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

Digital transmission of television signals

Transport mechanism for component-coded digital television signals using MPEG-2 4:2:2 P@ML including all service elements for contribution and primary distribution

ITU-T Recommendation J.89

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ITU-T RECOMMENDATION J.89

TRANSPORT MECHANISM FOR COMPONENT-CODED DIGITAL TELEVISION SIGNALS USING MPEG-2 4:2:2 P@ML INCLUDING ALL SERVICE ELEMENTS FOR CONTRIBUTION AND PRIMARY DISTRIBUTION

Summary

This Recommendation specifies the general transport mechanism for conveying all service elements needed for contribution and primary distribution applications of TV programs using MPEG-2 4:2:2 profile at Main level compression. The service elements provided to MPEG-2 coding systems are assumed to be (4:2:2) component video signals, studio quality audio signals and various data signals e.g. teletext and time code.

FOREWORD

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NOTE

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As of the date of approval of this Recommendation, the ITU had not 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.

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TRANSPORT MECHANISM FOR COMPONENT-CODED DIGITAL TELEVISION SIGNALS USING MPEG-2 4:2:2 P@ML INCLUDING ALL SERVICE ELEMENTS FOR CONTRIBUTION AND PRIMARY DISTRIBUTION

(Geneva, 1999)

1 Scope

This Recommendation specifies the general transport mechanism for conveying all service elements needed for contribution and primary distribution applications of TV programs using MPEG-2 4:2:2 profile at Main level compression. The service elements provided to MPEG-2 coding systems are assumed to be (4:2:2) component video signals, studio quality audio signals and various data signals e.g. teletext and time code. This Recommendation ensures the compatibility on level of bit-stream into a decoder. It is based on, and is in conformance with, the MPEG-2 standard ITU-T Rec. H.222.0 | ISO/IEC 13818-1 [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 edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

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

[2]   ITU-T Recommendation H.262 (1995) | ISO/IEC 13818-2:1996, *Information technology – Generic coding of moving pictures and associated audio information: Video*.

[3]   ISO/IEC 11172-3:1993, *Information technology – Coding of moving pictures and associated audio for digital storage media at up to about 1.5 Mbit/s – Part 3: Audio*.

[4]   ISO/IEC 13818-7:1997, *Information technology – Generic coding of moving pictures and associated audio information – Part 7: Advanced Audio Coding (AAC)*.

[5]   SMPTE 302-1998, *Television – Mapping of AES3 Data into MPEG-2 Transport Stream*.

[6]   Recommendation ITU-R BT.1364 (1998), *Format of ancillary data signals carried in digital component studio interfaces*.

[7]   Recommendation ITU-R BT.1304 (1997), *Checksum for error detection and status information in interfaces conforming with Recommendations ITU-R BT.656 and ITU-R BT.799*.

[8]   Recommendation ITU-R BT.1366 (1998), *Transmission of time code and control code in the ancillary data space of a digital television stream according to ITU-R BT.656, ITU-R BT.799 and ITU-R BT.1120*.

[9]   Recommendation ITU-R BT.1305 (1997), *Digital audio and auxiliary data as ancillary data signals in interfaces conforming to Recommendations ITU-R BT.656 and ITU-R BT.799*.

[10]   Recommendation ITU-R BT.653-3 (1998), *Teletext systems*.

[11]   Recommendation ITU-R BT.601-5 (1995), *Studio encoding parameters of digital television for standard 4:3 and wide-screen 16:9 aspect ratios*.

[12]   ITU-T Recommendation J.131 (1998), *Transport of MPEG-2 signals in PDH networks*.

[13]   ITU-T Recommendation J.132 (1998), *Transport of MPEG-2 signals in SDH networks*.

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

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

3   Terms and definitions

This Recommendation defines the following terms:

3.1   access unit: A coded representation of a presentation unit. In the case of audio, an access unit is the coded representation of an audio frame. In the case of video, an access unit includes all the coded data for a picture, and any stuffing that follows it, up to, but not including, the start of the next access unit. If a picture is not proceeded by a group_start_code or a sequence_header_code, the access unit begins with the picture_start_code. If a picture is preceded by a group_start_code and/or a sequence_header_code, the access unit begins with the first byte of the first of these start codes. If it is the last picture preceding a sequence_end_code in the bitstream, all bytes between the last byte of the coded picture and the sequence_end_code (including the sequence_end_code) belong to the access unit.

3.2   bit rate: The rate at which the compressed bit stream is delivered from the channel to the input of a decoder.

3.3   decoding time-stamp: A field that may be present in a PES packet header that indicates the time that an access unit is decoded in the system target decoder.

3.4   packet identifier: A unique integer value used to identify elementary streams of a program in a single or multi-program transport stream as described in 2.4.3 of ITU-T Rec. H.222.0 │ ISO/IEC 13818-1 [1].

3.5   payload: Payload refers to the bytes which follow the header bytes in a packet. For example, the payload of some transport stream packets includes a PES_packet_header and its PES_packet_data_bytes, or pointer_field and PSI sections, or private data: but a PES_packet_payload consists of only PES_packet_data_bytes. The transport stream packet header and adaptation fields are not payload.

3.6   PES packet: The data structure used to carry elementary stream data. A PES packet consists of a PES packet header followed by a number of contiguous bytes from an elementary data stream. It is a layer in the system coding syntax described in 2.4.3.6 of ITU-T Rec. H.222.0 | ISO/IEC 13818-1 [1].

3.7   PES packet header: The leading fields in a PES packet up to and not including the PES_packet_data_byte fields, where the stream is not a padding stream. In the case of a padding stream the PES packet header is similarly defined as the leading fields in a PES packet up to and not including padding_byte fields.

3.8   PES Stream: A PES stream consists of PES packets, all of whose payloads consist of data from a single elementary stream, and all of which have the same stream_id. Specific semantic constraints apply. Refer to Intro. 4 of ITU-T Rec. H.222.0 | ISO/IEC 13818-1 [1].

3.9   presentation time-stamp: A field that may be present in a PES packet header that indicates the time that a presentation unit is presented in the system target decoder.

3.10   presentation unit: A decoded audio access unit or a decoded picture.

3.11   program clock reference: A time stamp in the transport stream from which decoder timing is derived.

3.12   program specific information: PSI consists of normative data which is necessary for the demultiplexing of transport streams and the successful regeneration of programs and is described in 2.4.4 of ITU-T Rec. H.222.0 | ISO/IEC 13818-1 [1]. An example of privately defined PSI data is the non-mandatory network information table.

3.13   reserved: The term "reserved", when used in the clauses defining the coded bit stream, indicates that the value may be used in the future for ISO defined extensions. Unless otherwise specified within ITU-T Rec. H.222.0 | ISO/IEC 13818-1 [1], all reserved bits shall be set to "1".

3.14 **time-stamp**: A term that indicates the time of a specific action such as the arrival of a byte or the presentation of a presentation unit.

3.15 **transport stream packet header**: The leading fields in a transport stream packet, up to and including the continuity_counter field.

4 Abbreviations

This Recommendation uses the following abbreviations:

AAC   Advanced Audio Coding

ANC   Ancillary

DTS   Decoding Time Stamp

EDH   Error Detection and Handling

GOP   Group of Pictures

LTC   Longitudinal Time Code

MPEG   Moving Picture Experts Group

PCR   Program Clock Reference

PDH   Plesiochronous Digital Hierarchy

PES   Packetized Elementary Stream

PSI   Program Specific Information

PTS   Presentation Time Stamp

SDH   Synchronous Digital Hierarchy

SEQ   Sequences

TS   Transport Stream

VBI   Vertical Blanking Interval

VITC   Vertical Interval Time Code

VITS   Vertical Interval Test Signals

5 Transport mechanism

This Recommendation follows the method of describing bit stream syntax and uses symbols given in clause 2 of ITU-T Rec. H.222.0 | ISO/IEC 13818-1 [1].

5.1 Systems layer

PCR repetition rate: The PCR shall occur typically every field interval (16.6 ms for 525/60 TV system and 20 ms for 625/50 TV system) and at least every 100 ms.

PCR position: PCRs (and adaptation fields) shall be inserted either in the video stream or in a separate PCR stream.

5.2 Video

5.2.1 Video PES format

Stream_Id: "1110 xxxx" (video stream number xxxx).

PES_packet_length: "0x0000" (neither specified nor bounded and allowed only in PES packets whose payload consists of bytes from a video elementary stream contained in transport stream packets).

data_alignment_indication:	"1" (the PES packet header is immediately followed by the video start code). Alignment type 0x03 (GOP or SEQ).
PTS_DTS_flags:	"10" (PTS fields shall be present in the PES packet header).
	"11"(Both the PTS fields and DTS fields shall be present in the PES packet header).

5.2.2   Video layers

Profile and Level:	The 4:2:2 profile at Main level [2] shall be implemented.
Sequence header repetition rate:	Minimum every second.

5.3   Compressed audio

5.3.1   PES format

Stream_Id:	"110xxxxx" (audio stream number xxxxx).
data_alignment_indicator:	"1" (the PES packet header is immediately followed by the audio sync word).
	Alignment_type 0x01 (Sync word).
PTS_DTS_flags:	"10" (PTS fields shall be present in the PES packet header).

5.3.2   Audio layer

MPEG-1 Layer II [3] or MPEG-2 AAC [4] shall be implemented.

5.3.2.1   Coding for stereo

Coding:	MPEG-1 Layer II
Bit rate:	384 kbit/s other bit rates optional
Sampling frequency:	48 kHz
Emphasis:	no emphasis

5.3.2.2   Coding for multichannel

Coding:	MPEG-2 AAC
Number of channels:	up to 6
Bit rate per channel:	up to 80 kbit/s
Sampling frequency:	48 kHz
Emphasis:	no emphasis

5.4   Uncompressed audio

The preferred method for transport of uncompressed audio, including SDI embedded audio (Recommendation ITU-R BT.1305 [9]) is according to SMPTE 302 [5].

5.5 Ancillary data

Ancillary data is defined by Recommendation ITU-R BT.1364 [6], and includes checksum, timecode and uncompressed digital audio defined in Recommendation ITU-R BT.1304 [7], Recommendation ITU-R BT.1366 [8], and Recommendation ITU-R BT.1305 [9], respectively. The following applies for transport of the ancillary data. This method may optionally be applied to audio stream according to Recommendation ITU-R BT.1305 [9].

5.5.1 PES packet format

Stream_Id: "1011 1101" (private_stream_1).

data_alignment_indicator: "1" (the PES packet header is immediately followed by the sync word). Alignment_type "0x02" (Video Access Unit).

PTS_DTS_flags: "10" (PTS fields shall be present in the PES packet header).

PES_packet_data_byte: These bytes are coded in accordance with the ANC_data( ) syntax as defined below.

Table 1/J.89 – ANC data field

Syntax	No. of bits	Mnemonic
ANC_data( ) {		
for (i=0; i<N; i++) {		
ANC_data_field( )		
while (!bytealigned)		
zero_bit	1	"1"
}		
for (i=0; i<N1; i++){		
stuffing_byte	8	"1111 1111"
}		
}		
ANC_data_field ( ) {		
"0x000"	10	bslbf
line_number	10	bslbf
horizontal_offset	10	uimsbf
data_ID	10	bslbf
DBN_SDID	10	bslbf
data_count	10	bslbf
for (i=0, i<=data_count; i++){		
user_data_word	10	bslbf
}		
checksum_word	10	bslbf
}		
NOTE – The ANC_data_field ( ) consists of a header ("0x000", line_number, horizontal_offset) followed by the ancillary data packet content (as defined in Recommendation ITU-R BT.1364 [6]) starting after the ancillary data flag.		
line_number: This 10-bit word contains the line number (1 to 625 and 1 to 525 respectively).		
horizontal_offset: This 10-bit word contains the horizontal address (0 to 857 and 0 to 863 respectively) in a line indicated by the line_number.		

5.6 Data

The following PES/TS scheme allows optional user data channels (excluding ancillary data) to be transferred at any data rate.

The data format at the access-interface is signalled by user definition in PSI.

If time recovery is requested (e.g. synchronous data channels) it is supported by PTS.

5.6.1 PES format

Stream_Id:	"10111101" (private_stream_1).
PES_packet_length:	N * 184 – 6, where N is integer
data_alignment_indicator:	"0" (no alignment) or "1" (the PES packet header is immediately followed by the sync word). Alignment_type 0x01 (Sync word).
PTS_DTS_flags:	"10" (PTS fields shall be present in the PES packet header).
PES_header_data_length:	6.
PES_packet_data_bytes:	Filled with the bits of the data channel with removed channel coding.

5.7 Data lines

The content of the data lines (for example Teletext according to Recommendation ITU-R BT.653-2 [10] and EBU data line according to EBU Tech 3217) are carried by packets defined with the syntax defined below. The data lines of one video frame form one or more access units.

5.7.1 PES packet format

The PES packet syntax and semantics are followed noting the following constraints:

Stream_Id:	"1011 1101" (private_stream_1).
PES_packet_length:	N * 184 – 6, where N is an integer.
data_alignment_indicator:	"1" (the PES packet header is immediately followed by the sync word). Alignment_type 0x02 (Video Access Unit).
PES_header_data_length:	Set to "0x24".
stuffing_byte:	The PES header is followed by as many stuffing bytes as are required to make up the header data length, so that the entire PES header is 45 bytes long.
PES_packet_data_byte:	These bytes are coded in accordance with the PES data field syntax specified in 5.7.2.

PTS and other optional fields may be present in the PES header, but the header length is always fixed.

5.7.2 Syntax for PES data field

See Table 2.

Table 2/J.89 – PES data field

Syntax	No. of bits	Mnemonic
PES_data_field ( ) {		
data_identifier	8	uimsbf
for (i=0;I++){		
data_unit_id	8	uimsbf
data_unit_length	8	uimsbf
if (data_unit_id = = stuffing_unit){		
stuffing_field	43*8	bslbf
}		
else{		
data_field ( )		
}		
}		
}		

The syntax for data field is given in Table 3.

Table 3/J.89 – Teletext data field

Syntax	No. of bits	Mnemonic
data_field ( ) {		
reserved	2	bslbf
field_parity	1	bslbf
line_offset	5	uimsbf
framing_code	8	bslbf
magazine_and_packet_address	16	bslbf
data_block	320	bslbf
}		

5.7.3   Semantics for PES data field

data identifier: This 8-bit field identifies the type of data carried in the PES packet. It is coded as indicated in Table 4.

Table 4/J.89 – Data identifier

Data identifier	Value
0x00-0x0F	reserved
0x10-0x1F	TXT data
0x20-0x7F	reserved
0x80	TC data
0x81-0x9E	reserved
0x9F	testline
0xA0	encoder information
0xA1-0xFF	reserved

The data identifier shall be set to the same value for each PES packet conveying data in the same Teletext data stream.

data_unit_id: This 8-bit field identifies the type of data unit. It is coded as indicated in Table 5.

Table 5/J.89 – Data unit id

Data unit id	Value
0x00	reserved
0x01	EBU data line
0x02	teletext system B, 625-line system, non-subtitle data
0x03	teletext system B, 625-line system, subtitle data
0x04	teletext system A, 625-line system
0x05	reserved
0x06	teletext system C, 625-line system
0x07-0x10	reserved
0x11	teletext system A, 525-line system
0x12	reserved
0x13	teletext system B, 525-line system
0x14	reserved
0x15	teletext system C, 525-line system
0x16	reserved
0x17	teletext system D, 525-line system
0x18-0x80	reserved
0x81	VITC and LTC
0x82	VITC
0x83-0xA0	reserved
0xA1	encoder status
0xA2	video coding parameters
0xA3-0xFE	reserved
0xFF	stuffing unit

data_unit_length: This 8-bit field indicates the number of bytes in the data unit following the length field. For data units carrying Teletext data, this field shall always be set to "0x2C".

stuffing_field: This 43-bytes field is used if needed to fill up the PES to the PES packet length defined in 4.7.1. The field is set to all ones.

reserved: Set to "1".

field_parity: This 1-bit flag specifies the field for which the data is intended; the value "1" indicates the first field of a frame, the value "0" indicates the second field of a frame.

line_offset: This 5-bit field specifies the line number on which the Teletext data packet is intended to be presented if it is transcoded into the VBI.

Within a field, the line-offset numbering shall follow a progressive incremental order except for the undefined line offset value "0". The toggling of the field parity flag indicates a new field. The line_offset is coded as in Table 6.

Table 6/J.89 – Line offset

line_offset	line number			
	625-line system		525-line system	
	field_parity = 1	field_parity = 0	field_parity = 1	field_parity = 0
0x00	undefined	undefined	undefined	undefined
0x01-0x06	reserved	reserved	reserved	reserved
0x07	7	320	reserved	reserved
0x08	8	321	reserved	reserved
0x09	9	322	reserved	reserved
0xA0	10	323	10	273
---	---	---	---	---
0x15	21	334	21	284
0x16	22	335	reserved	reserved
0x17-0x1F	reserved	reserved	reserved	reserved

framing_code, **magazine_and_packet_address**, **data_block**: These field correspond to the 43 bytes following the clock-run-in sequence of a Teletext data packet as defined in Recommendation ITU-R BT.653-2 [10], system B, 625/50 television systems. Data packets are inserted in the same order as they are intended to arrive at the Teletext decoder or to be transcoded into the VBI.

For other Teletext systems or the EBU data line the same scheme has to be applied. For lines containing less data bits the remaining bits of the data block are set to 1.

5.8   Time code

In the case where the time code is delivered as LTC or VITC the following applies:

5.8.1   PES packet format

As defined in 5.7.1.

5.8.2   Syntax for PES data field

The syntax for the PES data field is defined in Table 2.

The syntax for data field is given in Table 7.

Table 7/J.89 – Timecode data field

Syntax	No. of bits	Mnemonic
data_field ( ){		
reserved	2	bslbf
field_parity	1	bslbf
line_offset	5	uimsbf
VITC_block	90	bslbf
reserved	38	bslbf
LTC_block	80	bslbf
reserved	17*8	bslbf
}		

5.8.3   Semantics for PES data field

data_identifier: This 8-bit field identifies the type of data carried in the PES packet. It is coded as indicated in Table 4.

data_unit_id: This 8-bit field identifies the type of data unit. It is coded as given in Table 5.

data_unit_length: This 8-bit field indicates the number of bytes in the data unit following the length field. For data units carrying time code only this field shall always be set to "0x2C".

reserved: Set to "1".

field_parity: This 1-bit flag specifies the field for which the data is intended; the value "1" indicates the first field of a frame, the value "0" indicates the second field of a frame.

line_offset: This 5-bit field specifies the line number on which the time code is intended to be presented if it is transcoded into the VBI.

The line_offset is coded as in Table 6.

VITC_block: This field corresponds to the 90 VITC data bits as defined in SMPTE 12M (2), starting with bit number 0. An unused block is filled with ones.

LTC_block: This field corresponds to the 80 LTC data bits defined in SMPTE 12M (2), starting with bit number 0. An unused block is filled with ones.

5.9   Composite testlines

The testlines are conveyed uncompressed in PES packets defined below.

5.9.1   PES packet format

Stream_Id:	Set to "1011 1101" (private_stream_1).
PES_packet_length:	914 (= 5 * 184 – 6).
PES_scrambling_control:	"00".
data_alignment_indicator:	Set to "1" (aligned).
PES_header_data_length:	9.

stuffing_byte: The required number to make up the header data length.

PES_packet_data_byte: These bytes are coded in accordance with the VITS_data_field syntax below.

5.9.2   Syntax for PES data field

Table 8/J.89 – VITS data field

Syntax	No. of bits	Mnemonic
VITS_data_field ( ){		
data_identifier	8	uimsbf
field_sequence	3	uimsbf
line_offset	5	uimsbf
for (i=0;i<N;i++){		
VITS_data_word	10	bslbf
}		
}		

5.9.3   Semantics for PES data field

data_identifier: This 8-bit field identifies the type of data carried in the PES packet. It is set to "0x9F".

field_sequence: A 3-bit integer which defines the number of the field in the eight field sequence used in PAL systems or the four field_sequence used in NTSC systems as defined in the Table 9.

Table 9/J.89 – field_sequence

field_sequence	frame	field
000	1	1
001	1	2
010	2	3
011	2	4
100	3	5
101	3	6
110	4	7
111	4	8

line_offset: This 5-bit field specifies the line number on which the testline is intended to be presented. It is coded according to Table 6.

VITS_data_word: The N VITS data bytes carries the 10-bit samples of the active part of one testline. That are the 720 samples of the digital active line.

The **sampling** for the testline is in accordance with Recommendation ITU-R BT.601-5 [11] luminance sampling with the following differences:

–   10-bit scale used, with range 0 ... 1023;

–   black corresponds to 288 (= 32 + 256);

–   100% white corresponds to 726.

Temporal sub-sampling respecting the PAL and NTSC sequence respectively may be applied.

5.10 Encoder information

Real time information from the encoder to the decoder may be conveyed by packets with the following syntax:

5.10.1 PES packet format

As defined in 5.7.1.

5.10.2 Syntax for PES data field

The syntax for the PES data field is defined in Table 2.

The syntax for data field is given in Table 10 below.

Table 10/J.89 – Data field for encoder information

Syntax	No. of bits	Mnemonic
data_field ( ){		
if (data_unit_id = =encoder_status){		
/*video*/		
video_loss	1	**bslbf**
EDH_flags_1	15	**bslbf**
EDH_flags_2	15	**bslbf**
reserved	1	**bslbf**
/*audio*/		
audio_loss_ch1	1	**bslbf**
audio_loss_ch2	1	**bslbf**
audio_loss_ch3	1	**bslbf**
audio_loss_ch4	1	**bslbf**
reserved	4	**bslbf**
for (k=5; k<data_unit_length; k++)		
stuffing_byte	8	**bslbf**
}		
}		

5.10.3 Semantics for PES data field

data_identifier: This 8-bit field identifies the type of data carried in the PES packet. It is coded as indicated in Table 4 ("0xA0").

data_unit_id: This 8-bit field identifies the type of data unit. It is coded as given in Table 5.

data_unit_length: This 8-bit field indicates the number of bytes in the data unit following the length field and is set to "0x2C".

video_loss: This bit indicates a loss of the video signal at the encoder input if set to "1".

EDH_flags_1: This 15-bit field contains the EDH error flags of the video field 1 as defined in Table 11. The meaning of the flags is in accordance with Recommendation ITU-R BT.1304 [7].

EDH_flags_2: This 15-bit field contains the EDH error flags of the video field 2 (see Table 11).

Table 11/J.89 – EDH_error_flags

Bit number	Flag
1(first)	ancillary data error flag edh
2	ancillary data error flag eda
3	ancillary data error flag idh
4	ancillary data error flag ida
5	ancillary data error flag ues
6	active picture error flag edh
7	active picture error flag eda
8	active picture error flag idh
9	active picture error flag ida
10	active picture error flag ues
11	full-field error flag edh
12	full-field error flag eda
13	full-field error flag idh
14	full-field error flag ida
15(last)	full-field error flag ues

audio_loss: The bit number in this field corresponds to the number of the stereo audio channel, and the flag indicates a loss of the audio channel if set to "1"

reserved: Set to "1".

stuffing_byte: This byte is used for stuffing. All bits are set to "1".

6   Channel adaptations

6.1   Transport in PDH/SDH networks

6.1.1   General approach

For PDH and SDH networks, the channel adaptations are according to Recommendations J.131 [12] and J.132 [13], respectively.

With this approach the clocks of the transport stream and of the network are independent and the two bit rates are only related by the network transport capacity limit.

6.1.2   Fixed bit rate approach for PDH network

If the transport stream bit rate is equal to the one of the network, a direct mapping could be applied. With this approach the transport stream clock and interface must meet the requirements of the network.

An error protection and scrambling mechanism is to be applied according to A.5/J.83 [14].

6.2   Transport in B-ISDN

For B-ISDN network, the channel adaptation is according to Recommendation J.82 [15].

7   Bibliography

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