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Part 10: Advanced video coding

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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. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

ISO/IEC 14496-10 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information.*

This part of ISO/IEC 14496 is technically aligned with ITU-T Rec. H.264 but is not published as identical text.

ISO/IEC 14496 consists of the following parts, under the general title *Information technology — Coding of audio-visual objects*:

— *Part 1: Systems*

— *Part 2: Visual*

— *Part 3: Audio*

— *Part 4: Conformance testing*

— *Part 5: Reference software*

— *Part 6: Delivery Multimedia Integration Framework (DMIF)*

— *Part 7: Optimized reference software for coding of audio-visual objects*

— *Part 8: Carriage of ISO/IEC 14496 contents over IP networks*

— *Part 9: Reference hardware description*

— *Part 10: Advanced video coding*

— *Part 11: Scene description and application engine*

— *Part 12: ISO base media file format*

— *Part 13: Intellectual Property Management and Protection (IPMP) extensions*

— *Part 14: MP4 file format*

— *Part 15: Advanced Video Coding (AVC) file format*

— *Part 16: Animation Framework eXtension (AFX)*

0 Introduction

This clause does not form an integral part of this Recommendation | International Standard.

0.1 Prologue

This subclause does not form an integral part of this Recommendation | International Standard.

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 Video Team (JVT) in 2001 for development of a new Recommendation | International Standard.

0.2 Purpose

This subclause does not form an integral part of this Recommendation | International Standard.

This Recommendation | International Standard 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 communication. It is also designed to enable the use of the coded video representation in a flexible manner for a wide variety of network environments. The use of this Recommendation | International Standard 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.

0.3 Applications

This subclause does not form an integral part of this Recommendation | International Standard.

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

CATV	Cable TV on optical networks, copper, etc.
DBS	Direct broadcast satellite video services
DSL	Digital subscriber line video services
DTTB	Digital terrestrial television broadcasting
ISM	Interactive storage media (optical disks, etc.)
MMM	Multimedia mailing
MSPN	Multimedia services over packet networks
RTC	Real-time conversational services (videoconferencing, videophone, etc.)
RVS	Remote video surveillance
SSM	Serial storage media (digital VTR, etc.)

0.4 Profiles and levels

This subclause does not form an integral part of this Recommendation | International Standard.

This Recommendation | International Standard 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 Specification, 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 Specification will facilitate video data interchange among different applications.

Considering the practicality of implementing the full syntax of this Specification, however, a limited number of subsets of the syntax are also stipulated by means of "profiles" 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 by this Recommendation | International Standard. 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 economic 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, "levels" are specified within each profile. A level 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).

Coded video content conforming to this Recommendation | International Standard 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.

0.5 Overview of the design characteristics

This subclause does not form an integral part of this Recommendation | International Standard.

The coded representation specified in the syntax is designed to enable a high compression capability for a desired image quality. The algorithm is 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 is then further compressed using a transform to remove spatial correlation inside the transform block before it is quantised, producing an 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 are combined with the quantised transform coefficient information and encoded using either variable length codes or arithmetic coding.

0.5.1 Predictive coding

This subclause does not form an integral part of this Recommendation | International Standard.

Because of the conflicting requirements of random access and highly efficient compression, two main coding types are specified. Intra coding is done without reference to other pictures. Intra coding may provide access points to the coded sequence where decoding can begin and continue correctly, but typically also shows only moderate compression efficiency. Inter coding (predictive or bi-predictive) is more efficient using inter prediction of each block of sample values from some previously decoded picture selected by the encoder. In contrast to some other video coding standards, pictures coded using bi-predictive inter prediction may also be used as references for inter coding of other pictures.

The application of the three coding types to pictures in a sequence is flexible, and the order of the decoding process is generally not the same as the order of the source picture capture process in the encoder or the output order from the decoder for display. The choice is left to the encoder and will depend on the requirements of the application. The decoding order is specified such that the decoding of pictures that use inter-picture prediction follows later in decoding order than other pictures that are referenced in the decoding process.

0.5.2 Coding of progressive and interlaced video

This subclause does not form an integral part of this Recommendation | International Standard.

This Recommendation | International Standard specifies a syntax and decoding process for video that originated in either progressive-scan or interlaced-scan form, which may be mixed together in the same sequence. The two fields of an interlaced frame are separated in capture time while the two fields of a progressive frame share the same capture time. Each field may be coded separately or the two fields may be coded together as a frame. Progressive frames are typically coded as a frame. For interlaced video, the encoder can choose between frame coding and field coding. Frame coding or field coding can be adaptively selected on a picture-by-picture basis and also on a more localized basis within a coded frame. Frame coding is typically preferred when the video scene contains significant detail with limited motion. Field coding typically works better when there is fast picture-to-picture motion.

0.5.3 Picture partitioning into macroblocks and smaller partitions

This subclause does not form an integral part of this Recommendation | International Standard.

As in previous video coding Recommendations and International Standards, a macroblock, consisting of a 16x16 block of luma samples and two corresponding blocks of chroma samples, is used as the basic processing unit of the video decoding process.

A macroblock can be further partitioned for inter prediction. The selection of the size of inter prediction partitions is a result of a trade-off between the coding gain provided by using motion compensation with smaller blocks and the quantity of data needed to represent the data for motion compensation. In this Recommendation | International Standard the inter prediction process can form segmentations for motion representation as small as 4x4 luma samples in size, using motion vector accuracy of one-quarter of the luma sample grid spacing displacement. The process for inter prediction of a sample block can also involve the selection of the picture to be used as the reference picture from a number of stored previously-decoded pictures. Motion vectors are encoded differentially with respect to predicted values formed from nearby encoded motion vectors.

Typically, the encoder calculates appropriate motion vectors and other data elements represented in the video data stream. This motion estimation process in the encoder and the selection of whether to use inter prediction for the representation of each region of the video content is not specified in this Recommendation | International Standard.

0.5.4 Spatial redundancy reduction

This subclause does not form an integral part of this Recommendation | International Standard.

Both source pictures and prediction residuals have high spatial redundancy. This Recommendation | International Standard is based on the use of a block-based transform method for spatial redundancy removal. After inter prediction from previously-decoded samples in other pictures or spatial-based prediction from previously-decoded samples within the current picture, the resulting prediction residual is split into 4x4 blocks. These are converted into the transform domain where they are quantised. After quantisation many of the transform coefficients are zero or have low amplitude and can thus be represented with a small amount of encoded data. The processes of transformation and quantisation in the encoder are not specified in this Recommendation | International Standard.

0.6 How to read this specification

This subclause does not form an integral part of this Recommendation | International Standard.

It is suggested that the reader starts with clause 1 (Scope) and moves on to clause 3 (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 subclauses 7.1-7.3 for syntactical order and see subclause 7.4 for semantics; i.e., 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). Finally, clause 8 (Decoding process) specifies how the syntax elements are mapped into decoded samples. Throughout reading this specification, the reader should refer to clauses 2 (Normative references), 4 (Abbreviations), and 5 (Conventions) as needed. Annexes A through E also form an integral part of this Recommendation | International Standard.

Annex A defines three profiles (Baseline, Main, and Extended), each being tailored to certain application domains, and defines the so-called 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 and its use to check bitstream and decoder conformance. Annex D specifies syntax and semantics for supplemental enhancement information message payloads. Finally, Annex E specifies syntax and semantics of the video usability information parameters of the sequence parameter set.

Throughout this specification, statements appearing with the preamble "NOTE -" are informative and are not an integral part of this Recommendation | International Standard.

Information technology — Coding of audio-visual objects —

Part 10:
Advanced Video Coding

1 Scope

This document specifies ITU-T Recommendation H.264 | ISO/IEC International Standard ISO/IEC 14496-10 video coding.

2 Normative references

The following Recommendations and International Standards contain provisions that, through reference in this text, constitute provisions of this Recommendation | International Standard. At the time of publication, the editions indicated were valid. All Recommendations and Standards are subject to revision, and parties to agreements based on this Recommendation | International Standard are encouraged to investigate the possibility of applying the most recent edition of the Recommendations and Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The Telecommunication Standardisation Bureau of the ITU maintains a list of currently valid ITU-T Recommendations.

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

ISO/IEC 11578:1996, Annex A, *Universal Unique Identifier*

ISO/CIE 10527:1991, *Colorimetric Observers*

3 Definitions

For the purposes of this Recommendation | International Standard, the following definitions apply.

3.1 **access unit**: A set of *NAL units* always containing a *primary coded picture*. In addition to the *primary coded picture*, an access unit may also contain one or more *redundant coded pictures* or other *NAL units* not containing *slices* or *slice data partitions* of a *coded picture*. The decoding of an access unit always results in a *decoded picture*.

3.2 **AC transform coefficient**: Any *transform coefficient* for which the *frequency index* in one or both dimensions is non-zero.

3.3 **adaptive binary arithmetic decoding process**: An entropy *decoding process* that recovers the values of *bins* from a *bitstream* produced by an *adaptive binary arithmetic encoding process*.

3.4 **adaptive binary arithmetic encoding process**: An entropy *encoding process*, not normatively specified in this Recommendation | International Standard, that codes a sequence of *bins* and produces a *bitstream* that can be decoded using the *adaptive binary arithmetic decoding process*.

3.5 **arbitrary slice order**: A *decoding order* of *slices* in which the *macroblock address* of the first *macroblock* of some *slice* of a *picture* may be smaller than the *macroblock address* of the first *macroblock* of some other preceding *slice* of the same *coded picture*.

3.6 **B slice**: A *slice* that may be decoded using *intra prediction* from decoded samples within the same *slice* or *inter prediction* from previously-decoded *reference pictures*, using at most two *motion vectors* and *reference indices* to *predict* the sample values of each *block*.

3.7 **bin**: One bit of a *bin string*.

3.8 **binarization**: The set of intermediate binary representations of all possible values of a *syntax element*.

3.9 **binarization process**: A unique mapping process of possible values of a *syntax element* onto a set of *bin strings*.

3.10 **bin string**: A string of *bins*. A bin string is an intermediate binary representation of values of *syntax elements*.

3.11 **bi-predictive slice:** See *B slice*.

3.12 **bitstream**: A sequence of bits that forms the representation of *coded pictures* and associated data forming one or more *coded video sequences*. Bitstream is a collective term used to refer either to a *NAL unit stream* or a *byte stream*.

3.13 **block**: An MxN (M-column by N-row) array of samples, or an MxN array of *transform coefficients*.

3.14 **bottom field**: One of two *fields* that comprise a *frame*. Each row of a *bottom field* is spatially located immediately below a corresponding row of a *top field*.

3.15 **bottom macroblock (of a macroblock pair)**: The *macroblock* within a *macroblock pair* that contains the samples in the bottom row of samples for the *macroblock pair*. For a *field macroblock pair*, the bottom macroblock represents the samples from the region of the *bottom field* of the *frame* that lie within the spatial region of the *macroblock pair*. For a *frame macroblock pair*, the bottom macroblock represents the samples of the *frame* that lie within the bottom half of the spatial region of the *macroblock pair*.

3.16 **broken link**: A location in a *bitstream* at which it is indicated that some subsequent *pictures* in *decoding order* may contain serious visual artefacts due to unspecified operations performed in the generation of the *bitstream*.

3.17 **byte**: A sequence of 8 bits, written and read with the most significant bit on the left and the least significant bit on the right. When represented in a sequence of data bits, the most significant bit of a byte is first.

3.18 **byte-aligned**: A bit in a *bitstream* is byte-aligned when its position is an integer multiple of 8 bits from the first bit in the *bitstream*.

3.19 **byte stream**: An encapsulation of a *NAL unit stream* containing *start code prefixes* and *NAL units* as specified in Annex B.

3.20 **category**: A number associated with each *syntax element*. The category is used to specify the allocation of *syntax elements* to *NAL units* for *slice data partitioning*. It may also be used in a manner determined by the application to refer to classes of *syntax elements* in a manner not specified in this Recommendation | International Standard.

3.21 **chroma**: An adjective specifying that a sample array or single sample is representing one of the two colour difference signals related to the primary colours. The symbols used for a chroma array or sample are Cb and Cr.

NOTE - 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.

3.22 **coded field**: A *coded representation* of a *field*.

3.23 **coded frame**: A *coded representation* of a *frame*.

3.24 **coded picture**: A *coded representation* of a *picture*. A coded picture may be either a *coded field* or a *coded frame*. Coded picture is a collective term referring to a *primary coded picture* or a *redundant coded picture*, but not to both together.

3.25 **coded picture buffer (CPB)**: A first-in first-out buffer containing *access units* in *decoding order* specified in the *hypothetical reference decoder* in Annex C.

3.26 **coded representation**: A data element as represented in its coded form.

3.27 **coded video sequence**: A sequence of *access units* that consists, in decoding order, of an *IDR access unit* followed zero or more non-IDR access *units* including all subsequent *access units* up to but not including any subsequent *IDR access unit*.

3.28 **component**: An array or single sample from one of the three arrays (*luma* and two *chroma*) that make up a *field* or *frame*.

3.29 **complementary field pair:** A collective term for a *complementary reference field pair* or a *complementary non-reference field pair*.

3.30 **complementary non-reference field pair**: Two *non-reference fields* that are in consecutive *access units* in *decoding order* as two *coded fields* of opposite parity where the first *field* is not already a paired *field.*

3.31 **complementary reference field pair**: Two *reference fields* that are in consecutive *access units* in *decoding order* as two *coded fields* and share the same value of *frame number*, where the second *field* in *decoding order* is not an *IDR picture* and does not include a memory_management_control_operation *syntax element* equal to 5.

3.32 **context variable**: A variable specified for the *adaptive binary arithmetic decoding process* of a *bin* by an equation containing recently decoded *bins*.

3.33 **DC transform coefficient**: A *transform coefficient* for which the *frequency index* is zero in all dimensions.

3.34 **decoded picture**: A *decoded picture* is derived by decoding a *coded picture*. A *decoded picture* is either a decoded *frame*, or a decoded *field*. A decoded *field* is either a decoded *top field* or a decoded *bottom field*.

3.35 **decoded picture buffer (DPB)**: A buffer holding *decoded pictures* for reference, output reordering, or output delay specified for the *hypothetical reference decoder* in Annex C.

3.36 **decoder**: An embodiment of a *decoding process*.

3.37 **decoding order**: The order in which *syntax elements* are processed by the *decoding process*.

3.38 **decoding process**: The process specified in this Recommendation | International Standard that reads a *bitstream* and produces *decoded pictures*.

3.39 **direct prediction**: An *inter prediction* for a *block* for which no *motion vector* is decoded. Two direct *prediction* modes are specified that are referred to as spatial direct *prediction* and temporal *prediction* mode.

3.40 **decoder under test (DUT)**: A *decoder* that is tested for conformance to this Recommendation | International Standard by operating the *hypothetical stream scheduler* to deliver a conforming *bitstream* to the *decoder* and to the *hypothetical reference decoder* and comparing the values and timing of the output of the two *decoders*.

3.41 **emulation prevention byte**: A byte equal to 0x03 that may be present within a *NAL unit*. The presence of emulation prevention bytes ensures that no sequence of consecutive byte-aligned bytes in the *NAL unit* contains a *start code prefix*.

3.42 **encoder**: An embodiment of an *encoding process*.

3.43 **encoding process**: A process, not specified in this Recommendation | International Standard, that produces a *bitstream* conforming to this Recommendation | International Standard.

3.44 **field**: An assembly of alternate rows of a *frame*. A *frame* is composed of two *fields*, a *top field* and a *bottom field*.

3.45 **field macroblock**: A macroblock containing samples from a single *field*. All *macroblocks* of a *coded field* are field macroblocks. When *macroblock-adaptive frame/field decoding* is in use, some macroblocks of a *coded frame* may be field macroblocks.

3.46 **field macroblock pair**: A *macroblock pair* decoded as two *field macroblocks.*

3.47 **field scan**: A specific sequential ordering of *transform coefficients* that differs from the *zig-zag* scan by scanning columns more rapidly than rows. Field scan is used for *transform coefficients* in *field macroblocks.*

3.48 **flag**: A variable that can take one of the two possible values 0 and 1.

3.49 **frame**: A *frame* contains an array of luma samples and two corresponding arrays of chroma samples. A *frame* consists of two *fields*, a *top field* and a *bottom field*.

3.50 **frame macroblock**: A *macroblock* representing samples from two *fields* of a *coded frame*. When *macroblock-adaptive frame/field decoding* is not in use, all macroblocks of a *coded frame* are frame macroblocks. When *macroblock-adaptive frame/field decoding* is in use, some macroblocks of a *coded frame* may be frame macroblocks.

3.51 **frame macroblock pair**: A *macroblock pair* decoded as two *frame macroblocks.*

3.52 **frequency index**: A one-dimensional or two-dimensional index associated with a *transform coefficient* prior to an *inverse transform* part of the *decoding process.*

3.53 **hypothetical reference decoder (HRD)**: A hypothetical *decoder* model that specifies constraints on the variability of conforming *NAL unit streams* or conforming *byte streams* that an encoding process may produce.

3.54 **hypothetical stream scheduler (HSS)**: A hypothetical delivery mechanism for the timing and data flow of the input of a *bitstream* into the *hypothetical reference decoder*. The HSS is used for checking the conformance of a *bitstream* or a *decoder*.

3.55 **I slice**: A *slice* that is decoded using *prediction* only from decoded samples within the same *slice*.

3.56 **instantaneous decoding refresh (IDR) access unit**: An *access unit* in which the *primary coded picture* is an *IDR picture*.

3.57 **instantaneous decoding refresh (IDR) picture**: A *coded picture* containing only *slices* with *I* or *SI slice types* that causes the *decoding process* to mark all *reference pictures* as "unused for reference" immediately after decoding the IDR picture. After the decoding of an IDR picture all following *coded pictures* in *decoding order* can be decoded without *inter prediction* from any *picture* decoded prior to the IDR picture. The first *picture* of each *coded video sequence* is an IDR picture.

3.58 **inter coding**: Coding of a *block*, *macroblock*, *slice*, or *picture* that uses *inter prediction*.

3.59 **inter prediction**: A *prediction* derived from decoded samples of *reference pictures* other than the current *decoded picture*.

3.60 **intra coding**: Coding of a *block, macroblock*, *slice*, or *picture* that uses *intra prediction*.

3.61 **intra prediction**: A *prediction* derived from the decoded samples of the same *decoded slice*.

3.62 **intra slice**: See I slice.

3.63 **inverse transform**: A part of the *decoding process* by which a set of *transform coefficients* are converted into spatial-domain values, or by which a set of *transform coefficients* are converted into *DC transform coefficients*.

3.64 **layer**: One of a set of syntactical structures in a non-branching hierarchical relationship. Higher layers contain lower layers. The coding layers are the *coded video sequence*, *picture*, *slice*, and *macroblock* layers.

3.65 **level**: A defined set of constraints on the values that may be taken by the *syntax elements* and variables of this Recommendation | International Standard. 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 may, within specified constraints, support a different level for each supported *profile*. In a different context, *level* is the value of a *transform coefficient* prior to *scaling*.

3.66 **list 0 (list 1) motion vector**: A *motion vector* associated with a *reference index* pointing into *reference picture list 0* (*list 1*).

3.67 **list 0 (list 1) prediction**: *Inter prediction* of the content of a *slice* using a *reference index* pointing into *reference picture list 0* (*list 1*).

3.68 **luma**: An adjective specifying that a sample array or single sample is representing the monochrome signal related to the primary colours. The symbol used for luma is Y.

NOTE – 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.

3.69 **macroblock**: A 16x16 *block* of *luma* samples and two corresponding *blocks* of *chroma* samples. The division of a *slice* or a *macroblock pair* into macroblocks is a *partitioning*.

3.70 **macroblock-adaptive frame/field decoding**: A *decoding process* for *coded frames* in which some *macroblocks* may be decoded as *frame macroblocks* and others may be decoded as *field macroblocks.*

3.71 **macroblock address**: When *macroblock-adaptive frame/field decoding* is not in use, a macroblock address is the index of a macroblock in a *macroblock raster scan* of the *picture* starting with zero for the top-left *macroblock* in a *picture*. When *macroblock-adaptive frame/field decoding* is in use, the macroblock address of the *top macroblock* of a *macroblock pair* is two times the index of the *macroblock pair* in a *macroblock pair raster scan* of the *picture*, and the macroblock address of the *bottom macroblock* of a *macroblock pair* is the macroblock address of the corresponding *top macroblock* plus 1. The macroblock address of the *top macroblock* of each *macroblock pair* is an even number and the macroblock address of the *bottom macroblock* of each *macroblock pair* is an odd number.

3.72 **macroblock location**: The two-dimensional coordinates of a *macroblock* in a *picture* denoted by (x, y). For the top left *macroblock* of the *picture* (x, y) is equal to (0, 0). x is incremented by 1 for each *macroblock* column from left to right. When *macroblock-adaptive frame/field decoding* is not in use, y is incremented by 1 for each *macroblock* row from top to bottom. When *macroblock-adaptive frame/field decoding* is in use, y is incremented by 2 for each *macroblock pair* row from top to bottom, and is incremented by an additional 1 when a macroblock is a *bottom macroblock*.

3.73 **macroblock pair**: A pair of vertically contiguous *macroblocks* in a *frame* that is coupled for use in *macroblock-adaptive frame/field decoding* processing. The division of a *slice* into macroblock pairs is a *partitioning*.

3.74 **macroblock partition**: A *block* of *luma* samples and two corresponding *blocks* of *chroma* samples resulting from a *partitioning* of a *macroblock* for *inter prediction*.

3.75 **macroblock to slice group map**: A means of mapping *macroblocks* of a *picture* into *slice groups*. The macroblock to slice group map consists of a list of numbers, one for each coded *macroblock*, specifying the *slice group* to which each coded *macroblock* belongs.

3.76 **map unit to slice group map**: A means of mapping *slice group map units* of a *picture* into *slice groups*. The map unit to slice group map consists of a list of numbers, one for each *slice group map unit*, specifying the *slice group* to which each coded *slice group map unit* belongs.

3.77 **memory management control operation**: Seven operations that control *reference picture marking*.

3.78 **motion vector**: A two-dimensional vector used for *inter prediction* that provides an offset from the coordinates in the *decoded picture* to the coordinates in a *reference picture*.

3.79 **NAL unit**: A syntax structure containing an indication of the type of data to follow and bytes containing that data in the form of an *RBSP* interspersed as necessary with *emulation prevention bytes*.

3.80 **NAL unit stream**: A sequence of *NAL units*.

3.81 **non-paired field**: A collective term for a *non-paired reference field* or a *non-paired non-reference field*.

3.82 **non-paired non-reference field:** A decoded *non-reference field* that is not part of a *complementary non-reference field pair*.

3.83 **non-paired reference field**: A decoded *reference field* that is not part of a *complementary reference field pair*.

3.84 **non-reference field**: A *field* coded with nal_ref_idc equal to 0.

3.85 **non-reference frame**: A *frame* coded with nal_ref_idc equal to 0.

3.86 **non-reference picture**: A *picture* coded with nal_ref_idc equal to 0. A *non-reference picture* is not used for *inter prediction* of any other *pictures*.

3.87 **opposite parity**: The *opposite parity* of *top* is *bottom*, and vice versa.

3.88 **output order**: The order in which the *decoded pictures* are output from the *decoded picture buffer*.

3.89 **P slice**: A *slice* that may be decoded using *intra prediction* from decoded samples within the same *slice* or *inter prediction* from previously-decoded *reference pictures*, using at most one *motion vector* and *reference index* to *predict* the sample values of each *block*.

3.90 **parameter**: A *syntax element* of a *sequence parameter set* or a *picture parameter set*. Parameter is also used as part of the defined term *quantisation parameter*.

3.91 **parity**: The *parity* of a *field* can be *top* or *bottom*.

3.92 **partitioning**: The division of a set into subsets such that each element of the set is in exactly one of the subsets.

3.93 **picture**: A collective term for a *field* or a *frame*.

3.94 **picture order count**: A variable having a value that is non-decreasing with increasing *picture* position in output order relative to the previous *IDR picture* in *decoding order* or relative to the previous *picture* containing the *memory management control operation* that marks all *reference pictures* as "unused for reference".

3.95 **prediction**: An embodiment of the *prediction process*.