RECOMMANDATION UIT-R BT.1532

Ensemble de données de recodage MPEG-2 nécessaire au maintien de la qualité de l'image en cas de mise en cascade de codecs MPEG-2

(Question UIT-R 41/6)

(2001)

L'Assemblée des radiocommunications de l'UIT,

considérant

a)　　que la télévision numérique utilise des signaux comprimés codés suivant la norme MPEG ISO/CEI 13818-2:2000;

b)　　que le traitement des signaux télévisuels sous forme comprimée durant l'acquisition et la production présente des avantages tant sur le plan économique que sur celui de l'exploitation;

c)　　que, sauf mesures spéciales, l'utilisation en cascade de codecs MPEG ISO/CEI 13818-2:2000 peut conduire à des dégradations de la qualité de l'image;

d)　　que les paramètres de codage MPEG ISO/CEI 13818-2:2000 d'origine peuvent être extraits dans un décodeur MPEG;

e)　　qu'il est possible de mettre en cascade des codecs pratiquement sans provoquer de dégradation à condition que les paramètres de recodage correspondent parfaitement aux paramètres utilisés aux étapes de codage précédentes,

recommande

1　　que l'ensemble de données décrit dans la norme SMPTE 327M-2000 «MPEG-2 Video Recoding Data Set» soit utilisé pour acheminer les informations de paramètres de codage d'un décodeur MPEG ISO/CEI 13818-2:2000 vers un recodeur situé en aval.

Résumé de la norme SMPTE 327M-2000

Cette norme spécifie le contenu de l'ensemble de données de recodage de l'image nécessaire à la représentation des informations de codage MPEG ISO/CEI 13818-2 pour une utilisation optimale de décodeurs et recodeurs successifs quel que soit le débit binaire ou la structure du groupe d'images (GoP). Ces informations de codage sont obtenues à partir du flux binaire MPEG (répondant à la norme ISO/CEI 13818) durant le processus de décodage de l'image, comme le décrit la norme ISO/CEI 13818-2. Cette norme a pour rôle et utilité de définir le contenu d'un ensemble de données de recodage suffisant pouvant être extrait dans les décodeurs conformes à la norme ISO/CEI 13818-2, en particulier pour tous les profils non échelonnables définis par la norme ISO/CEI 13818-2. Pour permettre la resynchronisation après traitement de la vidéo ainsi que de l'audio ou des données associées, on fait également figurer dans cette norme un mécanisme utilisant certaines informations supplémentaires issues de la norme ISO/CEI 13818-1. On peut acheminer cet ensemble suffisant de données par différents moyens définis dans d'autres normes SMPTE ou dans des Recommandations de l'UIT-R.

L'objet principal de cette norme est de maintenir la qualité du signal vidéo lors de la mise en cascade de décodeurs et de codeurs MPEG-2 (dont les transcodeurs) en transmettant en aval les décisions de codage précédentes. On considère que l'on dispose d'un ensemble de données MPEG-2

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Note du Secrétariat: La norme SMPTE 327M-2000, dont la version électronique était disponible sur un site web, a été annexée au texte de cette Recommandation.

suffisant si ces données, combinées à une image entièrement ou partiellement décodée suivant la norme MPEG-2, permettent la reconstitution au bit près du flux binaire de l'image précédemment codée. Les diverses méthodes permettant le transport simultané de l'ensemble de données et des informations relatives à l'image complètement ou partiellement décodée suivant la norme MPEG-2, font l'objet d'autres normes.

NOTE 1 – La norme SMPTE 327M-2000 est donnée dans l'Annexe 1. Ce document renvoie certes à la version de la norme MPEG datant de 1996, mais la mise à jour correspondant à la version 2000 n'induit aucune modification des spécifications techniques de l'ensemble de données de recodage. La norme SMPTE 327M-2000 et son résumé renvoient uniquement à la version 2000, qui est celle qui a été approuvée, le 30-06-01 en application de la Résolution UIT-R 45, par les Administrations des Etats Membres de l'UIT et par les Membres du Secteur des radiocommunications participant aux travaux de la Commission d'études 6 des radiocommunications. Comme convenu entre l'UIT et la SMPTE, ladite version a été fournie par la SMPTE qui en a autorisé l'utilisation et l'UIT-R a accepté de l'inclure dans la présente Recommandation. Toute version ultérieure de la norme SMPTE 327M, qui n'aurait pas été agréée et approuvée par la Commission d'études 6, n'entre pas dans le cadre de la présente Recommandation. Pour des versions ultérieures de documents SMPTE, le lecteur est prié de consulter le site web de la SMPTE à l'adresse suivante: http://www.smpte.org/.

SMPTE STANDARD	**SMPTE 327M-2000**

SMPTE STANDARD

for Television —
MPEG-2 Video Recoding Data Set

Table of contents

1 Scope

This standard specifies the content of the picture related recoding data set for the representation of ISO/IEC 13818-2 MPEG coding information for the purpose of optimally cascading decoders and recoders at any bit rate or GOP structure. The coding information is as derived from an ISO/IEC 13818 compliant MPEG bit stream during the picture decoding process, as described in ISO/IEC 13818-2.

The scope and operation of this standard are the definition of the content of a sufficient recoding data set which may be derived in decoders that comply with ISO/IEC 13818-2, including all nonscalable profiles defined in ISO/IEC 13818-2.

To allow the resynchronization of the video and its associated audio or data after processing, a mechanism using some additional information derived from ISO/IEC 13818-1 is also included in this standard.

This sufficient data set may be transported by various means defined in other SMPTE standards.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standards indicated below.

ITU-T H.222.0 with amend 1-2, ISO/IEC 13818-1:1996, Information Technology — Generic Coding of Moving Pictures and Associated Audio Information — Part 1: Systems

ITU-T H.262 with amend 1/corr 1 and amend 2/corr 2, ISO/IEC 13818-2:1996, Information Technology — Generic Coding of Moving Pictures and Associated Audio Information — Part 2: Video

3 General

The principal application of this standard is to preserve the quality of the video signal when cascading MPEG-2 decoders and coders (including transcoding) by feeding forward previous coding decisions.

The MPEG-2 recoding data set is described as sufficient when it contains the data required that, in combination with an MPEG-2 decoded or partially decoded picture, allows bit accurate recreation of the previously picture coded bit stream.

The various methods whereby the data set is transported alongside the MPEG-2 decoded or partially decoded picture information are the subject of other standards.

This standard describes the content of the MPEG-2 recoding data set as extracted or derived from an MPEG-2 bit stream.

The information required in the sufficient MPEG-2 recoding data set can be broken down into three parts. These three parts consist of the picture rate information (described in clause 5), the macroblock rate information (described in clause 6), and some additional information (described in clause 7).

4 Definitions

4.1 bit stream: An ordered series of bits conforming to ISO/IEC 13818-2.

4.2 bottom field: One of two fields that comprise a frame. Each line of a bottom field is spatially located immediately below the corresponding line of the top field.

4.3 cascading: The process where video that has once been coded (compressed) is subsequently decoded and coded once more. This cascaded step could carry on for any number of generations.

4.4 coding: The process by which an uncompressed video sequence is compressed to a bit stream that conforms to ISO/IEC 13818-2.

4.5 column: A vertical column of macroblocks spanning the full height of the decoded picture (columns are numbered from left to right starting at 0).

4.6 decoder: A compressed bit stream decoder that complies with ISO/IEC 13818-2.

4.7 DTS: Decoding time stamp (see ISO/IEC 13818-1).

4.8 macroblock: Defined in ISO/IEC 13818-2 as a block of 16×16 luminance pixels.

4.9 macroblock rate information: This corresponds to the coding information from the ISO/IEC 13818-2 bit stream that relates to the individual macroblocks as defined in this standard.

4.10 MPEG profile / level: As defined in ISO/IEC 13818-2.

4.11 picture: As defined in ISO/IEC 13818-2.

4.12 picture rate information: In this standard, this corresponds to the coding information from the ISO/IEC 13818-2 bit stream that relates to the whole picture plus some additional information derived from sequence and GOP headers.

4.13 PTS: Presentation time stamp (see ISO/IEC 13818-1).

4.14 recoding data set: The set of information derived from an ISO/IEC 13818-1/2 compliant stream which, when accompanied by decoded or partially decoded video information, assists in the recreation of the original bit stream as defined in this standard.

4.15 stripe: A horizontal row of macroblocks spanning the full width of the decoded picture (stripes are numbered from top to bottom starting at 0).

4.16 sufficient: [As applied usually to the recoding data set] allows bit accurate recreation of the previously picture coded bit stream when used in combination with the decoded or partially decoded picture.

4.17 top field: One of two fields that comprise a frame. Each line of a top field is spatially located immediately above the corresponding line of the bottom field.

4.18 transcoding: A conversion within the MPEG-2 stream domain, such as bit-rate changing or changing the group of pictures (GOP) structure.

5 Picture rate information

This clause defines the minimum picture rate information required by the MPEG-2 recoding data set. Table 1 lists the elements taken from the bit stream which shall be included.

For the bit order and number format of this information, refer to the corresponding transport mechanism.

Table 1 – Picture rate elements

Parameter	No. of bits (See note 1)	Notes
Sequence header present flag	1-bit flag	
GOP header present flag	1 flag	
Extension start code flags	16 flags	Indicates if a given extension start code exists. The 16 flags correspond to the 16 entries in table 6.2 of ISO/IEC 13818-2 in the order they are listed.
Other start code flags	3 flags	user_data_start_code, sequence_error_code, sequence_end_code
sequence header		
horizontal_size	14-bit ui	Includes extension
vertical_size	14-bit ui	Includes extension
aspect_ratio_information	4-bit ui	
frame_rate_code	4-bit ui	
bit_rate	30-bit ui	
vbv_buffer_size	18-bit ui	Includes extension
constrained_parameters_flag	1-bit flag	
sequence extension		
profile_and_level_indication	8-bit ui	
progressive_sequence	1-bit flag	
chroma_format	2-bit ui	
low_delay	1-bit flag	
sequence display extension		
video_format	3-bit ui	
color_description	1-bit flag	
color_primaries	8-bit ui	
transfer characteristics	8-bit ui	
matrix_coefficients	8-bit ui	
display_horizontal_size	14-bit ui	
display_vertical_size	14-bit ui	
group of pictures header		
time_code	25-bit field	
closed_gop	1-bit flag	
broken_link	1-bit flag	
picture header		
temporal_reference	10-bit ui	
picture_coding_type	3-bit ui	
vbv_delay	16-bit ui	See note 2
full_pel_forward_vector	1-bit flag	
forward_f_code	3-bit ui	
full_pel_backward_vector	1-bit flag	
backward_f_code	3-bit ui	
picture coding extension		
forward_horizontal_f_code	4-bit ui	
forward_vertical_f_code	4-bit ui	
backward_horizontal_f_code	4-bit ui	
backward_vertical_f_code	4-bit ui	

(continued)

Table 1 – Picture rate elements (concluded)

Parameter	No. of bits (See note 1)	Notes
intra_dc_precision	2-bit ui	
picture_structure	2-bit ui	
top_field_first	1-bit flag	
frame_pred_frame_dct	1-bit flag	
concealment_motion_vectors	1-bit flag	
q_scale_type	1-bit flag	
intra_vic_format	1-bit flag	
alternate_scan	1-bit flag	
repeat_first_field	1-bit flag	
chroma_420_type	1-bit flag	
progressive_frame	1-bit flag	
composite_display_flag	1-bit flag	
v_axis	1-bit flag	
field_sequence	3-bit ui	
sub_carrier	1-bit flag	
burst_amplitude	7-bit ui	
sub_carrier_phase	8-bit ui	
quant matrix extension		See note 3
load_intra_quantizer_matrix	1-bit field	
load_non_intra_quantizer_matrix	1-bit flag	
load_chroma_intra_quantizer_matrix	1-bit flag	
load_chroma_non_intra_quantizer_matrix	1-bit flag	
intra_quantizer_matrix [64]	64* 0..255	
non_intra_quantizer_matrix [64]	64* 0..255	
chroma_intra_quantizer_matrix [64]	64* 0..255	
chroma_non_intra_quantizer_matrix [64]	64* 0..255	
picture display extension		
frame_center_horizontal_offset_1	16-bit ui	
frame_center_vertical_offset_1	16-bit ui	
frame_center_horizontal_offset_2	16-bit ui	
frame_center_vertical_offset_2	16-bit ui	
frame_center_horizontal_offset_3	16-bit ui	
frame_center_vertical_offset_3	16-bit ui	

NOTES
1 The order and number format of each element is defined in the appropriate transport mechanism.
2 This value shall be recalculated as vbv_delay = DTS-PCR, where this calculation is done at the points where the DTS is received. If no DTS is present for the current picture, then the value of DTS shall be calculated as defined in reference clause 2.5.2.3 of ISO/IEC 13818-1.
3 The following elements of the bit stream may be present in either the sequence header or the quant matrix extension (or both). The information required by the MPEG-2 recoding data set is exactly that required by an MPEG-2 video decoder. That is, in the case of 4:2:2 profile, the quantizer matrix values shall be taken from the last set of values received in the bit stream for each of the four matrices, unless a sequence header was received at the beginning of the current picture and no matrix was loaded in either the sequence header or the quant matrix extension, in which case the values will be taken from the default tables in ISO/IEC 13818-2. The load_quantizer_matrix flags shall be set to 1 if, and only if, either of the two possible occurrences of those flags in the bit stream takes the value 1. In the case of the Main Profile, exactly the same procedure is followed except that all values relating to chroma matrices are undefined.

6 Macroblock rate information

The MPEG-2 recoding data set contains macro-block rate elements that are either extracted or derived from the MPEG-2 bit stream. Table 2 contains the information directly extracted from the MPEG-2 bit stream while table 3 contains the elements that are derived.

Together these lists show all the data elements that are required for each macroblock in order to create the sufficient MPEG-2 recoding data set.

6.1 Information extracted from the original bit stream

Where reference is made to elements in ISO/IEC 13818-2, these are indicated in the text in italics (see table 2).

6.2 Information derived from the original bit stream

The following information is not available directly from the original MPEG-2 stream, but can be derived from the bit stream during the decoding process. Where reference is made to elements in ISO/IEC 13818-2, these are indicated in the text in italics (see table 3).

Table 2 – Information extracted from MPEG-2 bit stream

Parameter	No. of bits	Definition
mb_quant	1-bit flag	Value equal to *macroblock_quant*, derived from *macroblock_type*.
mb_mfwd	1-bit flag	Value equal to *macroblock_motion_forward*, derived from *macroblock_type*.
mb_mbwd	1-bit flag	Value equal to *macroblock_motion_backward*, derived from *macroblock_type*.
mb_pattern	1-bit flag	Value equal to *macroblock_pattern*, derived from *macroblock_type*.
mb_intra	1-bit flag	Value equal to *macroblock_intra*, derived from *macroblock_type*.
mb_vert_field_sel[r][s]	4-bit ui	Value equal to *motion_vertical_field_select[r][s]*.
dct_type	1-bit flag	Value equivalent to *dct_type* held in the original bit stream.
motion_type	2-bit ui	Value equivalent to *frame_motion_type* in frame pictures and *field_motion_type* in field pictures when present in the original bit stream. If neither *frame_motion_type* nor *field_motion_type* is present in the bit stream, then the value of motion_type is not defined.
q_scale_code	5-bit ui	Value equal to *q_scale_code*.
coded_block_pattern[7...0]	8-bit ui	Value equivalent to *coded_block_pattern[7...0]* held in the original bit stream.
mv [r][s][t] mv [0][0][0] mv [0][0][1] mv [0][1][0] mv [0][1][1] mv [1][0][0] mv [1][0][1] mv [1][1][0] mv [1][1][1]	 13-bit si 9-bit si 13-bit si 9-bit si 13-bit si 9-bit si 13-bit si 9-bit si	Values corresponding to the derived motion vectors *vector'[r][s][t]*, as defined in clause 7.6.3 of ISO/IEC 13818-2. The meanings associated with the dimensions in the arrays mv [r] [s] [t] and *vector'[r][s][t]* are defined in table 7-7 of ISO/IEC 13818-2. The number format is twos complement and is specified to an accuracy of one half sample.

Table 3 – Information derived from MPEG-2 bit stream

Parameter	No. of bits	Definition
skipped_mb	1-bit flag	Derived from the values of *macroblock_escape* and *macroblock_address_increment* as defined in clause 6.3.17 of ISO/IEC 13818-2. skipped_mb will be set to 1 if the current macroblock has been skipped; otherwise it is 0.
slice_start_flag	1-bit flag	Set to the value 1 if the current macroblock is the first macroblock in a slice; otherwise it is set to 0.
num_coef_bits	14-bit ui	Set to the number of bits used by all codes in the syntax elements *coded_block_pattern()* and *block()*, within the syntax element *macroblock()*, defined in clause 6.2.5 of ISO/IEC 13818-2.
num_mv_bits num_mv_bits [7:2] num_mv_bits [1:0]	 6-bit ui 2-bit ui	Set to the number of bits used by all codes in the syntax elements *motion_vectors(0)* and *motion_vectors(1)* within the syntax element *macroblock()*, defined in clause 6.2.5 of ISO/IEC 13818-2.
num_other_bits	7-bit ui	Set to the number of bits used in the syntax element *macroblock()*, defined in clause 6.2.5 of ISO/IEC 13818-2, excluding those codes accounted for by num_mv_bits and num_coef_bits.

7 Transport of the MPEG-2 recoding data set

The previous clauses describe the necessary information for the sufficient MPEG-2 recoding data set. However, additional information and suitable transport mechanisms are required in order to be able to fully exploit this information in practical systems. The following additional information shall be available in all transport mechanisms:

– User data: This is unbounded by ISO/IEC 13818-2. A defined capacity shall be made available by the transport system employed, so that essential elements can be passed with the MPEG-2 recoding data set.

– Copyright: The copyright extension defined in ISO/IEC 13818-2 is not necessary for cascading operations. However, it is necessary that this information should be propagated through the system and it, therefore, forms an integral part of the standard.

7.1 Additional information derived from a packetized elementary stream

Where the original source was derived from a packetized elementary stream, the following additional information must be included:

– PTS/DTS as defined in ISO/IEC 13818-1. As audio, video, and other services are frequently split apart and pass through independent signal processing paths, it is necessary to add this information to enable the reconstruction of the complete stream after such processing.

7.2 Additional information derived from an elementary stream

Where this information is derived from an elementary stream, the appropriate mechanism is described in SMPTE 328M.

8 Compressed stream format for bandwidth reduced systems

There are, however, circumstances in which the transmission of the sufficient data set described in this

standard is not possible. Some existing equipment has a very low capacity for the transmission of the recoding data and this limit will have an impact on subsequent stages including the MPEG-2 recoding process.

Examples of such equipment are those which are not transparent in the active video region and/or are restricted in their capacity to carry the additional data. However, such equipment may still be able to transport some recoding information.

Transporting a limited set of recoding data can still have a beneficial effect on the final recoding stage though clearly not as effective as the use of the sufficient data set. There are two methods to reduce the bit rate of the sufficient recoding data set:

The first step is to use variable-length coding (VLC) for those parts of the recoding data which have redundancy.

A full description of this mechanism is defined in SMPTE 329M.

Where this remains insufficient for the reduced bandwidth available, use of a subset of the recoding data, considering the balance and trade-off between the band limiting effect and the recoded picture quality, may be used.

To ensure interoperablity between the various transport mechanisms proposed for the MPEG-2 recoding data set, it is essential to ensure the consistency of the reduced bandwidth syntax representation. This is defined in the reduced bandwidth indicator table (table 4) and shall be incorported into all transport mechanisms using this data set.

Reduced bandwidth operation shall be signaled in the following manner:

red_bw_flag shall be set to 0 in normal operation. For reduced bandwidth operation, this flag shall be set to 1.

Where the red_bw_flag is set to 1, then the red_bw_indicator shall be examined to determine what information shall be present from the MPEG-2 recoding data set as defined in table 4.

Table 4 – Reduced bandwidth indicators

red_bw_indicator_	num_coef_bits, num_mv_bits, num_other_bits	q_scale_code, q_scale_type	motion_type, mv_vert_field_sel[r][s], mv[r][s][t]	mb_mfwd, mb_mbwd	mb_pattern	coded_block_pattern	mb_intra	slice_start	dct_type	mb_quant	skipped mb
Indicator 0	0	1	1	1	1	1	1	1	1	1	1
Indicator 1	0	1	1	1	1	0	1	0	1	0	0
Indicator 2	0	1	0	0	0	0	0	0	0	0	0
Indicator 3	0	0	0	0	0	0	0	0	0	0	0

NOTES
1 0 = this information is not present.
2 1 = this information exists.

Annex A (informative)
Transport mechanisms

This annex contains information about the various proposed transport mechanisms for the MPEG-2 recoding data set and the relationships among these standards (see figure A.1).

A.1 Transport mechanism for macroblock based editing

To allow for the editing of the MPEG-2 recoding data set to occur in parallel with the decoded video, the following key features will be required of the transport mechanism:

  – Spatial alignment of the decoded video and the MPEG-2 recoding data set on a macroblock basis;

  – Temporal alignment of the decoded video and the MPEG-2 recoding data set on a macroblock and picture basis;

  – A system to accompany or embed this information into the ITU-R BT.601 stream without adversely affecting the picture quality for standard definition systems and a similar system for high-definition systems;

  – This system must also allow the MPEG-2 recoding data set to be destroyed in the areas of the picture where two or more video signals overlap.

For this type of transport mechanism, all macroblock rate information must be available on a macroblock basis.

If in the MPEG-2 decoding process, there is a need to derive or infer certain elements for use in the decoding of the current macroblock (e.g., skipped macroblock), then all the elements described in clause 6 must be set to those used by the decoding process, as defined in ISO/IEC 13818-2.

A full description of the standard defined version of this transport mechanism is given in SMPTE 319M.

A.2 History information

There are instances where a video signal is first coded by a long GOP, low bit rate coder to get the cost benefit of the source media. This may then be converted to a short GOP, high bit rate stream to get functional benefits, such as splicing and VTR stunt play modes. The short GOP signal may then be converted back to a long GOP low bit rate stream at the output.

In such cases, conversion may be done in the compressed domain and it is useful to keep the first set of long GOP coding data present in the short GOP compressed bit stream and pass this to the next compression recoder to achieve the best picture quality at each generation. The carriage of this recoding data from the last but one encoder is called history recoding data. For the reasons outlined in clause 8, a bandwidth limited recoding data set may also be required for this history.

It is also clear that the history recoding data may be carried either in the baseband (ITU-R BT.601 for standard definition signals) domain or the compressed bit stream domain depending on the application. Methods for the carriage of history recoding data will be required for both the baseband and bit stream domains.

The system required to reduce the bandwidth is described in SMPTE 329M.

The method of transporting this signal in the baseband domain is defined in SMPTE 319M.
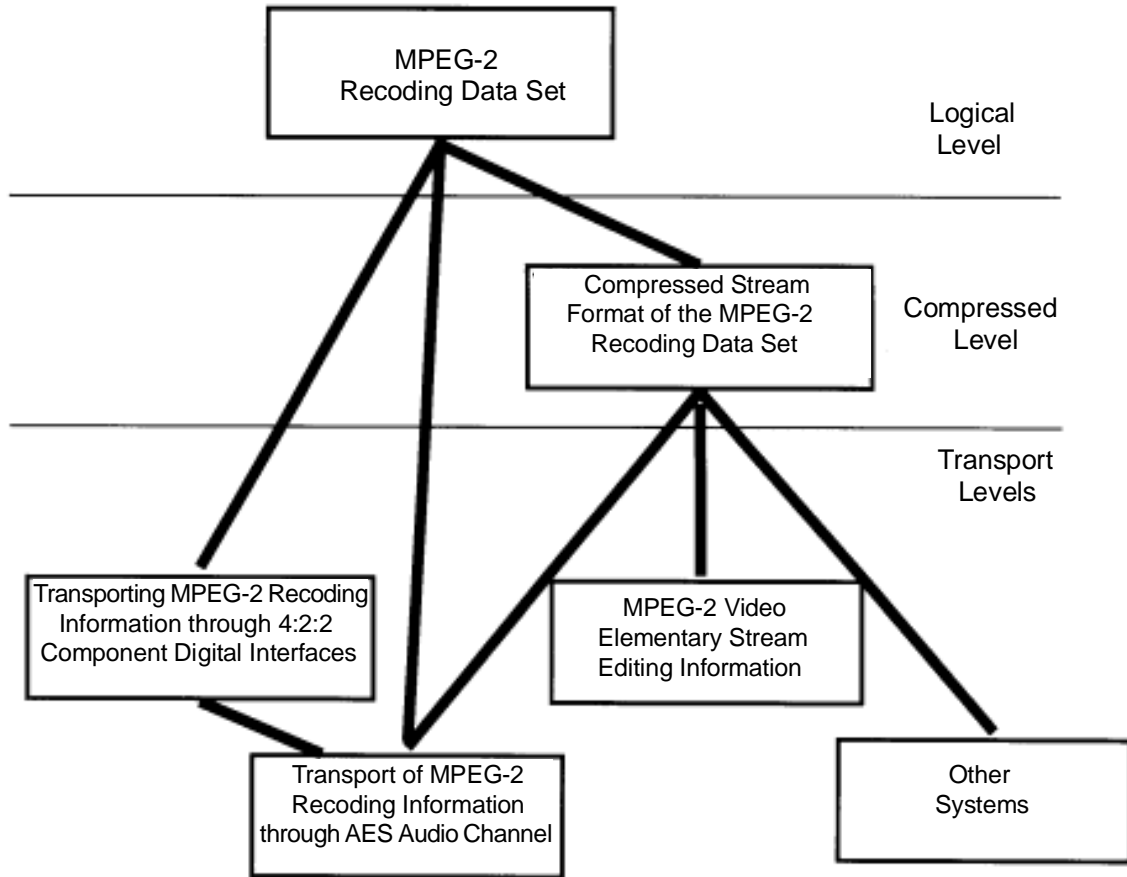
Figure A.1 – Relationships among SMPTE standards

Annex B (informative)
Bibliography

SMPTE 319M-2000, Television — Transporting MPEG-2 Recoding Information through 4:2:2 Component Digital Interfaces

SMPTE 328M-2000, Television — MPEG-2 Video Elementary Stream Editing Information

SMPTE 329M-2000, Television — MPEG-2 Video Recoding Data Set — Compressed Stream Format

ITU-R BT.601-5 (1994), Studio Encoding Parameters of Digital Television for Standard 4:3 and Wide-Screen 16:9 Aspect Ratios