International Telecommunication Union

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

H.222.0

Amendment 5

(05/2011)

SERIES H: AUDIOVISUAL AND MULTIMEDIA SYSTEMS

Infrastructure of audiovisual services – Transmission multiplexing and synchronization

---

Information technology – Generic coding of moving pictures and associated audio information: Systems

Amendment 5: Transport of JPEG 2000 Part 1 (ITU-T T.800 | ISO/IEC 15444-1) video over ITU-T H.222.0 | ISO/IEC 13818-1

Recommendation ITU-T H.222.0 (2006) – Amendment 5

International Telecommunication Union

ITU-T H-SERIES RECOMMENDATIONS

AUDIOVISUAL AND MULTIMEDIA SYSTEMS

CHARACTERISTICS OF VISUAL TELEPHONE SYSTEMS	H.100–H.199
INFRASTRUCTURE OF AUDIOVISUAL SERVICES	
General	H.200–H.219
Transmission multiplexing and synchronization	**H.220–H.229**
Systems aspects	H.230–H.239
Communication procedures	H.240–H.259
Coding of moving video	H.260–H.279
Related systems aspects	H.280–H.299
Systems and terminal equipment for audiovisual services	H.300–H.349
Directory services architecture for audiovisual and multimedia services	H.350–H.359
Quality of service architecture for audiovisual and multimedia services	H.360–H.369
Supplementary services for multimedia	H.450–H.499
MOBILITY AND COLLABORATION PROCEDURES	
Overview of Mobility and Collaboration, definitions, protocols and procedures	H.500–H.509
Mobility for H-Series multimedia systems and services	H.510–H.519
Mobile multimedia collaboration applications and services	H.520–H.529
Security for mobile multimedia systems and services	H.530–H.539
Security for mobile multimedia collaboration applications and services	H.540–H.549
Mobility interworking procedures	H.550–H.559
Mobile multimedia collaboration inter-working procedures	H.560–H.569
BROADBAND, TRIPLE-PLAY AND ADVANCED MULTIMEDIA SERVICES	
Broadband multimedia services over VDSL	H.610–H.619
Advanced multimedia services and applications	H.620–H.629
IPTV MULTIMEDIA SERVICES AND APPLICATIONS FOR IPTV	
General aspects	H.700–H.719
IPTV terminal devices	H.720–H.729
IPTV middleware	H.730–H.739
IPTV application event handling	H.740–H.749
IPTV metadata	H.750–H.759
IPTV multimedia application frameworks	H.760–H.769
IPTV service discovery up to consumption	H.770–H.779

For further details, please refer to the list of ITU-T Recommendations.

INTERNATIONAL STANDARD ISO/IEC 13818-1
RECOMMENDATION ITU-T H.222.0

Information technology – Generic coding of moving pictures and associated audio information: Systems

Amendment 5

Transport of JPEG 2000 Part 1 (ITU-T T.800 | ISO/IEC 15444-1) video over ITU-T H.222.0 | ISO/IEC 13818-1

Summary

Amendment 5 to Recommendation ITU-T H.222.0 | ISO/IEC 13818-1 specifies the carriage of JPEG 2000 video bitstreams conforming to one or more profiles defined in Recommendation ITU-T T.800 | ISO/IEC 15444-1 over Recommendation ITU-T H.222.0 (05/2006) | ISO/IEC 13818-1:2007. The structure of JPEG 2000 access units as well as the syntax and semantics are specified in the JPEG 2000 standards and are also included in Annex S of this Recommendation | International Standard. Each access unit is self-contained and decodable without reference to any other access unit in the video stream. The carriage of JPEG 2000 video will be limited to transport streams only in this amendment.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T H.222.0	1995-07-10	15
1.1	ITU-T H.222.0 (1995) Amd. 1	1996-11-11	16
1.2	ITU-T H.222.0 (1995) Amd. 2	1996-11-11	16
1.3	ITU-T H.222.0 (1995) Technical Cor. 1	1998-02-06	16
1.4	ITU-T H.222.0 (1995) Amd. 3	1998-02-06	16
1.5	ITU-T H.222.0 (1995) Amd. 4	1998-02-06	16
1.6	ITU-T H.222.0 (1995) Amd. 5	1999-05-27	16
1.7	ITU-T H.222.0 (1995) Amd. 6	1999-05-27	16
2.0	ITU-T H.222.0	2000-02-17	16
2.1	ITU-T H.222.0 (2000) Technical Cor. 1	2001-03-01	16
2.2	ITU-T H.222.0 (2000) Technical Cor. 2	2002-03-29	16
2.3	ITU-T H.222.0 (2000) Amd. 1	2002-12-14	16
2.4	ITU-T H.222.0 (2000) Amd. 1/Cor. 1	2003-06-29	16
2.5	ITU-T H.222.0 (2000) Amd. 2	2003-06-29	16
2.6	ITU-T H.222.0 (2000) Amd. 3	2004-03-15	16
2.7	ITU-T H.222.0 (2000) Technical Cor. 3	2005-01-08	16
2.8	ITU-T H.222.0 (2000) Amd. 4	2005-01-08	16
2.9	ITU-T H.222.0 (2000) Amd. 5	2005-01-08	16
2.10	ITU-T H.222.0 (2000) Technical Cor. 4	2005-09-13	16
3.0	ITU-T H.222.0	2006-05-29	16
3.1	ITU-T H.222.0 (2006) Amd. 1	2007-01-13	16
3.2	ITU-T H.222.0 (2006) Amd. 2	2007-08-29	16
3.3	ITU-T H.222.0 (2006) Cor. 1	2008-06-13	16
3.4	ITU-T H.222.0 (2006) Cor. 2	2009-03-16	16
3.5	ITU-T H.222.0 (2006) Amd. 3	2009-03-16	16
3.6	ITU-T H.222.0 (2006) Cor. 3	2009-12-14	16
3.7	ITU-T H.222.0 (2006) Cor. 4	2009-12-14	16
3.8	ITU-T H.222.0 (2006) Amd. 4	2009-12-14	16
3.9	ITU-T H.222.0 (2006) Amd. 5	2011-05-14	16
3.10	ITU-T H.222.0 (2006) Amd. 6	2011-05-14	16

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications, information and communication technologies (ICTs). The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

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

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 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

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

INTELLECTUAL PROPERTY RIGHTS

ITU draws attention to the possibility that the practice or implementation of this Recommendation may involve the use of a claimed Intellectual Property Right. ITU takes no position concerning the evidence, validity or applicability of claimed Intellectual Property Rights, whether asserted by ITU members or others outside of the Recommendation development process.

As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

CONTENTS

INTERNATIONAL STANDARD
RECOMMENDATION ITU-T

Information technology – Generic coding of moving pictures and associated audio information: Systems

Amendment 5

Transport of JPEG 2000 Part 1 (ITU-T T.800 | ISO/IEC 15444-1) video over ITU-T H.222.0 | ISO/IEC 13818-1

1) Clause 1.2.3

In 1.2.3, Additional References, add the following reference:

– Recommendation ITU-T T.800 (2002) | ISO/IEC 15444-1:2004, *Information technology – JPEG 2000 image coding system: Core coding system.*

2) New clauses 2.1.89 to 2.1.92

After 2.1.88, add 2.1.89 to 2.1.92:

2.1.89 JPEG 2000 (J2K) video access unit: An access unit defined in Rec. ITU-T T.800 (2002)/Amd.3 (2010) | ISO/IEC 15444-1:2004/Amd.3:2010 which includes all the parameters required to decode the access unit and display the decoded data.

2.1.90 J2K video elementary stream: Video elementary stream consisting of a succession of J2K video access units.

2.1.91 J2K video sequence: J2K video elementary stream where all the access units have the same profile/level, J2K video access unit coding parameters and video parameters.

2.1.92 J2K still picture (system): J2K video access unit as defined in 2.1.89 with constraints as specified in S.2.

3) New clause 2.4.2.10

After 2.4.2.9, add 2.4.2.10:

2.4.2.10 T-STD extensions for carriage of J2K video elementary streams

The interpretation, extensions, use and constraints for syntax elements in the adaptation header (2.4.3.4 and 2.4.3.5) for JPEG 2000 part 1 video are defined in S.5.

The interpretation, extensions, use and constraints for syntax elements in the PES header (2.4.3.6 and 2.4.3.7) for JPEG 2000 Part 1 video are defined in S.5.

To define the decoding of J2K video elementary streams carried in a Transport Stream, the T-STD model needs to be extended. The T-STD extensions and T-STD parameters for decoding of J2K video elementary streams conforming to one or more profiles defined in Rec. ITU-T T.800 (2002) | ISO/IEC 15444-1:2004 are defined in S.6.

NOTE – No extensions are specified for P-STD model, as carriage of J2K video elementary streams in program streams is not supported.

4) Clause 2.4.3.7

In 2.4.3.7, replace Table 2-22 with the following:

Table 2-22 – Stream_id assignments

stream_id	Notes	Stream coding
1011 1100	1	program_stream_map
1011 1101	2 and 9	private_stream_1
1011 1110		padding_stream
1011 1111	3	private_stream_2
110x xxxx		ISO/IEC 13818-3 or ISO/IEC 11172-3 or ISO/IEC 13818-7 or ISO/IEC 14496-3 audio stream number x xxxx
1110 xxxx		Rec. ITU-T H.262 | ISO/IEC 13818-2 or ISO/IEC 11172-2 or ISO/IEC 14496-2 or Rec. ITU-T H.264 | ISO/IEC 14496-10 video stream number xxxx
1111 0000	3	ECM_stream
1111 0001	3	EMM_stream
1111 0010	5	Rec. ITU-T H.222.0 | ISO/IEC 13818-1 Annex A or ISO/IEC 13818-6_DSMCC_stream
1111 0011	2	ISO/IEC_13522_stream
1111 0100	6	Rec. ITU-T H.222.1 type A
1111 0101	6	Rec. ITU-T H.222.1 type B
1111 0110	6	Rec. ITU-T H.222.1 type C
1111 0111	6	Rec. ITU-T H.222.1 type D
1111 1000	6	Rec. ITU-T H.222.1 type E
1111 1001	7	ancillary_stream
1111 1010		ISO/IEC14496-1_SL-packetized_stream
1111 1011		ISO/IEC14496-1_FlexMux_stream
1111 1100		metadata stream
1111 1101	8	extended_stream_id
1111 1110		reserved data stream
1111 1111	4	program_stream_directory

The notation x means that the values '0' or '1' are both permitted and results in the same stream type. The stream number is given by the values taken by the x's.

NOTE 1 – PES packets of type program_stream_map have unique syntax specified in 2.5.4.1.

NOTE 2 – PES packets of type private_stream_1 and ISO/IEC_13552_stream follow the same PES packet syntax as those for Rec. ITU-T H.262 | ISO/IEC 13818-2 video and ISO/IEC 13818-3 audio streams.

NOTE 3 – PES packets of type private_stream_2, ECM_stream and EMM_stream are similar to private_stream_1 except no syntax is specified after PES_packet_length field.

NOTE 4 – PES packets of type program_stream_directory have a unique syntax specified in 2.5.5.

NOTE 5 – PES packets of type DSM-CC_stream have a unique syntax specified in ISO/IEC 13818-6.

NOTE 6 – This stream_id is associated with stream_type 0x09 in Table 2-29.

NOTE 7 – This stream_id is only used in PES packets, which carry data from a Program Stream or an ISO/IEC 11172-1 System Stream, in a Transport Stream (refer to 2.4.3.8).

NOTE 8 – The use of stream_id 0xFD (extended_stream_id) identifies that this PES packet employs an extended syntax to permit additional stream types to be identified.

NOTE 9 – JPEG 200 video streams (stream_type = 0x21) are carried using the same PES packet syntax as private_stream_1.

5) Clause 2.4.4.9

In 2.4.4.9, Semantic definition of fields in Transport Stream program map section, replace Table 2-34 with the following:

Table 2-34 – Stream type assignments

Value	Description
0x00	ITU-T | ISO/IEC Reserved
0x01	ISO/IEC 11172-2 Video
0x02	Rec. ITU-T H.262 | ISO/IEC 13818-2 Video or ISO/IEC 11172-2 constrained parameter video stream
0x03	ISO/IEC 11172-3 Audio
0x04	ISO/IEC 13818-3 Audio
0x05	Rec. ITU-T H.222.0 | ISO/IEC 13818-1 private_sections
0x06	Rec. ITU-T H.222.0 | ISO/IEC 13818-1 PES packets containing private data
0x07	ISO/IEC 13522 MHEG
0x08	Rec. ITU-T H.222.0 | ISO/IEC 13818-1 Annex A DSM-CC
0x09	Rec. ITU-T H.222.1
0x0A	ISO/IEC 13818-6 type A
0x0B	ISO/IEC 13818-6 type B
0x0C	ISO/IEC 13818-6 type C
0x0D	ISO/IEC 13818-6 type D
0x0E	Rec. ITU-T H.222.0 | ISO/IEC 13818-1 auxiliary
0x0F	ISO/IEC 13818-7 Audio with ADTS transport syntax
0x10	ISO/IEC 14496-2 Visual
0x11	ISO/IEC 14496-3 Audio with the LATM transport syntax as defined in ISO/IEC 14496-3
0x12	ISO/IEC 14496-1 SL-packetized stream or FlexMux stream carried in PES packets
0x13	ISO/IEC 14496-1 SL-packetized stream or FlexMux stream carried in ISO/IEC 14496_sections
0x14	ISO/IEC 13818-6 Synchronized Download Protocol
0x15	Metadata carried in PES packets
0x16	Metadata carried in metadata_sections
0x17	Metadata carried in ISO/IEC 13818-6 Data Carousel
0x18	Metadata carried in ISO/IEC 13818-6 Object Carousel
0x19	Metadata carried in ISO/IEC 13818-6 Synchronized Download Protocol
0x1A	IPMP stream (defined in ISO/IEC 13818-11, MPEG-2 IPMP)
0x1B	AVC video stream conforming to one or more profiles defined in Annex A of Rec. ITU-T H.264 | ISO/IEC 14496-10 or AVC video sub-bitstream, as defined in 2.1.78, or MVC base view sub-bitstream, as defined in 2.1.85, or AVC video sub-bitstream of MVC, as defined in 2.1.88
0x1C	ISO/IEC 14496-3 Audio, without using any additional transport syntax, such as DST, ALS and SLS
0x1D	ISO/IEC 14496-17 Text
0x1E	Auxiliary video stream as defined in ISO/IEC 23002-3
0x1F	SVC video sub-bitstream of an AVC video stream conforming to one or more profiles defined in Annex G of Rec. ITU-T H.264 | ISO/IEC 14496-10
0x20	MVC video sub-bitstream of an AVC video stream conforming to one or more profiles defined in Annex H of Rec. ITU-T H.264 | ISO/IEC 14496-10
0x21	Video stream conforming to one or more profiles as defined in Rec. ITU-T T.800 | ISO/IEC 15444-1
0x22-0x7E	Rec. ITU-T H.222.0 | ISO/IEC 13818-1 Reserved
0x7F	IPMP stream
0x80-0xFF	User Private

6) Clause 2.6.1

In 2.6.1, Semantic definition of fields in program and program element descriptors, replace Table 2-45 with:

Table 2-45 – Program and program element descriptors

descriptor_tag	TS	PS	Identification
0	N/A	N/A	Reserved
1	N/A	X	Forbidden
2	X	X	video_stream_descriptor
3	X	X	audio_stream_descriptor
4	X	X	hierarchy_descriptor
5	X	X	registration_descriptor
6	X	X	data_stream_alignment_descriptor
7	X	X	target_background_grid_descriptor
8	X	X	video_window_descriptor
9	X	X	CA_descriptor
10	X	X	ISO_639_language_descriptor
11	X	X	system_clock_descriptor
12	X	X	multiplex_buffer_utilization_descriptor
13	X	X	copyright_descriptor
14	X		maximum_bitrate_descriptor
15	X	X	private_data_indicator_descriptor
16	X	X	smoothing_buffer_descriptor
17	X		STD_descriptor
18	X	X	IBP_descriptor
19-26	X		Defined in ISO/IEC 13818-6
27	X	X	MPEG-4_video_descriptor
28	X	X	MPEG-4_audio_descriptor
29	X	X	IOD_descriptor
30	X		SL_descriptor
31	X	X	FMC_descriptor
32	X	X	external_ES_ID_descriptor
33	X	X	MuxCode_descriptor
34	X	X	FmxBufferSize_descriptor
35	X		multiplexBuffer_descriptor
36	X	X	content_labeling_descriptor
37	X	X	metadata_pointer_descriptor
38	X	X	metadata_descriptor
39	X	X	metadata_STD_descriptor
40	X	X	AVC video descriptor
41	X	X	IPMP_descriptor (defined in ISO/IEC 13818-11, MPEG-2 IPMP)
42	X	X	AVC timing and HRD descriptor
43	X	X	MPEG-2_AAC_audio_descriptor
44	X	X	FlexMuxTiming_descriptor
45	X	X	MPEG-4_text_descriptor
46	X	X	MPEG-4_audio_extension_descriptor
47	X	X	Auxiliary_video_stream_descriptor
48	X	X	SVC extension descriptor
49	X	X	MVC extension descriptor

Table 2-45 – Program and program element descriptors

descriptor_tag	TS	PS	Identification
50	X	n/a	J2K video descriptor
51-63	n/a	n/a	Rec. ITU-T H.222.0 | ISO/IEC 13818-1 Reserved
64-255	n/a	n/a	User Private

7) New clauses 2.6.80 and 2.6.81

After 2.6.79, add 2.6.80 and 2.6.81:

2.6.80 J2K video descriptor

For J2K video elementary streams conforming to one or more profiles defined in Rec. ITU-T T.800 | ISO/IEC 15444-1, the J2K video descriptor provides information that may be present in each J2K access unit as well as for the J2K video sequence. In addition, it provides information to signal J2K still pictures. This descriptor shall be included for each J2K video elementary stream component in the PMT with stream_type equal to 0x21.

Table AMD5-1 – J2K video descriptor

Syntax	No. of bits	Mnemonic
J2K_video_descriptor() {		
descriptor_tag	**8**	**uimsbf**
descriptor_length	**8**	**uimsbf**
profile_and_level	**16**	**uimsbf**
horizontal_size	**32**	**uimsbf**
vertical_size	**32**	**uimsbf**
max_bit_rate	**32**	**uimsbf**
max_buffer_size	**32**	**uimsbf**
DEN_frame_rate	**16**	**uimsbf**
NUM_frame_rate	**16**	**uimsbf**
color_specification	**8**	**bslbf**
still_mode	**1**	**bslbf**
interlaced_video	**1**	**bslbf**
reserved	**6**	**bslbf**
for (i=0; i<N; i++) {		
private_data_byte	**8**	**bslbf**
}		
}		

2.6.81 Semantics of fields in J2K video descriptor

profile_and_level – This field shall be in the range 0x0101-0x04ff and coded as defined in Table A.10 of Rec. ITU-T T.800 | ISO/IEC 15444-1 and indicates broadcast profile and level values.

horizontal_size – This field shall be coded the same as Xsiz parameter found in the J2K codestream main header, as defined in Annex A of Rec. ITU-T T.800 | ISO/IEC 15444-1.

vertical_size – This field shall be coded the same as Ysiz parameter found in the J2K codestream main header, as defined in Annex A of Rec. ITU-T T.800 | ISO/IEC 15444-1.

max_bit_rate – This field may be coded the same as the Maxbr value in the j2k_brat field box specified in Table S.1 and shall not exceed the maximum compressed bit rate value for the profile and level specified in Table S.2. This field shall be set appropriately and signalled when profile_and_level = 0x0307, where no maximum bit rate is specified.

max_buffer_size – This field shall not exceed the Maximum buffer size value for the profile and level specified in the j2k_brat box in Table S.2. When profile_and_level = 0x0307, the max_buffer_size shall be set appropriately and shall not exceed (max_bit_rate/1.60E5), where max_bit_rate is expressed in bit/s.

DEN_frame_rate – This field shall be coded the same as frat_denominator field in the j2k_frat box specified in Table S.1 (see Annex S).

NUM_frame_rate – This field shall be coded the same as frat_numerator field in the frat box specified in Table S.1 (see Annex S).

NOTE – J2K frame rate is derived from the DEN_frame_rate and NUM_frame_rate values. Table AMD5-2 lists examples of typical broadcast frame rates with associated values of DEN_frame_rate and NUM_frame_rate.

Table AMD5-2 – Example frame rates based on DEN_frame_rate and NUM_frame_rate values

DEN_frame_rate	NUM_frame_rate	Frame rate ratio (decimal representation)	Frame rate
0000 0000 0000 0000			Forbidden
0000 0011 1110 1001	0101 1101 1100 0000	24 000 / 1001	23.976
0000 0000 0000 0001	0000 0000 0001 1000	24 / 1	24.0
0000 0000 0000 0001	0000 0000 0001 1001	25 / 1	25.0
0000 0011 1110 1001	0111 0101 0011 0000	30 000 / 1001	29.97
0000 0000 0000 0001	0000 0000 0001 1110	30 / 1	30.0
0000 0000 0000 0001	0000 0000 0011 0010	50 / 1	50.0
0000 0011 1110 1001	1110 1010 0110 0000	60 000 / 1001	59.94
0000 0000 0000 0001	0000 0000 0011 1100	60 / 1	60.00

color_specification – This field shall be coded the same as the bcol_colrc 8-bit field of the j2k_bcol box as specified in Table S.1 (see Annex S).

still_mode – This 1-bit field, when set to '1', indicates that the J2K video stream may include J2K still pictures. When set to '0', then the associated J2K video stream shall not contain J2K still pictures.

interlaced_video – This 1-bit field indicates whether the J2K video stream contains interlaced video. When this flag is set to '1' the J2K access unit elementary stream header (see Table S.1) shall include the syntax elements Auf2, fiel_box_code, fic and fio. When this flag is set to '0', these syntax elements shall not be present in the J2K access unit elementary stream header.

8) Annex S

After Annex R, add the following annex:

Annex S

Carriage of JPEG 2000 part 1 video over MPEG-2 Transport Streams

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

S.1 Introduction

This annex specifies normative constraints for the carriage of JPEG 2000 video in an MPEG-2 transport stream. The parameters specified include mapping of J2K video streams into MPEG-2 transport packets, signalling of J2K video streams as well as T-STD parameters for various profiles. Transport of J2K video shall be limited to transport stream only. Program stream support may be added in the future based on application requirements.

S.2 J2K video access unit, J2K video elementary stream, J2K video sequence and J2K still picture

The J2K video access unit contains the elementary stream (elsm) header created in a manner following Annex M of Rec. ITU-T T.800 (2002)/Amd.3 | ISO/IEC 15444-1:2004/Amd.3 concatenated with self-contained Rec. ITU-T T.800 | ISO/IEC 15444-1 codestream(s). The (elsm) header contains all video-related parameters necessary to display the decoded codestream(s). Multiple codestreams may comprise an access unit when, for instance, the access unit is an interlaced frame. The J2K video elementary stream is a progression of J2K access units and the J2K video sequence is a subset of J2K video elementary stream where all the J2K access units have the same parameters in the (elsm) header.

The J2K still picture (system) consists of a J2K video sequence which contains exactly one J2K access unit. This still picture has an associated PTS and the presentation time of succeeding pictures, if any, is later than that of the still picture by at least two picture periods. The J2K still picture (system) mode is used to support transmission of J2K video access units at a rate much lower than the display frame rate (determined by the difference in PTS values between successive J2K access units). J2K still picture can be used in applications such as 'slide show' and 'stills with Music'.

S.3 Elementary stream header (elsm) and mapping to PES packets

Table S.1 shows each portion of the elsm header as defined in Annex M of Rec. ITU-T T.800 (2002)/Amd.3 | ISO/IEC 15444-1:2004/Amd.3 and the concatenation of detailed metadata boxes within the elsm header.

Table S.1 – J2K Access unit elementary stream header

Syntax	No. of bits	Mnemonic
j2k_es() {		
j2k_elsm '0x656c 736d'	32	bslbf
// j2k_frat		
frat_box_code '0x6672 6174'	32	bslbf
frat_denominator	16	uimsbf
frat_numerator	16	uimsbf
// j2k_brat		
brat_box_code = '0x6272 6174'	32	bslbf
Maxbr	32	uimsbf
Auf1	32	uimsbf
// If (interlaced_video == 1) {		
Auf2	32	uimsbf
}		
// j2k_fiel		
// If (interlaced_video == 1) {		
fiel_box_code = 0x6669 656c	32	bslbf
fic	8	uimsbf
fio	8	uimsbf
}		
// j2k_tcod		
tocd_code = 0x7463 6f64	32	bslbf
HH (0-23)	8	uimsbf
MM (0-59)	8	uimsbf
SS (0-59)	8	uimsbf
FF (1-60)	8	uimsbf
// j2k_bcol		
bcol_code = 0x6263 686c	32	bslbf
bcol_colcr	8	uimsbf
reserved	8	bsfbf
}		

j2k_frat – A field box defined in Annex M of Rec. ITU-T T.800 (2002)/Amd.3 | ISO/IEC 15444-1:2004/Amd.3 corresponding to the required frat box containing frame rate coding.

j2k_brat – A field box defined in Annex M of Rec. ITU-T T.800 (2002)/Amd.3 | ISO/IEC 15444-1:2004/Amd.3 corresponding to the required brat box containing the maximum instantaneous bit rate of the elementary stream.

j2k_fiel – A field box defined in Annex M of Rec. ITU-T T.800 (2002)/Amd.3 | ISO/IEC 15444-1:2004/Amd.3 corresponding to the optional fiel box containing interleaved field coding. If the j2k_fiel is present, there shall be two contiguous codestreams present.

j2k_tcod – A field box defined in Annex M of Rec. ITU-T T.800 (2002)/Amd.3 | ISO/IEC 15444-1:2004/Amd.3 corresponding to the required tcod box containing time code and frame count information of the J2K video access unit.

j2k_bcol – A field box defined in Annex M of Rec. ITU-T T.800 (2002)/Amd.3 | ISO/IEC 15444-1:2004/Amd.3 corresponding to the required bcol box containing broadcast color specification coding.

Figure S.1 shows the structure and mapping of J2K video access unit into PES packets. JPEG 2000 represents each frame as one or two Part 1 (Rec. ITU-T T.800 | ISO/IEC 15444-1) contiguous codestreams. The codestream main header, included within each contiguous condestream contains all information to decode its image, including the image

size and the profile indicator, called a SIZ marker in Rec. ITU-T T.800 | ISO/IEC 15444-1. In addition to each codestream's main header, Annex M of Rec. ITU-T T.800 (2002)/Amd.3 | ISO/IEC 15444-1:2004/Amd.3 adds an elementary stream (elsm) header containing video-related information, as shown in Table S.1 and the j2k_video_descriptor in 2.6.80.

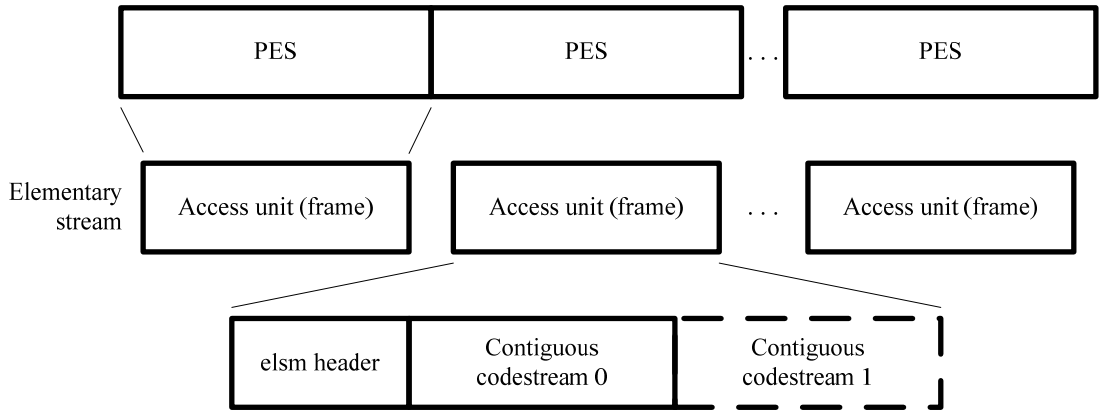

Figure S.1 – Structure and order of JPEG 2000 access units

S.4 J2K transport constraints

When a J2K video elementary stream conforming to one or more profiles as defined in Rec. ITU-T T.800 | ISO/IEC 15444-1 is transported using MPEG-2 systems, the following constraints apply:

1) Each J2K access unit shall contain an elementary stream header (elsm) defined in Table S.1 (as specified in Rec. ITU-T T.800 (2002)/Amd.3 | ISO/IEC 15444-1:2004/Amd.3) followed by one or two codestream(s).
2) Each J2K codestream main header contains a SIZ marker segment that includes a RSIZ capability parameter. Both the SIZ marker segment and RSIZ capability parameter are defined in Annex A of Rec. ITU-T T.800 | ISO/IEC 15444-1 equating to the profile_and_level parameter (see 2.6.81).
3) The J2K video access units shall be ordered in the J2K video elementary stream in a monotonic display order.
4) Each J2K video access unit shall include a PES header with PTS and each PES packet shall contain exactly one J2K video access unit.
5) For successive J2K video access units, the increments to PTS shall be consistent with increments to corresponding J2K_tcod parameters in the elsm header.
6) The following constraints apply to the coding of syntax elements in the adaptation header for transport of J2K video elementary stream:
    a) Both random_access_indicator and elementary_stream_priority_indicator flags can be set to '1' for each J2K video access unit contained in the transport packet. Applications may limit the signalling of random access based on their use cases. Any J2K video access unit is also a J2K video 'access point' required for random access.
    b) All other flags should be set appropriately.
7) The following constraints apply to the coding of syntax elements in the PES header for transport of J2K video elementary stream:
    a) stream_id shall be set to 0xBD (same as Private_stream_1).
    b) PES_packet_length shall be set to 0x0000.
    c) data_alignment_indicator shall be set to '1'. Also see S.5 for alignment constraints.
    d) PTS_DTS_flags shall be set to '10'. This precludes display re-ordering for J2K video access units.
    e) All other flags should be set appropriately.

S.5 Interpretation of flags in adaptation and PES headers for J2K video elementary streams

The interpretation, extensions, use and constraints for the following syntax elements in the adaptation header (2.4.3.4 and 2.4.3.5) and PES header (2.4.3.6 and 2.4.3.7) for JPEG 2000 Part 1 video are defined in this clause:

- In the semantics for discontinuity_indicator (see 2.4.3.5), a J2K video elementary stream access point is defined as the first byte of the J2K video access unit.
- The elementary_stream_priority_indicator in adaptation header (see 2.4.3.4 and 2.4.3.5) may be set to '1' if the transport packet payload contains the start of a J2K video access unit.
- For J2K video elementary streams, when the data_alignment_indicator (see 2.4.3.6) is set to '1', the PES packet header shall be immediately followed by the first byte of J2K video access unit. The data_stream_alignment_descriptor is optional and, if included for J2K video, the alignment_type shall be set to 0x00.

For J2K video elementary streams conforming to one or more profiles defined in Rec. ITU-T T.800 | ISO/IEC 15444-1, if a PTS is present in the PES packet header (see 2.4.3.7), it shall refer to the first byte of J2K video access unit that commences in this PES packet.

S.6 T-STD extension for J2K video elementary streams

The T-STD model includes a transport buffer TB_n and J2K video elementary stream buffer EB_n for decoding of each J2K video elementary stream n. See Figure S.2.

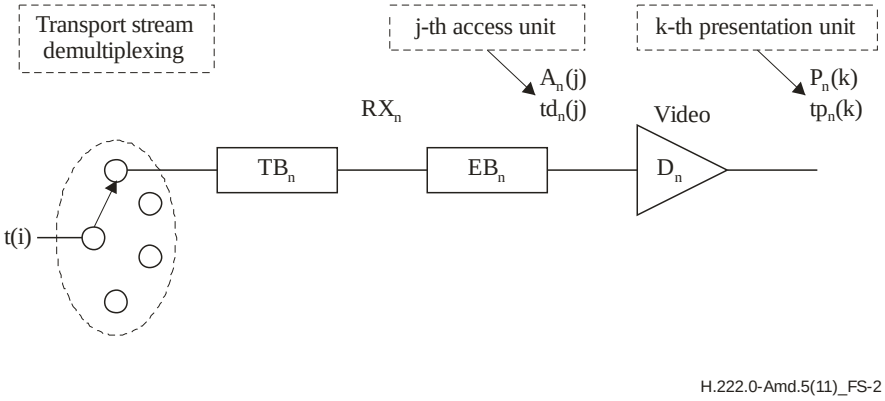

Figure S.2 – T-STD model extensions for J2K Video

The following notation is used to describe the transport stream system target decoder and is partially illustrated in Figure 2-1.

i index to bytes in the transport stream. The first byte has index 0.

j is an index to access units in the elementary streams.

k index to presentation units in the elementary streams.

n is an index to the elementary streams.

p is an index to transport stream packets in the transport stream.

t(i) indicates the time in seconds at which the i-th byte of the transport stream enters the system target decoder. The value t(0) is an arbitrary constant.

PCR(i) is the time encoded in the PCR field measured in units of the period of the 27 MHz system clock where i is the byte index of the final byte of the program_clock_reference_base field.

$A_n(j)$ is the j-th access unit in elementary stream n. $A_n(j)$ is indexed in decoding order.

$td_n(j)$ is the decoding time, measured in seconds, in the system target decoder of the j-th access unit in elementary stream n.

$P_n(k)$ is the k-th presentation unit in elementary stream n. $P_n(k)$ results from decoding $A_n(j)$. $P_n(k)$ is indexed in presentation order.

$tp_n(k)$ is the presentation time, measured in seconds, in the system target decoder of the k-th presentation unit in elementary stream n.

t is time measured in seconds.

$F_n(t)$ is the fullness, measured in bytes, of the system target decoder input buffer for elementary stream n at time t.

B_n is the main buffer for elementary stream n. It is present only for audio elementary streams.

BS_n is the size of buffer, B_n, measured in bytes.

EB_n is the elementary stream buffer for elementary stream n. It is present only for video elementary streams.

EBS_n is the size of the elementary stream buffer EB_n, measured in bytes.

TB_n is the transport buffer for elementary stream n.

TBS_n is the size of TB_n, measured in bytes.

Rx_n is the rate at which data are removed from TB_n.

TB_n and EB_n buffer management

The input to buffer TB_n and its size TBS_n are specified in 2.4.2.3. The rate Rx_n between TB_n and buffer EB_n and the following constraints apply for the carriage of a J2K video elementary stream:

Size EBS_n of buffer EB_n: See Table S.2 for the maximum buffer size based on profile and level of J2K video stream.

Rate Rx_n:

when there is no data in TB_n then Rx_n is equal to zero,

otherwise: Rx_n = bit_rate,

where bit_rate is the bit rate as specified for the profile level in Table S.2. All J2K video payload data bytes enter EB_n instantaneously upon leaving TB_n.

Removal of J2K access units from EB_n

Each J2K video access unit $A_n(j)$ that is present in EB_n is removed instantaneously at time $td_n(j)$. The decoding time $td_n(j)$ is specified by the PTS (as PTS = DTS for J2K video elementary streams) in the PES header for the J2K video access unit.

STD delay

The total delay of any J2K video elementary stream data other than J2K still picture data through the system target decoders buffers TB_n and EB_n shall be constrained by $td_n(j) - t(i) \leq 1$ second for all j, and all bytes i in J2K video access unit $A_n(j)$.

The delay of any J2K still picture data through the system target decoders buffers TB_n and EB_n shall be constrained by $td_n(j) - t(i) \leq 60$ seconds for all j, and all bytes i in J2K video access unit $A_n(j)$.

Buffer management conditions

Transport streams shall be constructed so that the following conditions for buffer management are satisfied:

- TB_n shall not overflow and shall be empty at least once every second.
- EB_n shall not overflow or underflow.

NOTE – EB_n shall not underflow as J2K video elementary streams do not support low delay mode.

S.6.1 J2K video elementary stream buffer size

Rec. ITU-T T.800 (2002)/Amd.3 | ISO/IEC 15444-1:2004/Amd.3 elementary stream supplies parameters suitable for determining a standard decoder model buffer size. This CODEC uses variable rate compression. Profiles from Rec. ITU-T T.800 (2002)/Amd.3 | ISO/IEC 15444-1:2004/Amd.3 specify operating levels that limit the maximum compressed bit rate of the Rec. ITU-T T.800 | ISO/IEC 15444-1 code stream. Moreover, within access units an elementary stream header contains the present maximum bit rate an encoder must support to decode video without overflow. A decoder may scale the buffer size by reading the maximum bit rate expected by a particular sequence of frames from the elsm header. This header information shall not exceed the limit set by the operating level specified in Rec. ITU-T T.800 (2002)/Amd.3 | ISO/IEC 15444-1:2004/Amd.3.

Table S.2 – Operating levels and maximum buffer size for JPEG 2000 broadcast profiles (from Table A.48 in Rec. ITU-T T.800 (2002)/Amd.3 | ISO/IEC 15444-1:2004/Amd.3)

Levels (Note)	Max. compressed bit rate (Mbit/s)	Maximum buffer size for a 60.0 Hz frame rate, progressive video (MBytes)
Level 1	200	1.25
Level 2	200	1.25
Level 3	200	1.25
Level 4	400	2.5
Level 5	800	5
Level 6	1600	10
Level 7	Unspecified	Unspecified
NOTE – Levels are specified in the JPEG 2000 codestream main header SIZ marker segment, RSIZ capability parameter. Refer to Table A.10 of Rec. ITU-T T.800 (2002)/Amd.3 | ISO/IEC 15444-1:2004/Amd.3.		

SERIES OF ITU-T RECOMMENDATIONS

Series A	Organization of the work of ITU-T
Series D	General tariff principles
Series E	Overall network operation, telephone service, service operation and human factors
Series F	Non-telephone telecommunication services
Series G	Transmission systems and media, digital systems and networks
Series H	**Audiovisual and multimedia systems**
Series I	Integrated services digital network
Series J	Cable networks and transmission of television, sound programme and other multimedia signals
Series K	Protection against interference
Series L	Construction, installation and protection of cables and other elements of outside plant
Series M	Telecommunication management, including TMN and network maintenance
Series N	Maintenance: international sound programme and television transmission circuits
Series O	Specifications of measuring equipment
Series P	Terminals and subjective and objective assessment methods
Series Q	Switching and signalling
Series R	Telegraph transmission
Series S	Telegraph services terminal equipment
Series T	Terminals for telematic services
Series U	Telegraph switching
Series V	Data communication over the telephone network
Series X	Data networks, open system communications and security
Series Y	Global information infrastructure, Internet protocol aspects and next-generation networks
Series Z	Languages and general software aspects for telecommunication systems

Printed in Switzerland
Geneva, 2012