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Recommendation ITU-R BT.1203-2
(02/2015)

User requirements for generic video bit-rate reduction coding of digital TV signals for an end-to-end television system

BT Series

Broadcasting service (television)

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SA	Space applications and meteorology
SF	Frequency sharing and coordination between fixed-satellite and fixed service systems
SM	Spectrum management
SNG	Satellite news gathering
TF	Time signals and frequency standards emissions
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Note: *This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

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RECOMMENDATION ITU-R BT.1203-2*

User requirements for generic video bit-rate reduction coding of digital TV signals for an end-to-end television system

(Question ITU-R 12/6)

(1995-2007-2015)

Scope

This Recommendation is intended to provide user requirements for video bit-rate reduction coding of digital TV signals for an end-to-end television system, with respect to picture formats, coding schemes, picture quality, etc.

Keywords

Video bit rate reduction, Satellite News Gathering (SNG), Electronic News Gathering (ENG), primary distribution, secondary distribution

The ITU Radiocommunication Assembly,

considering

a) that rapid progress is being made in bit-rate reduction coding techniques;

b) that video bit-rate reduction coding of digital TV signals has found wide applications for SNG[1]/ENG[2], studio production, contribution, both primary and secondary distribution[3] [4] and emission by terrestrial and satellite delivery;

c) that in the total chain of broadcasting, a number of codecs will be used in a cascade, and this may lead to a loss of picture quality;

d) that Recommendations ITU-T H.262 | ISO/IEC 13818-2 (MPEG-2 Video), H.264 | ISO/IEC 14496-10 (MPEG-4 AVC) and H.265 | ISO/IEC 23008-2 (MPEG-H HEVC) are already used or proposed for codecs for the applications above;

e) that there could be advantages to having generic (i.e. related) bit-rate reduction coding in the various applications so that maximum commonality among various applications can be utilized;

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* Radiocommunication Study Group 6 made editorial amendments to this Recommendation in October 2017 in accordance with Resolution ITU-R 1.

1 The definition of SNG (Satellite News Gathering) can be found in Annex 1, § 1.1 of Recommendation ITU-R SNG.770.

2 The definition of ENG (Electronic News Gathering) can be found in Annex 3, § 2 of Recommendation ITU-R SA.1154 and § 3 of Report ITU-R BT.2069.

3 Primary distribution is defined as distribution of broadcasters' content from a content aggregation centre (playout centre) or a content production centre to either a broadcast transmitting centre or the head-end of a secondary distribution network.

4 Secondary distribution is defined as transmission of broadcasters' content to the general public, irrespective of the delivery medium.

f) that interoperability should be achieved between different video formats and distribution media;

g) that digital and analogue broadcasting systems will both exist during a transition period,

recommends

1 that the same picture format or closely related signal formats should be used as far as possible, throughout the broadcasting chain;

2 that the picture format of both input and output signals for coding and decoding should be the same;

3 that the same or closely related coding schemes should be used as much as possible for terrestrial and satellite emission and secondary distribution in order to minimize the receiver cost and the quality degradation;

4 that the encoder should as far as possible allow non-changing parameters that may be used in subsequent coding processes, e.g. motion information to be down-loaded into the subsequent codecs;

5 that the interface between the codecs should be simple,

further recommends

1 that the values listed in Table 1 should be used for the input of the encoder and output of the decoder;

2 that the functional and operational requirements described in Table 6 should be satisfied;

3 that the benefits of generic coding applied to the total or parts of the total broadcasting chain should be studied in terms of ease of operation, equipment cost, and picture quality;

4 that the choice between Recommendation ITU-T H.262 | ISO/IEC 13818-2 (MPEG-2 Video), Recommendation ITU-T H.264 | ISO/IEC 14496-10 (MPEG-4 AVC)[5], or Recommendation ITU-T H.265 | ISO/IEC 23008-2 (MPEG-H HEVC) for the source coding method used by individual administrations should depend on a number of considerations including, for instance, interoperability with legacy equipment, efficient use of the bit rate available in the delivery channel, and harmonization with source coding methods adopted by neighbouring administrations for digital terrestrial and satellite broadcast channels.

[5] *Note from the Secretariat*: Recommendations ITU-T H.262, H.264 and H.265 are available in electronic form at the ITU-T website.

Annex 1

TABLE 1

Input signal format for codecs

Items	SNG/ENG		Contribution	Studio production	Primary distribution	Primary distribution	Terrestrial emission	Satellite emission	Secondary distribution
	Mode 1(1)	**Mode 2**(1)			**Case 1**(2)	**Case 2**(3)			
No. of samples/line and No. of lines/frame	Examples are listed in Table 2								
Colour format	4:2:0, 4:2:2 or 4:4:4 should be used for the digital interface as per the specified studio formats.				4:2:0, 4:2:2 or 4:4:4 should be used for the digital interface as per the specified studio formats.				

(1) Mode 1: good transmission conditions.

Mode 2: poor transmission conditions.

(2) Case 1: digital primary distribution followed by analogue secondary distribution or emission.

(3) Case 2: digital primary distribution followed by digital secondary distribution or emission.

TABLE 2

Examples of input picture formats for codecs

Recommendation ITU-R	Spatial resolution	Frame frequency (Hz)	Scanning
BT.2020	7 680 × 4 320	120, 120/1.001, 100, 60, 60/1.001, 50, 30, 30/1.001, 25, 24, 24/1.001	Progressive
	3 840 × 2 160	120, 120/1.001, 100, 60, 60/1.001, 50, 30, 30/1.001, 25, 24, 24/1.001	Progressive
BT.709	1 920 × 1 080(1)	60, 60/1.001, 50, 30, 30/1.001, 25, 24, 24/1.001	Progressive
	1 920 × 1 080(1)	30, 30/1.001, 25	Interlace
BT.1543	1 280 × 720	60, 60/1.001, 30, 30/1.001	Progressive
BT.1847	1 280 × 720	50	Progressive
BT.601	720 × 576	25	Interlace
	720 × 483(2)	30, 30/1.001	Interlace

(1) For internal coding, the number of samples per line may be reduced to 1 440.

(2) The number of coded lines may be 480 in the case of emission and secondary distribution applications, although aspect ratio and the picture centre are defined using 483 active lines.

NOTE 1 – Tables 3 and 4 show information about profiles and levels defined in Recommendation ITU-T H.262.

NOTE 2 – Table 5 shows information about levels defined in Recommendation ITU-T H.264.

NOTE 3 – Table 6 shows information about levels defined in Recommendation ITU-T H.265.

TABLE 3

Upper bounds for sampling density and luminance sample rate currently in use among those specified in Recommendation ITU-T H.262

Level		Profile				
		Simple	Main	High		4:2:2
				(4:2:0)	(4:2:2)	
High	Samples/line lines/frame frames/s samples/s		1 920 1 088 60 62 668 800	1 920 1 088 60 83 558 400	1 920 1 088 60 62 668 800	1 920 1 088 60 62 668 800
High-1 440	Samples/line lines/frame frames/s samples/s		1 440 1 088 60 47 001 600	1 440 1 088 60 62 668 800	1 440 1 088 60 47 001 600	
Main	Samples/line lines/frame frames/s samples/s	720 576 30 10 368 000	720 576 30 10 368 000	720 576 30 14 745 600	720 576 30 11 095 200	720 608[1] 30 11 095 200
Low	Samples/line lines/frame frames/s samples/s		352 288 30 3 041 280			

[1] 512 lines/frame for 525/60, 608 lines/frame for 625/50.

TABLE 4

Upper bounds for bit rates (Mbit/s) currently in use among those specified in Recommendation ITU-T H.262

Level	Profile			
	Simple	Main	High	4:2:2
High		80	100	300
High-1 440		60	80	
Main	15	15	20	50
Low		4		

TABLE 5

Levels to be used among those specified in Recommendation ITU-T H.264

Level number	Picture size (samples/line × lines/frame)	Frame frequency[1] (Hz)	Maximum video bit rate[2]	Maximum number of reference frames for picture size
3	720 × 480 720 × 576	30 25	10 Mbit/s	5
3.1	1 280 × 720	30	14 Mbit/s	5
3.2	1 280 × 720	60, 50	20 Mbit/s	4
4	1 920 × 1 080	30, 25, 24	20 Mbit/s	4
4.1	1 920 × 1 080	30, 25, 24	50 Mbit/s	4
4.2	1 920 × 1 080	60, 50	50 Mbit/s	4
5.1	3 840 × 2 160	30, 25, 24	240 Mbit/s	5
5.2	3 840 × 2 160	60, 50	240 Mbit/s	5

(1) Including those multiplied by 1000/1001 for 24, 30, 60, and 120 Hz.

(2) For High, High 10, and High 4:2:2 profiles, the following bit-rate multipliers apply:
High: × 1.25, High 10: × 3, High 4:2:2: × 4

TABLE 6

Levels to be used among those specified in Recommendation ITU-T H.265

Level number	Picture size (samples/line × lines/frame)	Frame frequency[1] (Hz)	Maximum video bit rate[2]	Maximum number of reference frames for picture size
3	720 × 480 720 × 576	30 25	6 Mbit/s	8 8
3.1	1 280 × 720	30	10 Mbit/s	6
4	1 280 × 720 1 920 × 1 080	60, 50 30, 25, 24	12 Mbit/s	16 6
4.1	1 920 × 1 080	60, 50	20 Mbit/s	6
5	3 840 × 2 160	30, 25, 24	25 Mbit/s	6
5.1	3 840 × 2 160	60, 50	40 Mbit/s	6
5.2	3 840 × 2 160	120, 100	60 Mbit/s	6
6	7 680 × 4 320	30, 25, 24	240 Mbit/s	6
6.1	7 680 × 4 320	60, 50	480 Mbit/s	6
6.2	7 680 × 4 320	120, 100	800 Mbit/s	6

(1) Including those multiplied by 1000/1001 for 24, 30, 60, and 120 Hz.

(2) In the case of Main Tier and Main 10 or Main Profile.

Annex 2

TABLE 7

Functional and operational requirements

Item	SNG/ENG Mode 1	SNG/ENG Mode 2	Contribution	Studio production	Primary distribution Case 1	Primary distribution Case 2	Terrestrial emission	Satellite emission	Secondary distribution
No. of audio channels BT.2020/UHDTV BT.709/HDTV BT.1543 and BT.1847 BT.601 /SDTV	Minimum 2 Minimum 2 Minimum 2 Minimum 2		Maximum 24[5] Maximum 8 Maximum 8 Maximum 6		Maximum 24[5] Maximum 6 Maximum 6 Maximum 6				
Range of bit rates	See Tables 3 to 6				Corresponds to SNG and contribution bit rates	Corresponds to secondary distribution	See Tables 3 to 6		
Prediction mode[1]	I, P				(I, B, P) and (I, P) are used in non-live and live broadcasting, respectively				
Picture quality loss[2]	12%[3]	36%[3]	12%[3]		12%[3]	12%[3]	12%[4]		
Compatibility	Not required				Desirable				
Hierarchical coding	Not required				Required only for the graceful degradation system				
Scalability	Not required, but if needed then lower quality can be obtained with a spatial interpolator				Desirable, needed for hierarchical coding				
Interoperability	Not required				A decoder should decode bit streams with as many picture formats as possible, but not necessarily all				

TABLE 7 (*end*)

Item	SNG/ENG Mode 1	SNG/ENG Mode 2	Contribution	Studio production	Primary distribution Case 1	Primary distribution Case 2	Terrestrial emission	Satellite emission	Secondary distribution
Editability				Required in the bit stream domain					
Bit-rate flexibility	A decoder should decode bit streams at any bit rate described in the item of "range of bit rates"								
Codec delay	An overall delay of less than 300 ms would be desirable for interactive talk-back applications								
Recovery time (after a break of 50 ms)	≤ 1 s		≤ 500 ms		≤ 500 ms				
Acquisition time	The major contributions to acquisition time are the decoding delay and the interval between I pictures. A desirable figure for this value is less than 500 ms								
Error concealment	Required, a decoder should support this functionality and should also provide a signalling function of error conditions for studio applications				Desirable				
Graceful degradation	Not required					Desirable, essential for mobile and portable reception			
Channel hopping latency	Not required					Less than 550 ms			
Relative delay between sound and vision	±2 ms per codec[3]						±2 ms per codec[4]		

(1) I: I-picture, P: P-picture, B: B-picture.

(2) When DSCQS (Double Stimulus Continuous Quality Scale) method is used. DSIS (Double Stimulus Impairment Scale) method may be used alternatively.

(3) See Recommendation ITU-R BT.1868.

(4) See Recommendation ITU-R BT.1122.

(5) See Recommendation ITU-R BS.2051.

Attachment[6]

Definition and explanation of items listed in Tables 1, 3, 5, 6, and 7

Generic coding: digital coding of pictures based on a family of related coding methods.

No. of samples/line: number of luminance samples per active line.

No. of lines/frame: number of vertical lines per active frame.

Colour format: ratio between the number of the luminance pixels and the number of the co-sited chroma difference pixels or the ratio between the colour pixels *R*, *G*, and *B*.

No. of audio channels: total number of sound channels per programme, together with a description of how these channels can be combined for different applications.

Range of bit rates: minimum and maximum encoder output bit rates for several input formats.

Prediction mode: type of prediction used inside the encoder. This very strongly influences the maximum achievable picture quality of the following codecs.

Picture quality: results of the subjective evaluation of the encoding and decoding performance in an error-free channel.

Compatibility: description of whether the bit stream syntax allows the separate signal processing of parts of the total bit stream in subsequent codecs.

Hierarchical coding: method to achieve different resolution layers on the decoder side.

Scalability: access to several picture qualities in a single bit stream.

Interoperability: description of the grade of commonality between different bit streams inside the broadcasting chain.

Editability: ability to edit a programme taking into account the structure of the encoder output data.

Bit-rate flexibility: the coding algorithm may allow the use of either CBR (constant bit rate) – or VBR (variable bit rate) – coding.

Codec delay: the delay introduced by the coding/decoding algorithm.

Recovery time: the time period between a physical interruption inside the broadcasting chain and the achievement of full functionality.

Acquisition time: the maximum acceptable waiting time from the start of the decoding process until the display of the picture. This might influence the choice of the generic coding scheme.

Error concealment: possibility of the decoder reacting in a specified way to alarm signals coming from the FEC part of the decoder.

Graceful degradation: to avoid an abrupt degradation of the picture quality on the decoder side, the output of scalable encoders can be protected by different FEC schemes or by non-uniform modulation schemes. A combination of both methods is also possible.

Channel hopping latency: waiting time introduced by the switching between different TV channels.

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6 The definitions of this Attachment only relate to this Recommendation.