INTERNATIONAL STANDARD

ISO/IEC
15444-1

Second edition
2004-09-15
AMENDMENT 3
2010-12-15

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

AMENDMENT 3: Profiles for broadcast applications

Technologies de l'information — Système de codage d'images JPEG 2000: Système de codage de noyau

AMENDEMENT 3: Profils pour applications de diffusion

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Amendment 3 to ISO/IEC 15444-1:2004 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*, in collaboration with ITU-T. The identical text is published as ITU-T Rec. T.800 (2002)/Amd.3 (06/2010).

INTERNATIONAL STANDARD
RECOMMENDATION ITU-T

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

Amendment 3

Profiles for broadcast applications

1)   Subclause 2.2

Add the following normative references to subclause 2.2:

  – ISO 11664-1:2007 (CIE S 014-1/E:2006), *Colorimetry – Part 1: CIE standard colorimetric observers.*

  – ISO 26428-1:2008, *Digital cinema (D-cinema) distribution master – Part 1: Image characteristics.*

  – Recommendation ITU-R BT.601-6 (2007), *Studio encoding parameters of digital television for standard 4:3 and wide screen 16:9 aspect ratios.*

  – Recommendation ITU-R BT.709-5 (2002), *Parameter values for the HDTV standards for production and international programme exchange.*

2)   Clause 3

Add the following definitions to clause 3, and adjust the numbering of the other definitions as necessary:

access unit: A coded representation of one video frame.

instantaneous bit rate: For each frame, corresponds to the size of the contiguous codestream for the frame in bits multiplied by the frame rate.

3)   Table A.10

Add the following rows to Table A.10 (prior to the line specifying that other values are reserved):

0000 0001 0000 0001	Broadcast Contribution Single Tile Profile Level 1
0000 0001 0000 0010	Broadcast Contribution Single Tile Profile Level 2
0000 0001 0000 0011	Broadcast Contribution Single Tile Profile Level 3
0000 0001 0000 0100	Broadcast Contribution Single Tile Profile Level 4
0000 0001 0000 0101	Broadcast Contribution Single Tile Profile Level 5
0000 0010 0000 0101	Broadcast Contribution Multi-tile Profile Level 5
0000 0011 0000 0110	Broadcast Contribution Multi-tile Reversible Profile Level 6
0000 0011 0000 0111	Broadcast Contribution Multi-tile Reversible Profile Level 7

4)　　　Additional Tables A.47 and A.48

Add the following additional tables after Table A.46:

Table A.47 – Codestream restrictions for broadcast application profiles

	Broadcast contribution single tile profile	Broadcast contribution multi-tile profile	Broadcast contribution multi-tile reversible profile
SIZ marker segment			
Profile Indication	See Table A.10	See Table A.10	See Table A.10
Tiles	One tile for the whole image: YTsiz + YTOsiz >= Ysiz XTsiz + XTOsiz >= Xsiz	1 or 4 tiles If 1 tile YTsiz + YTOsiz >= Ysiz XTsiz + XTOsiz >= Xsiz If 4 tiles Ysiz/4 <= YTsiz + YTOsiz <= Ysiz Xsiz/2<= XTsiz + XTOsiz <= Xsiz All tiles shall be of the same size	1 or 4 tiles If 1 tile YTsiz + YTOsiz >= Ysiz XTsiz + XTOsiz >= Xsiz If 4 tiles Ysiz/4 <= YTsiz + YTOsiz <= Ysiz Xsiz/2<= XTsiz + XTOsiz <= Xsiz All tiles shall be of the same size
Image and tile origin	XOsiz = YOsiz = XTOsiz = YTOsiz = 0	Same	Same
Sub-sampling	(XRsizi = 1 for all components) or (XRsiz1=1, XRsiz4=1 and XRsizi=2 for remaining components). YRsizi=1	Same	Same
Number of components	Csiz $\leq$ 4	Same	Same
Bit depth	$7 \leq$ Ssiz^i ≤ 11 (8-12 bits unsigned)	Same	Same
RGN marker segment	Disallowed, i.e., no region of interest	Same	Same
Marker locations			
Packed headers (PPM, PPT)	Disallowed	Same	Same
COD, COC, QCD, QCC	Main header only	Same	Same
COD/COC marker segments			
Number of decomposition levels	$1 <= N_L <= 5$ 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.	Same	Same
Number of layers	Shall be exactly 1	Same	Same
Code-block size	$5 \leq xcb \leq 7$ and $5 \leq ycb \leq 6$ and restrictions in Table A.18 apply. Codeblock sizes shall be the same across all components. The *xcb* and *ycb* values shall be set accordingly in all COD and COC markers.	Same	Same
Code-block style	SPcod, SPcoc = 0000 0000	Same	Same
Transformation	9-7 Irreversible Transform	9-7 Irreversible Transform	5-3 Reversible Transform

Table A.47 – Codestream restrictions for broadcast application profiles

	Broadcast contribution single tile profile	Broadcast contribution multi-tile profile	Broadcast contribution multi-tile reversible profile
Precinct size	PPx = PPy = 7 for N_LLL band, else 8. The corresponding values shall be set accordingly in all COD and COC markers.	Same	Same
Progression order	CPRL, POC marker disallowed	Same	Same
Tile-parts	≤4; One for each component	≤16; One for each tile component	≤16; One for each tile component
Tile-part lengths	TLM marker segments are required in each image.	Same	Same
Application-specific restrictions			
Max components sampling rate	See Table A.48.	Same	Same
Max compressed bit rate	See Table A.48. The maximum codestream size is the Max compressed Bit rate divided by the frame rate.	Same	Same

Table A.48 – Operating levels for the broadcast contribution single tile profile, broadcast contribution multi-tile profile, and broadcast contribution multi-tile reversible profile

Sampling Rate = (Average Components/pixel) × (pixels/line) × (total lines/frame) × (frames/s)
Where Average Components is two for 4:2:2, three for 4:4:4 or 4:2:2:4, and four for 4:4:4:4

Levels	Max. components sampling rate (MSamples/s)	Max. compressed bit rate # (Mbit/s)
Level 1	65	200
Level 2	130	200
Level 3	195	200
Level 4	260	400
Level 5	520	800
Level 6	520	1600
Level 7	520	Unspecified
# Max. compressed bit rate = Max. instantaneous bit rate Mega (M), in the context of this Specification, is 10^6.		

5)   New Annex M

Add the following new annex:

Annex M

Elementary stream for broadcast applications

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

M.1   Introduction

The broadcast application profiles are the Broadcast Contribution Single Tile Profile, the Broadcast Contribution Multi-tile Profile, and the Broadcast Contribution Multi-tile Reversible Profile. Support for this annex is required for a decoder that supports the broadcast application profiles, and is optional for other decoders. Decoders supporting the broadcast application profiles use JPEG 2000 for timed sequences of images, hereafter called video. Such a target decoder shall support certain characteristics defined within this annex.

M.2   Definitions

JPEG 2000 access unit: The JPEG 2000 codestream or codestreams comprising a decodable and randomly accessible image.

M.3   Access unit construction

The access unit defines a series of boxes forming an elementary stream header preceding one or more contiguous codestreams. This header is in a box structure where each box is structured as defined in I.4, including a length field, a box type field, an extended box length field, and the box content. The possible box types are defined in Table M.1. A particular order of those boxes in the access unit is not generally implied. Other boxes may be found between the boxes defined in this Recommendation | International Standard. However, all information contained within an access unit shall be in the box format, such that a decoder can skip unknown boxes.

All conforming access units shall contain all boxes required by this Recommendation | International Standard, and those boxes shall be as defined in this Recommendation | International Standard. Also, all conforming readers shall correctly interpret all required boxes defined in this Recommendation | International Standard, and thus shall correctly interpret all conforming access units.
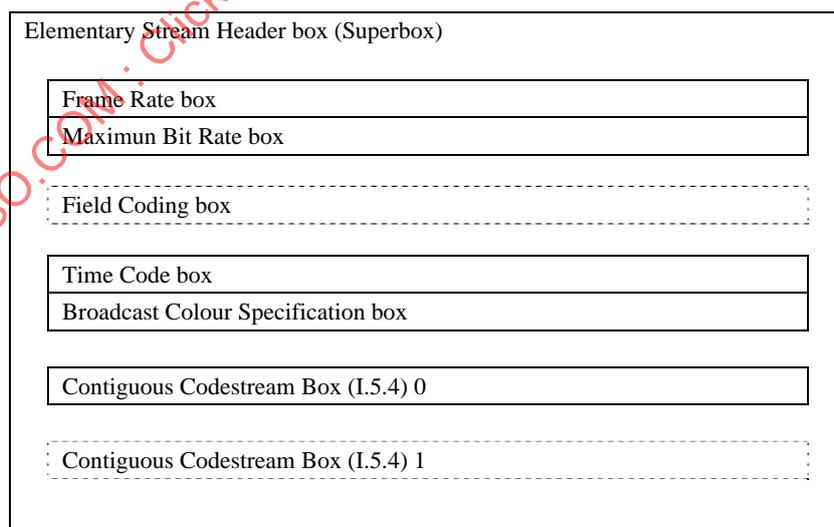

**Figure M.1 – Elementary stream structure for broadcast application profiles –
Boxes with dashed borders are optional**

A set of parameters for each box of Figure M.1 is defined in M.4 using the graphical notation introduced in I.3.6.

Table M.1 – Definitions of elementary stream boxes

Box name	Type	Required?	Comments
Elementary stream Marker	'elsm' (0x656c736d)	Required if an elementary stream is defined.	This marker precedes a series of boxes that contain header type information about the JPEG 2000 elementary stream
Frame Rate Box	'frat' (0x66726174)	Required	This box specifies the frame rate
Maximum Bit Rate Box	'brat' (0x62726174)	Required	This box specifies the compressed bit rate
Field Coding Box	'fiel' (0x6669656c)	Optional	This box specifies interlacing
Time Code Box	'tcod' (0x74636f64)	Required	This box specifies time code
Broadcast Colour Specification Box	'bcol' (0x62636f6c)	Required	This box specifies the broadcast colour specification

M.4 Elementary stream marker box (superbox)

This superbox specifies all parameters required to define an elementary JPEG 2000 access unit. If this superbox exists, it shall contain one frame rate coding box, one maximum bit rate box, one time code box and one broadcast colour specification box.

This superbox may contain other optional boxes. One or two contiguous codestreams must immediately follow the elsm superbox as defined by the coding boxes contained in the elsm superbox.

The type of an elementary stream marker box shall be 'elsm' (0x656c 736d). The contents of the elementary stream marker box are as in Figure M.1.

frat: Frame rate coding box. This box specifies the frame rate in frames per second. The format of this box is specified in M.4.1.

brat: Maximum bit rate box. This box specifies the maximum bit rate of the elementary stream in bits per second. The format of this box is specified in M.4.2.

fiel: Field coding box. This box specifies the field order if the access unit contains two fields. The format of this box is specified in M.4.3. This box is optional.

tcod: Time code box. This box specifies the time code of the access unit in the elementary stream marker superbox. The format of this box is specified in M.4.4.

bcol: Broadcast colour specification box. This box specifies the colour space of the access unit. The format of this box is specified in M.4.5.

M.4.1 Frame rate coding box (required)

This box specifies the frame rate in frames per second. It contains two fields: denominator and numerator. If either is zero, the frame rate is variable or undefined. Otherwise, the frame rate is expressed by a rational number of the form numerator/denominator. If the frame rate is an integer, the denominator shall be equal to 1. If there are two fields per access unit, then the field rate is twice the frame rate. The type of the Frame Rate Box shall be 'frat' (0x6672 6174). This field is specified by a four-byte string of ISO/IEC 646 characters. The contents of this box shall be as in Figure M.2.

DEM	NUM

Figure M.2 – Frame rate coding box content

DEM This parameter is defined as a 2-byte big endian unsigned integer. This parameter specifies the denominator used to calculate the frame rate.

NUM The parameter is defined as a 2-byte big endian unsigned integer. This parameter specifies the numerator used to calculate the frame rate.

NOTE – The NTSC frame rate is correctly expressed as 30000/1001. A frame rate of 24 frames/s is coded as 24/1 and the frame rate typically referred to as 23.98 frames/s is coded as 24000/1001.

M.4.2   Maximum bit rate box (required)

This box specifies the maximum bit rate of the elementary stream and the actual access unit size. The type of the maximum bit rate box shall be 'brat' (0x6272 6174) and contents of the box shall have the format as in Figure M.3:
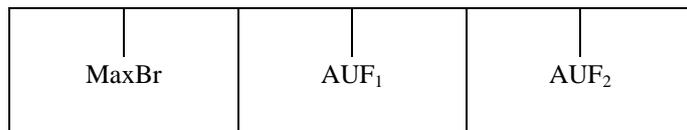
MaxBr	AUF$_1$	AUF$_2$

Figure M.3 – Maximum bit rate box content

MaxBr   This parameter is defined as a 4-byte big endian unsigned integer which specifies a maximum instantaneous bit rate that is not to be exceeded, expressed in bits per second for the elementary stream at the frame rate specified in M.4.1. The maximum bit rate shall not exceed the bit rate specified for a given profile and level.

AUF$_1$ This parameter is defined as a 4-byte big endian unsigned integer which specifies the size of the contiguous codestream corresponding to the first field.

AUF$_2$ This parameter is defined as a 4-byte big endian unsigned integer which specifies the size of the contiguous codestream corresponding to the second field. If there is only one field per access unit, this field is set to '0x0000 0000'.

NOTE – The access unit sizes of each field are defined to help hardware implementations determine the size of each field codestream in advance of reading the contiguous codestream boxes.

M.4.3   Field coding box (optional)

This box specifies the field order if the access unit contains two fields as is the case with interlaced video.

If there is no field coding box present, or the field count is 1, the JPEG 2000 access unit shall contain precisely one codestream. If the field count is 2, then there shall be two contiguous codestreams. The type of the field coding box shall be 'fiel' (0x6669 656c) and contents of the box shall have the format as in Figure M.4.
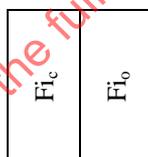
Fi$_c$	Fi$_o$

Figure M.4 – Field coding box content

Fi$_c$ This parameter is defined as a 1-byte unsigned integer which specifies the number of fields in the access unit and shall be 1 or 2. If Fi$_c$ equals one, there shall be exactly one contiguous code stream. If Fi$_c$ equals two, there shall be exactly two contiguous code streams. No other values are permitted.

Fi$_o$ This parameter is defined as a 1-byte unsigned integer which describes the order of the two fields and is only relevant if Fi$_c$ equals 2:

0   field coding unknown;

1   field with the topmost line is stored first in the access unit; fields are in temporal order;

6   field with the topmost line is stored second in the access unit; fields are in temporal order.

M.4.4   Time code box (required)

This time code box specifies the time code of the access unit in the superbox using a 32-bit field. The type of the time code box shall be 'tcod' (0x7463 6f64) and contents of the box shall have the format as in Figure M.5.
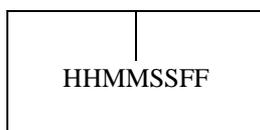
HHMMSSFF

Figure M.5 – Time code box content

HHMMSSFF This parameter is a 4-byte unsigned integer field which specifies the Hour (HH: 0-23), Minutes (MM: 0-59), Seconds (SS: 0-59) and Frame Count (FF: 1-60). The HH, MM, SS, and FF fields are individual bytes packed contiguously.

M.4.5 Broadcast colour specification box (required)

This box specifies the colour space of the access unit. Each broadcast colour specification box defines one method by which an application can interpret the colour space of the decompressed access unit. This colour specification is to be applied to the access unit after it has been decompressed and after any reverse decorrelating component transform has been applied to the image data. The type of the broadcast colour specification box shall be 'bcol' (0x6263 6f6c) and contents of the box shall have the format as in Figure M.6.

Figure M.6 – Broadcast colour specification box content

ColrC This parameter is a 1-byte integer which specifies the corresponding colour standard as defined in Table M.2.

Table M.2 – Code for identifying colour specification

Code	Colour specification
0x00	Unspecified
0x01	IEC 61966-2-1:1999
0x02	Rec. ITU-R BT.601-6
0x03	Rec. ITU-R BT.709-5
0x04	See Tables M.3, M.4 and M.5
0x05	ISO 26428-1 (X'Y'Z')
0x06-0xFF	Reserved

Table M.3 – Colorimetric parameters and related characteristics

Parameter	Values
1 Primaries	CIE 1931 XYZ Tri-stimulus values (as defined in ISO 11664-1)

Table M.4 – Real-valued intermediate luminance and chrominance equations

Parameter	Equations
2 Luminance equation	$L = 1 + \alpha \log_2 Y$ for $Y > 2^{-1/\alpha}$ $L = 0$ otherwise $\alpha = 77/1024$
3 Chrominance equations	$u' = \dfrac{4X}{X + 15Y + 3Z}$ $v' = \dfrac{9Y}{X + 15Y + 3Z}$
4 Inverse transformation from luminance and chrominance signals	$Y = 2^{(L-1)/\alpha}$ $X = \dfrac{9u'}{4v'}Y$ $Z = \dfrac{12 - 3u' - 20v'}{4v'}Y$