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SERIES J: TRANSMISSION OF TELEVISION, SOUND PROGRAMME AND OTHER MULTIMEDIA SIGNALS

Transport of MPEG-2 signals on packetised networks

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## Transport of MPEG-2 signals in PDH networks

ITU-T Recommendation J.131

(Previously CCITT Recommendation)

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# ITU-T J-SERIES RECOMMENDATIONS

**TRANSMISSION OF TELEVISION, SOUND PROGRAMME AND OTHER MULTIMEDIA SIGNALS**



*For further details, please refer to ITU-T List of Recommendations.*

**ITU-T RECOMMENDATION J.131**

# TRANSPORT OF MPEG-2 SIGNALS IN PDH NETWORKS


## Summary

This Recommendation provides the requirements for equipment called "PDH network adapter" for the transport of MPEG-2 signals over PDH networks. It describes the necessary operations to adapt the MPEG-2 Transport Stream into interfaces of PDH networks and the functional characteristics associated with this equipment.



## Source

ITU-T Recommendation J.131 was prepared by ITU-T Study Group 9 (1997-2000) and was approved under the WTSC Resolution No. 1 procedure on the 18th of March 1998.

## FOREWORD

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# CONTENTS

# TRANSPORT OF MPEG-2 SIGNALS IN PDH NETWORKS

*(Geneva, 1998)*

## 1 Scope

This Recommendation specifies the transmission of MPEG-2 transport streams within PDH networks working at the Recommendation G.702 [1] hierarchical bit rates of 1544 kbit/s, 2048 kbit/s, 6312 kbit/s, 34 368 kbit/s, 44 736 kbit/s and 139 264 kbit/s. The use of any of these bit rates is optional; if, however, one or more rates are selected, the complete specification applies. The definition of the network aspects of the transmission of MPEG-2 Transport Streams is based to the maximum extent on existing international standards.

The 8 Mbit/s frame structure for the support of ATM is not yet defined. Further study is required.

The equipment considered in this Recommendation is the Network Adapter performing the adaptation between MPEG-2 transport streams and the interfaces of PDH networks.

The application of this Recommendation is restricted to a physical layer point-to-point connection without ATM connection functionality at intermediate points.

## 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 are valid. All Recommendations and other references are subject to revisions; all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

[1] CCITT Recommendation G.702 (1988), *Digital hierarchy bit rates*.

[2] CCITT Recommendation G.703 (1991), *Physical/electrical characteristics of hierarchical digital interfaces*.

[3] ITU-T Recommendation G.783 (1997), *Characteristics of Synchronous Digital Hierarchy (SDH) equipment functional blocks*.

[4] ITU-T Recommendation G.804 (1998), *ATM cell mapping into Plesiochronous Digital Hierarchy (PDH)*.

[5] ITU-T Recommendation G.826 (1996), *Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate*.

[6] ITU-T Recommendation G.832 (1995), *Transport of SDH elements on PDH networks – Frame and multiplexing structure*.

[7] ITU-T Recommendation H.222.0 (1995) | ISO/IEC 13818-1:1996, *Information technology – Generic coding of moving pictures and associated audio information: Systems*.

[8] ITU-T Recommendation I.361 (1995), *B-ISDN ATM layer specification*.

[9] ITU-T Recommendation I.363.1 (1996), *B-ISDN ATM adaptation layer (AAL) specification – Type 1 AAL*.

[10] ITU-T Recommendation I.432 (1993), *B-ISDN user-network interface – Physical layer specification*.

[11] ITU-T Recommendation I.732 (1996), *Functional characteristics of ATM equipment*.

[12] ITU-T Recommendation J.82 (1996), *Transport of MPEG-2 constant bit rate television signals in B-ISDN*.

[13] ITU-T Recommendation J.83 (1997), *Digital multi-programme systems for television, sound and data services for cable distribution*.

[14] ITU-T Recommendation M.2120 (1997), *Digital paths, section and transmission system fault detection and localization procedures*.

[15] ITU-T Recommendation Q.822 (1994), *Stage 1, stage 2 and stage 3 description for the Q3 interface – Performance management*.

[16] ETS 300 417-2-1 (1997), *Transmission and Multiplexing (TM), Generic requirements of transport functionality of equipment; Part 2-1: Synchronous Digital Hierarchy (SDH) and Plesiochronous Digital Hierarchy (PDH) physical section layer functions*.

[17] ETS 300 417-5-1 (1998), *Transmission and Multiplexing (TM), Generic requirements of transport functionality of equipment; Part 5-1: PDH path layer functions*.

[18] ETR 290 (1997), *Digital Video Broadcasting (DVB); Measurement guidelines for DVB systems*.

[19] EN 50083-9 (1998), *Cabled distribution systems for television, sound and interactive multimedia signals; Part 9: Interfaces for CATV/SMATV headends and similar professional equipment for DVB/MPEG-2 transport streams*.

[20] ANSI T1.102 (1993), *Telecommunications – Digital Hierarchy – Electrical Interfaces*.

[21] ITU-T Recommendation G.704 (1995), *Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 kbit/s hierarchical levels.*

## 3 Terms and definitions

This Recommendation defines the following terms.

**3.1 fixed stuff**: Bytes that are used to fill up unused data positions.

**3.2 MPEG-2 Transport Stream (TS) packet**: A data packet possessing a length of 188 bytes including 4 bytes of header information. The header contains MPEG-related data.

**3.3 RS-coded MPEG-2 Transport Stream (TS) packet**: A data packet possessing a length of 204 bytes. Bytes 1 to 188 contain an MPEG-2 transport stream packet. Bytes 189 to 204 contain the parity-check bytes for the error correction of the preceding bytes of this packet. These parity-check bytes are generated using a shortened Reed Solomon Code RS (204, 188), as specified in Annex A/J.83 [13].

## 4 Acronyms and abbreviations

This Recommendation uses the following abbreviations:

| | |
|---|---|
| AAL | ATM Adaptation Layer |
| ASI | Asynchronous Serial Interface |
| ATM | Asynchronous Transfer Mode |
| BER | Bit Error Rate |
| CRC | Cyclic Redundancy Check |
| CS | Convergence Sublayer |
| DVB | Digital Video Broadcasting |

| | |
|---|---|
| EMF | Equipment Management Function |
| FAS | Frame Alignment Signal |
| FEC | Forward Error Correction |
| LOF | Loss of Frame |
| LOS | Loss of Signal |
| MAA | MPEG/ATM Adaptation |
| MON | Monitoring |
| MPEG | Moving Pictures Experts Group |
| MPEG-2-TS | MPEG-2 Transport Stream |
| MPI | MPEG Physical Interface |
| NE | Network Element |
| PDH | Plesiochronous Digital Hierarchy |
| PDU | Protocol Data Unit |
| PL | Path Layer |
| PPI | PDH Physical Interface |
| PPT | PDH Path Termination |
| PSL | Physical Section Layer |
| RDI | Remote Defect Indication |
| RS | Reed Solomon |
| SAP | Service Access Point |
| SAR | Segmentation and Reassembly sublayer |
| SN | Sequence Number |
| SPI | Synchronous Parallel Interface |
| SSI | Synchronous Serial Interface |
| TS | Transport Stream |
| VP | Virtual Path |
| VPE | Virtual Path Entity |
| VPME | Virtual Path Multiplexing Entity |

# 5 Conventions

Unless otherwise mentioned, in this Recommendation the following conventions hold true:

– The order of transmission of information in all diagrams is first from left to right and then from top to bottom. Within each byte or octet the most significant bit is transmitted first.

# 6 Network adapter overview

## 6.1 Functional description

The Network Adapter is an equipment which performs the adaptation of data structured as an MPEG-2 Transport Stream to the characteristics of a PDH link. The solution selected for the transmission of MPEG-2-TS packets, or optionally for the transmission of RS-coded MPEG-2-TS packets, over PDH links is based on the use of ATM cells. Therefore, the adaptation of the transport of an MPEG-2-TS basically consists in:

– adaptation of MPEG-2-TS packets or RS-coded MPEG-2-TS packets to ATM cells;

– adaptation of ATM cells to PDH framing.

NOTE – The processing of ATM VC level is not performed.

The normative references applicable to the adaptation unless specifically mentioned are given here below:

– the adaptation of MPEG-2-TS packets into ATM cells using an AAL type 1 shall be performed as described in Recommendation J.82 [12]. AAL type 1 is specified in Recommendation I.363.1 [9], the ATM layer is specified in Recommendation I.361 [8];

– the adaptation of ATM cells into PDH framing shall be performed as described in Recommendation G.804 [4].

There is no normative reference for the adaptation of RS-coded MPEG-2-TS packets to ATM cells. This adaptation shall be performed as described in Recommendation J.82 [12] for MPEG-2-TS packets, with the only exception that the RS-coded MPEG-2-TS packets are not aligned with the structure of the AAL1 interleaving matrix.

The Network Adapter is described as a group of functional blocks. The partitioning into functional blocks is based on existing Recommendations on SDH equipment (Recommendation G.783 [3]) and ATM equipment (Recommendation I.732 [11]). The equipment consists of the following blocks (see also Figure 1):

– MPEG Physical Interface (MPI);

– MPEG/ATM Adaptation (MAA);

– Virtual Path Entity (VPE);

– VP Multiplexing Entity (VPME);

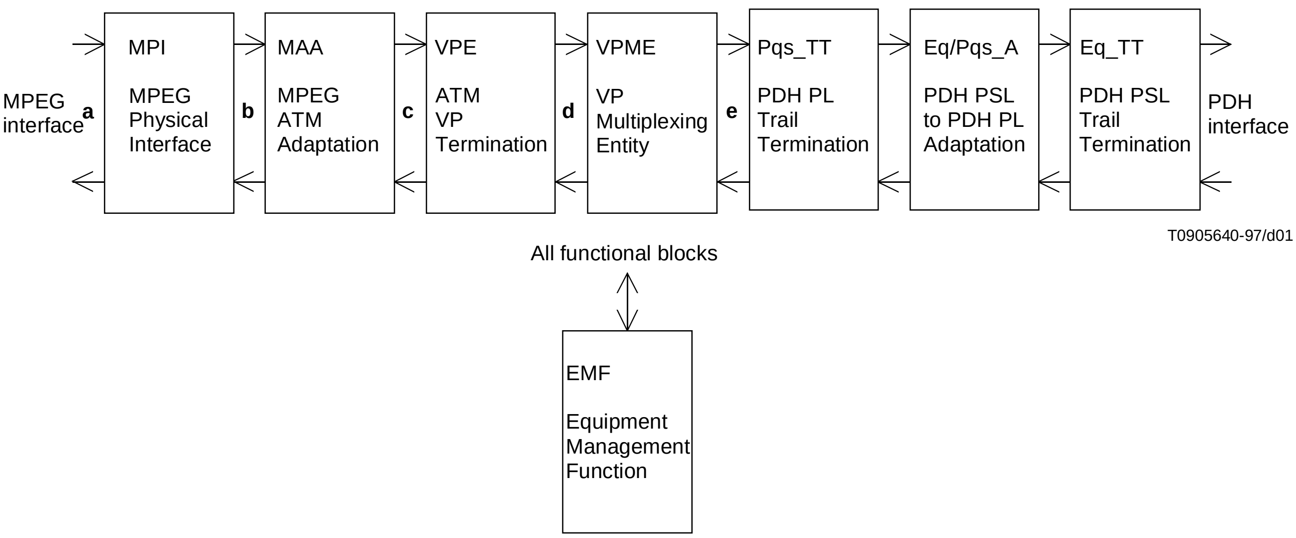
– PDH Path Layer Trail Termination (Pqs_TT);

– PDH Physical Section Layer to PDH Path Layer Adaptation (Eq/Pqs_A);

– PDH Physical Section Layer Trail Termination (Eq_TT); and

– Equipment Management Function (EMF).

The present description is a functional description and does not imply any specific equipment implementation but it allows for the implementation of a separate transmitter and receiver as well as a combined transmitter/receiver.




NOTE – Synchronization functions are for further study.

**Figure 1/J.131 – Functional blocks for the Network Adapter**

The protocol stack used by this equipment is shown in Figure 2.

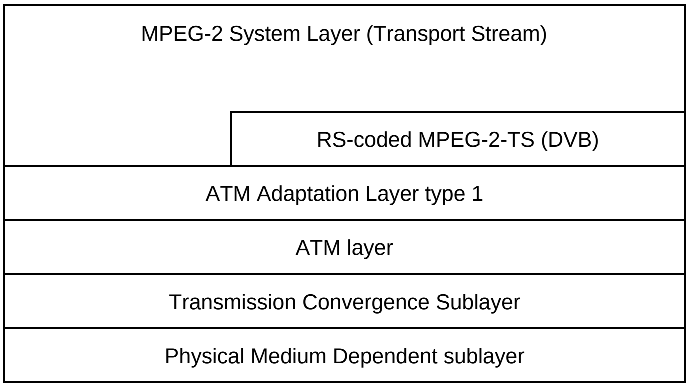



**Figure 2/J.131 – Protocol stack for the adaptation process**

The following functional blocks are identified:

– *The MPEG-2-TS Physical Interface*: the Network Adapter accepts, at its input port, either an MPEG-2-TS consisting of consecutive MPEG-2-TS packets, or optionally an extended version of an MPEG-2-TS that already contains error protection as specified in Annex A/J.83 [13] (RS-coded MPEG-2-TS packets). Packets length of 188 bytes and optionally 204 bytes can be handled.

– *The MPEG/ATM Adaptation:* this corresponds to the adaptation between the MPEG-2-TS, or the RS-coded MPEG 2-TS, and the ATM cells via an AAL type 1. This adaptation, besides format adaptation, provides functions for the MPEG-2-TS clock transmission transparency (adaptive clock method) and information transparency using the clock and data recovery mechanism of AAL1. It is expected that under normal transmission conditions the received MPEG-2-TS will be quasi error free, corresponding to a Bit Error Rate (BER) of about $10^{-10}$ to $10^{-11}$ at the input of an MPEG-2 equipment at the receiver site. This requirement is in accordance with cable systems specified in Annex A/J.83 [13] .

– *The Virtual Path Entity:* the only function performed is the VP setting. It allows the simultaneous transmission of several independent MPEG-2-TS on one PDH link.

– *The VP Multiplexing Entity:* if different MPEG-2-TS have to be simultaneously transported, the ATM cells belonging to different VPs are multiplexed in the transmitter respectively demultiplexed in the receiver. If only one MPEG-2-TS has to be transported, only one VP is used. The adaptation to the useful bit rate offered by the PDH link is performed by adding respectively removing idle cells. At the receiver, this block also performs cell delineation and ATM cell header checking.

– *The PDH Path Layer Trail Termination (Pqs_TT):* this function generates and terminates all the overhead of the PDH frames carrying ATM cells. The overhead contains information providing Operation Administration and Maintenance functions.

– *The PDH Physical Section Layer to PDH Path Layer Adaptation (Eq/Pqs_A):* this function extracts timing from the received signal and regenerates the data.

– *The PDH Physical Section Layer Trail Termination (Eq_TT):* this function provides the interface between the equipment and the physical medium carrying a signal which may have any of the physical characteristics of those described in Recommendation G.703 [2].

– *The Equipment Management Function:* this block manages all the other functional blocks. It ensures the Man Machine Interface.

# 7 Detailed description of the basic functions

## 7.1 MPEG Physical Interface (MPI)

### 7.1.1 Basic characteristics

This function provides the interface between the Network Adapter and the MPEG-2-TS sources or receivers.

In order to prevent alarms being raised and failures being reported during set-up procedures or if the input port is not in use (in the case of a multi-port equipment), the MPI function shall have the ability to enable or disable fault case declaration. The MPI shall be either monitored (MON) or not monitored (NMON). The state MON or NMON is provisioned by the equipment manager to the MPI via the EMF function.

#### 7.1.1.1 Signal processing in the receiver (Signal flow from a to b in Figure 1)

a) *Recovery of MPEG-2 packets*

This function recovers the data bytes and their clock from the received signals.

The function also realizes the sync acquisition of the MPEG-2-TS packets, or optionally of the RS-coded MPEG-2-TS packets, on the basis of the method proposed in subclause 3.2 of ETR 290 [18] (five consecutive correct sync bytes for sync acquisition; two or more consecutive corrupted sync bytes should indicate sync loss).

The function passes the recovered MPEG-2-TS packets or the RS-coded MPEG-2-TS packets and the timing information to point b of Figure 1.

This function shall also detect the absence of valid input signals and the absence of clock.

If any of these defects is detected, a Loss of Signal (LOS) is reported at the EMF if the function is in MON state.

If a loss of synchronization of MPEG-2-TS packets or RS-coded MPEG-2-TS packets is detected according to the procedure proposed in subclause 3.2 of ETR 290 [18] (i.e. two or more consecutive corrupted sync bytes are found), a TS_sync_loss error on the input signal (TSLE_I) is reported at the EMF if the function is in MON state.

b) *Performance monitoring*

Errored blocks are detected on the basis of the transport_error_indicator present in the headers of the incoming MPEG-2-TS packets, in accordance to ETR 290 [18]. One-second filters perform a simple integration of errored blocks by counting during a one-second interval. The function generates the following performance parameters concerning the input MPEG-2-TS signal received on the interface:

– N_EBC_I: every second, the number of errored blocks within that second is counted as the Near-End Error Block Count (N_EBC_I);

– N_DS_I: every second with at least one occurrence of TSLE_I or LOS (corresponding to the notion of Severely Disturbed Period introduced in ETR 290 [18]) shall be indicated as Near -End Defect Second (N_DS_I).

If the function is in the MON state, at the end of each one second interval, the contents of the N_EBC_I counter and of the N_DS_I indicator are reported to the EMF. Furthermore, on request of the EMF block, the MPI block evaluates and reports to the EMF the number of received MPEG-2-TS packets within one second (BC_I).

#### 7.1.1.2 Signal processing in the transmitter (Signal flow from b to a in Figure 1)

a) *Generation of the signals at the MPEG physical interface*

This function receives the data bytes provided at the reference point b of Figure 1 by the MAA block and recovers the synchronization of the MPEG-2-TS packets or optionally of the RS-coded MPEG-2-TS packets on the basis of the method proposed in subclause 3.2 of ETR 290 [18] (five consecutive correct sync bytes for sync acquisition; two or more consecutive corrupted sync bytes should indicate sync loss). Optionally, the type of packet (MPEG-2-TS packet or RS-coded MPEG-2-TS packet) is determined on the basis of the periodicity of the synchronization bytes. After the recovery of the packet structure and only in the case of a MPEG-2-TS packet structure, the function shall use the status indicator of the AAL-SAP (available at reference point b) to set the transport_error_indicator of the MPEG-2-TS packets.

The function generates the appropriate signals at the output interface.

If a loss of synchronization of MPEG-2-TS packets or optionally of the RS-coded MPEG-2-TS packets is detected according to the procedure proposed in the subclause 3.2 of ETR 290 [18] (i.e. two or more consecutive corrupted sync bytes are found), a TS_sync_loss error for the output signal (TSLE_O) is reported at the EMF if the function is in MON state.

b) *Performance monitoring*

Errored blocks are detected on the basis of the transport_error_indicator present in the headers of the MPEG-2-TS packets regenerated in the MPI block, in accordance to ETR 290 [18]. One-second filters perform a simple integration of errored blocks by counting during a one-second interval. The function generates the following performance parameters concerning the output MPEG-2-TS signal delivered by the interface:

– N_EBC_O: every second, the number of errored blocks within that second is counted as the Near-End Error Block Count (N_EBC_O);

– N_DS_O: every second with at least one occurrence of TSLE_O or LOS (corresponding to the notion of Severely Disturbed Period introduced in ETR 290 [18]) shall be indicated as Near-End Defect Second (N_DS_O).

If the function is in the MON state, at the end of each one-second interval, the contents of the N_EBC_O counter and of the N_DS_O indicator are reported to the EMF. Furthermore, on request of the EMF block, the MPI block evaluates and reports at the EMF the number of received MPEG-2-TS packets within one second (BC_O).

### 7.1.2 Additional characteristics for System A (European system)

The physical characteristics of the interface shall follow the specification given in EN 50083-9 [19]. Three different types of interfaces are specified. They are called:

– Synchronous Parallel Interface (SPI);

– Synchronous Serial Interface (SSI);

– Asynchronous Serial Interface (ASI).

The interfaces use the MPEG-2-TS packet structure (188 bytes) or the RS-coded packet structure (204 bytes). For the Synchronous Parallel Interface and the Synchronous Serial Interface, the 204-byte format may be used either for the transmission of 188-byte MPEG-2-TS packets with 16 dummy bytes, or for the transmission of 204-byte RS-coded packets.

#### 7.1.2.1 Signal processing in the receiver

Data bytes and their clock are recovered from the received signals as specified below:

– For the Synchronous Parallel Interface, this recovery is based on the use of the Data (0-7), the DVALID, PSYNC and clock signals, as specified in subclause 4.1 of EN 50083-9 [19].

– For the SSI interface, the processing includes optical receiver (for fibre-optic-based link) or coupling/impedance matching (for coaxial cable), amplifier/buffer, clock recovery and bi-phase decoding, serial to parallel conversion, as specified in Annex A of EN 50083-9 [19].

– For the ASI interface, the processing includes optical receiver (for fibre-optic-based link) or coupling/impedance matching (for coaxial cable), amplifier/buffer, clock/data recovery and serial-to-parallel conversion, FC comma deletion, 8B/10B decoding, as specified in Annex B of EN 50083-9 [19]. In the next step, the recovery of the transport stream clock is performed (see Annex E of EN 50083-9 [19]: implementation guidelines and deriving clocks from the MPEG-2 packets for the ASI).

The packet size (188 bytes or 204 bytes) may be recovered from the received signals, on the basis of the PSYNC signal for the parallel interface, or on the basis of periodicity of the synchronization bytes for the serial interfaces. For the case of the Synchronous Parallel Interface and of the SSI interface, the decision between 204-byte format for MPEG-2-TS packets with 16 dummy bytes and 204-byte format for RS-coded MPEG-2-TS packets can be made:

– on the basis of the DVALID signal for the Synchronous Parallel Interface: a high level during the last 16 bytes indicates RS redundancy bytes (subclause 4.1.1 of EN 50083-9 [19]); or

– on the basis of the value of received synchronization bytes for the SSI interface: 47H indicates 204-byte format with 16 dummy bytes and B8H indicates 204-byte RS-coded (subclause A.3.2 of EN 50083-9 [19]).

For the case of the ASI Interface, the following decision is taken: If the packet size is 204 bytes, it is an RS-coded MPEG-2-TS packet.

Dummy bytes are discarded by the MPI function in the case of the 204-byte format with 16 dummy bytes.

The function shall meet the electrical/optical characteristics, return loss and jitter requirements specified in EN 50083-9 [19].

A Loss of Signal (LOS) is reported at the EMF if the function is in MON state if any of the following defects is detected: absence of valid input signals, absence of clock or a DVALID signal constantly low in the case of the Synchronous Parallel Interface.

#### 7.1.2.2 Signal processing in the transmitter

The function determines the transmission format to be used at the output interface according to Table 1.

**Table 1/J.131 – Transmission format of the output interface**

| Type of packets received by the MPI block | Transmission format on the physical interface | |
|---|---|---|
| MPEG-2-TS packets (188 bytes) | SPI, SSI: | 188-byte packets or 204-byte packets with 16 dummy bytes, according to the parameter FORMAT provided by the EMF block |
| | ASI: | 188-byte packets |
| RS-coded MPEG-2-TS packets (204 bytes) | SPI, SSI, ASI: | 204-byte packets |

The function generates the appropriate signals at the output interface, according to the type of physical interface and to the transmission format selected:

– For the Synchronous Parallel Interface, the function generates the Data (0-7), the DVALID, PSYNC and clock signals, as specified in subclause 4.1 of EN 50083-9 [19].

– For the SSI interface, the processing includes parallel-to-serial conversion, bi-phase coding, amplifier/buffer and optical emitter (for fibre-optic-based link) or coupling/impedance matching (for coaxial cable), as specified in Annex A of EN 50083-9 [19].

– For the ASI interface, the processing includes 8B/10B coding, FC comma symbols insertion, parallel-to-serial conversion, amplifier buffer and optical emitter (for fibre-optic-based link) or coupling/impedance matching (for coaxial cable), as specified in Annex B of EN 50083-9 [19].

The function shall meet the electrical/optical characteristics, return loss and jitter requirements specified in EN 50083-9 [19].

## 7.2 MPEG/ATM Adaptation (MAA)

The MPEG/ATM Adaptation (MAA) utilizes the AAL type 1. The AAL type 1 is described in Recommendation I.363.1 [9] where its functions are described for all corresponding applications. Specifically, the utilization of the AAL1 for the transport of MPEG-2 constant bit rate television signals is described in clause 7/J.82 [12]. As a result, the description of the MPEG/ATM Adaptation is based on clause 7/J.82 [12]. The structure of AAL type 1 is given in Figure 3. The SAR-PDU (Segmentation and Reassembly – Protocol Data Unit) payload of 47 octets is headed by an SAR-PDU header of 8 bits. For the transmission, the payload data is protected by an FEC scheme.

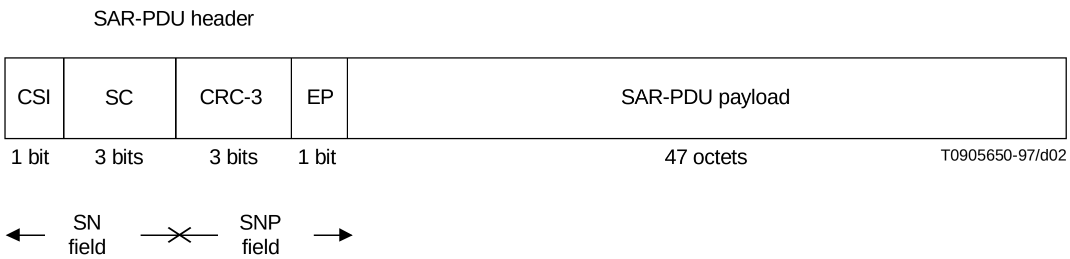



**Figure 3/J.131 – Structure of AAL type 1**

To prevent alarms being raised and failures being reported during set-up procedures, or if the input port is not in use (in the case of a multi-port equipment), the MAA function shall have the ability to enable or disable fault case declaration. The MAA shall either be monitored (MON) or not monitored (NMON). The state MON or NMON is provisioned by the equipment manager to the MAA via the EMF function.

### 7.2.1 Signal processing in the transmitter (Signal flow from b to c in Figure 1)

The MAA accepts signals from the MPI and conveys them to the VPE by using a transmitting AAL1. From the protocol stack point of view, signals are transported from the AAL-SAP (AAL-Service Access Point) to the ATM-SAP.

Functions to be performed are those of the AAL1-CS (Convergence Sublayer) and of the AAL1-SAR (Segmentation and Reassembly). The results of these functions are used to set the appropriate fields of the SAR-PDU header. The SAR Sublayer accepts a 47-octet block of data from the CS layer and prepends a one-octet SAR-PDU header.

a) *Handling of user information (CS function)*

   In compliance with 7.1/J.82 [12], the length of the AAL-SDU (Service Data Unit) is one octet.

b) *Handling of lost and misinserted cells (SC field) (CS function)*

   In the transmitting CS this function is related to the Sequence Count (SC) processing. After processing, the 3-bit sequence count value is passed to the transmitting SAR in order to be inserted in the SC field of the SAR-PDU header (see 7.3/J.82 [12]).

c) *Handling of the timing relationship (CS function)*

   As it is stated in 7.4/J.82 [12], the adaptive clock method shall be used. In this method, no function is to be performed in the transmitting CS.

d) *Forward error correction for SAR-PDU payload (CS function)*

   This function is performed by the method described in detail in 2.5.2.4.2/I.363.1 [9]. As stated in 7.5/J.82 [12], this method shall be used.

   Basically the method combines octet interleaving (the size of the interleaver is 128 × 47 octets), and FEC using RS (124, 128) codes.

   In the transmitting CS, 4 octets of Reed Solomon code are appended to 124 successive octets of incoming data from the AAL-SAP. The resulting 128-octet long blocks are then forwarded to the octet interleaver. See Figure 4 for the format of the interleaver matrix.

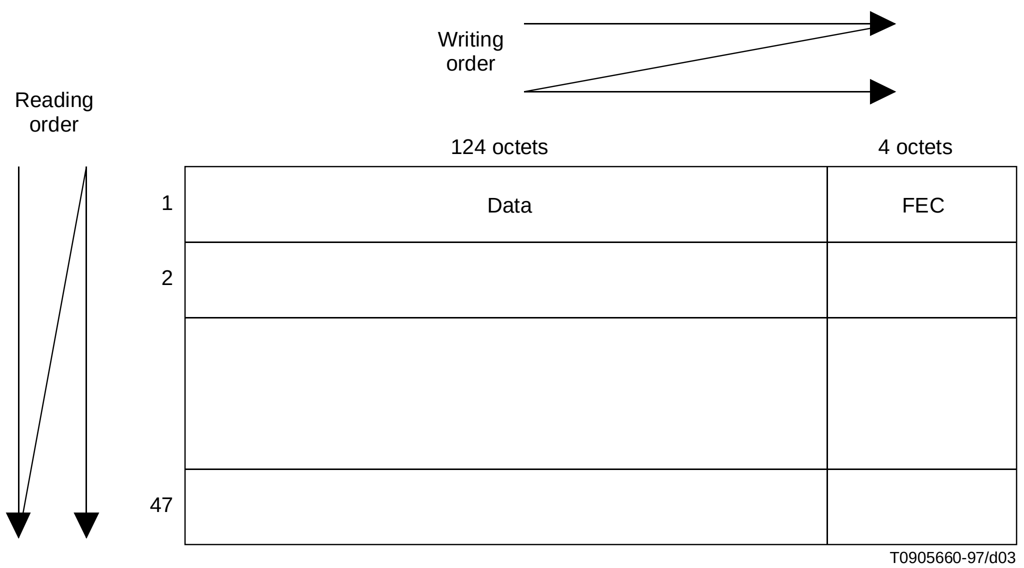



**Figure 4/J.131 – Structure and format of the interleaver matrix**

The octet interleaver is organized as a matrix of 128 columns and 47 rows. In the transmitting CS, the interleaver is operated as follows: at the input, incoming 128-octet long blocks are stored row by row (one block corresponding to one row); at the output, octets are read out column by column. The matrix has $128 \times 47 = 6016$ octets, corresponding to 128 SAR-PDU payloads. These 128 SAR-PDU payloads constitute one CS-PDU.

When MPEG-2-TS packets of 188 octets are transmitted by the MPI, then the interleaver contains exactly 31 MPEG-2-TS packets. In the case of the option in which RS-coded MPEG-2-TS packets of 204 octets are transmitted, then the number of RS-coded MPEG-2-TS packets contained in the interleaver is not an integer number. This has no impact on the processing.

Columns from the interleaver are then passed to the SAR where a SAR-PDU header is put in front of each of them.

e) *Synchronization of the CS-PDU (CS function)*

The CSI bit is used to synchronize the interleaving matrix, i.e. the CS-PDU. Following 7.5/J.82 [12], the CSI bit is set to "1" for the first SAR-PDU payload of the CS-PDU.

f) *Protection of the sequence number field (SAR function)*

The first four bits of every SAR-PDU header form the Sequence Number (SN) field. This SN field is protected by a 3-bit CRC code following the calculation described in 2.4.2.2/I.363.1 [9]. The result of this calculation, the remainder of the division (modulo 2) by the generator polynomial $x^3 + x + 1$ of the product $x^3$ multiplied by the content of the SN field, is written into the CRC field.

g) *Protection of the SAR-PDU header (SAR function)*

The first seven bits of each SAR-PDU header are protected by an even parity check bit that is written into bit EP of the actual SAR-PDU header.

The AAL1 SAR passes 48-octet blocks to the VPE.

### 7.2.2 Signal processing in the receiver (Signal flow from c to b in Figure 1)

The MAA receives signals from the VPE block and conveys them to the MPI block by using a receiving AAL1. From the protocol stack point of view, signals are transported from the ATM-SAP (ATM-Service Access Point) to the AAL-SAP.

Functions to be performed are those of the AAL1-SAR (Segmentation and Reassembly) and of the AAL1-CS (Convergence Sublayer). The content of the SAR-PDU header is evaluated in order to specify relevant functions of the AAL1-SAR respectively of the AAL1-CS.

The MAA receives from the VPE 48-octet long blocks corresponding to cell payloads. The SAR separates the SAR-PDU header (one octet) and passes the 47-octet block of data to the receiving CS.

a) *Evaluation of the SNP field (CRC-3 field and EP bit) (SAR function)*

The SAR protocol is described in 2.4.2/I.363.1 [9]. After processing of the SNP field (Sequence Number Protection), the Sequence Count field and the CSI bit are passed to the receiving CS together with the SN check status indicator (valid or invalid). The use of the SN check status together with the considered processing is described in detail in 2.4.2.2/I.363.1 and in Table 1/I.363.1 [9].

If the SN check status indicator has been set to invalid, a SNI (Sequence Number Invalid) indication is forwarded to the EMF.

b) *Handling of user information (CS function)*

In compliance with 7.1/J.82 [12], the length of the AAL-SDU (Service Data Unit) is one octet and the status parameter is used. As mentioned in Recommendation I.363.1 [9], the status parameter possesses two values: "valid" and "invalid". "Invalid" is used in the case where errors have been detected and have not been corrected [for the use of this parameter, see description under e)].

c) *Handling of lost and misinserted cells (CS function)*

Detection of lost and misinserted cell events is performed by using the Sequence Count (SC) value transmitted by the receiving SAR. The CS processing for SC operation is described in detail in 2.5.2.1.2 /I.363.1 [9].

In the receiving AAL1-CS, the processing is as follows: the SC is processed in order to detect cell loss events. In case of a detected cell loss, 47 dummy octets are inserted in the signal flow in order to maintain bit count integrity. Detected misinserted cells are merely discarded.

Lost and Misinserted Cells (LMC) events are transmitted to the EMF.

d) *Handling of the timing relationship (CS function)*

The end-to-end synchronization function is performed by the adaptive clock method described in 2.5.2.2.2/I.363.1 [9]. A short description of the method is given in Appendix I. It is pointed out that the adaptive clock method does not need any external clock to be operated.

e) *Correction of bit errors and lost cells (CS function)*

In the receiving AAL1-CS, the mechanism in the interleaver is the inverse of that of the transmitting interleaver, i.e. the writing order is vertical and the reading order is horizontal. Information is stored in the receiving interleaver column by column. In the case of insertion of dummy octets, an indication is provided in order to enable the use of the erasure mode of the RS codes. After the whole interleaving matrix has been stored, it is read out block by block to the RS decoder where errors and erasures are corrected.

Correction capabilities are up to 4 cell losses in a group of 128 cells and up to 2 errored octets in a block of 128 octets. It ensures that, under normal transmission conditions, the received MPEG-2-TS flow is quasi error free.

If the RS decoder is unable to correct the errors, then the "status" indicator of the AAL-SAP shall be used (see 7.1/J.82 [12]) in order to signal this error. The indicator is passed to the MPI block and to the EMF.

## 7.3 Virtual Path Entity (VPE)

Among all the functions referenced in Recommendation I.732 [11] for this functional block, only the VP setting is ensured. This function only concerns the signal flow from point c to point d in Figure 1. The ATM cell header that contains the Virtual Path Identifier (VPI) is organized as shown in Figure 5.

| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | bit / byte |
|---|---|---|---|---|---|---|---|---|
| Generic Flow Control (GFC) | | | | Virtual Path Identifier (VPI) | | | | 1 |
| Virtual Path Identifier (VPI) | | | | Virtual Channel Identifier (VCI) | | | | 2 |
| Virtual Channel Identifier (VCI) | | | | | | | | 3 |
| Virtual Channel Identifier (VCI) | | | | Payload Type (PT) Field | | | CLP | 4 |
| Header Error Control (HEC) | | | | | | | | 5 |

**Figure 5/J.131 – Structure of an ATM cell header**

### 7.3.1 Signal processing in the transmitter (Signal flow from c to d in Figure 1)

*VP setting*

The VPI value is processed in accordance with the assigned values. As far as no VC-related block is implemented in the Network Adapter, VC setting is also performed in this block to the fixed value 0020h. VPI value 00h is forbidden. Any other value may be used. However, it is suggested the VPI values listed in Table 2 be used:

**Table 2/J.131 – Default values for the setting of the VPI**

| Number of MPEG-2-TS to be simultaneously transported | MPEG-2-TS number | VPI value |
|---|---|---|
| 1 | MPEG-2-TS No. 1 | 11h |
| 2 | MPEG-2-TS No. 1<br>MPEG-2-TS No. 2 | 11h<br>12h |
| 3 | MPEG-2-TS No. 1<br>MPEG-2-TS No. 2<br>MPEG-2-TS No. 3 | 11h<br>12h<br>13h |
| 4 | MPEG-2-TS No. 1<br>MPEG-2-TS No. 2<br>MPEG-2-TS No. 3<br>MPEG-2-TS No. 4 | 11h<br>12h<br>13h<br>14h |
| 5 | MPEG-2-TS No. 1<br>...<br>MPEG-2-TS No. 4<br>MPEG-2-TS No. 5 | 11h<br>...<br>14h<br>15h |
| 6 | MPEG-2-TS No. 1<br>...<br>MPEG-2-TS No. 5<br>MPEG-2-TS No. 6 | 11h<br>...<br>15h<br>16h |
| 7 | MPEG-2-TS No. 1<br>...<br>MPEG-2-TS No. 6<br>MPEG-2-TS No. 7 | 11h<br>...<br>16h<br>17h |
| 8 | MPEG-2-TS No. 1<br>...<br>MPEG-2-TS No. 7<br>MPEG-2-TS No. 8 | 11h<br>...<br>17h<br>18h |

The VPI values used are setable by the EMF. The default values used are in accordance with Table 2 above.

### 7.3.2 Signal processing in the receiver (Signal flow from d to c in Figure 1)

No function of the VPE is implemented in this direction.

## 7.4 Virtual Path Multiplexing Entity (VPME)

This functional block is responsible for the adaptation between an ATM cell structure and a PDH transmission path structure. The partitioning of the VPME into functional blocks as described below is in accordance with Recommendation I.732 [11]. The organization of the ATM cell header whose content is partly set in this functional block is shown in Figure 5.

In order to prevent alarms being raised and failures being reported during path provisioning, the VPME function shall have the ability to enable or disable fault cause declaration. The Virtual Path Multiplexing Entity shall be either monitored (MON) or not monitored (NMON). The state MON or NMON is provisioned by the equipment manager to the VPME via the EMF function. The state of the VPME and the associated PPT and PPI shall be identical.

### 7.4.1 Signal processing in the transmitter (Signal flow from d to e in Figure 1)

a) *VP multiplexing*

This function enables individual cell flows to be logically combined into a single cell flow according to the VPI values.

b) *Congestion control*

This function is not used in this equipment. The cell loss priority bit CLP shall be set to "0" (corresponding to high cell priority in ATM terminology).

GFC: This function is not used in this equipment. The GFC field shall be set to "0000" (corresponding to uncontrolled equipment in ATM technology).

c) *PT field*

This function is not used in this equipment. The three bits of the PT field shall be set to "000".

d) *Cell rate decoupling*

Idle cells are inserted into the cell stream in order to match the rate of the PDH transmission path payload (i.e. the useful rate of the PDH path) in accordance with Recommendation I.432 [10]. The format of the idle cell shall be in accordance with Recommendation I.432 [10]. It is described in Figure 6.

| | | | |
|---|---|---|---|
| Octet 1 | 00h | | |
| Octet 2 | 00h | | |
| Octet 3 | 00h | | ATM cell header |
| Octet 4 | 01h | | |
| Octet 5 | 52h | (Valid HEC) | |
| Octets 6 to 53 | 6Ah | | ATM cell information field |

**Figure 6/J.131 – Idle cell format**

e) *HEC processing*

The HEC value for each cell is calculated and inserted into the HEC field. The method of HEC value calculation shall be in accordance with Recommendation I.432 [10]. Basically, the HEC field is the remainder of the division (modulo 2) by the generator polynomial $x^8 + x^2 + x + 1$ of the product $x^8$ multiplied by the content of the header excluding the HEC field, to which is added the value 55h.

f) *Scrambling*

The information field of each cell is scrambled with a self-synchronizing scrambler $x^{43} + 1$. The operation of the scrambler shall be in accordance with Recommendation I.432 [10].

g) *Cell stream mapping*

The cell stream shall be inserted into PDH transmission path payload which shall be in accordance with Recommendation G.804 [4] . The mapping into 44 736 kbit/s shall be HEC-based as described in 7.3/G.804 [4]. The cell boundaries are aligned with the transmission path octet boundaries if an octet structure is considered.

### 7.4.2 Signal processing in the receiver (Signal flow from e to d in Figure 1)

a) *Cell stream demapping*

The cell stream shall be extracted from PDH transmission path payload which shall be in accordance with Recommendation G.804 [4]. The demapping of cells out of the 44 736 kbit/s data stream has to take into account the HEC-based mapping scheme mentioned in 7.4.1 g) above. The cell boundaries are aligned with the transmission path octet boundaries if an octet structure is considered.

b) *Cell delineation*

Cell delineation is performed on the continuous cell stream extract from the transmission path frames. The cell delineation algorithm shall be in accordance with Recommendation I.432 [10]. Basically, it is based on the correlation between the header bits to be protected (32 bits) and the relevant control bits (8 bits) introduced in the header by the HEC. Cell delineation is deemed to be lost causing a LCD defect after 7 consecutive incorrect HECs. Cell delineation is deemed to be recovered after 6 consecutive correct HECs. If the function is in the MON state, the LCD defect is reported to the EMF.

c) *Descrambling*

The information field of each cell is descrambled with a self-synchronizing scrambler polynomial $x^{43} + 1$. The operation of the descrambler shall be in accordance with Recommendation G.804 [4].

d) *HEC processing*

HEC verification and correction are based on the methods described in Recommendation I.432 [10]. The HEC correction mode may be activated/deactivated by the EMF. In case of cells determined to have an invalid and uncorrectable HEC pattern, two options are possible. Either the invalid cells may be discarded (in accordance with Recommendation I.432 [10]) or the invalid cells may not be discarded (not in accordance with Recommendation I.432 [10]). The wanted option is selected by the EMF. Further information is given in Appendix II.

e) *Cell rate decoupling*

Idle cells are extracted from the cell stream. They are identified by the standardized pattern for the cell header.

f) *PT identification*

This function is not implemented. The corresponding bits are ignored.

g) *Cell header verification*

The receiving Network Adapter shall verify that the first four octets of the ATM cell header are recognizable as being a valid header pattern. Invalid header pattern is (p = any value) given in Figure 7.

| GFC | VPI | VCI | PT | CLP |
|---|---|---|---|---|
| pppp | 0000 0000 | 0000 0000 0000 0000 | ppp | 1 |

**Figure 7/J.131 – Invalid header pattern**

Idle cells are discarded.

h) *GFC check*

This function is not implemented. The corresponding bits of the GFC field are ignored.

i) *VPI verification*

The receiving Network Adapter shall verify that the VPI of the received cell is valid. If the VPI is determined to be invalid (i.e. out-of-range or unassigned – see 7.3.1, item "VP setting"), the cell shall be discarded.

j) *Congestion control*

This function is not implemented. The corresponding bit CLP is ignored.

h) *VP demultiplexing*

This function enables the flow of cells which have to be logically separated into individual data flows according to their VP values.

## 7.5 PDH Path Layer Trail Termination (Pqs_TT)

Based on the hierarchical bit rates of 1544 kbit/s, 2048 kbit/s, 6312 kbit/s, 34 368 kbit/s, 44 736 kbit/s and 139 264 kbit/s, the references to Recommendations and information for the PDH path layer trail termination are given in Table 3.

**Table 3/J.131 – References for the Pqs_TT functions**

| Bit rate | Function name | Frame structure Recommendation | Atomic functions |
|---|---|---|---|
| 2 Mbit/s | P12s_TT | G.704 | See [17] |
| 34 Mbit/s | P31s_TT | G.832 | See [17] |
| 140 Mbit/s | P4s_TT | G.832 | See [17] |
| 1.5 Mbit/s | P11s_TT | G.704 | For further study |
| 6 Mbit/s | P21s_TT | G.704 | For further study |
| 45 Mbit/s | P32s_TT | G.704 | For further study |

## 7.6 PDH Physical Section Layer to PDH Path Layer Adaptation (Eq/Pqs_A)

Based on the hierarchical bit rates of 1544 kbit/s, 2048 kbit/s, 6312 kbit/s, 34 368 kbit/s, 44 736 kbit/s and 139 264 kbit/s, the references to Recommendations and information for the PDH physical section layer are given in Table 4.

**Table 4/J.131 – References for the Eq/Pqs_A functions**

| Bit rate | Function name | Frame structure Recommendation | Atomic functions |
|---|---|---|---|
| 2 Mbit/s | E12/P12s_A | G.704 | Annex D/G.783 |
| 34 Mbit/s | E31/P31s_A | G.832 | See [16] |
| 140 Mbit/s | E4/P4s_A | G.832 | See [16] |
| 1.5 Mbit/s | E11/P11s_A | G.704 | Annex D/G.783 |
| 6 Mbit/s | E21/P21s_A | G.704 | For further study |
| 45 Mbit/s | E32/P32s_A | G.704 | For further study |

## 7.7 PDH Physical Section Layer Trail Termination (Eq_TT)

Based on the hierarchical bit rates of 1544 kbit/s, 2048 kbit/s, 6312 kbit/s, 34 368 kbit/s, 44 736 kbit/s and 139 264 kbit/s, the references to Recommendations and information for the PDH physical section trail termination are given in Table 5.

**Table 5/J.131 – References for the Eq_TT functions**

| Bit rate | Function name | Physical characteristics Recommendation | Atomic functions |
|---|---|---|---|
| 2 Mbit/s | E12_TT | G.703 | Annex D/G.783 |
| 34 Mbit/s | E31_TT | G.703 | Annex D/G.783 |
| 140 Mbit/s | E4_TT | G.703 | Annex D/G.783 |
| 1.5 Mbit/s | E11_TT | G.703 | Annex D/G.783 |
| 6 Mbit/s | E21_TT | G.703 | Annex D/G.783 |
| 45 Mbit/s | E32_TT | G.703 (Note) | Annex D/G.783 |
| NOTE – Further information is available in [20]. | | | |

## 7.8 Equipment Management Function (EMF)

### 7.8.1 Overview of the EMF

The EMF provides the means through which the Network Element (NE) is managed by an external manager. The EMF interacts with the other basic functions by exchanging information across the MP (Management Points) reference points. The EMF contains a number of filters that provide a data reduction mechanism on the information received across the MP reference points.

The interface between the processing in the basic functions and the equipment management function is indicated by the dashed line in Figure 8 and represents the MP reference points. For performance monitoring, the signals passed over this interface are the 1 second Near (Far)-end Errored Block Counts (N_EBC, F_EBC) and the 1 second Near (Far)-end Defect Seconds (N_DS, F_DS). For fault management, the signals passed over this interface are the defects.

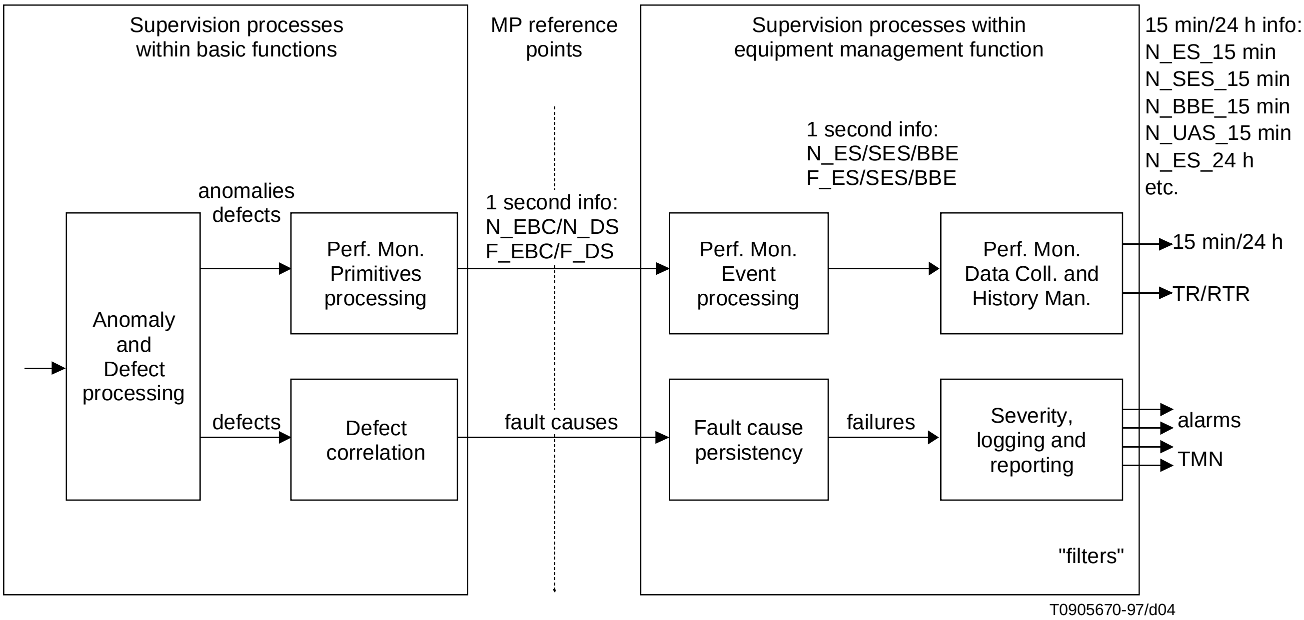



**Figure 8/J.131 – Supervision process within equipment management function**

The filtering functions provide a data reduction mechanism on the defect and performance monitoring primitives information presented at the MP reference points. Two types of techniques can be distinguished:

a) The fault cause persistency filter will provide a persistency check on the fault causes that are reported across the MP reference points. In addition to the transmission failures listed in Table 6, hardware failures with signal transfer interruption are also reported at the input of the fault cause filter for further processing.

b) The performance monitoring event processing processes the information available from the one-second window and reported across the MP reference points in order to derive errored seconds and severely errored seconds, and background block errors (see Recommendation G.826 [5]).

**Time-stamping**

Events, performance reports and registers containing event counts that require time-stamping shall be time stamped with a resolution of one second. The time shall be as indicated by the local real time clock of the NE. The required accuracy and precise details of the time-stamping of events/reports relative to UTC is the subject of further study (a maximum value in the range 1 to 10 seconds is being considered). The start of 15-minute and 24-hour counts should be accurate to within ± 10 seconds with respect to the NE clock.

**Table 6/J.131 – Basic function associated failure list**

| Basic functions | Failure |
|---|---|
| Pqs_TT, Eq_TT, Eq/Pqs_A | See G.783 [3] or ETS 300 417-2-1 [16] or ETS 300 417-5-1 [17] |
| VPME | LCD |
| VPE | |
| MAA | STATUS<br>SNI<br>LMC |
| MPI | LOS<br>TSLE_I<br>TSLE_O |

### 7.8.2 Configuration

The information flow over the MP reference points that arises from configuration and provisioning data is given in Table 7. The information listed under "Set" refers to configuration and provisioning data that is passed from the EMF to the other basic functions. The information listed under "Get" refers to status reports made in response to a request from the EMF for such information.

**Table 7/J.131 – Command, configuration information flow over MP**

| | Get | Set |
|---|---|---|
| Pqs_TT, Eq_TT, Eq/Pqs_A | See G.783 [3] or ETS 300 417-2-1 [16] or ETS 300 417-5-1 [17] | See G.783 [3] or ETS 300 417-2-1 [16] or ETS 300 417-5-1 [17] |
| VPME | Cell Discarded: Active or Not_Active<br>HEC correction mode: Active or Not_Active<br>VPI value | Supervision State: MON or NMON (Note 1)<br>Cell Discarded: Active or Not_Active<br>HEC correction mode: Active or Not_Active |
| VPE | | Supervision State: MON or NMON (Note 2)<br>VPI value |
| MAA | | Supervision State: MON or NMON (Note 2) |
| MPI | Supervision State: MON or NMON<br>Number of packets per second<br>Option for system A (European system):<br>FORMAT: 188 or 204 bytes packet with 16 dummy bytes (Note 3) | Supervision State: MON or NMON (Note 2)<br><br>Option for system A (European system):<br>FORMAT: 188 or 204 bytes packet with 16 dummy bytes (Note 3) |

NOTE 1 – Eq_TT and associated Pqs_TT and VPME are always in the same supervision state.

NOTE 2 – For a given MPEG interface, MPI and associated MAA and VPE are in the same state.

NOTE 3 – This status is only relevant for the selection of the transmission format (188 bytes or 204 with 16 dummy bytes) to be used at an output SSI or SPI interface for the delivery of MPEG-2-TS packets.

### 7.8.3 Fault (maintenance) management

#### 7.8.3.1 Fault cause persistency filter

The equipment management function within the network element performs a persistency check on the fault causes before it declares a fault cause a failure. A transmission failure shall be declared if the fault cause persists continuously for 2.5 ± 0.5 seconds. The failure shall be cleared if the fault cause is absent continuously for 10 ± 0.5 seconds. Transmission failures associated with the basic functions are listed in Table 6.

#### 7.8.3.1.1 Alarm history management

Alarm history management is concerned with the recording of alarms. Historical data shall be stored in registers in the NE. Each register contains all the parameters of an alarm message. Registers shall be readable on demand or periodically. The operator can define the operating mode of the registers as wrapping or stop when full. The operator may also flush the registers or stop recording at any time.

NOTE – Wrapping is the deletion of the earliest record to allow a new record when a register is full. Flushing is the deletion of all the records.

### 7.8.4 Performance management

Performance management consists of performance monitoring event processes, data collection and history processes along with thresholding and reporting functions. Performance monitoring consists of the first three items.

Within performance monitoring, the concepts of "near-end" and "far-end" are used to refer to performance monitoring information associated with the two directions of transport in the case of a bidirectional transmission path. For a trail from A to Z:

– at node A the near-end information represents the performance of the unidirectional trail from Z to A, while the far-end information represents the performance of the unidirectional trail from A to Z;

– at node Z the near-end information represents the performance of the unidirectional trail from A to Z, while the far-end information represents the performance of the unidirectional trail from Z to A.

At either end of the trail (A or Z), the combination of near-end and far-end information presents the performance of the two directions of the trail.

#### 7.8.4.1 Performance monitoring event process

The performance monitoring event processing processes the information available from the performance monitoring primitives processing (basic functions) giving the performance primitives (EBC and DS) to derive the performance events (errored seconds, severely errored seconds and background block errors).

*Near-end Performance Monitoring Event (NPME) function*

Figure 9 presents the processes and their interconnect within the Near-end Performance Monitoring Event (NPME) function. This function processes information from PPT and MPI functional blocks.

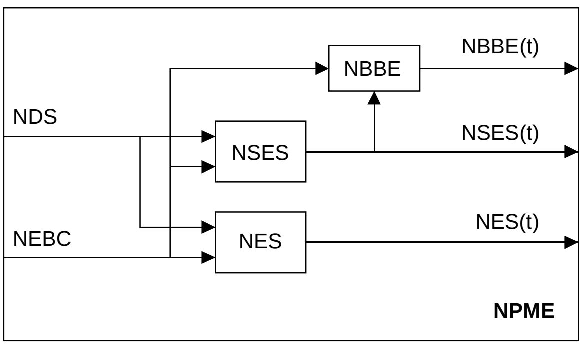



**Figure 9/J.131 – Near-end Performance Monitoring Event (NPME) function**

A Near-end Errored Second (NES) shall be generated if the defect second (NDS) is set or if the Near-end Errored Block Count (NEBC) is greater or equal to 1: NES(t) ← (NDS = true) or (NEBC ≥ 1).

A Near-end Severely Errored Second (NSES) shall be generated if the Near-end Defect Second (NDS) is set or if the Near-end Errored Block Count (NEBC) is greater or equal to 30% of the blocks in a one-second period: NSES(t) ← (NDS = true) or (NEBC ≥ "30% of blocks in a one-second period").

The number of Near-end Background Block Errors (NBBE) in a one-second period shall be equal to the Near-end Errored Block Count (NEBC) if the second is not a Near-end Severely Errored Second (NSES). Otherwise (NSES is set), NBBE shall be zero. NBBE(t) ← NEBC (NSES = false) or 0 (NSES = true).

*Far-end Performance Monitoring Event (FPME) function*

Figure 10 presents the processes and their interconnect within the Far-end Performance Monitoring Event (FPME) function. This function processes information from PPT functional blocks in case of bidirectional transmission.

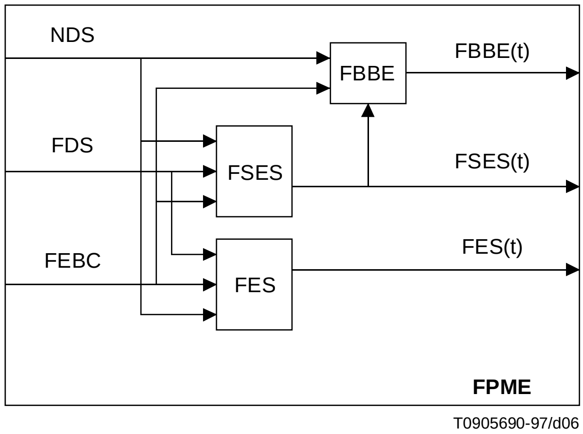



**Figure 10/J.131 – Far-end Performance Monitoring Event (FPME) function**

A Far-end Errored Second (FES) shall be generated if the Far-end Defect Second (FDS) is set or if the Far-end Errored Block Count (FEBC) is greater or equal to 1, and if that second is not a Near-end Defect Second (NDS): FES(t) ← (NDS = false) and [(FDS = true) or (FEBC ≥ 1)].

A Far-end Severely Errored Second (FSES) shall be generated if the Far-end Defect Second (FDS) is set or if the Far-end Errored Block Count (FEBC) is greater or equal to 30% of the blocks in a one-second period, and that second is not a Near-end Defect Second (NDS): FSES(t) ← (NDS = false) and [(FDS = true) or (FEBC ≥ "30% of blocks in a one second period")].

The number of Far-end Background Block Errors (FBBE) in a one-second period shall be equal to the Far-end Errored Block Count (FEBC) if the second is not a Far-end Severely Errored Second (FSES), and if that second is not a Near-end Defect Second (NDS). Otherwise, FBBE shall be zero:

FBBE(t) ← FEBC (FSES = false and NDS = false) or 0 (FSES = true or NDS = true).

#### 7.8.4.2 Performance data collection

Performance data collection refers to the event counting associated with each of the performance events BBE, ES, SES as defined in Recommendation G.826 [5], and any additional performance parameter defined in this ETS. The collection as specified in Recommendation M.2120 [14] is based on information for each direction of transport independently. This type is further referred to as performance data collection for maintenance purposes. This type of collection counts the events over fixed time periods of 15 minutes and 24 hours. Counting is stopped during unavailable time. These counters operate as follows:

**15-minute counter**

The performance events (e.g. SES) are counted in a counter per event. These counters are called the current registers. At the end of the 15-minute period, the contents of the current registers are transferred to the first of the recent registers, with a time-stamp to identify the 15-minute period (including the day), after which the current register shall be reset to zero (see Note). It is an option not to transfer the content of a current register to a recent register if this content is zero.

NOTE – A capability should be provided to insure that, in the absence of reports, the reporting process is functioning properly.

It shall be possible to reset an individual current register to zero by means of an external command.

Any register whose content is suspect shall be flagged, using the "suspect interval flag" provided in Recommendation Q.822 [15]. This flag shall be raised independently for far-end and near-end counts. Examples of conditions for raising this flag are provided in Recommendation Q.822 [15].

**24-hour counter**

The performance events (e.g. SES) are counted in a counter per event, independent of the 15-minute counters. These counters are called the current registers. It was agreed that it is up to the NE implementation to update the register counts. It is not required that it shall be done on a second by second basis. At the end of the 24-hour period, the contents of the current registers are transferred to recent registers, with a time-stamp to identify the 24-hour period, after which the current register shall be reset to zero. It shall be possible to reset an individual current register to zero by means of an external command.

Any register whose content is suspect shall be flagged, using the "suspect interval flag" provided in Recommendation Q.822 [15]. This flag shall be raised independently for far-end and near-end counts. Examples of conditions for raising this flag are provided in Recommendation Q.822 [15].

#### 7.8.4.2.1 Performance data collection during unavailable time

The onset and exit of unavailable time is defined in Annex A/G.826 [5] and in Recommendation M.2120 [14]. A period of unavailable time begins at the onset of ten consecutive SES. These ten seconds are part of unavailable time. A period of available time begins at the onset of ten consecutive non-SES. These ten seconds are part of available time. Performance monitoring event counting for ES, SES, and BBE shall be inhibited during unavailable time.

### 7.8.4.3 Availability data collection

When a period of unavailability occurs, the beginning and ending of this period should be stored in a log in the NE, and as a consequence time-stamped. The NE should be able to store these data for at least 6 periods of unavailability.

### 7.8.4.4 Performance monitoring history

Performance history data are necessary to assess the recent performance of transmission systems. Such information can be used to sectionalise faults and to locate the source of intermittent errors. Historical data, in the form of performance monitoring event counts, may be stored in registers in the NE or in mediation devices associated with the NE. For specific applications, for example when only Quality of Service alarms are used, historical data may not be stored. All the history registers shall be time-stamped. The history registers operate as follows (see also Figure 11):

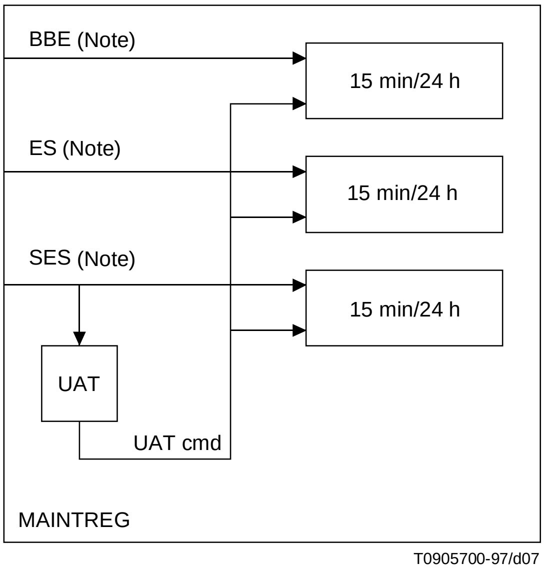
**15-minute registers**

The history of the 15-minute monitoring is contained in a stack of 16 registers per monitored event. These registers are called the recent registers. Every 15 minutes, the contents of the current registers are moved to the first of the recent registers. When all 15-minute registers are used, the oldest information will be discarded.

**24-hour registers**

The history of the 24-hour monitoring is contained in a single register per monitored event. This register is called the recent register. Every 24 hours, the contents of the current registers are moved to the recent register.

NOTE – This implies that all 24-hour data are discarded after 24 hours.




NOTE – The determination of (un)available time introduces (functionally) a delay of 10 seconds. This delay should be considered when counting BBE, ES, SES.

**Figure 11/J.131 – Performance monitoring data collection and history for maintenance purposes**

### 7.8.4.5 Performance data reporting

Performance data stored in the NE may be collected by the operator for analysis without affecting the content of the register.

# Appendix I

## Mechanisms of the adaptive clock method

The adaptive clock method is a general method for source clock frequency recovery. No explicit timing information of the source clock is transported by the network; the method is based on the fact that the amount of transmitted data is an indication of the source frequency, and this information can be used at the receiver to recover the source clock frequency.

The adaptive clock method is implemented at the receiving AAL. The implementation of the method is not standardized. One possible method to measure the amount of data is to use the fill level of the AAL user data buffer. The following is the general description of this method and does not preclude other adaptive clock methods.

The receiver writes the received data into a buffer, and then reads it out using a locally-generated clock. Therefore the fill level of the buffer depends on the source frequency and it is used to control the frequency of the local clock. Operations are the following: the fill level of the buffer is continuously measured and the measure is used to drive the phase-locked loop generating the local clock. The method maintains the fill level of the buffer around its medium position. To avoid buffer underflow or overflow, the fill level is maintained between two limits. When the level in the buffer goes to the lower limit, this means the frequency of the local clock is too high compared to the one of the source and so it has to be decreased; when the level in the buffer goes to upper limit, the frequency of the local clock is too low compared to the one of the source, and so it has to be increased.

It is pointed out that the compensation of cell delay variation is also performed by the adaptive clock method. However, a cell delay variation is not to be expected if no ATM network is to be crossed.

# Appendix II

## Enabling/disabling the Header Error Control functions

The Header Error Control (HEC) functions of the ATM cells, as described in Recommendation I.432 [10], can correct single errors and detect almost all multiple errors in the header. In an ATM network, when the HEC detects errors that it cannot correct, the whole cell is discarded and its payload is lost for an end-to-end connection.

When a FEC is applied on a link, it can generate error bursts if it fails to correct errors. In presence of error bursts, the single-bit correcting code of the HEC is unable to correct most errors encountered. In an error bursts environment, the probability of discarding cells is proportional to the BER and not to the square of the BER as in a random error environment. Although bursts of errors due to error correction failures have different lengths and rate of occurrence according to the different FEC schemes, this behaviour would apply to all transmission systems using FEC.

Therefore, for a given bit error probability, the discarded cell probability in presence of error bursts is definitely different from the discarded cell probability in presence of randomly distributed errors.

It is then recommended to disable the Header Error Control functions when using the ATM cell format for transporting an MPEG-2-TS over a PDH-network based on transmission systems using FEC (e.g. radio relays, satellites). This measure avoids unwanted and unnecessary degradation of the end-to-end quality.

# Appendix III

## Transmission capacity of the Network Adapter

Transmission capacity of the Network Adapter for MPEG-2-TSs and RS-coded MPEG-2-TSs at specified digital hierarchy bit rates of Recommendation G.702 [1].

| PDH link transmission capacity | Transmission capacity for MPEG-2-TSs and RS-coded MPEG-2-TSs (Note) |
|---|---|
| 1544 kbit/s | 1320 kbit/s |
| 2048 kbit/s | 1649 kbit/s |
| 6312 kbit/s | 5279 kbit/s |
| 34 368 kbit/s | 29 140 kbit/s |
| 44 736 kbit/s | 37 980 kbit/s |
| 139 264 kbit/s | 118 759 kbit/s |
| NOTE – Depending on the application, these figures may be slightly reduced. | |

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