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Information technology — High efficiency coding and media delivery in heterogeneous environments —

Part 2: High efficiency video coding

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Partie 2: Codage vidéo à haute efficacité

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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 or www.iec.ch/members_experts/refdocs).

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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 (as Rec. ITU-T H.265).

This seventh edition cancels and replaces the sixth edition (ISO/IEC 23008-2:2025), which has been technically revised.

The main changes are as follows:

— the specification of an additional profile (the Multiview Main 10profile);

— the support of 12 additional SEI messages through referencing to Rec. ITU-T H.274 | ISO/IEC 23002-7, namely the 1) SEI processing order, 2) processing order nesting, 3) encoder optimization information, 4) source picture timing information, 5) modality information, 6) digitally signed content initialization, 7) digitally signed content selection, 8) digitally signed content verification, 9) generative face video, 10) generative enhancement face video, 11) AI usage restrictions request, and 12) packed regions information SEI messages;

— some updates to the interface text for support of the two neural-network post-filter (NNPF) SEI messages, and an extension to the film grain characteristics SEI message.

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A list of all parts in the ISO/IEC 23008 series can be found on the ISO and IEC websites.

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Introduction

As the costs for both processing power and memory have reduced, network support for coded video data has diversified, and advances in video coding technology have progressed. The need has arisen for an industry standard for compressed video representation with substantially increased coding efficiency and enhanced robustness to network environments. Toward these ends, the ITU-T Video Coding Experts Group (VCEG) and the ISO/IEC Moving Picture Experts Group (MPEG) formed a Joint Collaborative Team on Video Coding (JCT-VC) in 2010 and a Joint Collaborative Team on 3D Video Coding Extension Development (JCT-3V) in 2012 for development of a new Recommendation | International Standard. This document was developed in the JCT-VC and the JCT-3V.

Purpose

This document was developed in response to the growing need for higher compression of moving pictures for various applications such as videoconferencing, digital storage media, television broadcasting, internet streaming, and communications. It is also designed to enable the use of the coded video representation in a flexible manner for a wide variety of network environments as well as to enable the use of multi-core parallel encoding and decoding devices. The use of this document allows motion video to be manipulated as a form of computer data and to be stored on various storage media, transmitted and received over existing and future networks and distributed on existing and future broadcasting channels. Supports for higher bit depths and enhanced chroma formats, including the use of full-resolution chroma are provided. Support for scalability enables video transmission on networks with varying transmission conditions and other scenarios involving multiple bit rate services. Support for multiview enables representation of video content with multiple camera views and optional auxiliary information. Support for 3D enables joint representation of video content and depth information with multiple camera views.

Applications

This document is designed to cover a broad range of applications for video content including but not limited to the following:

— broadcast (cable TV on optical networks / copper, satellite, terrestrial, etc.);

— camcorders;

— content production and distribution;

— digital cinema;

— home cinema;

— internet streaming, download and play;

— medical imaging;

— mobile streaming, broadcast and communications;

— real-time conversational services (videoconferencing, videophone, telepresence, etc.);

— remote video surveillance;

— storage media (optical disks, digital video tape recorder, etc.);

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— wireless display.

Publication and versions of this document

This document has been jointly developed by ITU-T Video Coding Experts Group (VCEG) and the ISO/IEC Moving Picture Experts Group (MPEG). It is published as technically-aligned twin text in both ITU-T and ISO/IEC. As the basis text has been drafted to become both an ITU-T Recommendation and an ISO/IEC International Standard, the term "Specification" (with capitalization to indicate that it refers to the whole of the text) is used herein when the text refers to itself.

This is the tenth version of this document and the sixth edition published by ISO/IEC.

Rec. ITU-T H.265 | ISO/IEC 23008-2 version 1 refers to the first approved version of this document. The first edition published by ISO/IEC as ISO/IEC 23008-2:2013 corresponded to the first version.

Rec. ITU-T H.265 | ISO/IEC 23008-2 version 2 refers to the integrated text additionally containing format range extensions, scalability extensions, multiview extensions, additional supplement enhancement information, and corrections to various minor defects in the prior content of the specification. The second edition published by ISO/IEC as ISO/IEC 23008-2:2015 corresponded to the second version.

Rec. ITU-T H.265 | ISO/IEC 23008-2 version 3 refers to the integrated text additionally containing 3D extensions, additional supplement enhancement information, and corrections to various minor defects in the prior content of the specification.

Rec. ITU-T H.265 | ISO/IEC 23008-2 version 4 refers to the integrated text additionally containing screen content coding extensions profiles, scalable range extensions profiles, additional high throughput profiles, additional supplement enhancement information, additional colour representation identifiers, and corrections to various minor defects in the prior content of the specification. The third edition published by ISO/IEC as ISO/IEC 23008-2:2017 corresponded to the fourth version.

Rec. ITU-T H.265 | ISO/IEC 23008-2 version 5 refers to the integrated text additionally containing additional SEI messages that include omnidirectional video specific SEI messages, a Monochrome 10 profile, a Main 10 Still Picture profile, and corrections to various minor defects in the prior content of the specification.

Rec. ITU-T H.265 | ISO/IEC 23008-2 version 6 refers to the integrated text additionally containing additional SEI messages for SEI manifest and SEI prefix, and corrections to various minor defects in the prior content of the specification.

Rec. ITU-T H.265 | ISO/IEC 23008-2 version 7 refers to the integrated text additionally containing the fisheye video information SEI message and the annotated regions SEI message, and corrections to various minor defects in the prior content of the specification. The fourth edition published by ISO/IEC as ISO/IEC 23008-2:2020 corresponded to the seventh version.

Rec. ITU-T H.265 | ISO/IEC 23008-2 version 8 refers to the integrated text additionally containing the shutter interval SEI message and corrections to various minor defects in the prior content of the specification.

Rec. ITU-T H.265 | ISO/IEC 23008-2 version 9 refers to the integrated text additionally containing specification of levels 6.3, 7, 7.1, and 7.2, the specification of level 8.5 for the video profiles, and corrections to various minor defects in the prior content of the specification. This fifth edition published by ISO/IEC as ISO/IEC 23008-2:2023 corresponds to the ninth version.

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Rec. ITU-T H.265 | ISO/IEC 23008-2 version 10 refers to the integrated text additionally containing specification of six additional profiles (the Multiview Extended, Multiview Extended 10, Multiview Monochrome, Multiview Monochrome 10, Multiview Monochrome 12, and Multiview Monochrome 16 profiles), the specification of three additional colour type identifiers, the specification of three additional SEI messages for neural network post-filter characteristics (NNPFC), neural-network post-filter activation (NNPFA), and phase indication (through referencing to Rec. ITU-T H.274 | ISO/IEC 23002-7), and corrections to various minor defects in the prior content of the specification. This sixth edition published by ISO/IEC as ISO/IEC 23008-2:2025 corresponds to the tenth version.

Rec. ITU-T H.265 | ISO/IEC 23008-2 version 11 (the current version) refers to the integrated text additionally containing the specification of an additional profile (the Multiview 10 profile), the support of 12 new SEI messages through referencing to Rec. ITU-T H.274 | ISO/IEC 23002-7, namely the 1) SEI processing order, 2) processing order nesting, 3) encoder optimization information, 4) source picture timing information, 5) modality information, 6) digitally signed content initialization, 7) digitally signed content selection, 8) digitally signed content verification, 9) generative face video, 10) generative enhancement face video, 11) AI usage restrictions request, and 12) packed regions information SEI messages, some updates to the interface text for support of the two neural-network post-filter (NNPF) SEI messages, an extension to the film grain characteristics SEI message, and corrections to various minor defects in the prior content of the specification. This seventh edition published by ISO/IEC as ISO/IEC 23008-2:202X corresponds to the eleventh version.

Profiles, tiers, and levels

This document is designed to be generic in the sense that it serves a wide range of applications, bit rates, resolutions, qualities, and services. Applications should cover, among other things, digital storage media, television broadcasting, and real-time communications. In the course of creating this document, various requirements from typical applications have been considered, necessary algorithmic elements have been developed, and these have been integrated into a single syntax. Hence, this document will facilitate video data interchange among different applications.

Considering the practicality of implementing the full syntax of this document, however, a limited number of subsets of the syntax are also stipulated by means of "profiles", "tiers", and "levels". These and other related terms are formally defined in Clause 3.

A “profile” is a subset of the entire bitstream syntax that is specified in this document. Within the bounds imposed by the syntax of a given profile it is still possible to require a very large variation in the performance of encoders and decoders depending upon the values taken by syntax elements in the bitstream such as the specified size of the decoded pictures. In many applications, it is currently neither practical nor economical to implement a decoder capable of dealing with all hypothetical uses of the syntax within a particular profile.

In order to deal with this problem, "tiers" and "levels" are specified within each profile. A level of a tier is a specified set of constraints imposed on values of the syntax elements in the bitstream. These constraints may be simple limits on values. Alternatively they may take the form of constraints on arithmetic combinations of values (e.g. picture width multiplied by picture height multiplied by number of pictures decoded per second). A level specified for a lower tier is more constrained than a level specified for a higher tier.

Coded video content conforming to this document uses a common syntax. In order to achieve a subset of the complete syntax, flags, parameters, and other syntax elements are included in the bitstream that signal the presence or absence of syntactic elements that occur later in the bitstream.

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Overview of the design characteristics

The coded representation specified in the syntax is designed to enable a high compression capability for a desired image or video quality. The algorithm is typically not lossless, as the exact source sample values are typically not preserved through the encoding and decoding processes. A number of techniques may be used to achieve highly efficient compression. Encoding algorithms (not specified in this Recommendation | International Standard) may select between inter and intra coding for block-shaped regions of each picture. Inter coding uses motion vectors for block-based inter prediction to exploit temporal statistical dependencies between different pictures. Intra coding uses various spatial prediction modes to exploit spatial statistical dependencies in the source signal for a single picture. Motion vectors and intra prediction modes may be specified for a variety of block sizes in the picture. The prediction residual may then be further compressed using a transform to remove spatial correlation inside the transform block before it is quantized, producing a possibly irreversible process that typically discards less important visual information while forming a close approximation to the source samples. Finally, the motion vectors or intra prediction modes may also be further compressed using a variety of prediction mechanisms, and, after prediction, are combined with the quantized transform coefficient information and encoded using arithmetic coding.

How to read this document

It is suggested that the reader starts with Clause 1 (Scope) and moves on to Clause 3 (Terms and definitions). Clause 6 should be read for the geometrical relationship of the source, input, and output of the decoder. Clause 7 (Syntax and semantics) specifies the order to parse syntax elements from the bitstream. See 7.1 to 7.3 for syntactical order and see 7.4 for semantics; e.g. the scope, restrictions, and conditions that are imposed on the syntax elements. The actual parsing for most syntax elements is specified in Clause 9 (Parsing process). Clause 10 (Sub-bitstream extraction process) specifies the sub-bitstream extraction process. Finally, Clause 8 (Decoding process) specifies how the syntax elements are mapped into decoded samples. Throughout reading this document, the reader should refer to Clauses 2 (Normative references), 4 (Abbreviated terms), and 5 (Conventions) as needed. Annexes A through I also form an integral part of this document.

Annex A specifies profiles each being tailored to certain application domains, and defines the so-called tiers and levels of the profiles. Annex B specifies syntax and semantics of a byte stream format for delivery of coded video as an ordered stream of bytes. Annex C specifies the hypothetical reference decoder, bitstream conformance, decoder conformance, and the use of the hypothetical reference decoder to check bitstream and decoder conformance. Annex D specifies syntax and semantics for supplemental enhancement information message payloads. Annex E specifies syntax and semantics of the video usability information parameters of the sequence parameter set. Annex F specifies general multi-layer support for bitstreams and decoders. Annex G contains support for multiview coding. Annex H contains support for scalability. Annex I contains support for 3D coding.

Throughout this document, statements appearing with the preamble "NOTE" are informative and are not an integral part of this document.

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Information technology — High efficiency coding and media delivery in heterogeneous environments —

Part 2:
High efficiency video coding

1 Scope

This document specifies high efficiency video coding.

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.

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

ISO 12232, *Photography — Digital still cameras — Determination of exposure index, ISO speed ratings, standard output sensitivity, and recommended exposure index*

ISO/IEC 10646, *Information technology — Universal Coded Character Set (UCS)*

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

ISO/IEC 23001-11, *Information technology — MPEG systems technologies — Part 11: Energy-efficient media consumption (green metadata)*

Recommendation ITU-T H.274 | ISO/IEC 23002-7, *Versatile supplemental enhancement information messages for coded video bitstreams*

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

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

IETF RFC 5646, *Tags for Identifying Languages*

3 Terms and definitions

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

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

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3.1
access unit
set of *NAL units* (3.87) that are associated with each other according to a specified classification rule, are consecutive in *decoding order* (3.44), and contain exactly one *coded picture* (3.25) with nuh_layer_id equal to 0

Note 1 to entry: In addition to containing the *VCL NAL units* (3.181) of the coded picture with nuh_layer_id equal to 0, an access unit can also contain non-VCL NAL units. The decoding of an access unit with the decoding process specified in Clause 8 always results in a decoded picture with nuh_layer_id equal to 0.

Note 2 to entry: An access unit is defined differently in Annex F and might not contain a coded picture with nuh_layer_id equal to 0.

3.2
AC transform coefficient
transform coefficient (3.175) for which the *frequency index* (3.58) in at least one of the two dimensions is non-zero

3.3
associated IRAP picture
previous *IRAP picture* (3.71) in *decoding order* (3.44) (when present)

3.4
associated non-VCL NAL unit
non-VCL NAL unit (3.91) (when present) for a *VCL NAL unit* (3.180) where the VCL NAL unit is the *associated VCL NAL unit* (3.5) of the non-VCL NAL unit

3.5
associated VCL NAL unit
preceding *VCL NAL unit* (3.180) in *decoding order* (3.44) for a *non-VCL NAL unit* (3.91) with nal_unit_type equal to EOS_NUT, EOB_NUT, FD_NUT, or SUFFIX_SEI_NUT, or in the ranges of RSV_NVCL45..RSV_NVCL47 or UNSPEC56..UNSPEC63; or otherwise, the next VCL NAL unit in decoding order

3.6
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.

3.7
base layer
layer in which all *NAL units* (3.87) have nuh_layer_id equal to 0

3.8
bin
one bit of a *bin string* (3.11)

3.9
binarization
set of *bin strings* (3.11) for all possible values of a *syntax element* (3.162)

3.10
binarization process
unique mapping process of all possible values of a *syntax element* (3.162) onto a set of *bin strings* (3.11)

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3.11
bin string
intermediate binary representation of values of *syntax elements* (3.162) from the *binarization* (3.9) of the syntax element

3.12
bi-predictive slice
B slice
slice (3.143) that is decoded using *intra prediction* (3.69) or using *inter prediction* (3.67) with at most two *motion vectors* (3.86) and *reference indices* (3.127) to predict the sample values of each *block* (3.14)

3.13
bitstream
sequence of bits, in the form of a *NAL unit stream* (3.88) or a *byte stream* (3.21), that forms the representation of *coded pictures* (3.25) and associated data forming one or more *CVSs* (3.30)

3.14
block
MxN (M-column by N-row) array of samples or an MxN array of *transform coefficients* (3.175)

3.15
broken link
location in a *bitstream* (3.13) at which it is indicated that some subsequent *pictures* (3.99) in *decoding order* (3.44) may contain serious visual artefacts due to unspecified operations performed in the generation of the bitstream

3.16
broken link access access unit
BLA access unit
access unit (3.1) in which the *coded picture* (3.25) with nuh_layer_id equal to 0 is a *BLA picture* (3.17)

3.17
broken link access picture
BLA picture
IRAP picture (3.71) for which each *VCL NAL unit* (3.181) has nal_unit_type equal to BLA_W_LP, BLA_W_RADL, or BLA_N_LP

Note 1 to entry: A BLA picture does not refer to any pictures other than itself for *inter prediction* (3.67) in its *decoding process* (3.45), and can be the first picture in the *bitstream* (3.13) in decoding order, or can appear later in the bitstream. Each BLA picture begins a new *CVS* (3.30), and has the same effect on the decoding process as an *IDR picture* (3.65). However, a BLA picture contains *syntax elements* (3.162) that specify a non-empty *RPS* (3.132). When a BLA picture for which each VCL NAL unit has nal_unit_type equal to BLA_W_LP, it can have associated RASL pictures, which are not output by the decoder and can be non-decodable, as they can contain references to pictures that are not present in the bitstream. When a BLA picture for which each VCL NAL unit has nal_unit_type equal to BLA_W_LP, it can also have associated RADL pictures, which are specified to be decoded. When a BLA picture for which each VCL NAL unit has nal_unit_type equal to BLA_W_RADL, it does not have associated RASL pictures but can have associated RADL pictures. When a BLA picture for which each VCL NAL unit has nal_unit_type equal to BLA_N_LP, it does not have any associated leading pictures.

3.18
buffering period
set of *access units* (3.1) starting with an access unit that contains a buffering period SEI message and containing all subsequent access units in *decoding order* (3.44) up to but not including the next access unit (when present) that contains a buffering period SEI message

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3.19
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

3.20
byte-aligned
position in a *bitstream* (3.13) is byte-aligned when the position is an integer multiple of 8 bits from the position of the first bit in the bitstream and a bit or *byte* (3.19) or *syntax element* (3.162) is said to be byte-aligned when the position at which it appears in *a* bitstream is byte-aligned

3.21
byte stream
sequence of bytes forming an encapsulation of a *NAL unit stream* (3.88) into a format containing *start code prefixes* (3.150) and *NAL units* (3.87)

Note 1 to entry: See Annex B.

3.22
chroma
Cb
Cr
sample array or single sample representing one of the two colour difference signals related to the primary colours

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

3.23
clean random access access unit
CRA access unit
access unit (3.1) in which the *coded picture* (3.25) with nuh_layer_id equal to 0 is a *CRA picture* (3.24)

3.24
clean random access picture
CRA picture
IRAP picture (3.71) for which each *VCL NAL unit* (3.181) has nal_unit_type equal to CRA_NUT

Note 1 to entry: A CRA picture does not refer to any pictures other than itself for inter prediction in its decoding process, and can be the first picture in the bitstream in decoding order, or can appear later in the bitstream. A CRA picture can have associated RADL or RASL pictures. As with a BLA picture, a CRA picture can contain syntax elements that specify a non-empty *RPS* (3.131). When a CRA picture has NoRaslOutputFlag equal to 1, the associated RASL pictures are not output by the decoder, because they can be non-decodable, as they can contain references to pictures that are not present in the bitstream.

3.25
coded picture
coded representation of a picture containing all *CTUs* (3.34) of the picture

3.26
coded picture buffer
CPB
first-in first-out buffer containing *decoding units* (3.46) in *decoding order* (3.44) specified in the *hypothetical reference decoder* (3.56)

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Note 1 to entry: The hypothetical reference decoder is defined in Annex C.

3.27
coded representation
data element as represented in its coded form

3.28
coded slice segment NAL unit
NAL unit (3.87) that has nal_unit_type in the range of TRAIL_N to RASL_R, inclusive, or in the range of BLA_W_LP to RSV_IRAP_VCL23, inclusive, which indicates that the NAL unit contains a coded *slice segment* (3.145)

3.29
coded layer-wise video sequence
CLVS
sequence of *pictures* (3.99) and the associated *non-VCL NAL units* (3.91) of the base layer of a *CVS* (3.30)

3.30
coded video sequence
CVS
sequence of *access units* (3.1) that consists, in *decoding order* (3.44), of an *IRAP access unit* (3.65) with NoRaslOutputFlag equal to 1, followed by zero or more access units that are not IRAP access units with NoRaslOutputFlag equal to 1, including all subsequent access units up to but not including any subsequent access unit that is an IRAP access unit with NoRaslOutputFlag equal to 1

Note 1 to entry: An IRAP access unit can be an IDR access unit, a BLA access unit, or a CRA access unit. The value of NoRaslOutputFlag is equal to 1 for each IDR access unit, each BLA access unit, and each CRA access unit that is the first access unit in the bitstream in decoding order, is the first access unit that follows an end of sequence NAL unit in decoding order, or has HandleCraAsBlaFlag equal to 1.

3.31
coded video sequence group
CVSG
one or more consecutive *CVSs* (3.30) in *decoding order* (3.44) that collectively consist of an *IRAP access unit* (3.65) that activates a VPS RBSP firstVpsRbsp that was not already active followed by all subsequent access units, in decoding order, for which firstVpsRbsp is the active VPS RBSP up to the end of the *bitstream* (3.13) or up to but excluding the access unit that activates a different VPS RBSP than firstVpsRbsp, whichever is earlier in decoding order

3.32
coding block
NxN *block* (3.14) of samples for some value of N such that the division of a *CTB* (3.33) into coding blocks is a *partitioning* (3.98)

3.33
coding tree block
CTB
NxN *block* (3.14) of samples for some value of N such that the division of a *component* (3.36) into CTBs is a *partitioning* (3.98)

3.34
coding tree unit
CTU

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CTB (3.33) of *luma* (3.85) samples, two corresponding CTBs of *chroma* (3.22) samples of a *picture* (3.99) that has three sample arrays, or a CTB of samples of a monochrome picture or a picture that is coded using three separate colour planes and *syntax structures* (3.163) used to code the samples

3.35
coding unit
coding block (3.32) of *luma* (3.85) samples, two corresponding coding blocks of *chroma* (3.22) samples of a *picture* (3.99) that has three sample arrays, or a coding block of samples of a monochrome picture or a picture that is coded using three separate colour planes and *syntax structures* (3.163) used to code the samples

3.36
component
array or single sample from one of the three arrays [*luma* (3.85) and two *chroma* (3.22)] that compose a *picture* (3.99) 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

3.37
constituent picture
part of a spatially *frame* (3.57)-packed stereoscopic *picture* (3.99) 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

3.38
context variable
variable specified for the adaptive binary arithmetic *decoding process* (3.45) of a *bin* (3.8) by a formula containing recently decoded bins

3.39
cropped decoded picture
result of cropping a *decoded picture* (3.40) based on the conformance cropping window specified in the *SPS* (3.140) that is referred to by the corresponding *coded picture* (3.25)

3.40
decoded picture
picture derived by decoding a *coded picture* (3.25)

3.41
decoded picture buffer
DPB
buffer holding *decoded pictures* (3.40) for reference, output reordering, or output delay specified for the *hypothetical reference decoder* (3.61)

3.42
decoder
embodiment of a *decoding process* (3.45)

3.43
decoder under test
DUT
decoder (3.42) that is tested for conformance by operating the *hypothetical stream scheduler* (3.62) to deliver a conforming *bitstream* (3.13) to the decoder and to the *hypothetical reference decoder* (3.61) and comparing the values and timing or order of the output of the two decoders

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3.44
decoding order
order in which *syntax elements* (3.162) are processed by the *decoding process* (3.45)

3.45
decoding process
process that reads a *bitstream* (3.13) and derives *decoded pictures* (3.40) from it

Note 1 to entry: The decoding process is specified in this document.

3.46
decoding unit
access unit (3.1) if SubPicHrdFlag is equal to 0 or a subset of an access unit otherwise, consisting of one or more *VCL NAL units* (3.181) in an access unit and the *associated non-VCL NAL units* (3.4)

3.47
dependent slice segment
slice segment (3.145) for which the values of some *syntax elements* (3.162) of the *slice segment header* (3.146) are inferred from the values for the preceding *independent slice segment* (3.63) in *decoding order* (3.44)

3.48
display process
process having, as its input, the *cropped decoded pictures* (3.39) that are the output of the *decoding process* (3.45)

Note 1 to entry: The display process is not specified in this document.

3.49
elementary stream
sequence of one or more *bitstreams* (3.13)

Note 1 to entry: An elementary stream that consists of two or more bitstreams would typically have been formed by splicing together two or more bitstreams (or parts thereof).

3.50
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* (3.60) like a longitude circle on the earth.

3.51
emulation prevention byte
byte (3.19) equal to 0x03 that is present within a *NAL unit* (3.87) when the *syntax elements* (3.162) of the *bitstream* (3.13) form certain patterns of byte values in a manner that ensures that no sequence of consecutive *byte-aligned* (3.20) bytes in the NAL unit can contain a *start code prefix* (3.150)

3.52
encoder
embodiment of an *encoding process* (3.53)

3.53
encoding process
process that produces a *bitstream* (3.13)

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Note 1 to entry: The bitstream produced conforms to this document. This process is not specified in this document.

3.54
field
assembly of alternative rows of samples of a *frame* (3.57)

3.55
filler data NAL unit
NAL unit (3.87) with nal_unit_type equal to FD_NUT

3.56
flag
variable or single-bit *syntax element* (3.162) that can take one of the two possible values, 0 and 1

3.57
frame
composition of a top *field* (3.54) 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

3.58
frequency index
one-dimensional or two-dimensional index associated with a *transform coefficient* (3.175) prior to the application of a *transform* (3.173) in the *decoding process* (3.45)

3.59
global coordinate axes
coordinate axes associated with *omnidirectional video* (3.92) that are associated with an externally referenceable position and orientation

Note 1 to entry: The global coordinate axes can 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.

3.60
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.

3.61
hypothetical reference decoder
HRD
hypothetical *decoder* (3.42) model that specifies constraints on the variability of conforming *NAL unit streams* (3.88) or conforming *byte streams* (3.21) that an *encoding process* (3.53) may produce

3.62
hypothetical stream scheduler
HSS
hypothetical delivery mechanism used for checking the conformance of a *bitstream* (3.13) or a *decoder* (3.42) with regards to the timing and data flow of the input of a bitstream into the *hypothetical reference decoder* (3.61)

3.63
independent slice segment

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slice segment (3.145) for which the values of the *syntax elements* (3.162) of the *slice segment header* (3.146) are not inferred from the values for a preceding slice segment

3.64
instantaneous decoding refresh access unit
IDR access unit
access unit (3.1) in which the *coded picture* (3.25) with nuh_layer_id equal to 0 is an *IDR picture* (3.65)

3.65
instantaneous decoding refresh picture
IDR picture
IRAP picture (3.71) for which each *VCL NAL unit* (3.181) has nal_unit_type equal to IDR_W_RADL or IDR_N_LP

Note 1 to entry: An IDR picture does not refer to any pictures other than itself for inter prediction in its decoding process, and can be the first picture in the bitstream in decoding order, or can appear later in the bitstream. Each IDR picture is the first picture of a CVS in decoding order. When an IDR picture for which each VCL NAL unit has nal_unit_type equal to IDR_W_RADL, it can have associated RADL pictures. When an IDR picture for which each VCL NAL unit has nal_unit_type equal to IDR_N_LP, it does not have any associated leading pictures. An IDR picture does not have associated RASL pictures.

3.66
inter coding
coding of a *coding block* (3.33), *slice* (3.143), or *picture* (3.99) that uses *inter prediction* (3.67)

3.67
inter prediction
prediction (3.103) derived in a manner that is dependent on data elements (e.g. sample values or motion vectors) of one or more *reference pictures* (3.128)

Note 1 to entry: A prediction from a reference picture that is the current picture itself is also inter prediction.

3.68
intra coding
coding of a *coding block* (3.33), *slice* (3.143), or *picture* (3.99) that uses *intra prediction* (3.69)

3.69
intra prediction
prediction (3.103) derived from only data elements (e.g. sample values) of the same decoded *slice* (3.143) without referring to a *reference picture* (3.128)

3.70
intra random access point access unit
IRAP access unit
access unit (3.1) in which the *coded picture* (3.25) with nuh_layer_id equal to 0 is an *IRAP picture* (3.71)

3.71
intra random access point picture
IRAP picture
coded picture (3.25) for which each *VCL NAL unit* (3.181) has nal_unit_type in the range of BLA_W_LP to RSV_IRAP_VCL23, inclusive

Note 1 to entry: An IRAP picture does not refer to any pictures other than itself for inter prediction in its decoding process, and can be a BLA picture, a CRA picture or an IDR picture. The first picture in the bitstream in decoding order is an IRAP picture. Provided the necessary parameter sets are available when they are activated, the IRAP

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picture and all subsequent non-RASL pictures in decoding order can be correctly decoded without performing the decoding process of any pictures that precede the IRAP picture in decoding order. There can be pictures in a bitstream that do not refer to any pictures other than itself for inter prediction in its decoding process that are not IRAP pictures.

3.72
intra slice
I slice
slice (3.143) that is decoded using *intra prediction* (3.69) only

3.73
layer
<scalable> set of *VCL NAL units* (3.181) that all have a particular value of nuh_layer_id and the *associated non-VCL NAL units* (3.4)

Note 1 to entry: Depending on the context, either the first layer concept or the second layer concept applies. This first layer concept is also referred to as a scalable layer, wherein a layer can be a spatial scalable layer, a quality scalable layer, a view, etc. A temporal strict subset of a scalable layer is not referred to as a layer but referred to as a sub-layer or temporal sub-layer. The second layer concept is also referred to as a coding layer, wherein higher layers contain lower layers, and the coding layers are the CVS, picture, slice, slice segment, and CTU layers.

3.74
layer identifier list
list of nuh_layer_id values that is associated with a *layer set* (3.75) or an *operation point* (3.93) and can be used as an input to the *sub-bitstream extraction process* (3.154)

3.75
layer set
set of layers represented within a *bitstream* (3.13) created from another bitstream by operation of the *sub-bitstream extraction process* (3.154) with the another bitstream, the target highest TemporalId equal to 6, and the target *layer identifier list* (3.74) equal to the layer identifier list associated with the layer set as inputs

3.76
leading picture
picture (3.99) that precedes the associated *IRAP picture* (3.71) in *output order* (3.94)

3.77
leaf
terminating node of a *tree* (3.178) that is a root node of a tree of depth 0

3.78
level
<constraint> defined set of constraints on the values that may be taken by the *syntax element*s (3.162) and variables of this document

Note 1 to entry: The same set of levels is defined for all profiles, with most aspects of the definition of each level being in common across different profiles. Individual implementations can, within the specified constraints, support a different level for each supported profile.

3.79
level
<transform coefficient> value of a *transform coefficient* (3.175) prior to *scaling* (3.139)

3.80

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list 0 (list 1) motion vector
motion vector (3.86) associated with a reference index pointing into reference picture list 0 (list 1)

3.81
list 0 (list 1) prediction
inter prediction (3.67) of the content of a *slice* (3.143) using a reference index pointing into reference picture list 0 (list 1)

3.82
local coordinate axes
coordinate axes having a specified rotation relationship relative to the *global coordinate axes* (3.59)

3.83
long-term reference picture
picture (3.99) that is marked as "used for long-term reference"

3.84
long-term reference picture set
two *RPS* (3.132) lists that may contain *long-term reference pictures* (3.83)

3.85
luma
Y or L
sample array or single sample representing the monochrome signal related to the primary colours

Note 1 to entry: The term luma is used rather than the term luminance in order to avoid the implication of 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.

3.86
motion vector
two-dimensional vector used for *inter prediction* (3.67) that provides an offset from the coordinates in the *decoded picture* (3.40) to the coordinates in a *reference picture* (3.128)

3.87
network abstraction layer unit
NAL unit
syntax structure (3.163) containing an indication of the type of data to follow and *bytes* (3.19) containing that data in the form of an *RBSP* (3.124) interspersed as necessary with *emulation prevention bytes* (3.51)

3.88
network abstraction layer unit stream
NAL unit stream
sequence of *NAL units* (3.87)

3.89
non-scalable-nested SEI message
SEI message that is not contained in a scalable nesting SEI message

3.90
non-reference picture
picture (3.99) that is marked as "unused for reference"

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Note 1 to entry: A non-reference picture contains samples that cannot be used for inter prediction in the decoding process of subsequent pictures in decoding order. In other words, once a picture is marked as "unused for reference", it can never be marked back as "used for reference".

3.91
non-VCL NAL unit
NAL unit (3.87) that is not a *VCL NAL unit* (3.181)

3.92
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* (3.183), reflecting a potentially rotated viewing position

3.93
operation point
bitstream (3.13) created from another bitstream by operation of the *sub-bitstream extraction process* (3.154) with another bitstream, a target highest TemporalId, and a target *layer identifier list* (3.74) as inputs

Note 1 to entry: If the target highest TemporalId of an operation point is equal to the greatest value of TemporalId in the layer set associated with the target layer identification list, the operation point is identical to the layer set. Otherwise it is a subset of the layer set.

3.94
output order
order in which the *decoded pictures* (3.40) are output from the *decoded picture buffer* (3.41) for the decoded pictures that are to be output from the decoded picture buffer

3.95
output time
time when a *decoded picture* (3.40) is to be output as specified by the *HRD* (3.56) according to the output timing *decoded picture buffer* (3.41) operation

3.96
packed region
region in a *region-wise packed picture* (3.133) that is mapped to a *projected region* (3.113) according to a *region-wise packing* (3.134)

3.97
parameter
syntax element of a *VPS* (3.182), *SPS* (3.140) or *PPS* (3.100), or the second word of the defined term *quantization parameter* (3.117)

3.98
partitioning
division of a set into subsets such that each element of the set is in exactly one of the subsets

3.99
picture
array of *luma* (3.85) samples in monochrome format or an array of luma samples and two corresponding arrays of *chroma* (3.22) samples in 4:2:0, 4:2:2, and 4:4:4 colour format

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

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3.100
picture parameter set
PPS
syntax structure (3.163) containing *syntax elements* (3.162) that apply to zero or more entire *coded pictures* (3.25) as determined by a syntax element found in each *slice segment header* (3.146)

3.101
picture order count
POC
variable that is associated with each *picture* (3.99), uniquely identifies the associated picture among all pictures in the *CVS* (3.30), and, when the associated picture is to be output from the *decoded picture buffer* (3.41), indicates the position of the associated picture in *output order* (3.94) relative to the output order positions of the other pictures in the same CVS that are to be output from the decoded picture buffer

3.102
picture unit
set of *NAL units* (3.87) that contain all *VCL NAL units* (3.181) of a *coded picture* (3.25) and their *associated non-VCL NAL units* (3.4)

3.103
prediction
embodiment of the *prediction process* (3.105)

3.104
prediction block
rectangular MxN *block* (3.14) of samples on which the same *prediction* (3.103) is applied

3.105
prediction process
use of a *predictor* (3.108) to provide an estimate of the data element (e.g. sample value or motion vector) currently being decoded

3.106
prediction unit
prediction block (3.104) of *luma* (3.85) samples, two corresponding prediction blocks of *chroma* (3.22) samples of a *picture* (3.99) that has three sample arrays, or a prediction block of samples of a monochrome picture or a picture that is coded using three separate colour planes and *syntax structures* (3.163) used to predict the prediction block samples

3.107
predictive slice
P slice
slice (3.143) that is decoded using *intra prediction* (3.69) or using *inter prediction* (3.67) with at most one *motion vector* (3.86) and *reference index* (3.127) to predict the sample values of each *block* (3.14)

3.108
predictor
combination of specified values or previously decoded data elements (e.g. sample value or motion vector) used in the *decoding process* (3.45) of subsequent data elements

3.109
prefix SEI message
SEI message that is contained in a *prefix SEI NAL unit* (3.110)

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3.110
prefix SEI NAL unit
SEI NAL unit (3.161) that has nal_unit_type equal to PREFIX_SEI_NUT

3.111
profile
specified subset of syntax

Note 1 to entry: The syntax of this document.

3.112
projected picture
picture that uses a *projection* (3.114) format for *omnidirectional video* (3.92)

3.113
projected region
region in a *projected picture* (3.112) that is mapped to a *packed region* (3.96) according to a *region-wise packing* (3.134)

3.114
projection
specified correspondence between the colour samples of a *projected picture* (3.112) and azimuth and elevation positions on a sphere

3.115
pulse code modulation
PCM
coding of the samples of a *block* (3.14) by directly representing the sample values without *prediction* (3.103) or application of a transform

3.116
quadtree
tree (3.178) in which a parent node can be split into four child nodes, each of which may become parent node for another split into four child nodes

3.117
quantization parameter
variable used by the *decoding process* (3.45) for scaling of transform coefficient levels

3.118
random access
act of starting the decoding process for a *bitstream* (3.13) at a point other than the beginning of the stream

3.119
random access decodable leading access unit
RADL access unit
access unit (3.1) in which the *coded picture* (3.25) with nuh_layer_id equal to 0 is a *RADL picture* (3.120)

3.120
random access decodable leading picture
RADL picture
coded picture for which each *VCL NAL unit* (3.181) has nal_unit_type equal to RADL_R or RADL_N

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Note 1 to entry: All RADL pictures are leading pictures. RADL pictures are not used as reference pictures for the decoding process of trailing pictures of the same associated IRAP picture. When present, all RADL pictures precede, in decoding order, all trailing pictures of the same associated IRAP picture.

3.121
random access skipped leading access unit
RASL access unit
access unit (3.1) in which the *coded picture* (3.25) with nuh_layer_id equal to 0 is a RASL picture

3.122
random access skipped leading picture
RASL picture
coded picture (3.25) for which each *VCL NAL unit* (3.181) has nal_unit_type equal to RASL_R or RASL_N

Note 1 to entry: All RASL pictures are leading pictures of an associated BLA or CRA picture. When the associated IRAP picture has NoRaslOutputFlag equal to 1, the RASL picture is not output and can be non-correctly-decodable, as the RASL picture can contain references to pictures that are not present in the bitstream. RASL pictures are not used as reference pictures for the decoding process of non-RASL pictures. When present, all RASL pictures precede, in decoding order, all trailing pictures of the same associated IRAP picture.

3.123
raster scan
mapping of a rectangular two-dimensional pattern to a one-dimensional pattern such that the first entries in the one-dimensional pattern are from the first top row of the two-dimensional pattern scanned from left to right, followed similarly by the second, third, etc. rows of the pattern (going down) each scanned from left to right

3.124
raw byte sequence payload
RBSP
syntax structure (3.163) containing an integer number of *bytes* (3.19) that is encapsulated in a *NAL unit* (3.87) and that is either empty or has the form of a *string of data bits* (3.153) containing *syntax elements* (3.162) followed by an *RBSP stop bit* (3.125) and zero or more subsequent bits equal to 0

3.125
raw byte sequence payload stop bit
RBSP stop bit
bit equal to 1 present within a *raw byte sequence payload* (3.124) after a *string of data bits* (3.153), for which the location of the end within an RBSP can be identified by searching from the end of the RBSP for the RBSP stop bit, which is the last non-zero bit in the RBSP

3.126
recovery point
point in the *bitstream* (3.13) at which the recovery of an exact or an approximate representation of the *decoded pictures* (3.40) represented by the bitstream is achieved after a *random access* (3.118) or *broken link* (3.15)

3.127
reference index
index into a *reference picture list* (3.129)

3.128
reference picture
picture (3.99) that is a *short-term reference picture* (3.141) or a *long-term reference picture* (3.83)

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Note 1 to entry: A reference picture contains samples that can be used for inter prediction in the decoding process of subsequent pictures in decoding order.

3.129
reference picture list
list of *reference pictures* (3.128) that is used for *inter prediction* (3.67) of a *P slice* (3.107) or *B slice* (3.12)

Note 1 to entry: For the decoding process of a P slice, there is one reference picture list – reference picture list 0. For the decoding process of a B slice, there are two reference picture lists – reference picture list 0 and reference picture list 1.

3.130
reference picture list 0
reference picture list (3.129) used for *inter prediction* (3.67) of a *P slice* (3.107) or the first reference picture list used for inter prediction of a *B slice* (3.12)

3.131
reference picture list 1
second *reference picture list* (3.129) used for *inter prediction* (3.67) of a *B slice* (3.12)

3.132
reference picture set
RPS
set of *reference pictures* (3.128) associated with a *picture* (3.99), consisting of all reference pictures that are prior to the associated picture in *decoding order* (3.44), that may be used for *inter prediction* (3.67) of the associated picture or any picture following the associated picture in decoding order

Note 1 to entry: The RPS of a picture consists of five RPS lists, three of which are to contain short-term reference pictures and the other two are to contain long-term reference pictures.

3.133
region-wise packed picture
decoded picture (3.40) that contains one or more *packed regions* (3.96)

Note 1 to entry: A region-wise packed picture can contain a *region-wise packing* (3.134) of a *projected picture* (3.112).

3.134
region-wise packing
transformation, resizing, and relocation of *packed regions* (3.96) of a *region-wise packed picture* (3.133) to remap the packed regions to *projected region*s (3.113) of a *projected picture* (3.112)

3.135
reserved
<value of a particular syntax element> value that may be used in the future by ITU-T | ISO/IEC

Note 1 entry: These values cannot be used in *bitstreams* (3.13) conforming to this document, but can be used in bistreams conforming to future editions of this document by ITU-T | ISO/IEC.

3.136
residual
decoded difference between a *prediction* (3.103) of a sample or data element and its decoded value

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3.137
sample aspect ratio
ratio between the intended horizontal distance between the columns and the intended vertical distance between the rows of the *luma* (3.85) sample array in a *picture* (3.99), which is specified for assisting the *display process* (3.48) (not specified in this document) and expressed as *h*:*v*, where *h* is the horizontal width and *v* is the vertical height, in arbitrary units of spatial distance

3.138
scalable-nested SEI message
SEI message that is contained in a scalable nesting SEI message

3.139
scaling
process of multiplying *transform coefficient levels* (3.176) by a factor, resulting in *transform coefficients* (3.175)

3.140
sequence parameter set
SPS
syntax structure (3.163) containing *syntax elements* (3.162) that apply to zero or more entire *CVSs* (3.30) as determined by the content of a syntax element found in the *PPS* (3.100) referred to by a syntax element found in each *slice segment header* (3.146)

3.141
short-term reference picture
picture (3.99) that is marked as "used for short-term reference"

3.142
short-term reference picture set
three *RPS* (3.132) lists that may contain short-term reference pictures

3.143
slice
integer number of *CTUs* (3.34) contained in one *independent slice segment* (3.58) and all subsequent *dependent slice segments* (3.47) (if any) that precede the next independent slice segment (if any) within the same *access unit* (3.1)

3.144
slice header
slice segment header (3.146) of the *independent slice segment* (3.63) that is a current *slice segment* (3.145) or the most recent independent slice segment that precedes a current *dependent slice segment* (3.47) in *decoding order* (3.44)

3.145
slice segment
integer number of *CTUs* (3.34) ordered consecutively in the *tile scan* (3.170) and contained in a single *NAL unit* (3.87)

3.146
slice segment header
part of a coded *slice segment* (3.145) containing the data elements pertaining to the first or all *CTUs* (3.34) represented in the slice segment

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3.147
source
video material or some of its attributes before encoding

3.148
sphere coordinates
azimuth and elevation angles identifying a location of a point on a sphere

3.149
sphere region
region on a sphere, specified either by four *great circles* (3.60) or by two *azimuth circles* (3.6) and two *elevation circles* (3.50), or such a region on a rotated sphere after applying yaw, pitch, and roll rotations

3.150
start code prefix
unique sequence of three *bytes* (3.19) equal to 0x000001 embedded in the *byte stream* (3.21) as a prefix to each *NAL unit* (3.87)

Note 1 to entry: The location of a start code prefix can be used by a decoder to identify the beginning of a new NAL unit and the end of a previous NAL unit. Emulation of start code prefixes is prevented within NAL units by the inclusion of emulation prevention bytes.

3.151
step-wise temporal sub-layer access access unit
STSA access unit
access unit (3.1) in which the *coded picture* (3.25) with nuh_layer_id equal to 0 is an *STSA picture* (3.152)

3.152
step-wise temporal sub-layer access picture
STSA picture
coded picture (3.25) for which each *VCL NAL unit* (3.181) has nal_unit_type equal to STSA_R or STSA_N

Note 1 to entry: An STSA picture does not use pictures with the same TemporalId as the STSA picture for inter prediction reference. Pictures following an STSA picture in decoding order with the same TemporalId as the STSA picture do not use pictures prior to the STSA picture in decoding order with the same TemporalId as the STSA picture for inter prediction reference. An STSA picture enables up-switching, at the STSA picture, to the sub-layer containing the STSA picture, from the immediately lower sub-layer. STSA pictures have TemporalId greater than 0.

3.153
string of data bits
SODB
sequence of some number of bits representing *syntax elements* (3.162) present within a *raw byte sequence payload* (3.124) prior to the *raw byte sequence payload stop bit* (3.125), 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

3.154
sub-bitstream extraction process
specified process by which *NAL units* (3.87) in a *bitstream* (3.13) that do not belong to a target set, determined by a target highest TemporalId and a target *layer identifier list* (3.74), are removed from the bitstream, with the output sub-bitstream consisting of the NAL units in the bitstream that belong to the target set

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3.155
sub-layer
temporal sub-layer
temporal scalable layer of a temporal scalable *bitstream* (3.13), consisting of *VCL NAL units* (3.181) with a particular value of the TemporalId variable and the associated *non-VCL NAL units* (3.91)

3.156
sub-layer non-reference picture
SLNR picture
picture (3.99) that contains samples that cannot be used for *inter prediction* (3.67) in the *decoding process* (3.43) of subsequent pictures of the same *sub-layer* (3.142) in *decoding order* (3.42)

Note 1 to entry: Samples of an SLNR picture can be used for inter prediction in the decoding process of subsequent pictures of higher sub-layers in decoding order.

3.157
sub-layer reference picture
picture (3.93) that contains samples that may be used for *inter prediction* (3.62) in the *decoding process* (3.45) of subsequent pictures of the same *sub-layer* (3.155) in *decoding order* (3.44)

Note 1 to entry: Samples of a sub-layer reference picture can also be used for inter prediction in the decoding process of subsequent pictures of higher sub-layers in decoding order.

3.158
sub-layer representation
subset of the *bitstream* (3.13) consisting of *NAL units* (3.87) of a particular *sub-layer* (3.155) and the lower sub-layers

3.159
suffix SEI message
SEI message that is contained in a *suffix SEI NAL unit* (3.160)

3.160
suffix SEI NAL unit
SEI NAL unit (3.161) that has nal_unit_type equal to SUFFIX_SEI_NUT

3.161
supplemental enhancement information NAL unit
SEI NAL unit
NAL unit (3.87) that has nal_unit_type equal to PREFIX_SEI_NUT or SUFFIX_SEI_NUT

3.162
syntax element
element of data represented in the *bitstream* (3.13)

3.163
syntax structure
zero or more *syntax elements* (3.162) present together in the *bitstream* (3.13) in a specified order

3.164
temporal sub-layer access access unit
TSA access unit
access unit (3.1) in which the *coded picture* (3.25) with nuh_layer_id equal to 0 is a *TSA picture* (3.165)

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3.165
temporal sub-layer access picture
TSA picture
coded picture (3.25) for which each *VCL NAL unit* (3.181) has nal_unit_type equal to TSA_R or TSA_N

Note 1 to entry: A TSA picture and pictures following the TSA picture in decoding order do not use pictures prior to the TSA picture in decoding order with TemporalId greater than or equal to that of the TSA picture for inter prediction reference. A TSA picture enables up-switching, at the TSA picture, to the sub-layer containing the TSA picture or any higher sub-layer, from the immediately lower sub-layer. TSA pictures have TemporalId greater than 0.

3.166
tier
specified category of *level* (3.79) constraints imposed on values of the *syntax elements* (3.162) in the *bitstream* (3.13)

Note 1 to entry: The level constraints are nested within a tier and a *decoder* (3.42) conforming to a certain tier and level would be capable of decoding all bitstreams that conform to the same tier or the lower tier of that level or any level below it.

3.167
tile
rectangular region of *CTUs* (3.34) within a particular *tile column* (3.168) and a particular *tile row* (3.169) in a *picture* (3.99)

3.168
tile column
rectangular region of *CTUs* (3.34) having a height equal to the height of the *picture* (3.99) and a width specified by *syntax elements* (3.162) in the *picture parameter set* (3.100)

3.169
tile row
rectangular region of *CTUs* (3.34) having a height specified by *syntax elements* (3.162) in the *picture parameter set* (3.100) and a width equal to the width of the *picture* (3.99)

3.170
tile scan
specific sequential ordering of *CTUs* (3.34) *partitioning* (3.98) a *picture* (3.99) in which the CTUs are ordered consecutively in CTUs *raster scan* (3.123) in a *tile* (3.167)

Note 1 to entry: Tiles in a picture are ordered consecutively in a raster scan of the tiles of the picture.

3.171
tilt angle
angle indicating the amount of tilt of a *sphere region* (3.149), 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

3.172
trailing picture
non-IRAP *picture* (3.99) that follows the *associated IRAP picture* (3.3) in *output order* (3.94)

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Note 1 to entry: Trailing pictures associated with an IRAP picture also follow the IRAP picture in decoding order. Pictures that follow the associated IRAP picture in output order and precede the associated IRAP picture in decoding order are not allowed.

3.173
transform
part of the *decoding process* (3.45) by which a *block* (3.14) of *transform coefficients* (3.175) is converted to a block of spatial-domain values

3.174
transform block
rectangular MxN *block* (3.14) of samples resulting from a *transform* (3.173) in the *decoding process* (3.45)

3.175
transform coefficient
scalar quantity, considered to be in a frequency domain, that is associated with a particular one-dimensional or two-dimensional *frequency index* (3.58) in a *transform* (3.173) in the *decoding process* (3.45)

3.176
transform coefficient level
integer quantity representing the value associated with a particular two-dimensional frequency index in the *decoding process* (3.45) prior to scaling for computation of a transform coefficient value

3.177
transform unit
transform block (3.174) of *luma* (3.85) samples of size 8×8, 16×16, or 32×32 or four transform blocks of luma samples of size 4×4, two corresponding transform blocks of *chroma* (3.22) samples of a *picture* (3.99) in 4:2:0 colour format; or transform block of luma samples of size 8×8, 16×16, or 32×32, and four corresponding transform blocks of chroma samples, or four transform blocks of luma samples of size 4×4, and four corresponding transform blocks of chroma samples of a picture in 4:2:2 colour format; or transform block of luma samples of size 4×4, 8×8, 16×16, or 32×32, and two corresponding transform blocks of chroma samples of a picture in 4:4:4 colour format that is not coded using three separate colour planes and *syntax structures* (3.163) used to transform the transform block samples; or transform block of luma samples of size 8×8, 16×16, or 32×32 or four transform blocks of luma samples of size 4×4 of a monochrome picture or a picture in 4:4:4 colour format that is coded using three separate colour planes; and the associated syntax structures used to transform the transform block samples

3.178
tree
finite set of nodes with a unique root node

3.179
universal unique identifier
UUID
identifier that is unique with respect to the space of all universal unique identifiers

3.180
unspecified
<value of a particular syntax element> value not to be used in the future by ITU-T/ISO/IEC

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Note 1 to entry: These values have no specified meaning in this document and will not have a specified meaning in the future as an integral part of future editions of this document.

3.181
video coding layer NAL unit
VCL NAL unit
collective term for *coded slice segment NAL units* (3.28) and the subset of *NAL units* (3.87) that have *reserved* (3.135) values of nal_unit_type that are classified as VCL NAL units

3.182
video parameter set
VPS
syntax structure (3.163) containing *syntax elements* (3.162) that apply to zero or more entire *CVSs* (3.30) as determined by the content of a syntax element found in the *SPS* (3.140) referred to by a syntax element found in the *PPS* (3.100) referred to by a syntax element found in each *slice segment header* (3.146)

3.183
viewport
region of *omnidirectional video* (3.92) content suitable for display and viewing by the user

3.184
z-scan order
specified sequential ordering of *blocks* (3.14) *partitioning* (3.98) a *picture* (3.99) where the order is identical to *CTBs* (3.33) *raster scan* (3.123) of the picture when the blocks are of the same size as CTBs and, when the blocks are of a smaller size than CTBs, i.e. CTBs are further partitioned into smaller *coding blocks* (3.32), the order traverses from CTB to CTB in CTB raster scan of the picture, and inside each CTB, which may be divided into *quadtrees* (3.116) hierarchically to lower levels, the order traverses from quadtree to quadtree of a particular level in quadtree-of-the-particular-level raster scan of the quadtree of the immediately higher level

4 Abbreviated terms

ATSC	Advanced Television Systems Committee
B	bi-predictive
BLA	broken link access
BPB	bitstream partition buffer
CABAC	context-based adaptive binary arithmetic coding
CB	coding block
CBR	constant bit rate
CLVS	coded layer-wise video sequence
CPB	coded picture buffer
CRA	clean random access
CTB	coding tree block
CTU	coding tree unit
CU	coding unit
CVS	coded video sequence

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