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# G.997.1

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

Digital transmission systems – Digital sections and digital line system – Access networks

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# Physical layer management for digital subscriber line (DSL) transceivers

ITU-T Recommendation G.997.1

(Previously CCITT Recommendation)

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**ITU-T RECOMMENDATION G.997.1**

# PHYSICAL LAYER MANAGEMENT FOR DIGITAL SUBSCRIBER LINE (DSL) TRANSCEIVERS


## Summary

This Recommendation specifies the physical layer management for ADSL transmission systems. It specifies means of communication on a transport transmission channel defined in the physical layer Recommendations G.992.1 and G.992.2. It specifies Network Elements content and syntax for Configuration, Fault and Performance Management.



## Source

ITU-T Recommendation G.997.1 was prepared by ITU-T Study Group 15 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 22nd of June 1999.

## FOREWORD

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The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

## NOTE

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As of the date of approval of this Recommendation, the ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

**CONTENTS**

**Recommendation G.997.1**

# PHYSICAL LAYER MANAGEMENT FOR DIGITAL SUBSCRIBER LINE (DSL) TRANSCEIVERS

*(Geneva, l999)*

## 1 Scope

This Recommendation specifies the physical layer management for ADSL transmission systems based on the usage of indicator bits and EOC messages defined in G.992.x-series Recommendation and the clear embedded operation channel defined in this Recommendation.

It specifies Network Management elements content for configuration, fault and performance management.

The mechanisms to provide OAM functions and to generate OAM flows F1, F2 and F3 will depend on the transport mechanism of the physical layer transmission system as well as on the supervision functions contained within the physical layer termination functions of equipment. This Recommendation only specifies flow F3 – transmission path level.

For interrelationships of this Recommendation with other G.99x-series Recommendations, see Recommendation G.995.1.

## 2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent editions of the Recommendations and other references listed below. A list of the currently valid Recommendations is regularly published.


[1] RFC 1157, *A Simple Network Management Protocol (SNMP).*

[2] ITU-T Recommendation G.992.1 (1999), *Asymmetric Digital Subscriber Line (ADSL) transceivers*.

[3] ITU-T Recommendation G.992.2 (1999), *Splitterless Asymmetric Digital Subscriber Line (ADSL) transceivers*.

[4] ITU-T Recommendation G.994.1 (1999), *Handshake procedures for Digital Subscriber Line (DSL) transceivers*.

[5] ITU-T Recommendation I.610 (1999), *B-ISDN operation and maintenance principles and functions*.

[6] ITU-T I.432.x-series Recommendations, *B-ISDN user-network interface – Physical layer specification*.

[7] CCITT Recommendation T.35 (1991), *Procedure for the allocation of CCITT defined codes for non-standard facilities*.

## 3 Definitions

This Recommendation defines the following terms:

**3.1 Clear EOC**: An octet oriented data channel multiplexed in the physical layer transmission frame structure.

**3.2 anomaly**: An anomaly is a discrepancy between the actual and desired characteristics of an item.

The desired characteristic may be expressed in the form of a specification.

An anomaly may or may not affect the ability of an item to perform a required function.

**3.3 defect**: A defect is a limited interruption in the ability of an item to perform a required function. It may or may not lead to maintenance action depending on the results of additional analysis.

Successive anomalies causing a decrease in the ability of an item to perform a required function are considered as a defect.

**3.4 failure**: A failure is the termination of the ability of an item to perform a required function.

NOTE – After failure, the item has a fault.

Analysis of successive anomalies or defects affecting the same item can lead to the item being considered as "failed".

**3.5 net data rate**: Net data rate is defined in G.992.x-series Recommendations.

## 4 Abbreviations

This Recommendation uses the following abbreviations:

| | |
|---|---|
| ADSL | Asymmetric digital subscriber line |
| AME | ADSL management entity |
| AN | Access node |
| AS0 to AS3 | Downstream simplex bearer channel designators |
| ATM | Asynchronous transfer mode |
| ATU-C | ADSL transceiver unit-central office end (i.e. network operator) |
| ATU-R | ADSL transceiver unit-remote terminal end (i.e. CP) |
| CRC | Cyclic redundancy check |
| CVF-L | Code Violation-line (Fast path) |
| CVI-L | Code Violation-line (Interleaved path) |
| DMT | Discrete multitone |
| DSL | Digital subscriber line |
| ECF-L | Forward Error Correction Count Line (Fast path) |
| ECI-L | Forward Error Correction Count Line (Interleaved path) |
| ECS-L | Forward Error Correction second-Line |
| EOC | Embedded operations channel |
| ES | Errored second |
| ES-L | Errored Second-Line |

| | |
|---|---|
| FEBE-F | Binary indication of far-end block error count-fast data |
| FEBE-I | Binary indication of far-end block error count-interleaved data |
| FEC | Forward error correction |
| FFEC-F | Binary indication of far-end forward error correction count-fast data |
| FFEC-I | Binary indication of far-end forward error correction count-interleaved data |
| HDLC | High-level data link control |
| HDSL | High bit rate digital subscriber line |
| HEC | Header error control |
| ib0-23 | Indicator bits |
| ID code | Vendor identification code |
| ISDN | Integrated Services Digital Network |
| kbit/s | kilo bits per second |
| LCD | Loss of Cell Delineation |
| LOF | Loss of frame |
| LOS | Loss of signal |
| LOSS-L | LOS Second |
| LS0-2 | DUPLEX bearer channel designators |
| LSB | Least significant bit |
| MIB | Management information base |
| MSB | Most significant bit |
| NCD | No cell delineation |
| NE | Network Element |
| NMS | Network Management System |
| NT | Network termination |
| OAM | Operations, administration and maintenance |
| POTS | Plain old telephone service; one of the services using the voiceband; sometimes used as a descriptor for all voiceband services |
| PSTN | Public switched telephone network |
| RDI | Remote defect indication |
| RFI | Remote failure indication |
| SEF | Severely errored frame |
| SES-L | Severely Errored Second-line |
| SNMP | Simple Network Management Protocol |
| STM | Synchronous transfer mode |
| T/S | Interface(s) between ADSL network termination and Customer Installation or home network |
| TC | Transmission convergence (layer) |

| | |
|---|---|
| TCM | Time Compression Multiplex |
| TE | Terminal Equipment |
| T-R | Interface(s) between ATU-R and switching layer (ATM or STM) |
| TR | Threshold Reports |
| UAS | Unavailable seconds |
| U-C | Loop interface-central office end |
| U-R | Loop interface-remote terminal end |
| V-C | Logical interface between ATU-C and a digital network element such as one or more switching systems |

## 5 Overview

Figure 1 shows the system reference model for this Recommendation.

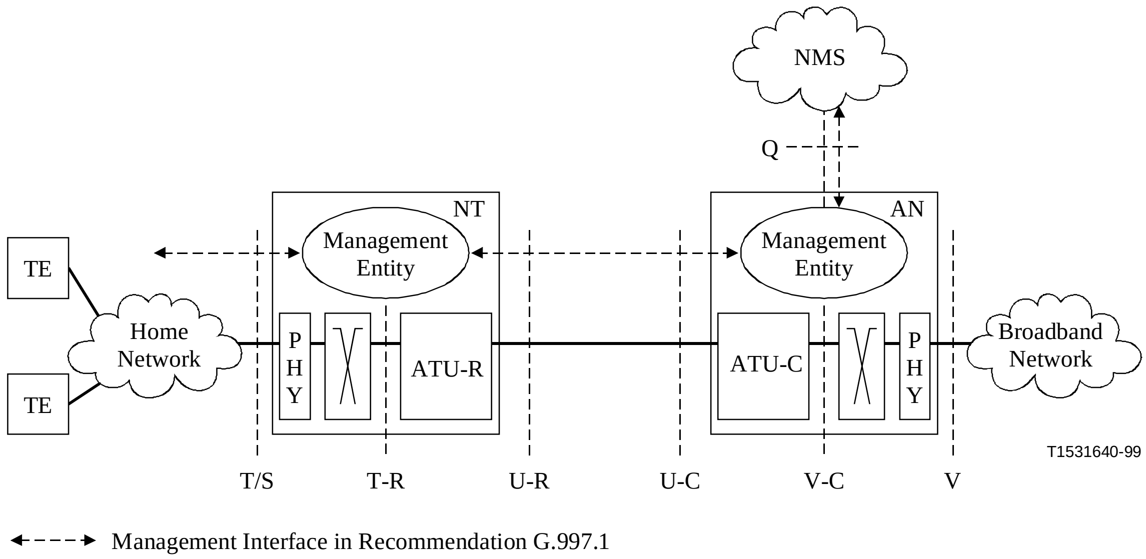



**Figure 1/G.997.1 – System reference model**

There are four management interfaces defined in this Recommendation.

The Q-interface at the AN for Network Management Systems (NMS). All the parameters specified in this Recommendation apply at the Q-interface. The Q-interface provides the interface between the Network Management Systems of the operator and the Management Entity in the Access Node.

The near-end parameters supported in the Management Entity are derived from ATU-C while the far-end parameters (from the ATU-R) can be derived by either of two interfaces over the U-interface:

- By use of the indicator bits and EOC message, which are provided at the PMD layer, can be used to generate the required ATU-R parameters in the Management Entity of the AN.
- By use of the OAM channel and protocol (specified in clause 6) to retrieve the parameters from the ATU-R, when requested by the Management Entity of the AN.

The definition of the transport of the management instrumentation over the Q-interface is outside the scope of this Recommendation.

At the U-interface there are two management interfaces, one at the ATU-C and one at the ATU-R. The main purposes are to provide:

- At the ATU-C: the ATU-C near-end parameters for the ATU-R to retrieve over the U-interface.
- At the ATU-R: the ATU-R near-end parameters for the ATU-C to retrieve over the U-interface.

This Recommendation defines (see clause 6) a method for the communication of the parameters (as defined in clause 7) over the U-interface.

At the T-/S-interface a subset of the parameters specified in this Recommendation may apply. The purpose is to indicate the ADSL link status to the TE. These parameters are maintained by the Management Entity of the NT and are made available over the T-/S-interface.

The far-end parameters (from the ATU-C) can be derived by either of two interfaces over the U-interface:

- By use of the indicator bits and EOC message, which are provided at the PMD layer, can be used to generate the required ATU-C parameters in the Management Entity of the NT.
- By use of the OAM channel and protocol (specified in clause 6) to retrieve the parameters from the ATU-C, when requested by the Management Entity of the NT.

The definition of the transport of this management information over the T-/S-interfaces is outside the scope of this Recommendation.

Dependent on the transceiver Recommendation (e.g. G.992.1 or G.992.2), some of the parameters may not apply (i.e. fast data stream parameters for Recommendation G.992.2).

## 5.1 Physical layer management mechanisms

The general definition of OAM for ATM networks is defined in Recommendation I.610. The physical layer contains the three lowest OAM levels as outlined in Figure 2. The allocation of the OAM flows is as follows:

– F1: regenerator section level;

– F2: digital section level;

– F3: transmission path level.

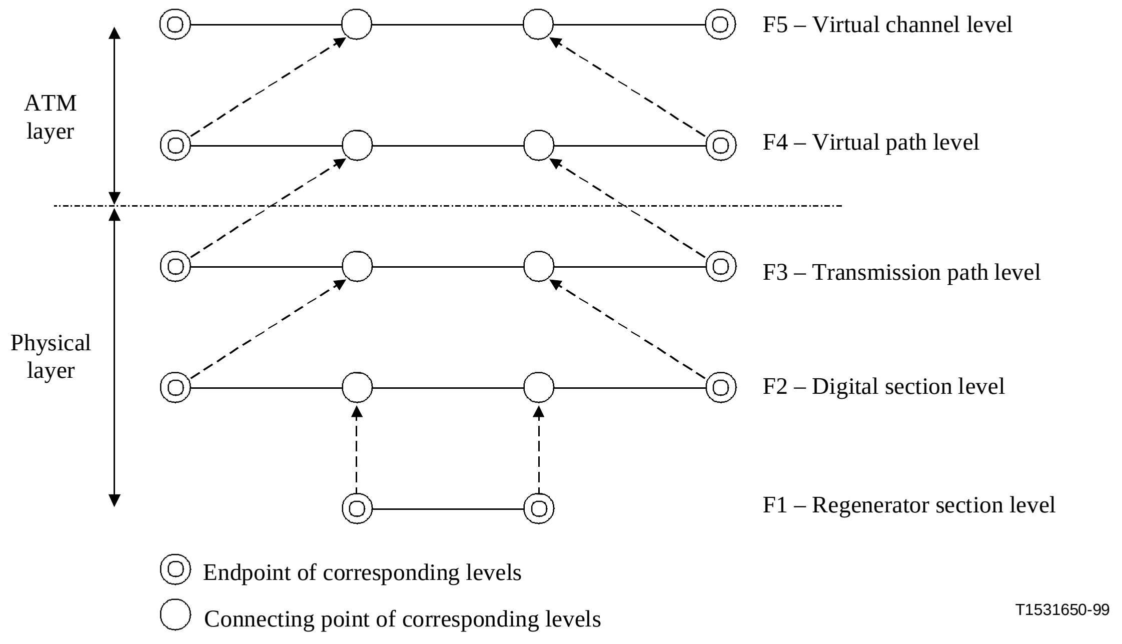



**Figure 2/G.997.1 – OAM hierarchical levels and their relationship with the ATM layer and physical layer**

The physical layer (F1-F3) is in this Recommendation defined as the PMD – Physical Media Dependent layer and the ATM-TC layer. The Physical layer and the ATM layer are coupled from the fault management perspective. When a F3 fault (e.g. LOS) is detected it is reported to the NMS but a F4/F5, as defined in Recommendation I.610, fault is generated as well.

The ADSL LINE (see Figure 3) is characterized by a metallic transmission medium utilizing an analogue coding algorithm, which provides both analogue and digital performance monitoring at the line entity. The ADSL LINE is delimited by the two end points, known as line terminations. ADSL LINE terminations are the point, where the analogue coding algorithms end, and the subsequent digital signal is monitored for integrity. The ADSL LINE is defined between the V-D and the T-D reference points.

The ADSL ATM PATH is defined between the V-C and T-R reference points.

The ADSL STM PATH is for further study.

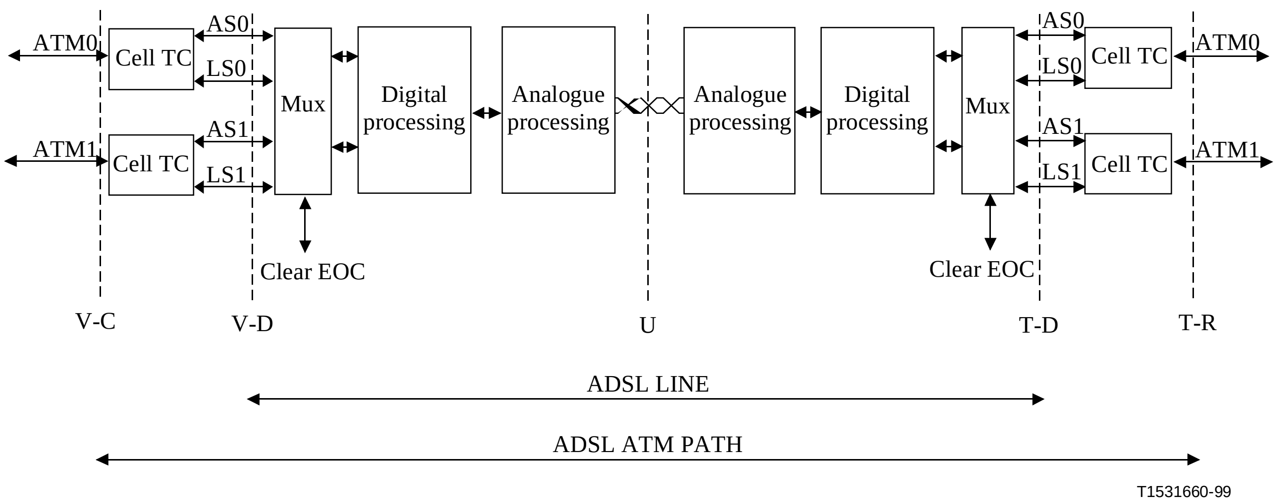



**Figure 3/G.997.1 – ADSL LINE and ADSL ATM PATH definition**

The HDSL LINE (see Figure 4) is terminated in the HTU-C and HTU-R. It is also called an Access Digital Section. Within the Access Digital Section a regenerator could be present.

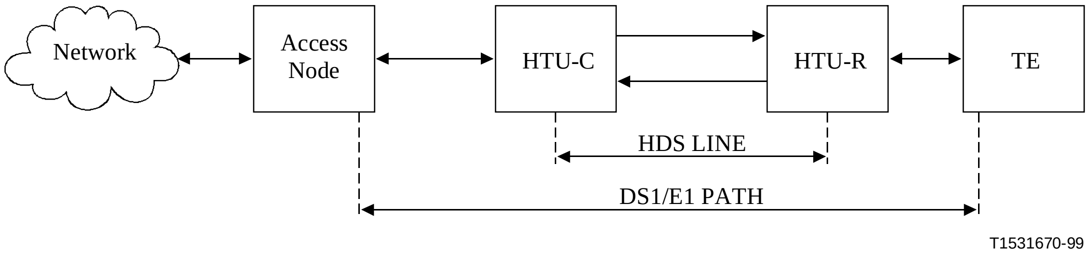



**Figure 4/G.997.1 – HDSL LINE and PATH definition**

## 6 OAM communications channel

This clause specifies an optional OAM communication channel across the U-interface (see Figure 5). If this channel is implemented, the ATU-C and the ATU-R may use it for transporting physical layer OAM messages. If either the ATU-C or the ATU-R do not have the capability of this OAM channel, the far-end parameters, defined in clause 7, at the ATU-C shall be derived from the indicator bits and EOC messages defined in Recommendations G.992.1 and G.992.2. Support for the OAM communication channel defined in this section will be indicated during initialization by messages defined in Recommendation G.994.1.

NOTE – In those cases where neither the ATU-R nor ATU-C implements this communication channel, there are some reduced physical layer OAM capabilities (see clause 7).

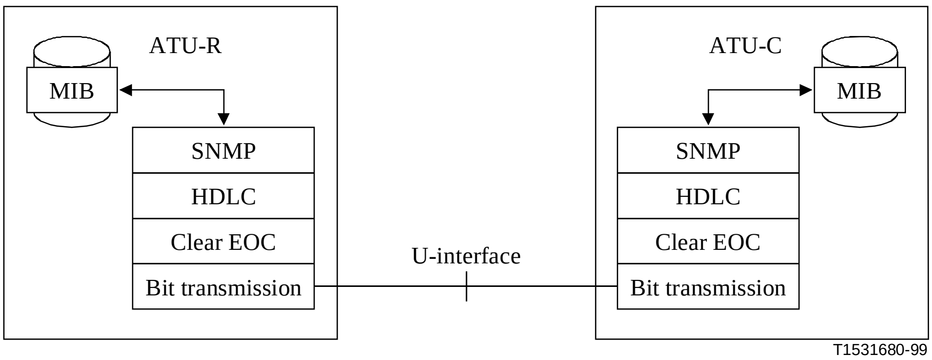



**Figure 5/G.997.1 – OAM communication channel layers**

### 6.1 Requirements on the PMD layer for the Clear EOC

In order to support the physical layer OAM protocols defined in this Recommendation, a physical layer Recommendation shall provide a full duplex data channel for support of the data link layer defined in 6.2.

The Clear EOC serves the function of a physical layer of the protocol stack defined in this Recommendation for Recommendations G.992.2 and G.992.1.

1) The Clear EOC shall be a part of the protocol overhead for the particular xDSL line coding.

2) The Clear EOC shall be available to carry traffic whenever the xDSL protocol is in a normal transmission mode (e.g. "showtime").

3) The Clear EOC shall be available regardless of the specific configuration options or run time adaptation of an ATU-C and ATU-R that are communicating.

4) The Clear EOC shall be terminated in the ATU-R and the ATU-C.

5) The Clear EOC shall support traffic of at least 4 kbit/s.

6) The Clear EOC shall support delineation of individual octets in order to support the link level protocol defined in 7.1.

7) The Clear EOC should not support error correction or detection. Error correction and detection is supported by use of the OAM stack defined in this Recommendation.

8) The Clear EOC should not guarantee the delivery of data carried over the channel.

9) The Clear EOC should not support retransmission of data upon error.

10) The Clear EOC should not acknowledge the receipt of data by the far end of the link.

11) The Clear EOC should not require a specific initialization procedure, it can be assumed to be operational whenever the two modems are in synchronization for "showtime" transport of data.

### 6.2 Data link layer

For the transport mechanism, an HDLC-like mechanism is proposed with the characteristics detailed in the following subclauses. The defined method is based on ISO/IEC 3309.

#### 6.2.1 Format convention

The basic format convention used for messages is illustrated in Figure 6. Bits are grouped into octets. The bits of each octet are shown horizontally and are numbered from 1 to 8. Octets are displayed vertically and are numbered from 1 to N.

The octets are transmitted in ascending numerical order.

The Frame Check Sequence (FCS) field spans two octets: Bit 1 of the first octet is the MSB and bit 8 of the second octet is the LSB (Figure 7).

| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Octet |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 1 |
| | | | | | | | | 2 |
| | | | | | | | | ... |
| | | | | | | | | N |

**Figure 6/G.997.1 – Format Convention**

| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | Octet |
|---|---|---|---|---|---|---|---|---|
| $2^8$ | | | | | | | $2^{15}$ | 1 |
| $2^0$ | | | | | | | $2^7$ | 2 |

**Figure 7/G.997.1 – FCS mapping convention**

### 6.2.2 OAM Frame Structure

The frame structure is as depicted below (Figure 8):

| | |
|---|---|
| $7E_{16}$ | Opening Flag |
| $FF_{16}$ | Address field |
| $03_{16}$ | Control field = UI frame |
| Information Payload | Max 510 bytes |
| FCS | Frame Check Sequence (First octet) |
| FCS | Frame Check Sequence (Second octet) |
| $7E_{16}$ | Closing Flag |

**Figure 8/G.997.1 – OAM Frame structure**

The opening and closing flag sequence shall be the octet $7E_{16}$. The address and control field of the frame shall be coded with $FF_{16}$ and $03_{16}$, respectively.

Transparency of the information payload to the flag sequence and the frame check sequence are described below.

### 6.2.3 Octet Transparency

In this approach, any data that is equal to $7E_{16}$ ($01111110_2$) (the Flag Sequence) or $7D_{16}$ (the Control Escape) are escaped as described below.

After Frame Check Sequence (FCS) computation, the transmitter examines the entire frame between the two Flag Sequences. Any data octets which are equal to the Flag Sequence ($7E_{16}$) or the Control Escape ($7D_{16}$D) are replaced by a two-octet sequence consisting of the Control Escape octet followed by the original octet Exclusive-OR'ed with hexadecimal 0x20 (this is bit 5 complemented, where the bit positions are numbered 76543210). In summary, the following substitutions are made:

- a data octet of $7E_{16}$ is encoded as two octets $7D_{16}$, $5E_{16}$
- a data octet of $7D_{16}$ is encoded as two octets $7D_{16}$, $5D_{16}$

On reception, prior to FCS computation, each Control Escape octet ($7D_{16}$) is removed, and the following octet is exclusive-OR'ed with hexadecimal $20_{16}$ (unless the following octet is $7E_{16}$, which is the flag, and indicates the end of frame, and therefore an abort has occurred). In summary, the following substitutions are made:

- a sequence of $7D_{16}$, $5E_{16}$ is replaced by the data octet $7E_{16}$
- a sequence of $7D_{16}$, $5D_{16}$ is replaced by the data octet $7D_{16}$
- a sequence of $7D_{16}$, $7E_{16}$ aborts the frame.

Note that since octet stuffing is used, the data frame is guaranteed to have an integer number of octets.

### 6.2.4 Frame Check Sequence

The FCS field is 16 bits (2 octets) in length. As defined in ISO/IEC 3309, it shall be the one's complement of the sum (modulo 2) of:

a) the remainder of x k ($x^{15} + x^{14} + x^{13} + x^{12} + x^{11} + x^{10} + x^9 + x^8 + x^7 + x^6 + x^5 + x^4 + x^3 + x^2 + x + 1$) divided (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, where k is the number of bits in the frame existing between, but not including, the last bit of the final opening flag and the first bit of the FCS, excluding octets inserted for transparency; and

b) the remainder of the division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, of the product of $x^{16}$ by the content of the frame existing between, but not including, the last bit of the final opening flag and the first bit of the FCS, excluding octets inserted for transparency.

As a typical implementation at the transmitter, the initial content of the register of the device computing the remainder of the division is preset to all binary ONEs and is then modified by division by the generator polynomial (as described above) on the information field. The one's complement of the resulting remainder is transmitted as the 16-bit FCS.

As a typical implementation at the receiver, the initial content of the register of the device computing the remainder of the division is preset to all binary ONEs. The final remainder, after multiplication by 16 and then division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$ of the serial incoming protected bits after removal of the transparency octets and the FCS, will be $0001110100001111_2$ ($x^{15}$ through $x^0$, respectively) in the absence of transmission errors.

The FCS is calculated over all bits of the Address, Control, and Information payload fields of the frame.

The register used to calculate the CRC shall be initialized to the value $FFFF_{16}$, both at the transmitter and the receiver.

The LSB of the FCS is sent first, followed by the MSB.

On the receiver a message received without errors results in a CRC calculation of $F0B8_{16}$.

### 6.2.5 Invalid Frames

The following conditions result in an invalid frame:

- Frames which are too short (less than 4 octets in between flags not including transparency octets).
- Frames which contain a Control Escape octet followed immediately by a Flag (i.e. $7D_{16}$, $7E_{16}$).
- Frames which contain control escape sequences other than $7D_{16}$, $5E_{16}$ and $7D_{16}$, $5D_{16}$.

Invalid frames shall be discarded. The receiver shall immediately start looking for the beginning flag of a subsequent frame.

### 6.2.6 Synchronism

The EOC frame structure transport is octet synchronous. Octet transport and synchronism for this transport is defined in accordance with the TC layer.

### 6.2.7 Time Fill

Inter-frame time fill is accomplished by inserting additional flag octets ($7E_{16}$) between the closing and the subsequent opening flag on the EOC transport channel. Inter-octet time fill is not supported.

## 6.3 The SNMP protocol

If implemented, SNMP messages shall be used as the message encoding over the HDLC data link channel defined in 6.2.

### 6.3.1 SNMP message mapping in HDLC frames

The SNMP messages are placed directly in the HDLC frame together with the protocol identifier (see Figure 9). The protocol identifier is two bytes ahead of the SNMP message. The two bytes contain the ethertype SNMP value $814C_{16}$ as defined in RFC 1700. A single HDLC frame is used to transport each SNMP message.

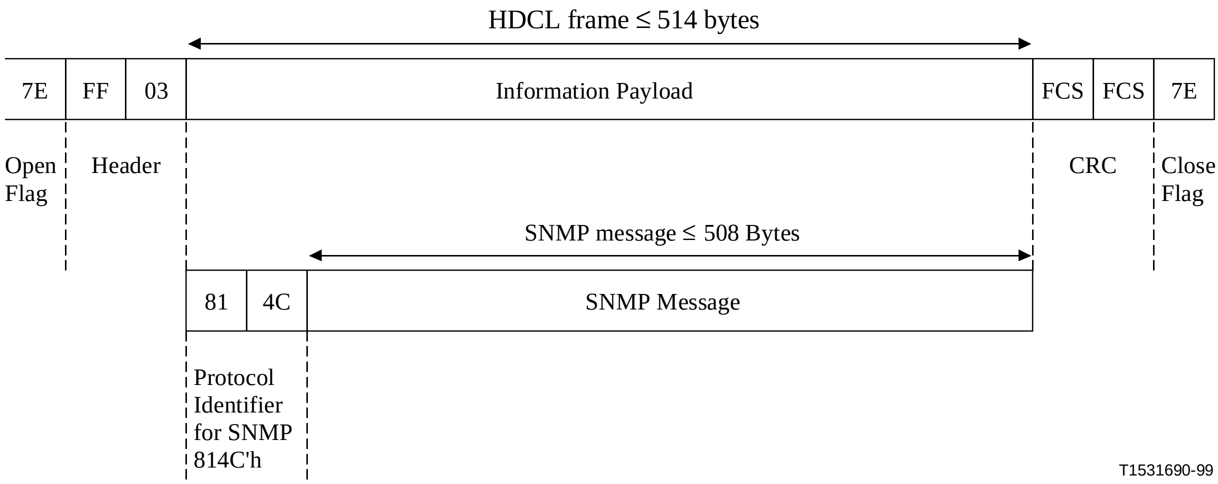



**Figure 9/G.997.1 – OAM communication channel protocol over the U-Interface**

The length of an SNMP message shall be less than or equal to 508 bytes.

Due to the transparency mechanism described in 6.2.3, the number of bytes actually transmitted in between opening and closing flag may be higher than 514.

### 6.3.2 Protocol based on SNMP

The SNMP protocol as defined in [1] consists of four types of operations, which are used to manipulate management information. These are:

| | |
|---|---|
| Get | Used to retrieve specific management information. |
| Get-Next | Used to retrieve, via traversal of the MIB, management information. |
| Set | Used to alter management information. |
| Trap | Used to report extraordinary events. |

These four operations are implemented using five types of PDUs:

| | |
|---|---|
| GetRequest-PDU | Used to request a Get operation. |
| GetNextRequest-PDU | Used to request a Get-Next operation. |
| GetResponse-PDU | Used to respond to a Get, Get-Next, or Set operation. |
| SetRequest-PDU | Used to request a Set operation. |
| Trap-PDU | Used to report a Trap operation. |

If implemented, SNMP messages shall be used according to the following requirements.

#### 6.3.2.1 Use of EOC Channel

The ADSL OAM channel will be used for sending HDLC-encapsulated SNMP messages between adjacent AME's.

An AME-ADSL Management Entity residing in the ATU-R and ATU-C will send and interpret these SNMP messages. This ADSL OAM channel is used for requests, responses, and traps, differentiated according to the SNMP PDU type.

#### 6.3.2.2 Message Format

The message format specified in [1] shall be used. That is, messages shall be formatted according to SNMP version 1.

All SNMP messages shall use the community name "ADSL", that is, the OCTET STRING value: "$4144534C_{16}$".

In all SNMP Traps, the agent-addr field (which has syntax NetworkAddress), shall always have the IpAddress value: 0.0.0.0.

In all SNMP Traps, the time-stamp field in the Trap-PDU shall contain the value of an AME's MIB object at the time of trap generation.

In any standard SNMP Trap, the enterprise field in the Trap-PDU shall contain the value of the agent's sysObjectID MIB object (sysObjectID is defined in the system group of MIB-II).

#### 6.3.2.3 Message Sizes

All ADSL OAM implementations shall be able to support SNMP messages of size up to and including 508 octets.

#### 6.3.2.4 Message Response Time

Response time refers to the elapsed time from the submission of an SNMP message (e.g. GetRequest, GetNextRequest, or SetRequest message) by an AME across an ADSL Interface to the receipt of the corresponding SNMP message (e.g. GetResponse message) from the adjacent AME. An SNMP GetRequest, GetNextRequest, or SetRequest message is defined in this context as a request concerning a single object.

The AME shall support maximum Response Times of 1 s for 95% of all SNMP GetRequests, GetNextRequests or SetRequests containing a single object received from an adjacent AME independent of the ADSL Interface's physical line rate.

#### 6.3.2.5 Object Value Data Correctness

Data correctness refers to the maximum elapsed time since an object value in the ADSL Interface MIB was known to be current. The following specifies the requirements on the Data Correctness of the ADSL OAM objects and the event notifications.

The ADSL Interface MIB objects shall have the Data Correctness of a maximum of 30 s.

The AME shall support event notifications (i.e. SNMP Traps) for generic SNMP events within 2 s of the event detection by the AME.

# 7 Network Management Elements

Figure 10 shows the In-service performance monitoring process.

**Error! Objects cannot be created from editing field codes.**

**Figure 10/G.997.1 – In-service performance monitoring process**

This Recommendation specifies the parameters for fault and performance monitoring. The primitives are specified in the physical layer Recommendations G.992.1 and G.992.2.

## 7.1 Failures

Any failure defined in this clause shall be conveyed to the NMS by the ATU-C and should be conveyed to the NMS by the ATU-R after it is detected.

### 7.1.1 Line Failures

#### 7.1.1.1 Near-end failures

The following near-end failure detections shall be provided at the ATU-C and the ATU-R.

##### 7.1.1.1.1 Loss of signal (LOS) failure

An LOS failure is declared after 2.5 ± 0.5 s of contiguous LOS defect, or, if LOS defect is present when the criteria for LOF failure declaration have been met (see LOF definition below). An LOS failure is cleared after 10 ± 0.5 s of no LOS defect.

##### 7.1.1.1.2 Loss of frame (LOF) failure

An LOF failure is declared after 2.5 ± 0.5 s of contiguous SEF defect, except when an LOS defect or failure is present (see LOS definition above). An LOF failure is cleared when LOS failure is declared, or after 10 ± 0.5 s of no SEF defect.

##### 7.1.1.1.3 Loss of power (LPR) failure

An LPR failure is declared after the occurrence of an LPR primitive, followed by other to be determined conditions. This definition is under study.

#### 7.1.1.2 Far-end failures

The following far-end failure detections shall be provided at the ATU-C (ATU-R is at the far-end), and are optional at the ATU-R (ATU-C is at the far-end).

##### 7.1.1.2.1 Far-end Loss of Signal (LOS-FE) failure

A far-end Loss of Signal (LOS-FE) failure is declared after 2.5 ± 0.5 s of contiguous far-end LOS defect, or, if far-end LOS defect is present when the criteria for LOF failure declaration have been met (see LOF definition below). A far-end LOS failure is cleared after 10 ± 0.5 s of no far-end LOS defect.

##### 7.1.1.2.2 Far-end Loss of frame (LOF-FE) failure

A far-end Loss of Frame (LOF-FE) failure is declared after 2.5 ± 0.5 s of contiguous RDI defect, except when a far-end LOS defect or failure is present (see LOS definition above). A far-end LOF failure is cleared when far-end LOS failure is declared, or after 10 ± 0.5 s of no RDI defect.

##### 7.1.1.2.3 Far-end Loss of Power (LPR-FE) failure

A far-end Loss of Power (LPR-FE) failure is declared after the occurrence of a far-end LPR primitive followed by 2.5 ± 0.5 s of contiguous near-end LOS defect. An LPR failure is cleared after 10 ± 0.5 s of no near-end LOS defect.

### 7.1.2 ADSL ATM Data path Failures

Any failure defined in this subclause shall be conveyed to the NMS by the ATU-C and should be conveyed to the NMS by the ATU-R after it is detected.

#### 7.1.2.1 ATM data path related near-end failures

The following near-end failures shall be provided at the ATU-C and the ATU-R:

##### 7.1.2.1.1 No Cell Delineation Interleaved (NCD-I) failure

An NCD-I failure is declared when an NCD-I anomaly persists for more than 2.5 ± 0.5 s after the start of SHOWTIME. An NCD-I failure terminates when no NCD-I anomaly is present for more than 10 ± 0.5 s.

##### 7.1.2.1.2 No Cell Delineation Fast (NCD-F) failure

An NCD-F failure is declared when an NCD-F anomaly persists for more than 2.5 ± 0.5 s after the start of SHOWTIME. An NCD-F failure terminates when no NCD-F anomaly is present for more than 10 ± 0.5 s.

##### 7.1.2.1.3 Loss of Cell Delineation Interleaved (LCD-I) failure

An LCD-I failure is declared when an LCD-I defect persists for more than 2.5 ± 0.5 s. An LCD-I failure terminates when no LCD-I defect is present for more than 10 ± 0.5 s.

##### 7.1.2.1.4 Loss of Cell Delineation Fast (LCD-F) failure

An LCD-F failure is declared when an LCD-F defect persists for more than 2.5 ± 0.5 s. An LCD-F failure terminates when no LCD-F defect is present for more than 10 ± 0.5 s.

#### 7.1.2.2 ATM data path related far-end failures

The following far-end failure indications shall be provided at the ATU-C (ATU-R is at the far-end), and are optional at the ATU-R (ATU-C is at the far-end).

#### 7.1.2.2.1 Far-end No Cell Delineation Interleaved (FNCD-I) failure

An FNCD-I failure is declared when an FNCD-I anomaly persists for more than 2.5 ± 0.5 s after the start of SHOWTIME. An FNCD-I failure terminates when no FNCD-I anomaly is present for more than 10 ± 0.5 s.

#### 7.1.2.2.2 Far-end No Cell Delineation Fast (FNCD-F) failure

An FNCD-F failure is declared when an FNCD-F anomaly persists for more than 2.5 ± 0.5 s after the start of SHOWTIME. An FNCD-F failure terminates when no FNCD-F anomaly is present for more than 10 ± 0.5 s.

#### 7.1.2.2.3 Far-end Loss of Cell Delineation Interleaved (FLCD-I) failure

An FLCD-I failure is declared when an FLCD-I defect persists for more than 2.5 ± 0.5 s. An FLCD-I failure terminates when no FLCD-I defect is present for more than 10 ± 0.5 s.

#### 7.1.2.2.4 Far-end Loss of Cell Delineation Fast (FLCD-F) failure

An FLCD-F failure is declared when an FLCD-F defect persists for more than 2.5 ± 0.5 s. An FLCD-F failure terminates when no FLCD-F defect is present for more than 10 ± 0.5 s.

## 7.2 Performance Monitoring Functions

Near-end performance monitoring (PM) functions shall be provided at the ATU-C and at the ATU-R. Far-end performance monitoring functions shall be provided at the ATU-C (ATU-R is at the far-end) and are optional at the ATU-R (ATU-C is at the far-end).

### 7.2.1 ADSL line related performance parameters

Specifications are given in this subclause and in Table 1. Support of the performance parameters in a network element is indicated in Table 1 as: required (R), application specific (A), or optional (O). Table 1 is the primary authority for requirements on ADSL line performance parameters.

#### 7.2.1.1 Near-end ADSL line performance parameters

##### 7.2.1.1.1 Code violation-line (CVI-L)

This parameter is a count of interleaved data stream CRC-8 anomalies occurring during the accumulation period. This parameter is subject to inhibiting – see 7.2.3.13.

##### 7.2.1.1.2 Code violation-line (CVF-L)

This parameter is a count of fast data stream CRC-8 anomalies occurring during the accumulation period. This parameter is subject to inhibiting – see 7.2.3.13.

##### 7.2.1.1.3 Forward Error Correction Count Line (ECI-L)

This parameter is a count of interleaved data stream FEC-I anomalies (the number of corrected code words) occurring during the accumulation period. This parameter is subject to inhibiting – see 7.2.3.13.

##### 7.2.1.1.4 Forward Error Correction Count Line (ECF-L)

This parameter is a count of fast data stream FEC-F anomalies (the number of corrected code words) occurring during the accumulation period. This parameter is subject to inhibiting – see 7.2.3.13.

##### 7.2.1.1.5 Forward Error Correction second-line (ECS-L)

This parameter is a count of 1-second intervals with one or more FEC anomalies.

#### 7.2.1.1.6 Errored second-line (ES-L)

This parameter is a count of 1-second intervals with one or more CRC-8 anomalies, or one or more LOS defects, or one or more SEF defects, or one or more LPR defects.

#### 7.2.1.1.7 Severely errored second-line (SES-L)

This parameter is a count of 1-second intervals with 18 or more CRC-8 anomalies, or one or more LOS defects, or one or more SEF defects, or one or more LPR defects.

#### 7.2.1.1.8 LOS second (LOSS-L)

This parameter is a count of 1-second intervals containing one or more LOS defects.

#### 7.2.1.1.9 Unavailable seconds (UAS-L)

This parameter is a count of 1-second intervals for which the ADSL line is unavailable. The ADSL line becomes unavailable at the onset of 10 contiguous SES-Ls. The 10 SES-Ls are included in unavailable time. Once unavailable, the ADSL line becomes available at the onset of 10 contiguous seconds with no SES-Ls. The 10 seconds with no SES-Ls are excluded from unavailable time. Some parameter counts are inhibited during unavailability – see 7.2.3.13.

### 7.2.1.2 Far-end ADSL line performance parameters

For valid far-end monitoring, far-end parameters shall be derived based on the receipt of valid far-end reporting signals.

As a minimum, an invalid data flag shall be provided for each stored interval for each direction for each monitored transmission entity.

An invalid data flag is set to indicate that the data stored is incomplete or otherwise invalid when:

– The data in the previous and recent intervals has been accumulated over a period of time that is greater or less than the nominal accumulation period duration.

– The data in the current interval is suspect because an ATU is restarted or a register is reset in the middle of an accumulation period.

– The data is incomplete in an accumulation period. For example, an incoming transmission failure or defect may prevent complete collection of far-end performance information.

The invalid data flag is not set as a result of register saturation.

#### 7.2.1.2.1 Code violation-line far-end (CVI-LFE)

This parameter is a count of interleaved data stream FEBE-I anomalies occurring during the accumulation period. This parameter is subject to inhibiting – see 7.2.3.13.

#### 7.2.1.2.2 Code violation-line far-end (CVF-LFE)

This parameter is a count of fast data stream FEBE-F anomalies occurring during the accumulation period. This parameter is subject to inhibiting – see 7.2.3.13.

#### 7.2.1.2.3 Forward Error Correction Count Line far-end (ECI-LFE)

This parameter is a count of interleaved data stream FFEC-I anomalies occurring during the accumulation period. This parameter is subject to inhibiting – see 7.2.3.13.

#### 7.2.1.2.4 Forward Error Correction Count Line far-end (ECF-LFE)

This parameter is a count of fast data stream FFEC-F anomalies occurring during the accumulation period. This parameter is subject to inhibiting – see 7.2.3.13.

#### 7.2.1.2.5 Forward Error Correction second-line far-end (ECS-LFE)

This parameter is a count of 1-second intervals with one or more FFEC anomalies.

#### 7.2.1.2.6 Errored second far-end (ES-LFE)

This parameter is a count of 1-second intervals with one or more FEBE anomalies, or one or more LOS-FE defects, or one or more RDI defects, or one or more LPR-FE defects.

#### 7.2.1.2.7 Severely Errored Second-line far-end (SES-LFE)

This parameter is a count of 1-second intervals with 18 or more FEBE, or one or more far-end LOS defects, or one or more RDI defects, or one or more LPR-FE defects.

#### 7.2.1.2.8 LOS second far-end (LOSS-LFE)

This parameter is a count of 1-second intervals containing one or more far-end LOS defects.

#### 7.2.1.2.9 Unavailable seconds far-end (UAS-LFE)

This parameter is a count of 1-second intervals for which the far-end ADSL line is unavailable.

The far-end ADSL line becomes unavailable at the onset of 10 contiguous SES-LFEs. The 10 SES-LFEs are included in unavailable time. Once unavailable, the far-end ADSL line becomes available at the onset of 10 contiguous seconds with no SES-LFEs. The 10 seconds with no SES-LFEs are excluded from unavailable time.

Some parameter counts are inhibited during unavailability – see 7.2.3.13.

### 7.2.1.3 ADSL Line Performance data collection

Parameter definitions, failure definitions, and other indications, parameters, and signals are defined above and in Table 1. Functions are indicated as required (R), application specific (A), or optional (O). Required and application specific functions are mandatory, and shall be met for ADSL performance monitoring. Optional functions should be provided according to the needs of the users.

ADSL performance monitoring applications:

- ADSL application 1 ($A_1$): Near-end and far-end monitoring applications for interleaved data stream signals at the ATU-C:
  - An NE shall process interleaved data stream primitives when the interleaved channel is utilized.
- ADSL application 2 ($A_2$): Near-end and far-end monitoring application for fast data stream signals at the ATU-C:
  - An NE shall process fast data stream primitives when the fast channel is utilized.
- ADSL application 3 ($A_3$): Near-end and far-end monitoring applications for interleaved data stream signals at the ATU-R:
  - It is optional for the NE to provide near-end and far-end monitoring. However, if the NE provides near-end and far-end monitoring, it shall process interleaved data stream primitives when the interleaved channel is utilized.
- ADSL application 4 ($A_4$): Near-end and far-end monitoring application for fast data stream signals at the ATU-R:
  - It is optional for the NE to provide near-end and far-end monitoring. However, if the NE provides near-end and far-end monitoring, it shall process fast data stream primitives when the fast channel is utilized.

- ADSL application 5 ($A_5$): Near-end and far-end forward error correction monitoring application should be provided by both the ATU-C and ATU-R when FEC is used to measure the impact of system degradation.
- ADSL application 6 ($A_6$): Far-end monitoring application shall be provided by the ATU-C and is optional at the ATU-R.

**Table 1/G.997.1 – ADSL parameter definitions**

| Name | Text Subclause | End | Use | Definition |
|---|---|---|---|---|
| CVI-L | 7.2.1.1.1 | Near | $A_{1,3}$ | Count of interleaved data stream CRC-8 anomalies |
| CVI-LFE | 7.2.1.2.1 | Far | $A_{1,3,6}$ | Count of interleaved data stream FEBE-I anomalies |
| CVF-L | 7.2.1.1.2 | Near | $A_{2,4}$ | Count of fast data stream CRC-8 anomalies |
| CVF-LFE | 7.2.1.2.2 | Far | $A_{2,4,6}$ | Count of fast data stream FEBE-F anomalies |
| ECI-L | 7.2.1.1.3 | Near | $A_{1,3,5}$ | Count of interleaved data stream FEC-I anomalies |
| ECI-LFE | 7.2.1.2.3 | Far | $A_{1,3,5,6}$ | Count of interleaved data stream FFEC-I anomalies |
| ECF-L | 7.2.1.1.4 | Near | $A_{2,4,5}$ | Count of fast data stream FEC-F anomalies |
| ECF-LFE | 7.2.1.2.4 | Far | $A_{2,4,5,6}$ | Count of fast data stream FFEC-F anomalies |
| ECS-L | 7.2.1.1.5 | Near | $A_5$ | FEC-I ≥ 1<br>**OR**<br>FEC-F ≥ 1 |
| ECS-LFE | 7.2.1.2.5 | Far | $A_{5,6}$ | FFEC-I ≥ 1<br>**OR**<br>FFEC-F ≥ 1 |
| ES-L | 7.2.1.1.6 | Near | R | interleaved CRC-8 ≥ 1<br>**OR**<br>fast CRC-8 ≥ 1<br>**OR**<br>LOS ≥ 1<br>**OR**<br>SEF ≥ 1<br>**OR**<br>LPR ≥ 1 |
| ES-LFE | 7.2.1.2.6 | Far | $A_6$ | FEBE-I ≥ 1<br>**OR**<br>FEBE-F ≥ 1<br>**OR**<br>LOS-FE ≥ 1<br>**OR**<br>RDI ≥ 1<br>**OR**<br>LPR-FE ≥ 1 |

**Table 1/G.997.1 – ADSL parameter definitions *(concluded)***

| Name | Text Subclause | End | Use | Definition |
|---|---|---|---|---|
| SES-L | 7.2.1.1.7 | Near | R | (interleaved CRC-8 + fast CRC-8 ) ≥ 18<br>**OR**<br>LOS ≥ 1<br>**OR**<br>SEF ≥ 1<br>**OR**<br>LPR ≥ 1 |
| SES-LFE | 7.2.1.2.7 | Far | $A_6$ | (FEBE-I + FEBE-F ) ≥ 18<br>**OR**<br>LOS-FE ≥ 1<br>**OR**<br>RDI ≥ 1<br>**OR**<br>LPR-FE ≥ 1 |
| LOSS-L | 7.2.1.1.8 | Near | O | LOS ≥ 1 |
| LOSS-LFE | 7.2.1.2.8 | Far | O | Far-end LOS ≥ 1 |
| UAS-L | 7.2.1.1.9 | Near | R | A second of unavailability |
| UAS-LFE | 7.2.1.2.9 | Far | $A_6$ | A second of unavailability |
| NOTE 1 – Note that **OR** represents a logical OR of two conditions, while **AND** represents a logical AND of two conditions. Note that "+" represents an arithmetic addition.<br>NOTE 2 – Unavailability begins at the onset of 10 contiguous severely errored seconds, and ends at the onset of 10 contiguous seconds with no severely errored seconds | | | | |

### 7.2.2 ATM data path related performance parameters

This subclause defines a set of ATM cell transfer performance parameters using the cell transfer outcomes. The HEC violation count parameters (near-end and far-end) shall be provided at the ATU-C and may be provided at the ATU-R. The other ATM parameters may be provided at the ATU-C and the ATU-R.

NOTE – The far-end parameters specified in 7.2.2.2.3 to 7.2.2.2.8 cannot be supported using only the indicator bits or EOC messages specified in Recommendation G.992.1 or G.992.2. They may be provided using the OAM communication channel specified in clause 6.

#### 7.2.2.1 ATM data path related near-end performance parameters

##### 7.2.2.1.1 Near-end HEC violation count Interleaved

The near-end HEC_violation_count-I performance parameter is a count of the number of occurrences of a near-end HEC-I anomaly.

##### 7.2.2.1.2 Near-end HEC violation count Fast

The near-end HEC_violation_count-F performance parameter is a count of the number of occurrences of a near-end HEC-F anomaly.

#### 7.2.2.1.3 Near-end HEC total cell count Interleaved

The near-end HEC_total_cell_count-I performance parameter is a count of the total number of cells passed through the cell delineation process operating on the interleaved data while in the SYNC state.

#### 7.2.2.1.4 Near-end HEC total cell count Fast

The near-end HEC_total_cell_count-F performance parameter is a count of the total number of cells passed through the cell delineation process operating on the fast data while in the SYNC state.

#### 7.2.2.1.5 Near-end User total cell count Interleaved

The near-end User_total_cell_count-I performance parameter is a count of the total number of cells in the interleaved data path delivered at the V-C (for ATU-C) or T-R (for ATU-R) interface.

#### 7.2.2.1.6 Near-end User total cell count Fast

The near-end User_total_cell_count-F performance parameter is a count of the total number of cells in the fast data path delivered at the V-C (for ATU-C) or T-R (for ATU-R) interface.

#### 7.2.2.1.7 Near-end Idle Cell Bit Error Count Interleaved

The near-end Idle_bit_error_count-I performance parameter in a count of the number of bit errors in the idle cell payload received in the Interleaved data path at the near-end.

NOTE – The idle cell payload is defined in Recommendations I.361 and I.432.

#### 7.2.2.1.8 Near-end Idle Cell Bit Error Count Fast

The near-end Idle_bit_error_count-F performance parameter is a count of the number of bit errors in the idle cell payload received in the Fast data path at the near-end.

### 7.2.2.2 ATM data path related far-end performance parameters

#### 7.2.2.2.1 Far-end HEC violation count Interleaved

The far-end HEC_violation_count-I performance parameter is a count of the number of occurrences of a far-end HEC-I anomaly.

#### 7.2.2.2.2 Far-end HEC violation count Fast

The far-end HEC_violation_count-F performance parameter is a count of the number of occurrences of a far-end HEC-F anomaly.

#### 7.2.2.2.3 Far-end HEC total cell count Interleaved

The far-end HEC_total_cell_count-I performance parameter is a count of the total number of cells passed through the cell delineation process operating on the interleaved data while in the SYNC state.

#### 7.2.2.2.4 Far-end HEC total cell count Fast

The far-end HEC_total_cell_count-F performance parameter is a count of the total number of cells passed through the cell delineation process operating on the fast data while in the SYNC state.

#### 7.2.2.2.5 Far-end User total cell count Interleaved

The far-end User_total_cell_count-I performance parameter is a count of the total number of cells in the interleaved data path delivered at the V-C (for ATU-C) or T-R (for ATU-R) interface.

#### 7.2.2.2.6 Far-end User total cell count Fast

The far-end User_total_cell_count-F performance parameter is a count of the total number of cells in the fast data path delivered at the V-C (for ATU-C) or T-R (for ATU-R) interface.

#### 7.2.2.2.7 Far-end Idle Cell Bit Error Count Interleaved

The far-end Idle_bit_error_count-I performance parameter is a count of the number of bit errors in the idle cell payload received in the Interleaved data path at the far-end.

#### 7.2.2.2.8 Far-end Idle Cell Bit Error Count Fast

The far-end Idle_bit_error_count-F performance parameter is a count of the number of bit errors in the idle cell payload received in the Fast data path at the far-end.

### 7.2.3 Procedures for Performance Monitoring Functions

The functions described in this subclause can be performed inside or outside the network element.

#### 7.2.3.1 Transmission states

A path can be in one of two transmission states:

- unavailable state;
- available state.

The transmission state is determined from filtered SES/non-SES data. The definition of unavailable state is defined in 7.2.1.1.9 and 7.2.1.2.9. An ADSL LINE is available when it is not unavailable.

#### 7.2.3.2 Threshold reports

A TR is an unsolicited error performance report from a ME (Management Entity) over the Q-interface and from the ATU-R over the U-interface with respect to either a 15-minute or 24-hour evaluation period.

TRs can only occur when the concerned direction is in the available state.

TRs for ES, SES and UAS parameters at the Q-interface are mandatory. TRs for the other defined parameters are optional.

TR1s shall occur within 10 s after the 15-minute threshold is reached or exceeded.

TR2s shall occur within 10 s after the 24-hour threshold is reached or exceeded.

#### 7.2.3.3 Unavailable and available state filters

The unavailable state filter is a 10-second rectangular sliding window with 1-second granularity of slide.

The available state filter is also a 10-second rectangular sliding window with 1-second granularity of slide.

#### 7.2.3.4 TR1 filter

The TR1 filters are 15-minute rectangular fixed windows. The start and end times for the 15-minute rectangular fixed windows shall fall on the hour and at 15, 30, and 45 minutes after the hour.

#### 7.2.3.5 TR2 filter

The TR2 filter is a 24-hour rectangular fixed window. The start and end times for the 24-hour rectangular fixed windows shall fall on a 15-minute window boundary.

#### 7.2.3.6 Evaluation of TR1

The parameters are counted separately, second by second, over each 15-minute rectangular fixed window period. The threshold values should be programmable over the range 0 to 900 with default values. The default values are given in Recommendations M.2100 and M.2101.1.

A threshold can be crossed at any second within the 15-minute rectangular fixed window. As soon as a threshold is crossed, a TR1 as appropriate should be sent to the performance management centre together with a date/time-stamp. Moreover, performance events should continue to be counted to the end of the current 15-minute period, at which time the current parameter counts are stored in the history registers and the current parameter registers are reset to zero.

#### 7.2.3.7 Evaluation of TR2

The parameters are counted separately over each 24-hour period. The threshold values should be programmable with default values.

The network element shall recognize a 24-hour threshold crossing within 15 minutes of its occurrence. The threshold crossing shall be given the date/time-stamp of the moment of recognition. A TR2 as appropriate should be sent to the performance management centre with the date/time-stamp. Moreover, performance events should continue to be counted to the end of the current 24-hour period, at which time the parameter counts are stored in the history registers and the current parameter registers are reset to zero.

#### 7.2.3.8 Threshold report evaluation during transmission state changes

Care should be taken to ensure that threshold reports are correctly generated and parameter counters are correctly processed during changes in the transmission state. This implies that all threshold reports should be delayed by 10 s (see Recommendations M.2120).

#### 7.2.3.9 Performance history storage in network elements

The parameters for ME performance history storage at the Q-interface that shall be supported are ES, SES and UAS. Performance history storage for the other defined parameters is optional.

There should be a current 15-minute (which can also facilitate the TR1 filter) register plus a further *N* 15-minute history registers for each parameter in each ME. The *N* 15-minute history registers are used as a stack, i.e. the value held in each register is pushed down the stack one place at the end of each 15-minute period, and the oldest register value at the bottom of the stack is discarded.

The *N* for the parameters ES, SES and UAS shall be at least 16. For the other parameters, *N* shall be at least 1 (i.e. only current and previous value is required).

There should be a current 24-hour register (which can also facilitate the TR2 filter) plus one previous 24-hour register for each parameter.

As a minimum, an invalid data flag shall be provided for each stored interval for each direction for each monitored transmission entity. For example:

An invalid data flag is set to indicate that the data stored is incomplete or otherwise invalid when:

– The data in the previous and recent intervals has been accumulated over a period of time that is greater or less than the nominal accumulation period duration.

– The data in the current interval is suspect because a terminal is restarted or a register is reset in the middle of an accumulation period.

– The data is incomplete in an accumulation period. For example, an incoming transmission failure or defect may prevent complete collection of far-end performance reports.

The invalid data flag is not set as a result of register saturation.

#### 7.2.3.10 Register size

Every performance parameter register shall be large enough to accumulate all integer numbers from zero to a particular maximum value, which determines the minimum register size for that parameter. When the maximum value of a register is reached, the register shall remain at that maximum value until it is reset, or the value is transferred or discarded, as described in this subclause. Minimum register sizes are 16 bits.

#### 7.2.3.11 Parameter counts

All parameter counts should be actual counts for the 15-minute filtering period.

Although all parameter counts should (ideally) also be actual for the 24-hour filtering periods, it is recognized that it might be desirable to limit register sizes. In such cases register overflow could occur. Should register overflow occur, the registers should hold their maximum value for the parameter considered until the registers are read and reset at the end of the 24-hour period. An implementation involving setting and resetting an overflow bit may be used.

#### 7.2.3.12 Date/time-stamping of reports

The date/time-stamping accuracy of reports, together with the method of maintaining the accuracy, is under study.

The format for date/time-stamps is as follows:

- 15-minute window will be stamped Year, Month, Day, Hour, Minute.
- 24-hour window will be stamped Year, Month, Day, Hour.
- Unavailable Time events will be stamped Year, Month, Day , Hour, Minute, Second.
- Alarms will be stamped either at the declaration of the alarm by the equipment or at the exact time of the event (to be decided) with Year, Month, Day, Hour, Minute, Second.

Equipment clock accuracy requirements are for further study.

#### 7.2.3.13 Inhibiting performance monitoring parameters

For a given monitored entity, the accumulation of certain performance parameters is inhibited during periods of unavailability, during SESs, or during seconds containing defects on that monitored entity. Inhibiting on a given monitored entity (e.g. ADSL ATM path) is not explicitly effected by conditions on any other monitored entity (ADSL line). The inhibiting rules are as follows:

– UAS and FC: Failure Count parameter counts shall not be inhibited.

– All other performance parameter counts shall be inhibited during UAS and SES, Inhibiting shall be retroactive to the onset of unavailable time and shall end retroactively to the end of unavailable time.

## 7.3 Network Element for Configuration

### 7.3.1 ADSL Line Type

This parameter defines the type of ADSL physical line. Five (5) ADSL line types are defined as follows:

- No channels exist.
- Fast channel exists only.
- Interleaved channel exists only.
- Either fast or interleaved channels can exist, but only one at any time.
- Both fast and interleaved channels exist.

Recommendation G.992.2 operates in Interleaved mode only.

### 7.3.2 ATU-C ADSL Transmission System Enabling

This parameter defines the ATU-C ADSL transmission system coding types allowed on this line. It applies only to the Q-interface.

It is coded in a bitmap representation with following definition:

| Bit # | Representation |
|---|---|
| 1 | Regional standards (Note) |
| 2 | Regional standards (Note) |
| 3 | G.992.1 operation over POTS non-overlapped spectrum (Annex A/G.992.1) |
| 4 | G.992.1 operation over POTS overlapped spectrum (Annex A/G.992.1) |
| 5 | G.992.1 operation over ISDN non-overlapped spectrum (Annex B/G.992.1) |
| 6 | G.992.1 operation over ISDN overlapped spectrum (Annex B/G.992.1) |
| 7 | G.992.1 operation in conjunction with TCM-ISDN non-overlapped spectrum (Annex C/G.992.1) |
| 8 | G.992.1 operation in conjunction with TCM-ISDN overlapped spectrum (Annex C/G.992.1) |
| 9 | G.992.2 operation over POTS non-overlapped spectrum (Annex A/G.992.2) |
| 10 | G.992.2 operation over POTS overlapped spectrum (Annex B/G.992.2) |
| 11 | G.992.2 operation in conjunction with TCM-ISDN non-overlapped spectrum (Annex C/G.992.2) |
| 12 | G.992.2 operation in conjunction with TCM-ISDN overlapped spectrum (Annex C/G.992.2) |
| NOTE – It is recommended that the bit 2 be used for ETSI DTS/TM-06006 and the bit 1 for other than G.992.x compliant devices. | |

### 7.3.3 Noise Margin parameters

The following parameters are defined to control the Noise Margin in the transmit direction in the ATU-C & ATU-R.

NOTE – The Noise Margin should be controlled to ensure a BER (Bit Error Rate) of $10^{-7}$ or better. Figure 11 shows the relationship between these parameters. They will be described in detail in the following subclauses.

| | |
|---|---|
| | Reduce Power |
| Maximum Noise Margin | ---------------------------------------------------------------- |
| | Increase Rate if Noise Margin > Up-shift Noise Margin for Upshift Interval |
| Up-shift Noise Margin | ---------------------------------------------------------------- |
| | Steady State Operation |
| Target Noise Margin | ---------------------------------------------------------------- |
| | Steady State Operation |
| Down-shift Noise Margin | ---------------------------------------------------------------- |
| | Decrease Rate if Noise Margin < Down-shift Noise Margin for Downshift Interval |
| Minimum Noise Margin | ---------------------------------------------------------------- |
| | Increase Power. If not possible – re-initialize |

NOTE 1 – Up-shift Noise Margin, and Down-shift Noise Margin are only supported for Rate Adaptive Mode.

NOTE 2 – Minimum Noise Margin ≤ Down-shift Noise Margin ≤ Target Noise Margin ≤ Up-shift Noise Margin ≤ Maximum Noise Margin.

**Figure 11/G.997.1 – Noise Margins**

#### 7.3.3.1 ATU-C Target Noise Margin

This is the Noise Margin the ATU-C shall achieve with a BER of $10^{-7}$ or better to successfully complete initialization. The target noise margin ranges from 0 to 31 dB with 0.1 dB steps.

#### 7.3.3.2 ATU-R Target Noise Margin

This is the Noise Margin the ATU-R shall achieve with a BER of $10^{-7}$ or better to successfully complete initialization. The target noise margin ranges from 0 to 31 dB with 0.1 dB steps.

#### 7.3.3.3 ATU-C Maximum Noise Margin

This is the maximum noise margin the ATU-C should try to sustain. If the Noise Margin is above this level, the ATU-C should attempt to reduce its power output to optimize its operation. The maximum noise margin ranges from 0 to 31 dB with 0.1 dB steps.

#### 7.3.3.4 ATU-R Maximum Noise Margin

This is the maximum noise margin an ATU-R should try to sustain. If the Noise Margin is above this level, the ATU-R should attempt to reduce its power output to optimize its operation. The maximum noise margin ranges from 0 to 31 dB with 0.1 dB steps.

#### 7.3.3.5 ATU-C Minimum Noise Margin

This is the minimum Noise Margin the ATU-C should tolerate. If the noise margin falls below this level, the ATU-C should attempt to increase its power output. If that is not possible, the modem will attempt to re-initialize. The minimum noise margin ranges from 0 to 31 dB with 0.1 dB steps.

#### 7.3.3.6 ATU-R Minimum Noise Margin

This is the minimum Noise Margin the ATU-R should tolerate. If the noise margin falls below this level, the ATU-R should attempt to increase its power output. If that is not possible, the modem will attempt to re-initialize. The minimum noise margin ranges from 0 to 31 dB with 0.1 dB steps.

### 7.3.4 Dynamic Rate Adaptation parameters

The following parameters are defined to manage the Rate-Adaptive behaviour in the transmit direction for both the ATU-C and the ATU-R.

#### 7.3.4.1 ATU-C Rate Adaptation Mode

This parameter specifies the mode of operation of a rate-adaptive ATU-C in the transmit direction. (If this functionality is supported.)

**Mode 1**: MANUAL – Rate changed manually.

*At startup*:

The Desired Minimum Rate parameter specifies the bit rate the modem shall support, with a noise margin which is at least as large as the specified Target Noise Margin, and a BER of better than $10^{-7}$.

If it fails to achieve the bit rate, the modem will fail, and the NMS will be notified. Although the modem might be able to support a higher bit rate, it will not provide more than what is requested. When the noise margin for the selected transport configuration is higher than the Maximum Noise Margin, then the modem shall reduce its power to get a noise margin below this limit. (If this functionality is supported.)

*At showtime:*

The modem shall maintain the specified Desired Minimum Rate. When the current noise margin falls below the Minimum Noise Margin, then the modem will fail, and the NMS will be notified. When the current noise margin rises above Maximum Noise Margin, then the power shall be reduced to get the noise margin below this limit. (If this functionality is supported.)

**Mode 2**: AT_INIT – Rate automatically selected at startup only and does not change after that.

*At startup*:

The Desired Minimum Rate parameter specifies the minimum bit rate the modem shall support, with a noise margin which is at least as large as the specified Target Noise Margin, and a BER of better than $10^{-7}$. If it fails to achieve the bit rate, the modem will fail, and the NMS will be notified. If the modem is able to support a higher bit rate for that direction at initialization, the excess bit rate will be distributed amongst the fast and interleaved latency path according to the ratio (0 to 100%) specified by the Rate Adaptation Ratio parameter. The ratio, in percent is defined as Fast/(Fast + Interleave) bit rate. A ratio of 30% means that 30% of the excess bit rate should be assigned to the fast latency path, and 70% to the interleaved latency path. When the Desired Maximum Rate is achieved in one of the latency paths, then the remaining excess bit rate is assigned to the other latency path, until it also reaches its Desired Maximum Rate. A ratio of 100% will assign all excess bit rates first to the fast latency path, and only when the Desired Maximum Rate of Fast channel is obtained, the remaining excess bit rate will be assigned to the interleaved latency path, a ratio of 0% will give priority to the interleaved latency path. When the noise margin for the selected transport configuration is higher than the Maximum Noise Margin, then the modem shall reduce its power to get a noise margin below this limit.

NOTE – This can happen only when Desired Maximum Rates are reached for both latencies, since bit rate increase has priority over power reduction. (If this functionality is supported.)

*At showtime*:

During showtime, no rate adaptation is allowed. The bit rate, which has been settled during initialization, shall be maintained. When the current noise margin falls below the Minimum Noise Margin, then the modem will fail, and the NMS will be notified. When the current noise margin rises above the Maximum Noise Margin, then the power shall be reduced to get the noise margin below this limit. (If this functionality is supported.)

**Mode 3**: DYNAMIC (optional) – Rate is automatically selected at startup and is continuously adapted during operation (showtime).

*At startup*:

In Mode 3, the modem shall start up as in Mode 2.

*At showtime*:

During showtime, rate adaptation is allowed with respect to the Ratio Adaptation Ratio for distributing the excess bit rate amongst the interleaved and fast latency path (see Mode 2), and assuring that the Desired Minimum Rate remains available at a BER of $10^{-7}$. or better. The bit rate can vary between the Desired Minimum Rate, and the Desired Maximum Rate. Rate Adaptation is performed when the conditions specified for Up-shift Noise Margin and Upshift Interval – or for Down-shift Noise Margin and Downshift Interval – are satisfied. This means:

– For an Upshift action: Allowed when the current noise margin is above Up-shift Noise Margin during Minimum Time Interval for Upshift Rate Adaptation.

– For a Downshift action: Allowed when the current noise margin is below Down-shift Noise Margin during Minimum Time Interval for Downshift Rate Adaptation.

When the current noise margin falls below the Minimum Noise Margin, then the modem will fail, and the NMS will be notified. When Desired Maximum Rates have been reached in both latency paths, and when the current noise margin rises above Maximum Noise Margin, then the power shall be reduced to get the noise margin below this limit.

#### 7.3.4.2 ATU-R Rate Adaptation Mode

This parameter specifies the mode of operation of a rate-adaptive ATU-R in the transmit direction (if this functionality is supported). The definition of the modes is defined in 7.3.4.1.

#### 7.3.4.3 ATU-C Up-shift Noise Margin (optional)

If the ATU-C Noise Margin is above the ATU-C Up-shift Noise Margin and stays above that for more than the time specified by the ATU-C Minimum Upshift Rate Adaptation Interval, the modem should increase its ATU-C transmit net data rate. The ATU-C up-shift noise margin ranges from 0 to 31 dB with 0.1 dB steps.

#### 7.3.4.4 ATU-R Up-shift Noise Margin (optional)

If the ATU-R Noise Margin is above the ATU-R Up-shift Noise Margin and stays above that for more than the time specified by the ATU-R Minimum Upshift Rate Adaptation Interval, the modem should increase its ATU-R transmit net data rate. The ATU-R up-shift noise margin ranges from 0 to 31 dB with 0.1 dB steps.

#### 7.3.4.5 ATU-C Minimum Time Interval for Upshift Rate Adaptation (optional)

This parameter defines the interval of time the ATU-C Noise Margin should stay above the ATU-C Up-shift Noise Margin before the ATU-C will attempt to increase the transmit net data rate. The time ranges from 0 to 16 383 s.

#### 7.3.4.6 ATU-R Minimum Time Interval for Upshift Rate Adaptation (optional)

This parameter defines the interval of time the ATU-R Noise Margin should stay above the ATU-R Up-shift Noise Margin before the ATU-R will attempt to increase the transmit net data rate. The time ranges from 0 to 16 383 s.

#### 7.3.4.7 ATU-C Down-shift Noise Margin (optional)

If the ATU-C Noise Margin is below the ATU-C Down-shift Noise Margin and stays below that for more than the time specified by the ATU-C Minimum Downshift Rate Adaptation Interval, the ATU-C should decrease its transmit net data rate. The ATU-C down-shift noise margin ranges from 0 to 31 dB with 0.1 dB steps.

#### 7.3.4.8 ATU-R Down-shift Noise Margin (optional)

If the ATU-R Noise Margin is below the ATU-R Down-shift Noise Margin and stays below that for more than the time specified by the ATU-R Minimum Downshift Rate Adaptation Interval, the ATU-R should decrease its transmit net data rate. The ATU-R down-shift noise margin ranges from 0 to 31 dB with 0.1 dB steps.

#### 7.3.4.9 ATU-C Minimum Time Interval for Downshift Rate Adaptation (optional)

This parameter defines the interval of time the ATU-C Noise Margin should stay below the ATU-C Down-shift Noise Margin before the ATU-C will attempt to decrease the transmit net data rate. The time ranges from 0 to 16 383 s.

#### 7.3.4.10 ATU-R Minimum Time Interval for Downshift Rate Adaptation (optional)

This parameter defines the interval of time the ATU-R Noise Margin should stay below the ATU-R Down-shift Noise Margin before the ATU-R will attempt to decrease the transmit net data rate. The time ranges from 0 to 16 383 s.

### 7.3.5 Bit rate parameters

These bit rate parameters refer to the transmit direction for both the ATU-C and the ATU-R. The two desired bit rate parameters define the desired bit rate as specified by the operator of the system (the operator of the ATU-C). It is assumed that the ATU-C and the ATU-R will interpret the value set by the operator as appropriate for the specific implementation of ADSL between the ATU-C and the ATU-R in setting the line rates. This model defined in this interface makes no assumptions about the possible range of these attributes. The Network Management System used by the operator to manage the ATU-R and the ATU-C may implement its own limits on the allowed values for the desired bit rate parameters based on the particulars of the system managed. The definition of such a system is outside the scope of this model.

NOTE – G.992.2 operating mode uses the interleaved path only. As a consequence, G.992.2 operating mode will use the bit rate parameters for the interleaved path. If the interleaved path bit rate parameters are not provided in the Line Configuration Profile, an initialization failure will occur if a single Line Configuration Profile is used.

#### 7.3.5.1 ATU-C Desired Maximum Rate Fast

This parameter specifies the desired maximum ATU-C transmit net data rate for the fast data stream as desired by the operator of the system. The rate is coded in bit/s.

#### 7.3.5.2 ATU-C Desired Maximum Rate Interleaved

This parameter specifies the desired maximum ATU-C transmit net data rate for the interleaved data stream as desired by the operator of the system. The rate is coded in bit/s.

#### 7.3.5.3 ATU-R Desired Maximum Rate Fast

This parameter specifies the desired maximum ATU-R transmit net data rate for the fast data stream as desired by the operator of the system. The rate is coded in bit/s.

#### 7.3.5.4 ATU-R Desired Maximum Rate Interleaved

This parameter specifies the desired maximum ATU-R transmit net data rate for the interleaved data stream as desired by the operator of the system. The rate is coded in bit/s.

#### 7.3.5.5 ATU-C Desired Minimum Rate Fast

This parameter specifies the desired minimum ATU-C transmit rate for the fast data stream as desired by the operator of the system. The rate is coded in bit/s.

#### 7.3.5.6 ATU-C Desired Minimum Rate Interleaved

This parameter specifies the desired minimum ATU-C transmit rate for the interleaved data stream as desired by the operator of the system. The rate is coded in bit/s.

#### 7.3.5.7 ATU-R Desired Minimum Rate Fast

This parameter specifies the desired minimum ATU-R transmit rate for the fast data stream as desired by the operator of the system. The rate is coded in bit/s.

#### 7.3.5.8 ATU-R Desired Minimum Rate Interleaved

This parameter specifies the desired minimum ATU-R transmit rate for the interleaved data stream as desired by the operator of the system. The rate is coded in bit/s.

#### 7.3.5.9 ATU-C Rate Adaptation Ratio

This parameter (expressed in %) specifies the ratio that should be taken into account for distributing the ATU-C transmit bit rate considered for rate adaptation amongst the fast and interleaved data streams in case of excess bit rate. The ratio is defined as: [Fast/(Fast + Interleaved)] × 100.

Following this rule, a ratio of 20% means that 20% of the additional bit rate (in excess of the fast minimum plus the interleaved minimum bit rate) will be assigned to the fast channel, and 80% to the interleaved channel.

#### 7.3.5.10 ATU-R Rate Adaptation Ratio

This parameter (expressed in %) specifies the ratio that should be taken into account for distributing the ATU-R transmit bit rate considered for rate adaptation amongst the fast and interleaved data streams in case of excess bit rate. The ratio is defined as: [Fast/(Fast + Interleaved)] × 100.

### 7.3.6 Power down state L1 ATU-C net data rate

This parameter specifies the L1 state ATU-C transmit bit rate.

### 7.3.7 Power down state L1 ATU-R net data rate

This parameter specifies the L1 state ATU-R transmit bit rate.

### 7.3.8 Maximum ATU-C ADSL Line Delay (Interleaved)

This ATU-C ADSL line delay parameter is the requested ATU-C transmission delay between the V-D and the T-D reference points. The interleaving and the FEC process introduce the delay. For example, in Recommendation G.992.1, the delay is defined as $(4 + (S - 1)/4 + S \times D/4)$ ms, where "S" is the S-factor (symbols per codeword), and "D" is the "Interleaving Depth". The ATU-C and the ATU-R shall choose their S and D parameters so they are equal or as close as possible (but below) to the requested delay. The delay is coded in ms.

NOTE – A Line Configuration Profile contains a single Maximum Interleaved Line Delay value. As a consequence, ATU-C's supporting both Recommendations G.992.1 and G.992.2 operating mode will use the configured value regardless of the operating mode actually being selected at line initialization.

### 7.3.9 Maximum ATU-R ADSL Line Delay (Interleaved)

This ATU-R ADSL line delay parameter is the requested ATU-R transmission delay between the T-D and the V-D reference points. The interleaving and the FEC process introduce the delay. For example, in Recommendation G.992.1, the delay is defined as $(4 + (S - 1)/4 + S \times D/4)$ ms, where "S" is the S-factor (symbols per codeword), and "D" is the "Interleaving Depth". The ATU-C and the ATU-R shall choose their S and D parameters so they are equal or as close as possible (but below) to the requested delay. The delay is coded in ms.

### 7.3.10 Parameter thresholds

All performance parameters shall have an individual 15-minute and 24-hour threshold parameter if supported.

### 7.3.11 ATU-C ADSL Line state change L0 to L3

This parameter requests the ATU-C to go from the synchronized state (L0) to the no-power state (L3). This parameter only applies to the Q-interface.

The definition of the power management states (L0, L1 and L3) are defined in Recommendation G.992.2.

### 7.3.12 ATU-C ADSL Line state change L3 to L0

This parameter requests the ATU-C to go from the no-power state (L3) to the synchronized state (L0). This parameter only applies to the Q-interface.

### 7.3.13 ATU-R ADSL Line state change L0 to L3

This parameter requests the ATU-R to go from the synchronized state (L0) to the no-power state (L3). This parameter only applies to the T-/S-interface.

### 7.3.14 ATU-R ADSL Line state change L3 to L0

This parameter requests the ATU-R to go from the no-power state (L3) to the synchronized state (L0). This parameter only applies to the T-/S-interface.

### 7.3.15 Inventory information

#### 7.3.15.1 ATU-C Vendor ID

The ATU-C Vendor ID consists of a country code followed by a (regionally allocated) provider code, defined in Recommendation T.35 (see Table 2).

**Table 2/G.997.1 – Vendor ID information block**

| |
|---|
| T.35 country code (K = 1 octets) |
| One octet reserved by ITU-T |
| T.35 provider code (Vendor Identification) (L octets) |
| T.35 provider oriented code (Vendor revision number) (M octets) |

Further details are defined in Recommendation G.994.1.

#### 7.3.15.2 ATU-R Vendor ID

The ATU-R Vendor ID consists of a country code followed by a (regionally allocated) provider code as defined in 7.3.15.1.

#### 7.3.15.3 ATU-C Version Number

The ATU-C version number is for version control and is vendor specific information.

#### 7.3.15.4 ATU-R Version Number

The ATU-R version number is for version control and is vendor specific information.

#### 7.3.15.5 ATU-C Serial Number

The ATU-C serial number is vendor specific and should be no longer than 32 bytes.

Note that the combination of vendor ID and serial number creates a unique number for each ATU unit.

#### 7.3.15.6 ATU-R Serial Number

The ATU-R serial number is vendor specific and should be no longer than 32 bytes.

## 7.4 Network Element test, diagnostic and status parameters

The provision of the registers (current and previous) is under study.

### 7.4.1 ATU-C ADSL Transmission System Capabilities

This parameter defines the ATU-C transmission system capability list of the different coding types.

It is coded in a bitmap representation with the bits defined in 7.3.2.

### 7.4.2 ATU-R ADSL Transmission System Capabilities

This parameter defines the ATU-R transmission system capability list of the different coding types.

It is coded in a bitmap representation with the bits defined in 7.3.2.

This parameter may be derived from the handshaking procedures defined in Recommendation G.994.1.

### 7.4.3 ADSL Transmission System

The actual ADSL transmission system in use.

It is coded as an integer with the value correlated to the bitmap representation with the bits defined in 7.3.2.

### 7.4.4 ATU-C Line attenuation (ATN)

This parameter is the measured difference in the total power transmitted by the ATU-R and the total power received by the ATU-C in dB. The attenuation ranges from 0 to 63 dB with 0.1 dB steps.

### 7.4.5 ATU-R Line attenuation (ATN)

This parameter is the measured difference in the total power transmitted by the ATU-C and the total power received by the ATU-R in dB. The attenuation ranges from 0 to 63 dB with 0.1 dB steps.

### 7.4.6 Actual ATU-C Signal-to-Noise Ratio (SNR) margin

The ATU-C signal-to-noise ratio margin represents the amount of increased received noise (in dB) relative to the noise power that the system is designed to tolerate and still meet the target BER of $10^{-7}$, accounting for all coding gains included in the design. The SNR margin ranges from –64 dB to +63 dB with 0.1 dB steps.

NOTE – The SNR measurement may take up to 10 s.

### 7.4.7 Actual ATU-R Signal-to-Noise Ratio (SNR) margin

The ATU-R signal-to-noise ratio margin represents the amount of increased received noise (in dB) relative to the noise power that the system is designed to tolerate and still meet the target BER of $10^{-7}$, accounting for all coding gains included in the design. The SNR margin ranges from –64 dB to +63 dB with 0.1 dB steps.

NOTE – The SNR measurement may take up to 10 s.

### 7.4.8 ATU-C Total Output Power

This parameter is to show total output transmit power from the ATU-C. The total output power level ranges from –31 dBm to +31 dBm with 0.1 dB steps.

### 7.4.9 ATU-R Total Output Power

This parameter is to show total output transmit power from the ATU-R. The total output power level ranges from –31 dBm to +31 dBm with 0.1 dB steps.

#### 7.4.10 Bit Rate Parameters

##### 7.4.10.1 ATU-C Maximum Attainable Rate

This parameter indicates the maximum ATU-C transmit net data rate currently attainable by the ATU-C. The rate is coded in bit/s.

##### 7.4.10.2 ATU-R Maximum Attainable Rate

This parameter indicates the maximum ATU-R transmit net data rate currently attainable by the ATU-R. The rate is coded in bit/s.

##### 7.4.10.3 ATU-C Current Rate Fast

This parameter reports the current ATU-C transmit net data rate in the fast data stream to which the ATU-C is adapted. The rate is coded in bit/s.

##### 7.4.10.4 ATU-C Current Rate Interleaved

This parameter reports the current ATU-C transmit net data rate in the interleaved data stream to which the ATU-C is adapted. The rate is coded in bit/s.

##### 7.4.10.5 ATU-R Current Rate Fast

This parameter reports the current ATU-R transmit net data rate in the fast data stream to which the ATU-R is adapted. The rate is coded in bit/s.

##### 7.4.10.6 ATU-R Current Rate Interleaved

This parameter reports the current ATU-R transmit net data rate in the interleaved data stream to which the ATU-R is adapted. The rate is coded in bit/s.

##### 7.4.10.7 ATU-C Previous Rate Fast

This parameter reports the ATU-C net data rate in the fast data stream to which the previous "rate change" event occurred. A rate change can occur after a full initialization, fast retrain, power down or dynamic rate adaptation. The rate is coded in bit/s.

##### 7.4.10.8 ATU-C Previous Rate Interleaved

This parameter reports the ATU-C net data rate in the interleaved data stream to which the previous "rate change" event occurred. A rate change can occur after a full initialization, fast retrain, power down or dynamic rate adaptation. The rate is coded in bit/s.

##### 7.4.10.9 ATU-R Previous Rate Fast

This parameter reports the ATU-R net data rate in the fast data stream to which the previous "rate change" event occurred. A rate change can occur after a full initialization, fast retrain, power down or dynamic rate adaptation. The rate is coded in bit/s.

##### 7.4.10.10 ATU-R Previous Rate Interleaved

This parameter reports the ATU-R net data rate in the interleaved data stream to which the previous "rate change" event occurred. A rate change can occur after a full initialization, fast retrain, power down or dynamic rate adaptation. The rate is coded in bit/s.

#### 7.4.11 Rate Threshold

The rate threshold parameter procedures shall be as defined in 7.2.3.

#### 7.4.11.1 ATU-C Rate Threshold Up Fast

This parameter provides ATU-C transmit net data rate in the fast data stream up thresholds which trigger a rate change alarm (event) when the ATU-C Current Rate Fast > ATU-C Previous Rate Fast.

The rate is coded in bit/s.

#### 7.4.11.2 ATU-C Rate Threshold Up Interleaved

This parameter provides ATU-C transmit net data rate in the interleaved data stream up thresholds which trigger a rate change alarm (event) when the ATU-C Current Rate Interleaved > ATU-C Previous Rate Interleaved.

The rate is coded in bit/s.

#### 7.4.11.3 ATU-C Rate Threshold Down Fast

This parameter provides ATU-C transmit net data rate in the fast data stream down thresholds which trigger a rate change alarm (event) when the ATU-C Current Rate Fast < ATU-C Previous Rate Fast.

The rate is coded in bit/s.

#### 7.4.11.4 ATU-C Rate Threshold Down Interleaved

This parameter provides ATU-C transmit net data rate in the interleaved data stream down thresholds which trigger a rate change alarm (event) when the ATU-C Current Rate Interleaved < ATU-C Previous Rate Interleaved.

The rate is coded in bit/s.

#### 7.4.11.5 ATU-R Rate Threshold Up Fast

This parameter provides ATU-R transmit net data rate in the fast data stream up thresholds which trigger a rate change alarm (event) when the ATU-R Current Rate Fast > ATU-R Previous Rate Fast.

The rate is coded in bit/s.

#### 7.4.11.6 ATU-R Rate Threshold Up Interleaved

This parameter provides ATU-R transmit net data rate in the interleaved data stream up thresholds which trigger a rate change alarm (event) when the ATU-R Current Rate Interleaved > ATU-R Previous Rate Interleaved.

The rate is coded in bit/s.

#### 7.4.11.7 ATU-R Rate Threshold Down Fast

This parameter provides ATU-R transmit net data rate in the fast data stream down thresholds which trigger a rate change alarm (event) when the ATU-R Current Rate Fast < ATU-R Previous Rate Fast.

The rate is coded in bit/s.

#### 7.4.11.8 ATU-R Rate Threshold Down Interleaved

This parameter provides ATU-R transmit net data rate in the interleaved data stream down thresholds which trigger a rate change alarm (event) when the ATU-R Current Rate Interleaved < ATU-R Previous Rate Interleaved.

The rate is coded in bit/s.

### 7.4.12 ATU-C ADSL Line Delay (Interleaved)

This ATU-C ADSL line delay parameter is the actual ATU-C transmission delay between the V-D and the T-D reference points. In Recommendation G.992.1, the delay is defined as $(4 + (S – 1)/4 + S \times D/4)$ ms, where "S" is the Symbols per codeword, and "D" is the "Interleaving Depth". This parameter is derived from the S and D parameters. The delay is coded in ms (rounded to the nearest ms).

### 7.4.13 ATU-R ADSL Line Delay (Interleaved)

This ATU-R ADSL line delay parameter is the actual ATU-R transmission delay between the T-D and the V-D reference points. The delay is coded in ms (rounded to the nearest ms).

### 7.4.14 ADSL Line states

The ADSL line has three line states:

- L0 – Synchronized: This Line state (L0) is when the ADSL Line has full transmission (i.e. showtime). The on/off hook conditions in Recommendation G.992.2 are regarded as the L0 state.
- L3 – No-power: This Line state (L3) is when there is No Power transmitted on the line at all.
- L1 – Power Down Data transmission: This Line state (L1) is when there is transmission on the line but the net data rate is reduced (e.g. only for OAM and higher layer connection and session control).

### 7.4.15 Fast Retrain parameters

Fast Retrain is defined in Recommendation G.992.2.

#### 7.4.15.1 Fast-Retrain-Count

The Fast-Retrain-Count performance parameter is a count of the total number of fast retrains.

Parameter procedures shall be as defined in 7.2.3.

#### 7.4.15.2 Failed-Fast-Retrain-Count

The Failed-Fast-Retrain-Count performance parameter is a count of the total number of failed fast retrains. A failed fast retrain is either when:

- A CRC error is detected.
- A time-out occurs.
- A profile is unknown.

Parameter procedures shall be as defined in 7.2.3.

### 7.4.16 Initialization Failure

This parameter indicates an initialization failure.

An Initialization-failure shall be conveyed to the NMS by the ATU-C and should be conveyed to the NMS by the ATU-R after it is detected.

The Initialization-Failure is coded as an integer:

1) Configuration error in profile:

   This error occurs, for example, with inconsistencies in configuration profile or if the line is initialized in G.992.2 mode and the line configuration profile does not contain an interleaved path configuration, or the minimum or maximum interleaved path net data rate configured is not supported.

2) Configuration not feasible on line:

This error occurs if the combination of minimum net data rate, minimum requested noise margin and requested PSD level cannot be reached on the line.

3) Communication problem:

This error occurs, for example, due to corrupted or bad syntax messages or if no common mode can be selected in the handshaking procedure or due to a time-out.

4) No peer ATU detected:

This error occurs if the peer ATU is not powered or not connected or if the line is too long to allow detection of a peer ATU.

NOTE – Other events may result in an Initialization-Failure and may be coded as a 5.

### 7.5 Network Management Elements partitioning

This subclause defines the network elements which correspond to the specific management interfaces. It is mandatory to provide the parameters at the Q-interface. It is optional to provide parameters at the U- and S/T-interfaces.

NOTE 1 – This does not imply that management information transmission over the U-Interface (e.g. indicator bits) is optional.

The ATU-C U-Interface provides its near-end parameters (ATU-R far-end) for the ATU-R to retrieve.

The ATU-R U-Interface provides its near-end parameters (ATU-C far-end) for the ATU-C to retrieve.

The T-/S-interface has its near-end at the ATU-R and its far-end at the ATU-C.

Parameters indicated with:

- R are read only.
- W are write only.
- R/W are read and write.
- (M) are mandatory.
- (O) are optional.
- * Requires the OAM communication channel specified in this Recommendation.

NOTE 2 – ATU-C far-end is equal to ATU-R near-end and ATU-C near-end is equal to ATU-R far-end.

| Category/Element | Defined in | Q-Interface | ATU-C U-Interface | ATU-R U-Interface | T-/S-Interface |
|---|---|---|---|---|---|
| **Configuration** | 7.3 | | | | |
| ADSL Line Type | 7.3.1 | R/W (M) | R (O) * | | R (O) |
| ADSL Transmission System Enabling ATU-C | 7.3.2 | R/W (M) | R (O) * | | R (O) |
| ATU-C Target Noise Margin | 7.3.3.1 | R/W (M) | R (O) * | | |
| ATU-R Target Noise Margin | 7.3.3.2 | R/W (M) | R (O) * | | |
| ATU-C Maximum Noise Margin | 7.3.3.3 | R/W (M) | R (O) * | | |
| ATU-R Maximum Noise Margin | 7.3.3.4 | R/W (M) | R (O) * | | |
| ATU-C Minimum Noise Margin | 7.3.3.5 | R/W (M) | R (O) * | | |
| ATU-R Minimum Noise Margin | 7.3.3.6 | R/W (M) | R (O) * | | |

| Category/Element | Defined in | Q-Interface | ATU-C U-Interface | ATU-R U-Interface | T-/S-Interface |
|---|---|---|---|---|---|
| ATU-C Rate Adaptation Mode | 7.3.4.1 | R/W (M) | R (O) * | | |
| ATU-R Rate Adaptation Mode | 7.3.4.2 | R/W (M) | R (O) * | | |
| ATU-C Up-shift Noise Margin | 7.3.4.3 | R/W (O) | R (O) * | | |
| ATU-R Up-shift Noise Margin | 7.3.4.4 | R/W (O) | R (O) * | | |
| ATU-C Minimum Time Interval for Upshift Rate Adaptation | 7.3.4.5 | R/W (O) | R (O) * | | |
| ATU-R Minimum Time Interval for Upshift Rate Adaptation | 7.3.4.6 | R/W (O) | R (O) * | | |
| ATU-C Down-shift Noise Margin | 7.3.4.7 | R/W (O) | R (O) * | | |
| ATU-R Down-shift Noise Margin | 7.3.4.8 | R/W (O) | R (O) * | | |
| ATU-C Minimum Time Interval for Downshift Rate Adaptation | 7.3.4.9 | R/W (O) | R (O) * | | |
| ATU-R Minimum Time Interval for Downshift Rate Adaptation | 7.3.4.10 | R/W (O) | R (O) * | | |
| ATU-C Desired Maximum Rate Fast | 7.3.5.1 | R/W (M) | R (O) * | | |
| ATU-C Desired Maximum Rate Interleaved | 7.3.5.2 | R/W (M) | R (O) * | | |
| ATU-R Desired Maximum Rate Fast | 7.3.5.3 | R/W (M) | R (O) * | | |
| ATU-R Desired Maximum Rate Interleaved | 7.3.5.4 | R/W (M) | R (O) * | | |
| ATU-C Desired Minimum Rate Fast | 7.3.5.5 | R/W (M) | R (O) * | | |
| ATU-C Desired Minimum Rate Interleaved | 7.3.5.6 | R/W (M) | R (O) * | | |
| ATU-R Desired Minimum Rate Fast | 7.3.5.7 | R/W (M) | R (O) * | | |
| ATU-R Desired Minimum Rate Interleaved | 7.3.5.8 | R/W (M) | R (O) * | | |
| ATU-C Rate Adaptation Ratio | 7.3.5.9 | R/W (O) | R (O) * | | |
| ATU-R Rate Adaptation Ratio | 7.3.5.10 | R/W (O) | R (O) * | | |
| Power down state L1 ATU-C net data rate | 7.3.6 | R/W (O) | R (O) * | | R (O) |
| Power down state L1 ATU-R net data rate | 7.3.7 | R/W (O) | R (O) * | | R (O) |
| Maximum ATU-C ADSL Line Delay | 7.3.8 | R/W (M) | R (O) * | | |
| Maximum ATU-R ADSL Line Delay | 7.3.9 | R/W (M) | R (O) * | | |
| 15-min and 24-hour Parameter Thresholds for the parameters in 7.2. | 7.3.10 | R/W (M) | R (O) * | | |
| ATU-C ADSL Line state change L0 to L3 | 7.3.11 | W (M) | | | |
| ATU-C ADSL Line state change L3 to L0 | 7.3.12 | W (M) | | | |
| ATU-R ADSL Line state change L0 to L3 | 7.3.13 | | | | W (O) |

| Category/Element | Defined in | Q-Interface | ATU-C U-Interface | ATU-R U-Interface | T-/S-Interface |
|---|---|---|---|---|---|
| ATU-R ADSL Line state change L3 to L0 | 7.3.14 | | | | W (O) |
| ATU-C Vendor ID | 7.3.15.1 | R (M) | R (O) * | | R (O) |
| ATU-R Vendor ID | 7.3.15.2 | R (M) | | R (O) * | R (O) |
| ATU-C Version Number | 7.3.15.3 | R (M) | R (O) * | | R (O) * |
| ATU-R Version Number | 7.3.15.4 | R (M) | | R (O) * | R (O) * |
| ATU-C Serial Number | 7.3.15.5 | R (M) | R (O) * | | R (O) * |
| ATU-R Serial Number | 7.3.15.6 | R (M) | | R (O) * | R (O) * |
| **Line Failures** | 7.1.1 | | | | |
| **Near-end failures (ATU-C)** | 7.1.1.1 | | | | |
| Loss of signal (LOS) | 7.1.1.1.1 | R (M) | R (O) * | | R (O) |
| Loss of frame (LOF) | 7.1.1.1.2 | R (M) | R (O) * | | R (O) |
| Loss of power (LPR) | 7.1.1.1.3 | R (M) | R (O) * | | R (O) |
| **Far-end failures (ATU-C)** | 7.1.1.2 | | | | |
| Far-end Loss of Signal (LOS-FE) failure | 7.1.1.2.1 | R (M) | | R (O) * | R (O) |
| Far-end Loss of frame (LOF-FE) failure | 7.1.1.2.2 | R (M) | | R (O) * | R (O) |
| Far-end Loss of Power (LPR-FE) failure | 7.1.1.2.3 | R (M) | | R (O) * | R (O) |
| **ADSL ATM Data path Failures** | 7.1.2 | | | | |
| **ATM data path related near-end failures (ATU-C)** | 7.1.2.1 | | | | |
| No Cell Delineation NCD-I failure | 7.1.2.1.1 | R (M) | R (O) * | | |
| No Cell Delineation NCD-F failure | 7.1.2.1.2 | R (M) | R (O) * | | |
| Loss of Cell Delineation LCD-I failure | 7.1.2.1.3 | R (M) | R (O) * | | |
| Loss of Cell Delineation LCD-F failure | 7.1.2.1.4 | R (M) | R (O) * | | |
| **ATM data path related far-end failures (ATU-C)** | 7.1.2.2 | | | | |
| Far-end No Cell Delineation Interleaved (FNCD-I) failure | 7.1.2.2.1 | R (M) | | R (O) * | |
| Far-end No Cell Delineation Fast (FNCD-F) failure | 7.1.2.2.2 | R (M) | | R (O) * | |
| Far-end Loss of Cell Delineation Interleaved (FLCD-I) failure | 7.1.2.2.3 | R (M) | | R (O) * | |
| Far-end Loss of Cell Delineation Fast (FLCD-F) failure | 7.1.2.2.4 | R (M) | | R (O) * | |
| Performance | 7.2 | | | | |

| Category/Element | Defined in | Q-Interface | ATU-C U-Interface | ATU-R U-Interface | T-/S-Interface |
|---|---|---|---|---|---|
| **Near-end (ATU-C) ADSL line performance parameters** | 7.2.1.1 | | | | |
| Code violation-line (CVI-L) | 7.2.1.1.1 | R (M) | R (O) * | | |
| Code violation-line (CVF-L) | 7.2.1.1.2 | R (M) | R (O) * | | |
| Forward Error Correction Count Line (ECI-L) | 7.2.1.1.3 | R (M) | R (O) * | | |
| Forward Error Correction Count Line (ECF-L) | 7.2.1.1.4 | R (M) | R (O) * | | |
| Forward Error Correction second-line (ECS-L) | 7.2.1.1.5 | R (M) | R (O) * | | |
| Errored second-line (ES-L) | 7.2.1.1.6 | R (M) | R (O) * | | R (O) |
| Severely errored second-line (SES-L) | 7.2.1.1.7 | R (M) | R (O) * | | R (O) |
| LOS second (LOSS-L) | 7.2.1.1.8 | R (M) | R (O) * | | |
| Unavailable seconds (UAS-L) | 7.2.1.1.9 | R (M) | R (O) * | | |
| **Far-end (ATU-C) ADSL line performance parameters** | 7.2.1.2 | | | | |
| Code violation-line far-end (CVI-LFE) | 7.2.1.2.1 | R (M) | | R (O) * | |
| Code violation-line far-end (CVF-LFE) | 7.2.1.2.2 | R (M) | | R (O) * | |
| Forward Error Correction Count Line far-end (ECI-LFE) | 7.2.1.2.3 | R (M) | | R (O) * | |
| Forward Error Correction Count Line far-end (ECF-LFE) | 7.2.1.2.4 | R (M) | | R (O) * | |
| Forward Error Correction second-line far-end (ECS-LFE) | 7.2.1.2.5 | R (M) | | R (O) * | |
| Errored second far-end (ES-LFE) | 7.2.1.2.6 | R (M) | | R (O) * | R (O) |
| Severely errored second-line far-end (SES-LFE) | 7.2.1.2.7 | R (M) | | R (O) * | R (O) |
| LOS second far-end (LOSS-LFE) | 7.2.1.2.8 | R (M) | | R (O) * | |
| Unavailable seconds far-end (UAS-LFE) | 7.2.1.2.9 | R (M) | | R (O) * | |
| **Near-End (ATU-C) ADSL ATM data path performance parameters** | 7.2.2.1 | | | | |
| Near-end HEC violation count Interleaved | 7.2.2.1.1 | R (M) | R (O) * | | |
| Near-end HEC violation count Fast | 7.2.2.1.2 | R (M) | R (O) * | | |
| Near-end HEC total cell count Interleaved | 7.2.2.1.3 | R (O) | R (O) * | | |
| Near-end HEC total cell count Fast | 7.2.2.1.4 | R (O) | R (O) * | | |
| Near-end User total cell count Interleaved | 7.2.2.1.5 | R (O) | R (O) * | | |
| Near-end User total cell count Fast | 7.2.2.1.6 | R (O) | R (O) * | | |

| Category/Element | Defined in | Q-Interface | ATU-C U-Interface | ATU-R U-Interface | T-/S-Interface |
|---|---|---|---|---|---|
| Near-end Idle Cell Bit Error Count Interleaved | 7.2.2.1.7 | R (O) | R (O) * | | R (O) * |
| Near-end Idle Cell Bit Error Count Fast | 7.2.2.1.8 | R (O) | R (O) * | | R (O) * |
| **Far-End (ATU-C) ADSL ATM data path performance parameters** | 7.2.2.2 | | | | |
| Far-end HEC violation count Interleaved | 7.2.2.2.1 | R (M) | | R (O) * | |
| Far-end HEC violation count Fast | 7.2.2.2.2 | R (M) | | R (O) * | |
| Far-end HEC total cell count Interleaved | 7.2.2.2.3 | R (O) * | | R (O) * | |
| Far-end HEC total cell count Fast | 7.2.2.2.4 | R (O) * | | R (O) * | |
| Far-end User total cell count Interleaved | 7.2.2.2.5 | R (O) * | | R (O) * | |
| Far-end User total cell count Fast | 7.2.2.2.6 | R (O) * | | R (O) * | |
| Far-end Idle Cell Bit Error Count Interleaved | 7.2.2.2.7 | R (O) * | | R (O) * | R (O) |
| Far-end Idle Cell Bit Error Count Fast | 7.2.2.2.8 | R (O) * | | R (O) * | R (O) |
| **Test, Diagnostics and status parameters** | 7.4 | | | | |
| ATU-C ADSL Transmission System Capabilities | 7.4.1 | R (M) | | | |
| ATU-R ADSL Transmission System Capabilities | 7.4.2 | R (M) | | R (O) * | R (O) |
| ADSL Transmission System | 7.4.3 | R (M) | | | |
| ATU-C Line Attenuation | 7.4.4 | R (M) | | R (O) * | |
| ATU-R Line Attenuation | 7.4.5 | R (M) | R (O) * | | |
| Actual ATU-C Signal-to-Noise Ratio (SNR) margin | 7.4.6 | R (M) | | R (O) * | |
| Actual ATU-R Signal-to-Noise Ratio (SNR) margin | 7.4.7 | R (M) | R (O) * | | |
| ATU-C Total Output Power | 7.4.8 | R (M) | R (O) * | | |
| ATU-R Total Output Power | 7.4.9 | R (M) | | R (O) * | |
| ATU-C Maximum Attainable Rate | 7.4.10.1 | R (M) | R (O) * | | R (O) |
| ATU-R Maximum Attainable Rate | 7.4.10.2 | R (M) | | R (O) * | R (O) |
| ATU-C Current Rate Fast | 7.4.10.3 | R (M) | | | R (O) |
| ATU-C Current Rate Interleaved | 7.4.10.4 | R (M) | | | R (O) |
| ATU-R Current Rate Fast | 7.4.10.5 | R (M) | | | R (O) |
| ATU-R Current Rate Interleaved | 7.4.10.6 | R (M) | | | R (O) |
| ATU-C Previous Rate Fast | 7.4.10.7 | R (M) | | | R (O) |
| ATU-C Previous Rate Interleaved | 7.4.10.8 | R (M) | | | R (O) |

| Category/Element | Defined in | Q-Interface | ATU-C U-Interface | ATU-R U-Interface | T-/S-Interface |
|---|---|---|---|---|---|
| ATU-R Previous Rate Fast | 7.4.10.9 | R (M) | | | R (O) |
| ATU-R Previous Rate Interleaved | 7.4.10.10 | R (M) | | | R (O) |
| ATU-C Rate Threshold Up Fast | 7.4.11.1 | R/W (M) | | | |
| ATU-C Rate Threshold Up Interleaved | 7.4.11.2 | R/W (M) | | | |
| ATU-C Rate Threshold Down Fast | 7.4.11.3 | R/W (M) | | | |
| ATU-C Rate Threshold Down Interleaved | 7.4.11.4 | R/W (M) | | | |
| ATU-R Rate Threshold Up Fast | 7.4.11.5 | R/W (M) | | | |
| ATU-R Rate Threshold Up Interleaved | 7.4.11.6 | R/W (M) | | | |
| ATU-R Rate Threshold Down Fast | 7.4.11.7 | R/W (M) | | | |
| ATU-R Rate Threshold Down Interleaved | 7.4.11.8 | R/W (M) | | | |
| ATU-C ADSL Line Delay | 7.4.12 | R (M) | | | R (O) |
| ATU-R ADSL Line Delay | 7.4.13 | R (M) | | | R (O) |
| ADSL Line states | 7.4.14 | R (M) | | | R (O) |
| Fast Retrain parameters<br>15-min and 24-hour current and previous counters for Fast Retrains and Failed Fast Retrains | 7.4.15 | R (M) | | | |
| Initialization Failure | 7.4.16 | R (M) | | | R (O) |

APPENDIX I

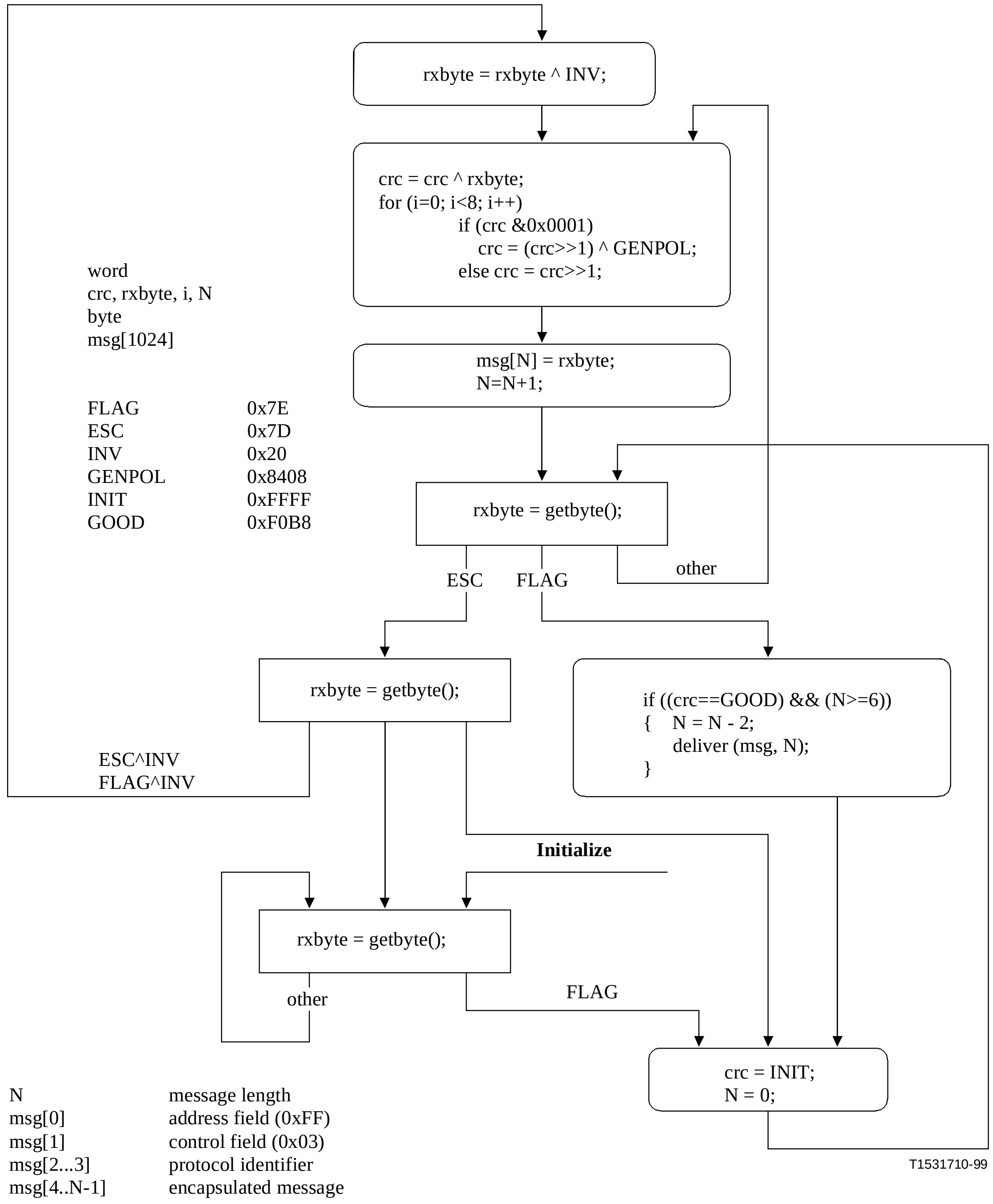
## I.1 Illustration of Transmitter Processing

```
#define     INIT      0xFFFF
#define     FLAG      0x7E
#define     ESC       0x7D
#define     INV       0x20
#define     GENPOL    0x8408
unsigned char        msg[1024], temp;     /*  8 bit unsigned char      */
unsigned short int   crc;                 /* 16 bit unsigned integer */
int                  N, j, msglen;
{
        crc = INIT;
        msg[0] = 0xFF;
        crc = update_crc(msg[0], crc);
        msg[1] = 0x03;
        crc = update_crc(msg[1], crc);
```

```
        N = 2;
        j = 0;
        while (j < msglen)
        {
            temp = xmit_msg_byte(j++);
            crc = update_crc(temp, crc);
            if ( (temp = FLAG) || (temp = ESC) )
            {
                msg[N] = ESC;
                msg[N+1] = temp ^ INV;
                N = N + 2;
            }
            else
            {
                msg[N] = temp;
                N = N + 1;
            }
        }
        crc = ~crc;
        msg [N] = crc & 0x00FF;
        msg[N+1] = (crc >> 8) & 0x00FF;
        xmit_msg();
}

unsigned short int update_crc(unsigned char new_byte, unsigned short int crc_reg)
{
int     i;
        crc_reg = crc_reg ^ new_byte;
        for (i=0; i<8; i++)
            if (crc_reg & 0x0001)
                crc_reg = (crc_reg>>1) ^ GENPOL;
            else
                crc_reg = crc_reg >> 1;
        return (crc_reg);
}
```

## I.2 Illustration of Receiver Processing



## APPENDIX II

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