International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.998.4

Amendment 2
(04/2012)

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

Digital sections and digital line system – Access networks

Improved impulse noise protection for DSL transceivers

Amendment 2

Recommendation ITU-T G.998.4 (2010) – Amendment 2

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Recommendation ITU-T G.998.4

Improved impulse noise protection for DSL transceivers

Amendment 2

Summary

Amendment 2 to Recommendation ITU-T G.998.4 (2010) covers the following functionality:

− Intra-data transfer unit (DTU) interleaver (new functionality).

− Extended memory for enhanced net data rates with vectoring (new functionality).

− Improved attainable net data rate (ATTNDR) calculation methods (new functionality).

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T G.998.4	2010-06-11	15
1.1	ITU-T G.998.4 (2010) Cor. 1	2010-11-29	15
1.2	ITU-T G.998.4 (2010) Cor. 2	2011-04-13	15
1.3	ITU-T G.998.4 (2010) Amd. 1	2011-06-22	15
1.4	ITU-T G.998.4 (2010) Cor. 3	2011-12-16	15
1.5	ITU-T G.998.4 (2010) Amd. 2	2012-04-06	15

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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Recommendation ITU-T G.998.4

Improved impulse noise protection for DSL transceivers

Amendment 2

1) Scope

This amendment covers the following functionality:

– Intra-data transfer unit (DTU) interleaver (new functionality).
– Extended memory for enhanced net data rates with vectoring (new functionality).
– Improved attainable net data rate (ATTNDR) calculation methods (new functionality).

2) Clause 2, References

Add the following new reference:

[5] Recommendation ITU-T G.993.5 (2010), *Self-FEXT cancellation (vectoring) for use with VDSL2 transceivers*.

3) Clause 4, Abbreviations and acronyms

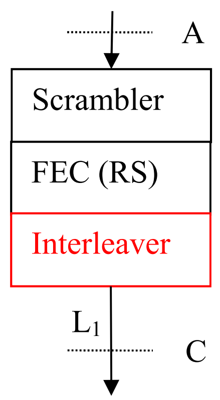
Add the following new abbreviation:

ATTNDR Attainable Net Data Rate

4) Intra-DTU interleaver

In clause 6, adapt Figures 6-1 and 6-2 to insert an interleaver inside L1 processing chain:

6 Functional Reference model



Modification in Figures 6-1 and 6-2 – Reference model

Modify clause 9.2 as follows:

9.2 FEC and interleaving

For operation per Annex A, ~~T~~the FEC shall be the same as in [ITU-T G.992.3]~~, ITU-T G.992.5, and ITU-T G.993.2~~. The interleaving used on Latency path #0 shall be the same convolutional interleaving as defined in [ITU-T G.992.3].

For operation per Annex B, the FEC shall be the same as in [ITU-T G.992.5]. The interleaving used on Latency path #0 shall be the same convolutional interleaving as defined in [ITU-T G.992.5].

For operation per Annex C, the FEC shall be the same as in [ITU-T G.993.2]. The interleaving used on Latency path #0 shall be the same convolutional interleaving as defined in [ITU-T G.993.2].

The interleaving used on Latency path #1 shall be a block interleaving. The interleaving block shall have a size of $D_1 \times N_{FEC}$ bytes, with N_{FEC} being the length of the RS codeword, and D_1 being the interleaving depth. If D_1=1, then an interleaving block equals an RS codeword. If D_1=Q (the number of RS codewords per DTU) then an interleaving block equals a DTU. Each byte B_k within an interleaving block (input at position k, with index k in the interval 0 to $D_1 \times N_{FEC} - 1$) shall be located at the output of the interleaving function at position l given by $l = i \times D_1 + j$, where $i = k$ MOD N_{FEC} and j = floor(k / N_{FEC}). The block interleaver is illustrated in Figure 9-1a.

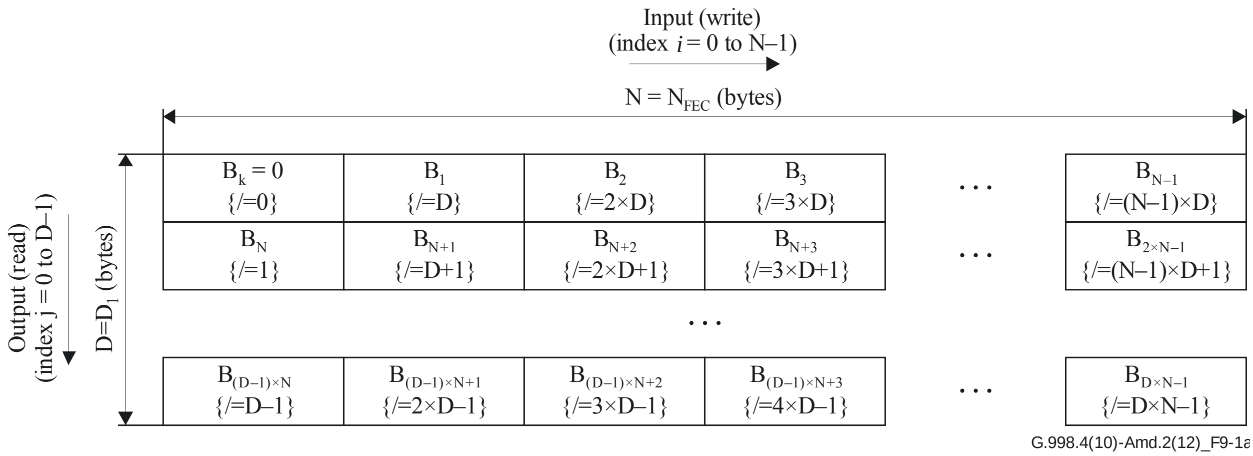


Figure 9-1a – Illustration of the block interleaver

In clause 9.4.1, insert a row "D_1" in Table 9-1 after row "Q" as follows:

9.4.1 Primary Parameters

Table 9-1 – Primary framing parameters

Q	The number of RS codewords per DTU (Note 1)
D_1	The interleaving depth for latency path #1

In clause 9.4.3, insert a row "D_1" in Table 9-3 after row "Q" as follows:

9.4.3 Valid configurations

Table 9-3 – Valid configurations of framing parameters

Q	The valid values of Q are any integer from 1 to 64 if the associated Recommendation is ITU-T G.993.2. The valid values of Q are any integer from 1 to 16 if the associated Recommendation is ITU-T G.992.3 or ITU-T G.992.5. Furthermore, valid configurations of Q shall be such that $0.5 \le Q \times S_1 \le 4$ in L_0 state.
D_1	The only valid value of D_1 is 1 if the associated Recommendation is ITU-T G.992.3 or ITU-T G.992.5. The valid values of D_1 are any integer from 1 to 64 if the associated Recommendation is ITU-T G.993.2, but restricted to the set of values advised by the remote transmitter (see clauses C.2.1.1 and C.2.2.1). Furthermore, valid values of D_1 shall be such that D_1 = Q or D_1 = 1.

In clause 9.4.4, insert a row "D_1" in Table 9-4 after row "Q" as follows:

9.4.4 Mandatory configurations

Table 9-4 – Mandatory configurations of the framing parameters

Q	All valid values shall be supported
D_1	The only mandatory value of D_1 is 1.

In clause C.2.1.1, add a row at the end of Table C.2 with field definition as follows:

C.2.1.1 O-MSG 1

Table C.2 – ITU-T G.998.4 parameter field for O-MSG1

~~Octet~~	Field ~~C~~contents	Format	Description
8	Downstream D_1 values supported	1 byte [edddddddd]	Indicates the optional block interleaving depth values supported by the VTU-O transmitter

Field #8 "Downstream D_1 values supported" contains the description of the set of downstream block interleaving depth values supported by the VTU-O transmitter on the latency path #1. The field shall be coded as a single byte [eddddddd], where:

- ddddddd is a seven-bit unsigned integer indicating the maximum interleaving depth D_1 value supported;
- e is set to 1 to indicate that the VTU-O only supports D_1 values that are an integer power of 2, and set to 0 otherwise.

In clause C.2.1.2, change heading row of Table C.3 with field definition as follows:

C.2.1.2 O-TPS

Table C.3 – ITU-T G.998.4 parameter field for O-TPS

~~Octet~~	Field ~~C~~contents	Format	Description

In clause C.2.1.3, add a row at the end of Table C.4 with field definition as follows:

C.2.1.3 O-PMS

Table C.4 – ITU-T G.998.4 parameter field for O-PMS

~~Octet~~	Field content	Format	Description
9	D_1	1 byte	Block interleaving depth in the upstream direction.

Field #9 "D_1" indicates the block interleaving depth in the upstream direction on the latency path #1. D_1 shall take a value in the range from 1 to 64 (inclusive). D_1 shall be either equal to 1 or equal to Q.

In clause C.2.2.1, add a row at the end of Table C.5 with field definition as follows:

C.2.2.1 R-MSG 2

Table C.5 – ITU-T G.998.4 parameter field for R-MSG2

~~Octet~~	Field content	Format	Description
9	Upstream D_1 values supported	1 byte [eddddddd]	Indicates the optional block interleaving depth values supported by the VTU-R transmitter

Field #9 "Upstream D_1 values supported" contains the description of the set of upstream block interleaving depth values supported by the VTU-R transmitter. The field shall be coded as a single byte [eddddddd], where:

- ddddddd is a seven-bit unsigned integer indicating the maximum interleaving depth D_1 value supported;
- e is set to 1 to indicate that the VTU-R only supports D_1 values that are an integer power of 2, and set to 0 otherwise.

In clause C.2.2.2, add a row at the end of Table C.6 with field definition as follows:

C.2.2.2 R-PMS

Table C.6 – ITU-T G.998.4 parameter field for R-PMS

~~Octet~~	Field content	Format	Description
9	D_1	1 byte	Block interleaving depth in the downstream direction.

Field #9 "D_1" indicates the block interleaving depth in the downstream direction on the latency path #1. D_1 shall take a value in the range from 1 to 64 (inclusive). D_1 shall be either equal to 1 or equal to Q.

5) Extended memory for enhanced bit rates when operating with vectoring

In clause C.2.2.1, add a row at the end of Table C.5 with field definition as follows:

C.2.2.1 R-MSG 2

Table C.5 – ITU-T G.998.4 parameter field for R-MSG2

~~Octet~~	Field content	Format	Description
10	Reserved for [ITU-T G.993.5]	3 bytes	Reserved for [ITU-T G.993.5] (see clause D.2.2.1)

Field #10 is reserved for [ITU-T G.993.5]. It is a 24-bit field that shall be coded as 000000_{16}.

Add new Annex D in ITU-T G.998.4 as follows:

Annex D

Support of ITU-T G.998.4 with ITU-T G.993.5

(This annex forms an integral part of this Recommendation.)

If ITU-T G.993.5 vectoring is selected in at least one direction (as indicated in the ITU-T G.994.1 MS message), then operation of ITU-T G.998.4 shall comply with this Annex D.

Annex D is defined relative to Annex C. All requirements of Annex C apply, with the replacements and supplements as identified in this Annex D.

~~C~~D.1.1 Memory (replaces clause C.1.1)

The following definitions shall apply:

$$\text{delay\_octet}_{DS,0} = (D_{DS,0} - 1) \times (I_{DS,0} - 1)$$

$$\text{delay\_octet}_{US,0} = (D_{US,0} - 1) \times (I_{US,0} - 1).$$

If retransmission is enabled in the downstream direction,

then $\text{delay\_octet}_{DS,1} = 2 \times Q_{tx,DS} \times Q_{DS} \times H_{DS}$

otherwise $\text{delay\_octet}_{DS,1} = (D_{DS,1} - 1) \times (I_{DS,1} - 1)$

If retransmission is enabled in the upstream direction,

then $\text{delay\_octet}_{US,1} = 2 \times Q_{tx,US} \times Q_{US} \times H_{US}$

otherwise $\text{delay\_octet}_{DS,1} = (D_{US,1} - 1) \times (I_{US,1} - 1)$

The AGGDELAYOCTET is defined as:

$$\text{AGGDELAYOCTET} = \text{delay\_octet}_{DS,0} + \text{delay\_octet}_{DS,1} + \text{delay\_octet}_{US,0} + \text{delay\_octet}_{US,1}$$

The following constraint shall apply:

~~delay_octet~~ $\cancel{\text{delay\_octet}_{DS,0} + \text{delay\_octet}_{DS,1} + \text{delay\_octet}_{US,0} + \text{delay\_octet}_{US,1}}$

$$\text{AGGDELAYOCTET} \leq \text{MAXDELAYOCTET\_ext.}$$

If the MAXDELAYOCTET_ext_R (as indicated by the VTU-R in R-MSG 2, see clause C.2.2.1) is greater than ~~where~~ MAXDELAYOCTET (~~is~~ the parameter "aggregate interleaver and de-interleaver delay", in octets, specified in Table 6-1 of ITU-T G.993.2 for the profile) then extended memory operation shall be enabled with MAXDELAYOCTET_ext equal to the minimum of MAXDELAYOCTET_ext_R (defined in clause C.1.1.1) and MAXDELAYOCTET_ext_O (defined in clause C.1.1.1). Otherwise extended memory operation shall be disabled, with MAXDELAYOCTET_ext equal to MAXDELAYOCTET.

NOTE – Since the VTU-O controls the splitting of the MAXDELAYOCTET_ext octets over upstream and downstream (see clause C.2.1.3), the MAXDELAYOCTET_ext_O value does not need to be communicated from the VTU-O to the VTU-R.

Moreover, the following constraint shall apply on the memory allocated for the interleavers:

- If retransmission is enabled in both directions:

$$delay\_octet_{DS,0} + delay\_octet_{US,0} \le MAXDELAYOCTET.$$

- If retransmission is enabled only in downstream direction:

$$delay\_octet_{DS,0} + delay\_octet_{US,0} + delay\_octet_{US,1} \le MAXDELAYOCTET.$$

- If retransmission is enabled only in the upstream direction:

$$delay\_octet_{DS,0} + delay\_octet_{DS,1} + delay\_octet_{US,0} \le MAXDELAYOCTET.$$

The VTU-O and VTU-R shall support all values of ~~(~~$delay\_octet_{DS,0}$, ~~+~~ $delay\_octet_{DS,1}$, ~~+~~ $delay\_octet_{US,0}$, ~~+~~ and $delay\_octet_{US,1}$~~)~~ such that both of the above constraints are met~~up to the maximum of MAXDELAYOCTET~~. The minimum amount of memory required in a transceiver (VTU-O or VTU-R) to meet this requirement is $\frac{MAXDELAYOCTET}{2}$ $\frac{MAXDELAYOCTET\_ext}{2}$ octets. The actual amount of memory used is implementation specific.

The minimum memory for the receiver retransmission queue shall be identical to the amount of the memory for the related transmit queue of the same direction.

The maximal DTU size in octets ($Q \times H$) shall be equal to the value given in Table ~~C~~D.1 depending on the profile and direction.

Table ~~C~~D.1 – Maximal DTU size

Profile	**Maximal DTU size ($Q \times H$)**	
	Downstream	Upstream
8a,8b,8c,8d	2048 bytes	512 bytes
12a	2048 bytes	1536 bytes
17a	3072 bytes	1536 bytes
30a	3072 bytes	3072 bytes

The MAXDELAYOCTET-split (MDOSPLIT) configuration parameter shall be applied in ITU-T G.998.4 to the MAXDELAYOCTET_ext. With $delay\_octet_{x,p}$ (with x = DS or US and p = 0 or 1) as defined in this clause, the sum of the max_delay_octet values specified in O-PMS (see clause C.2.1.3) shall be limited to (see clause 11.4.2.7 of ITU-T G.993.2):

$$max\_delay\_octet_{DS,0} + max\_delay\_octet_{DS,1} \le MAXDELAYOCTET\cancel{S}\_DS,$$

$$max\_delay\_octet_{US,0} + max\_delay\_octet_{US,1} \le MAXDELAYOCTET\cancel{S}\_US.$$

with MAXDELAYOCTET_DS = ⌈MDOSPLIT × MAXDELAYOCTET_ext⌉,
MAXDELAYOCTET_US = MAXDELAYOCTET_ext – MAXDELAYOCTET_DS,
and ⌈x⌉ denoting rounding to the higher integer.

~~C~~D.1.1.1 Extended memory operation for enhanced net data rates with ITU-T G.993.5 (vectoring) (new clause)

The reference half roundtrip (HRT_{ref}) values for determining ~~Max~~AggAchievableNDR_O~~Mem~~ and AggAchievableNDR_R are the following:

- Profile 17a: HRT_{ref} = 8 DMT symbols (2 ms)
- Profile 30a: HRT_{ref} = 12 DMT symbols (1.5 ms)

The Maximum Aggregate Achievable Net Data Rate (MaxAggAchievableNDR) for each profile, are the following:

- Profile 17a = 150 Mbit/s
- Profile 30a = 250 Mbit/s

The above values may be used for provisioning the amount of memory in the VTU based on knowledge of the VTU's actual half roundtrip value (HRT_{VTU}) and the reference half roundtrip (HRT_{ref}) assumed for the far-end VTU.

If the VTU-O

- has actual half roundtrips expressed in symbols ≤ HRT_{ref}, i.e., $HRT_{rx}^{S} \le HRT_{ref}$, and $HRT_{tx}^{S} \le HRT_{ref}$ and,
- has actual half roundtrips computed in DTU equal to 0, i.e., $\cancel{HRT_{rx}^{DTU}}$ HRT_{rx}^{D}=0, and $\cancel{HRT_{tx}^{DTU}}$ HRT_{tx}^{D}=0 and,
- aligns the sync symbols in the direction of DTU transmission with the sync symbols in the RRC direction in a range from $-HRT_{rx}^{S} + \lfloor Q \times S_1 \rfloor$ to $HRT_{tx}^{S} - 1$ DMT symbols, where a positive value indicates that the sync symbol in the direction of DTU transmission is sent after the sync symbol in the RRC direction,

then for a given value of AGGDELAYOCTET supported in the VTU-O (denoted as MAXDELAYOCTET_ext_O), the AggAchievableNDR_O shall be computed as follows:

$$AggAchievableNDR\_O(\text{kbit/s}) = \min\left(\frac{8\,(\text{bits/byte}) \times \text{MAXDELAYOCTET\_ext\_O}\,(\text{bytes})/2}{(HRT_{VTU-O}^{S} + HRT_{ref} + 1)/\text{f}_{\text{DMT}}\ (\text{kHz})}, MaxAggAchievableNDR\right),$$

with HRT_{VTU-O}^{S} being the highest of the VTU-O's actual half roundtrips HRT_{tx}^{S} and HRT_{rx}^{S}. Otherwise, the AggAchievableNDR_O shall be undefined.

If the VTU-R

- has actual half roundtrips expressed in symbols ≤ HRT_{ref}, i.e., $HRT_{rx}^{S} \le HRT_{ref}$, and $HRT_{tx}^{S} \le HRT_{ref}$ and,
- has actual half roundtrips computed in DTU equal to 0, i.e., $\cancel{HRT_{rx}^{DTU}}$ HRT_{rx}^{D}=0, and $\cancel{HRT_{tx}^{DTU}}$ HRT_{tx}^{D}=0 ,

then for a given value of AGGDELAYOCTET supported in the VTU-R (denoted as MAXDELAYOCTET_ext_R), the AggAchievableNDR_R shall be computed as follows:

$$AggAchievableNDR\_R(\text{kbit/s}) = \min\left(\frac{8\,(\text{bits/byte}) \times \text{MAXDELAYOCTET\_ext\_R}\,(\text{bytes})/2}{(HRT^{S}_{VTU-R} + HRT_{ref} + 1)/\text{f}_{\text{DMT}}\,(\text{kHz})}, MaxAggAchievableNDR \right),$$

with HRT^{S}_{VTU-R} being the highest of the VTU-R's actual half roundtrips HRT^{S}_{tx} and HRT^{S}_{rx}. Otherwise, the AggAchievableNDR_R shall be undefined.

The AggAchievableNDR_O shall be reported in the CO-MIB as ~~near-end AggAchievableNDR~~AGGACHNDR_NE. The AggAchievableNDR_R shall be reported in the CO-MIB as ~~far-end AggAchievableNDR~~AGGACHNDR_FE. A special value shall be reported to indicate that the AggAchievableNDR is undefined.

NOTE 1 – Some transceiver designs may choose to implement additional memory or lower HRT to potentially support net data rates that are greater than the above MaxAggAchievableNDR values. If the actual memory used in showtime is sufficiently large or the actual roundtrip in showtime is sufficiently small, then net data rates greater than MaxAggAchievableNDR may be achieved.

NOTE 2 – The above calculation assumes that the DTU is configured within one DMT symbol. If this or other conditions are not satisfied, then the actual aggregate NDR may be less than the minimum of AggAchievableNDR_O and AggAchievableNDR_R.

NOTE 3 – The following is an example:

- To support MaxAggNDR for profile 17a, transceiver A has an actual half roundtrip value of $HRT^{S} = 8$ DMT symbols. To support the profile 17a MaxAggNDR value of 150 Mbit/s, the transceiver needs 79,688 bytes of memory under the assumption that far-end transceiver has an *HRT* no higher than the HRT_{ref} of 2 ms.
- Transceiver B has an actual half roundtrip value of $HRT^{S} = 7$ DMT symbols. To support the MaxAggNDR of 150 Mbit/s, this transceiver needs 75,000 bytes of memory.
- If transceivers A and B were to interoperate with each other, then operation at 150 Mbit/s NDR would be achieved, assuming that the line conditions permit.

D.1.3.3 ATTNDR_MAXDELAYOCTET-split (ATTNDR_MDOSPLIT) (supplements clause C.1.3.3)

See clause 11.4.2.8 of ITU-T G.993.2, with:

ATTNDR_MAXDELAYOCTET_DS = $\lceil$ATTNDR_MDOSPLIT × MAXDELAYOCTET_ext$\rceil$,

ATTNDR_MAXDELAYOCTET_US = MAXDELAYOCTET_ext – ATTNDR_MAXDELAYOCTET_DS

and $\lceil x \rceil$ denoting rounding to the higher integer.

~~C~~D.2.2.1 R-MSG 2 (supplements clause C.2.2.1)

Replace field #10 of Table C.5 with field definition as follows:

Table C.5 – ITU-T G.998.4 parameter field for R-MSG2

~~Octet~~	Field content	Format	Description
10	MAXDELAYOCTET_ext_R	3 bytes	Value of AGGDELAYOCTET supported in the VTU-R for extended memory operation

Field #10 "MAXDELAYOCTET_ext_R" is a 3 octet field that indicates the value of AGGDELAYOCTET supported in the VTU-R (see clause C.1.1.1) for extended memory operation (see clause C.1.1). This field shall be coded as an unsigned 24-bit integer representing the value in multiples of 1 octet.

6) Improved definition of attainable net data rate (ATTNDR)

Modify clause C.1.2 as follows:

C.1.2 Overhead channel

If the ROC is enabled in O-TPS, single latency with ROC mode (see clause 9.1 of ITU-T G.993.2) shall be used and the overhead channel shall use the ROC as specified in ITU-T G.993.2.

If ROC is disabled in O-TPS or is not supported by either the VTU-O or the VTU-R, single latency with ROC mode (see clause 9.1 of ITU-T G.993.2) shall be used and the overhead channel shall use the framing parameters as they are derived for the ROC (see framer constraint limitations in Table 12-47 of ITU-T G.993.2) with the following configuration:

– SNRMOFFSET-ROC = 0 dB,

– INPMIN-ROC = max(INPMIN_REIN, 2),

with the exception that sub-carriers loaded with the bits of the overhead channel may share sub-carriers loaded with the bits of the latency path #1.

Add clause C.1.3 (new clause)

C.1.3 Attainable net data rate (ATTNDR)

See clause 11.4.1.1.7 of ITU-T G.993.2.

NOTE – The calculation of the ATTNDR in loop diagnostics uses an SNRGAP value that is defined for a 10^{-7} bit error ratio on 4-QAM (no coding gain, no retransmission, $INP\_min_{0\cancel{n}}$=0).

C.1.3.1 The basic attainable net data rate method

See clause 11.4.1.1.7.1 of ITU-T G.993.2.

C.1.3.2 The improved attainable net data rate method

Support of the improved attainable net data rate method is optional.

The attainable net data rate is the maximum net data rate that the receive PMS-TC and PMD functions are designed to support, assuming the conditions of the basic attainable net data rate method (see clause 11.4.1.1.7.1) and the following conditions:

- ~~Using the configured impulse noise protection limit values (*INP_min*$_n$, *INP_min_rein*$_n$, and *iat_rein*$_n$) if the CO-MIB parameter ATTNDR_METHOD is set to a value of 1 or using assumed values of ZERO (*INP_min*$_n$=0, and *INP_min_rein*$_n$=0) if the CO-MIB parameter ATTNDR_METHOD is set to a value of 2 (see clause 7.3.1.15.1/G.997.1);~~
- If the control parameter *attndr_method* is set to a value of 1, the VTU-O and VTU-R shall use the impulse noise protection limit *INP_min*$_0$ with value as indicated in O-TPS (see clause C.2.1.2);
- If the control parameter *attndr_method* is set to a value of 2, the VTU-O and VTU-R shall use an impulse noise protection limit *INP_min*$_0$ = 0;
- Use of Erasure decoding or not is identical to usage on the bearer channels;
- Taking into account the framing limitations;
- Latency not less than the minimum latency configured for the bearer channel ($delay\_act_{0\cancel{n}} \geq delay\_min_{0\cancel{n}}$);
- Taking into account the value of the ~~ATTNDR-MDO-split~~ATTNDR_MDOSPLIT parameter;
- Net data rate is neither limited by the configured maximum net data rate, nor by the configured maximum ETR;

- Taking into account the actual half roundtrip delay of the VTU-O and VTU-R;
- Channel Initialization Policy CIP = 0;
- Transmit PSD is equal to MREFPSD for all sub-carriers for which gi ≠ 0.

  NOTE – The ATTNDR value may be lower due to possible transmit power reductions, as a consequence of configured MAXMARGIN setting, configured MAXNDR setting and vendor discretionary transmit power reductions (e.g., subcarriers with $g_i = 0$, due to AFE dynamic range, …).

NOTE – The basic method does not specify a number of conditions to calculate ATTNDR, which leads to vendor discretionary behaviour in the reported ATTNDR values. The improved method defines additional conditions to reduce variation of reported ATTNDR values over implementations.

When the ATTNDR value is reported during Showtime for a direction in which retransmission is disabled, the following parameters used in the calculation of the ATTNDR shall also be reported over the eoc with the ATTNDR value (see clause 11.4.1.1.7.2 and Table 11-28a of ITU-T G.993.2) and also be reported in the CO-MIB with the ATTNDR value (see clauses 7.5.1.19 and 7.5.1.20 of ITU-T G.997.1):

- *ATTNDR_INP_act*$_{\underline{0}\cancel{n}}$ (see clauses 7.5.1.41.2 and 7.5.41.3 of ITU-T G.997.1);
- *ATTNDR_delay_act*$_{\underline{0}\cancel{n}}$ (see clauses 7.5.1.41.6 and 7.5.41.7 of ITU-T G.997.1).

When the ATTNDR value is reported during Showtime for a direction in which retransmission is enabled, the following parameters used in the calculation of the ATTNDR shall also be reported over the eoc with the ATTNDR value (see Table C.1a) and also be reported in the CO-MIB with the ATTNDR value (see clauses 7.5.1.19 and 7.5.1.20 of ITU-T G.997.1):

- *ATTNDR_INP_act_SHINE*$_{\underline{0}\cancel{n}}$ (see clauses 7.5.1.41.2 and 7.5.41.3 of ITU-T G.997.1);
- *ATTNDR_INP_act_REIN*$_{\underline{0}\cancel{n}}$ (see clauses 7.5.1.41.4 and 7.5.41.5 of ITU-T G.997.1);
- *ATTNDR_delay_act_RTX*$_{\underline{0}\cancel{n}}$ (see clauses 7.5.1.41.6 and 7.5.41.7 of ITU-T G.997.1).

The parameter *ATTNDR_INP_act_SHINE*$_{\underline{0}\cancel{n}}$ is the SHINE far-end actual impulse noise protection used in the calculation of the ATTNDR. The actual impulse noise protection *ATTNDR_INP_act_SHINE*$_{\underline{0}\cancel{n}}$ shall be represented as a 16-bit unsigned integer *attndr_inp_act_shine*$_{\underline{0}\cancel{n}}$, with the value of *ATTNDR_INP_act_SHINE*$_{\underline{0}\cancel{n}}$ defined as *ATTNDR_INP_act_SHINE*$_{\underline{0}\cancel{n}}$ = *attndr_inp_act_shine*$_{\underline{0}\cancel{n}}$ / 10 DMT symbols. This data format supports an *ATTNDR_INP_act_SHINE*$_{\underline{0}\cancel{n}}$ granularity of 0.1 DMT symbol. The range is from 0 DMT symbols (represented as 0) to 204.6 DMT symbols (represented as 2046). The value 2047 is a special value indicating an *ATTNDR_INP_act_SHINE*$_{\underline{0}\cancel{n}}$ higher than 204.6 DMT symbols.

The parameter *ATTNDR_INP_act_REIN*$_{\underline{0}\cancel{n}}$ is the far-end REIN actual impulse noise protection used in the calculation of the ATTNDR. The actual impulse noise protection *ATTNDR_INP_act_REIN*$_{\underline{0}\cancel{n}}$ shall be represented as an 8-bit unsigned integer *attndr_inp_act_REIN*$_{\underline{0}\cancel{n}}$, with the value of *ATTNDR_INP_act_rein*$_{\underline{0}\cancel{n}}$ defined as *ATTNDR_INP_act_REIN*$_{\underline{0}\cancel{n}}$ = *attndr_inp_act_rein*$_{\underline{0}\cancel{n}}$ / 10 DMT symbols. This data format supports an *ATTNDR_INP_act_REIN*$_{\underline{0}\cancel{n}}$ granularity of 0.1 DMT symbol. The range is from 0 DMT symbols (represented as 0) to 25.4 DMT symbols (represented as 254). The value 255 is a special value indicating an *ATTNDR_INP_act_REIN*$_{\underline{0}\cancel{n}}$ higher than 25.4 DMT symbols.

The parameter *ATTNDR_delay_act_RTX*$_{\underline{0}\cancel{n}}$ is the far-end actual delay used in the calculation of the ATTNDR. The actual delay *ATTNDR_delay_act_RTX*$_{\underline{0}\cancel{n}}$ shall be represented as an 8-bit unsigned integer *attndr_delay_ac_rtxt*$_{\underline{0}\cancel{n}}$, with the value of *ATTNDR_delay_act_RTX*$_{\underline{0}\cancel{n}}$ defined as *ATTNDR_delay_act_RTX*$_{\underline{0}\cancel{n}}$ = *attndr_delay_act_rtx*$_{\underline{0}\cancel{n}}$ / 10 ms. This data format supports an *ATTNDR_delay_act_RTX*$_{\underline{0}\cancel{n}}$ granularity of 0.1 ms. The range is from 0 ms (represented as 0) to 25.4 ms (represented as 254). The value 255 is a special value indicating an *ATTNDR_DELAY_act_RTX*$_{\underline{0}\cancel{n}}$ higher than 25.4 ms.

C.1.3.3 ATTNDR_MAXDELAYOCTET-split (ATTNDR_MDOSPLIT)

<u>See clause 11.4.2.8 of ITU-T G.993.2.</u>

~~See clause 11.4.2.8/G.993.2, where the ATTNDR_max_delay_octet values shall be defined as:~~

~~ATTNDR_max_delay_octet$_{DS,1}$ = ATTNDR_MAXDELAYOCTET_DS – delay_octet$_{DS,0}$~~

~~ATTNDR_max_delay_octet$_{US,1}$ = ATTNDR_MAXDELAYOCTET_US – delay_octet$_{US,0}$~~

~~with~~

~~ATTNDR_MAXDELAYOCTET_DS = $\lceil$ATTNDR_MDOSPLIT × MAXDELAYOCTET_ext$\rceil$,~~

~~ATTNDR_MAXDELAYOCTET_US = MAXDELAYOCTET_ext – ATTNDR_MAXDELAYOCTET_DS.~~

~~and $\lceil x \rceil$ denoting rounding to the higher integer.~~

~~The delay_octet$_{DS,0}$ and delay_octet$_{US,0}$ values correspond to the actual configuration of the latency path #0 as applicable at the instant of ATTNDR calculation.~~

~~The ATTNDR_max_delay_octet$_{DS,1}$ specifies the maximum of delay_octet$_{DS,1}$ that the VTU-R shall assume in the calculation of ATTNDR in downstream (see clause 12.3.5.2.1.3).~~

~~The ATTNDR_max_delay_octet$_{US,1}$ specifies the maximum of delay_octet$_{US,1}$ that the VTU-O shall assume in the calculation of ATTNDR in upstream.~~

C.1.3.4 ATTNDR test parameter read commands and responses

See clause 11.2.3.11 of ITU-T G.993.2, with the ATTNDR test parameter defined as shown in Table C.1a.

Table C.1a – ATTNDR test parameter

Octet number	Basic method	Improved method (retransmission disabled)	Improved method (retransmission enabled)
1 - 4	*ATTNDR*	*ATTNDR*	*ATTNDR*
5	N/A	Reserved and set to 00_{16}	*ATTNDR_INP_act_SHINE*$_{\underline{0}\cancel{n}}$
6	N/A	*ATTNDR_INP_act*$_{\underline{0}\cancel{n}}$	
7	N/A	Reserved and set to 00_{16}	*ATTNDR_INP_act_REIN*$_{\underline{0}\cancel{n}}$
8	N/A	*ATTNDR_delay_act*$_{\underline{0}\cancel{n}}$	*ATTNDR_delay_act_RTX*$_{\underline{0}\cancel{n}}$
NOTE – The format of the fields is defined in clause 11.4.1.1.7.			

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Printed in Switzerland
Geneva, 2012