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G.992.3

Amendment 3

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SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS
Digital sections and digital line system – Access networks

Amendment 3 to Recommendation G.992.3

CAUTION !

PREPUBLISHED RECOMMENDATION

This prepublication is an unedited version of a recently approved Recommendation. It will be replaced by the published version after editing. Therefore, there will be differences between this prepublication and the published version.

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Amendment 3 to Recommendation G.992.3

Summary

This Annex C deals with Specific requirements for an ADSL system operating in the same cable as ISDN as defined in ITU-T Recommendation G.961 Appendix III. It is a delta to the main body of this Recommendation. For sections where no supplements or amendments are made, the section heading is repeated to maintain the numbering of section headings aligned with the main body.

ANNEX C to G.992.3

Specific requirements for an ADSL system operating in the same cable as ISDN as defined in ITU-T Recommendation G.961 Appendix III

This Annex is a delta to the main body of this Recommendation. For sections where no supplements or amendments are made, the section heading is repeated to maintain the numbering of section headings aligned with the main body.

C.1 Scope (supplements §1)

This annex describes those specifications that are unique to an ADSL system coexisting in the same binder as TCM-ISDN as defined Recommendation G.961 Appendix III. The subclauses in this annex provide supplementary and replacement material to the clauses in the main body. The modifications described in this annex allow a performance improvement from the ADSL system specified in Annex A in an environment coexisting with TCM-ISDN in the same cable. It is recommended that an ADSL system implementing Annex C also implements Annex A.

For this Annex, support of STM-TC as defined in § K1 is left for further study.

C.2 References

This Annex does not define any additional references.

C.3 Definitions (supplements § 3)

This Annex defines the following additional terms:

Bitmap-F_C	ATU-R transmitter bitmap under TCM-ISDN FEXT noise generated at ATU-C
Bitmap-F_R	ATU-C transmitter bitmap under TCM-ISDN FEXT noise generated at ATU-R
Bitmap-N_C	ATU-R transmitter bitmap under TCM-ISDN NEXT noise generated at ATU-C
Bitmap-N_R	ATU-C transmitter bitmap under TCM-ISDN NEXT noise generated at ATU-R
Dual Bitmap	The Dual Bitmap method has dual bit rates under the FEXT and NEXT noise from TCM-ISDN
FEXT Bitmap	Similar to the Dual Bitmap method however transmission only occurs during FEXT noise from TCM-ISDN
$FEXT_C$ duration	TCM-ISDN FEXT duration at ATU-C estimated by the ATU-R
$FEXT_C$ symbol	DMT symbol transmitted by ATU-R during TCM-ISDN FEXT
$FEXT_R$ duration	TCM-ISDN FEXT duration at ATU-R estimated by the ATU-C
$FEXT_R$ symbol	DMT symbol transmitted by ATU-C during TCM-ISDN FEXT
Hyperframe	5 Superframes structure which synchronized TTR
$NEXT_C$ duration	TCM-ISDN NEXT duration at ATU-C estimated by the ATU-R
$NEXT_C$ symbol	DMT symbol transmitted by ATU-R during TCM-ISDN NEXT
$NEXT_R$ duration	TCM-ISDN NEXT duration at ATU-R estimated by the ATU-C
$NEXT_R$ symbol	DMT symbol transmitted by ATU-C during TCM-ISDN NEXT
N_{SWF}	Sliding Window frame counter
Subframe	10 consecutive DMT symbols (except for sync symbols) according to TTR timing
TTR	TCM-ISDN Timing Reference

TTR_C Timing reference used in ATU-C
TTR_R Timing reference used in ATU-R

C.4 Abbreviations (supplements § 4)

This Annex defines the following additional abbreviations:

UI Unit Interval

C.5 Reference Models (supplements § 5)

C.5.1 ATU Functional Model

C.5.2 User Plane Protocol Reference Model (supplements § 5.2)

Due to the use of dual bitmapping (see §C.8.4.2), the one-way maximum payload transfer delay for Annex C may be longer than the specified values in § 5.2. Depending on the number of bits (L) assigned to a particular latency path for each symbol type (see §C.8.4.2.2), an additional payload transfer delay of between 0 and 4.25 ms will result.

NOTE: Buffering to support this additional delay may be included in the PMS-TC function, the TPS-TC function, or beyond the γ interface.

C.5.3 Management Plane Reference Model

C.5.4 Application Models

C.6 Transport Protocol Specific Transmission Convergence (TPS-TC) function

C.6.1 G.994.1 Phase (supplements § 6.6.1)

C.6.1.1 G.994.1 Capabilities List Message (supplements § 6.6.1.1)

Replace Table 6-2 with Table C6-1:

Table C6-1/G.992.3 - Format for TPS-TC Capabilities Information

Spar(2) bits	Definition of Npar(3) bits
Maxtype Upstream (Note)	Parameter block of 2 octets that describes the *maxtype* values for upstream, using an unsigned 3-bit value in the 0 to 4 range for each of the TPS-TC types 2 (ATM) and 3 (PTM).
Maxtype Downstream (Note)	Parameter block of 2 octets that describes the *maxtype* values for downstream, using an unsigned 3-bit value in the 0 to 4 range for each of the TPS-TC types 2 (ATM) and 3 (PTM).
Note – TPS-TC type 1 (STM) is left for further study.	

C.7 Physical Media Specific Transmission Convergence (PMS-TC) function (supplements § 7)

C.7.1 Transport Capabilities

C.7.2 Additional Functions

C.7.3 Block Interface Signals and Primitives

C.7.4 Block Diagram and Internal Reference Point Signals (supplements § 7.4)

The Figure 7-4 shall be replaced with Figure C7-1. Figure C7-1 shows the block diagram of the transmit PMS-TC function.

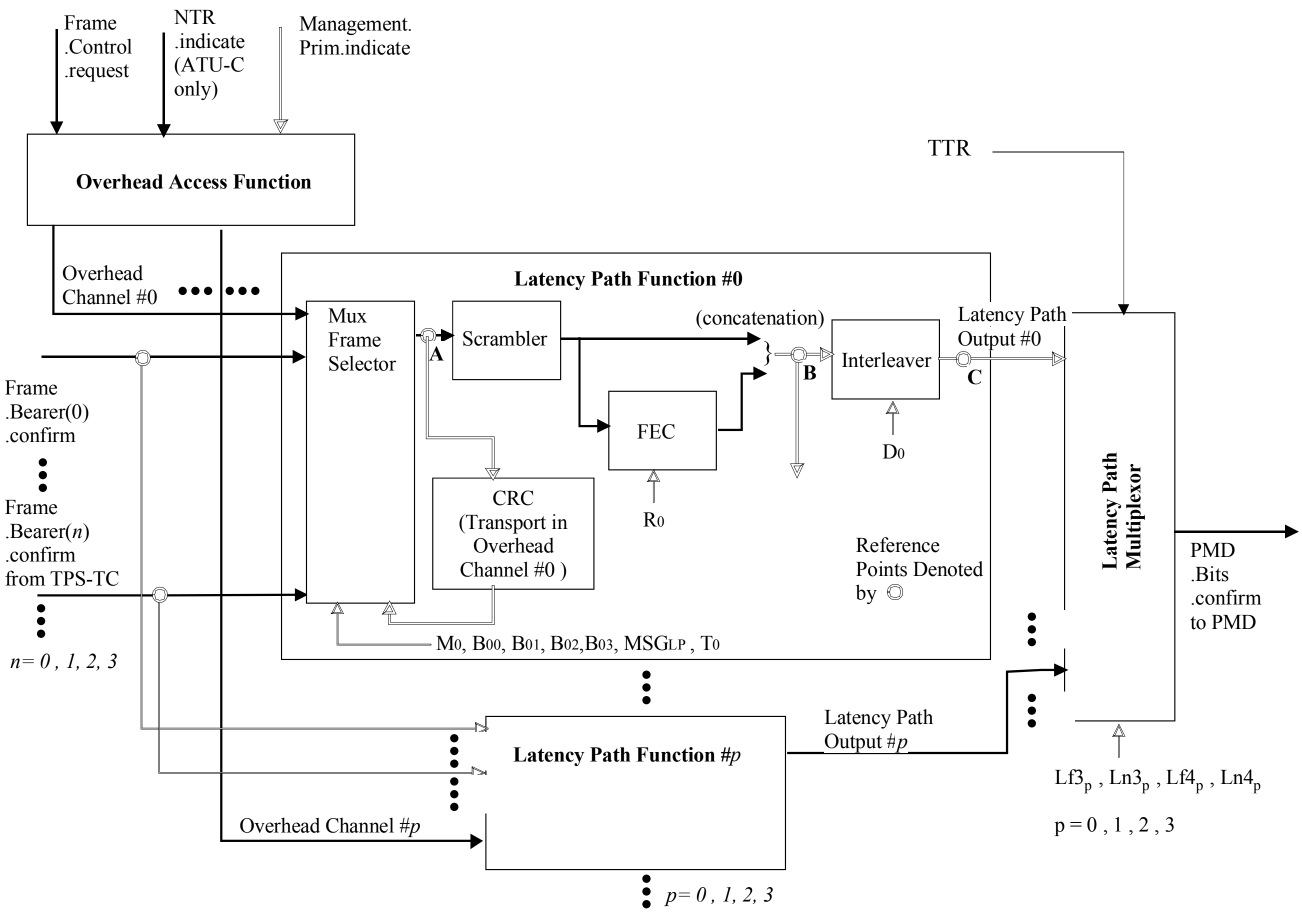


Figure C7-1/G.992.3 – Block Diagram of Transmit PMS-TC Function

C.7.5 Control Parameters

C.7.6 Frame structure (supplements §7.6)

Four types of symbols are defined in Table C8-2. When operating with frame structure with single latency dual bearers and $T_p = 1$ (see Figure 7-7), L_0 is the average number of bits per data symbol passed from the PMS-TC to the PMD.

C.7.6.1 Derived Definitions (supplements §7.6.1)

Replace Table 7-7 with Table C7-1.

NOTE - The only differences between these tables is the addition of the parameters L_p and $Jitter_p$.

Table C7-1/G.992.3 - Derived Characteristics of the ATU Data Frame

K_p	The number of octets per Mux Data Frame in latency path function #p is always $K_p = \sum_{i=0}^{N_{BC}-1} B_{p,i} + 1$.
$N_{FEC\,p}$	The number of octets per FEC Data Frame and Interleaved FEC Data Frame in latency path function #p is always $N_{FEC\,p} = M_p \times K_p + R_p$.
L_p	Average number of bits per data symbol $L_p = (96 \times Lf4_p + 30 \times Lf3_p + 144 \times Ln4_p + 70 \times Ln3_p) / 340$.
S_p	Not accounting for the interleaving procedure, the number of PMD.Bits.request primitives (and correspondingly the number of PMD symbols) over which the FEC Data Frame spans is always $S_p = \frac{8 \times N_{FEC,p}}{L_p}$. The value of S_p may represent a non-integer value.
Net data rate $net\_act_{p\,n}$ of frame bearer #n in latency path function #p	When $T_p = 1$, the net data rate for frame bearer #n in latency path #p is given by $net\_act_{p\,n}$ $= \frac{B_{p,n} \times M_p}{S_p} \times 32 Kbit/s = \frac{B_{p,n} \times M_p \times L_p}{K_p \times M_p + R_p} \times 4 Kbit/s$. When $T_p \neq 1$, then the net data rateof the frame bearer with the lowest index, that is assigned to latency path #p is given by $net\_act_{p\,n}$ $= \left(\frac{B_{p,n} \times M_p}{S_p} + \frac{(T_p - 1) \times M_p}{T_p \times S_p} \right) \times 32 Kbit/s = \frac{(T_p \times (B_{p,n} + 1) - 1) \times M_p \times L_p}{T_p \times (K_p \times M_p + R_p)} \times 4 Kbit/s$; the net data rate for bearers associated with subsequence values in the list is given by $net\_act_{p\,n}$ $= \frac{B_{p,n} \times M_p}{S_p} \times 32 Kbit/s = \frac{B_{p,n} \times M_p \times L_p}{K_p \times M_p + R_p} \times 4 Kbit/s$.
Net data rate $Net_{p\,act}$ of latency path function #p	Net data rate $Net_{p\,act}$ is affected by the value of T_p. When $T_p = 1$, the $Net_{p\,act}$ is $= \frac{(K_p - 1) \times M_p}{S_p} \times 32 Kbit/s = \frac{(K_p - 1) \times M_p \times L_p}{K_p \times M_p + R_p} \times 4 Kbit/s$. When $T_p \neq 1$, the $Net_{p\,act}$ is $= \left(\frac{(K_p - 1) \times M_p}{S_p} + \frac{(T_p - 1) \times M_p}{T_p \times S_p} \right) \times 32 Kbit/s = \frac{(T_p \times K_p - 1) \times M_p \times L_p}{T_p \times (K_p \times M_p + R_p)} \times 4 Kbit/s$
Overhead rate OR_p of latency path function #p	Overhead rate is always $OR_p = \frac{M_p}{T_p \times S_p} \times 32 Kbit/s = \frac{M_p \times L_p}{T_p \times (K_p \times M_p + R_p)} \times 4 Kbit/s$
PMS-TC Delay $delay_p$ of latency path function #p	Nominal one-way maximum transport delay of latency path function #p is defined as (where $\lceil x \rceil$ denotes rounding to the higher integer): $delay_p = \frac{\lceil S_p \times D_p \rceil}{4} ms$
SEQ_p	Length of the sync octet sequence of latency path function #p, defined as $SEQ_p = \begin{cases} 2, \ if\ p \neq MSG_{LP}\ and\ latency\ path\ \#\ p\ is\ not\ the\ lowest\ latency\ path\ (See\ 7.8.2.1) \\ 6\ \ if\ p \neq MSG_{LP}\ and\ latency\ path\ \#\ p\ is\ the\ lowest\ latency\ path\ (See\ 7.8.2.1) \\ MSG_C + 2, \ if\ p = MSG_{LP}\ and\ latency\ path\ \#\ p\ is\ not\ the\ lowest\ latency\ path\ (See\ 7.8.2.1) \\ MSG_C + 6\ \ if\ p = MSG_{LP}\ and\ latency\ path\ \#\ p\ is\ the\ lowest\ latency\ path\ (See\ 7.8.2.1) \end{cases}$

PER_p	The period of the overhead channel in latency path #p is $PER_p = \frac{T_p \times S_p \times SEQ_p}{4 \times M_p} ms$
INP_p	Impulse Noise Protection INP_p in number of DMT symbols of latency path function #p: $INP_p = \left(\frac{1}{2}\right) \times (S \times D) \times \left(\frac{R}{N\_FEC}\right)$
$Jitter_p$	Jitter of latency path function #p is expressed in symbols and defined as: $jitter_p = \left\lceil \frac{112}{L_p} \times \left\lvert \frac{4 \times Lf4_p + 6 \times Ln4_p - 3 \times Lf3_p - 7 \times Ln3_p}{34} \right\rvert + \max\left(\frac{21 \times (Lf3_p - Ln3_p)}{3 \times Lf3_p + 7 \times Ln3_p}, \frac{24 \times (Lf4_p - Ln4_p)}{4 \times Lf4_p + 6 \times Ln4_p} \right) \right\rceil$ where |x| denotes absolute value and $\lceil x \rceil$ denotes rounding to the higher integer.

C.7.6.2 Valid Framing Configurations

C.7.6.3 Mandatory Framing Configurations

C.7.7 Data Plane Procedures (supplements § 7.7)

C.7.7.1 Latency Path Function

C.7.7.2 Frame multiplexing (supplements § 7.7.2)

Four distinct L values are defined, one for each symbol type. These are $Lf3_p$, $Lf4_p$, $Ln3_p$, and $Ln4_p$ (see §8.4.2.2). L_p is a derived parameter and is defined in Table C7-1.

C.7.8 Control Plane Procedures

C.7.9 Management Plane Procedures

C.7.10 Initialization Procedures (supplements § 7.10)

C.7.10.1 G.994.1 Phase

C.7.10.2 Channel Analysis Phase

C.7.10.3 Exchange Phase (replaces § 7.10.3)

The remaining values of the control parameters for the TPS-TC functions as well as additional information about the TPS-TC functions shall be reported by the receive TPS-TC function and transported to the transmit TPS-TC function during the exchange procedure.

The information in C-PARAM includes:

- The latency path MSG_{LP} to carry the upstream message oriented portion of the overhead channel.
- Assignment of upstream frame bearers to upstream latency paths.
- The number of message octets MSG_c included in the upstream overhead structure
- B_{pn} for each upstream latency path and frame bearer
- M_p for each upstream latency path
- R_p for each upstream latency path
- D_p for each upstream latency path
- T_P for each upstream latency path.
- $Lf3_p$, $Ln3_p$, $Lf4_p$, $Ln4_p$ corresponding to each upstream latency path.

The information in R-PARAM includes:

- The latency path MSG_{LP} to carry the downstream message oriented portion of the overhead channel.

- Assignment of downstream frame bearers to downstream latency paths.
- The number of message octets MSG_c include in the downstream overhead structure
- B_{pn} for each downstream latency path and frame bearer
- M_p for each downstream latency path
- R_p for each downstream latency path
- D_p for each downstream latency path
- T_p for each downstream latency path.
- $Lf3_p$, $Ln3_p$, $Lf4_p$, $Ln4_p$ corresponding to each downstream latency path.

This C-PARAMS and R-PARAMS information is represented as a parameter block as in Table C7-2. The information is transmitted in the order shown during C-PARAM and R-PARAM as described in the PMD initialization procedure.

Table C7-2/G.992.3 - – Format for PMS-TC PARAMS Information

Octet Number [i]	**Format PMS-TC Bits [8*i+7 to 8*i+0]**	**Description**
Octet 0	[0000 00bb] bit 1 to 0	The bits bb encode the value of $MSG_{LP.}$ MSG_{LP}. Indicates the latency path in which the message based overhead information is to be transmitted. The values 00, 01, 10, and 11 correspond to latency path #0, #1, #2, #3, respectively.
Octet 1	[cccc dddd] bit 7 to 0	The bits cccc are set to 0000, 0001, 0010, or 0011 if the frame bearer #0 is to be carried in latency path #0, #1, #2, or #3 respectively. The bits cccc are set to 1111 if $type_0$ is zero (i.e., disabled frame bearer, see Table 6-1). The bits dddd describe where the frame bearer #1 is to be carried using the same encoding method as cccc.
Octet 2	[eeee ffff] bit 7 to 0	The bits eeee and ffff describe where the frame bearers #2 and #3, respectively, are to be carried using the same encoding method as cccc of octet 1.
Octet 3	[gggg gggg] bit 7 to 0	The bits gggggggg encode the value of MSG_C, the number of octets in the message based portion of the overhead structure. The latency path #MSG_{LP} is used to transport the message based overhead information.
Octet 4	[hhhh hhhh] bit 7 to 0	The bits hhhhhhhh give the number of octets from bearer #0 per Mux Data Frame being transported. This value is zero or the non-zero value from the value of the set $\{B_{00}, B_{10}, B_{20}, B_{30}\}$.
Octet 5	[iiii iiii] bit 7 to 0	The bits iiiiiii give the number of octets from bearer #1 per Mux Data Frame being transported. This value is zero or the non-zero value from the value of the set $\{B_{01}, B_{11}, B_{21}, B_{31}\}$.
Octet 6	[jjjj jjjj] bit 7 to 0	The bits jjjjjjj give the number of octets from bearer #2 per Mux Data Frame being transported. This value is zero or the non-zero value from the value of the set $\{B_{02}, B_{12}, B_{22}, B_{32}\}$.
Octet 7	[kkkk kkkk] bit 7 to 0	The bits kkkkkkkk give the number of octets from bearer #3 per Mux Data Frame being transported. This value is zero or the non-zero value from the value of the set $\{B_{03}, B_{13}, B_{23}, B_{33}\}$.
Octet 8	[mmmm mmmm] bit 7 to 0	The bits mmmmmmmm give the value of M_P for latency path #0. They are always present and set to zero if not used.
Octet 9	[tttt tttt] bit 7 to 0	The bits ttttttt give the value of T_P for latency path #0. They are always present and set to zero if not used.
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.
Octet 11	[llll llll] bit 7 to 0	The bits lllllll give the lsb of the value of $Lf3_P$ for latency path #0. They are always present and set to zero if not used.
Octet 12	[llll llll] bit 15 to 8	The bits llllllll give the msb of the value of $Lf3_p$ for the latency path #0. These are always present and set to zero if not used.

Octet Number [i]	Format PMS-TC Bits [8*i+7 to 8*i+0]	Description
Octet 13	[llll llll] bit 7 to 0	The bits llllllll give the lsb of the value of $Ln3_P$ for latency path #0. They are always present and set to zero if not used.
Octet 14	[llll llll] bit 15 to 8	The bits llllllll give the msb of the value of $Ln3_P$ for latency path #0. They are always present and set to zero if not used.
Octet 15	[llll llll] bit 7 to 0	The bits llllllll give the lsb of the value of $Lf4_P$ for latency path #0. They are always present and set to zero if not used.
Octet 16	[llll llll] bit 15 to 8	The bits llllllll give the msb of the value of $Lf4_P$ for latency path #0. They are always present and set to zero if not used.
Octet 17	[llll llll] bit 7 to 0	The bits llllllll give the lsb of the value of $Ln4_P$ for latency path #0. They are always present and set to zero if not used.
Octet 18	[llll llll] bit 15 to 8	The bits llllllll give the msb of the value of $Ln4_P$ for latency path #0. They are always present and set to zero if not used.
Octets 19-29	same as octets 8-18	These octets describe the parameters for latency path #1, in the same format as octets 8 through 18. They are always present and set to zeros if unused.
Octets 30-40	same as octets 8-18	These octets describe the parameters for latency path #2, in the same format as octets 8 through 18. They are always present and set to zeros if unused.
Octets 41-51	same as octets 8-18	These octets describe the parameters for latency path #3, in the same format as octets 8 through 18. They are always present and set to zeros if unused.

The value of N_{LP} (i.e., the number of enabled latency paths) is conveyed implicitly in the settings of octets 0 (bits bb), 1 (bits cccc and dddd) and 2 (bits eeee and ffff). Latency paths with a label contained in the set {*bb, cccc, dddd, eeee, ffff*} shall be enabled. Latency paths that are supported but with a label not contained in this set shall be disabled.

The octet 0 in Table C7-2 assigns the message based overhead to a particular latency path #MSG_{LP} (with MSG_{LP} in the 0 to 3 range). The octets 1 and 2 in Table C7-2 assign frame bearer #n (for n=0 to 3) to a particular latency path #p (with p in the 0 to 3 range), or disable the frame bearer. The message based overhead and the enabled frame bearers shall be assigned to a latency path that is supported by both ATUs (as indicated in CL and CLR, see Table 7-19). If an ATU supports a particular latency path #p, it shall support assignment of message based overhead and/or any number of enabled frame bearers (0 to N_{BC}) to that latency path. It is possible to assign frame bearer #n to latency path #p, with the number of octets from frame bearer #n per Mux Data Frame (as indicated in octet 4, 5, 6 or 7 in Table C7-2) set to zero (i.e., $B_{p,n} = 0$).

It is not possible to configure at initialization a latency path #*p* with overhead sequence length $SEQ_p = 6$ (i.e. one that carries only a CRC and the bit oriented portion of the overhead) without also carrying at least one frame bearer in the latency path *p*.

The method used by the receiver to select these values is implementation dependent. However, within the limit of the raw data rate and coding gain provided by the local PMD, the selected values shall meet all of the constraints communicated by the transmitter prior to the Exchange Phase, including:

- (Message based) Overhead data rate ≥ Minimum overhead data rate
- Net data rate ≥ Minimum net data rate for all bearer channels
- Impulse noise protection ≥ Minimum impulse noise protection for all bearer channels
- Delay ≤ Maximum delay for all bearer channels
- Jitter ≤ Maximum jitter for all bearers channels (values of $Lf3_p$, $Lf4_p$, $Ln3_p$, and $Ln4_p$ shall meet the specified jitter requirement, see Table C7-1). See §C.K.2.1.1 for valid jitter configuration.

Within those constraints, the receiver shall select the values as to optimize in the priority listed:

1. Maximize net data rate for all bearer channels, per the allocation of the net data rate, in excess of sum of the minimum net data rates over all bearer channels (see § 7.10.2).
2. Minimize excess margin (see § 8.6.4)

If within those constraints, the receiver is unable to select a set of configuration parameters, then an initialization failure cause shall be indicated in the PMS-TC PARAMS information (4-bit integer, see Table 7-20), with the other bits in the

PMS-TC PARAMS information set to 0. The transmitter shall enter the SILENT state (see Annex D) instead of the SHOWTIME state at completion of the initialization procedures. Valid failure causes are the failure cause values 1 (configuration error) and 2 (configuration not feasible on line), as defined in G.997.1. If within those constraints, the receiver is able to select a set of configuration parameters, then value 0 is used to indicate a successful initialization. The values 3 to 15 are reserved.

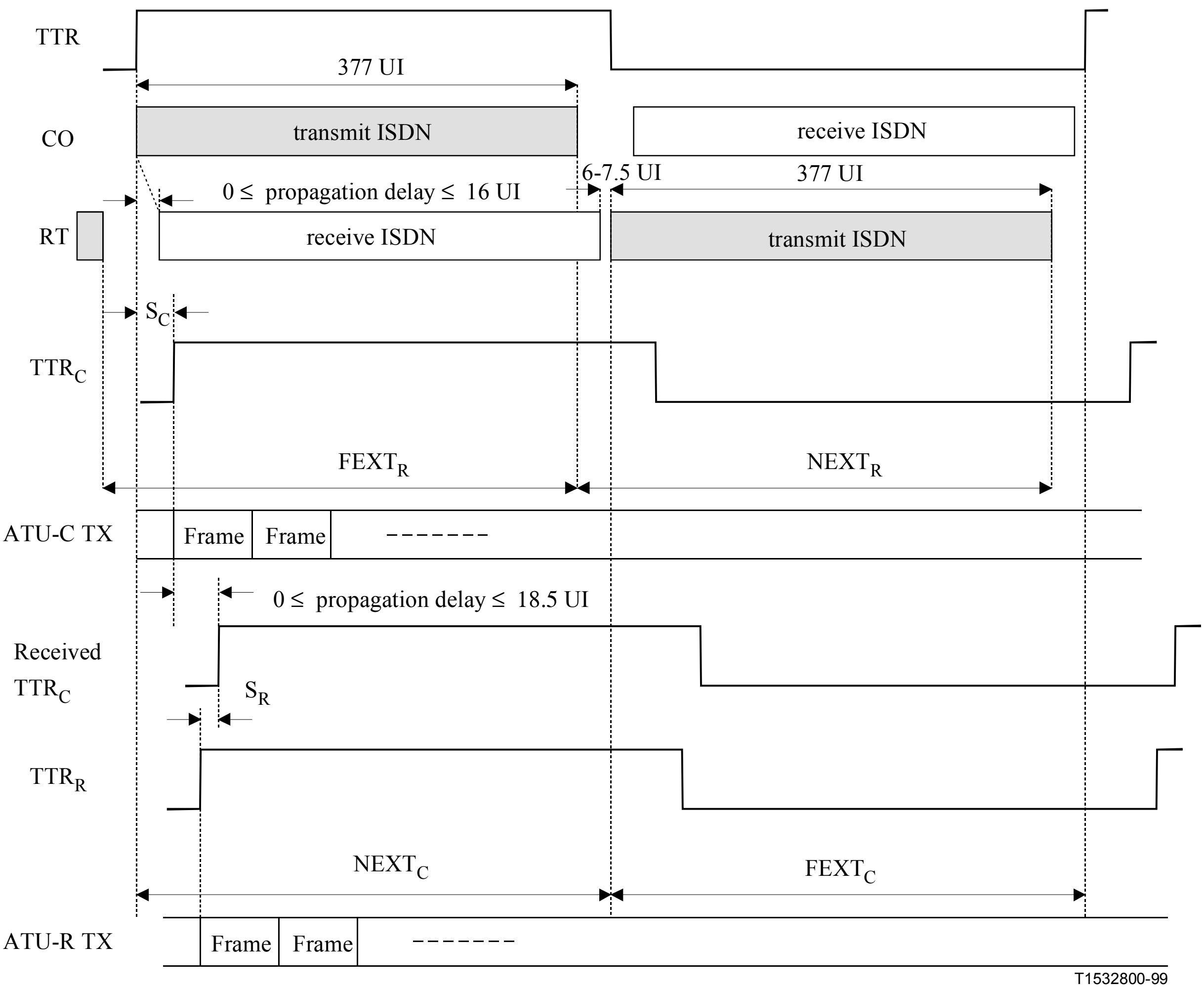
C.7.11 Online Reconfiguration

C.8 Physical media dependent function (supplements § 8)

C.8.1 ATU-C/R transmitter timing model (new)

C.8.1.1 TCM-ISDN crosstalk timing model

Figure C8-1 shows the timing chart of the crosstalk from TCM-ISDN.



1 UI = 3.125 µs

$FEXT_R$ and **$NEXT_R$** are estimated by ATU-C

$FEXT_C$ and **$NEXT_C$** are estimated by ATU-R

TTR	TCM-ISDN timing reference
TTR_C	Timing reference used in ATU-C
Received TTR_C	Received TTR_C at ATU-R
TTR_R	Timing reference used in ATU-R
S_C	55 × 0.9058 µs: Offset from TTR to TTR_C
S_R	–42 × 0.9058 µs: Offset from received TTR_C to TTR_R

Figure C8-1/G.992.3 – Timing chart of the TCM-ISDN crosstalk

The data stream of TCM-ISDN is transmitted synchronously with the TTR period. The CO transmits TCM-ISDN during the first half of the TTR period while the RT transmits TCM-ISDN during the second half of the TTR period. The ATU-C experiences NEXT noise from TCM-ISDN in the first half of the TTR period and FEXT noise from TCM-ISDN in the second half of the TCM-ISDN period. On the other hand, the ATU-R experiences FEXT noise from TCM-ISDN in the first half of the TTR period and NEXT noise from TCM-ISDN in the second half of the TTR period.

As defined in § C.8.13.5.1.4 and § C.8.13.5.2.4, the ATU-C shall estimate the $FEXT_R$ and $NEXT_R$ duration at the ATU-R, and the ATU-R shall estimate the $FEXT_C$ and $NEXT_C$ duration at the ATU-C, taking into consideration the propagation delay on the subscriber line. The ATU-C shall transmit any symbols by synchronizing with the TTR_C. The ATU-R shall transmit any symbols by synchronizing with the TTR_R generated from received TTR_C.

C.8.1.2 Sliding window

Figure C8-2 shows the timing chart for downstream transmission (i.e., at the ATU-C).

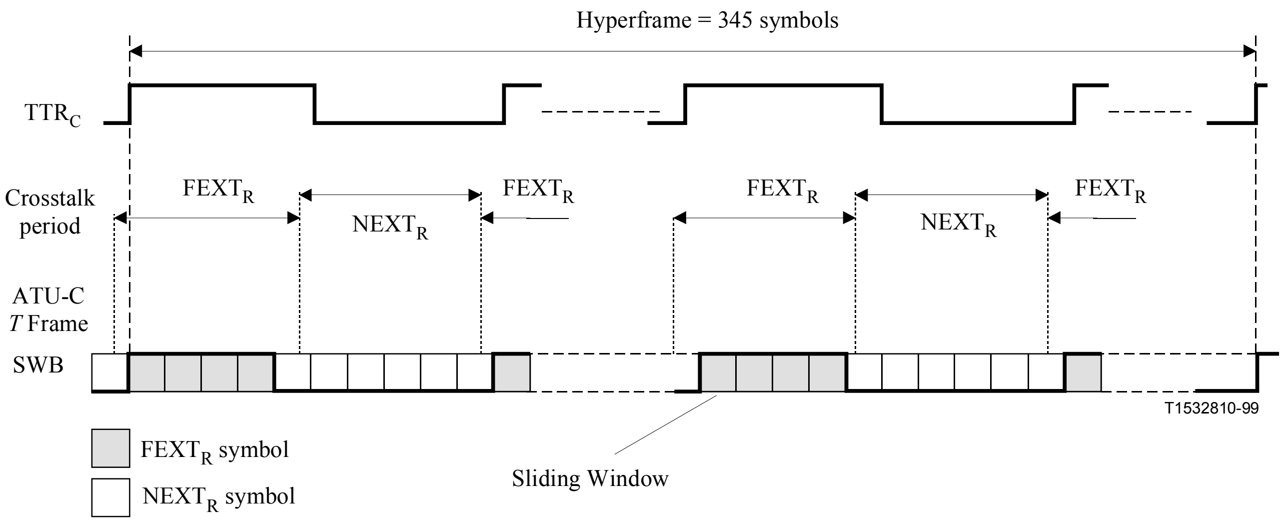


Figure C8-2/G.992.3 – Sliding window for downstream symbols

The Sliding Window defines the transmission symbols under the crosstalk noise environment synchronized to the TTR period. The $FEXT_{C/R}$ symbol represents the symbol completely inside the $FEXT_{C/R}$ duration. The $NEXT_{C/R}$ symbol represents any symbol containing the $NEXT_{C/R}$ duration. Thus, there are more $NEXT_{C/R}$ symbols than $FEXT_{C/R}$ symbols.

The ATU-C decides which transmission symbol is a $FEXT_R$ or $NEXT_R$ symbol according to the sliding window and transmits it with the corresponding bit table. Similarly, the ATU-R decides whether the transmission symbol is a $FEXT_C$ or $NEXT_C$ symbol and transmits it with the corresponding bit table. Although the phase of the sliding window is asynchronous with $TTR_{C/R}$, the pattern is fixed to the 345 frames of the hyperframe.

C.8.1.3 ATU-C Symbol Synchronization to TTR

345 symbols are 34 cycles with cyclic prefix of TTR_C (or 32 cycles of TTR_C without cyclic prefix). This implies a PLL lock at the ATU-R.

C.8.1.4 Dual Bitmap switching

The ATU-C transmits $FEXT_R$ symbols using Bitmap-F_R (during the $FEXT_R$ duration), and transmits $NEXT_R$ symbols using Bitmap-N_R (during the $NEXT_R$ duration) according to the result of initialization. The ATU-R transmits $FEXT_C$ symbols using Bitmap-F_C (during the $FEXT_C$ duration), and transmits $NEXT_C$ symbols using Bitmap-N_C (during the $NEXT_C$ duration) in the same manner.

The ATU-C shall have the capability to disable Bitmap-N_C and Bitmap-N_R. As an option, an ATU-C may have the ability to enable or disable Bitmap-N_C independently of Bitmap-N_R . This is controlled by way of the profiles negotiated through G.994.1.

C.8.1.5 Loop timing at ATU-R

The phase relation between received symbol and transmitted symbol at the ATU-R at the U-R interface shall meet the phase tolerances as shown in Figure C8-3.

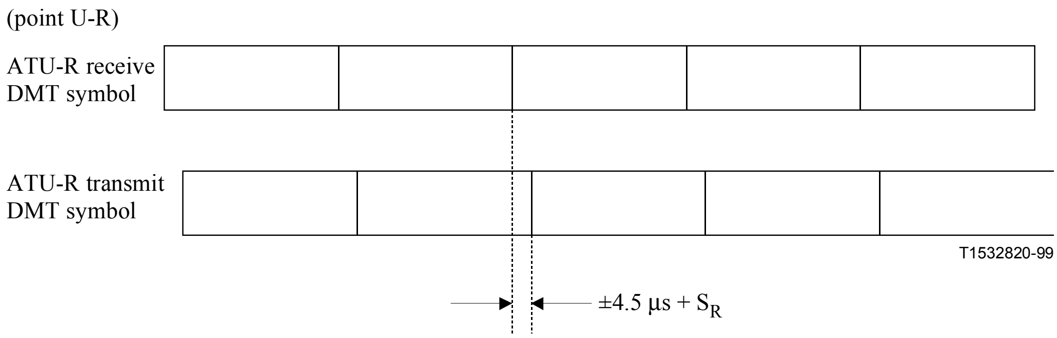


Figure C8-3/G.992.3 – Loop timing for ATU-R

C.8.2 Operating modes (new)

The following profiles are defined to support independent control of FEXT and NEXT bitmaps in the upstream and downstream direction, as well as independent control of the downstream spectrum for each downstream bitmap:

Profile 1

For Profile 1, upstream transmission only uses Bitmap-F_C, and downstream transmission only uses Bitmap-F_R with non-overlapped spectrum.

Profile 2

For Profile 2, upstream transmission uses both Bitmap-F_C and Bitmap-N_C, and downstream transmission uses both Bitmap-F_R and Bitmap-N_R. Non-overlapped spectrum is used with both downstream bitmaps.

Profile 3

For Profile 3, upstream transmission only uses Bitmap-F_C, and downstream transmission only uses Bitmap-F_R with overlapped spectrum. An example of a downstream PSD mask for this operating mode is shown in Figure V.3 and described in Table V.3 in Appendix V.

Profile 4

For Profile 4, upstream transmission uses both Bitmap-F_C and Bitmap-N_C, and downstream transmission uses both Bitmap-F_R and Bitmap-N_R. Overlapped spectrum is used with both downstream bitmaps.

Profile 5

For Profile 5, upstream transmission only uses Bitmap-F_C, and downstream transmission uses both Bitmap-F_R and Bitmap-N_R. Non-overlapped spectrum is used with Bitmap-N_R, and overlapped spectrum is used with Bitmap-F_R. An example of a downstream PSD mask for use with Bitmap-N_R is shown in Figure V.1 and described in Table V.1 in Appendix V. An example of a downstream PSD mask for use with Bitmap-F_R is shown in Figure V.2 and described in Table V.2 in Appendix V.

Profile 6

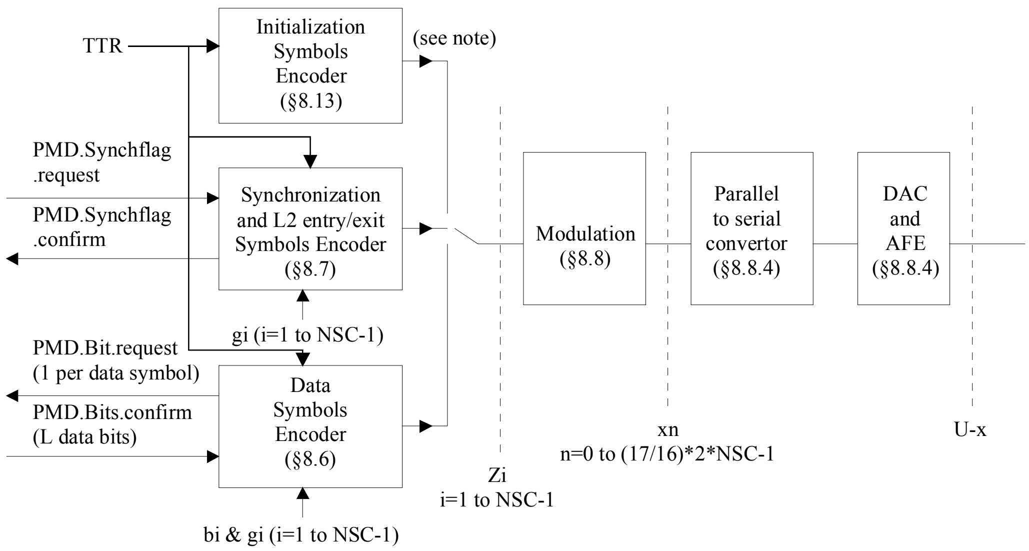
For Profile 6, upstream transmission uses both Bitmap-F_C and Bitmap-N_C, and downstream transmission uses both Bitmap-F_R and Bitmap-N_R. Non-overlapped spectrum is used with Bitmap-N_R, and overlapped spectrum is used with Bitmap-F_R. An example of a downstream PSD mask for use with Bitmap-N_R is shown in Figure V.1 and described in Table V.1 in Appendix V. An example of a downstream PSD mask for use with Bitmap-F_R is shown in Figure V.2 and described in Table V.2 in Appendix V.

Table 11.41.1/G.994.1 contains the code points to support these profiles.

C.8.3 Block interface signals and primitives

C.8.4 Block diagram and internal reference point signals (supplements § 8.4)

Replace Figure 8-5 with Figure C8-4:



NOTE – The Initialization Symbols Encoder defines Zi values for i=1 to 2*NSC-1 (see § 8.13.2.4).

Figure C8-4/G.992.3 - Block Diagram of the Transmit PMD Function

C.8.4.1 Framing (new)

C.8.4.1.1 Hyperframe structure

C.8.4.1.1.1 ATU-C Hyperframe structure

The ATU-C transmitter uses the hyperframe structure shown in Figure C8-5. Figure C8-5 shows the phase relationship between the TTR_C and the hyperframe at the point U-C. Each hyperframe is composed of 5 superframes, which are numbered from 0 to 4.

The bit-level data stream from the rate-converter is extracted according to the size of Bitmap-F_R and Bitmap-N_R using the Sliding Window (see § C.8.1.2).

The hyperframe is composed of 345 DMT symbols, numbered from 0 to 344. Each symbol is assigned as $FEXT_R$ or $NEXT_R$ symbol in a $FEXT_R$ or $NEXT_R$ duration, and the following numerical formula describes which duration the N_{dmt}-th symbol belongs to at the ATU-C transmitter (see Figure C8-6).

For N_{dmt} = 0, 1, ..., 344

$S = 272 \times N_{dmt} \bmod 2760$

if { (S + 271 < a) or (S > a + b) } then $FEXT_R$ symbol

else then $NEXT_R$ symbol

where a = 1243, b = 1461

Thus, 128 DMT symbols are allocated in the $FEXT_R$ duration, and 217 DMT symbols are allocated in the $NEXT_R$

duration. The symbols are composed of:

$FEXT_R$ symbol:

Number of symbol using Bitmap-F_R = 126

Number of sync symbol = 2

$NEXT_R$ symbol:

Number of symbol using Bitmap-N_R = 214

Number of sync symbol = 3

For transceivers using Profile 1, the ATU-C shall transmit only the pilot tone in the $NEXT_R$ symbols. For Profile 3, the ATU-C shall not transmit any signal in $NEXT_R$ symbols. The remaining Profiles, i.e., Profiles 2, 4, 5 and 6 use the dual bitmap technique.

For transceivers using profiles 5 or 6, the ATU-C may use different tssi's in $FEXT_R$ symbols and $NEXT_R$ symbols. The tssi used during $FEXT_R$ symbols is conveyed in G.994.1 and the tssi used in $NEXT_R$ symbols are not transmitted to the receiver. For the remaining profiles, the same tssi provided during G.994.1 shall be used in $FEXT_R$ and $NEXT_R$ symbols.

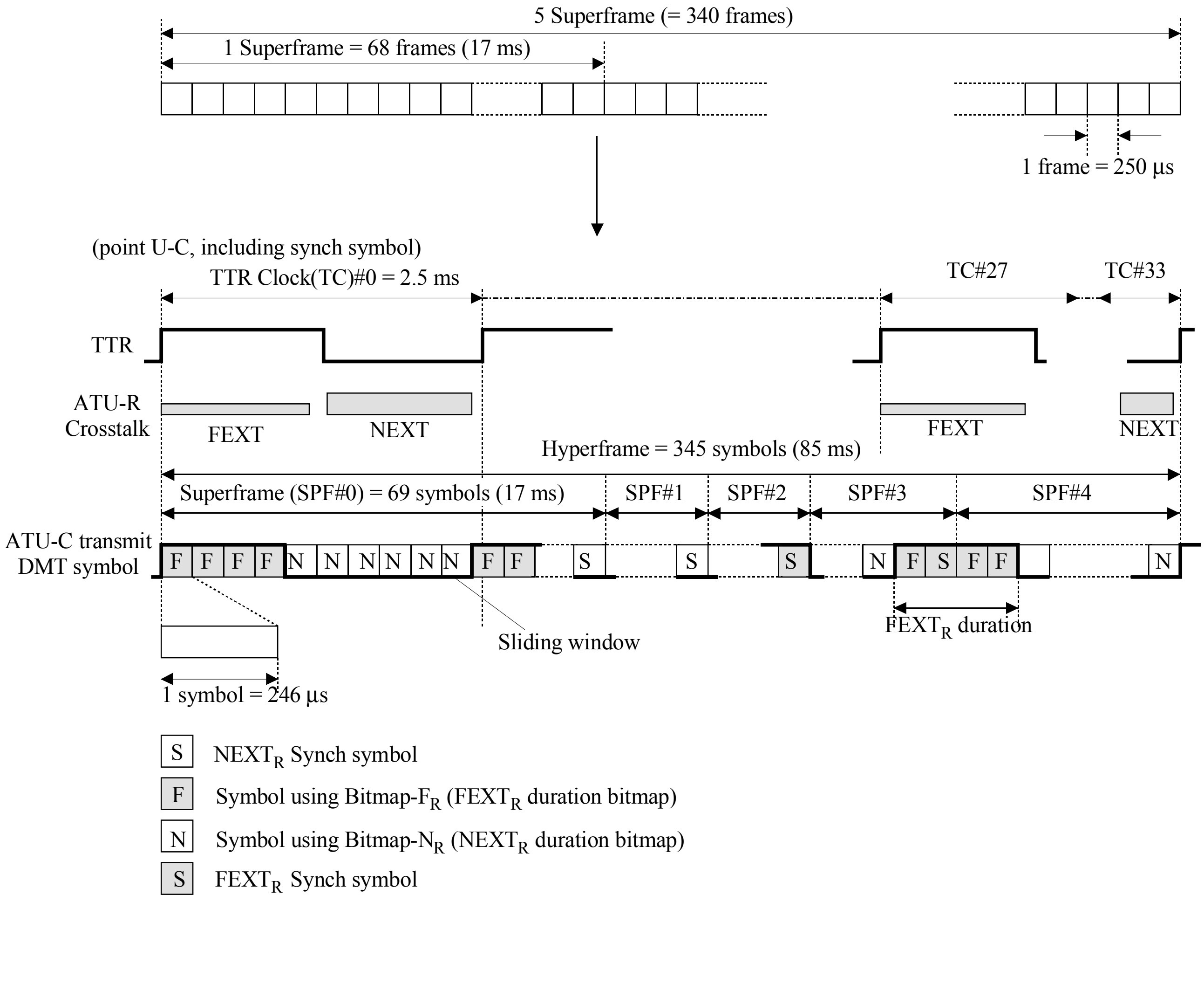


Figure C8-5/G.992.3 – Hyperframe structure for downstream

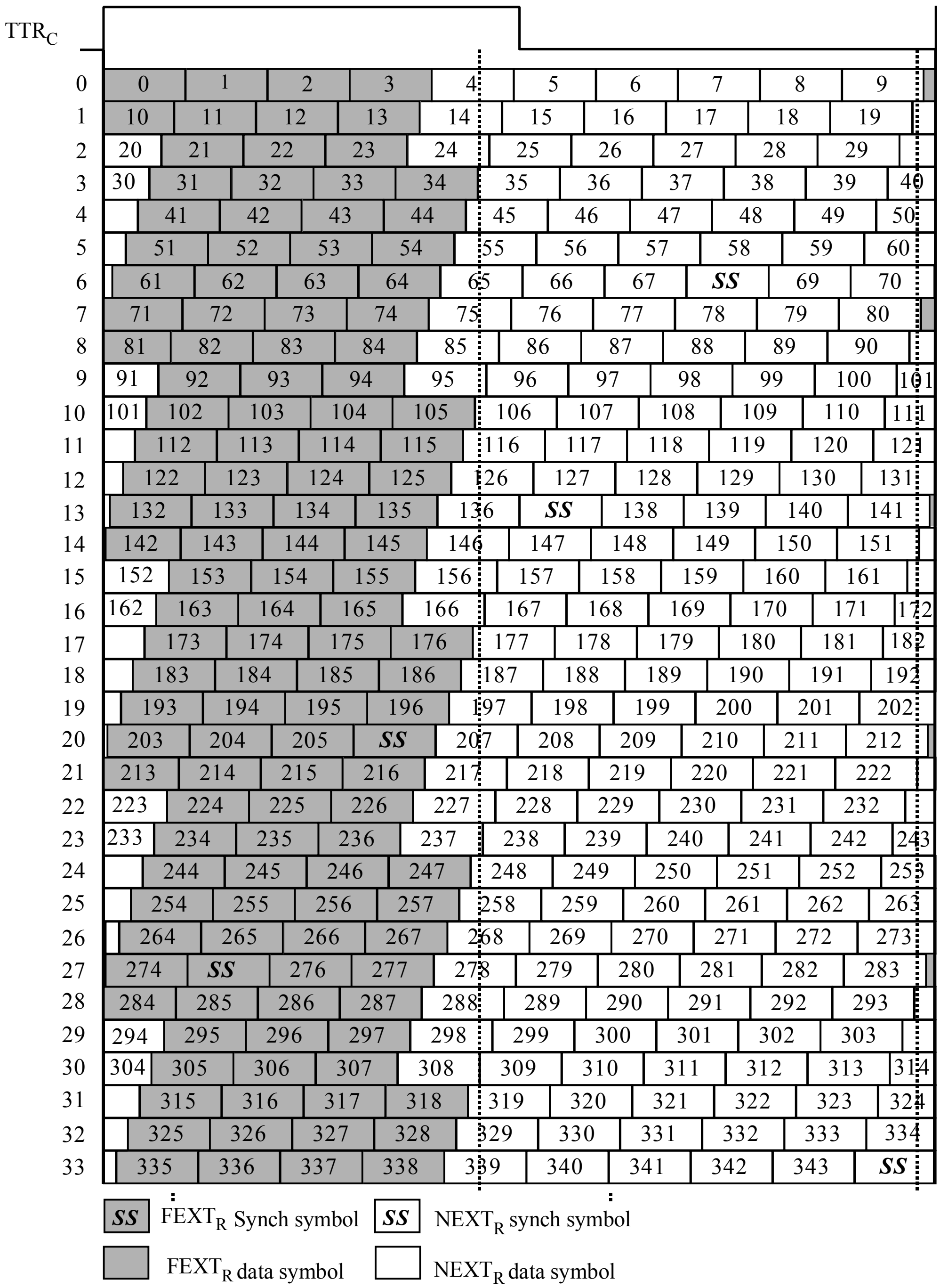


Figure C8-6/G.992.3 – Symbol pattern in a hyperframe with cyclic prefix – Downstream

C.8.4.1.1.2 ATU-R Hyperframe structure

The hyperframe structure of the ATU-R transmitter is functionally similar to that of the ATU-C transmitter (see Figure C8-7). The hyperframe is composed of 345 DMT symbols, numbered from 0 to 344. Each symbol is under $FEXT_C$ or $NEXT_C$ duration, and the following numerical formula describes which duration the N_{dmt}-th symbol belongs to at the ATU-R transmitter (see Figure C8-8).

For N_{dmt} = 0, 1, …, 344

S = 272 x N_{dmt} mod 2760

if { (S > a) and (S + 271 < a + b) } then $FEXT_C$ symbol

else then $NEXT_C$ symbol

where a = 1315, b = 1293

128 DMT symbols are allocated in the $FEXT_C$ duration, and 217 DMT symbols are allocated in the $NEXT_C$ duration. The symbols are composed of:

$FEXT_C$ symbol:

Number of symbol using Bitmap-F_C	= 126
Number of sync symbol	= 2

$NEXT_C$ symbol:

Number of symbol using Bitmap-N_C	= 214
Number of sync symbol	= 3

For transceivers using Profiles 1 and 3, the ATU-R shall not transmit any signal in the $NEXT_C$ symbols. The remaining Profiles, i.e., Profiles 2, 4, 5 and 6 use the dual bitmap technique.

For transceivers using profiles 5 or 6, the ATU-R may use different tssi's in $FEXT_C$ symbols and $NEXT_C$ symbols. The tssi used during $FEXT_C$ symbols is conveyed in G.994.1 and the tssi used in $NEXT_C$ symbols are not transmitted to the receiver. For the remaining profiles, the same tssi provided during G.994.1 shall be used in $FEXT_C$ and $NEXT_C$ symbols.

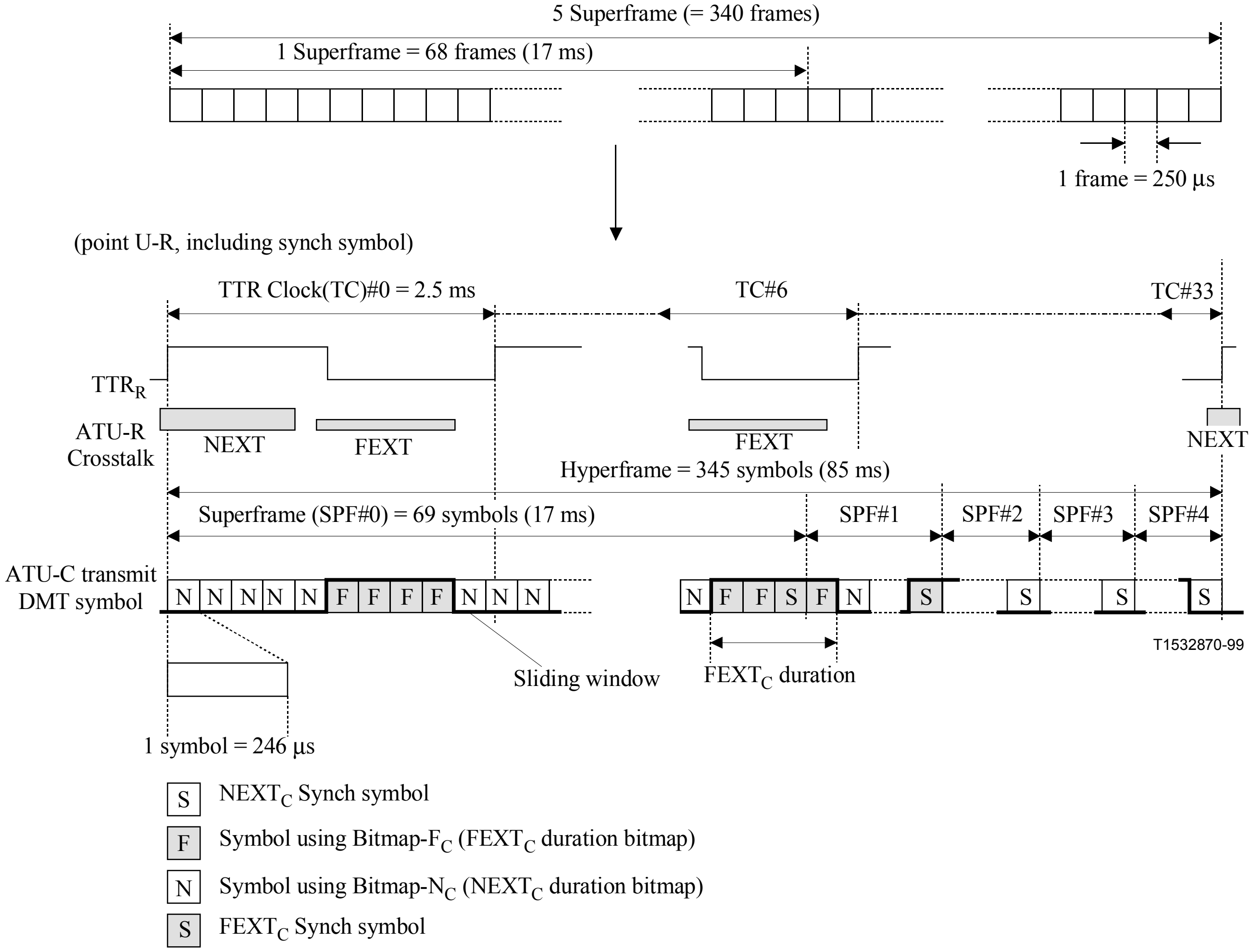


Figure C8-7/G.992.3 – Hyperframe structure for upstream

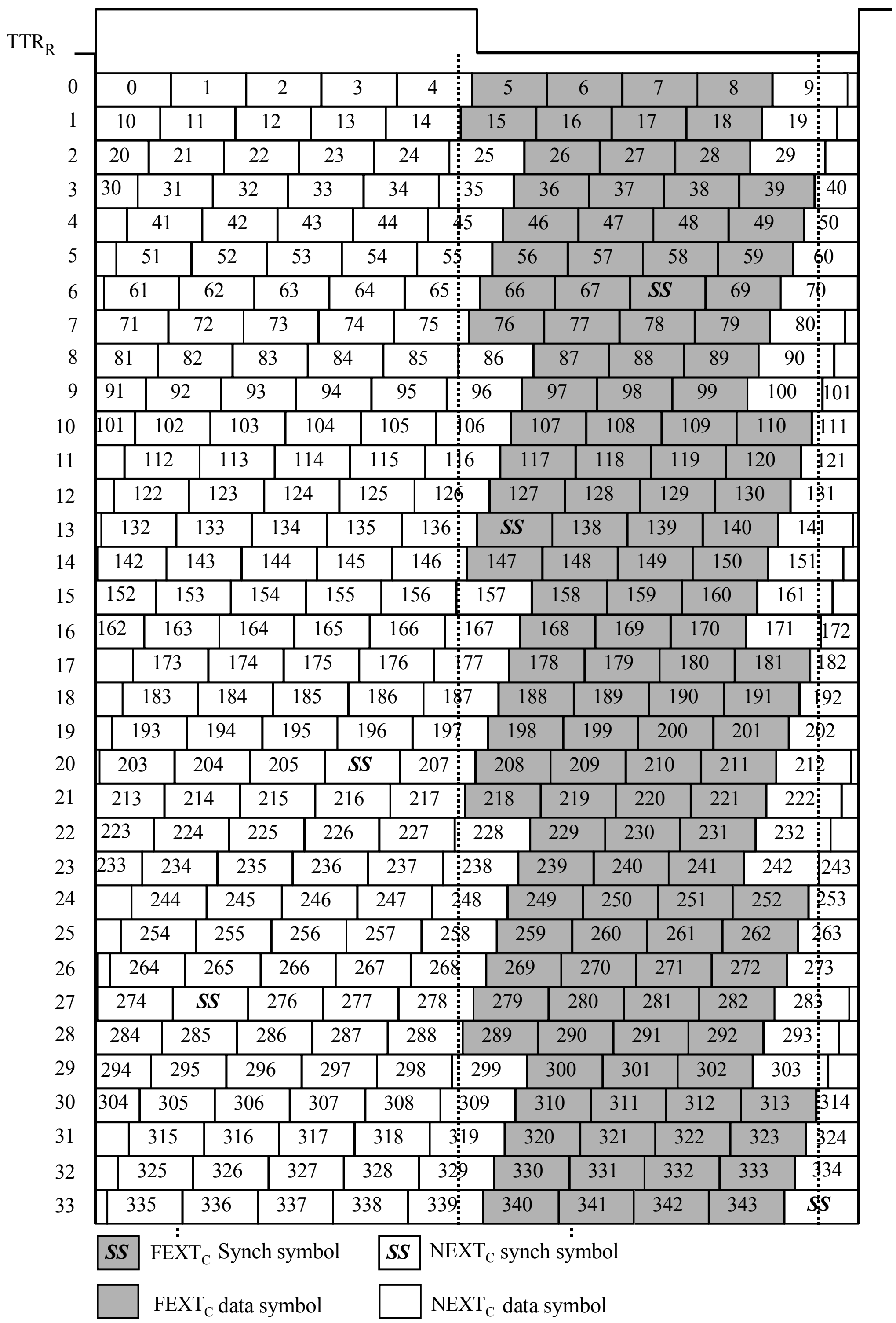


Figure C8-8/G.992.1 – Symbol pattern in a hyperframe with cyclic prefix – Upstream

C.8.4.1.2 Subframe Structure

A subframe consists of 10 consecutive symbols (the sync symbol is not counted) as shown in Table C8-1. The 34 subframes form a hyperframe. The subframe structure shall apply to both the downstream and upstream directions.

Table C8-1/G.992.3 – Subframe

Subframe No.	DMT symbol No.	Note
0	0-9	
1	10-19	
2	20-29	
3	30-39	
4	40-49	
5	50-59	
6	60-70	#68 is Sync Symbol
7	71-80	
8	81-90	
9	91-100	
10	101-110	
11	111-120	
12	121-130	
13	131-141	#137 is Sync Symbol
14	142-151	
15	152-161	
16	162-171	
17	172-181	
18	182-191	
19	192-201	
20	202-212	#206 is Sync Symbol
21	213-222	
22	223-232	
23	233-242	
24	243-252	
25	253-262	
26	263-272	
27	273-283	#275 is Sync Symbol
28	284-293	
29	294-303	
30	304-313	
31	314-323	
32	324-333	
33	334-344	#344 is Sync Symbol

C.8.4.2 Dual Bitmapping and Latency Path Multiplexing (new)

The functions of the latency path multiplexor (§7.7.2), tone ordering, constellation encoding, and gain scaling shall use one of two bitmaps stored in the ATU. This method is called the dual bitmap.

C.8.4.2.1 Dual Bitmap

The Dual Bitmap method has individual bit rates under FEXT and NEXT noise, respectively. This requires two sets of bit, gain and tone ordering tables, $\{b_i, g_i, t_i\}$, for i=1 to NSC-1. The two sets of $\{b_i, g_i, t_i\}$ tables are switched synchronous with the sliding window pattern of NEXT/FEXT symbols.

C.8.4.2.2 Latency path multiplexing

Unlike G.992.1 Annex C, this Recommendation does not specify a rate converter, and does not use dummy bits. However, in order to accommodate the uneven data flow associated with dual bitmapping, additional latency path multiplexing parameters are defined.

Data rates and latency are controlled by the following independent parameters for each latency path and symbol type:

$Lf3_P$ The number of bits from the latency path function #p included per PMD.Bits.confirm primitive for symbol type f3.

$Ln3_P$ The number of bits from the latency path function #p included per PMD.Bits.confirm primitive for symbol type n3.

$Lf4_P$ The number of bits from the latency path function #p included per PMD.Bits.confirm primitive for symbol type f4.

$Ln4_P$ The number of bits from the latency path function #p included per PMD.Bits.confirm primitive for symbol type n4.

where the symbol types are defined in Table C8-2 as follows:

Table C8-2/G.992.3 – Symbol Types

Symbol Type	Definition
f3	a FEXT symbol in a subframe that contains 3 FEXT symbols excluding any sync symbol.
n3	a NEXT symbol in a subframe that contains 3 FEXT symbols excluding any sync symbol.
f4	a FEXT symbol in a subframe that contains 4 FEXT symbols excluding any sync symbol.
n4	a NEXT symbol in a subframe that contains 4 FEXT symbols excluding any sync symbol.

These parameters allow complete flexibility in adjusting the rates and latencies between multiple latency paths.
The L_P values are exchanged during initialization and during SRA, and shall comply with the following:

With $Lf3 = \sum_{P=0}^{3} Lf3_P$ and $Lf4 = \sum_{P=0}^{3} Lf4_P$,

Lf3 and Lf4 shall be equal to the total number of bits that can be mapped in a FEXT symbol.

(e.g., for downstream, $Lf3 = Lf3_0 + Lf3_1 + Lf3_2 + Lf3_3 = f_R$, where f_R is the total number of bits mapped in a $FEXT_R$ symbol).

With $Ln3 = \sum_{P=0}^{3} Ln3_P$ and $Ln4 = \sum_{P=0}^{3} Ln4_P$,

Ln3 and Ln4 shall be equal to the total number of bits that can be mapped in a NEXT symbol

(e.g., for downstream, $Ln3 = Ln3_0 + Ln3_1 + Ln3_2 + Ln3_3 = f_N$, where f_N is the total number of bits mapped in a $NEXT_R$ symbol).

Two examples are shown below where the delay on latency path 1 is minimized. In the first example, shown in Figure C8-9, the number of bits mapped to the NEXT symbol (n_R) can support the data rate of the required low latency path, and the $Lf4_1$, $Lf3_1$, $Ln4_1$ and $Ln3_1$ values are simply programmed to the required payload with the $Lf4_0$, $Lf3_0$, $Ln4_0$ and $Ln3_0$ values set to accommodate the remaining bits in each symbol.

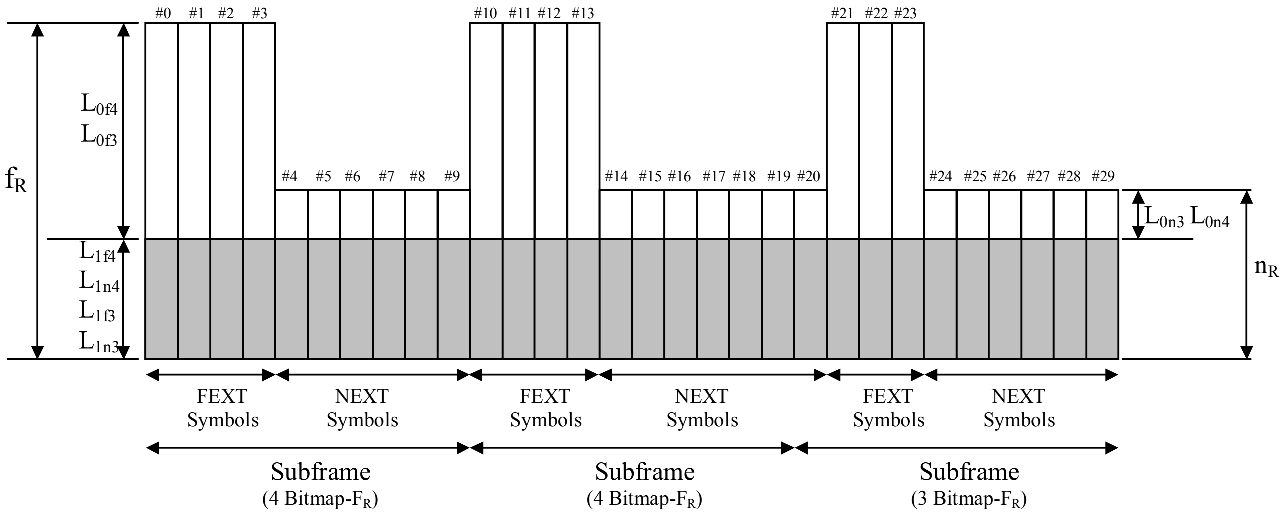


Figure C8-9/G.992.3 – First example of data rate to symbol type mapping.

###Editorial: In Figure C8-9, change notation to $Lf4_0$, $Lf3_0$, $Ln4_0$ and $Ln3_0$ and to $Lf4_1$, $Lf3_1$, $Ln4_1$ and $Ln3_1$

In the second example, shown in Figure C8-10, the n_R cannot support the data rate of the required low latency path. Therefore, all NEXT data is assigned to latency path 1, with the extra data accommodated in the FEXT symbols.

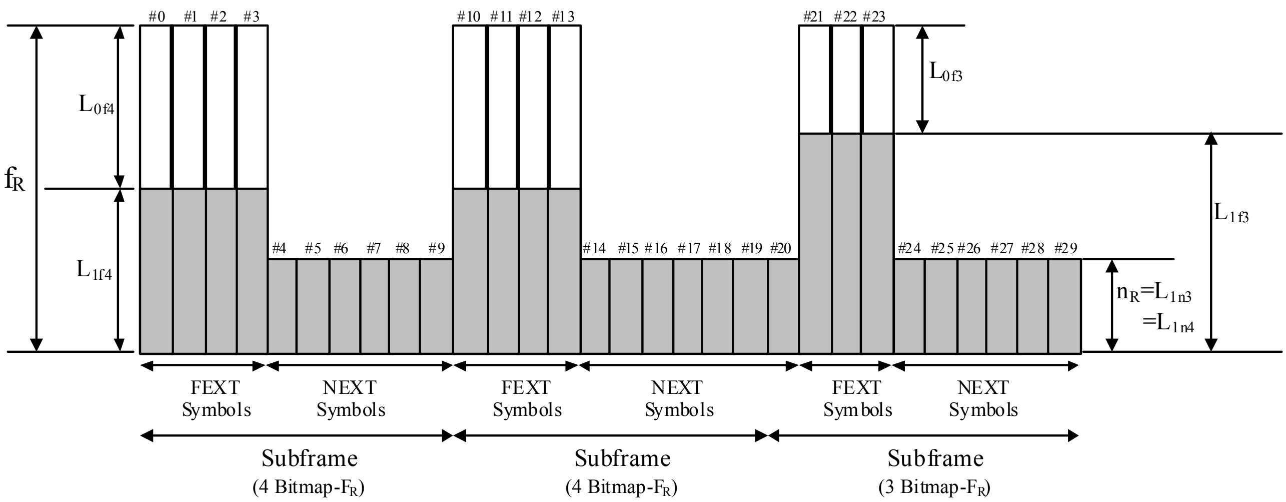


Figure C8-10/G.992.3 – Second example of data rate to symbol type mapping.

###Editorial: In Figure C8-10, change notation to $Lf4_0$, $Lf3_0$, and to $Lf4_1$, $Lf3_1$, $Ln4_1$ and $Ln3_1$

The selection of $Lf4_0$, $Lf3_0$, $Ln4_0$ and $Ln3_0$ values and $Lf4_1$, $Lf3_1$, $Ln4_1$ and $Ln3_1$ values is implementation dependent.

C.8.5 Control Parameters (supplements § 8.5)

C.8.5.1 Definition of control parameters

C.8.5.2 During the Channel Analysis Phase

C.8.5.3 Setting control parameters during initialization (supplements § 8.5.3)

C.8.5.3.1 During the G.994.1 Phase

C.8.5.3.2 During the Channel Analysis Phase

C.8.5.3.3 During the Exchange Phase (supplements § 8.5.3.3)

The Table 8-15 shall be replaced with Table C8-3. The Table C8-3 shows the PMD function control parameters included in C-PARAMS.

Table C8-3/G.992.3 - PMD function control parameters included in C-PARAMS.

Octet Nr [i]	Parameter	Format PMD bits [8*i+7 to 8*i+0]
0	LATNus (lsb)	[xxxx xxxx], bit 7 to 0
1	LATNus (msb)	[0000 00xx], bit 9 and 8
2	SATNus (lsb)	[xxxx xxxx], bit 7 to 0
3	SATNus (msb)	[0000 00xx], bit 9 and 8
4	FEXT SNRMus (lsb)	[xxxx xxxx], bit 7 to 0
5	FEXT SNRMus (msb)	[ssss sxxx], bit 10 to 8
6	FEXT ATTNDRus (lsb)	[xxxx xxxx], bit 7 to 0
7	FEXT ATTNDRus	[xxxx xxxx], bit 15 to 8
8	FEXT ATTNDRus	[xxxx xxxx], bit 23 to 16
9	FEXT ATTNDRus (msb)	[xxxx xxxx], bit 31 to 24
10	FEXT ACTATPus (lsb)	[xxxx xxxx], bit 7 to 0
11	FEXT ACTATPus (msb)	[ssss ssxx], bit 9 and 8
12	NEXT SNRMus (lsb)	[xxxx xxxx], bit 7 to 0
13	NEXT SNRMus (msb)	[ssss sxxx], bit 10 to 8
14	NEXT ATTNDRus (lsb)	[xxxx xxxx], bit 7 to 0
15	NEXT ATTNDRus	[xxxx xxxx], bit 15 to 8
16	NEXT ATTNDRus	[xxxx xxxx], bit 23 to 16
17	NEXT ATTNDRus (msb)	[xxxx xxxx], bit 31 to 24
18	NEXT ACTATPus (lsb)	[xxxx xxxx], bit 7 to 0
19	NEXT ACTATPus (msb)	[ssss ssxx], bit 9 and 8
20	TRELLISus	[0000 000x], bit 0
21	Reserved	[0000 0000]
22	FEXT Upstream Bits and Gains For subcarrier 1 (lsb)	[gggg bbbb], bit 7 to 0
23	FEXT Upstream Bits and Gains For subcarrier 1 (msb)	[gggg gggg], bit 15 to 8
…..	…..	…..
18+2*NSCus	FEXT Upstream Bits and Gains Subcarrier NSCus-1 (lsb)	[gggg bbbb], bit 7 to 0
19+2*NSCus	FEXT Upstream Bits and Gains Subcarrier NSCus-1 (msb)	[gggg gggg], bit 15 to 8
20+2*NSCus	NEXT Upstream Bits and Gains For subcarrier 1 (lsb)	[gggg bbbb], bit 7 to 0
21+2*NSCus	NEXT Upstream Bits and Gains For subcarrier 1 (msb)	[gggg gggg], bit 15 to 8
…..	…..	…..
16+4*NSCus	NEXT Upstream Bits and Gains Subcarrier NSCus-1 (lsb)	[gggg bbbb], bit 7 to 0
17+4*NSCus	NEXT Upstream Bits and Gains Subcarrier NSCus-1 (msb)	[gggg gggg], bit 15 to 8
18+4*NSCus	Reserved	[0000 0000]
19+4*NSCus	Upstream Tone ordering First subcarrier to map	[xxxx xxxx], bit 7 to 0
…..	…..	…..
17+5*NSCus	Upstream Tone ordering Last subcarrier to map	[xxxx xxxx], bit 7 to 0

The Table 8-16 shall be replaced with Table C8-4. The Table C8-4 shows the PMD function control parameters included in R-PARAMS.

Table C8-4/G.992.3 - PMD function control parameters included in R-PARAMS.

Octet Nr [i]	Parameter	Format PMD bits [8*i+7 to 8*i+0]
0	LATNds (lsb)	[xxxx xxxx], bit 7 to 0
1	LATNds (msb)	[0000 00xx], bit 9 and 8
2	SATNds (lsb)	[xxxx xxxx], bit 7 to 0
3	SATNds (msb)	[0000 00xx], bit 9 and 8
4	FEXT SNRMds (lsb)	[xxxx xxxx], bit 7 to 0
5	FEXT SNRMds (msb)	[ssss sxxx], bit 10 to 8
6	FEXT ATTNDRds (lsb)	[xxxx xxxx], bit 7 to 0
7	FEXT ATTNDRds	[xxxx xxxx], bit 15 to 8
8	FEXT ATTNDRds	[xxxx xxxx], bit 23 to 16
9	FEXT ATTNDRds (msb)	[xxxx xxxx], bit 31 to 24
10	FEXT ACTATPds (lsb)	[xxxx xxxx], bit 7 to 0
11	FEXT ACTATPds (msb)	[ssss ssxx], bit 9 and 8
12	NEXT SNRMds (lsb)	[xxxx xxxx], bit 7 to 0
13	NEXT SNRMds (msb)	[ssss sxxx], bit 10 to 8
14	NEXT ATTNDRds (lsb)	[xxxx xxxx], bit 7 to 0
15	NEXT ATTNDRds	[xxxx xxxx], bit 15 to 8
16	NEXT ATTNDRds	[xxxx xxxx], bit 23 to 16
17	NEXT ATTNDRds (msb)	[xxxx xxxx], bit 31 to 24
18	NEXT ACTATPds (lsb)	[xxxx xxxx], bit 7 to 0
19	NEXT ACTATPds (msb)	[ssss ssxx], bit 9 and 8
20	TRELLISds	[0000 000x], bit 0
21	Reserved	[0000 0000]
22	FEXT Downstream Bits and Gains For subcarrier 1 (lsb)	[gggg bbbb], bit 7 to 0
23	FEXT Downstream Bits and Gains For subcarrier 1 (msb)	[gggg gggg], bit 15 to 8
…..	…..	…..
18+2*NSCds	FEXT Downstream Bits and Gains Subcarrier NSCus-1 (lsb)	[gggg bbbb], bit 7 to 0
19+2*NSCds	FEXT Downstream Bits and Gains Subcarrier NSCus-1 (msb)	[gggg gggg], bit 15 to 8
20+2*NSCds	NEXT Downstream Bits and Gains For subcarrier 1 (lsb)	[gggg bbbb], bit 7 to 0
21+2*NSCds	NEXT Downstream Bits and Gains For subcarrier 1 (msb)	[gggg gggg], bit 15 to 8
…..	…..	…..
16+4*NSCds	NEXT Downstream Bits and Gains Subcarrier NSCus-1 (lsb)	[gggg bbbb], bit 7 to 0
17+4*NSCds	NEXT Downstream Bits and Gains Subcarrier NSCus-1 (msb)	[gggg gggg], bit 15 to 8
18+4*NSCds	Reserved	[0000 0000]
19+4*NSCds	Downstream Tone ordering First subcarrier to map	[xxxx xxxx], bit 7 to 0
…..	…..	…..
17+5*NSCds	Downstream Tone ordering Last subcarrier to map	[xxxx xxxx], bit 7 to 0

C.8.6 Constellation encoder for data symbols (supplements § 8.6)

C.8.6.1 Tone Ordering (supplements § 8.6.1)

The downstream bit allocation table and the gain table for each of the two bitmaps (Bitmap-F_R and Bitmap-N_R) are calculated in the ATU-R receiver, and sent back to the ATU-C in the R-PARAMS message. For each of the two bitmaps (Bitmap-F_R and Bitmap-N_R) a common tone ordering table is exchanged during initialization, separate re-ordered tone tables are derived from the exchanged table, and separate tone ordering is performed according to § 8.6.1.

The upstream tone ordering algorithm shall be the same as for the downstream data. Two ordered bit tables for Bitmap-F_C and Bitmap-N_C shall be prepared.

C.8.6.2 Low Power L2 State (new)

During L2 link state, The ATU-C shall transmit data during $FEXT_R$ symbols only.

During L2 $FEXT_R$ data symbols the ATU-C shall use the bit loading (bi) according to the L2 Grant message for the first 256 sub-carriers (sub-carrier 0 to sub-carrier 255). The rest of the sub-carriers shall not carry data (bi=0).

During L2 $FEXT_R$ data symbols, sub-carriers that carry no data (bi=0) shall be modulated with a vendor discretionary dummy 4QAM signal.

L2 $FEXT_R$ data symbols shall use the gain scaling (gi) of the L0 $FEXT_R$ symbols.

L2 $FEXT_R$ data symbols shall use the downstream power cutback (PCBds) indicated in the L2 Grant message or the last granted L2 Trim message.

During L2 $NEXT_R$ data symbols the ATU-C shall transmit a vendor discretionary dummy 4QAM signal. L2 $NEXT_R$ data symbols shall use the gain scaling (gi) of the L0 $NEXT_R$ symbols. L2 $NEXT_R$ data symbols shall use the downstream power cutback (PCBds) indicated in the L2 Grant message or the last granted L2 Trim message (the same power cutback as the L2 $FEXT_R$ data symbols).

During L2 $FEXT_R$ synchronization symbols the constellation mapper shall be defined as for SS-REVERB (see §8.7.1). L2 $FEXT_R$ synchronization symbols shall use the gain scaling (gi) and power cutback (PCBds) of the L2 $FEXT_R$ data symbols.

During L2 $NEXT_R$ synchronization symbols the constellation mapper shall be defined as for SS-REVERB (see §8.7.1). L2 $NEXT_R$ synchronization symbols shall use the gain scaling (gi) and power cutback (PCBds) of the L2 $NEXT_R$ data symbols.

C.8.7 Constellation encoder for synchronization and L2 exit symbols (supplements § 8.7)

The constellation mapper for the L2 exit symbols shall be as defined in §8.7. $FEXT_R$ exit symbols shall use the $FEXT_R$ symbols (data/synchronization, L0/L2) gain scaling and $NEXT_R$ exit symbols shall use the $NEXT_R$ symbols (data/synchronization, L0/L2) gain scaling. The L2 Grant and L2 Trim Grant messages indicate the PCBds value to be used with the L2 exit symbols.

C.8.7.1 Constellation mapper

C.8.7.2 Gain scaling

C.8.7.3 On-line reconfiguration during the L0 state

C.8.7.4 Entry from the L0 into the L2 power management state

C.8.7.5 Power trimming during the L2 state

C.8.7.6 Exit from the L2 power management into the L0 state (supplements § 8.7.6)

For profiles 1 and 3, the L2 exit symbols shall be synchronized to the next $FEXT_R$ symbol. For the remaining profiles, 2, 4, 5 and 6, The L2 exit procedure depends on the number of loaded sub-carriers (bi>0) in L0 Bitmap-N_R at the moment of transition from L0 to L2. If the number of loaded sub-carriers in L0 Bitmap-N_R is greater than 20, L2 exit symbols shall be synchronized to the next data symbol regardless if it is a $NEXT_R$ or $FEXT_R$ symbol. If the number of loaded sub-carriers in L0 Bitmap-N_R is less than 20, L2 exit symbols shall be synchronized to the next $FEXT_R$ symbol, as in the case for profiles 1 and 3.

C.8.8 Modulation

C.8.9 Transmitter dynamic range

C.8.10 Transmitter spectral masks (supplements § 8.10)

Spectral masks for the different service options are defined in the corresponding sub-annexes. The spectral mask defines the maximum passband PSD, maximum stopband PSD and maximum aggregate transmit power.

See Sub-annex C.A.

C.8.11 Control plane procedures

C.8.12 Management plane procedures (supplements § 8.12)

C.8.12.1 ADSL line related primitives (supplements § 8.12.1)

Two near-end defects are further defined:

- *Loss-of-signal (LOS)*: The ADSL power shall be measured only in the $FEXT_C$ duration at ATU-C, or only in the $FEXT_R$ duration at ATU-R.
- *Severely errored frame (SEF)*: A SEF defect occurs when the content of two consecutively received ADSL synchronization symbols in the $FEXT_C$ duration at ATU-C, or in the $FEXT_R$ duration at ATU-R, does not correlate with the expected content over a subset of the tones. An SEF defect terminates when the content of two consecutively received ADSL synchronization symbols in the $FEXT_C$ duration at ATU-C, or in the $FEXT_R$ duration at ATU-R, correlate with the expected contents over the same subset. The correlation method, the selected subset of tones, and the threshold for declaring these defect conditions are implementation discretionary.

C.8.12.2 Other Primitives

C.8.12.3 Test Parameters (supplements § 8.12.3)

The near-end primitives are further defined:

- *Attenuation (ATN)*: The received signal power shall be measured only in the $FEXT_C$ duration at ATU-C, or only in the $FEXT_R$ duration at ATU-R.
- *Signal-to-Noise ratio (SNR) margin*: During FEXT Bitmap mode, this primitive represents the snr margin in the $FEXT_C$ duration at ATU-C, or in the $FEXT_R$ duration at ATU-R.

The far-end primitives are further defined:

- *Attenuation (ATN)*: The received signal power shall be measured only in the $FEXT_C$ duration at ATU-C, or only in the $FEXT_R$ duration at ATU-R.
- *Signal-to-Noise ratio SNR margin*: During FEXT Bitmap mode, this primitive represents the snr margin in the $FEXT_C$ duration at ATU-C, or in the $FEXT_R$ duration at ATU-R.

C.8.12.3.1 Channel Characteristics Function per subcarrier (CCF-ps)

C.8.12.3.2 Quiet Line Noise PSD per subcarrier (QLN-ps) (supplements § 8.12.3.2)

The following Figures C8-11, C8-12 and C8-13 illustrates quiet line noise measurements.

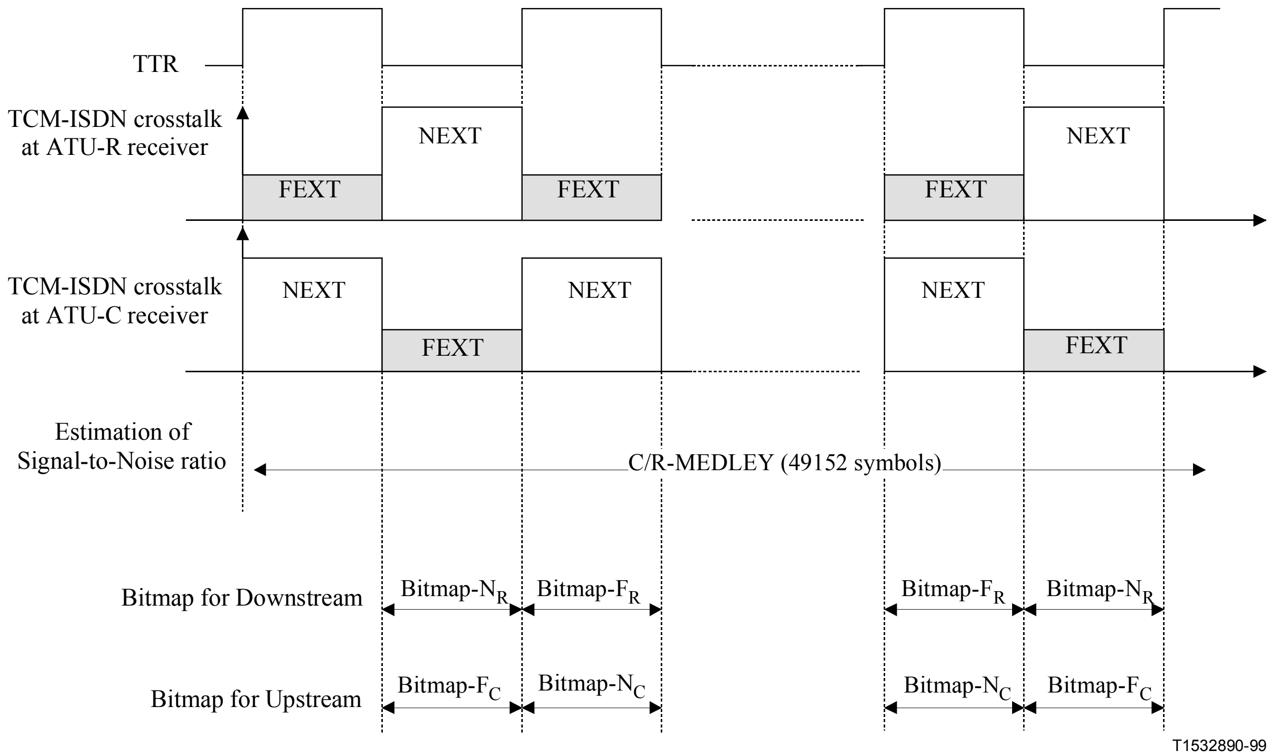


Figure C8-11/G.992.3 – Estimation of periodic Signal-to-Noise Ratio

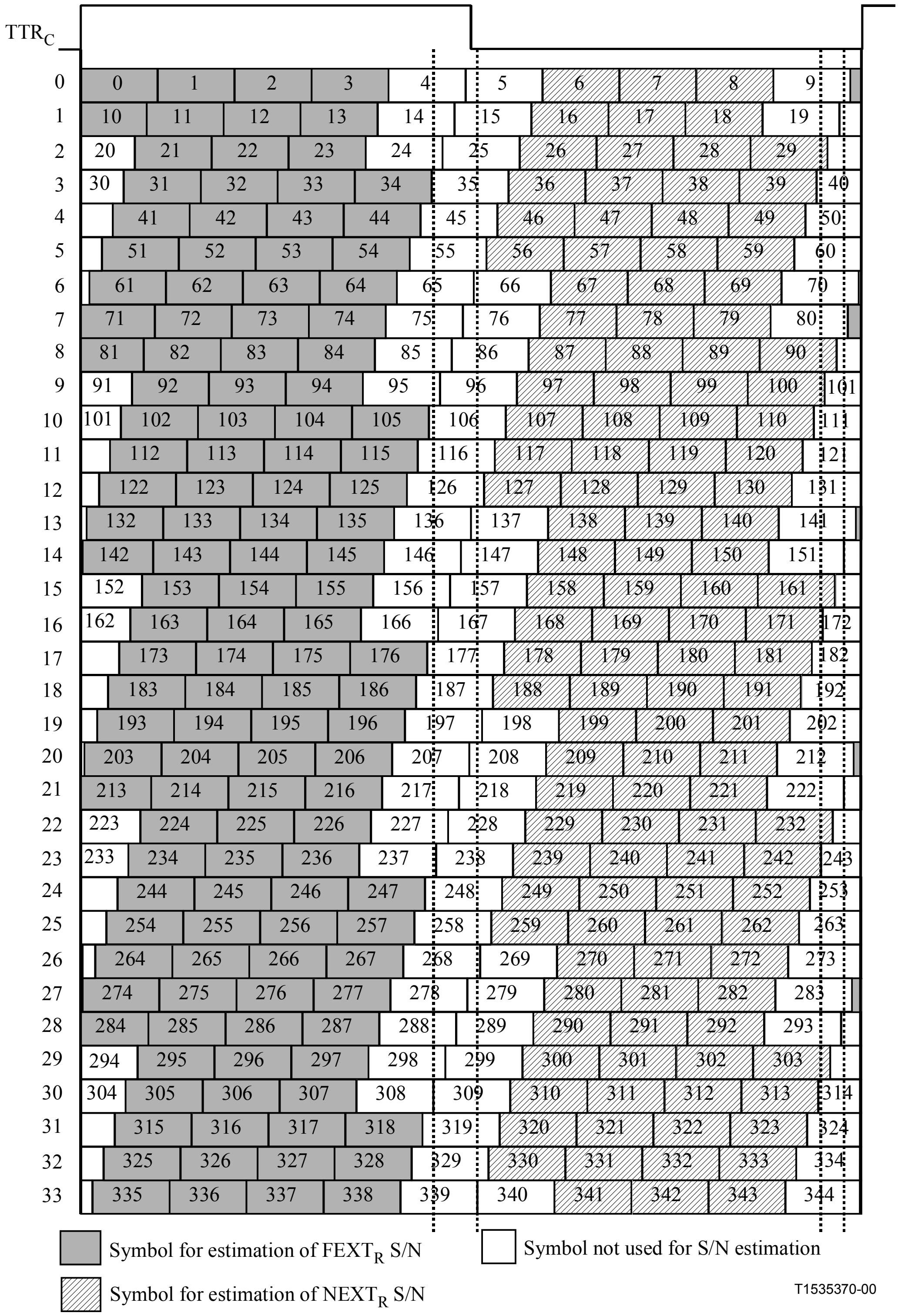


Figure C8-12/G.992.3 – Symbol pattern in a hyperframe for S/N estimation – Downstream

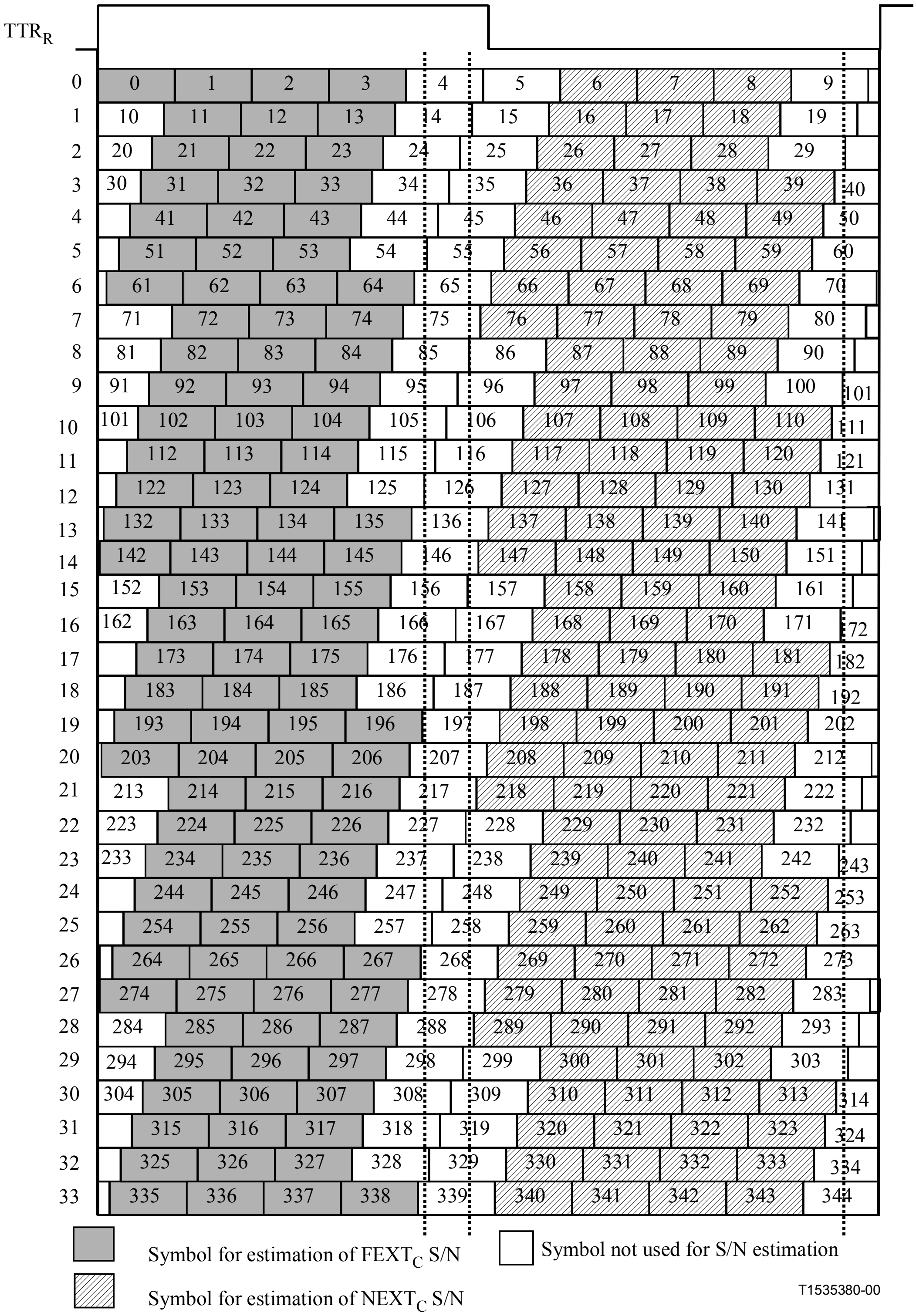


Figure C8-13/G.992.3 – Symbol pattern in a hyperframe for S/N estimation – Upstream

C.8.13 Initialization (supplements § 8.13)

C.8.13.1 Initialization with Hyperframe (new)

The exchange of messages between ATU-C and ATU-R should be performed in $FEXT_C$ and $FEXT_R$. The DMT symbol has two symbol rates: one is 4.3125 kbaud for the symbol without a cyclic prefix, and the other is 4 x 69/68 kbaud for the symbol with a cyclic prefix. 32 times of the TTR has the same period as 345 times of the 4.3125 kbaud, and 34 times of the TTR is the same as 345 times of 4 x 69/68 kHz.

The ATU-C begins transmitting C-TTRSYNC1 at the beginning of the hyperframe without cyclic prefix. The ATU-C transmits $NEXT_R$ / $FEXT_R$ information to the ATU-R during C-TTRSYNC1. The ATU-R begins transmitting R-COMB1 at the beginning of the hyperframe without cyclic prefix. The ATU-R performs the training of any receiver equalizer using the phase information of the TTR_R generated from the received TTR_C. From C-TTRSYNC1 to C-SEGUE1, the following numerical formula describes which duration the N_{dmt}-th symbol belongs to at the ATU-R (see Figure C8-14).

For N_{dmt} = 0, 1, …344
    $S = 256 \times N_{dmt} \bmod 2760$
    if { (S + 255 < a) or (S > a + b) }   then $FEXT_R$ symbols
    else   then $NEXT_R$ symbols
where a = 1243, b = 1461

In order to enter C-MSG1 at the beginning of the hyperframe with cyclic prefix, the number of symbols from C-TTRSYNC1 to C-SEGUE1 shall be a multiple of 345 symbols.

From R-COMB1 to R-SEGUE1, the following numerical formula describes which duration the N_{dmt}-th symbol belongs to at the ATU-C (see Figure C8-15).

For N_{dmt} = 0, 1, …, 344,
    $S = 256 \times N_{dmt} \bmod 2760$
    if { (S > a) and (S + 255 < a + b) }   then $FEXT_C$ symbols
    else   then $NEXT_C$ symbols
where a = 1315, b = 1293

From C-MSG1 to C-SEGUE4, the number of symbols is a multiple of 345 DMT symbols. The following numerical formula describes which duration the N_{dmt}-th symbol belongs to at the ATU-R.

For N_{dmt} = 0, 1, ..., 344
    $S = 272 \times N_{dmt} \bmod 2760$
    if { (S + 271 ≥ a) and (S ≤ a + b) }   then $NEXT_R$ symbols
    else   then $FEXT_R$ symbols
where a = 1243, b = 1461

The ATU-R enters R-REVERB5 at the beginning of the hyperframe with cyclic prefix, which is extracted from received signal. From R-REVERB5 to R-SEGUE4, the number of symbols is a multiple of 345 DMT symbols. The following numerical formula describes which duration the N_{dmt}-th symbol belongs to at the ATU-C.

For N_{dmt} = 0, 1, ..., 344
    $S = 272 \times N_{dmt} \bmod 2760$
    if { (S > a) and (S + 271 < a + b) }   then $FEXT_C$ symbols
    else   then $NEXT_C$ symbols
where a = 1315, b = 1293

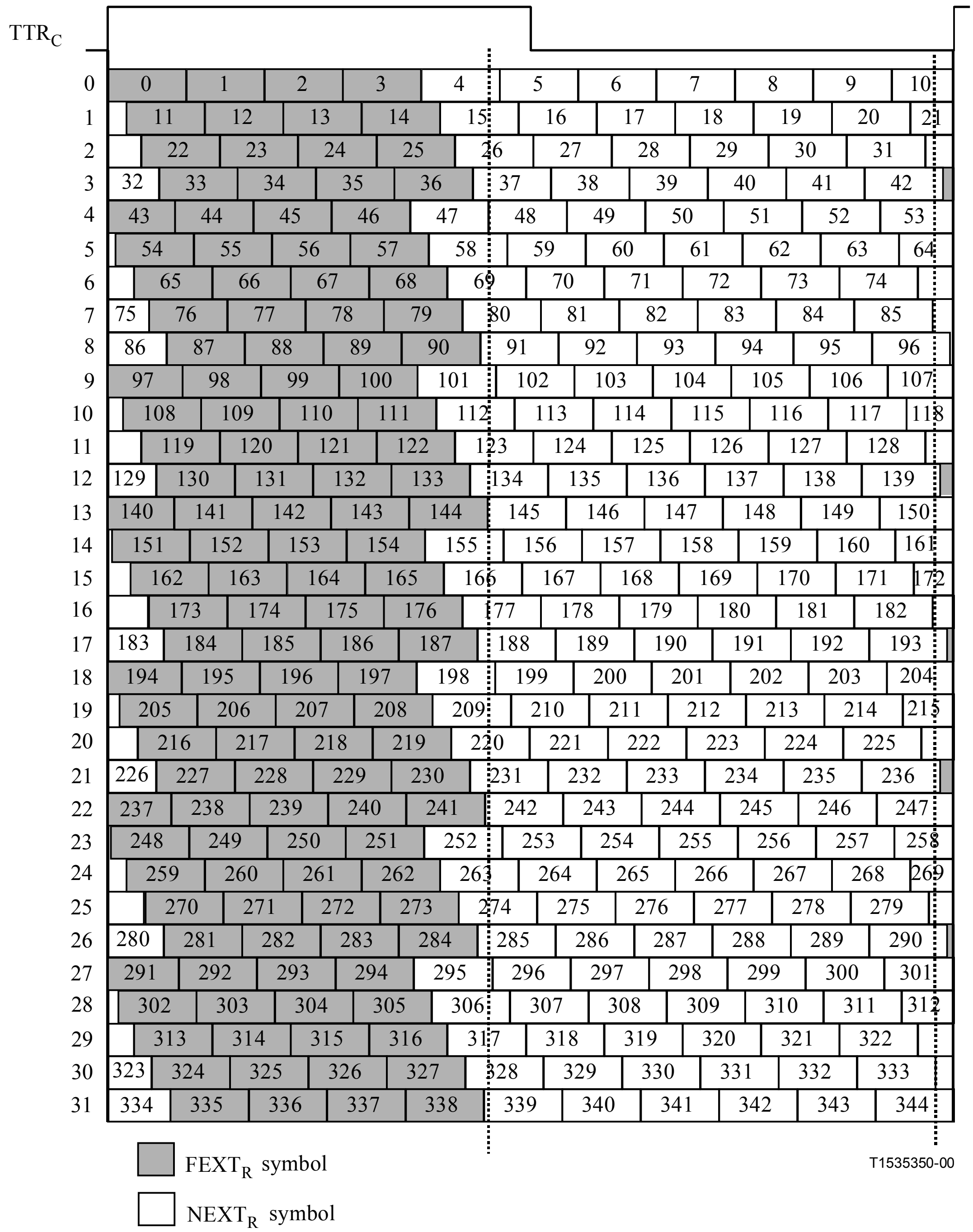


Figure C8-14/G.992.3 – Symbol pattern in a hyperframe without cyclic prefix – Downstream

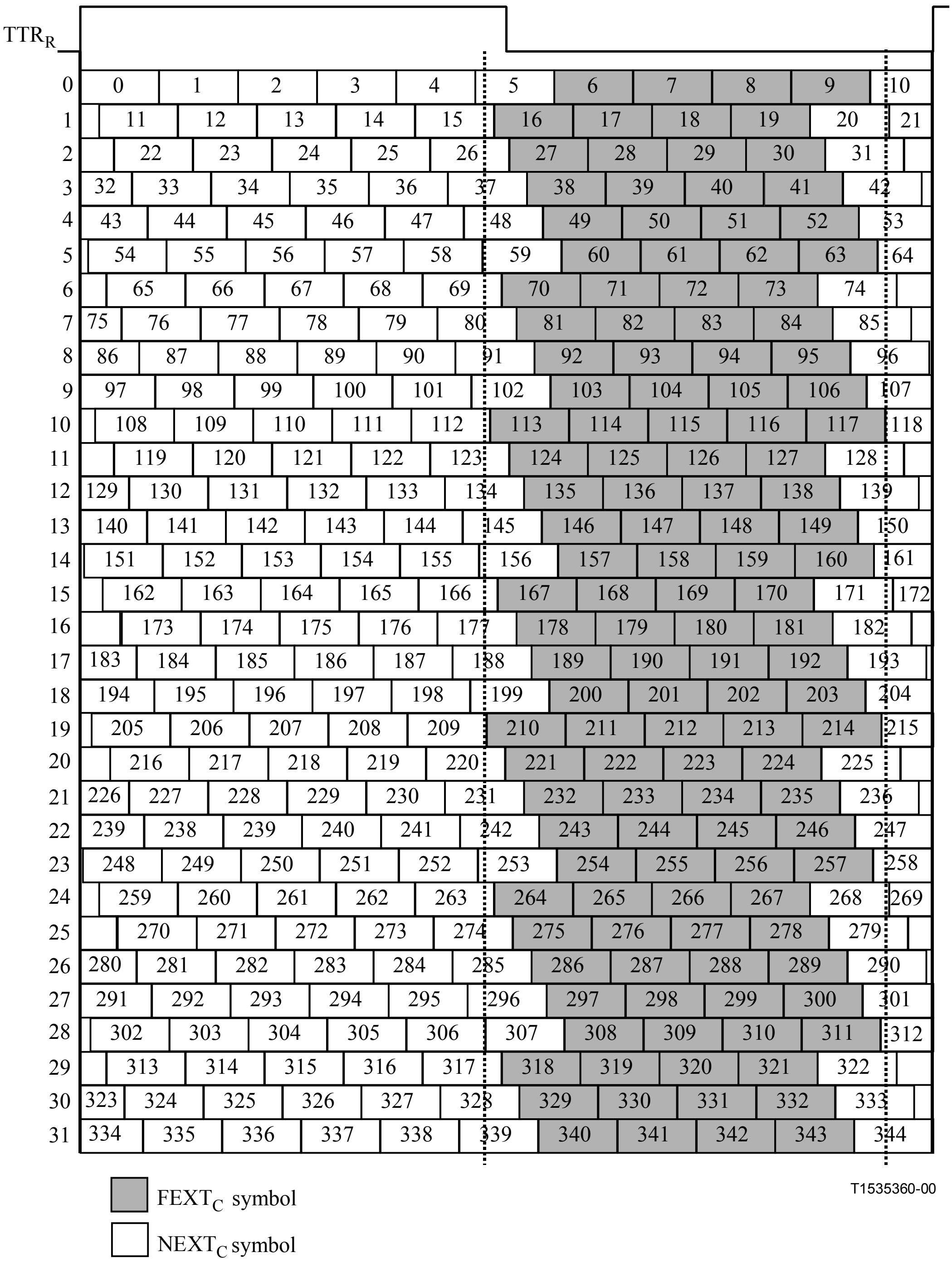


Figure C8-15/G.992.3 – Symbol pattern in a hyperframe without cyclic prefix – Upstream

C.8.13.2 G.994.1 phase (supplements § 8.13.2)

C.8.13.2.1 Handshake – ATU-C (supplements § 8.13.2.1)

C.8.13.2.1.1 CL messages (replaces § 8.13.2.1.1)

An ATU-C wishing to indicate G.992.3 Annex C capabilities in a G.994.1 CL message shall do so by setting bit 7 in Table 11.0.2/G.994.1 to ONE. A corresponding {Par(2)} field shall also be present (see § 9.4/G.994.1). The G.994.1 CL message {Par(2)} field corresponding to the G.992.3 Annex C {SPar(1)} bit is defined in Table C8-5.

Table C8-5/G.992.3 – ATU-C CL message Par(2) PMD bit definitions

NPar(2) bit	Definition
Tones 1 to 32	Applies to ISDN related service options only (see Annexes).
Diagnostics Mode	When set to 1, indicates the ATU-C wants to enter diagnostics mode (see § 8.15). When set to 0, indicates the ATU-C wants to enter initialization (see § 8.13).
Profile 1	If set to ONE, this bit shall indicate that the ATU-C supports Profile 1
Profile 2	If set to ONE, this bit shall indicate that the ATU-C supports Profile 2
Profile 3	If set to ONE, this bit shall indicate that the ATU-C supports Profile 3
Profile 4	If set to ONE, this bit shall indicate that the ATU-C supports Profile 4
Profile 5	If set to ONE, this bit shall indicate that the ATU-C supports Profile 5
Profile 6	If set to ONE, this bit shall indicate that the ATU-C supports Profile 6
SPar(2) bit	**Definition of related Npar(3) bits**
Spectrum bounds upstream	A parameter block indicating the Nominal transmit PSD level, the Maximum transmit PSD level and the Maximum aggregate transmit power. The parameter block length shall be 6 octets. Codepoints shall be structured as: • Nominal transmit PSD level (NOMPSD) shall be represented as a 9-bit 2's complement signed value in 0.1 dB steps, -25.6 to +25.5 dB, relative to the value defined in the applicable Annex for the selected service option and shall be coded in bits 3 downto 1 in octet 1, bits 6 downto 1 in octet 2; • Maximum nominal transmit PSD level (MAXNOMPSD) shall be represented as a 9-bit 2's complement signed value in 0.1 dB steps, -25.6 to +25.5 dB, relative to the value defined in the applicable Annex for the selected service option and shall be coded in bits 3 downto 1 in octet 3, bits 6 downto 1 in octet 4; • Maximum nominal aggregate transmit power (MAXNOMATP) shall be represented as a 9-bit 2'complement signed value in 0.1 dB steps, -25.6 to 25.5 dB, relative to the value defined for the applicable Annex for the selected service option and shall be coded in bits 3 downto 1 in octet 5, bits 6 downto 1 in octet 6.
Spectrum shaping upstream	A parameter block of pairs of subcarrier indexes and spectrum shaping log_tssi value at that subcarrier. Pairs shall be transmitted in ascending subcarrier index order. Each pair shall be represented as 4 octets. The parameter block length shall be a multiple of 4 octets. Codepoints shall be structured as: • The subcarrier index shall be a 9-bit unsigned value, indicating subcarrier index 1 to 2*NSCus-1, coded in bits 3 and 1 in octet 1, bits 6 downto 1 in octet 2; • The spectrum shaping log_tssi values shall be represented in logarithmic scale as a 7-bit unsigned value in -0.5 dB steps, ranging from 0 (value 0) to -63 dB (value 126), coded in bit 1 of octet 3 and bits 6 downto 1 in octet 4. Value 127 is a special value, indicating the sub-carrier is not transmitted (i.e., tssi=0 in linear scale); For profiles 5 and 6, this block shall contain the log_tssi for the FEXT symbols.
Spectrum bounds downstream	Parameter block with same definition and structure as spectrum bounds upstream.
Spectrum shaping downstream	Parameter block with same definition and structure as spectrum shaping upstream (with breakpoint frequencies indicating subcarrier index 1 to 2*NSCds-1).
Transmit Signal Images above the Nyquist frequency	A parameter block indicating the type of the transmit signal images above the Nyquist frequency. The parameter block shall consist of a single octet. Codepoints shall be structured as bits 6 to 3 indicating the N value and bits 2 and 1 indicating the definition of the transmit signal images above the Nyquist frequency (see § 8.8.2). The coding shall be as follows: ▪ (b6b5b4b3)=n, with 1≤n≤15 indicates that $N=2^n$; ▪ (b6b5b4b3)=n, with n=0 indicates that N is not a power of 2; ▪ (b2b1 = 01): complex conjugate of the base-band signal; ▪ (b2b1 = 10) : zero filled; ▪ (b2b1 = 00) : other (none of the above); ▪ (b2b1 = 11) : reserved.

C.8.13.2.1.2 MS messages (replaces § 8.13.2.1.2)

An ATU-C selecting the G.992.3 Annex C mode of operation in a G.994.1 MS message shall do so by setting bit 7 in Table 11.0.2/G.994.1 to ONE. A corresponding {Par(2)} field shall also be present (see § 9.4/G.994.1). The G.994.1 MS message {Par(2)} field corresponding to the G.992.3 Annex C {SPar(1)} bit is defined in Table C8-6.

Table C8-6/G.992.3 – ATU-C MS message Par(2) PMD bit definitions

NPar(2) bit	Definition
Tones 1 to 32	Applies to ISDN related service options only (see Annexes).
Diagnostics Mode	Set to 1 if the CL or the CLR message have this bit set to 1. When set to 1, indicates both ATUs shall enter diagnostics mode (see § 8.15). When set to 0, indicates both ATUs shall enter initialization (see § 8.13).
Profile 1	If set to ONE, this bit shall indicate that the ATU-C is selecting Profile 1
Profile 2	If set to ONE, this bit shall indicate that the ATU-C is selecting Profile 2
Profile 3	If set to ONE, this bit shall indicate that the ATU-C is selecting Profile 3
Profile 4	If set to ONE, this bit shall indicate that the ATU-C is selecting Profile 4
Profile 5	If set to ONE, this bit shall indicate that the ATU-C is selecting Profile 5
Profile 6	If set to ONE, this bit shall indicate that the ATU-C is selecting Profile 6

The SPar(2) bits shall be set to 0. No NPar(3) parameters shall be included in the MS message.

C.8.13.2.2 Handshake – ATU-R (supplements § 8.13.2.2)

C.8.13.2.2.1 CLR messages (replaces § 8.13.2.2.1)

An ATU-R wishing to indicate G.992.3 Annex C capabilities in a G.994.1 CL message shall do so by setting bit 7 in Table 11.0.2/G.994.1 to ONE. A corresponding {Par(2)} field shall also be present (see § 9.4/G.994.1). The G.994.1 CL message {Par(2)} field corresponding to the G.992.3 Annex C {SPar(1)} bit is defined in Table C8-7.

Table C8-7/G.992.3 – ATU-R CLR message Par(2) PMD bit definitions

NPar(2) bit	Definition
Tones 1 to 32	Applies to ISDN related service options only (see Annexes).
Diagnostics Mode	When set to 1, indicates the ATU-R wants to enter diagnostics mode (see § 8.15). When set to 0, indicates the ATU-R wants to enter initialization (see § 8.13).
Profile 1	If set to ONE, this bit shall indicate that the ATU-R supports Profile 1
Profile 2	If set to ONE, this bit shall indicate that the ATU-R supports Profile 2
Profile 3	If set to ONE, this bit shall indicate that the ATU-R supports Profile 3
Profile 4	If set to ONE, this bit shall indicate that the ATU-R supports Profile 4
Profile 5	If set to ONE, this bit shall indicate that the ATU-R supports Profile 5
Profile 6	If set to ONE, this bit shall indicate that the ATU-R supports Profile 6
SPar(2) bit	**Definition of related Npar(3) bits**
Spectrum bounds upstream	Parameter block with same definition and structure as spectrum bounds upstream parameter block in CL message.
Spectrum shaping upstream	Parameter block with same definition and structure as spectrum shaping upstream parameter block in CL message.
Spectrum bounds downstream	Parameter block shall not be included. This SPar(2) bit shall be set to 0.
Spectrum shaping downstream	Parameter block shall not be included. This SPar(2) bit shall be set to 0.
Transmit Signal Images above the Nyquist frequency	Parameter block with same definition and structure as Transmit Signal Images above the Nyquist frequency parameter block in CL message.

C.8.13.2.2.2 MS messages (replaces § 8.13.2.2.2)

An ATU-R selecting the G.992.3 Annex C mode of operation in a G.994.1 MS message shall do so by setting bit 7 in Table 11.0.2/G.994.1 to ONE. A corresponding {Par(2)} field shall also be present (see § 9.4/G.994.1). The G.994.1 MS message {Par(2)} field corresponding to the G.992.3 Annex C {SPar(1)} bit is defined in Table C8-8.

If the ATU-R transmits an MP message (as defined in § 7.5/G.994.1) , the format of the MP message shall be the same as the format of the MS message defined in Table C8-8.

Table C8-8/G.992.3 – ATU-R MS message Par(2) PMD bit definitions

NPar(2) bit	Definition
Tones 1 to 32	Applies to ISDN related service options only (see Annexes).
Diagnostics Mode	Set to 1 if the CL or the CLR message have this bit set to 1. When set to 1, indicates both ATUs shall enter diagnostics mode (see § 8.15). When set to 0, indicates both ATUs shall enter initialization (see § 8.13).
Profile 1	If set to ONE, this bit shall indicate that the ATU-R is selecting Profile 1.
Profile 2	If set to ONE, this bit shall indicate that the ATU-R is selecting Profile 2.
Profile 3	If set to ONE, this bit shall indicate that the ATU-R is selecting Profile 3.
Profile 4	If set to ONE, this bit shall indicate that the ATU-R is selecting Profile 4.
Profile 5	If set to ONE, this bit shall indicate that the ATU-R is selecting Profile 5.
Profile 6	If set to ONE, this bit shall indicate that the ATU-R is selecting Profile 6.

The Spar(2) bits shall be set to 0. No Npar(3) parameters shall be included in the MS message.

C.8.13.2.3 G.994.1 transmit PSD levels

C.8.13.2.4 Spectral bounds and shaping parameters

C.8.13.3 Channel discovery phase (supplements § 8.13.3)

C.8.13.3.1 ATU-C Channel Discovery (supplements § 8.13.3.1)

C.8.13.3.1.1 C-QUIET1 (supplements § 8.13.3.1.1)

In the C-QUIET1 state, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols. The ATU-C shall transmit a minimum of 512 and a maximum of 4204 C-QUIET symbols.

The ATU-C shall then transition to the next state C-TTRSYNC1 at a hyper-frame boundary.

C.8.13.3.1.2 C-TTRSYNC1 (replaces § 8.13.3.1.2)

The ATU-C shall set the sliding window frame counter (N_{SWF}) to 0 upon entering C-TTRSYNC1, and increment the N_{SWF} counter modulo 345 after transmission of each symbol.

The C-TTRSYNC1 state is of variable length. In the C-TTRSYNC1 state, the ATU-C shall transmit C-TTRSYNC symbols only during $FEXT_R$ symbols. During $NEXT_R$ symbols, no signal shall be transmitted (all Xi=Yi=0).

For an ATU using Profiles 1 or 2, the C-REVERB subcarriers 33-64 shall be transmitted during the first 4 $FEXT_R$ symbols of each hyper-frame, while initialization pilot carriers 48 and 64 shall be transmitted during all other $FEXT_R$ symbols. For transceivers using Profiles 3, 4, 5, or 6, the C-REVERB subcarriers 6-32 shall be transmitted during the first 4 $FEXT_R$ symbols of each hyper-frame, while initialization pilot carriers 16, 32, 48 and 64 shall be transmitted during all other $FEXT_R$ symbols.

The ATU-C shall transmit 345n (n>1) C-TTRSYNC symbols, corresponding to 130n $FEXT_R$ symbols and 215n $NEXT_R$ symbols.

The C-TTRSYNC1 state is used to transmit $NEXT_R/FEXT_R$ information to the ATU-R, and for coarse timing recovery for the ATU-R.

During the first 4 $FEXT_R$ symbols of a hyper-frame, the C-TTRSYNC1 signal shall be modulated as follows. The sub-carriers transmitted in the C-TTRSYNC1 symbol shall modulate the same data bits that are used for the C-REVERB symbols, in such a way that same sub-carrier indexes modulate the same data bits with the same 4-QAM constellation, as defined in § 8.13.4.1.1. The sub-carriers not transmitted in the C-TTRSYNC1 symbol shall be transmitted at no power (i.e., Xi=Yi=0). Bits d_{2i+1} and d_{2i+2}, which modulate the initialization pilot carrier that has tone index i, shall be overwritten by {0,0}, generating the (+,+) constellation point. This shall apply to all initialization pilot carriers pertaining to the profile in use, and shall apply during all $FEXT_R$ symbols, including the first 4 $FEXT_R$ symbols of a hyperframe.

The ATU-C shall continue to transmit C-TTRSYNC1 until the end of the hyper-frame in which it receives the last symbol of R-COMB1. The ATU-C shall then transition to the C-QUIET-TTR1 state immediately at the hyperframe boundary when the ATU-R transitions to R-QUIET2.

C.8.13.3.1.3 C-QUIET-TTR1 (replaces § 8.13.3.1.3)

The C-QUIET-TTR1 state is of fixed length. In the C-QUIET-TTR1 state, the ATU-C shall transmit the same signal as C-TTRSYNC1 during the first 4 FEXT symbols of each hyper-frame, and no signal in all other symbols. The ATU-C shall transmit LEN_C-QUIET-TTR1 C-QUIET-TTR symbols. The value of LEN_C-QUIET-TTR1 shall be 30 x 345 = 10350 symbols for normal initialization and 92x345=31740 symbols for loop diagnostics mode.

Both transceivers can perform quiet line noise PSD measurements during C-QUIET-TTR1.

C.8.13.3.1.4 C-COMB2 (supplements § 8.13.3.1.4)

In the C-COMB2 state, for transceivers using Profiles 2, 4, 5 or 6, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols. For transceivers using Profiles 1 or 3, the ATU-C shall transmit only during $FEXT_R$ symbols. The ATU-C shall transmit LEN_C-COMB2 C-COMB symbols. Whenever the initialization is invoked from Showtime as a fast error recovery procedure, the value LEN_C-COMB2 shall be set to 2760 symbols. Otherwise, the value LEN_C-COMB2 shall be set to 10350 symbols.

NOTE - § 8.13.3.1.4 specifies 1024 C-COMB2 symbols for the ATU-R to perform timing recovery and to measure downstream channel characteristics. Since there are 130 $FEXT_R$ symbols per hyper-frame, 2760 symbols (i.e. 8 hyper-frames) contain 1040 $FEXT_R$ symbols. However, $FEXT_R$ symbols adjacent to $NEXT_R$ symbols may be corrupted by the strong noise in $NEXT_R$ symbols and thus should be excluded from the downstream channel characteristics measurement. In this case, there are only 66 middle $FEXT_R$ symbols per hyper-frame, and 528 in 8 hyper-frames. There are 1980 middle $FEXT_R$ symbols if LEN_C-COMB2 is set to 10350 symbols (30 hyper-frames).

C.8.13.3.1.5 C-ICOMB1 (supplements § 8.13.3.1.5)

In the C-ICOMB1 state, for transceivers using Profiles 2, 4, 5 or 6, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols. For transceivers using Profiles 1 or 3, the ATU-C shall transmit only during $FEXT_R$ symbols. The duration of C-ICOMB1 shall be either 0 or 32 symbols, corresponding to 12 $FEXT_R$ symbols and 20 $NEXT_R$ symbols.

C.8.13.3.1.6 C-LINEPROBE (supplements § 8.13.3.1.6)

In the C-LINEPROBE state, for transceivers using Profiles 2, 4, 5 or 6, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols. For transceivers using Profiles 1 or 3, the ATU-C shall transmit only during $FEXT_R$ symbols. The ATU-C shall transmit a vendor discretionary signal with a duration of 0 or 1380 – 32 symbol periods.

The C-LINEPROBE state shall be followed by the C-QUIET-TTR2 state.

C.8.13.3.1.7 C-QUIET-TTR2 (replaces § 8.13.3.1.7)

The C-QUIET-TTR2 state is of fixed length. In the C-QUIET-TTR2 state, the ATU-C shall transmit either 2070 (normal initialization without R-LINEPROBE), 3450 (normal initialization with R-LINEPROBE) or 4830 (loop diagnostics) C-QUIET-TTR symbols.

The ATU-C may do an upstream channel attenuation measurement while the ATU-R is in the R-COMB2 state.

The ATU-C shall continue to transmit C-QUIET-TTR symbols until after the ATU-R transitions to the R-QUIET3 state. 345 symbols after the ATU-R transitions to the R-QUIET3 state, the ATU-C shall transition to the C-COMB3 state on a hyper-frame boundary.

C.8.13.3.1.8 C-COMB3 (replaces § 8.13.3.1.8)

In the C-COMB3 state, for transceivers using profiles 2,4,5, or 6 the ATU-C shall transmit COMB signal in both $FEXT_R$ and $NEXT_R$ symbols. For transceivers using profiles 1 or 3, the ATU-C shall transmit only during $FEXT_R$ symbols. The duration of C-COMB3 signal shall be 313 symbols.

The C-COMB3 state shall be followed by C-ICOMB2 state. The transition to C-ICOMB2 state provides time marker for C-MSG-FMT state.

C.8.13.3.1.9 C-ICOMB2 (replaces § 8.13.3.1.9)

In the C-ICOMB2 state, for transceivers using profiles 2,4,5, or 6 the ATU-C shall transmit ICOMB signal in both $FEXT_R$ and $NEXT_R$ symbols. For transceivers using profiles 1 or 3, the ATU-C shall transmit only during $FEXT_R$ symbols. The duration of C-ICOMB2 signal shall be 32 symbols.

The C-ICOMB2 state shall be followed by the C-MSG-FMT state.

C.8.13.3.1.10 C-MSG-FMT (supplements § 8.13.3.1.10)

In the C-MSG-FMT state, the ATU-C shall transmit the C-MSG-FMT message only during the $FEXT_R$ symbols, using C-COMB or C-ICOMB to modulate the C-MSG-FMT message and crc. During the $NEXT_R$ symbols, the ATU-C shall transmit no signal.

C-MSG-FMT shall start at a hyperframe boundary. The message and crc are transmitted using all $FEXT_R$ symbols of a subframe to send one bit. A zero bit shall be transmitted as all $FEXT_R$ symbols in a subframe being C-COMB symbols. A one bit shall be transmitted as all $FEXT_R$ symbols in a subframe being C-ICOMB symbols. The bit m0 shall be transmitted on the first subframe of the hyperframe, the bit c15 shall be transmitted on the last subframe of the hyperframe.

The C-MSG-FMT state has a duration of 345 symbols. It shall be followed by C-MSG-PCB.

C.8.13.3.1.11 C-MSG-PCB (supplements § 8.13.3.1.11)

In the C-MSG-PCB state, the ATU-C shall transmit the C-MSG-PCB message only during the $FEXT_R$ symbols, using C-COMB or C-ICOMB to modulate the C-MSG-PCB message and crc. One bit is transmitted in all the $FEXT_R$ symbols in one subframe (as defined for C-MSG-FMT, see § C.8.13.3.1.10). During the $NEXT_R$ symbols, the ATU-C shall transmit no signal.

The C-MSG-PCB state has a duration of 32 or 32 + NSCus subframes, depending on whether the C-BLACKOUT bits are included or not. The C-MSG-PCB state duration corresponds to an integer number of hyperframes. After all of the message bits are transmitted, initialization pilot carriers as described in C.8.13.3.1.2 C-TTRSYNC1 are transmitted.

C.8.13.3.1.12 C-TTRSYNC2 (replaces § 8.13.3.1.12)

The C-TTRSYNC2 state is of variable length. In the C-TTRSYNC2 state, the ATU-C shall transmit a minimum of 2070 and a maximum of (6+NSCds/32)*345 C-TTRSYNC symbols. The last C-TTRSYNC2 symbol that is transmitted shall align with the last symbol of the hyperframe.

For each hyperframe, the first 4 $FEXT_R$ symbols, the remaining $FEXT_R$ symbols and the $NEXT_R$ symbols shall be modulated as defined in § C.8.13.3.1.2.

The ATU-C shall continue to transmit C-TTRSYNC symbols until after the ATU-R transitions to the R-REVERB1 state. 345 symbols after the ATU-R transitions to the R-REVERB1 state, the ATU-C shall transition to the C-REVERB1 state on a hyper-frame boundary.

C.8.13.3.2 ATU-R Channel Discovery (supplements § 8.13.3.2)

C.8.13.3.2.1 R-QUIET1 (supplements § 8.13.3.2.1)

In the R-QUIET1 state, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols. The minimum duration of R-QUIET1 shall be 128 DMT symbols after the detection of C-TTRSYNC1.

The ATU-R shall continue to transmit R-QUIET symbols until it finishes TTR detection and coarse timing recovery. It shall then transition to the R-COMB1 state on a hyper-frame boundary. The maximum duration of R-QUIET1 shall be 15500 DMT symbols.

NOTE - The maximum duration of the R-QUIET1 state is the same as G.992.1 Annex C.

C.8.13.3.2.2 R-COMB1 (supplements § 8.13.3.2.2)

The ATU-R shall set the sliding window frame counter (N_{SWF}) to 0 upon entering R-COMB1, and increment the N_{SWF} counter modulo 345 after transmission of each symbol.

In the R-COMB1 state, the ATU-R shall transmit R-COMB symbols during $FEXT_C$ symbols and silence during $NEXT_C$ symbols. The duration of R-COMB1 shall be 345 symbols, corresponding to 130 $FEXT_C$ symbols of R-COMB and 215 $NEXT_C$ symbols of silence.

C.8.13.3.2.3 R-QUIET2 (supplements § 8.13.3.2.3)

The R-QUIET2 state is of fixed length. In the R-QUIET2 state, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols. The ATU-R shall transmit either (345 + LEN_C-QUIET-TTR1 + LEN_C-COMB2) or (1380 + 345 + LEN_C-QUIET-TTR1 + LEN_C-COMB2) R-QUIET symbols. The value LEN_C-QUIET-TTR1 is defined in § C.8.13.3.1.3 and the value LEN_C-COMB2 is defined in § C.8.13.3.1.4.

The ATU-R may do a downstream channel attenuation measurement while the ATU-C is in the C-COMB2 state.

The ATU-R shall continue to transmit R-QUIET symbols until after the ATU-C transitions to the C-QUIET-TTR2 state. 345 symbols after the ATU-C transitions to the C-QUIET-TTR2 state, the ATU-R shall transition to the R-COMB2 state on a hyper-frame boundary.

C.8.13.3.2.4 R-COMB2 (supplements § 8.13.3.2.4)

In the R-COMB2 state, for transceivers using Profiles 2, 4, or 6, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols. For transceivers using Profiles 1, 3 or 5, the ATU-R shall transmit only during $FEXT_C$ symbols. For loop diagnostics mode, the ATU-R shall transmit 2760 R-COMB symbols. Otherwise, the ATU-R shall transmit 1380 R-COMB symbols, corresponding to 520 $FEXT_C$ symbols and 860 $NEXT_C$ symbols.

C.8.13.3.2.5 R-ICOMB1 (supplements § 8.13.3.2.5)

In the R-ICOMB1 state, for transceivers using Profiles 2, 4, or 6, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols. For transceivers using Profiles 1, 3 or 5, the ATU-R shall transmit only during $FEXT_C$ symbols. The duration of R-ICOMB1 shall be 0 or 32 symbols, corresponding to 12 $FEXT_C$ symbols and 20 $NEXT_C$ symbols.

C.8.13.3.2.6 R-LINEPROBE (supplements § 8.13.3.2.6)

In the R-LINEPROBE state, for transceivers using Profiles 2, 4, or 6, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols. For transceivers using Profiles 1, 3 or 5, the ATU-R shall transmit only during $FEXT_C$ symbols. The ATU-R shall transmit a vendor discretionary signal with a duration of 0 or 1380 – 32 symbol periods.

C.8.13.3.2.7 R-QUIET3 (supplements § 8.13.3.2.7)

In the R-QUIET3 state, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols. The ATU-R shall transmit a minimum of 5 hyperframes and a maximum of 5+NSCus/32 hyperframes (with upstream blackout) of R-QUIET symbols.

The ATU-R shall continue to transmit R-QUIET symbols until after the ATU-C transitions to C-TTRSYNC2. 345 symbols after the ATU-C transitions to C-TTRSYNC2, the ATU-R shall transition to the R-COMB3 state on a hyperframe boundary.

C.8.13.3.2.8 R-COMB3 (replaces § 8.13.3.2.8)

In the R-COMB3 state, for transceivers using profiles 2, 4, or 6 the ATU-R shall transmit COMB signal in both $FEXT_C$ and $NEXT_C$ symbols. For transceivers using profiles 1, 3 or 5, the ATU-R shall transmit only during $FEXT_C$ symbols. The duration of R-COMB3 signal shall be 313 symbols.

The R-COMB3 state shall be followed by R-ICOMB2 state. The transition to R-ICOMB2 state provides time marker for R-MSG-FMT state.

C.8.13.3.2.9 R-ICOMB2 (replaces § 8.13.3.2.9)

In the R-ICOMB2 state, for transceivers using profiles 2, 4, or 6 the ATU-R shall transmit ICOMB signal in both $FEXT_C$ and $NEXT_C$ symbols. For transceivers using profiles 1, 3 or 5, the ATU-R shall transmit only during $FEXT_C$ symbols. The duration of R-ICOMB2 signal shall be 32 symbols.

The R-ICOMB2 state shall be followed by the R-MSG-FMT state.

C.8.13.3.2.10 R-MSG-FMT (supplements § 8.13.3.2.10)

In the R-MSG-FMT state, the ATU-R shall transmit the R-MSG-FMT message only during the $FEXT_C$ symbols, using R-COMB or R-ICOMB to modulate the R-MSG-FMT message and crc. During the $NEXT_C$ symbols, the ATU-R shall transmit no signal.

The R-MSG-FMT state has a duration of 345 symbols, corresponding to 130 $FEXT_C$ symbols and 215 $NEXT_C$ symbols. One bit is transmitted in all the $FEXT_C$ symbols in one subframe (as defined for C-MSG-FMT, see § C.8.13.3.1.10).

C.8.13.3.2.11 R-MSG-PCB (supplements § 8.13.3.2.11)

In the R-MSG-PCB state, the ATU-R shall transmit the R-MSG-PCB message only during the $FEXT_C$ symbols, using R-COMB or R-ICOMB to modulate the R-MSG-FMT message and crc. One bit is transmitted in all the $FEXT_C$ symbols in one subframe (as defined for C-MSG-FMT, see § C.8.13.3.1.10). During the $NEXT_C$ symbols, the ATU-R shall transmit no signal.

The R-MSG-PCB state has a duration of 48 or (48+ NSCds) subframes, depending on whether the C-BLACKOUT bits are included or not. The R-MSG-PCB state duration corresponds to an integer number of hyperframes, which is the round-up of the number of subframes divided by 32.

After all of the message bits are transmitted, quiet should be sent if R-MSG-PCB state is not finished..

The R-MSG-FMT state shall be followed by the R-REVERB1 state.

C.8.13.4 Transceiver training phase

C.8.13.4.1 ATU-C Transceiver Training (supplements § 8.13.4.1)

C.8.13.4.1.1 C-REVERB1 (supplements § 8.13.4.1.1)

The C-REVERB1 state is of fixed length. In the C- REVERB1 state, for transceivers using profiles 2, 4, 5 or 6, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols. For transceivers using profiles 1 or 3, the ATU-C shall transmit only during $FEXT_R$ symbols. During the C-REVERB1 state, the ATU-C shall transmit (LEN_R-REVERB1 + LEN_R-QUIET4 - 345) C-REVERB symbols. The values LEN_R-REVERB1 and LEN_R-QUIET4 are defined in § C.8.13.4.2.1 and § C.8.13.4.2.2, respectively.

C.8.13.4.1.2 C-TREF1 (supplements § 8.13.4.1.2)

The C-TREF1 state is of variable length. In the C-TREF1 state, for transceivers using profiles 2, 4, 5 or 6, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols. For transceivers using profiles 1 or 3, the ATU-C shall transmit only during $FEXT_R$ symbols.. During the C-TREF1 state, the ATU-C shall transmit a minimum of LEN_C-TREF1 and a maximum of 25875 (= 15 * 5 * 345) C_TREF symbols. The value LEN_C-TREF1 shall be defined as 5 * 345 times the FMT_C-TREF1 value (1 to 15) indicated by the ATU-R in the R-MSG-FMT message. The number of symbols transmitted in the C-TREF1 state shall be a multiple of 5 * 345 symbols (note that 5* 345 > 3 * 512, providing sufficient C-TREF symbols to the ATU-R.).

C.8.13.4.1.3 C-REVERB2 (supplements § 8.13.4.1.3)

The C-REVERB2 state is of fixed length. In the C- REVERB2 state, for transceivers using profiles 2, 4, 5 or 6, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols. For transceivers using profiles 1 or 3, the ATU-C shall transmit only during $FEXT_R$ symbols. During the C-REVERB2 state, the ATU-C shall transmit 345 C-REVERB symbols, corresponding to 130 $FEXT_R$ symbols and 215 $NEXT_R$ symbols.

C.8.13.4.1.4 C-ECT (supplements § 8.13.4.1.4)

The C-ECT state is of fixed length. In the C- ECT state, for transceivers using profiles 2, 4, 5 or 6, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols. For transceivers using profiles 1 or 3, the ATU-C shall transmit only during $FEXT_R$ symbols. During the C-ECT state, the ATU-C shall transmit a vendor discretionary signal with a duration of 1380 symbols, corresponding to 520 $FEXT_R$ symbols and 860 $NEXT_R$ symbols.

C.8.13.4.1.5 C-REVERB3 (supplements § 8.13.4.1.5)

The C-REVERB3 state is of variable length. In the C- REVERB3 state, for transceivers using profiles 2, 4, 5 or 6, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols. For transceivers using profiles 1 or 3, the ATU-C shall transmit only during $FEXT_R$ symbols. During the C-REVERB3 state, the ATU-C shall transmit a minimum of 1380 and a maximum of 43125 C-REVERB symbols, corresponding to a minimum of 5 to a maximum of 125 hyperframes.

The ATU-C shall continue to transmit C-REVERB symbols until after the ATU-R transitioning to the R-REVERB3 state. 345 symbols after the ATU-R transitioning to the R-REVERB3 state, the ATU-C shall transition to the next state on a hyperframe boundary.

C.8.13.4.1.6 C-TREF2 (supplements § 8.13.4.1.6)

The C-TREF2 state is of fixed length. In the C-TREF2 state, for transceivers using profiles 2, 4, 5 or 6, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols. For transceivers using profiles 1 or 3, the ATU-C shall transmit only during $FEXT_R$ symbols. During the C-TREF2 state, the ATU-C shall transmit 1380 C-TREF symbols.

C.8.13.4.1.7 C-QUIET5 (supplements § 8.13.4.1.7)

The C-QUIET5 state is of fixed length. In the C-QUIET5 state, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols. During the C-QUIET5 state, the ATU-C shall transmit 1380 C-QUIET symbols.

C.8.13.4.1.8 C-REVERB4 (supplements § 8.13.4.1.8)

The C-REVERB4 state is of fixed length. In the C- REVERB4 state, for transceivers using profiles 2, 4, 5 or 6, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols. For transceivers using profiles 1 or 3, the ATU-C shall transmit only during $FEXT_R$ symbols. During the C-REVERB4 state, the ATU-C shall transmit LEN_C-REVERB4 C-REVERB symbols. The value LEN_C-REVERB4 shall be equal to 3070 if the ATU-C or the ATU-R (or both) have set FMT_C-REVERB4 to 1 in the C-MSG-FMT or R-MSG-FMT message respectively. The value LEN_C-REVERB4 shall be equal to 1000 otherwise.

C.8.13.4.1.9 C-SEGUE1 (supplements § 8.13.4.1.9)

The C-SEGUE1 state is of fixed length. In the C-SEGUE1 state, for transceivers using profiles 2, 4, 5 or 6, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols. For transceivers using profiles 1 or 3, the ATU-C shall transmit only during $FEXT_R$ symbols. During the C-SEGUE1 state, the ATU-C shall transmit 35 C-SEGUE symbols.

C.8.13.4.2 ATU-R Transceiver Training (supplements § 8.13.4.2)

During transceiver training, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols. The duration of each state is defined in Figures C8-16 to C8-20.

C.8.13.4.2.1 R-REVERB1 (supplements § 8.13.4.2.1)

The R-REVERB1 state is of fixed length. In the R- REVERB1 state, for transceivers using profiles 2, 4 or 6, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols. For transceivers using profiles 1, 3 or 5, the ATU-R shall transmit only during $FEXT_C$ symbols. The ATU-R shall transmit LEN_R-REVERB1 R-REVERB symbols. The value LEN_R-REVERB1 is equal to 690 if the ATU-C or the ATU-R (or both) have set FMT_R-REVERB1 to 1 in the C-MSG-FMT or R-MSG-FMT message respectively. The value LEN_R-REVERB1 shall be equal to 1725 otherwise.

C.8.13.4.2.2 R-QUIET4 (supplements § 8.13.4.2.2)

The R-QUIET4 state is of fixed length. In the R-QUIET4 state, for transceivers using profiles 2, 4 or 6, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols. For transceivers using profiles 1, 3 or 5, the ATU-R shall transmit only during $FEXT_C$ symbols. In the R-QUIET4 state, the ATU-R shall transmit LEN_R-QUIET4 R-QUIET symbols. The value LEN_R-QUIET4 shall be defined as 5 * 345 times the FMT_R-QUIET4 value (0 to 31) indicated by the ATU-C in the C-MSG-FMT message, resulting in a length of the R-QUIET4 state between 0 and 53475 symbols.

C.8.13.4.2.3 R-REVERB2 (supplements § 8.13.4.2.3)

The R-REVERB2 state is of variable length. In the R- REVERB2 state, for transceivers using profiles 2, 4 or 6, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols. For transceivers using profiles 1, 3 or 5, the ATU-R shall transmit only during $FEXT_C$ symbols. The ATU-R shall transmit a minimum of 2070 and a maximum of 26220 R-REVERB symbols.

The ATU-R shall continue to transmit R-REVERB symbols until after the ATU-C transitioning to the C-REVERB2 state. 345 symbols after the ATU-C transitioning to the C-REVERB2 state, the ATU-R shall transition to the next state.

C.8.13.4.2.4 R-QUIET5 (supplements § 8.13.4.2.4)

The R-QUIET5 state is of variable length. In the R-QUIET5 state, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols. In the R-QUIET5 state, the ATU-R shall transmit a minimum of 2415 and a maximum of 44160 R-QUIET symbols. The last R-QUIET symbol that is transmitted shall align with the last symbol of a hyperframe.

C.8.13.4.2.5 R-REVERB3 (supplements § 8.13.4.2.5)

The R-REVERB3 state is of fixed length. In the R- REVERB3 state, for transceivers using profiles 2, 4 or 6, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols. For transceivers using profiles 1, 3 or 5, the ATU-R shall transmit only during $FEXT_C$ symbols. The ATU-R shall transmit 345 R-REVERB symbols, corresponding to 130 $FEXT_C$ symbols and 215 $NEXT_C$ symbols.

C.8.13.4.2.6 R-ECT (supplements § 8.13.4.2.6)

The R-ECT state is of fixed length. In the R- ECT state, for transceivers using profiles 2, 4 or 6, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols. For transceivers using profiles 1, 3 or 5, the ATU-R shall transmit only during $FEXT_C$ symbols. The ATU-R shall transmit 1380 vendor discretionary symbols, corresponding to 520 $FEXT_C$ symbols and 860 $NEXT_C$ symbols.

C.8.13.4.2.7 R-REVERB4 (supplements § 8.13.4.2.7)

The R-REVERB4 state is of fixed length. In the R- REVERB4 state, for transceivers using profiles 2, 4 or 6, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols. For transceivers using profiles 1, 3 or 5, the ATU-R shall transmit only during $FEXT_C$ symbols. The ATU-R shall transmit LEN_C-REVERB4 R-REVERB symbols.

C.8.13.4.2.8 R-SEGUE1 (supplements § 8.13.4.2.8)

The R-SEGUE1 state is of fixed length. In the R-SEGUE1 state, for transceivers using profiles 2, 4 or 6, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols. For transceivers using profiles 1, 3 or 5, the ATU-R shall transmit only during $FEXT_C$ symbols. During the R-SEGUE1 state, the ATU-R shall transmit 35 R-SEGUE symbols.

C.8.13.5 Channel analysis phase (supplements § 8.13.5)

C.8.13.5.1 ATU-C Channel Analysis (supplements § 8.13.5.1)

At the transmitter, the PRD sequence generator is always updated during $NEXT_R$ symbol periods when Bitmap-N_R is disabled (FEXT Bitmap mode).

C.8.13.5.1.1 C-MSG1 (supplements § 8.13.5.1.1)

The C-MSG1 state is of fixed length. In this state, the ATU-C shall transmit the C-MSG1 symbols only during the $FEXT_R$ symbols. During the $NEXT_R$ symbols, the ATU-C shall transmit the C-TREF pilot tone, except for Profile 3 where C-QUIET is transmitted during $NEXT_R$ symbols. The ATU-C shall transmit LEN_C-MSG1 C-REVERB or C-SEGUE symbols to modulate the C-MSG1 prefix, message and crc. The C-MSGS1 state shall be the first state in which the ATU-C transmits the cyclic prefix. There are LEN_C-MSG1 = 240 C-MSG1 symbols carrying information bits.

The C-MSG1 state shall have a duration of 690 symbols (ie two hyperframes, each consisting of 128 $FEXT_R$ symbols). The 240 C-MSG1 symbols carrying information bits shall be transmitted in the first 240 $FEXT_R$ symbols of the C-MSG1 state. For the remaining 256 – 240 = 16 $FEXT_R$ symbols, the ATU-C shall transmit the C-TREF pilot tone.

C.8.13.5.1.2 C-REVERB5 (supplements § 8.13.5.1.2)

The C-REVERB5 state is of fixed length. In the C-REVERB5 state, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols when bitmap N_R is enabled (DBM). When bitmap N_R is disabled (FBM), the ATU-C shall transmit C-REVERB symbols only during $FEXT_R$ symbols and the C-TREF pilot tone during $NEXT_R$ symbols, except for Profile 3 where C-QUIET is transmitted during $NEXT_R$ symbols. During the C-REVERB5 state, the ATU-C shall transmit $\{2+\lceil(48+NSCus)/128\rceil\} * 345 - 28$ C-REVERB symbols in normal mode, corresponding to 374 $FEXT_R$ symbols and 633 $NEXT_R$ symbols, where $\lceil x \rceil$ denotes rounding to the next higher integer.

The ATU-C shall continue to transmit C-REVERB symbols until after the ATU-R transitioning to the R-MEDLEY state. 345 – 28 symbols after the ATU-R transitioning to the R-MEDLEY state, the ATU-C shall transition to the next state.

C.8.13.5.1.3 C-SEGUE2 (supplements § 8.13.5.1.3)

The C-SEGUE2 state is of fixed length. In the C-SEGUE2 state, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols when bitmap N_R is enabled (DBM). When bitmap N_R is disabled (FBM), the ATU-C shall transmit C-SEGUE symbols only during $FEXT_R$ symbols and the C-TREF pilot tone during $NEXT_R$ symbols, except for Profile 3 where C-QUIET is transmitted during $NEXT_R$ symbols. During the C-SEGUE2 state, the ATU-C shall transmit 28 C-SEGUE symbols, corresponding to 10 $FEXT_R$ symbols and 18 $NEXT_R$ symbols.

C.8.13.5.1.4 C-MEDLEY (supplements § 8.13.5.1.4)

The C-MEDLEY state is of fixed length. In the C-MEDLEY state, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols when bitmap N_R is enabled (DBM). When bitmap N_R is disabled (FBM), the ATU-C shall transmit C-MEDLEY symbols only during $FEXT_R$ symbols and the C-TREF pilot tone during $NEXT_R$ symbols, except for Profile 3 where C-QUIET is transmitted during $NEXT_R$ symbols.

In the C-MEDLEY state, the ATU-C shall transmit LEN-MEDLEY symbols. The value LEN-MEDLEY shall be the maximum of the CA-MEDLEYus and CA-MEDLEYds values indicated by the ATU-C and the ATU-R in the C-MSG1 and R-MSG1 messages respectively. The value LEN-MEDLEY shall be a multiple of 3 * 345 and shall be less than or equal to 65205. The number of symbols transmitted in the C-MEDLEY state shall be equal to the number of symbols transmitted by the ATU-R in the R-MEDLEY state.

C.8.13.5.1.5 C-EXCHMARKER (supplements § 8.13.5.1.5)

The C-EXCHMARKER state is of fixed length. In the C-EXCHMARKER state, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols when bitmap-N_R is enabled (DBM). When bitmap-N_R is disabled, the ATU-C shall transmit C-REVERB or C-SEGUE symbols only during $FEXT_R$ symbols and the C-TREF pilot tone during $NEXT_R$ symbols, except for Profile 3 where C-QUIET is transmitted during $NEXT_R$ symbols.

During the C-EXCHMARKER state, the ATU-C shall transmit 345 C-REVERB symbols or 345 C-SEGUE symbols. By transmitting C-REVERB symbols, the ATU-C indicates that the states C-REVERB6, C-SEGUE3 and C-PARAMS will be included. By transmitting C-SEGUE symbols, the ATU-C indicates that the states C-REVERB6, C-SEGUE3 and C-PARAMS will be skipped.

In case the C-PARAMS message is skipped during the Initialization Exchange Phase, the last previous L0 state trellis setting, bits and gains table (possibly updated through on-line reconfiguration since the last previous C-PARAMS message exchange) and tone ordering table shall be used to enter the Showtime state.

NOTE - There are two bits and gains tables and one tone ordering table when bitmap N_R is enabled (DBM).

C.8.13.5.2 ATU-R Channel Analysis (supplements § 8.13.5.2)

At the transmitter, the PRD sequence generator is always updated during $NEXT_C$ symbol periods when Bitmap-N_C is disabled (FEXT Bitmap mode). When bitmap N_C is disabled (FBM), the ATU-R shall transmit R-QUIET symbols during $NEXT_C$ symbols.

C.8.13.5.2.1 R-REVERB5 (supplements § 8.13.5.2.1)

The R-REVERB5 state is of fixed length. In the R-REVERB5 state, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols when bitmap N_C is enabled (DBM). The ATU-R shall transmit R-REVERB symbols only during $FEXT_C$ symbols when bitmap N_C is disabled (FBM).

In the R-REVERB5 state, the ATU-R shall transmit 1035-23 R-REVERB symbols. The R-REVERB5 state shall be the first state in which the ATU-R transmits the cyclic prefix.

The ATU-R shall continue to transmit R-REVERB symbols until after the ATU-C transitioning to the C-REVERB5 state. 345-23 symbols after the ATU-C transitioning to the C-REVERB5 state, the ATU-R shall transition to the next state.

C.8.13.5.2.2 R-SEGUE2 (supplements § 8.13.5.2.2)

The R-SEGUE2 state is of fixed length. In the R-SEGUE2 state, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols when bitmap N_C is enabled (DBM). The ATU-R shall transmit R-SEGUE symbols only during $FEXT_C$ symbols when bitmap N_C is disabled (FBM). In this state, the ATU-R shall transmit 23 R-SEGUE symbols.

C.8.13.5.2.3 R-MSG1 (supplements § 8.13.5.2.3)

The R-MSG1 state is of fixed length. In the R-MSG1 state, the ATU-R shall transmit only during $FEXT_C$ symbols. In this state, the ATU-R shall transmit LEN_R-MSG1 R-REVERB or R-SEGUE symbols to modulate the R-MSG1 prefix, message and crc. There are LEN_R-MSG1 = 48+NSCus R-MSG1 symbols carrying information bits.

The R-MSG1 state shall have a duration of $\lceil (48+NSCus)/128 \rceil$ * 345 symbols, where $\lceil x \rceil$ denotes rounding to the next higher integer. The 48+NSCus R-MSG1 symbols carrying information bits shall be transmitted in the first 48+NSCus $FEXT_C$ symbols of the R-MSG1 state. For the remaining $\lceil (48+NSCus)/128 \rceil$ * 128 – 48+NSCus $FEXT_C$ symbols of the R-MSG1 state the ATU-R shall transmit R-QUIET symbols.

C.8.13.5.2.4 R-MEDLEY (supplements § 8.13.5.2.4)

The R-MEDLEY state is of fixed length. In the R-MEDELY state, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols when bitmap N_C is enabled (DBM). The ATU-R shall transmit transmit R-MEDLEY symbols only during $FEXT_C$ symbols when bitmap N_C is disabled (FBM).

The ATU-R shall transmit LEN-MEDLEY symbols. The value LEN-MEDLEY shall be the maximum of the CA-MEDLEYus and CA-MEDLEYds values indicated by the ATU-C and the ATU-R in the C-MSG1 and R-MSG1 messages respectively. The value LEN-MEDLEY shall be a multiple of 3*345 and shall be less than or equal to 65205. The number of symbols transmitted in the R-MEDLEY state shall be equal to the number of symbols transmitted by the ATU-C in the C-MEDLEY state.

C.8.13.5.2.5 R-EXCHMARKER (supplements § 8.13.5.2.5)

The R-EXCHMARKER state is of fixed length. In the R-EXCHMARKER state, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols when bitmap N_C is enabled (DBM). The ATU-R shall transmit transmit R-REVERB or R-SEGUE symbols only during $FEXT_C$ symbols when bitmap N_C is disabled (FBM).

During the R-EXCHMARKER state, the ATU-R shall transmit 345 R-REVERB symbols or 345 R-SEGUE symbols. By transmitting R-REVERB symbols, the ATU-R indicates that the states R-REVERB6, R-SEGUE3 and R-PARAMS will be included. By transmitting R-SEGUE symbols, the ATU-R indicates that the states R-REVERB6, R-SEGUE3 and R-PARAMS will be skipped.

In case the R-PARAMS message is skipped during the Initialization Exchange Phase, the last previous L0 state trellis setting, bits and gains table (possibly updated through on-line reconfiguration since the last previous R-PARAMS message exchange) and tone ordering table shall be used to enter the Showtime state.

NOTE - There are two bits and gains tables and one tone ordering table when bitmap N_C is enabled (DBM).

C.8.13.6 Exchange phase (supplements 8.13.6)

C.8.13.6.1 ATU-C Exchange Phase (supplements § 8.13.6.1)

C.8.13.6.1.1 C-MSG2 (supplements § 8.13.6.1.1)

The C-MSG2 state is of fixed length. In the C-MSG2 state, the ATU-C shall transmit the C-MSG2 symbols only during the $FEXT_R$ symbols. During the $NEXT_R$ symbols, the ATU-C shall transmit the C-TREF pilot tone, except for Profile 3 where C-QUIET is transmitted during $NEXT_R$ symbols. The ATU-C shall transmit (NSCus+16) $FEXT_R$ C-REVERB or C-SEGUE symbols to modulate the C-MSG2 message and crc. The C-MSG2 state shall have a duration of LEN_C-MSG2.

C.8.13.6.1.2 C-REVERB6 (supplements § 8.13.6.1.2)

The ATU-C shall transmit a minimum of LEN_R-MSG2 - LEN_C-MSG2 -75 and a maximum of LEN_R-MSG2 - LEN_C-MSG2 + 1995 C-REVERB symbols.

The C-REVERB6 state is of variable length. In the C-REVERB6 state, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols when bitmap N_R is enabled (DBM). When bitmap N_R is disabled (FBM), the ATU-C shall transmit C-REVERB symbols only during $FEXT_R$ symbols and the C-TREF pilot tone during $NEXT_R$ symbols except for Profile 3 where C-QUIET is transmitted during $NEXT_R$ symbols.

C.8.13.6.1.3 C-SEGUE3 (supplements § 8.13.6.1.3)

The C-SEGUE3 state is of fixed length. In the C-SEGUE3 state, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols when bitmap N_R is enabled (DBM). When bitmap N_R is disabled (FBM), the ATU-C shall transmit C-SEGUE symbols only during $FEXT_R$ symbols and the C-TREF pilot tone during $NEXT_R$ symbols, except for Profile 3 where C-QUIET is transmitted during $NEXT_R$ symbols. During the C-SEGUE3 state, the ATU-C shall transmit 28 C-SEGUE symbols, corresponding to 10 $FEXT_R$ symbols and 18 $NEXT_R$ symbols.

C.8.13.6.1.4 C-PARAMS (supplements § 8.13.6.1.4)

The C-PARAMS state is of fixed length. In the C-PARAMS state, the ATU-C shall transmit the C-PARAMS symbols only during the $FEXT_R$ symbols. During the $NEXT_R$ symbols, the ATU-C shall transmit the C-TREF pilot tone, except for Profile 3 where C-QUIET is transmitted during $NEXT_R$ symbols. The ATU-C shall transmit LEN_C-PARAMS C-PARAMS symbols to modulate the C-PARAMS message and crc at (2*NSC_C-PARAMS) bits per symbol. The value NSC_C-PARAMS shall be defined as the number of sub-carriers to be used for modulation of the C-PARAMS message as indicated by the ATU-R in the R-MSG2 message. The value LEN_C-PARAMS shall be defined as (length of the C-PARAMS message and crc in bits) divided by (2*NSC_C-PARAMS) and rounded to the higher integer.

If the number of message and crc bits to be transmitted is not an integer multiple of the number of bits per symbol (i.e., not a multiple of 2*NSC_C-PARAM), then the message and crc bits shall be further padded with zero bits such that the overall number of bits to be transmitted is equal to (2*NSC_C-PARAM*LEN_C-PARAMS).

The C-PARAMS state shall have a duration of $\lceil$LEN_C-PARAMS / 128$\rceil$ * 345 symbols, where $\lceil x \rceil$ denotes rounding to the next higher integer. The LEN_C-PARAMS C-PARAMS symbols shall be transmitted in the first LEN_C-PARAMS $FEXT_R$ symbols of the C-PARAMS state. For the remaining $FEXT_R$ symbols of the C-PARAMS state the ATU-C shall transmit the C-TREF pilot tone.

Two bit and gain tables and one tone ordering tables shall be transmitted during the C-PARAMS state. When bitmap N_C is disabled (FBM), the bit and gain table and the tone ordering table for the $NEXT_C$ symbols shall be set to zeros.

Table C8-9 lists the length of the C-PARAMS message summed over TPC-TC, PMS-TC and PMD layers. The TPS-TC, PMS-TC and PMD bits each correspond to an even number of octets. The PMD function control parameters are listed in § C.8.6.1.

Table C8-9/G.992.3 - C-PARAMS message and crc length

Part of message	Length (bits or symbols)
Npmd	144 + 40*NSCus
Npms	416
Ntps	0
Nmsg	560 + 40*NSCus
CRC	16
LEN_C-PARAMS	$\left\lceil \frac{576 + 40 * NSCus}{2 * NSC\_C - PARAMS} \right\rceil$
NOTE - $\lceil x \rceil$ denotes rounding to the higher integer.	

C.8.13.6.1.5 C-REVERB7 (supplements § 8.13.6.1.5)

The C-REVERB7 state is of variable length. In the C-REVERB7 state, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols when bitmap N_R is enabled (DBM). When bitmap N_R is disabled (FBM), the ATU-C shall transmit C-REVERB symbols only during $FEXT_R$ symbols and the C-TREF pilot tone during $NEXT_R$ symbols, except for Profile 3 where C-QUIET is transmitted during $NEXT_R$ symbols.

The ATU-C may transition to C-REVERB7 before or after the ATU-R transitions to R-REVERB7 (depending on the presence and length of the PARAMS and REVERB6 states). If the ATU-C transitions to the C-REVERB7 state before the ATU-R transitions to the R-REVERB7 state, then the ATU-C shall continue to transmit C-REVERB symbols until after the ATU-R transitions to the R-REVERB7 state. In this case, the ATU-C shall transition to the next state in 345 * n – 28 symbols after the ATU-R transitioning to the R-REVERB7 state, where $1 \leq n \leq 7$.

If the ATU-C transitions to the C-REVERB7 state after the ATU-R transitions to the R-REVERB7 state, then the ATU-C shall transmit 345 * n – 28 C-REVERB symbols in the C-REVERB7 state, where $1 \leq n \leq 7$.

C.8.13.6.1.6 C-SEGUE4 (supplements § 8.13.6.1.6)

The C-SEGUE4 state is of fixed length. In the C-SEGUE4 state, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols when bitmap N_R is enabled (DBM). When bitmap N_R is disabled (FBM), the ATU-C shall transmit C-SEGUE symbols only during $FEXT_R$ symbols and the C-TREF pilot tone during $NEXT_R$ symbols, except for Profile 3 where C-QUIET is transmitted during $NEXT_R$ symbols. During the C-SEGUE4 state, the ATU-C shall transmit 28 C-SEGUE symbols, corresponding to 10 $FEXT_R$ symbols and 18 $NEXT_R$ symbols.

The C-SEGUE4 state shall be followed by the C-SHOWTIME state. The duration of the preceding initialization stages ensures that the beginning of the C-SHOWTIME state is aligned with a hyperframe boundary.

C.8.13.6.2 ATU-R Exchange Phase (supplements § 8.13.6.2)

When bitmap N_C is disabled (FBM), the ATU-R shall transmit R-QUIET symbols during $NEXT_C$ symbols.

C.8.13.6.2.1 R-MSG2 (supplements § 8.13.6.2.1)

The R-MSG2 state is of fixed length. In the R-MSG2 state, the ATU-R shall transmit the R-MSG2 symbols only during the $FEXT_C$ symbols. The duration of R-MSG2 is NSCds+16 $FEXT_C$ symbols, or (NSCds/128)*345+47 symbols. The ATU-R shall transmit a minimum of 272 $FEXT_C$ R-REVERB or R-SEGUE symbols to modulate the R-MSG2 message and crc. The R-MSG2 state shall have a minimum duration of LEN_R-MSG2 = 737 symbols, corresponding to 272 $FEXT_C$ symbols and 465 $NEXT_C$ symbols.

C.8.13.6.2.2 R-REVERB6 (supplements § 8.13.6.2.2)

The R-REVERB6 state is of variable length. In the R-REVERB6 state, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols when bitmap N_C is enabled (DBM). The ATU-R shall transmit R-REVERB symbols only during $FEXT_C$ symbols when bitmap N_C is disabled (FBM). During the R-REVERB6 state, the ATU-R shall transmit 345 * n – 47 – 23 R-REVERB symbols, with $1 \leq n \leq 7$.

C.8.13.6.2.3 R-SEGUE3 (supplements § 8.13.6.2.3)

The R-SEGUE3 state is of fixed length. In the R-SEGUE3 state, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols when bitmap N_C is enabled (DBM). The ATU-R shall transmit transmit R-SEGUE symbols only during $FEXT_C$ symbols when bitmap N_C is disabled (FBM). During the R-SEGUE3 state, the ATU-R shall transmit 23 R-SEGUE symbols, corresponding to 10 $FEXT_C$ symbols and 13 $NEXT_C$ symbols.

C.8.13.6.2.4 R-PARAMS (supplements § 8.13.6.2.4)

The R-PARAMS state is of variable length. In the R-PARAMS state, the ATU-R shall transmit the R-PARAMS symbols only during the $FEXT_C$ symbols. The ATU-R shall transmit LEN_R-PARAMS symbols to modulate the R-PARAMS message and crc at (2*NSC_R-PARAMS) bits per symbol. The value NSC_R-PARAMS shall be defined as the number of sub-carriers to be used for modulation of the R-PARAMS message as indicated by the ATU-C in the C-MSG2 message. The value LEN_R-PARAMS shall be defined as (length of the R-PARAMS message and crc in bits) divided by (2*NSC_R-PARAMS) and rounded to the higher integer.

If the number of message and crc bits to be transmitted is not an integer multiple of the number of bits per symbol (i.e., not a multiple of 2*NSC_R-PARAM), then the message and crc bits shall be further padded with zero bits such that the overall number of bits to be transmitted is equal to (2*NSC_R-PARAM*LEN_R-PARAMS).

The R-PARAMS state shall have a duration of $\lceil$LEN_R-PARAMS / 128$\rceil$ * 345 symbols, where $\lceil x \rceil$ denotes rounding to the next higher integer. The LEN_R-PARAMS R-PARAMS symbols shall be transmitted in the first LEN_R-PARAMS $FEXT_C$ symbols of the R-PARAMS state. For the remaining $FEXT_C$ symbols of the R-PARAMS state the ATU-R shall transmit the R-QUIET symbol.

Two bit and gain tables and one tone ordering tables shall be transmitted during the R-PARAMS state. When bitmap N_R is disabled (FBM), the bit and gain table and the tone ordering table for the $NEXT_R$ symbols shall be set to zeros.

Table C8-10 lists the length of the R-PARAM message summed over TPC-TC, PMS-TC and PMD layers. The TPS-TC, PMS-TC and PMD bits each correspond to an even number of octets. § C.8.7.1 lists the PMD control parameters.

Table C8-10/G.992.3 - R-PARAMS message and crc length

Part of message	Length (bits or symbols)
Npmd	144 + 40*NSCds
Npms	416
Ntps	0
Nmsg	560 + 40*NSCds
CRC	16
LEN_R-PARAMS	$\left\lceil \frac{576+40*NSCds}{2*NSC\_R-PARAMS} \right\rceil$
NOTE - $\lceil x \rceil$ denotes rounding to the higher integer.	

C.8.13.6.2.5 R-REVERB7 (supplements § 8.13.6.2.5)

The R-REVERB7 state is of variable length. In the R-REVERB7 state, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols when bitmap N_C is enabled (DBM). The ATU-R shall transmit transmit R-REVERB symbols only during $FEXT_C$ symbols when bitmap N_C is disabled (FBM). The ATU-R may transition to R-REVERB7 before or after the ATU-C transitions to C-REVERB7 (depending on the presence and length of the PARAMS and REVERB6 states).

If the ATU-R transitions to the R-REVERB7 state before the ATU-C transitions to the C-REVERB7 state, then the ATU-R shall continue to transmit R-REVERB symbols until after the ATU-C transitions to the C-REVERB7 state. In this case, the ATU-R shall transition to the next state in 345 * n – 23 symbols after the ATU-C transitioning to the C-REVERB7 state, where $1 \le n \le 7$.

If the ATU-R transitions to the R-REVERB7 state after the ATU-C transitions to the C-REVERB7 state, then the ATU-R shall transmit 345 * n – 23 R-REVERB symbols in the R-REVERB7 state, where $1 \le n \le 7$.

C.8.13.6.2.6 R-SEGUE4 (supplements § 8.13.6.2.6)

The R-SEGUE4 state is of fixed length. In the R-SEGUE4 state, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols when bitmap N_C is enabled (DBM). The ATU-R shall transmit R-SEGUE symbols only during $FEXT_C$ symbols when bitmap N_C is disabled (FBM). During the R-SEGUE4 state, the ATU-R shall transmit 23 R-SEGUE symbols, corresponding to 10 $FEXT_C$ symbols and 13 $NEXT_C$ symbols.

The R-SEGUE4 state shall be followed by the R-SHOWTIME state. The duration of the preceding initialization stages ensures that the beginning of the R-SHOWTIME state is aligned with a hyperframe boundary.

C.8.13.7 Timing diagram of the initialization procedures

The Figure C8-16 show the timing diagram of the first part of the Initialization Procedures, from the G.994.1 phase up to the start of the Channel Analysis phase. The Figures C8-17 to C8-20 show the second part of the Initialization procedures, from the end of the Channel Analysis Phase up to Showtime. These four timing diagrams represent the four cases resulting from whether the C-PARAMS and/or R-PARAMS states are included or not.

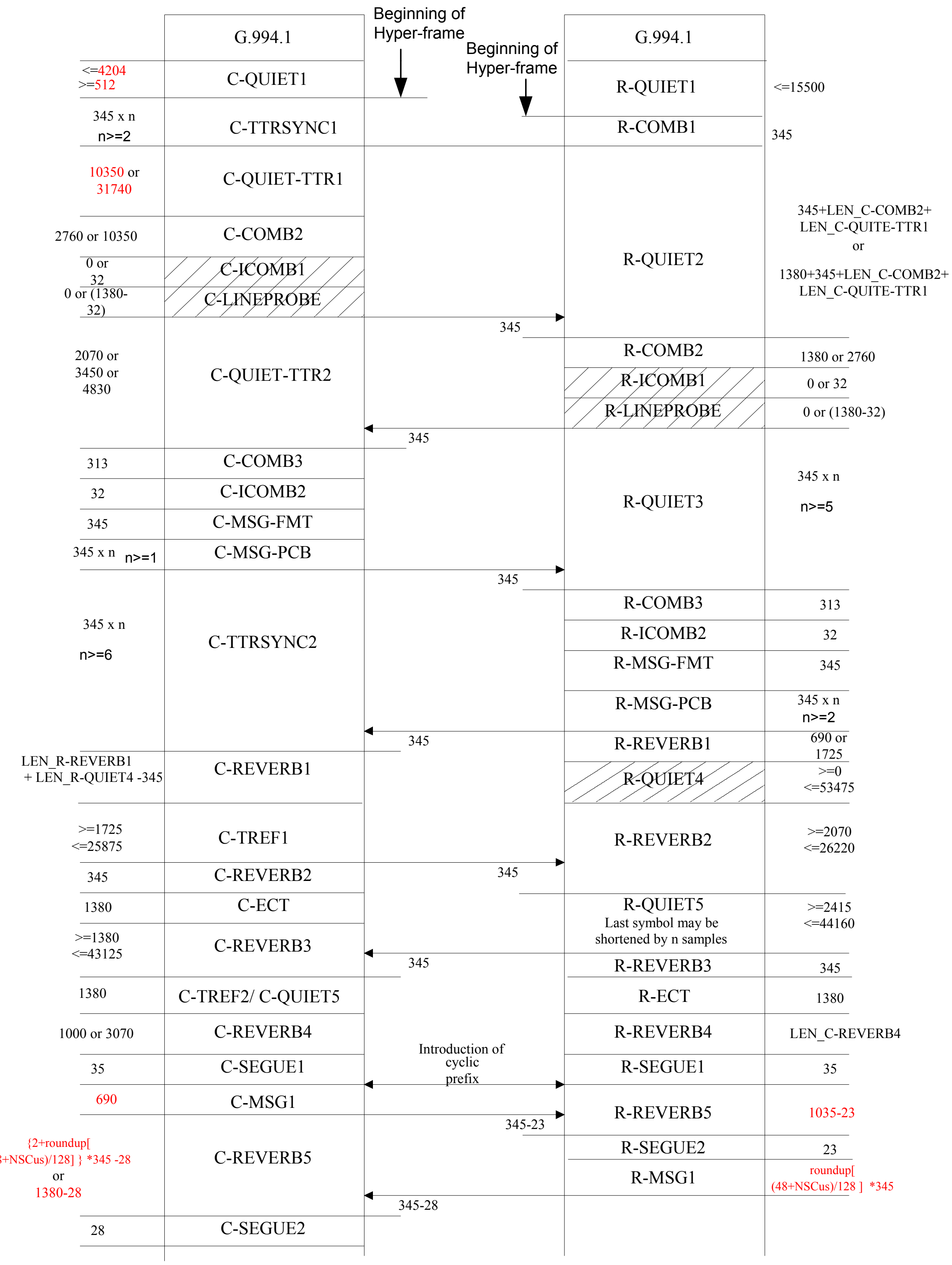


Figure C8-16/G.992.3 – Timing Diagram of the Initialization Procedure

###Editorial: In Figure C8-16, fix "QUITE" to "QUIET" next to R-QUIET2 (2x).
###Editorial: In Figure C8-16, change red colours to black.

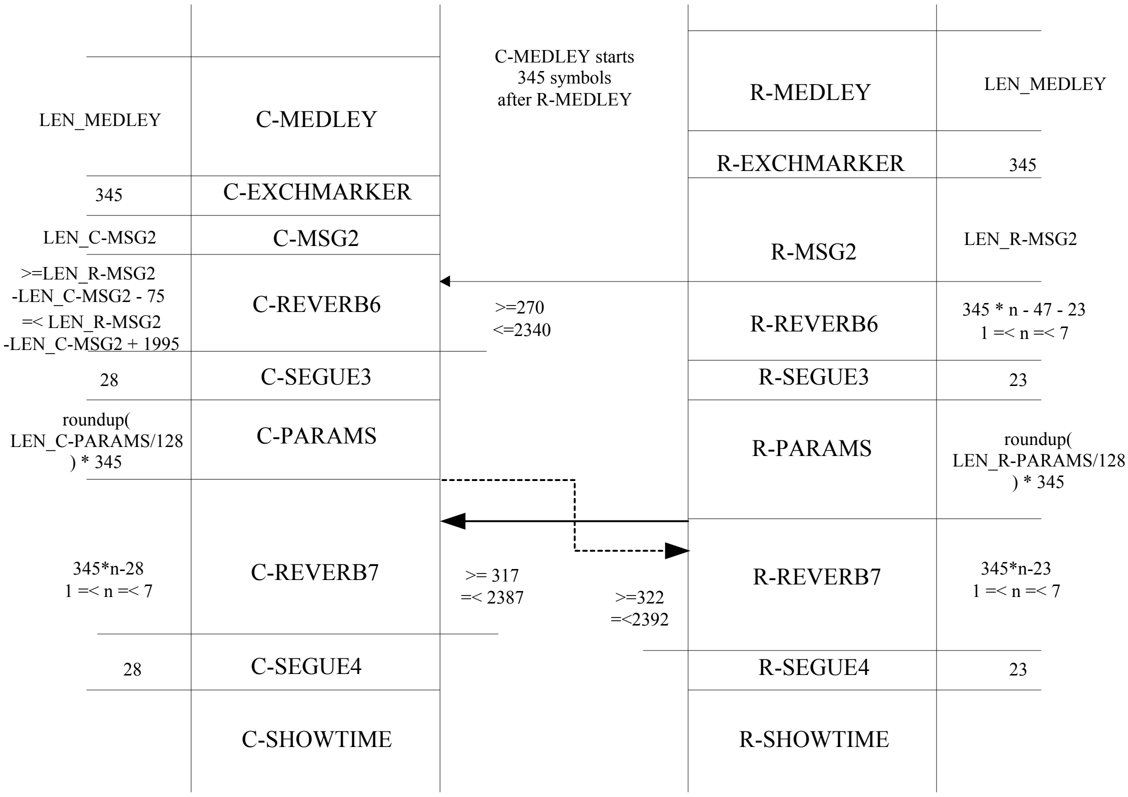


Figure C8-17/G.992.3 – Timing Diagram of the Initialization Procedure (part 2) with C-PARAMS and with R-PARAMS states

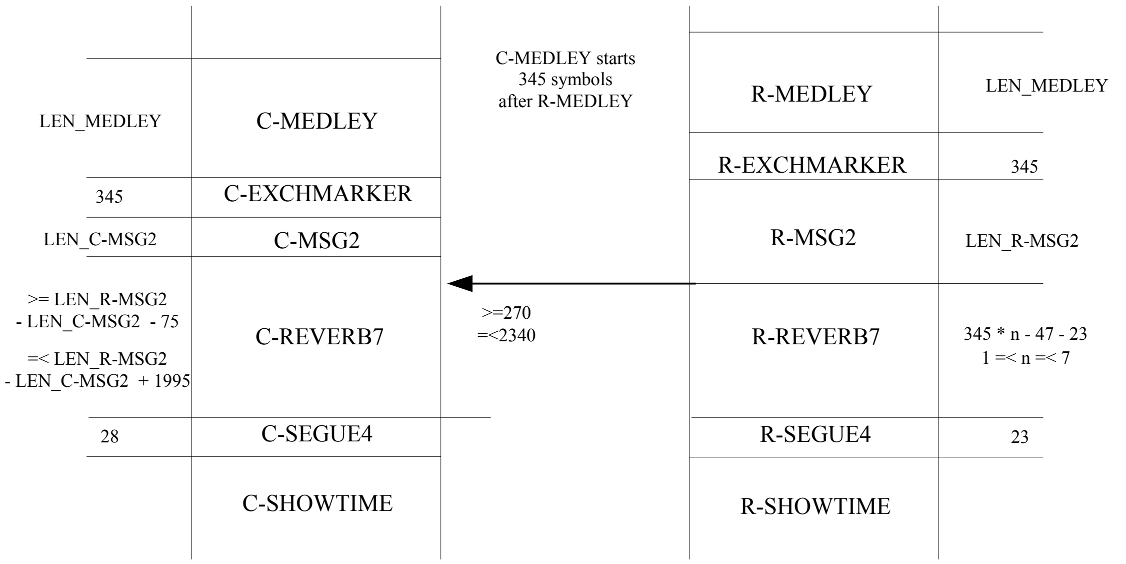


Figure C8-18/G.992.3 – Timing Diagram of the Initialization Procedure (part 2) without C-PARAMS and without R-PARAMS states

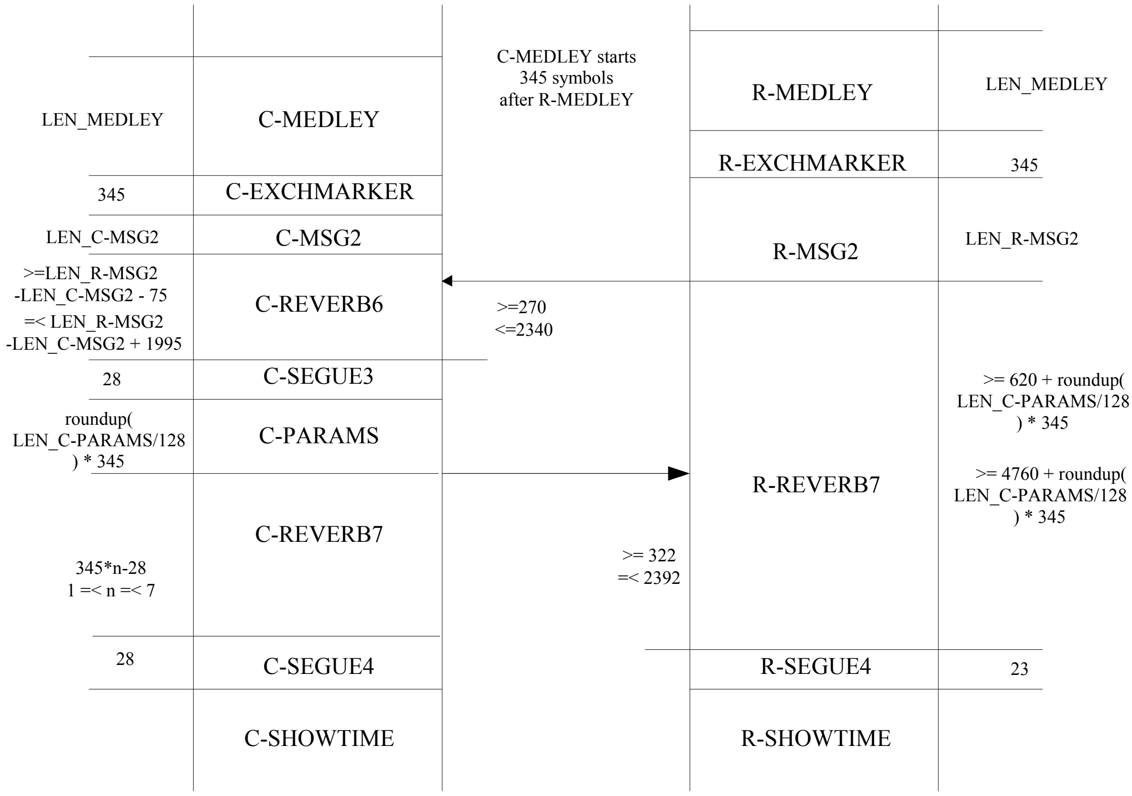


Figure C8-19/G.992.3 – Timing Diagram of the Initialization Procedure (part 2) with C-PARAMS and without R-PARAMS states

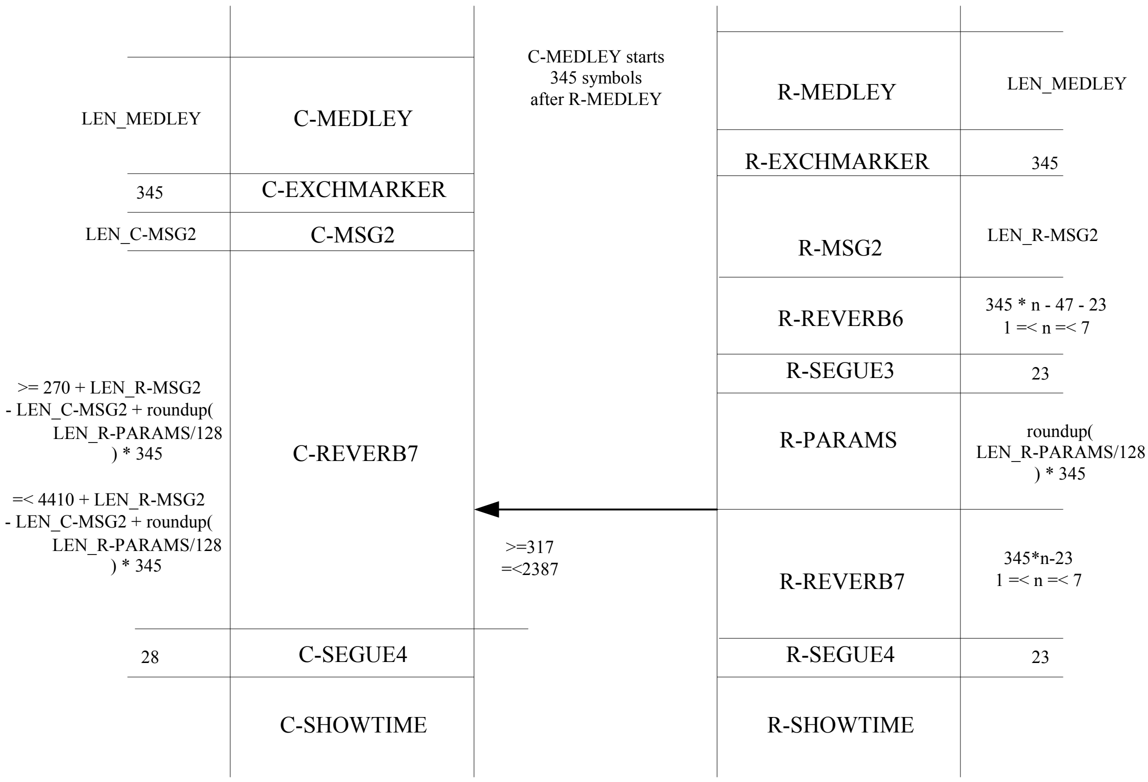


Figure C8-20/G.992.3 – Timing Diagram of the Initialization Procedure (part 2) without C-PARAMS and with R-PARAMS states

C.8.14 Short Initialization Procedures (replaces § 8.14)

The Short Initialization Procedure defined in §8.14 is not applicable to, and therefore shall not be used for Annex C.

C.8.15 Loop diagnostics mode procedures (supplements § 8.15)

C.8.15.1 Overview

C.8.15.2 Channel discovery phase (supplements § 8.15.2)

C.8.15.2.1 ATU-C channel discovery phase (supplements § 8.15.2.1)

In loop diagnostics mode, during the C-TTRSYNC2 state, the ATU-C shall transmit (6+NSCds/32)*345 C-TTRSYNC symbols.

In loop diagnostic mode, the duration of the C-MSG-PCB state shall be (2+NSCus/32)*345 symbols.

C.8.15.2.2 ATU-R channel discovery phase (supplements § 8.15.2.2)

In loop diagnostics mode, during the R-QUIET3 state, the ATU-C shall transmit (6 + NSCus/32)*345 R-QUIET symbols.

In loop diagnostics mode, the duration of the R-MSG-PCB state shall be (2+NSCds/32)*345 symbols.

C.8.15.3 Transceiver training phase

C.8.15.4 Channel analysis phase (supplements § 8.15.4)

In loop diagnostic mode, during the C-REVERB5 state the ATU-C shall transmit (4*345-28) C-REVERB symbols.

C.8.15.5 Exchange phase (supplements § 8.15.5)

C.8.15.5.1 ATU-C exchange phase (supplements § 8.15.5.1)

C.8.15.5.1.1 Channel information bearing messages (supplements § 8.15.5.1.1)

The Table C8-11 replaces Table 8-49.

Table C8-11/G.992.3 – Format of the C-MSG1-LD message

Octet Nr[i]	Information	Format message bits [8*i+7 to 8*i+0]
0	Sequence number	[0001 0001]
1	Reserved	[0000 0000]
2	Hlin scale (lsb)	[xxxx xxxx], bit 7 to 0
3	Hlin scale (msb)	[xxxx xxxx], bit 15 to 8
4	LATN (lsb)	[xxxx xxxx], bit 7 to 0
5	LATN (msb)	[0000 00xx], bit 9 and 8
6	SATN (lsb)	[xxxx xxxx], bit 7 to 0
7	SATN (msb)	[0000 00xx], bit 9 and 8
8	FEXT SNRM (lsb)	[xxxx xxxx], bit 7 to 0
9	FEXT SNRM (msb)	[0000 00xx], bit 9 and 8
10	FEXT ATTNDR (lsb)	[xxxx xxxx], bit 7 to 0
11	FEXT ATTNDR	[xxxx xxxx], bit 15 to 8
12	FEXT ATTNDR	[xxxx xxxx], bit 23 to 16
13	FEXT ATTNDR (msb)	[xxxx xxxx], bit 31 to 24
14	FEXT Far-end ACTATP (lsb)	[xxxx xxxx], bit 7 to 0
15	FEXT Far-end ACTATP (msb)	[ssss ssxx], bit 9 to 8
16	NEXT SNRM (lsb)	[xxxx xxxx], bit 7 to 0
17	NEXT SNRM (msb)	[0000 00xx], bit 9 and 8
18	NEXT ATTNDR (lsb)	[xxxx xxxx], bit 7 to 0
19	NEXT ATTNDR	[xxxx xxxx], bit 15 to 8
20	NEXT ATTNDR	[xxxx xxxx], bit 23 to 16
21	NEXT ATTNDR (msb)	[xxxx xxxx], bit 31 to 24
22	NEXT Far-end ACTATP (lsb)	[xxxx xxxx], bit 7 to 0
23	NEXT Far-end ACTATP (msb)	[ssss ssxx], bit 9 to 8

For the FEXT QLN(i), Table C8-12 replaces Table 8-52.

Table C8-12/G.992.3 – Format of the C-MSG4-LD message

Octet Nr[i]	Information	Format message bits [8*i+7 to 8*i+0]
0	Sequence number	[0100 0100]
1	Reserved	[0000 0000]
2	FEXT QLN(0)	[xxxx xxxx], bit 7 to 0
….	….	….
NSCus+1	FEXT QLN(NSCus-1)	[xxxx xxxx], bit 7 to 0

For the FEXT SNR(i), Table C8-13 replaces Table 8-53.

Table C8-13/G.992.3 – Format of the C-MSG5-LD message

Octet Nr[i]	Information	Format message bits [8*i+7 to 8*i+0]
0	Sequence number	[0101 0101]
1	Reserved	[0000 0000]
2	FEXT SNR(0)	[xxxx xxxx], bit 7 to 0
….	….	….
NSCus+1	FEXT SNR(NSCus-1)	[xxxx xxxx], bit 7 to 0

For the NEXT QLN(i), an additional message C-MSG6-LD is defined in Table C8-14.

Table C8-14/G.992.3 – Format of the C-MSG6-LD message

Octet Nr[i]	Information	Format message bits [8*i+7 to 8*i+0]
0	Sequence number	[0110 0110]
1	Reserved	[0000 0000]
2	NEXT QLN(0)	[xxxx xxxx], bit 7 to 0
….	….	….
NSCus+1	NEXT QLN(NSCus-1)	[xxxx xxxx], bit 7 to 0

For the NEXT SNR(i), an additional message C-MSG7-LD is defined in Table C8-15.

Table C8-15/G.992.3 – Format of the C-MSG7-LD message

Octet Nr[i]	Information	Format message bits [8*i+7 to 8*i+0]
0	Sequence number	[0111 0111]
1	Reserved	[0000 0000]
2	NEXT SNR(0)	[xxxx xxxx], bit 7 to 0
….	….	….
NSCus+1	NEXT SNR(NSCus-1)	[xxxx xxxx], bit 7 to 0

The Table C8-16 replaces Table 8-54.

Table C8-16/G.992.3 – ATU-C loop diagnostics state durations

State	Duration (round up in Hyperframes)	NSCus=32	NSCus=64
C-MSG1-LD	[(24*8)+16]/34	7	7
C-MSG2-LD	[32 + 32*NSCus]/34	32	62
C-MSG3-LD	[32 + 16*NSCus]/34	16	32
C-MSG4-LD	[32 + 8*NSCus]/34	9	16
C-MSG5-LD	[32 + 8*NSCus]/34	9	16
C-MSG6-LD	[32 + 8*NSCus]/34	9	16
C-MSG7-LD	[32 + 8*NSCus]/34	9	16

The resulting number of hyperframes needed to transmit each of the messages and crc is shown in the Loop Diagnostics timing diagrams in Figure C8-21 and Figure C8-22.

C.8.15.5.1.2 Message flow, acknowledgement and retransmission (supplements § 8.15.5.1.2)

The C-TREF1-LD state is of variable length. In the C-TREF1-LD state, for transceivers using profiles 2, 4, 5 or 6, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols. For transceivers using profiles 1 or 3, the ATU-C shall transmit only during $FEXT_R$ symbols. During the C-TREF1-LD state, the ATU-C shall transmit a duration of LENx_R C-TREF symbols.

The C-TREF1-LD state shall be followed by the C-ACK/NACK state.

The C-ACK/NACK state is of fixed length. In the C-ACK/NACK state, for transceivers using profiles 2, 4, 5 or 6, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols. For transceivers using profiles 1 or 3, the ATU-C shall transmit only during $FEXT_R$ symbols.

The C-ACK message is represented by “01010101” octet and shall be transmitted over 8 subframes or 81 symbols using the same modulation technique as the loop diagnostics information bearing messages. A zero bit shall be transmitted as all $FEXT_R$ symbols in a subframe being C-REVERB symbols. A one bit shall be transmitted as all $FEXT_R$ symbols in a sub frame being C-SEGUE symbols.

During the C-NACK state, ATU-C transmits C-TREF pilot tone on all $FEXT_R$ symbols.

The duration of C-ACK/NACK state has a duration of 81 symbols.

The C-ACK/NACK state shall be followed by the C-TREF2-LD state.

The C-TREF2-LD state is of fixed length. In the C-TREF-LD state, for transceivers using profiles 2, 4, 5 or 6, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols. For transceivers using profiles 1 or 3, the ATU-C shall transmit only during $FEXT_R$ symbols. During the C-TREF2-LD state, the ATU-C shall transmit a duration of 690-81 C-TREF symbols.

The C-TREF2-LD state shall be followed by the C-TREF1-LD state if all downstream messages are not received, else changes to C-SEGUE-LD state.

The C-SEGUE-LD state is of fixed length. In the C-SEGUE-LD state, for transceivers using profiles 2,4, 5 or 6, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols. For transceivers using profiles 1 or 3, the ATU-C shall transmit only during $FEXT_R$ symbols. During the C-SEGUE-LD state, the ATU-C shall transmit 345 C-SEGUE symbols.

The C-SEGUE-LD state shall be followed by the C-MSGx-LD state.

The C-MSGx-LD state is of variable length. In this state, the ATU-C shall transmit the C-MSGx symbols only during the $FEXT_R$ symbols. During the $NEXT_R$ symbols, the ATU-C shall transmit the C-TREF pilot tone, except for Profile 3 where C-QUIET is transmitted during $NEXT_R$ symbols.

The C-MSGx-LD message shall be transmitted over 345*n symbols using the same modulation technique as the loop diagnostics information bearing messages.

A zero bit shall be transmitted as all $FEXT_R$ symbols in a subframe being C-REVERB symbols. A one bit shall be transmitted as all $FEXT_R$ symbols in a subframe being C-SEGUE symbols.

The C-MSGx-LD state duration of LENx_C symbols corresponds to an integer number of hyperframes, which is equal to the minimum integer that is larger than or equal to the number of subframes divided by 34.

After all the message bits are transmitted, the C-TREF pilot tone should be sent if C-MSGx-LD state is not finished.

The C-TREF3-LD state is of fixed length. In the C-TREF-LD state, for transceivers using profiles 2, 4, 5 or 6, the ATU-C shall transmit during both $FEXT_R$ and $NEXT_R$ symbols. For transceivers using profiles 1 or 3, the ATU-C shall transmit only during $FEXT_R$ symbols. During the C-TREF3-LD state, the ATU-C shall transmit a duration of 345 C-TREF pilot tone symbols.

The C-TREF3-LD state shall be followed by the C-SEGUE-LD state if all C-MSGx messages are not transmitted or ACK is not received for all the transmitted messages, otherwise ATU-C changes its state to C-QUIET (L3).

C.8.15.5.2 ATU-R exchange phase (supplements § 8.15.5.2)

C.8.15.5.2.1 Channel information bearing messages (supplements 8.15.5.2.1)

The Table C8-17 replaces Table 8-55.

Table C8-17/G.992.3 – Format of the R-MSG1-LD message

Octet Nr[i]	Information	Format message bits [8*i+7 to 8*i+0]
0	Sequence number	[0001 0001]
1	Reserved	[0000 0000]
2	Hlin scale (lsb)	[xxxx xxxx], bit 7 to 0
3	Hlin scale (msb)	[xxxx xxxx], bit 15 to 8
4	LATN (lsb)	[xxxx xxxx], bit 7 to 0
5	LATN (msb)	[0000 00xx], bit 9 and 8
6	SATN (lsb)	[xxxx xxxx], bit 7 to 0
7	SATN (msb)	[0000 00xx], bit 9 and 8
8	FEXT SNRM (lsb)	[xxxx xxxx], bit 7 to 0
9	FEXT SNRM (msb)	[0000 00xx], bit 9 and 8
10	FEXT ATTNDR (lsb)	[xxxx xxxx], bit 7 to 0
11	FEXT ATTNDR	[xxxx xxxx], bit 15 to 8
12	FEXT ATTNDR	[xxxx xxxx], bit 23 to 16
13	FEXT ATTNDR (msb)	[xxxx xxxx], bit 31 to 24
14	FEXT Far-end ACTATP (lsb)	[xxxx xxxx], bit 7 to 0
15	FEXT Far-end ACTATP (msb)	[ssss ssxx], bit 9 to 8
16	NEXT SNRM (lsb)	[xxxx xxxx], bit 7 to 0
17	NEXT SNRM (msb)	[0000 00xx], bit 9 and 8
18	NEXT ATTNDR (lsb)	[xxxx xxxx], bit 7 to 0
19	NEXT ATTNDR	[xxxx xxxx], bit 15 to 8
20	NEXT ATTNDR	[xxxx xxxx], bit 23 to 16
21	NEXT ATTNDR (msb)	[xxxx xxxx], bit 31 to 24
22	NEXT Far-end ACTATP (lsb)	[xxxx xxxx], bit 7 to 0
23	NEXT Far-end ACTATP (msb)	[ssss ssxx], bit 9 to 8

For the FEXT QLN(i), Table C8-18 replaces Table 8-62.

Table C8-18/G.992.3 – Format of the R-MSG8-LD message

Octet Nr[i]	Information	Format message bits [8*i+7 to 8*i+0]
0	Sequence number	[1000 1000]
1	Reserved	[0000 0000]
2	FEXT QLN(0)	[xxxx xxxx], bit 7 to 0
….	….	….
257	FEXT QLN(255)	[xxxx xxxx], bit 7 to 0

For the FEXT SNR(i), Table C8-19 replaces Table 8-63.

Table C8-19/G.992.3 – Format of the R-MSG9-LD message

Octet Nr[i]	Information	Format message bits [8*i+7 to 8*i+0]
0	Sequence number	[1001 1001]
1	Reserved	[0000 0000]
2	FEXT SNR(0)	[xxxx xxxx], bit 7 to 0
….	….	….
257	FEXT SNR(255)	[xxxx xxxx], bit 7 to 0

For the NEXT QLN(i), an additional message R-MSG10-LD is defined in Table C8-20.

Table C8-20/G.992.3 – Format of the R-MSG10-LD message

Octet Nr[i]	Information	Format message bits [8*i+7 to 8*i+0]
0	Sequence number	[1010 1010]
1	Reserved	[0000 0000]
2	NEXT QLN(0)	[xxxx xxxx], bit 7 to 0
….	….	….
257	NEXT QLN(255)	[xxxx xxxx], bit 7 to 0

For the NEXT SNR(i), an additional message R-MSG11-LD is defined in Table C8-21.

Table C8-21/G.992.3 – Format of the R-MSG11-LD message

Octet Nr[I]	Information	Format message bits [8*i+7 to 8*i+0]
0	Sequence number	[1011 1011]
1	Reserved	[0000 0000]
2	NEXT SNR(0)	[xxxx xxxx], bit 7 to 0
….	….	….
257	NEXT SNR(255)	[xxxx xxxx], bit 7 to 0

The Table C8-22 replaces Table 8-64.

Table C8-22/G.992.3 –ATU-R loop diagnostics state durations

State	Duration (round up in Hyperframes)
R-MSG1-LD	[24*8+16]/34 = 7
R-MSG2-LD	[258*8+16]/34 = 62
R-MSG3-LD	[258*8+16]/34 = 62
R-MSG4-LD	[258*8+16]/34 = 62
R-MSG5-LD	[258*8+16]/34 = 62
R-MSG6-LD	[258*8+16]/34 = 62
R-MSG7-LD	[258*8+16]/34 = 62
R-MSG8-LD	[258*8+16]/34 = 62
R-MSG9-LD	[258*8+16]/34 = 62
R-MSG10-LD	[258*8+16]/34 = 62
R-MSG11-LD	[258*8+16]/34 = 62

The resulting number of hyperframes needed to transmit each of the messages and crc is shown in the Loop Diagnostics timing diagrams in Figures C8-21 and C8-22.

C.8.15.5.2.2 Message flow, acknowledgement and retransmission (supplements § 8.15.5.2.2)

The R-SEGUE-LD state is of fixed length. In the R-SEGUE-LD state, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols when bitmap N_C is enabled (DBM). The ATU-R shall transmit R-SEGUE symbols only during $FEXT_C$ symbols when bitmap N_C is disabled (FBM). In this state, the ATU-R shall transmit 345 R-SEGUE symbols.

The R-SEGUE-LD state shall be followed by the R-MSGx-LD state.

The R-MSGx-LD state is of variable length. In the R-MSGx-LD state, the ATU-R shall transmit only during $FEXT_C$ symbols.

The R-MSGx-LD message shall be transmitted over 345*n symbols using the same modulation technique as the loop diagnostics information bearing messages.

A zero bit shall be transmitted as all $FEXT_C$ symbols in a subframe being R-REVERB symbols. A one bit shall be transmitted as all $FEXT_C$ symbols in a subframe being R-SEGUE symbols.

The R-MSGx-LD state duration of LENx-R symbols corresponds to an integer number of hyperframes, which is equal to the minimum integer that is larger than or equal to the number of subframes divided by 34.

After all the message bits are transmitted, the ATU-R shall transmit R-QUIET if R-MSGx-LD state is not finished.

The R-QUIET1-LD state is of fixed length. In the R-QUIET1-LD state, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols, and shall transmit 345 R-QUIET symbols.

If all the R-MSGx downstream messages are not transmitted or ACK is not received for all transmitted messages, then ATU-R transit to R_SEGUE-LD state. Otherwise, ATU-R transit to R-QUIET2_LD state. State transition occurs on a hyper frame boundary.

The R-QUIET2-LD state is of variable length. In the R-QUIET2-LD state, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols, and shall transmit 345*n R-QUIET symbols.

The duration of R-QUIET2-LD shall be 690+LENx_C symbols if the transition is from R-QUIET1-LD and the duration shall be LENx_C symbols if the transition is from R-QUIET3-LD.

The R-QUIET2-LD state shall be followed by the R-ACK/NACK state.

The R-ACK/NACK state is of fixed length. In the R-ACK/NACK state, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols when bitmap N_C is enabled (DBM). The ATU-R shall transmit R-ACK/NACK symbols only during $FEXT_C$ symbols when bitmap N_C is disabled (FBM).

The R-ACK message is represented by "01010101" octet and shall be transmitted over 8 subframes or 81 symbols using the same modulation technique as the loop diagnostics information bearing messages. A zero bit shall be transmitted as all $FEXT_C$ symbols in a subframe being R-REVERB symbols. A one bit shall be transmitted as all $FEXT_R$ symbols in a sub frame being R-SEGUE symbols.

During the R-NACK state, ATU-R transmits R-QUIET on all $FEXT_C$ symbols.

The duration of R-ACK/NACK state has a duration of 81 symbols.

The R-ACK/NACK state shall be followed by the R-QUIET3-LD state.

The R-QUIET3-LD state is of fixed length. In the R-QUIET3-LD state, the ATU-R shall transmit during both $FEXT_C$ and $NEXT_C$ symbols. In the R-QUIET3-LD state, the ATU-R shall transmit 690-81 R-QUIET symbols.

The R-QUIET3-LD state shall be followed by the R-QUIET2-LD state if the ATU-R has not received all R-MSGx upstream messages. Otherwise changes its state to R-QUIET (L3).

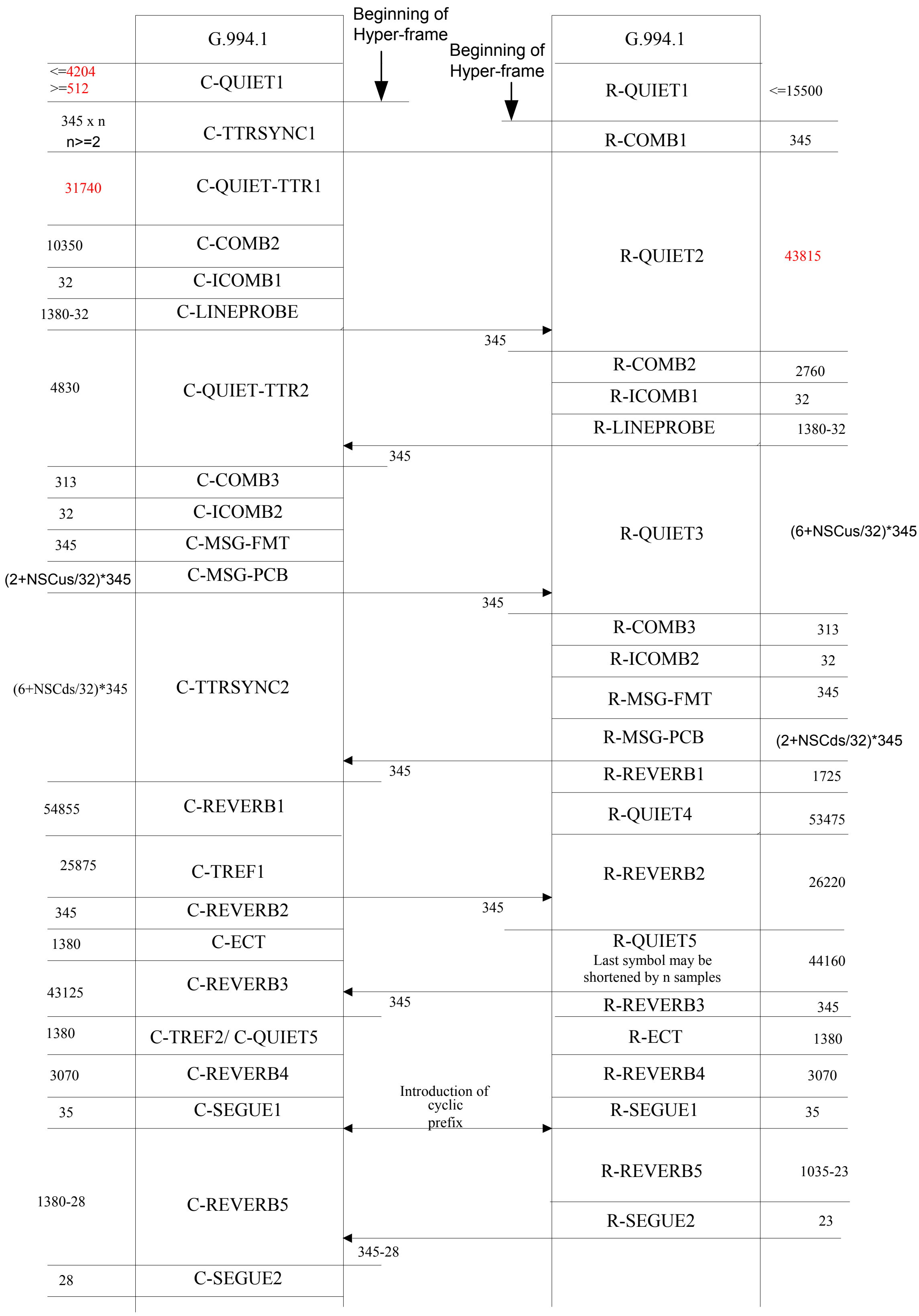


Figure C8-21/G.992.3 – Loop Diagnostics Timing Diagram (part 1)

###Editorial: In Figure C8-21, change red colours to black.

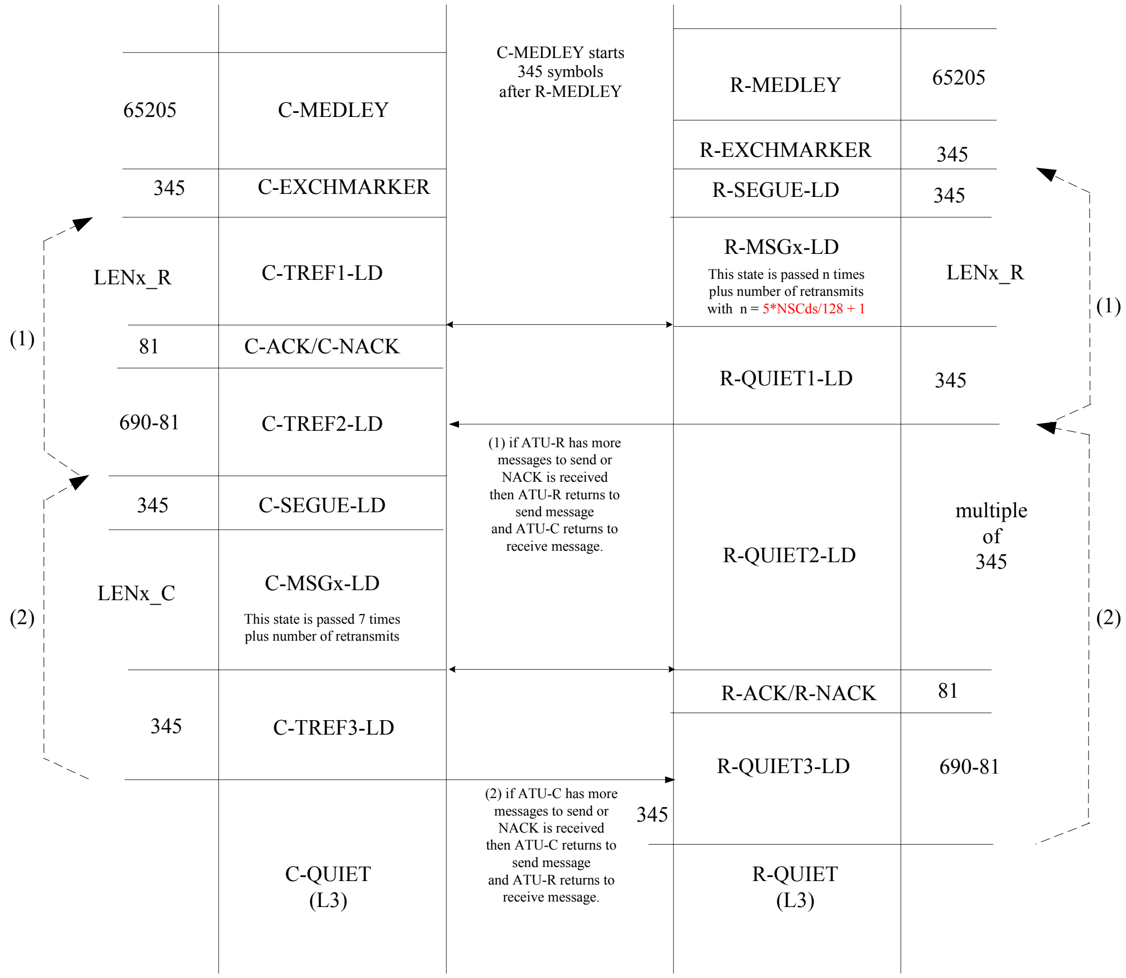


Figure C8-22/G.992.3 – Loop Diagnostics Timing Diagram (part 2)

###Editorial: In Figure C8-22, change red colours to black.

C.8.16 On-line reconfiguration of the PMD function

C.8.17 Power management in the PMD function

C.9 Management Protocol Specific Transmission Convergence (MPS-TC) functions (supplements § 9)

C.9.1 Management Plane Procedures (supplements § 9.4)

C.9.1.1 Commands (supplements 9.4.1)

C.9.1.1.1 On-line reconfiguration command (supplements 9.4.1.1)

On-line reconfiguration commands are based on §9.4.1.1 with the following changes:

- Request type 1 (bit swap) messages shall be restricted to only one bitmap per transaction.
- Request type 2 (DRR) message shall be left for further study.
- Request type 3 (SRA) messages shall allow changing L parameter for both FEXT and NEXT and shall be restricted to only one bitmap per transaction.

The same message designator (0000 0001b) shall be used for both FEXT and NEXT bitmap OLR commands. The OLR commands are listed in Table C9-1.

The Table C9-1 replaces Table 9-7.

Table C9-1/G.992.3 – On line reconfiguration commands transmitted by the Initiating Receiver

Message length (Octets)	ELEMENT NAME (Command)
$3 + 3*N_f$	01_{16} FEXT bitmap Request Type 1 followed by 1 octet for the number of sub-carriers N_f 3* N_f octets describing FEXT bitmap sub-carrier parameter field for each sub-carrier
$3 + 8*N_{LP} + 3*N_f$	08_{16} FEXT bitmap Request Type 3 followed by $2*N_{LP}$ octets containing new $Lf3_P$ values for the N_{LP} enabled latency paths, $2*N_{LP}$ octets containing new $Ln3_P$ values for the N_{LP} enabled latency paths, $2*N_{LP}$ octets containing new $Lf4_P$ values for the N_{LP} enabled latency paths, $2*N_{LP}$ octets containing new $Ln4_P$ values for the N_{LP} enabled latency paths, 1 octet for the number of carriers N_f 3* N_f octets describing FEXT bitmap sub-carrier parameter field for each sub-carrier
$3 + 3*N_f$	09_{16} NEXT bitmap Request Type 1 followed by 1 octet for the number of sub-carriers N_f 3* N_f octets describing NEXT bitmap sub-carrier parameter field for each sub-carrier
$3 + 8*N_{LP} + 3*N_f$	$0A_{16}$ NEXT bitmap Request Type 3 followed by $2*N_{LP}$ octets containing new $Lf3_P$ values for the N_{LP} enabled latency paths, $2*N_{LP}$ octets containing new $Ln3_P$ values for the N_{LP} enabled latency paths, $2*N_{LP}$ octets containing new $Lf4_P$ values for the N_{LP} enabled latency paths, $2*N_{LP}$ octets containing new $Ln4_P$ values for the N_{LP} enabled latency paths, 1 octet for the number of carriers N_f 3* N_f octets describing NEXT bitmap sub-carrier parameter field for each sub-carrier
	All other octet values are reserved by the ITU-T.

C.9.1.1.2 Power management commands (supplements § 9.4.1.7)

Power management commands are based on §9.4.1.7 with the following modifications:

The L2 Request command (02_{16}) in Table 9-21 is changed as described in Table C9-2 and the L2 Grant command (82_{16}) in Table 9-22 is changed as described in Table C9-3.

Revise row and add note in Table 9-21 as shown in Table C9-2.

Table C9-2/G.992.3 – Change in L2 Request command

Message length (Octets)	ELEMENT NAME (Command)
$4 + 4 * N_{LP}$	02_{16} L2 Request followed by 1 octet for minimum PCBds value (dB) 1 octet for maximum PCBds value (dB) $2*N_{LP}$ octets containing maximum Lf_p values for the N_{LP} enabled latency paths (See NOTE), $2*N_{LP}$ octets containing minimum Lf_p values for the N_{LP} enabled latency paths (See NOTE)

	NOTE: Since L2 state is not meant for data transmission, jitter requirements shall be ignored in this state for simplicity. The following relation shall be used during L2 state: $Lf3_p = Lf4_p = Lf_p$

Revise row and add note in Table 9-22 as shown in Table C9-3.

Table C9-3/G.992.3 - Change in L2 Grant command

Message length (Octets)	**ELEMENT NAME (Command)**
5+ $2*N_{LP}$ + $2*N_f$	82_{16} L2 Grant followed by $2*N_{LP}$ octets containing new Lf_p values for the N_{LP} enabled latency paths (See NOTE), 1 octet containing the actual PCBds value 1 octet containing the exit symbol PCBds value, 1 octet containing the exit symbol bi/gi table flag 1 octet for the number of carriers N_f 2 * N_f octets describing sub-carrier parameter field for each sub-carrier
	NOTE: Since L2 state is not meant for data transmission, jitter requirements shall be ignored in this state for simplicity. The following relation shall be used during L2 state: $Lf3_p = Lf4_p = Lf_p$

A sub-carrier parameter field contains 2 octets formatted as [cccc cccc 0000 bbbb]. The carrier index i (8-bits) and the b_i (4 bits). The carrier index shall be the first octet of the sub-carrier field. The b_i shall be the least significant 4 bits of the second octet.

C.9.1.1.3 Test Parameter Messages (supplements § 9.4.1.10)

Some of the test parameters listed in Table 9-30 need to be duplicated for separate measurements during FEXT and NEXT periods. The Test Parameter ID values listed in Table 9-30 are used for the FEXT period measurements. New Test Parameter ID values are defined for the NEXT period measurements, as shown in Table C9-4.

Table C9-4/G.992.3 - PMD Test Parameter ID Values

Test Parameter ID	Test Parameter Name	Length for Single Read	Length for Multiple Read
01_{16}	Channel Transfer Function *Hlog(f)* per sub-carrier	2 + *NSC* * 2 octets	4 octets
02_{16}	Reserved by ITU-T		
03_{16}	FEXT Quiet Line Noise PSD *QLN(f)* per sub-carrier	2 + *NSC* octets	3 octet
04_{16}	FEXT Signal to noise ratio *SNR(f)* per sub-carrier	2 + *NSC* octets	3 octet
05_{16}	Reserved by ITU-T		
21_{16}	Line Attenuation *LATN*	2 octets	N/a
22_{16}	Signal Attenuation *SATN*	2 octets	N/a
23_{16}	FEXT Signal-to-Noise Margin *SNRM*	2 octets	N/a
24_{16}	FEXT Attainable Net Data Rate *ATTNDR*	4 octets	N/a
25_{16}	FEXT Near-end Actual Aggregate Transmit Power *ACTATP*	2 octets	N/a
26_{16}	FEXT Far-end Actual Aggregate Transmit Power *ACTATP*	2 octets	N/a
83_{16}	NEXT Quiet Line Noise PSD *QLN(f)* per sub-carrier	2 + *NSC* octets	3 octet
84_{16}	NEXT Signal to noise ratio *SNR(f)* per sub-carrier	2 + *NSC* octets	3 octet
$A3_{16}$	NEXT Signal-to-Noise Margin *SNRM*	2 octets	N/a
$A4_{16}$	NEXT Attainable Net Data Rate *ATTNDR*	4 octets	N/a
$A5_{16}$	NEXT Near-end Actual Aggregate Transmit Power *ACTATP*	2 octets	N/a
$A6_{16}$	NEXT Far-end Actual Aggregate Transmit Power *ACTATP*	2 octets	N/a

C.10 Dynamic behaviour

C.K TPS-TC functional description

NOTE – This section includes Annex C specific supplements and replacements relative to Annex K.

C.K.1 STM transmission convergence function (replaces § K.1)

For further study

C.K.2 ATM transmission convergence function (supplements § K.2)

C.K.2.1 Control Parameters (replaces § K.2.7)

The configuration of the ATM-TC function is controlled by a set of control parameters displayed in Table C.K2.1 in addition to those specified in the main body of this Recommendation. The values of these control parameters are set communicated during initialization or reconfiguration of an ATU pair. All the values are determined by application requirements and means that are beyond the scope of this document.

Table C.K2.1/G.992.3 - ATM-TC Parameters

Minimum Net Data Rate net_min_n	The minimum net data rate supported by the ATM-TC stream #n. The ATU shall implement appropriate initialization and reconfiguration procedures to provide net_min_n data rate
Maximum Net Data Rate net_max_n	The maximum net data rate supported by ATM-TC stream #n. During activation and reconfiguration procedures, the net data rate shall not exceed this value.

Minimum Reserved Datarate *net_reserve*$_n$	The minimum net data rate supported by ATM-TC stream #n that shall always be available upon request by an appropriate reconfiguration procedure. The value of $net\_reserve_n$ shall be constrained such that $net\_min_n \leq net\_reserve_n \leq net\_max_n$.
Maximum PMS-TC latency *delay_max*$_n$	The ATM-TC stream #n shall be transported with underlying PMS-TC functions configured such that the derived parameter $delay_p$ is no larger than this control parameter $delay\_max_n$
Maximum PMS-TC BER *error_max*$_n$	The ATM-TC stream #n shall be transported with bit error ratio not to exceed $error\_max_n$, referenced to the output of the PMS-TC function in the receiver. The transceiver shall implement appropriate initialization and reconfiguration procedures to assure this value.
IMA Compatibility Mode flag IMA_flag	This single bit flag controls specialized functionality of the ATM-TC function. If set to one, the specialized functionality is enabled. See § K2.8.2 and § K2.8.5. More information on the IMA operation mode is available in Appendix IV– Bibliography [B17].
Minimum PMS-TC Impulse Noise Protection *INP_min*$_n$	The ATM-TC stream #n shall be transported with underlying PMS-TC functions configured such that the derived parameter INP_p is not lower than this control parameter INP_min_n
Maximum PMS-TC jitter *jitter_max*$_n$	The ATM-TC stream #n shall be transported with underlying PMS-TC functions configured such that the derived parameter $jitter_p$ is no larger than this control parameter $jitter\_max_n$

If the values of net_min_n, net_max_n, and $net\_reserve_n$ are set to the same value, then the ATM-TC stream is designated as a fixed datarate ATM-TC stream (i.e., RA_mode=MANUAL, see Table 8-6). If $net\_min_n = net\_reserve_n$ and $net\_min_n \neq net\_max_n$, then the ATM-TC stream is designated as a flexible datarate ATM-TC stream. If the value of $net\_min_n \neq net\_max_n \neq net\_reserve_{max}$, then the ATM-TC stream is designated as a flexible datarate ATM-TC stream with reserved datarate allocation.

During initialization and reconfiguration procedures, the actual net data rate net_actn for stream #n shall always be set to the value of the derived parameter $net\_act_{p\ n}$ of the underlying PMS-TC latency path function and shall be constrained such that $net\_min_n \leq net\_act_n \leq net\_max_n$. However, in case the $net\_min_n = net\_max_n$, the net_act_n may exceed the net_max_n by up to 8 kbit/s, to allow for the PMS-TC net data rate granularity (see Table 7-7). If $net\_min_n < net\_max_n$, the net_max_n shall be set at least 8 kbit/s above the net_min_n , to allow for the PMS-TC net data rate granularity to meet the $net\_min_n \leq net\_act_n \leq net\_max_n$. requirement. The latency $delay\_act_n$ shall always be set to the value of the derived parameter $delay_p$ of the underlying PMS-TC latency path function and constrained such that $delay\_act_n \leq delay\_max_n$ The values net_act_n and $delay\_act_n$ are not control parameters; these values are the result of specific initialization and reconfiguration procedures.

The impulse noise protection INP_act_n of transport of stream #n shall always be set to the value of the derived parameter INP_p of the underlying PMS-TC path function and constrained such that $INP\_act_n \geq INP\_min_n$ The jitter $jitter\_act_n$ of transport of stream #n shall always be set to the value of the derived parameter $jitter_p$ of the underlying PMS-TC path function and constrained such that $jitter\_act_n \leq jitter\_max_n$ The values net_act_n , $delay\_act_n$, $jitter\_act_n$ *and* INP_act_n are not control parameters; these values are the result of specific initialization and reconfiguration procedures.

C.K.2.1.1 Valid Configurations (Supplements § K.2.7.1)

The configurations listed in Table C.K2.2 are valid for the ATM-TC function.

Table C.K2.2/G.992.3 - Valid configuration for ATM-TC Function

Parameter	Capability
$Type_n$	2
Net_min_n	*net_min_n* may be supported for all valid framing configurations
Net_max_n	*net_max_n* may be supported for all valid framing configurations
$Net\_reserve_n$	*$net\_reserve_n$* may be supported for all valid framing configurations
$Delay\_max_n$	$0 < Delay\_max_n \leq$ the largest value of $delay_p$ (see § 7.6.1) for supported valid framing configurations. $Delay\_max_n = 0$ is a special value indicating no delay bound is being imposed. $Delay\_max_n = 1$ is a special value indicating the lowest delay is being imposed (see § 7.3.2.2/G.997.1).
$Error\_max_n$	10^{-3}, 10^{-5}, 10^{-7}
IMA_flag	0 and 1
INP_min_n	0 , 1/2 , 1 , 2, 4, 8, 16
$Jitter\_max_n$	$1 \leq jitter\_max_n \leq$ the largest value of $jitter_p$ (see Table C7-1) for supported valid framing configurations. $Jitter\_max_n = 31$ is a special value indicating no jitter bound is being imposed. $Jitter\_max_n = 0$ is a special value indicating that this bearer is mapped in a latency path where $Lf3_p = Lf4_p = Ln3_p = Ln4_p$.

C.K.2.1.2 Mandatory Configurations (Supplements § K.2.7.2)

If implementing an ATM-TC, an ATU shall support all combinations of the values of ATM-TC control parameters for ATM-TC function #0 displayed in Table C.K2.3 and Table C.K2.4 in the downstream and upstream directions, respectively. The transmitter and receiver shall support mandatory features displayed in the tables.

Table C.K2.3/G.992.3 - Mandatory downstream configuration for ATM-TC function #0

Parameter	Capability
$Type_n$	2
Net_min_n	*net_min_n* shall be supported for all valid framing configurations up to and equal to 8M bits/s . Note: Support for values above the required net data rate is optional and allowed.
Net_max_n	*net_max_n* shall be supported for all valid framing configurations up to and equal to 8M bits/s. Note: Support for values above the required net data rate is optional and allowed.
$Net\_reserve_n$	*$net\_reserve_n$* shall be supported for all valid framing configurations up to and equal to 8M bits/s.
$Delay\_max_n$	All valid values shall be supported
$Error\_max_n$	All valid values shall be supported
IMA_flag	All valid values shall be supported
INP_min_n	0 , 1/2 , 1 , 2
$Jitter\_max_n$	All valid values shall be supported

Table C.K2.4/G.992.3 – Mandatory upstream control configuration for ATM-TC function #0

Parameter	Capability
$Type_n$	2
Net_min_n	*net_min_n* shall be supported for all valid framing configurations up to and equal to 800Kbits/s. Note: Support for values above the required net data rate is optional and allowed.
Net_max_n	*net_max_n* shall be supported for all valid framing configurations up to and equal to 800Kbits/s. Note: Support for values above the required net data rate is optional and allowed.
$Net\_reserve_n$	*$net\_reserve_n$* shall be supported for all valid framing configurations up to and equal to 800Kbits/s.

	Note: Support for values above the required net data rate is optional and allowed.
$Delay\_max_n$	All valid values shall be supported
$Error\_max_n$	All valid values shall be supported
IMA_flag	All valid values shall be supported
INP_min_n	0 , 1/2 , 1 , 2
$Jitter\_max_n$	All valid values shall be supported

C.K.3 Packet transmission convergence function (PTM-TC)

ANNEX C.A

Specific requirements for an Annex C based ADSL system operating with a downstream bandwidth of 1104 kHz and an upstream bandwidth of 138 kHz

This annex defines those parameters of the ADSL system that have been left undefined in the body of Annex C because they are unique to an ADSL service that uses a downstream bandwidth up to 1104 kHz (subcarrier 256) and an upstream bandwidth up to 138 kHz (subcarrier 32).

CA.1 ATU-C functional characteristics (pertains to § 8)

CA.1.1 ATU-C control parameter settings

As defined in § A.1.1.

CA.1.2 ATU-C downstream transmit spectral mask for overlapped spectrum operation (supplements § 8.10)

As defined in § A.1.2.

CA.1.2.1 Passband PSD and response

As defined in § A.1.2.1.

CA.1.2.2 Aggregate transmit power

As defined in § A.1.2.2.

CA.1.3 ATU-C transmitter PSD mask for non-overlapped spectrum operation (supplements § 8.10)

As defined in § A.1.3.

CA.1.3.1 Passband PSD and response

As defined in § A.1.2.1.

CA.1.3.2 Aggregate transmit power

As defined in § A.1.3.2.

CA.2 ATU-R functional characteristics (pertains to § 8)

CA.2.1 ATU-R control parameter settings

As defined in § A.2.1.

CA.2.2 ATU-R upstream transmit spectral mask (supplements § 8.10)

As defined in A.2.2.

CA.2.2.1 Passband PSD and response

As defined in A.2.2.1.

CA.2.2.2 Aggregate transmit power

As defined in A.2.2.

CA.3 Initialization

For this Annex, no additional requirements apply (relative to the Annex C).