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ITU-T

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G.992.3

Amendment 1
(09/2005)

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

Digital sections and digital line system – Access networks

Asymmetric digital subscriber line transceivers 2 (ADSL2)

Amendment 1

ITU-T Recommendation G.992.3 (2005) – Amendment 1

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ITU-T Recommendation G.992.3

Asymmetric digital subscriber line transceivers 2 (ADSL2)

Amendment 1

Summary

This amendment is the first amendment to the integrated ITU-T Rec. G.992.3 approved in January 2005. It specifies the following additions:

1) Additions to clause 7 and Annex K for new optional valid S and D values in the PMS-TC framer configuration. This allows the achievement of higher net data rates while satisfying a configured minimum impulse noise protection (INP_min);
2) Addition to 8.13.2.4 for warm handshake. This defines default values for some configuration parameters, when not explicitly exchanged in the G.994.1 (handshake) phase of initialization;
3) Additions to Annex K to include new INP_min values. This allows a finer granularity for configuration of the minimum impulse noise protection (INP_min) and allows an optimization of related net data rates;
4) Additions to the PTM-TC Annex K.3 to support 64/65-octet packet encapsulation (as defined in new Annex N) in addition to HDLC packet encapsulation;
5) A new Annex N defining the 64/65-octet packet encapsulation. The 64/65-octet encapsulation is defined by the IEEE 802.3 Ethernet standard and is now also included in the ITU-T DSL Recommendations;
6) A new Appendix VI defining the packet layer to physical layer logical interface.

Revision marks are relative to the latest prepublished integrated version of ITU-T Rec. G.992.3.

Source

Amendment 1 to ITU-T Recommendation G.992.3 (2005) was approved on 22 September 2005 by ITU-T Study Group 15 (2005-2008) under the ITU-T Recommendation A.8 procedure.

FOREWORD

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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.

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Amendment 1

1) Table 7-7

In the first column of the last row change:

PMS-TC

to

INP_p.

2) Addition 1: Optional S and D values

7.6.2 Valid framing configurations

Modify Table 7-8 as follows:

Table 7-8/G.992.3 – Valid framing configurations

Parameter	Capability
D_p	1, 2, 4, 8, 16, 32, 64. For the downstream latency path #0, additional valid D_0 values are: 96, 128, 160, 192, 224, 256, 288, 320, 352, 384, 416, 448, 480, 511. If $R_p = 0$ then $D_p = 1$
Relationship of $N_{FEC\,0}$ and D_0	Configurations that satisfy the following relationship are valid: $(N_{FEC\,0} - 1) \times (D_0 - 1) \leq 254 \times 63 = 16002$
Relation of S_p and M_p	Configurations that satisfy the following relationship are valid: $M_p /2 \leq S_p \leq 32 \times M_p$ (see Note 1). For the downstream latency path #0, additional valid configurations are: $M_0 /16 \leq S_0 \leq M_0 /2$
Delay Constraints	Configurations that satisfy the following relationship are valid: $1/2 \leq S_p \leq 64$ (see Note 3). For the downstream latency path #0, additional valid S_0 values are: $1/16 \leq S_0 < 1/2$

7.6.3 Mandatory framing configurations

Modify Table 7-9 as follows:

Table 7-9/G.992.3 – Mandatory downstream control parameter support for latency path #0

Parameter	Capability
D_0	1, 2, 4, 8, 16, 32, 64. Support of additional optional D_0 values is indicated during initialization. All indicated values of D_0 shall be supported. ~~All valid values of D_0 shall be supported.~~
S_0	$1/2 \leq S_0 < 64$. Support of additional optional S_0 values is indicated during initialization, through $S_{0\ min}$, with $1/16 \leq S_{0\ min} \leq 1/2$. All values of S_0, with $S_{0\ min} \leq S_0 < 1/2$, shall be supported.

7.7.1.5 Interleaver

Change paragraph as follows:

With D_p one of the mandatory values identified in Table 7-9 or Table 7-11, and with the above-defined rule, the output octets from the interleaver always occupy distinct time slots when $N_{FEC.p}$ is odd and D_p is a power of 2. When $N_{FEC.p}$ is even, a dummy octet shall be added at the beginning of the codeword at the input to the interleaver. The resultant odd-length codeword is then convolutionally interleaved, and the dummy octet shall then be removed from the output of the interleaver.

With D_0 one of the optional (i.e., valid but not mandatory) values identified in Table 7-8, the codeword length $N_{FEC.0}$ and D_0 shall be co-prime (i.e., have no common divisors except for 1). No dummy octets shall be used, as with the above-defined rule, the output octets from the interleaver always occupy distinct time slots.

7.10.1.1 G.994.1 capabilities list message

Modify Table 7-18 and add the following new Tables 7-18a, 7-18b, 7-18c, 7-18d, 7-18e, 7-18f and text:

Table 7-18/G.992.3 – Format for PMS-TC capability list information

Spar(2) bit	Definition of related Npar(3) octets
Downstream PMS-TC latency path #0 supported (always set to 1)	Parameter block of ~~2~~6 octets that describes the maximum net_max downstream rate, downstream $S_{0\ min}$, and downstream D_0 values supported in the latency path #0. The unsigned 12-bit net_max value is the data rate divided by 4000. The net_max downstream rate shall be greater than or equal to the maximum required downstream data rate for each TPS-TC type that is supported by the ATU. The supported range of S_0 values shall be indicated by its lower bound $S_{0\ min}$. $S_{0\ min}$ shall equal 1/(n+1), with n coded as an unsigned 4-bit value, in the 1 to 15 range. The D_0 values supported shall be individually indicated with 1 bit per value.
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Table 7-18a/G.992.3 – Standard information field –
Downstream PMS-TC latency path #0 NPar(3) coding – Octet 1

Bits 8	7	6	5	4	3	2	1	Downstream PMS-TC latency path #0 NPar(3)s – Octet 1
x	x	x	x	x	x	x	x	Net_max (Maximum net data rate, bits 12 to 7)

Table 7-18b/G.992.3 – Standard information field –
Downstream PMS-TC latency path #0 NPar(3) coding – Octet 2

Bits 8	7	6	5	4	3	2	1	Downstream PMS-TC latency path #0 NPar(3)s – Octet 2
x	x	x	x	x	x	x	x	Net_max (Maximum net data rate, bits 6 to 1)

Table 7-18c/G.992.3 – Standard information field –
Downstream PMS-TC latency path #0 NPar(3) coding – Octet 3

Bits 8	7	6	5	4	3	2	1	Downstream PMS-TC latency path #0 NPar(3)s – Octet 3
x	x			x	x	x	x	$S_{0\ min}$ value (=1/(n+1), n coded in bits 4 to 1, n = 1 to 15)
x	x	x	x					Reserved for allocation by the ITU-T

The $S_{0\ min}$ value shall be less than or equal to 1/2 (i.e., n ≥ 1). If the $S_{0\ min}$ octet (see Table 7-18c) is not included in the CL or CLR message, the $S_{0\ min}$ value shall be set equal to 1/2 (implicit indication). The S_0 value selected during the Exchange Phase (see Table 7-7 and 7.10.3) shall be equal to or higher than the highest of the $S_{0\ min}$ values indicated in the CL and CLR message.

Table 7-18d/G.992.3 – Standard information field –
Downstream PMS-TC latency path #0 NPar(3) coding – Octet 4

Bits 8	7	6	5	4	3	2	1	Downstream PMS-TC latency path #0 NPar(3)s – Octet 4
x	x						x	D_0 value of 96 is supported
x	x					x		D_0 value of 128 is supported
x	x				x			D_0 value of 160 is supported
x	x			x				D_0 value of 192 is supported
x	x		x					D_0 value of 224 is supported
x	x	x						D_0 value of 256 is supported

Table 7-18e/G.992.3 – Standard information field –
Downstream PMS-TC latency path #0 NPar(3) coding – Octet 5

Bits 8	7	6	5	4	3	2	1	Downstream PMS-TC latency path #0 NPar(3)s – Octet 5
x	x						x	D_0 value of 288 is supported
x	x					x		D_0 value of 320 is supported
x	x				x			D_0 value of 352 is supported
x	x			x				D_0 value of 384 is supported
x	x		x					D_0 value of 416 is supported
x	x	x						D_0 value of 448 is supported

Table 7-18f/G.992.3 – Standard information field – Downstream PMS-TC latency path #0 NPar(3) coding – Octet 6

Bits 8	7	6	5	4	3	2	1	Downstream PMS-TC latency path #0 NPar(3)s – Octet 6
							x	D_0 value of 480 is supported
x	x					x		D_0 value of 511 is supported
x	x	x	x	x	x			Reserved for allocation by the ITU-T

The D_0 value selected during the Exchange Phase (see 7.10.3) shall be one of the mandatory values (see Table 7-9) or one of the optional values (see Table 7-8), support of which is indicated in both the CL and CLR message. The selected D_0 value is not necessarily the highest commonly supported D_0 value.

7.10.3 Exchange phase

Modify Table 7-21, add note and Table 7-21a as follows:

Table 7-21/G.992.3 – Format for PMS-TC PARAMS information

Octet number [i]	**PMS-TC format** bits [8 × i + 7 to 8 × i + 0]	**Description**
Octet 10	[rrrr 0DDD] bit 7 to 0	The bits rrrr0DDD give the value of R_P and D_P for latency path #0. The rrrr and DDD bits are coded as defined in Table 7-18. They are always present and set to zero if not used.
	[DDDD 1rrr] bit 7 to 0 (see Note)	The bits DDDD and rrr give the value of $D_0 > 64$ and $R_0 > 0$ for latency path #0. The DDDD shall represent the n value as defined in Table 7-21a. The rrr shall represent the R_0 as an unsigned 3-bit value and shall be one of the non-zero valid R_0 values divided by 2, minus 1.
NOTE – This octet format shall only be used to configure optional D_0 values for the downstream latency path #0.		

Table 7-21a/G.992.3 – Coding of D_0 value in the PARAMS message

***n* value**	**D_0 value**	***n* value**	**D_0 value**
0	96	8	352
1	128	9	384
2	160	10	416
3	192	11	448
4	224	12	480
5	256	13	511
6	288	14	Reserved
7	320	15	Reserved

K.1.7.1 Valid configurations

Modify the existing note and add Notes 2 and 3 as follows:

NOTE 1 – Configuration of minimum net data rates, such that the sum of all minimum net data rates over all bearer channels result in values higher than given in Table K.3a for downstream (using only mandatory D_p values) and Table K.3b for upstream, may lead to configuration errors by the ATU-C and/or initialization failures with "configuration error" failure caused by the ATU-R. Table K.3c gives the downstream net data rate values in case all the optional D_0 values (see Table 7-8) are supported.

NOTE 2 – The net data rates given in Table K.3c are calculated for latency path #0, based on the assumptions listed below. They are calculated independent of operation modes defined in annexes. Some annexes have PSD masks limiting the number of subcarriers, which results in lower net data rates than those given in Table K.3c.

- Number of subcarriers is 255;
- Trellis coding enabled;
- All valid R, S, D and N_{FEC} values listed in Table 7-8 are allowed;
- D and N_{FEC} are co-prime as defined in 7.7.1.5;
- OR = 64 kbit/s (see Table 7-7);
- *delay_max* and *INP_min* are as defined in Table 7-7.

Add new Table K.3c at the end of the clause as follows:

Table K.3c/G.992.3 – INP_min and delay_max-related downstream net data rates limits using the optional D_0 values for downstream latency path #0 (in kbit/s)

		INP_min						
		0	**½**	**1**	**2**	**4**	**8**	**16**
delay_max [ms]	**1(Note)**	14708	0	0	0	0	0	0
	2	14708	12674	10723	6592	0	0	0
	4	14708	13702	12698	10723	6879	0	0
	8	14708	14215	13745	12770	10723	6879	0
	16	14708	14249	13854	12976	11238	7984	4024
	32	14708	14249	13854	12976	11238	7984	4024
	63	14708	14249	13854	12976	11238	7984	4024
NOTE – In ITU-T Rec. G.997.1, a 1 ms delay is reserved to mean that $S_p \leq 1$ and $D_p = 1$.								

3) Addition 2: Changes to 8.13.2.4 for warm handshake

Amend the 7th paragraph as follows:

If no CLR/CL exchange transaction is included in the G.994.1 session, the spectrum shaping indicated in the last previous CLR/CL exchange shall apply (i.e., the downstream tss_i values contained in the last previous CL message and the upstream tss_i values contained in the last previous CLR message shall be applied). Additionally, if no CLR/CL exchange transaction is included in the G.994.1 session, the spectrum bounds indicated in the last previous CLR/CL exchange shall apply (i.e., the downstream bounds *MAXNOMPSDds*, *NOMPSDds* and *MAXNOMATPds* contained in the last previous CL message and the upstream bounds *MAXNOMPSDus*, *NOMPSDus* and *MAXNOMATPus* contained in the last previous CLR message shall be applied).

4) Addition 3: Changes to Annex K to include new INP_min values

Change INP_min row in Table K.3 as follows (with same change in Tables C.K.2-2, K.10 and K.19):

Table K.3/G.992.3 – Valid configuration for STM-TC function

Parameter	Capability
INP_min$_n$	0, 1/2, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16

Modify the **Definition of the parameter block of Npar(3) octets** *in Table K.6 as follows:*

Table K.6/G.992.3 – Format for an STM-TC CL and CLR message

	Definition of the parameter block of Npar(3) octets
	A parameter block of ~~8~~9 octets containing: – the value of *net_max*; – the value of *net_min*; – the value of *net_reserve*; – the value of *delay_max*; – the value of *error_max*; and – the minimum Impulse Noise Protection *INP_min*. The unsigned 12-bit *net_max, net_min* and *net_reserve* values represent the data rate divided by 4000 bit/s. The *delay_max* is a 6-bit unsigned value expressed in ms. A value of 000000 indicates no delay bound is being imposed. The *error_max* is a 2-bit indication, defined as 00 for an error ratio of 1E-3, 01 for an error ratio of 1E-5, and 10 for an error ratio of 1E-7. The value 11 is reserved. The *INP_min* value is an 8-bit indication, with values coded as defined in Table K.6a. ~~The *INP_min* is a 4 bits indication, defined as 0b0000 for *INP* = 0, 0b0001 for *INP* = 1/2, 0b0010 for *INP* = 1, 0b0011 for *INP* = 2, 0b0111 for INP = 4, 0b1011 for INP = 8, and 0b1111 for INP = 16. *INP_min* = 0 is a special value indicating no impulse noise protection bound is being imposed. The optional INP_min values are indicated such that the 2 lsb correspond to the highest mandatory INP value and the 2 msb represent the higher optional values. A receiver not supporting the optional INP_min values may ignore the 2 msb and hence will fallback to the highest mandatory INP_min value.~~

Add new Table K.6a as follows:

Table K.6a/G.992.3 – Coding of the INP_min value

INP_min	CL/MS coding	CLR coding
0	0b 0000 0000	0b 0000 0000
½	0b 0000 0001	0b 0000 0001
1	0b 0000 0010	0b 0000 0010
2	0b 0000 0011	0b 0000 0011
3	0b 0011 0111	0b 0011 0011

Table K.6a/G.992.3 – Coding of the INP_min value

INP_min	CL/MS coding	CLR coding
4	0b 0000 0111	0b 0100 0111 0b 0000 0111 (Note)
5	0b 0101 1011	0b 0101 0111
6	0b 0110 1011	0b 0110 0111
7	0b 0111 1011	0b 0111 0111
8	0b 0000 1011	0b 1000 1011 0b 0000 1011 (Note)
9	0b 1001 1111	0b 1001 1011
10	0b 1010 1111	0b 1010 1011
11	0b 1011 1111	0b 1011 1011
12	0b 1100 1111	0b 1100 1011
13	0b 1101 1111	0b 1101 1011
14	0b 1110 1111	0b 1110 1011
15	0b 1111 1111	0b 1111 1011
16	0b 0000 1111	0b 1111 1111 0b 0000 1111 (Note)
NOTE 1 – This alternative coding is defined only for the ATU-C receiver, to assure compatibility with an ATU-R only supporting values in the set {0, 1/2, 1, 2, 4, 8, 16}. In this case, the *INP_min* value in the MS message may need to be set higher than in the CL message. NOTE 2 – If the CL or CLR message has the 4 most significant bits set to 0, then the MS message shall also have these bits set to 0.		

Change parameter block size in Tables K.7, K.15 and K.16 as follows:

A parameter block of ~~8~~9 octets containing:

5) Addition 4: Changes to Annex K.3 to include 64/65 mode

Modify the appropriate K.3 clauses as follows:

• • •

K.3.8 Data Plane Procedures ~~Functionality~~

K.3.8.1 PTM-TC/PMS-TC function interface

In the PTM-TC stream and within the PTM-TC function, data octets are transmitted MSB first. Below the α and β interfaces of the ATU (starting with the Frame.Bearer primitives), data octets are transported LSB first. As a result, the MSB of the first octet of the first PTM-TC.Stream(*n*).confirm primitive will be the LSB of the first octet of the first Frame.Bearer(*n*).confirm primitive. The labelling of bits within the PTM-TC layer and at the frame bearer is depicted in Figure K.10a.

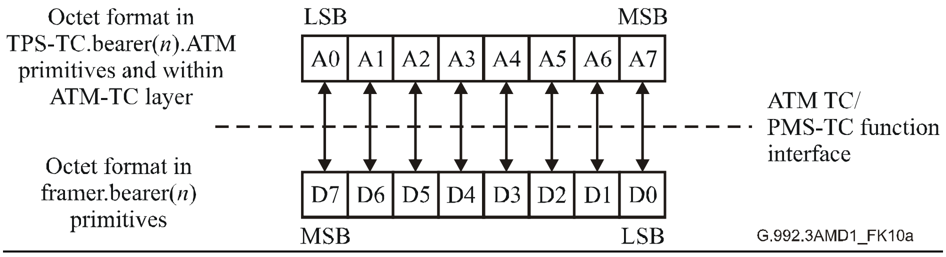


Figure K.10a/G.992.3 – Bit mapping of the user plane transport function of the PTM-TC function

K.3.8.2 Functionality

Two optional packet encapsulation methods are defined:

- HDLC encapsulation, as defined in H.4/G.993.1 [13];
- 64/65-octet encapsulation, as defined in Annex N.

The ATU may indicate during initialization support one or both packet encapsulation methods. Which packet encapsulation method is used, is selected during initialization (G.994.1 phase).

The functionality of the PTM-TC shall ~~be as defined in H.4/G.993.1 [13] and shall~~ include encapsulation, frame error monitoring, data rate decoupling, and frame delineation. For frame error monitoring, the transmitting PTM-TC shall insert the 16-bit CRC as defined for the selected packet encapsulation method.

K.3.9 Management plane procedures

K.3.9.1 Surveillance primitives

K.3.9.1.1 Surveillance primitives for HDLC encapsulation

The PTM-TC function surveillance primitives are PTM data path related~~ and defined in H.3.1.4/G.993.1 [13]. Anomalies and defects are under study~~.

Three near-end anomalies are defined:

- TC_out_of_sync (oos-*n*) anomaly: An oos-*n* anomaly occurs when the TC_synchronization signal is deasserted. An oos-*n* anomaly terminates when the TC_synchronization signal is asserted. The TC_synchronization signal is vendor discretionary.
- TC_CRC_error (crc-*n*) anomaly: a crc-*n* anomaly occurs when a frame is received with the TC_CRC_error signal asserted. The TC_CRC_error signal is asserted for packets received with incorrect CRC, and is deasserted otherwise.
- TC_coding_violation (cv-*n*) anomaly: a cv-*n* anomaly occurs when an octet is received with the TC_coding_error signal asserted. The TC_coding_error signal is vendor discretionary.

One far-end anomaly is defined:

- TC_out_of_sync (oos-*f*) anomaly: An oos-*f* anomaly occurs when the remote_TC_out_of_sync signal is asserted. An oos-*f* anomaly terminates when the remote_TC_out_of_sync signal is deasserted. The remote_TC_out_of_sync signal is vendor discretionary.

  NOTE 1 – There is no out-of-sync indication transmitted from the far-end within this Recommendation. Hence, the far-end TC_out_of_sync (oos-*f*) anomaly does not occur.

The TC_CRC_error and TC_coding_violation anomalies shall be counted locally by the PTM-TC management entity. The values of the counter may be read or reset by the management function (residing above the γ reference point) via local commands not defined in this Recommendation.

Two near-end counters are defined:

- TC_CRC_error_counter-*n*: This is a 16-bit counter of crc-*n* anomalies. The counter shall be reset to all zeroes when read by the management function or upon execution of a PTM-TC reset. The counter shall be held at all ones in the case of overflow.
- TC_coding_violation_counter-*n*: This is a 32-bit counter of cv-*n* anomalies. The counter shall be reset to all zeroes when read by the management function or upon execution of a PTM-TC reset. The counter shall be held at all ones in the case of overflow.

NOTE 2 – Related current 15 minutes and current 1 day performance monitoring counters to be maintained by the management function are defined in ITU-T Rec. G.997.1 [4].

NOTE 3 – No far-end counters are defined. It is assumed that each higher layer protocol running over this PTM-TC will provide means (outside the scope of this Recommendation) to retrieve far-end PTM-TC surveillance primitives from the far-end.

K.3.9.1.2 Surveillance primitives for 64/65-octet encapsulation

See Annex N.4.

K.3.9.2 Indicator bits

The indicator bits TIB#0 and TIB#1 shall be set to a 1 for use in 7.8.2.2.

• • •

K.3.10.1 G.994.1 capabilities list message

The following information about each upstream and downstream PTM-TC function supported within an ATU shall be defined in G.994.1 as part of the CL and CLR messages. This information may be optionally requested and reported via G.994.1 at the start of a session. However, the information shall be exchanged at least once prior to enabling a PTM-TC function between ATU-C and ATU-R but not necessarily at the start of each session. The information exchanged includes:

- Maximum net data rate that can be supported by the PTM-TC function;
- Maximum latency, maximum bit error ratio (BER) and minimum INP that might be acceptable for the PTM-TC function. The method for setting this value is out of the scope of the Recommendation.

This information for a PTM-TC function shall be represented using a block of G.994.1 information as shown in Table K.22.

Table K.22/G.992.3 – Format for a PTM-TC CL and CLR message

Spar(2) bit	Definition of related Npar(3) octets
Downstream PTM TPS-TC #0	A block of Npar(3) octets as defined below describing the capabilities of the downstream PTM-TC function #0, if present.
Downstream PTM TPS-TC #1	A block of Npar(3) octets as defined below describing the capabilities of the downstream PTM-TC function #1, if present.
Downstream PTM TPS-TC #2	A block of Npar(3) octets as defined below describing the capabilities of the downstream PTM-TC function #2, if present.
Downstream PTM TPS-TC #3	A block of Npar(3) octets as defined below describing the capabilities of the downstream PTM-TC function #3, if present.

Table K.22/G.992.3 – Format for a PTM-TC CL and CLR message

Spar(2) bit	Definition of related Npar(3) octets
Upstream PTM TPS-TC #0	A block of Npar(3) octets as defined below describing the capabilities of the upstream PTM-TC function #0, if present.
Upstream PTM TPS-TC #1	A block of Npar(3) octets as defined below describing the capabilities of the upstream PTM-TC function #1, if present.
Upstream PTM TPS-TC #2	A block of Npar(3) octets as defined below describing the capabilities of the upstream PTM-TC function #2, if present.
Upstream PTM TPS-TC #3	A block of Npar(3) octets as defined below describing the capabilities of the upstream PTM-TC function #3, if present.
	Definition of the parameter block of Npar(3) octets
	A parameter block of ~~8~~10 octets containing: – the maximum supported value of *net_max*; – the maximum supported value of *net_min*; – the maximum supported value of *net_reserve*; – the maximum supported value of *delay_max*; – the maximum supported value of *error_max*; and – the minimum Impulse Noise Protection *INP_min*. The format of the octets is as described in Table K.6. An additional octet containing indication of which encapsulation types are supported (see K.3.8). The format of this octet is as described in Table K.22a.

The format for the octet indicating the supported encapsulation types is shown in Table K.22a. If this octet is not included in the CL or CLR message, it shall be assumed that HDLC encapsulation is supported and that 64/65-octet encapsulation is not supported (implicit indication).

Add new Table K.22a as follows:

Table K.22a/G.992.3 – Indication of supported encapsulation types

Bits 8	7	6	5	4	3	2	1	**PMS-TC latency path #p NPar(3)s – Octet 10**
x	x						x	HDLC encapsulation
x	x					x		Reserved by ITU-T
x	x				x			Reserved by ITU-T
x	x			x				64/65-octet encapsulation with short packets (N.3.1.3)
x	x		x					64/65-octet encapsulation with Preemption (N.3.1.2)
x	x	x						64/65-octet encapsulation supported (N.3.1.1)
NOTE – Bit 4 and/or bit 5 may only be set if bit 6 is set.								

K.3.10.2 G.994.1 mode select message

Each of the control parameters for each upstream and downstream PTM-TC function shall be as defined in ITU-T Rec. G.994.1 as part of the MS message. This information for each enabled PTM-TC function shall be selected using a MS message prior to the PMD and TPS-TC initialization.

The configuration for a PTM-TC function shall be represented using a block of G.994.1 information as shown in Table K.23.

Table K.23/G.992.3 – Format for an PTM-TC MS message

Spar(2) bit	Definition of related Npar(3) octets
Downstream PTM TPS-TC #0	A block of Npar(3) octets as defined below describing the configuration of the downstream PTM-TC function #0, if present.
Downstream PTM TPS-TC #1	A block of Npar(3) octets as defined below describing the configuration of the downstream PTM-TC function #1, if present.
Downstream PTM TPS-TC #2	A block of Npar(3) octets as defined below describing the configuration of the downstream PTM-TC function #2, if present.
Downstream PTM TPS-TC #3	A block of Npar(3) octets as defined below describing the configuration of the downstream PTM-TC function #3, if present.
Upstream PTM TPS-TC #0	A block of Npar(3) octets as defined below describing the configuration of the upstream PTM-TC function #0, if present.
Upstream PTM TPS-TC #1	A block of Npar(3) octets as defined below describing the configuration of the upstream PTM-TC function #1, if present.
Upstream PTM TPS-TC #2	A block of Npar(3) octets as defined below describing the configuration of the upstream PTM-TC function #2, if present.
Upstream PTM TPS-TC #3	A block of Npar(3) octets as defined below describing the configuration of the upstream PTM-TC function #3, if present.
	Definition of the parameter block of Npar(3) octets
	A parameter block of ~~8~~10 octets containing: – the value of *net_max*; – the value of *net_min*; – the value of *net_reserve*; – the value of *delay_max*; – the value of *error_max*; and – the minimum Impulse Noise Protection *INP_min*. The format of the octets is as described in Table K.6. An additional octet containing indication of which encapsulation type is selected (see K.3.8). The format of this octet is as described in Table K.22a.

If the octet containing indication of which encapsulation type is selected, is not included in the MS message, it shall be assumed that HDLC encapsulation is selected (implicit indication). If the octet is included in the MS message, either HDLC or 64/65-octet encapsulation shall be selected. For 64/65-octet encapsulation, use of preemption and/or short packets shall only be selected if and only if support is indicated in both CL and CLR messages.

K.3.11 On-line reconfiguration

• • •

5) Addition 5: New Annex N

Annex N

64/65-octet PTM-TC sublayer functional specifications

N.1 Scope

The PTM-TC shall provide full transparent transfer of packets between the γ reference points at network and premises side (except non-correctable errors caused by the transmission medium). It shall also provide packet integrity and packet error monitoring capability.

In the transmit direction, the PTM-TC receives packets from the higher layer PTM entity via the γ-interface. An additional CRC is calculated on the packet and appended (to construct a PTM-TC frame). The PTM-TC then performs 64/65-octet encapsulation on the frame, and sends the resulting codewords to the PMS-TC via the α/β-interface. In the receive direction, the PTM-TC receives codewords from the PMS-TC via α/β-interface, recovers the transported PTM-TC frame, checks the CRC, and submits the extracted packet to the PTM entity via the γ-interface.

The γ-interface data, synchronization and control flows signals, (de)asserted by the higher layer PTM entity or by the PTM-TC, are summarized in Appendix VI.

The basic encapsulation and coding shall comply with IEEE 802.3 [1] clause 61.3.3, amended with support of preemption for insertion of high priority packets and amended with support for short packets (i.e., packets of less than 64 octets). Support of preemption and support of short packets are optional and are defined in the following subclauses. A transceiver supporting preemption, shall support it in both downstream and upstream direction.

NOTE 1 – In this annex, the term "packet" will be generically used to describe any type of packet (e.g., layer 2 or layer 3 packet or part thereof) that is presented to the PTM-TC at the γ reference point for transmission over the DSL link. IEEE 802.3 uses the term "fragment" as synonym for the term "packet" used in this annex.

NOTE 2 – If the PTM-TC carries IEEE 802.3 (Ethernet) packets, the packet length is at least 64 octets, in which case the codeword formats to support short packets do not occur.

NOTE 3 – If the PTM-TC defined in this annex carries a single Ethernet packet flow (no preemption and no short packets), it is identical to the Ethernet packet encapsulation defined in IEEE 802.3 [1] clause 61.3.

NOTE 4 – If the PTM-TC carries IEEE 802.3 (Ethernet) packets, it is assumed that the Preamble and SFD fields have been discarded by the PTM entity before transmitting the packets to the PTM-TC. See IEEE 802.3 [1] clause 61.1.4.1.2.

NOTE 5 – The choice to support preemption is service-related, particularly in low data rate environment.

N.2 References

[1] IEEE 802.3-2005, *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*.

N.3 PTM-TC functions

N.3.1 PTM-TC encapsulation and coding

N.3.1.1 PTM-TC basic encapsulation and coding

The PTM-TC basic encapsulation and coding shall comply with IEEE 802.3 [1] clause 61.3.3.1.

The PTM-TC coding function shall use the CRC as defined in the ITU-T Recommendations referencing this annex and generates codewords with a fixed length of 65 octets (64/65-octet coding). A codeword consists of a Sync Octet and 64 octet fields, where each octet field is either a data octet or one of the valid control characters. The PTM-TC basic codeword format and basic control character values are repeated for information in Tables N.1 and N.2.

Table N.1/G.992.3 – PTM-TC basic codeword formats

Type	Frame data	Sync octet	Octet fields 1-64									
All data	DDDD – DDDD	$0F_{16}$	D_0	D_1	D_2	D_3	D_4	D_5	…	D_{61}	D_{62}	D_{63}
End of frame	Contains k D's ($0 \le k \le 63$) and (63 – k) Z's	$F0_{16}$	C_k	D_0	D_1	D_2	D_3	…	D_{k-1}	Z	…	Z
Start of frame while transmitting	Contains last k D's of 1st frame ($0 \le k \le 62$), (62 – k – j) Z's and first j D's of second frame ($0 \le j \le 62 - k$)	$F0_{16}$	C_k	D_0	…	D_{k-1}	Z	Z	S	D_0	…	D_{j-1}
All idle	ZZZZ – ZZZZ	$F0_{16}$	Z	Z	Z	Z	Z	...	Z	Z	Z	Z
Start of frame while idle	Contains (63 – k) Z's and k D's ($0 \le k \le 63$)	$F0_{16}$	Z	Z	S	D_0	D_1	D_2	…	D_{k-3}	D_{k-2}	D_{k-1}
All idle out-of-sync	YZZZ – ZZZZ	$F0_{16}$	Y	Z	Z	Z	Z	...	Z	Z	Z	Z

Table N.2/G.992.3 – PTM-TC basic control character values

Character	Value
All data sync	$0F_{16}$ in sync position only
End or idle	$F0_{16}$ in sync position only
Z	00_{16}
C_k, $0 \le k \le 63$	$C_k = k + 10_{16}$, with MSB set so that resulting value has even parity; $C_0 = 90_{16}$, $C_1 = 11_{16}$, $C_2 = 12_{16}$, $C_3 = 93_{16}$, ... $C_{62} = 43_{16}$, $C_{63} = CF_{16}$
Y	$D1_{16}$
S	50_{16}
R	All other values (reserved)

N.3.1.2 Support for preemption

Preemption allows for the transport of a high and low priority packet flow through a single bearer channel. Under control of the PTM entity, the transmission of a low priority packet is paused, then high priority data is transmitted and the transmission of the low priority packet is resumed. Using preemption, the packet insertion delay is minimized for the high priority packets, at the expense of a higher delay for the low priority packets.

During the transmission of low priority data or idles, high priority data may be inserted in the data stream after the Sync position of the next 64/65-octet codeword, indicating a high priority codeword with a different sync octet value (AF_{16} or $F5_{16}$) as compared to low priority codewords ($0F_{16}$ or $F0_{16}$). The PTM entity indicates the presence of high-priority data to transmit through the preemptive γ-interface (corresponding to the high-priority packets flow) by asserting the Tx_Avbl synchronization signal (see Appendix VI).

Upon assertion of the Tx_Avbl synchronization signal of the preemptive γ-interface by the PTM entity (not necessarily coinciding with the start of a packet), the non-preemptive state machine for sending non-preemptive packets is, effectively, frozen in time while the high priority data is inserted. The preemptive state machine shall then send a 64/65-octet codeword starting with the preemptive sync octet $F5_{16}$ in the sync position. The preemptive codewords shall always use the same format as defined in Table N.1 for the peer non-preemptive codewords (except for different sync octet values). When starting a new preemptive frame from idle, the first preemptive codeword shall contain a start (S) character in the first position after the sync code (as a system will only insert a preemptive codeword when it has data ready to send). Subsequent 64/65-octet preemptive codewords shall start with AF_{16} in the sync position (if there are 64 or more bytes remaining) or $F5_{16}$ in sync position (if there are less than 64 bytes remaining). Starting from the next 64/65-octet codeword after the end of the last preemptive codeword, as the Tx_Avbl synchronization signal of the preemptive γ-interface is de-asserted (not necessarily coinciding with the end of a packet), the preemptive state machine for sending preemptive packets is, effectively, frozen in time, while the non-preemptive state machine continues as if it had not been interrupted and transmission of low-priority packets is resumed per the (de)assertion of the Tx_Avbl synchronization signal of the non-preemptive γ-interface (corresponding to the low priority packets flow).

There are two logically separated γ-interfaces if the PTM-TC supports preemption. The preemptive packets enter the PTM-TC sublayer through a different γ-interface than the one used by the non-preemptive packets. The two different sets of sync octets act as "virtual channel indicators" that make sure that preemptive packets can be presented to the correct γ-interface upon arrival at the receiver. If a PTM-TC with preemption is used over multiple bearer channels, then two logically separated γ-interfaces exist for each bearer channel. This is shown in Figure N.1, for the case where dual latency (with one bearer channel in each latency path) and preemption are combined.

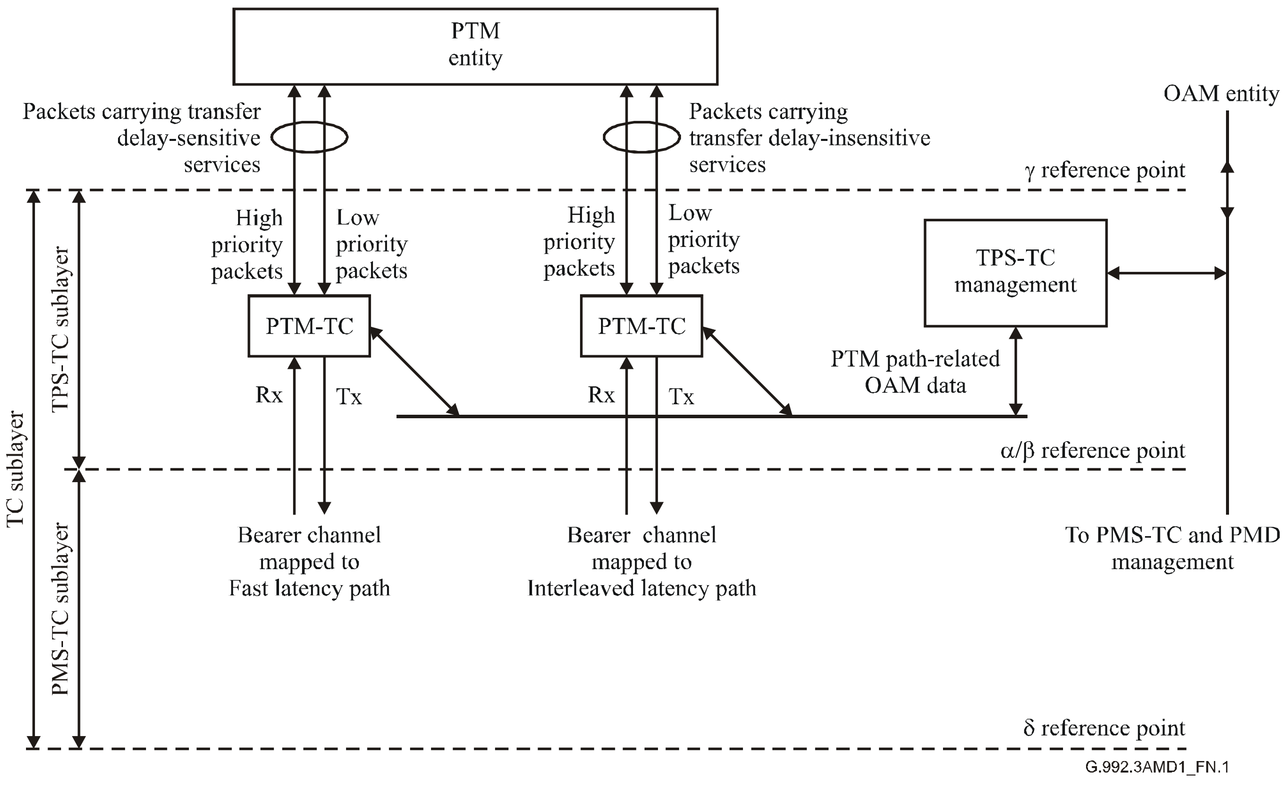


Figure N.1/G.992.3 – Reference model for packet transport with preemption

The preemptive PTM-TC frame is constructed by appending to the packet the same CRC as for constructing non-preemptive frames (see N.3.3), and is sent using the same types of 64/65-octet codewords as are used for non-preemptive frames (see Table N.3), except that all idle codewords and out-of-sync codewords are not supported with the preemptive sync octet. Upon loss of TC synchronization (TC_link_state becoming FALSE), the PTM-TC shall transmit the "All Idle Out-of-Sync" codeword from Table N.1 as the next codeword, flushing the remainder of the preemptive packet and the non-preemptive packet from the transmit buffer. The non-preemptive state machine then resumes operation.

The sync octet in the preemptive codeword uses new additional control character values that are reserved in operation without preemption (see Table N.4). All other control character values for use in the octet fields 1-64 are identical to the operation without preemption.

If the non-preemptive and preemptive Tx_Avbl are asserted mutually exclusive in time, and a full packet is transmitted over the respective γ-interface each time the respective Tx_Avbl is asserted, then the switchover from high to low or low to high priority codewords shall coincide with packet boundaries.

Table N.3/G.992.3 – PTM-TC codeword formats for preemption

Type	Frame data	Sync octet	Octet fields 1-64									
All preemptive data	DDDD – DDDD	AF_{16}	D_0	D_1	D_2	D_3	D_4	D_5	…	D_{61}	D_{62}	D_{63}
End preemptive frame (followed by the appropriate codeword from Table N.1)	Contain k D's ($0 \le k \le 63$) and ($63 - k$) Z's	$F5_{16}$	C_k	D_0	D_1	D_2	D_3	…	D_{k-1}	Z	…	Z
Start new preemptive frame after the end of preemptive frame	Contains last k D's of the first frame ($0 \le k \le 62$), ($62 - j - k$) Z's and first j D's of the second frame ($0 \le j \le 62 - k$)	$F5_{16}$	C_k	D_0	…	D_{k-1}	Z	Z	S	D_0	…	D_{j-1}
Start new preemptive frame from idle	Contains 63 D's	$F5_{16}$	S	D_0	D_1	D_2	D_3	…	D_{59}	D_{60}	D_{61}	D_{62}

NOTE – Depending on whether the use of preemption is enabled or not during initialization, codewords with sync code AF or F5 may or may not represent a coding violation. It is expected that the receiver takes this into account when declaring the coding violations defined in clause N.4.

Table N.4/G.992.3 – PTM-TC control character values for preemption

Character	Value
Continue preempt with all data, equivalent to $0F_{16}$	AF_{16} in sync position only
End preempt or start from idle, equivalent to $F0_{16}$	$F5_{16}$ in sync position only

N.3.1.3 Support for short packets

In order to support short packets (i.e., less than 64 octets) and related short frames, a C_j character shall be inserted immediately before the S character for any frame that will finish before the end of the codeword in which it starts. The definition of the C_j character shall be identical to the C_k character specified in Table N.1, with regard to the position *j* in the codeword the frame ends. If no C_j character precedes the S character, then the data shall continue to the end of the codeword as per the original definition in Table N.1.

NOTE 1 – For traffic containing no packets shorter than 63 octets, there will never be a need to insert a C_j character before an S character. Also, for short packets that start in one codeword and end in the next codeword, the extra C_j character is not inserted.

The short packet support (as indicated in ITU-T Rec. G.994.1) is applicable to both non-preemptive and preemptive codeword types using an identical definition for both. The extra codewords to support short frames (i.e., short packets with CRC appended) are defined in Table N.5, and are valid for both non-preemptive and preemptive coding.

There is no limit to the number of short frames carried in one codeword (other than the limit imposed by the minimum encapsulated packet length for $j = 1$ in Table N.5 and the codeword length).

Table N.5/G.992.3 – PTM-TC codeword formats for short packets

Type	Frame data	Sync octet	Octet fields 1-64												
Start short frame after end	(1)	$F0_{16}$	C_k	D_0	…	D_{k-1}	Z	…	C_{j1}	S	D_0	…	D_{j1-1}	Z, S or C_{j2}	…
Start short frame after idle	(2)	$F0_{16}$	Z		…		Z	…	C_{j1}	S	D_0	…	D_{j1-1}	Z, S or C_{j2}	…
Start short frame immediately after sync code	(3)	$F0_{16}$	C_{j1}	S	D_0	…		…			…		D_{j1-1}	Z, S or C_{j2}	…

(1) Contains last k D's of the first frame ($0 \le k \le 62$) and j1 D's comprising the second frame ($1 \le j1 \le 61 - k$). Note that another one or more frames could start before the end of the codeword.

(2) Contains up to ($62 - j1$) Z's and j D's comprising the short frame ($1 \le j1 \le 62$). Note that another one or more frames could start before the end of the codeword (leaving fewer Z's).

(3) Contains j1 D's comprising the short frame, where $1 \le j1 \le 62$ and ($62 - j1$) Z's. Note that another one or more frames could start before the end of the codeword (leaving fewer Z's).

NOTE 2 – Depending on whether the use of short packets is enabled or not during initialization, some octet sequences (like Z Cj S) may or may not represent a coding violation. It is expected that the receiver takes this into account when declaring the coding violations defined in clause N.4.

N.3.2 Sync insertion and transmit control

See IEEE 802.3 [1] clause 61.3.3.2.

This clause relates to the flow-control signals at the γ reference point. A logical description of the γ-interface is contained in Appendix VI.

N.3.3 PTM-TC CRC functions

See IEEE 802.3 [1] clause 61.3.3.3. This clause defines a 16-bit and a 32-bit CRC.

The PTM-TC shall use either the 16-bit or the 32-bit CRC, as defined in the relevant ITU-T Recommendations referencing this annex.

N.3.4 Bit ordering

See IEEE 802.3 [1] clause 61.3.3.4.

In this Recommendation, for each octet, the first bit received by the PTM-TC from the γ-interface shall be processed within the PTM-TC as the PTM-TC MSB. The first bit transmitted to the α/β-interface by the PTM-TC shall be the PTM-TC MSB. The PTM-TC MSB corresponds with the TC sublayer LSB b8 in IEEE 802.3, Figure 61-16.

N.3.5 Sync detection

See IEEE 802.3 [1] clause 61.3.3.5.

N.3.6 Receive control

See IEEE 802.3 [1] clause 61.3.3.6.

This clause relates to the flow-control signals at the γ reference point. A logical description of the γ-interface is contained in Appendix VI.

N.3.7 State diagrams for 64/65-octet encapsulation

N.3.7.1 Transmit state diagram

The transmit state diagram for 64/65-octet encapsulation is shown in Figures N.2 and N.3.

The transmit state diagram shows state transitions based on conditions driven by γ interface signals (Tx_Avbl and Tx_EoP), synchronization signals (TC_synchronized and TC_link_state) and state variables internal to the state diagram. For simplicity of the state diagram, the γ interface signals (Tx_Avbl and Tx_EoP) are used as applying to a frame (i.e., after the CRC has been appended to the packet), meaning the Tx_Avbl is asserted with each octet of the packet and with each CRC octet appended to the packet and meaning Tx_EoP is asserted with the last CRC octet appended to the packet.

NOTE 1 – This transmit state diagram is equivalent to the transmit state diagram defined in IEEE 802.3 [1] clause 61.3.3.7.1, with extensions for the support of preemption and short packets.

NOTE 2 – The use of Tx_Avbl and Tx_EoP as applying to the frame, rather than the packet, is identical to the use in the transmit state diagram in IEEE 802.3, Figure 61-18.

NOTE 3 – For the non-preemptive packet flow, the Tx_Avbl is asserted by the PTM entity for the full time period starting from Tx_SoP being asserted to and including Tx_EoP being asserted (i.e., non-preemptive packets are made available at the γ-interface in whole). For the preemptive packet flow, the Tx_Avbl may be (de)asserted by the PTM entity at instants not coinciding with packet boundaries (i.e., preemptive packets may be made available at the γ-interface in parts).

The transmit state diagram uses the following variables:

TC_synchronized	variable of type boolean, set to FALSE at BEGIN and indicating that receiver synchronization has been acquired.
TC_link_state	variable of type boolean, indicating link is active and framing has synchronized according to the definition in [1]/61.3.3 (TC_synchronized = TRUE) and remote_TC_out_of_sync (see [1]/61.3.3.7) is not asserted.
k	variable of type integer, used to keep track of the number of octets used in the current codeword, not including the sync symbols.
b	variable of type integer, used to keep track of the number of data octets currently in the data buffer.

sc — variable of type boolean, used to indicate that a start of frame (S) character is to be transmitted before the buffered data octets are transmitted.

ec — variable of type boolean, used to indicate that the last data octet of a frame has been written into the buffer but the end of frame (C) character is deferred to the next codeword for transmission.

ep — variable of type Boolean, used to indicate the state of the Tx_EoP signal for the last data octet written into the data buffer. The ep variable is set to TRUE under two distinct conditions:

a) at INIT;

b) when the last CRC octet is written into the transmit buffer. It is set to FALSE when the first data octet of a frame is written into the transmit buffer.

av — variable of type boolean, used to indicate that the Tx_Avbl signal is asserted and TC_link_state = TRUE.

The transmit state diagram uses the following functions. The character values are defined in Table N.2.

transmitSync() — function that transmits a single end or idle SYNC character to the α/β-interface.

transmitAllDataSync() — function that transmits a single all data SYNC character to the α/β-interface.

transmitS() — function that transmits a single S character to the α/β-interface.

transmitC(k) — function that transmits a single C_k character to the α/β-interface.

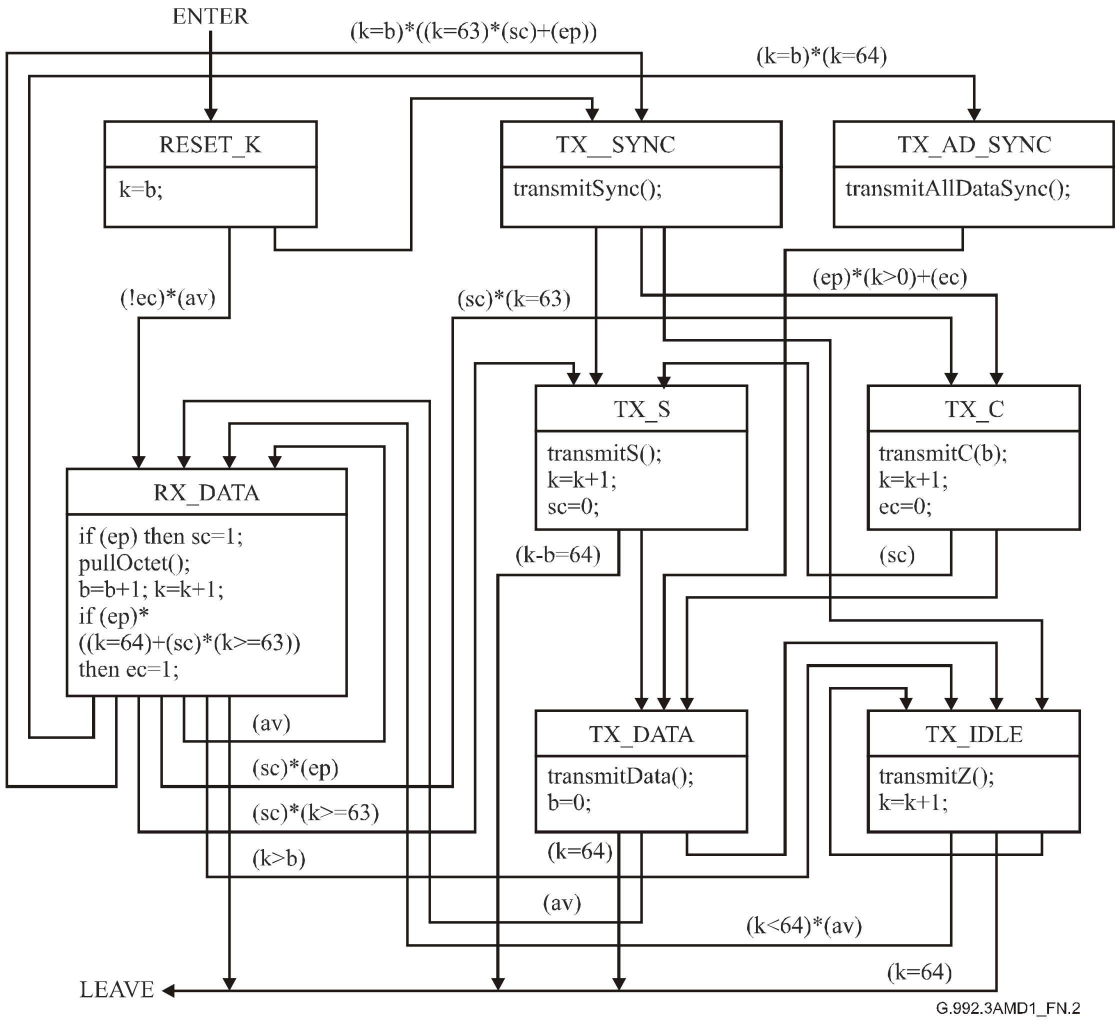
transmitZ() — function that transmits a single Z character to the α/β-interface.

transmitY() — function that transmits a single Y character to the α/β-interface.

transmitData() — function that transmits the b data octets currently in the transmit buffer to the α/β-interface.

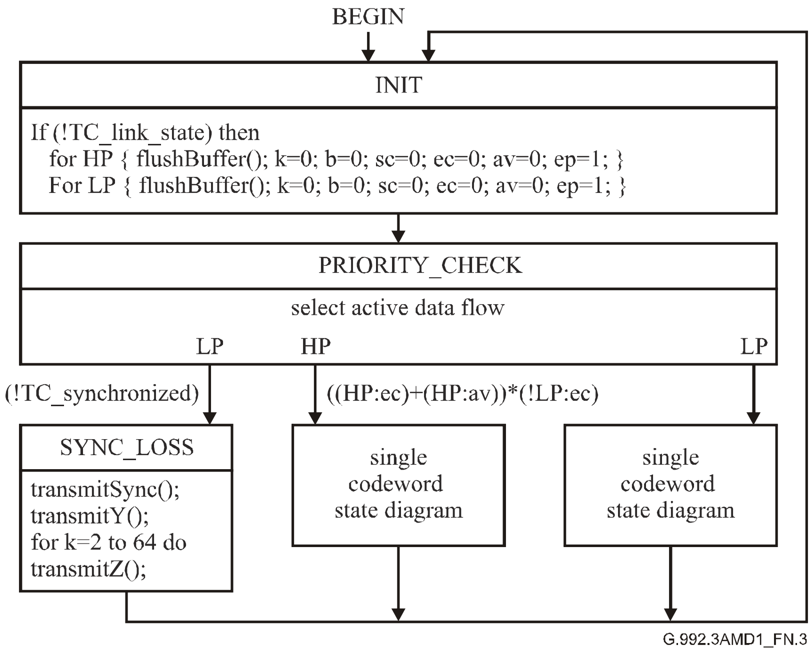
pullOctet() — function that receives a single data octet from the γ-interface into the transmit buffer and (re)sets the ep variable according to this data octet. At the end of a packet, this function returns the octets of the TC-CRC in the order specified in N.3.3.

flushBuffer() — function that removes any data octets that have been pulled by the function pullOctet() from the transmit buffer.



NOTE – The state exit conditions are evaluated left to right, the first condition evaluating TRUE is followed. The rightmost exit condition covers the ELSE/OTHERWISE conditions.

Figure N.2/G.992.3 – State diagram for the single codeword transmit function



NOTE 1 – The state exit conditions are evaluated left to right, the first condition evaluating TRUE is followed. The rightmost exit condition covers the ELSE/OTHERWISE conditions.

NOTE 2 – The LP and HP indicate the low priority (non-preemptive) and high priority (preemptive) packet flow respectively.

Figure N.3/G.992.3 – State diagram for the PTM-TC transmit function

N.3.7.2 Receive state diagram

The informative receive state diagram for 64/65-octet encapsulation (without support for preemption and short packets) is shown in IEEE 802.3 [1] clause 61.3.3.7.2.

N.3.8 PTM-TC sublayer management entity signals

See IEEE 802.3 [1] clause 61.3.3.8.

N.4 Surveillance primitives

The PTM-TC function surveillance primitives are PTM path related (see N.3.8). In case preemption is used, the preemptive and non-preemptive packet flows are separate logical packet flows over the γ reference point as shown in Figure N.1. Hence, the anomalies and related performance counters shall be maintained separately for both the preemptive and non-preemptive packet flow.

One near-end anomaly is defined for the entire bearer (applies to both the non-preemptive and preemptive packet flow):

- TC_out_of_sync (oos-*n*) anomaly: An oos-*n* anomaly occurs when the TC_synchronization signal is deasserted. An oos-*n* anomaly terminates when the TC_synchronization signal is asserted.

Two near-end anomalies are defined for the non-preemptive packet flow:

- TC_CRC_error (crc-*n*) anomaly: a crc-*n* anomaly occurs when a frame is received with the TC_CRC_error signal asserted (see N.3.7).
- TC_coding_violation (cv-*n*) anomaly: a cv-*n* anomaly occurs when an octet is received with the TC_coding_error signal asserted (see N.3.7).

Similarly, two near-end anomalies are defined for the preemptive packet flow:

- TC_CRC_error (crc-*np*) anomaly.
- TC_coding_violation (cv-*np*) anomaly.

One far-end anomaly is defined for the entire bearer channel (applies to both the non-preemptive and preemptive packet flow):

- Remote_TC_out_of_sync (oos-*f*) anomaly: An oos-*f* anomaly occurs when the remote_TC_out_of_sync signal is asserted. An oos-*f* anomaly terminates when the remote_TC_out_of_sync signal is deasserted.

  NOTE 1 – The out-of-sync codewords are defined as part of the non-preemptive packet flow (see Table N.1). The remote_TC_out_of_sync is therefore a common signal for both preemptive and non-preemptive packet flows.

The TC_CRC_error and TC_coding_violation anomalies shall be counted (separately for both the preemptive and non-preemptive packet flow) locally by the PTM-TC management entity. The values of the counter may be read or reset by the management function (residing above the γ reference point) via local commands not defined in this Recommendation.

Two near-end counters are defined for the non-preemptive packet flow:

- TC_CRC_error_counter-*n*: This is a 16-bit counter of crc-*n* anomalies. The counter shall be reset to all zeroes when read by the management function or upon execution of a PTM-TC reset. The counter shall be held at all ones in the case of overflow.
- TC_coding_violation_counter-*n*: This is a 32-bit counter of cv-*n* anomalies. The counter shall be reset to all zeroes when read by the management function or upon execution of a PTM-TC reset. The counter shall be held at all ones in the case of overflow.

Similarly, two near-end counters are defined for the preemptive packet flow:

- TC_CRC_error_counter-*np*.
- TC_coding_violation_counter-*np*.

NOTE 2 – Related current 15 minutes and current 1 day performance monitoring counters to be maintained by the management function are defined in ITU-T Rec. G.997.1 [4].

NOTE 3 – No far-end counters are defined. It is assumed that each higher layer protocol running over this PTM-TC will provide means (outside the scope of this Recommendation) to retrieve far-end PTM-TC surveillance primitives from the far-end.

NOTE 4 – In IEEE 802.3 [1], the PTM-TC sublayer management entity signals are mapped to clause 45 registers or cause clause 45 counters to increment. Clause 45 registers and counters are accessible over the local γ-interface (see clauses 45.2.6.11, 45.2.6.12 and 45.2.6.13) for a PTM-TC that is an MDIO (Management Data I/O) Manageable Device (TC MMD).

NOTE 5 – In IEEE 802.3 [1], the Ethernet management function (residing above the γ reference point) maps the near-end surveillance primitives and counters (obtained over the γ-interface through access to clause 45 MDIO registers) into MIB objects defined in clause 30. MIB objects can be read from the far-end using the Ethernet OAM PDU format and protocol defined in clause 57. The use of IEEE 802.3, clause 57 Ethernet OAM requires a bidirectional packet flow per logically separated γ-interface, i.e., that bearer channels and preemption, if enabled, are enabled in both downstream and upstream direction.

NOTE 6 – The receiver is expected to first separate the preemptive and non-preemptive codewords based on the sync code (including handling of invalid sync code values) and then detect preemptive and non-preemptive coding violations separately per the receiver state diagram in N.3.7.2, such that code violations are counted only once, as either preemptive or non-preemptive code violations.

NOTE 7 – The handling of invalid sync codes will imply that in some cases, code violations in the (non) preemptive stream are not detected as code violation of the (non) preemptive stream, but will be erroneously detected as code violation of the other stream.

6) Addition 6: New Appendix VI

Appendix VI

Packet layer to physical layer logical interface

The γ_C and γ_R reference points define interfaces between the higher layer packet functions (PTM entity) and PTM-TC at the network side transceiver and premises side transceiver respectively, as shown in Figure K.10. Both interfaces are identical, functional, and independent of the contents of the transported packets. The interfaces are defined by the following flows of signals between the PTM entity and the PTM-TC sublayer:

- data flow;
- synchronization flow;
- control flow;
- OAM flow.

VI.1 Data flow

The data flow consists of two contra-directional octet-based streams of packets: transmit packets (*Tx_PTM*) and receive packets (*Rx_PTM*). The packet transported in either direction over the γ interface may be of variable length. Bits within an octet are labelled a_1 through a_8, with a_1 being the LSB and a_8 being the MSB. If either of data streams is transmitted serially, the first octet of the packet is transmitted first and bit a_1 of each octet is transmitted first. The Data Flow signal description is presented in Table VI.1.

Table VI.1/G.993.1 – PTM-TC: γ interface data, synchronization and control flows signal summary

Flow	Signal	Description	Direction
Transmit signals			
Data	Tx_PTM	Transmit data	PTM → PTM-TC
Control	Tx_Enbl	Asserted by the PTM-TC; indicates PTM may push data to the PTM-TC	PTM ← PTM-TC
Control	TX_Err	Errored transmit packet (request to abort)	PTM → PTM-TC
Sync	Tx_Avbl	Asserted by the PTM entity if data is available for transmission	PTM → PTM-TC
Sync	Tx_Clk	Clock signal asserted by the PTM entity	PTM → PTM-TC
Sync	Tx_SoP	Start of the transmit Packet	PTM → PTM-TC
Sync	Tx_EoP	End of the transmit Packet	PTM → PTM-TC
Receive signals			
Data	Rx_PTM	Receive data	PTM ← PTM-TC
Control	Rx_Enbl	Asserted by the PTM-TC; indicates PTM may pull data from the PTM-TC	PTM ← PTM-TC
Control	RX_Err	Received error signals including FCS error, Invalid Frame, and OK	PTM ← PTM-TC

Table VI.1/G.993.1 – PTM-TC: γ interface data, synchronization and control flows signal summary

Flow	Signal	Description	Direction
Sync	Rx_Clk	Clock signal asserted by the PTM entity	PTM → PTM-TC
Sync	Rx_SoP	Start of the receive Packet	PTM ← PTM-TC
Sync	Rx_EoP	End of the receive Packet	PTM ← PTM-TC

For the non-preemptive packet flow, the PTM entity asserts Tx_Avbl when an entire packet is available for transmission, and de-assert Tx_Avbl when there are no packets to transmit. Tx_Avbl is never de-asserted during the transmission of a packet. For the preemptive packet flow, the PTM entity may (de)assert Tx_Avbl during the transmission of a packet.

VI.2 Synchronization flow

This flow provides synchronization between the PTM entity and the PTM-TC sublayer and contains the necessary timing to provide packet integrity during the transport. The synchronization flow consists of the following signals presented in Table VI.1:

- Transmit and receive timing signals (Tx_Clk, Rx_Clk); both asserted by PTM entity.
- Start of Packet signals (Tx_SoP, Rx_SoP): asserted by PTM entity and by PTM-TC respectively and intended to identify the beginning of the transported packet in the corresponding direction of transmission.
- End of Packet signals (Tx_EoP, Rx_EoP): asserted by PTM entity and by PTM-TC respectively and intended to identify the end of the transported packet in the corresponding direction of transmission.
- Transmit Packet Available signals (Tx_Avbl): asserted by PTM entity to indicate that data for transmission in the corresponding direction is ready.

VI.3 Control flow

Control signals are used to improve robustness of data transport between the PTM-entity and PTM-TC and are presented in Table H.1/G.993.1.

- Enable signals (Tx_Enbl, Rx_Enbl): asserted by PTM-TC and indicates that data may be respectively sent from PTM entity to PTM-TC or pulled from PTM-TC to PTM entity.
- Transmit error message (Tx_Err): asserted by the PTM entity and indicates that the packet or a part of the packet already transported from PTM entity to PTM-TC is errored or undesirable for transmission (abort of transmitted packet).
- Receive error message (Rx_Err): asserted by the PTM-TC to indicate that an errored packet is transported from PTM-TC to PTM entity.
- TC_link_state: asserted by the PTM-TC and indicates that the link is active AND the local TC state machine is synchronized (applies to 64/65-octet encapsulation only) AND the remote TC state machine is synchronized (applies to 64/65-octet encapsulation only).

VI.4 OAM flow

The OAM Flow across the γ interface exchanges OAM information between the OAM entity and its PTM related TPS-TC management functions. OAM flow is bidirectional.

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