International Telecommunication Union

ITU-T

TELECOMMUNICATION
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OF ITU

T.800

Amendment 5

(01/2012)

SERIES T: TERMINALS FOR TELEMATIC SERVICES

Still-image compression – JPEG 2000

Information technology – JPEG 2000 image coding system: Core coding system

Amendment 5: Enhancements for digital cinema and archive profiles (additional frame rates)

Recommendation ITU-T T.800 (2002) – Amendment 5

ITU International Telecommunication Union

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INTERNATIONAL STANDARD ISO/IEC 15444-1
RECOMMENDATION ITU-T T.800

Information technology – JPEG 2000 image coding system: Core coding system

Amendment 5

Enhancements for digital cinema and archive profiles (additional frame rates)

Summary

Amendment 5 adds additional frame rates that expand the set of profiles of ITU-T Rec. T.800 (2002) | ISO/IEC 15444-1:2004 for digital cinema and archive applications. These additional frame rates can be used for both archive and distribution applications. The frame rates added to the 2K distribution profiles include the following examples: 16 fps, 25 fps, 30 fps and 60 fps. The frame rates added to the 4K distribution profiles include the following examples: 16 fps, 25 fps and 30 fps.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T T.800	2002-08-29	16
1.1	ITU-T T.800 (2002) Amd. 1	2005-09-13	16
1.2	ITU-T T.800 (2002) Cor. 1	2007-01-13	16
1.3	ITU-T T.800 (2002) Cor. 2	2007-08-29	16
1.4	ITU-T T.800 (2002) Amd. 2	2009-03-16	16
1.5	ITU-T T.800 (2002) Amd. 3	2010-06-22	16
1.6	ITU-T T.800 (2002) Amd. 4	2011-05-14	16
1.7	ITU-T T.800 (2002) Amd. 5	2012-01-13	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.

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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/.

INTERNATIONAL STANDARD

RECOMMENDATION ITU-T

Information technology – JPEG 2000 image coding system: Core coding system

Amendment 5

Enhancements for digital cinema and archive profiles (additional frame rates)

1) Annex A

a) The following material should be placed immediately after Table A.45. This replaces all text that previously followed Table A.45 up to but not including Table A.47.

A.10.1 Codestream restrictions for digital cinema applications including archiving

In addition to the profiles defined in Table A.10, five profiles are defined for digital cinema and archiving applications as detailed in Table A.46. The first two, in form of Profile-3 and Profile-4, are primarily intended for distribution. In addition, the three profiles listed under profile indication numbers 5 to 7 are intended for archiving and production purposes. The two extended scalable profiles (Profile-5 and Profile-6) are intended to be used for easily accessible archives. The long-term storage profile (Profile-7) is intended for original camera capture or post-production workflows.

Table A.46 – Codestream restrictions for digital cinema applications

	2K digital cinema profile	4K digital cinema profile	Scalable 2K digital cinema profile	Scalable 4K digital cinema profile	Long-term storage profile
SIZ marker segment					
Profile Indication	Rsiz=3	Rsiz=4	Rsiz=5	Rsiz=6	Rsiz=7
Image size	Xsiz <= 2048, Ysiz <= 1080	Xsiz <= 4096, Ysiz <= 2160	Xsiz <= 2048, Ysiz <= 1080	Xsiz <= 4096, Ysiz <= 2160	Xsiz <= 16384, Ysiz <= 8640
Tiles	one tile for the whole image: YTsiz + YTOsiz >= Ysiz XTsiz + XTOsiz >= Xsiz	one tile for the whole image: YTsiz + YTOsiz >= Ysiz XTsiz + XTOsiz >= Xsiz	one tile for the whole image: YTsiz + YTOsiz >= Ysiz XTsiz + XTOsiz >= Xsiz	one tile for the whole image: YTsiz + YTOsiz >= Ysiz XTsiz + XTOsiz >= Xsiz	One tile for the whole image or minimum tile size: YTsiz + YTOsiz >= 512 XTsiz + XTOsiz >= 1024
Image and tile origin	XOsiz = YOsiz = XTOsiz = YTOsiz = 0	XOsiz = YOsiz = XTOsiz = YTOsiz = 0	XOsiz = YOsiz = XTOsiz = YTOsiz = 0	XOsiz = YOsiz = XTOsiz = YTOsiz = 0	XOsiz = YOsiz = XTOsiz = YTOsiz = 0
Sub-sampling	$XRsiz^i = YRsiz^i = 1$	$XRsiz^i = YRsiz^i = 1$	$XRsiz^i = YRsiz^i = 1$	$XRsiz^i = YRsiz^i = 1$	No restriction
Number of components	Csiz = 3	Csiz = 3	Csiz = 3	Csiz = 3	Csiz<=8
Bitdepth	Ssizi = 11 (i.e., 12 bit unsigned)	Ssizi = 11 (i.e., 12 bit unsigned)	$Ssiz^i$ = 11 (i.e., 12 bit unsigned)	$Ssiz^i$ = 11 (i.e., 12 bit unsigned)	No restriction
RGN marker segment	Disallowed, i.e., no region of interest	Disallowed, i.e., no region of interest	Disallowed, i.e., no region of interest	Disallowed, i.e., no region of interest	Disallowed, i.e., no region of interest
COD/COC marker segments	Main header only	Main header only	Main header only	Main header only	Main header only
Coding style	Scod, Scoc = 0000 0esp, where p=1, e=0 or e=1, s=0 or s=1 NOTE – p=1: precincts defined in SPcodIi/SPcocI	Scod, Scoc = 0000 0esp, where p=1, e=0 or e=1, s=0 or s=1 NOTE – p=1: precincts defined in SPcodIi/SPcocI	Scod, Scoc = 0000 0esp, where e=s=0, and p=1 NOTE – e=0: EPH marker shall not be used s=0: SOP marker shall not be used p=1: precincts defined in $SPcodI^i/SPcocI^i$	Scod, Scoc = 0000 0esp, where e=s=0, and p=1 NOTE – e=0: EPH marker shall not be used s=0: SOP marker shall not be used p=1: precincts defined in $SPcodI^i/SPcocI^i$	Scod, Scoc = 0000 0esp, where e=s=1, and p=0 or 1 NOTE – e: EPH marker shall be used s: SOP marker may be used p: precincts with PPx=15 and PPy=15 or defined in $SPcodI^i/SPcocI^i$
Progression order	CPRL	CPRL	CPRL	CPRL	CPRL
Number of layers	L=1	L=1	L=2	L=2	L<=5
Multiple component transform	All component transforms defined in ITU-T Rec. T.800 | ISO/IEC 15444-1 may be used.	All component transforms defined in ITU-T Rec. T.800 | ISO/IEC 15444-1 may be used.	All component transforms defined in ITU-T Rec. T.800 | ISO/IEC 15444-1 may be used.	All component transforms defined in ITU-T Rec. T.800 | ISO/IEC 15444-1 may be used.	All component transforms defined in ITU-T Rec. T.800 | ISO/IEC 15444-1 may be used.

Table A.46 – Codestream restrictions for digital cinema applications

	2K digital cinema profile	4K digital cinema profile	Scalable 2K digital cinema profile	Scalable 4K digital cinema profile	Long-term storage profile
Number of decomposition levels	NL <= 5 Every component of every image of a distribution shall have the same number of wavelet transform levels. The number of deployed decomposition levels shall be set accordingly in all COD and COC markers.	1<= NL <= 6 Every component of every image of a distribution shall have the same number of wavelet transform levels. The number of deployed decomposition levels shall be set accordingly in all COD and COC markers.	NL <= 5 Every component of every image of a codestream shall have the same number of wavelet transform levels. The number of deployed decomposition levels shall be set accordingly in all COD and COC markers.	1<= NL <= 6 Every component of every image of a codestream shall have the same number of wavelet transform levels. The number of deployed decomposition levels shall be set accordingly in all COD and COC markers.	No restriction, with respect to: (Xsiz-XOsiz)/D(I) <= 64 (Ysiz-YOsiz)/D(I) <= 64 and D(I)=pow(2,NL) for each component I Every component of every image of a codestream shall have the same number of wavelet transform levels. The number of deployed decomposition levels shall be set accordingly in all COD and COC markers.
Code-block size	xcb=ycb=5 The corresponding values shall be set accordingly in all deployed COD and COC markers.	xcb=ycb=5 The corresponding values shall be set accordingly in all deployed COD and COC markers.	xcb = ycb = 5 The corresponding values shall be set accordingly in all deployed COD and COC markers.	xcb = ycb = 5 The corresponding values shall be set accordingly in all deployed COD and COC markers.	xcb <= 6, ycb <= 6 The corresponding values shall be set accordingly in all deployed COD and COC markers. Note that codeblock sizes might differ between the existing components.
Code-block style	SPcod, SPcoc = 0000 0000	SPcod, SPcoc = 0000 0000	SPcod, SPcoc = 0000 0000	SPcod, SPcoc = 0000 0000	SPcod, SPcoc = 00sp vtra where r = v = 0, and a, t, p, s = 0 or 1 NOTE – a = 1 for selective arithmetic coding bypass t = 1 for termination on each coding pass, p = 1 for predictive termination s = 1 for segmentation symbols

Table A.46 – Codestream restrictions for digital cinema applications

	2K digital cinema profile	4K digital cinema profile	Scalable 2K digital cinema profile	Scalable 4K digital cinema profile	Long-term storage profile
Transformation	5-3 reversible filter or 9-7 irreversible filter[1] The corresponding filter shall be set accordingly in all COD and COC markers.	5-3 reversible filter or 9-7 irreversible filter1 The corresponding filter shall be set accordingly in all COD and COC markers.	9-7 irreversible filter The corresponding filter shall be set accordingly in all COD and COC markers.	9-7 irreversible filter The corresponding filter shall be set accordingly in all COD and COC markers.	9-7 irreversible filter 5-3 reversible filter The corresponding filter shall be set accordingly in all COD and COC markers.
Precinct size	PPx = PPy = 7 for NLLL band, else 8 The corresponding values shall be set accordingly in all COD and COC markers.	PPx = PPy = 7 for NLLL band, else 8 The corresponding values shall be set accordingly in all COD and COC markers.	PPx = PPy = 7 for NLLL band, else 8 The corresponding values shall be set accordingly in all COD and COC markers.	PPx = PPy = 7 for NLLL band, else 8 The corresponding values shall be set accordingly in all COD and COC markers.	PPx >= xcb, PPy >= ycb The corresponding values shall be set accordingly in all COD and COC markers. Note that the precinct sizes might differ between existing components.
Tile-parts	Each compressed image shall have exactly 3 tile parts. Each tile part shall contain all data from one colour component	Each compressed image shall have exactly 6 tile parts as depicted in Figure A.25 and Figure A.26. Each of the first 3 tile parts shall contain all data necessary to decompress one 2K colour component. Each of the next 3 tile parts shall contain all additional data necessary to decompress one 4K colour component.	Each compressed image shall have exactly 6 tile parts as depicted in Figure A.29. Each of the first 3 tile parts shall contain all data necessary to decompress one 2K colour component compatible to 2K digital cinema profile. Each of the next 3 tile parts shall contain all additional data necessary to decompress the rest of one 2K colour component.	Each compressed image shall have exactly 12 tile parts as depicted in Figures A.28, A.27 and A.25. Each of the first 3 tile parts shall contain all data necessary to decompress one 2K colour component compatible to 2K digital cinema profile. Each of the next 3 tile parts shall contain all additional data necessary to decompress one 4K colour component. Each of the next 3 tile parts shall contain all additional data necessary for the rest of one 2K colour component. Each of the next 3 tile parts shall contain all additional data necessary to decompress the rest of one 4K colour component.	Each compressed image tile shall consist of exactly Csiz tile parts. Each tile part shall contain all data from one component of the considered tile.
Other markers					
Packed headers (PPM, PPT)	Disallowed	Disallowed	Disallowed	Disallowed	Disallowed

[1] The use of the 9-7 irreversible filter is highly recommended to increase the usability for archives, since both the scalable 2K digital cinema profile and the scalable 4K digital cinema profile are restricted to this wavelet filter. In addition, digital cinema packages (DCPs) conform to the 9-7 filter.

Table A.46 – Codestream restrictions for digital cinema applications

	2K digital cinema profile	4K digital cinema profile	Scalable 2K digital cinema profile	Scalable 4K digital cinema profile	Long-term storage profile
Tile-part lengths (TLM)	TLM marker segments are required in each image	TLM marker segments are required in each image	TLM marker segments are required in each image	TLM marker segments are required in each image	TLM marker segments are required in each image
Packet length, tile-part header (PLT)	Optional	Optional	For each tile-part a complete list of packet lengths shall be provided	For each tile-part a complete list of packet lengths shall be provided	For each tile-part a complete list of packet lengths shall be provided
QCD, QCC	Main header only	Main header only	Main header only	Main header only	Main header only
SOP, EPH	Optional	Optional	Disallowed	Disallowed	Each packet in any given tile-part shall be prepended with a SOP marker segment and each packet header in any given tile-part shall be postpended with an EPH marker segment
POC marker	Disallowed	There shall be exactly one POC marker segment in the main header. Other POC marker segments are disallowed. The POC marker segment shall specify exactly two progressions having the following parameters: First progression: RSpoc = 0, CSpoc = 0, LYEpoc = 1, REpoc = N_L, CEpoc = 3, Ppoc = 4 Second progression: RSpoc = N_L, CSpoc = 0, LYEpoc = 1, REpoc = N_L +1, CEpoc = 3, Ppoc = 4	There shall be exactly one POC marker segment in the main header. Other POC marker segments are disallowed. The POC marker segment shall specify exactly two progressions having the following parameters: First progression: RSpoc = 0, CSpoc = 0, LYEpoc = 1, REpoc = N_L+1, CEpoc = 3, Ppoc = 4 Second progression: RSpoc = 0, CSpoc = 0, LYEpoc = 2, REpoc = N_L+1, CEpoc = 3, Ppoc = 4	There shall be exactly one POC marker segment in the main header. Other POC marker segments are disallowed. The POC marker segment shall specify exactly four progressions having the following parameters: First progression: RSpoc = 0, CSpoc = 0, LYEpoc = 1, REpoc = N_L, CEpoc = 3, Ppoc = 4 Second progression: RSpoc = N_L, CSpoc = 0, LYEpoc = 1, REpoc = N_L+1, CEpoc = 3, Ppoc = 4 Third Progression: RSpoc = 0, CSpoc = 0, LYEpoc = 2, REpoc = N_L, CEpoc = 3, Ppoc = 4 Fourth Progression: RSpoc = N_L, CSpoc = 0, LYEpoc = 2, REpoc = N_L+1, CEpoc = 3, Ppoc = 4	Disallowed
Application specific restrictions					

Table A.46 – Codestream restrictions for digital cinema applications

	2K digital cinema profile	4K digital cinema profile	Scalable 2K digital cinema profile	Scalable 4K digital cinema profile	Long-term storage profile
Error protection	Disallowed	Disallowed	Disallowed	Disallowed	The use of marker segments defined in ITU-T Rec. T.810 | ISO/IEC 15444-11 for the detection, correction and protection against errors that may result from aging media is not mandatory but optional and recommended.
Maximum instantaneous bit-rate for all 3 colour components[2]	Including possible PLT markers 250×10^6 Bit/s	Including possible PLT markers 250×10^6 Bit/s	Excluding PLT markers 500×10^6 Bit/s	Excluding PLT markers 500×10^6 Bit/s	No restrictions
Maximum instantaneous bit-rate for each single colour component including all relevant tile-part headers.	Including possible PLT markers 200×10^6 Bit/s	Including possible PLT markers 200×10^6 Bit/s for 2K portion of each component	Excluding PLT markers 400×10^6 Bit/s	Excluding PLT markers 400×10^6 Bit/s	No restrictions
Maximum instantaneous bit-rate for quality layer 0 of any image frame (aggregate of all 3 colour components) shall include relevant headers and markers assuring Digital Cinema packages can be obtained by simply stripping some tile parts.	–	–	Excluding PLT markers 250×10^6 Bit/s	Excluding PLT markers 250×10^6 Bit/s	No restrictions
Maximum instantaneous bit-rate for layer 0 of any single colour component of an image frame including all relevant tile-part headers.	–	–	Excluding PLT markers 200×10^6 Bit/s	Excluding PLT markers 200×10^6 Bit/s for 2K portion of each component	No restrictions
Maximum frame rate	60	30	60	30	No limitations

[2] The maximum instantaneous bit-rate must not be exceeded. The maximum admissible compressed bytes are explained in formula A-8.

In order to simplify access to the different codestream resolution, quality layer and component parts, codestreams in accordance with the profiles defined in Table A.46 have to follow a well-defined compressed image data ordering method defined by the following.

Figure A.25 shows the corresponding details for the position of the 4K information relative to the basic 2K information. Assuming N_L wavelet transform levels (N_L+1 resolutions), the rectangle labelled 2K_i (i = 0, 1, 2) contains all packets for colour component i, resolutions 0 through N_L–1 (and layer 1). The rectangle labelled 4K_i (i = 0, 1, 2) contains all packets for colour component i, resolution N_L (and layer 1).

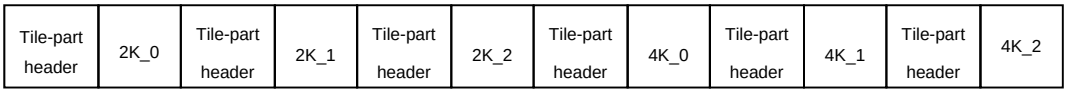

Figure A.25 – Compressed data ordering showing the relative position of the 4K tile parts relative to the basic 2K tile parts.

For the 4K digital cinema profile, Figure A.26 defines the overall file structure.

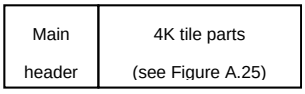

Figure A.26 – Codestream structure for 4K digital cinema profile

For the scalable 4K digital cinema profiles defined in Table A.46, Figure A.27 illustrates the relative compressed data layout of the 2K and 4K information belonging to the second quality layer. Assuming N_L wavelet transform levels (N_L+1 resolutions), the rectangle labelled Ext_2K_i (i = 0, 1, 2) contains all packets for colour component i, resolutions 0 through N_L–1 and layer 2. The rectangle labelled Ext_4K_i (i = 0, 1, 2) contains all packets for colour component i, resolution N_L and layer 2.

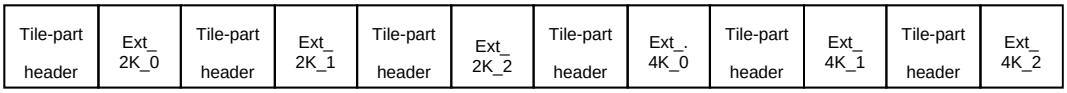

Figure A.27 – Extended tile parts for the scalable 4K digital cinema profile.

The overall file structure of the scalable 4K digital cinema profile results from concatenating the information of layer 1 and layer 2 as illustrated in Figure A.28.

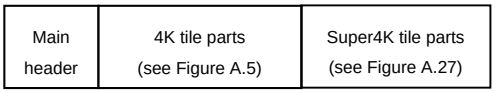

Figure A.28 – Codestream structure for the scalable 4K digital cinema profile

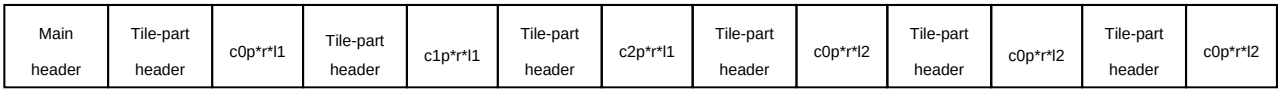

Figure A.29 – Proposed codestream structure for the scalable 2K digital cinema profile. Assuming N_L wavelet transform levels (N_L+1 resolutions), the rectangle labelled c*i*p*r*l1 (*i* = 0, 1, 2) contains all packets for colour component *i*, all precincts, resolutions 0 through N_L and layer 1. The rectangle labelled c*i*p*r*l2 (*i* = 0, 1, 2) contains all packets for colour component *i*, resolutions 0 through N_L and layer 2.

The maximum number of bytes per compressed image from the instantaneous bit-rate given in the previous table may be calculated using the following equation:

$$Max\_Compressed\_Bytes = \frac{Max\_Instantaneous\_Bitrate}{Frame\_Rate \times 8} \quad \text{(A-8)}$$

b) Insert the following table as Table A.47 and renumber current Tables A.47 and A.48 as Tables A.48 and A.49 respectively:

Table A.47 – Example file size limitations for digital cinema applications including archiving

File size (in bytes)	2K digital cinema profile	4K digital cinema profile	Scalable 2K digital cinema profile	Scalable 4K digital cinema profile
Max compressed bytes for any image frame (aggregate of all 3 colour components)	Including possible PLT markers 16 fps: 1953125 24 fps: 1302083 25 fps: 1250000 30 fps: 1041666 48 fps : 651041 60 fps: 520833	Including possible PLT markers 16 fps: 1953125 24 fps: 1302083 25 fps: 1250000 30 fps: 1041666	Excluding PLT markers 16 fps: 3906250 24 fps: 2604166 25 fps: 2500000 30 fps: 2083333 48 fps: 1302083 60 fps: 1041666	Excluding PLT markers 16 fps: 3906250 24 fps: 2604166 25 fps: 2500000 30 fps: 2083333
Max compressed bytes for any single colour component of an image frame including all relevant tile-part headers.	Including possible PLT markers 16 fps: 1562500 24 fps: 1041666 25 fps: 1000000 30 fps: 833333 48 fps: 520833 60 fps: 416666	Including possible PLT markers (2K portion) 16 fps: 1562500 24 fps: 1041666 25 fps: 1000000 30 fps: 833333	Excluding PLT markers 16 fps: 3125000 24 fps: 2083333 25 fps: 2000000 30 fps: 1666666 48 fps: 1041666 60 fps: 833333	Excluding PLT markers 16 fps: 3125000 24 fps: 2083333 25 fps: 2000000 30 fps: 1666666
Max compressed bytes for quality layer 0 of any image frame (aggregate of all 3 colour components) shall include relevant headers and markers assuring Digital Cinema packages can be obtained by simply stripping some tile parts.	–	–	Excluding PLT markers 16 fps: 1953125 24 fps: 1302083 25 fps: 1250000 30 fps: 1041666 48 fps : 651041 60 fps: 520833	Excluding PLT markers 16 fps: 1953125 24 fps: 1302083 25 fps: 1250000 30 fps: 1041666
Max compressed bytes for layer 0 of any single colour component of an image frame including all relevant tile-part headers.	–	–	Excluding PLT markers 16 fps: 1562500 24 fps: 1041666 25 fps: 1000000 30 fps: 833333 48 fps: 520833 60 fps: 416666	Excluding PLT markers (2K portion) 16 fps: 1562500 24 fps: 1041666 25 fps: 1000000 30 fps: 833333

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