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Information technology — MPEG video technologies —

Part 7: Versatile supplemental enhancement information messages for coded video bitstreams

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document 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 technically identical text is published as Recommendation ITU-T H.274 (08/2020).

A list of all parts in the ISO/IEC 23002 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The International Organization for Standardization (ISO) and International Electrotechnical Commission (IEC) draw attention to the fact that it is claimed that compliance with this document may involve the use of patents.

ISO and IEC take no position concerning the evidence, validity and scope of these patent rights.

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Information technology — MPEG video technologies —

Part 7:

Versatile supplemental enhancement information messages for coded video bitstreams

1 Scope

This document specifies the syntax and semantics of video usability information (VUI) parameters and supplemental enhancement information (SEI) messages. The VUI parameters and SEI messages defined in this document are designed to be conveyed within coded video bitstreams in a manner specified in a video coding specification or to be conveyed by other means determined by the specifications for systems that make use of such coded video bitstreams. This document is particularly intended for use with coded video bitstreams as specified by Rec. ITU-T H.266 | ISO/IEC 23090-3, although it can also be used with other types of coded video bitstreams.

VUI parameters and SEI messages can assist in processes related to decoding, display or other purposes. However, unless otherwise specified in a referencing specification, the interpretation and use of the VUI parameters and SEI messages specified in this document is not a required functionality of a video decoder or receiving video system. Although semantics are specified for the VUI parameters and SEI messages, decoders and receiving video systems can simply ignore the content of the VUI parameters and SEI messages or can use them in a manner that somewhat differs from what is specified in this document.

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2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Recommendation ITU-T H.273 | ISO/IEC 23091-2, *Coding-independent code points for video signal type identification*

ISO/CIE 11664-1, *Colorimetry — Part 1: CIE standard colorimetric observers*

ISO/IEC 11578:1996, *Information technology — Open Systems Interconnection — Remote Procedure Call (RPC)*

Recommendation ITU-T T.35:2000, *Procedure for the allocation of ITU-T defined codes for non standard facilities*

IETF RFC 1321, *The MD5 Message-Digest Algorithm*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

AU

access unit

set of *PUs* that belong to different *layers* and contain *coded pictures* associated with the same *output time*

3.2

APS

adaptation parameter set

syntax structure containing *syntax elements* that apply to zero or more *slices* as determined by zero or more *syntax elements* found in *slice headers*

3.3

associated IRAP picture

previous *IRAP picture* (when present) in *decoding order*, for a particular picture, in the same *layer* as the particular *picture*

3.4

azimuth circle

circle on a sphere connecting all points with the same azimuth value

Note 1 to entry: An azimuth circle is always a *great circle* like a longitude line on the earth.

3.5

byte

sequence of 8 bits, within which, when written or read as a sequence of bit values, the left-most and right-most bits represent the most and least significant bits, respectively, and the bits are written or read from left to right

3.6

chroma

sample array or single sample representing one of the two colour difference signals related to the primary colours, represented by the symbols *Cb* and *Cr*

Note 1 to entry: The term chroma is used rather than the term chrominance in order to avoid implying the use of linear light transfer characteristics that is often associated with the term chrominance.

3.7

CLVS

coded layer video sequence

sequence of *PUs* of the same layer that consists, in *decoding order*, of a *CLVSS PU*, followed by zero or more *PUs* that are not *CLVSS PUs*, including all subsequent *PUs* up to but not including any subsequent *PU* that is a *CLVSS PU*

3.8

CLVSS PU

PU in which the *coded picture* is a *CLVSS picture*

3.9

CLVSS

coded layer video sequence start

coded picture that starts a new *CLVS* as specified in a video coding specification

Note 1 to entry: In Rec. ITU-T H.266 | ISO/IEC 23090-3, a *CLVSS picture* is an *IRAP picture* with *NoIncorrectPicOutputFlag* equal to 1 or a gradual decoding refresh picture with *NoIncorrectPicOutputFlag* equal to 1. In Rec. ITU-T H.265 | ISO/IEC 23008-2, a *CLVSS picture* is an *IRAP picture* with *NoRaslOutputFlag* equal to 1.

3.10

coded picture

coded representation of a *picture* containing all *CTUs* of the *picture*

3.11**coded slice NAL unit**

NAL unit that contains a coded *slice*

3.12**coded video bitstream**

sequence of bits that forms the representation of a sequence of *AUs* forming one or more *CVSSs*

3.13**CVS****coded video sequence**

sequence of *AUs* that consists, in *decoding order*, of a *CVSS AU*, followed by zero or more *AUs* that are not *CVSS AUs*, including all subsequent *AUs* up to but not including any subsequent *AU* that is a *CVSS AU*

3.14**CVSS AU**

AU that has a *PU* for each *layer* present in the *CVS* and the *coded picture* in each *PU* is a *CLVSS picture*

3.15**component**

array or single sample from one of the three arrays (*luma* and two *chroma*) that compose a *picture* in 4:2:0, 4:2:2, or 4:4:4 colour format or the array or a single sample of the array that compose a *picture* in monochrome format

3.16**constituent picture**

part of a spatially *frame*-packed stereoscopic *picture* that corresponds to one view, or a *picture* itself when *frame* packing is not in use or the temporal interleaving *frame* packing arrangement is in use

3.17**cropped decoded picture**

result of cropping a *decoded picture* based on the conformance cropping window for the corresponding *coded picture*

3.18**decoded picture**

decoded picture is derived by decoding a *coded picture*

3.19**decoder**

embodiment of a *decoding process*

3.20**decoding order**

order in which *syntax elements* are conveyed in the *coded video bitstream* and are processed by a *decoding process*

3.21**decoding process**

process that reads a *coded video bitstream* and derives *decoded pictures* from it

3.22**elevation circle**

circle on a sphere connecting all points with the same elevation value

Note 1 to entry: An elevation circle is similar to a latitude line on the earth. Except when the elevation value is zero, an elevation circle is not a *great circle* like a longitude circle on the earth.

3.23**encoder**

embodiment of an *encoding process*

**3.24
encoding process**

process that produces a *coded video bitstream*

**3.25
field**

assembly of alternative rows of samples of a *frame*

**3.26
flag**

variable or single-bit *syntax element* that can take one of the two possible values: 0 and 1

**3.27
frame**

composition of a top *field* and a bottom *field*, where sample rows 0, 2, 4, ... originate from the top *field* and sample rows 1, 3, 5, ... originate from the bottom *field*

**3.28
global coordinate axes**

coordinate axes associated with *omnidirectional video* that are associated with an externally referenceable position and orientation

Note 1 to entry: The global coordinate axes could correspond to the position and orientation of a device or rig used for omnidirectional audio/video acquisition as well as the position of an observer's head in the three-dimensional space of the *omnidirectional video* rendering environment.

**3.29
great circle**

intersection of a sphere and a plane that passes through the centre point of the sphere

Note 1 to entry: A great circle is also known as an *orthodrome* or *Riemannian circle*.

**3.30
inter prediction**

aspect of the *decoding process* for a *coded picture* that makes use of data derived from the *decoding process* of one or more previously decoded *reference pictures*

**3.31
IRAP picture**

coded picture starting from which all *pictures* in the same *layer* in both *decoding order* and *output order* can be decoded without first decoding any *picture* in the same *layer* earlier in *decoding order* in the *coded video bitstream*

**3.32
layer**

set of *VCL NAL units* that all have a particular value of layer identifier and the associated non-VCL *NAL units*, wherein the layer identifier is a variable for which the value is specified by a video coding specification

Note 1 to entry: In the contexts of Rec. ITU-T H.266 | ISO/IEC 23090-3 and Rec. ITU-T H.265 | ISO/IEC 23008-2, the layer identifier is the value of the *nuh_layer_id* syntax element in the *NAL unit header*.

**3.33
leading picture**

picture that is in the same *layer* as the *associated IRAP picture* and precedes the *associated IRAP picture* in *output order*

**3.34
local coordinate axes**

coordinate axes having a specified rotation relationship relative to the *global coordinate axes*

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3.35**luma**

sample array or single sample representing the monochrome signal related to the primary colours, represented by the symbol or subscript Y or L

Note 1 to entry: The term luma is used rather than the term luminance in order to avoid implying the use of linear light transfer characteristics that is often associated with the term luminance. The symbol L is sometimes used instead of the symbol Y to avoid confusion with the symbol y as used for vertical location.

3.36**NAL unit**

syntax structure containing an indication of the type of data that follows and *bytes* containing that data in a manner that enables the extraction of a string of data bits from the syntax structure

3.37**non-VCL NAL unit**

NAL unit that is not a *VCL NAL unit*

3.38**omnidirectional video**

video content in a format that enables rendering according to the user's viewing orientation, e.g., if viewed using a head-mounted device, or according to a user's desired *viewport*, reflecting a potentially rotated viewing position

3.39**output order**

order in which the *decoded pictures* are output from the *decoder* (for the *decoded pictures* that are to be output from the *decoder*)

3.40**output time**

time when a *decoded picture* is to be output from the *decoder* (for the *decoded pictures* that are to be output from the *decoder*)

3.41**packed region**

region in a *region-wise packed picture* that is mapped to a *projected region* according to a *region-wise packing*

3.42**picture**

array of *luma* samples in monochrome format or an array of *luma* samples and two corresponding arrays of *chroma* samples in 4:2:0, 4:2:2, and 4:4:4 colour format

Note 1 to entry: A picture could be either a frame or a field. However, in one CLVS, either all pictures are frames or all pictures are fields.

3.43**PPS****picture parameter set**

A *syntax structure* containing *syntax elements* that apply to zero or more entire *coded pictures* as determined by a *syntax element* that is the same for all *slices* of a picture and found in the picture header or *slice headers* of each *picture*

3.44**PU****picture unit**

set of *NAL units* that contain all *VCL NAL units* of a *coded picture* and their associated non-VCL NAL units

3.45

projected picture

picture that uses a projection format for omnidirectional video

3.46

projected region

region in a projected picture that is mapped to a packed region according to a region-wise packing

3.47

projection

specified correspondence between the colour samples of a projected picture and azimuth and elevation positions on a sphere

3.48

random access

act of starting the decoding process for a coded video bitstream at a point other than the beginning of the bitstream

3.49

RASL picture

leading picture that cannot be correctly decoded when the decoding process starts from the associated IRAP picture

3.50

reference picture

picture that contains samples that could be used for inter prediction in the decoding process of subsequent pictures in decoding order

3.51

reference picture list

list of reference pictures that is used for inter prediction of a slice

3.52

region-wise packed picture

decoded picture that contains one or more packed regions

Note 1 to entry: A region-wise packed picture could contain a *region-wise packing* of a *projected picture*.

3.53

region-wise packing

transformation, resizing, and relocation of packed regions of a region-wise packed picture to remap the packed regions to projected regions of a projected picture

3.54

sample aspect ratio

indicated width-to-height aspect ratio of the luma samples of the associated decoded pictures

3.55

slice

region of a picture that can be decoded separately from other regions of the same coded picture (although in some cases the decoding process for the picture might use inter prediction that makes reference to other previously decoded reference pictures)

3.56

source

term used to describe the video material or some of its attributes before encoding

3.57

sphere coordinates

azimuth and elevation angles identifying a location of a point on a sphere

3.58**sphere region**

region on a sphere, specified either by four *great circles* or by two *azimuth circles* and two *elevation circles*, or such a region on a rotated sphere after applying yaw, pitch, and roll rotations

3.59**STSA picture**

coded picture that enables up-switching, at the *coded picture*, to the *temporal sublayer* containing the *coded picture*, from the immediately lower *temporal sublayer* of the same *layer* when the *coded picture* does not belong to the lowest *temporal sublayer*

Note 1 to entry: An STSA picture does not use pictures in the same layer and with the same temporal sublayer identifier as the STSA picture for inter prediction reference. Pictures following an STSA picture in decoding order in the same layer and with the same temporal sublayer identifier as the STSA picture do not use pictures prior to the STSA picture in decoding order in the same layer and with the same temporal sublayer identifier as the STSA picture for inter prediction reference. STSA pictures in an independent layer (i.e., a layer that does not depend on other layers in its decoding) always have a temporal sublayer identifier greater than 0.

3.60**syntax element**

element of data represented in a *syntax structure*

3.61**syntax structure**

zero or more *syntax elements* that are present together in a specified order in a string of data bits, where the left-most bit is considered to be the first and most significant bit, and the right-most bit is considered to be the last and least significant bit

3.62**SEI message**

syntax structure that provides a particular type of information that assists in processes related to decoding, display or other purposes but is not needed by the *decoding process* in order to determine the values of the samples in *decoded pictures*

3.63**temporal sublayer**

subset of a temporal scalable *bitstream*, consisting of *VCL NAL units* with a particular value of *temporal sublayer identifier* and the associated *non-VCL NAL units*

3.64**temporal sublayer identifier**

number greater than or equal to 0 defined by a variable for which the value is specified by a video coding specification such that pictures of all *temporal sublayers* have a specified temporal output order relative to each other and pictures with a lower temporal sublayer identifier can be decoded without reference to pictures with a higher temporal sublayer identifier

3.65**tilt angle**

angle indicating the amount of tilt of a *sphere region*, measured as the amount of rotation of a *sphere region* along the axis originating from the sphere origin passing through the centre point of the *sphere region*, where the angle value increases clockwise when looking from the origin towards the positive end of the axis

3.66**trailing picture**

coded picture that is associated with an *IRAP picture* and follows the *IRAP picture* in both decoding order and output order

3.67

VCL NAL unit

collective term for *coded slice NAL units* and the subset of other *NAL units* that have *reserved* values of *NAL unit* type identifiers that are classified as VCL NAL units in a referencing specification

3.68

VUI parameters

syntax structure that identifies properties of interpretation of decoded pictures for display purposes, particularly including colour representation information

3.69

viewport

region of *omnidirectional video* content suitable for display and viewing by the user

4 Abbreviated terms

AU access unit

APS adaptation parameter set

CRC cyclic redundancy check

CLVS coded layer video sequence

CLVSS coded layer video sequence start

CVS coded video sequence

DRAP dependent random access point

FIR finite impulse response

IRAP intra random access point

NAL network abstraction layer

PPS picture parameter set

PU picture unit

RASL random access skipped leading

RWP region-wise packing

SAR sample aspect ratio

SARI sample aspect ratio information

SEI supplemental enhancement information

STSA step-wise temporal sublayer access

VCL video coding layer

VUI video usability information

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5 Conventions

5.1 General

The term "this document" is used to refer to this Recommendation | International Standard.

In this document, the following verbal forms are used:

- "shall" indicates a requirement. When used to express a mandatory constraint on the values of syntax elements or the values of variables derived from these syntax elements, it is the responsibility of the encoder to ensure that the constraint is fulfilled.
- "should" indicates a recommendation. It is used to refer to behaviour of an implementation that is encouraged to be followed under anticipated ordinary circumstances, but is not a requirement for conformance to this document.
- "may" indicates a permission.
- "can" indicates a possibility or a capability.

Information marked as "NOTE" is intended to assist the understanding or use of the document. "Notes to entry" used in Clause 3 provide additional information that supplements the terminological data and can contain provisions relating to the use of a term.

The word "reserved" is used to specify that some values of a particular syntax element are for future use by ITU-T | ISO/IEC and shall not be used in syntax structures conforming to this document, but could potentially be used in syntax structures conforming to future editions of this document by ITU-T | ISO/IEC.

The word "unspecified" is used to describe some values of a particular syntax element to indicate that the values have no specified meaning in this document and are not expected to have a specified meaning in future editions of this document by ITU-T | ISO/IEC.

The mathematical operators used in this document are similar to those used in the C programming language. However, the results of integer division and arithmetic shift operations are defined more precisely, and additional operations are defined, such as exponentiation and real-valued division.

Numbering and counting conventions generally begin from 0, e.g., "the first" is equivalent to the 0-th, "the second" is equivalent to the 1-th, etc.

5.2 Arithmetic operators

- | | |
|-------|---|
| + | addition |
| – | subtraction (as a two-argument operator) or negation (as a unary prefix operator) |
| * | multiplication, including matrix multiplication |
| x^y | exponentiation
Specifies x to the power of y . In other contexts, such notation is used for superscripting not intended for interpretation as exponentiation. |
| / | integer division with truncation of the result toward zero
For example, $7 / 4$ and $-7 / -4$ are truncated to 1 and $-7 / 4$ and $7 / -4$ are truncated to -1 . |
| ÷ | division in mathematical equations where no truncation or rounding is intended |