$ (note)	Minimum c_8	Nominal c_8	Maximum c_8	Ceiling $C_{8,max}$ (note)
ODUflex(GFP)	1	8	15163	15163.089	15164.909	15166.729	15167
ODUflex(GFP)	2	16	30326	30326.178	30329.818	30333.457	30334
ODUflex(GFP)	3	24	45489	45489.267	45494.726	45500.186	45501
ODUflex(GFP)	4	32	60652	60652.356	60659.635	60666.914	60667
ODUflex(GFP)	5	40	75815	75815.445	75824.544	75833.643	75834
ODUflex(GFP)	6	48	90978	90978.534	90989.453	91000.372	91001
ODUflex(GFP)	7	56	106141	106141.623	106154.361	106167.100	106168
ODUflex(GFP)	8	64	121304	121304.712	121319.270	121333.829	121334

Table 19-9B –C_n (n=8) for ODUj (j=flex, ODU3.ts) into ODTU3.M

ODUj signal	M	m=8×M	Floor $C_{8,min}$ (note)	Minimum c_8	Nominal c_8	Maximum c_8	Ceiling $C_{8,max}$ (note)
ODUflex(GFP)	9	72	137045	137045.095	137062.502	137079.909	137080
ODUflex(GFP)	10		152272	152272.176	152291.668	152311.162	152312
ODUflex(GFP)	11		167499	167499.226	167520.835	167542.446	167543
ODUflex(GFP)	12		182726	182726.245	182750.002	182773.760	182774
ODUflex(GFP)	13		197953	197953.234	197979.169	198005.105	198006
ODUflex(GFP)	14		213180	213180.193	213208.336	213236.480	213237
ODUflex(GFP)	15		228407	228407.121	228437.503	228467.886	228468
ODUflex(GFP)	16		243634	243634.019	243666.670	243699.322	243700
ODUflex(GFP)	17		258860	258860.886	258895.836	258930.788	258931
ODUflex(GFP)	18		274087	274087.723	274125.003	274162.285	274163
ODUflex(GFP)	19		289314	289314.529	289354.170	289393.812	289394
ODUflex(GFP)	20		304541	304541.305	304583.337	304625.370	304626
ODUflex(GFP)	21		319768	319768.051	319812.504	319856.959	319857
ODUflex(GFP)	22		334994	334994.766	335041.671	335088.577	335089
ODUflex(GFP)	23		350221	350221.450	350270.838	350320.227	350321
ODUflex(GFP)	24		365448	365448.104	365500.004	365551.906	365552
ODUflex(GFP)	25		380674	380674.728	380729.171	380783.617	380784
ODUflex(GFP)	26		395901	395901.321	395958.338	396015.357	396016
ODUflex(GFP)	27		411127	411127.884	411187.505	411247.128	411248
ODUflex(GFP)	28		426354	426354.416	426416.672	426478.930	426479
ODUflex(GFP)	29		441580	441580.918	441645.839	441710.762	441711
ODUflex(GFP)	30		456807	456807.389	456875.005	456942.624	456943
ODUflex(GFP)	31		472033	472033.830	472104.172	472174.517	472175
ODUflex(GFP)	32		487260	487260.241	487333.339	487406.441	487407

2.18 Clause 19.6.3

Modify Table 19-10 as follows:

Table 19-10 – C_m and C_n (n=8) for ODUj into ODTU4.M

ODUj signal	M	m=8×M	Floor $C_{m,min}$ (note)	Minimum c_m	Nominal c_m	Maximum c_m	Ceiling $C_{m,max}$ (note)
ODU0	1	8	14527	14527.419	14528.000	14528.581	14529
ODU1	2	16	14588	14588.458	14589.042	14589.626	14590
ODU2	8	64	14650	14650.013	14650.599	14651.185	14652

ODU2e	8	64	15177	15177.527	15179.348	15181.170	15182
ODU3	31	248	15186	15186.673	15187.280	15187.888	15188
ODUflex(GFP), n=1..8, ODU2.ts	n	8 × n	14584	14584.836	14586.586	14588.336	14589
ODUflex(GFP), n=9..32, ODU3.ts	n	8 × n	14646	14646.636	14648.394	14650.151	14651
ODUflex(GFP), n=33..80, ODU4.ts	n	8 × n	15195	15195.349	15197.173	15198.996	15199
~~**ODUflex(GFP), n=1..80**~~	~~n~~	~~8 × n~~	~~ODUflex(GFP) rate dependent~~				
ODUflex(CBR)	ODUflex(CBR) dependent						
- ODUflex(IB SDR)	2	16	14655	14655.763	14657.522	14659.281	14660
- ODUflex(IB DDR)	4	32	14655	14655.763	14657.522	14659.281	14660
- ODUflex(IB QDR)	8	64	14655	14655.763	14657.522	14659.281	14660
- ODUflex(FC-400)	4	32	12457	12457.399	12458.894	12460.389	12461
- ODUflex(FC-800)	7	56	14237	14237.027	14238.736	14240.444	14241
- ODUflex(FC-1600)	11	88	14948	14948.878	14950.672	14952.467	14953
- ODUflex(3G SDI) (2 970 000)	3	24	11607	11607.364	11608.757	11610.150	11611
- ODUflex(3G SDI) (2 970 000/1.001)	3	24	11595	11595.769	11597.160	11598.552	11599
			Floor $C_{8,min}$ (note)	**Minimum** c_8	**Nominal** c_8	**Maximum** c_8	**Ceiling** $C_{8,max}$ (note)
ODU0	1	8	14527	14527.419	14528.000	14528.581	14529
ODU1	2	16	29176	29176.917	29178.084	29179.251	29180
ODU2	8	64	117200	117200.105	117204.793	117209.482	117210
ODU2e	8	64	121420	121420.214	121434.786	121449.359	121450
ODU3	31	248	470786	470786.863	470805.695	470824.528	470825
ODUflex(GFP), n=1..80	n	8 × n	ODUflex(GFP) ~~rate dependent~~see Tables 19-10A, 19-10B and 19-10C				
ODUflex(CBR)	ODUflex(CBR) dependent						
- ODUflex(IB SDR)	2	16	29311	29311.526	29315.044	29318.562	29319
- ODUflex(IB DDR)	4	32	58623	58623.052	58630.088	58637.124	58638
- ODUflex(IB QDR)	8	64	117246	117246.105	117260.176	117274.247	117275
- ODUflex(FC-400)	4	32	49829	49829.595	49835.575	49841.555	49842
- ODUflex(FC-800)	7	56	99659	99659.189	99671.149	99683.110	99684
- ODUflex(FC-1600)	11	88	164437	164437.662	164457.396	164477.132	164478
- ODUflex(3G SDI) (2 970 000)	3	24	34822	34822.093	34826.272	34830.451	34831
- ODUflex(3G SDI)	3	24	34787	34787.306	34791.481	34795.656	34796

(2 970 000/1.001)							

NOTE – Floor $C_{m,min}$, Floor $C_{n,min}$ (n=8), Ceiling $C_{m,max}$ and Ceiling $C_{n,max}$ (n=8) values represent the boundaries of ODUj/ODTU4.M ppm offset combinations (i.e. min. ODUj/max. ODTU and max. ODUj/min. ODTU). In steady state, given instances of ODUj/ODTU offset combinations should not result in generated C_n and C_m values throughout this range but rather should be within as small a range as possible. Under transient ppm offset conditions (e.g. AIS to normal signal), it is possible that C_n and C_m values outside the range $C_{n,min}$ to $C_{n,max}$ and $C_{m,min}$ to $C_{m,max}$ may be generated and a GMP demapper should be tolerant of such occurrences. Refer to Annex D for a general description of the GMP principles.

Add Tables 19-10A,B,C as follows:

Table 19-10A –C_n (n=8) for ODUj (j=flex, ODU2.ts) into ODTU4.M

ODUj signal	M	m=8×M	Floor $C_{8,min}$ (note)	Minimum c_8	Nominal c_8	Maximum c_8	Ceiling $C_{8,max}$ (note)
ODUflex(GFP)	1	8	14584	14584.836	14586.586	14588.336	14589
ODUflex(GFP)	2	16	29169	29169.671	29173.172	29176.673	29177
ODUflex(GFP)	3	24	43754	43754.507	43759.758	43765.009	43766
ODUflex(GFP)	4	32	58339	58339.342	58346.344	58353.346	58354
ODUflex(GFP)	5	40	72924	72924.178	72932.930	72941.682	72942
ODUflex(GFP)	6	48	87509	87509.014	87519.516	87530.018	87531
ODUflex(GFP)	7	56	102093	102093.849	102106.102	102118.355	102119
ODUflex(GFP)	8	64	116678	116678.685	116692.688	116706.691	116707

Table 19-10B –C_n (n=8) for ODUj (j=flex, ODU3.ts) into ODTU4.M

ODUj signal	M	m=8×M	Floor $C_{8,min}$ (note)	Minimum c_8	Nominal c_8	Maximum c_8	Ceiling $C_{8,max}$ (note)
ODUflex(GFP)	9	72	131819	131819.722	131835.542	131851.362	131852
ODUflex(GFP)	10		146466	146466.358	146483.935	146501.514	146502
ODUflex(GFP)	11		161112	161112.993	161132.329	161151.665	161152
ODUflex(GFP)	12		175759	175759.629	175780.722	175801.817	175802
ODUflex(GFP)	13		190406	190406.265	190429.116	190451.968	190452
ODUflex(GFP)	14		205052	205052.901	205077.510	205102.119	205103
ODUflex(GFP)	15		219699	219699.536	219725.903	219752.271	219753
ODUflex(GFP)	16		234346	234346.172	234374.297	234402.422	234403
ODUflex(GFP)	17		248992	248992.808	249022.690	249052.573	249053
ODUflex(GFP)	18		263639	263639.444	263671.084	263702.725	263703
ODUflex(GFP)	19		278286	278286.080	278319.477	278352.876	278353
ODUflex(GFP)	20		292932	292932.715	292967.871	293003.028	293004
ODUflex(GFP)	21		307579	307579.351	307616.264	307653.179	307654

ODUflex(GFP)	22		322225	322225.987	322264.658	322303.330	322304
ODUflex(GFP)	23		336872	336872.623	336913.051	336953.482	336954
ODUflex(GFP)	24		351519	351519.258	351561.445	351603.633	351604
ODUflex(GFP)	25		366165	366165.894	366209.838	366253.784	366254
ODUflex(GFP)	26		380812	380812.530	380858.232	380903.936	380904
ODUflex(GFP)	27		395459	395459.166	395506.625	395554.087	395555
ODUflex(GFP)	28		410105	410105.801	410155.019	410204.239	410205
ODUflex(GFP)	29		424752	424752.437	424803.413	424854.390	424855
ODUflex(GFP)	30		439399	439399.073	439451.806	439504.541	439505
ODUflex(GFP)	31		454045	454045.709	454100.200	454154.693	454155
ODUflex(GFP)	32		468692	468692.344	468748.593	468804.844	468805

Table 19-10C –C_n (n=8) for ODUj (j=flex, ODU4.ts) into ODTU4.M

ODUj signal	**M**	**m=8×M**	**Floor** $C_{8,min}$ (note)	**Minimum** c_8	**Nominal** c_8	**Maximum** c_8	**Ceiling** $C_{8,max}$ (note)
ODUflex(GFP)	33		15195	15195.349	15197.173	15198.996	15199
ODUflex(GFP)	34		30390	30390.698	30394.346	30397.993	30398
ODUflex(GFP)	35		45586	45586.048	45591.518	45596.989	45597
ODUflex(GFP)	36		60781	60781.397	60788.691	60795.986	60796
ODUflex(GFP)	37		75976	75976.746	75985.864	75994.982	75995
ODUflex(GFP)	38		91172	91172.004	91183.037	91194.070	91195
ODUflex(GFP)	39		106367	106367.231	106380.210	106393.188	106394
ODUflex(GFP)	40		121562	121562.429	121577.382	121592.337	121593
ODUflex(GFP)	41		136757	136757.595	136774.555	136791.516	136792
ODUflex(GFP)	42		151952	151952.732	151971.728	151990.725	151991
ODUflex(GFP)	43		167147	167147.838	167168.901	167189.965	167190
ODUflex(GFP)	44		182342	182342.914	182366.074	182389.235	182390
ODUflex(GFP)	45		197537	197537.959	197563.246	197588.535	197589
ODUflex(GFP)	46		212732	212732.974	212760.419	212787.866	212788
ODUflex(GFP)	47		227927	227927.958	227957.592	227987.227	227988
ODUflex(GFP)	48		243122	243122.912	243154.765	243186.619	243187
ODUflex(GFP)	49		258317	258317.836	258351.938	258386.041	258387
ODUflex(GFP)	50		273512	273512.729	273549.110	273585.493	273586
ODUflex(GFP)	51		288707	288707.592	288746.283	288784.976	288785
ODUflex(GFP)	52		303902	303902.424	303943.456	303984.489	303985
ODUflex(GFP)	53		319097	319097.227	319140.629	319184.033	319185
ODUflex(GFP)	54		334291	334291.998	334337.802	334383.607	334384
ODUflex(GFP)	55		349486	349486.740	349534.974	349583.211	349584
ODUflex(GFP)	56		364681	364681.450	364732.147	364782.846	364783
ODUflex(GFP)	57		379876	379876.131	379929.320	379982.511	379983

ODUflex(GFP)	58		395070	395070.781	395126.493	395182.207	395183
ODUflex(GFP)	59		410265	410265.401	410323.666	410381.933	410382
ODUflex(GFP)	60		425459	425459.990	425520.838	425581.689	425582
ODUflex(GFP)	61		440654	440654.549	440718.011	440781.476	440782
ODUflex(GFP)	62		455849	455849.078	455915.184	455981.293	455982
ODUflex(GFP)	63		471043	471043.576	471112.357	471181.141	471182
ODUflex(GFP)	64		486238	486238.044	486309.530	486381.019	486382
ODUflex(GFP)	65		15195	15195.349	15197.173	15198.996	15199
ODUflex(GFP)	66		30390	30390.698	30394.346	30397.993	30398
ODUflex(GFP)	67		45586	45586.048	45591.518	45596.989	45597
ODUflex(GFP)	68		60781	60781.397	60788.691	60795.986	60796
ODUflex(GFP)	69		75976	75976.746	75985.864	75994.982	75995
ODUflex(GFP)	70		91172	91172.004	91183.037	91194.070	91195
ODUflex(GFP)	71		106367	106367.231	106380.210	106393.188	106394
ODUflex(GFP)	72		121562	121562.429	121577.382	121592.337	121593
ODUflex(GFP)	73		136757	136757.595	136774.555	136791.516	136792
ODUflex(GFP)	74		151952	151952.732	151971.728	151990.725	151991
ODUflex(GFP)	75		167147	167147.838	167168.901	167189.965	167190
ODUflex(GFP)	76		182342	182342.914	182366.074	182389.235	182390
ODUflex(GFP)	77		197537	197537.959	197563.246	197588.535	197589
ODUflex(GFP)	78		212732	212732.974	212760.419	212787.866	212788
ODUflex(GFP)	79		227927	227927.958	227957.592	227987.227	227988
ODUflex(GFP)	80		243122	243122.912	243154.765	243186.619	243187

2.19 Appendix VIII

Replace the NOTE with the following text:

~~NOTE – Performance evaluation of the CPRI over OTN transport is ongoing and there is no guarantee yet that all CPRI performance specifications can be met.~~

NOTE – OTN transport of CPRI [b-CPRI] is intended for use within an administrative domain. Users of this Recommendation should not assume that the required performance for the CPRI client is met. It is the responsibility of the network operator to determine if the required performance can be met. The noise generated by the OTN would have to be handled by the CPRI system in order to meet the application requirements. This is considered as a complex task according to the current OTN specification. The OTN network should also be designed in order to meet the applicable symmetry requirements.

Further details are provided below.

Simulation analyses were done for the transport of CPRI Option 2, Option 3, and Option 4 clients over OTN for the following four cases:

a) CPRI Option 2 client signal → ODU0 → ODU2 → OTU2 → ODU2 → ODU0 → CPRI Option 2 client signal

b) CPRI Option 3 client signal → ODU1 → ODU2 → OTU2 → ODU2 → ODU1 → CPRI Option 3 client signal

c) CPRI Option 3 client signal → ODU1 → OTU1 → ODU1 → CPRI Option 3

d) CPRI Option 4 client signal → ODU2 → OTU2 → ODU2 → CPRI Option 4

In accordance with this Appendix VIII, the mappings of the CPRI Option 2 client to ODU0 and the CPRI Option 3 client to ODU1 are via GMP. The CPRI Option 4 client is mapped to ODUflex, and the ODUflex is mapped to ODU2 via GMP. Finally, in (a) the ODU0 is mapped to ODU2 via GMP, and in (b) the ODU1 is mapped to ODU2 via AMP. Cases (a) and (b) have a single mapping of the CPRI client to OTN and one level of OTN multiplexing. Cases (c) and (d) have a single mapping to OTN and no OTN multiplexing.

Simulations were run for no use of additional phase information for the CPRI client to LO ODU mapper (i.e., C_n with n = 8) and 1 UI of additional phase information for the CPRI client to LO ODU mapper (i.e., C_n with n = 1). The desynchronizer bandwidth for the HO ODU to LO ODU demappers was 300 Hz.

The simulation results indicated that, for CPRI client desynchronizer bandwidth in the range of 100 – 300 Hz (current OTN client desynchronizers are 300 Hz or, in a few cases, 100 Hz or 200 Hz) RMS frequency offset ranges from approximately 113 ppb to 190 ppb for transport of CPRI Option 2 for case (a) and 156 ppb to 317 ppb for transport of CPRI Option 3 for case (b). In addition, for the same range of desynchronizer bandwidths, RMS frequency offset ranges from approximately 29 ppb to 116 ppb for CPRI option 3 for case (c) and 32 ppb to 130 ppb for CPRI Option 4 for case (d).

The simulation results also indicated that, for CPRI client desynchronizer bandwidth in the range of 100 – 300 Hz, peak-to-peak jitter ranges from approximately 6.9 – 14.2 UIpp (unit intervals peak-to-peak) for transport of CPRI Option 2 for case (a) and 6.7 – 14.1 UIpp for transport of CPRI Option 3 for case (b). In addition, for the same range of desynchronizer bandwidths, peak-to-peak jitter ranges from approximately 0.8 – 7.2 UIpp for CPRI option 3 for case (c) and 0.76 – 7.2 UIpp for CPRI Option 4 for case (d).

In order to allow compatibility with OTN transport, CPRI REs would need to be designed to tolerate and filter properly at least the noise added by the OTN transport, which is not currently budgeted by CPRI. Additional sources of noise may also exist. The OTN network should also be designed in order to meet the applicable CPRI stringent symmetry requirements; this is something that has not been studied. Interworking between OTN and the CPRI REs, in terms of jitter and wander, is still unknown and has to be considered.

2.20 Bibliography

Add the following reference:

[b-CPRI] CPRI Specification V5.0 (2011-09-21) Common Public Radio Interface (CPRI), *Interface Specification*.