INTERNATIONAL STANDARD

ISO/IEC 23008-8

Second edition
2018-08

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

Part 8: Conformance specification for HEVC

Technologies de l'information — Codage à haute efficacité et livraison des medias dans des environnements hétérogènes —

Partie 8: Spécification de conformité du codage video à haute efficacité

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Reference number
ISO/IEC 23008-8:2018(E)

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Published in Switzerland

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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.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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

This document was prepared by Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 29, *Coding of audio, picture, multimedia and hypermedia information*, in collaboration with ITU-T. A technically aligned twin text is published as ITU-T H.265.1.

This second edition cancels and replaces the first edition (ISO/IEC ISO/IEC 23008-8:2015), which has been technically revised.

The main changes compared to the previous edition are as follows:

— addition of conformance testing for Multiview Main and 3D Main profiles;

— addition of conformance testing for Format Range Extensions profiles;

— addition of conformance testing for Scalable profiles.

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

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

Part 8: Conformance specification for HEVC

1 Scope

This document specifies a set of tests and procedures designed to indicate whether encoders or decoders meet the normative requirements specified in Rec. ITU-T H.265 | ISO/IEC 23008-2.

NOTE The conformance bitstreams identified within the text are available at http://standards.iso.org/iso-iec/23008/-8/ed-2/en.

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.

Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, *Information technology — High efficiency video coding and media delivery in heterogeneous environment — Part 2: High Efficiency Video Coding*

Rec. ITU-T H.265.2 | ISO/IEC 23008-5, *Information technology — High efficiency video coding and media delivery in heterogeneous environment — Part 2: High Efficiency Video Coding Reference Software*

3 Terms, definitions, abbreviated terms and conventions

For the purposes of this document, the terms, definitions, abbreviated terms and conventions given in Rec. ITU-T H.265 | ISO/IEC 23008-2 and the following apply.

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

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

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

3.1
bitstream
sequence of bits, in the form of a NAL unit stream or a byte stream, that forms the representation of coded pictures and associated data forming one or more CVSs

Note 1 to entry: In this document, this refers specifically to video bitstream according to ISO/IEC 23008-2.

[SOURCE: Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, 3.12, modified – Note 1 to entry added]

3.2
decoder
embodiment of a decoding process

Note 1 to entry: In this document, this refers specifically to a video decoder as specified in ISO/IEC 23008-2.

Note 2 to entry: The decoder does not include the display process, which is outside the scope of this document.

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[SOURCE: Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, 3.40, modified – Notes 1 and 2 to entry added]

3.3
encoder
embodiment of an encoding process

Note 1 to entry: The process, not specified in this document (except in regard to identification of the reference software encoder), produces a bitstream.

[SOURCE: Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, 3.49, modified – Note 1 to entry added]

3.4
reference software decoder
decoding software required for this document

Note 1 to entry: For this document, the reference software decoder is provided in Rec. ITU-T H.265.2 | ISO/IEC 23008-5.

3.5
reference software encoder
encoding software required for this document

Note 1 to entry: For this document, the reference software encoder is provided in Rec. ITU-T H.265.2 | ISO/IEC 23008-5.

4 Conformance testing for Rec. ITU-T H.265 | ISO/IEC 23008-2

4.1 General

The following clauses specify normative tests for verifying conformance of video bitstreams as well as decoders. Those normative tests make use of test data (bitstream test suites) provided at http://standards.iso.org/iso-iec/23008/-8/ed-2/en and the reference software decoder specified in Rec. ITU-T H.265.2 | ISO/IEC 23008-5.

4.2 Bitstream conformance

Bitstream conformance for Rec. ITU-T H.265 | ISO/IEC 23008-2 is specified by ISO/IEC 23008-2:2017, C.4.

4.3 Decoder conformance

Decoder conformance for Rec. ITU-T H.265 | ISO/IEC 23008-2 is specified by ISO/IEC 23008-2:2017, C.5.

4.4 Procedure to test bitstreams

A bitstream that claims conformance with Rec. ITU-T H.265 | ISO/IEC 23008-2 shall pass the following normative test.

The bitstream shall be decoded by processing it with the reference software decoder. When processed by the reference software decoder, the bitstream shall not cause any error or non-conformance messages to be reported by the reference software decoder. This test should not be applied to bitstreams that are known to contain errors introduced by transmission, as such errors are highly likely to result in bitstreams that lack conformance to Rec. ITU-T H.265 | ISO/IEC 23008-2.

Successfully passing the reference software decoder test provides only a strong presumption that the bitstream under test is conforming to the video layer, i.e., that it does indeed meet all the requirements for the video layer (except Annexes C, D and E) specified in Rec. ITU-T H.265 | ISO/IEC 23008-2 that are tested by the reference software decoder.

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Additional tests may be necessary to more thoroughly check that the bitstream properly meets all the requirements specified in Rec. ITU-T H.265 | ISO/IEC 23008-2 including the hypothetical reference decoder (HRD) conformance (based on Annexes C, D and E). These complementary tests may be performed using other video bitstream verifiers that perform more complete tests than those implemented by the reference software decoder.

Rec. ITU-T H.265 | ISO/IEC 23008-2 contains several informative recommendations that are not an integral part of that Document. When testing a bitstream for conformance, it may also be useful to test whether or not the bitstream follows those recommendations.

To check correctness of a bitstream, it is necessary to parse the entire bitstream and to extract all the syntax elements and other values derived from those syntactic elements and used by the decoding process specified in Rec. ITU-T H.265 | ISO/IEC 23008-2.

A verifier may not necessarily perform all stages of the decoding process specified in Rec. ITU-T H.265 | ISO/IEC 23008-2 in order to verify bitstream correctness. Many tests can be performed on syntax elements in a state prior to their use in some processing stages.

4.5 Procedure to test decoder conformance

4.5.1 Conformance bitstreams

A bitstream has values of general_profile_idc, general_tier_flag, and general_level_idc corresponding to a set of specified constraints on a bitstream for which a decoder conforming to a specified profile, tier, and level is required in Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, Annex A to properly perform the decoding process.

4.5.2 Contents of the bitstream file

The conformance bitstreams are provided at http://standards.iso.org/iso-iec/23008/-8/ed-2/en. The following information is included in a single zipped file for each such bitstream.

— bitstream;

— decoded pictures or hashes of decoded pictures (may not be present);

— short description of the bitstream;

— trace file (results while decoding the bitstream, in ASCII format).

In cases where the decoded pictures or hashes of decoded pictures are not available, the reference software decoder shall be used to generate the necessary reference decoded pictures from the bitstream.

4.5.3 Requirements on output of the decoding process and timing

Two classes of decoder conformance are specified:

— output order conformance;

— output timing conformance.

The output of the decoding process is specified in Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, Clause 8 and Annex C.

For output order conformance, it is a requirement that all of the decoded pictures specified for output in Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, Annex C shall be output by a conforming decoder in the specified order and that the values of the decoded samples in all of the pictures that are output shall be (exactly equal to) the values specified in Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, Clause 8.

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For output timing conformance, it is a requirement that a conforming decoder shall also output the decoded samples at the rates and times specified in Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, Annex C.

The display process, which ordinarily follows the output of the decoding process, is outside the scope of this document.

4.5.4 Recommendations (informative)

In addition to the requirements, it is desirable that conforming decoders implement various informative recommendations specified in Rec. ITU-T H.265 | ISO/IEC 23008-2 that are not an integral part of that document. This clause discusses some of these recommendations.

It is recommended that a conforming decoder be able to resume the decoding process as soon as possible after the loss or corruption of part of a bitstream. In most cases it is possible to resume decoding at the next start code or slice header. It is recommended that a conforming decoder be able to perform concealment for the coding tree blocks or video packets for which all the coded data has not been received.

4.5.5 Static tests for output order conformance

Static tests of a video decoder require testing of the decoded samples. This clause explains how this test can be accomplished when the decoded samples at the output of the decoding process are available. It may not be possible to perform this type of test with a production decoder (due to the lack of an appropriate accessible interface in the design at which to perform the test). In that case this test should be performed by the manufacturer during the design and development phase. Static tests are used for testing the decoding process. The test will check that the values of the samples decoded by the decoder under test shall be identical to the values of the samples decoded by the reference decoder. When a hash of the values of the samples of the decoded pictures is attached to the bitstream file, a corresponding hash operation performed on the values of the samples of the decoded pictures produced by the decoder under test shall produce the same results.

4.5.6 Dynamic tests for output timing conformance

Dynamic tests are applied to check that all the decoded samples are output and that the timing of the output of the decoder's decoded samples conforms to the specification of Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, Clause 8 and Annex C, and to verify that the HRD models (as specified by the CPB and DPB specification in Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, Annex C) are not violated when the bits of the bitstream are delivered at the proper rate.

The dynamic test is often easier to perform on a complete decoding system, which may include a systems decoder, a video decoder and a display process. It may be possible to record the output of the display process and to check that display order and timing of decoded pictures are correct at the output of the display process. However, since the display process is not within the normative scope of Rec. ITU-T H.265 | ISO/IEC 23008-2, there may be cases where the output of the display process differs in timing or value even though the video decoder is conforming. In this case, the output of the video decoder itself (before the display process) would need to be captured in order to perform the dynamic tests on the video decoder. In particular the output order and timing of the decoded pictures shall be correct.

If buffering period and picture timing SEI messages are included in the test bitstream, HRD conformance shall be verified using the values of nal_initial_cpb_removal_delay, nal_initial_cpb_removal_offset, au_cpb_removal_delay_minus1 and pic_dpb_output_delay that are included in the bitstream.

If buffering period and picture timing SEI messages are not included in the bitstream, the following inferences shall be made to generate the missing parameters:

— fixed_pic_rate_within_cvs_flag shall be inferred to be equal to 1;

— low_delay_hrd_flag shall be inferred to be equal to 0;

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— cbr_flag shall be inferred to be equal to 0;

— The frame rate of the bitstream shall be inferred to be equal to the frame rate value specified in the corresponding table of subclause 6.7, where the bitstream is listed. If this is missing, then a frame rate of either 25 or 30 000 ÷ 1 001 can be inferred;

— vui_time_scale shall be set equal to 90 000 and the value of vui_num_units_in_tick shall be computed based on frame rate;

— The bit rate of the bitstream shall be inferred to be equal to the maximum value for the level specified in Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, Table A-1;

— CPB and DPB sizes shall be inferred to be equal to the maximum value for the level specified in Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, Table A-1.

With the above inferences, the HRD shall be operated as follows.

— The CPB is filled starting at time t = 0, until it is full, before removal of the first access unit. This means that the nal_initial_cpb_removal_delay shall be inferred to be equal to the total CPB buffer size divided by the bit rate divided by 90 000 (rounded downwards) and nal_initial_cpb_removal_offset shall be inferred to be equal to zero.

— The first access unit is removed at time t = nal_initial_cpb_removal_delay ÷ 90 000 and subsequent access units are removed at intervals based on the frame distance, i.e. (90 000 ÷ vui_num_units_in_tick).

— Using these inferences, the CPB will not overflow or underflow and the DPB will not overflow.

4.5.7 Decoder conformance test of a particular profile, tier, and level

In order for a decoder of a particular profile, tier, and level to claim output order conformance to Rec. ITU-T H.265 | ISO/IEC 23008-2 as specified by this document, the decoder shall successfully pass the static test specified in subclause 6.5.5 with all the bitstreams of the normative test suite specified for testing decoders of this particular profile, tier, and level combination.

In order for a decoder of a particular profile, tier, and level to claim output timing conformance to Rec. ITU-T H.265 | ISO/IEC 23008-2 as specified by this document, the decoder shall successfully pass both the static test specified in subclause 6.5.5 and the dynamic test specified in subclause 6.5.6 with all the bitstreams of the normative test suite specified for testing decoders of this particular profile, tier, and level. Tables 1 through 6 specify the normative test suites for each profile, tier, and level combination. The test suite for a particular profile, tier, and level combination is the list of bitstreams that are marked with an 'X' in the column corresponding to that profile, tier, and level combination. In the column 'Main tier', 'X' indicates the bitstream is for Main tier. A decoder conformed to Main tier shall be capable of decoding the specified bitstreams, among the testing profile-level combination, indicated by 'X' at 'Main tier' column in Table 1. A decoder conformed to High tier shall be capable of decoding all the specified bitstreams, among the testing profile-level combination, in Table 1.

'X' indicates that the bitstream is designed to test both the dynamic and static conformance of the decoder.

The bitstream column specifies the bitstream used for each test.

A decoder that conforms to the Main profile, Main Still Picture profile, or Main 10 profile at a specific level shall be capable of decoding the specified bitstreams in Table 1.

A decoder that conforms to the Multiview Main profile at specific level shall be capable of decoding the specified bitstreams in Table 2. In addition to the bitstreams defined in Table 3, a decoder that conforms to the Multiview Main profile shall be capable of decoding the Main profile bitstreams specified in Table 1.

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A decoder that conforms to the 3D Main profile (as specified in Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, Clause I.11) at specific level shall be capable of decoding the specified bitstreams in Table 3. In addition to the bitstreams defined in Table 3, a decoder that conforms to the 3D Main profile shall be capable of decoding the Multiview Main profile bitstreams specified in Table 2.

A decoder that conforms to the Monochrome, Monochrome 12, Monochrome 16, Main 12, Main 4:2:2 10, Main 4:2:2 12, Main 4:4:4, Main 4:4:4 10, Main 4:4:4 12, Main Intra, Main 10 Intra, Main 12 Intra, Main 4:2:2 10 Intra, Main 4:2:2 12 Intra, Main 4:4:4 Intra, Main 4:4:4 10 Intra, Main 4:4:4 12 Intra, Main 4:4:4 16 Intra, Main 4:4:4 Still Picture, or Main 4:4:4 16 Still Picture profile (as specified in Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, A.3.5), which are collectively referred to as the format range extensions profiles, shall be capable of decoding the specified bitstreams in Table 4. A decoder that conforms to some format range extensions profiles is also required to be capable of decoding bitstreams that conform to particular other profiles. Thus, in addition to the specified bitstreams in Table 4, a decoder that conforms to a format range extensions profile shall also be capable of decoding the bitstreams specified in Table 1 that conform to the decoding requirements specified for the format range extensions profile in Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, A.3.5.

A decoder that conforms to the High Throughput 4:4:4 16 Intra profile (as specified in Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, A.3.6) at specific level shall be capable of decoding the specified bitstreams in Table 4.

A decoder that conforms to a list of profile, tier, level, INBLD capability quadruplets such that one of the quadruplets corresponds to a profile indication of Scalable Main or Scalable Main 10 profile (as specified in Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, H.11.1.1) at specific level, shall be capable of decoding the specified bitstreams in Table 5. A decoder that conforms to a list of profile, tier, level, INBLD capability quadruplets such that one of the quadruplets corresponds to a profile indication of Scalable Main or Scalable Main 10 profile at specific level shall also be capable of decoding the specified bitstreams in Table 1.

A decoder that conforms to a list of profile, tier, level, INBLD capability quadruplets such that one of the quadruplets corresponds to a profile indication of Scalable Monochrome, Scalable Monochrome 12, Scalable Monochrome 16 or Scalable Main 4:4:4 (as specified in Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, H.11.1.2, collectively referred to as scalable format range extension profiles) at specific level, shall be capable of decoding the specified bitstreams in Table 6. A decoder that conforms to a list of profile, tier, level, INBLD capability quadruplets such that one of the quadruplets corresponds to a scalable format range extension profile is also required to be capable of decoding bitstreams that conform to particular other profiles. Thus, in addition to the specified bitstreams in Table 6, a decoder that conforms to a list of profile, tier, level, INBLD capability quadruplets such that one of the quadruplets corresponds to a scalable format range extension profile shall also be capable of decoding the bitstreams specified in Table 1 and Table 5 that conform to the decoding requirements specified for the scalable format range extensions profile in Rec. ITU-T H.265 | ISO/IEC 23008-2:2017, H.11.1.2.

4.6 Specification of the test bitstreams

4.6.1 General

Some characteristics of each bitstream listed in Table 1 are specified in this clause. In Table 1, the value "29.97" shall be interpreted as an approximation of an exact value of 30 000 ÷ 1 001 and the value "59.94" shall be interpreted as an approximation of an exact value of 60 000 ÷ 1 001.

4.6.2 Test bitstreams — Block structure

4.6.2.1 Test bitstreams #STRUCT_A

Specification: All slices are coded as I, P or B slices. Each picture contains one slice. Various CTU and maximum CU sizes are used.

Functional stage: Test the reconstruction process of slices.

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Purpose: Check that the decoder can properly decode I, P and B slices with various CTU and maximum CU sizes.

4.6.2.2 Test bitstreams #STRUCT_B

Specification: All slices are coded as I, P or B slices. Each picture contains one slice. Various CTU and minimum CU sizes are used.

Functional stage: Test the reconstruction process of slices.

Purpose: Check that the decoder can properly decode I, P and B slices with various CTU and minimum CU sizes.

4.6.3 Test bitstreams — Intra coding

4.6.3.1 Test bitstreams #IPRED_A, #IPRED_B, and #IPRED_C

Specification: All slices are coded as I slices. Each picture contains one slice. All intra prediction modes (35 modes for each of luma 32x32, luma 16x16, luma 8x8, luma 4x4, chroma 16x16, chroma 8x8 and chroma 4x4, for a total 245 modes) are used. The IPRED_B bitstream contains only one picture, and conforms to the Main Still Picture profile.

Functional stage: Test the reconstruction process of I slices.

Purpose: Check that the decoder can properly decode I slices with all intra prediction modes.

4.6.3.2 Test bitstreams #CIP_A

Specification: The bitstream contains one I slice and one B slice, using one slice per picture. Both SAO and the deblocking filter are disabled.

Functional stage: Test the reference sample substitution process for intra sample prediction.

Purpose: Check that the decoder can properly decode slices of coded pictures containing intra TUs with unavailable samples for intra prediction.

4.6.3.3 Test bitstreams #CIP_B

Specification: The bitstream contains an I-picture and 4 P-pictures. Each picture contains only one slice. constrained_intra_pred_flag is equal to 1.

Functional stage: Test the reference sample substitution process for intra sample prediction.

Purpose: Check that the decoder can properly decode slices of coded pictures containing intra TUs with unavailable samples for intra prediction.

4.6.3.4 Test bitstreams #CIP_C

Specification: The bitstream contains one I slice and one B slice, using more than one slice per picture. Both SAO and the deblocking filter are disabled.

Functional stage: Test the reference sample substitution process for intra sample prediction.

Purpose: Check that the decoder can properly decode slices of coded pictures containing intra TUs with unavailable samples for intra prediction.

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4.6.4 Test bitstreams — Inter frame coding

4.6.4.1 Test bitstreams #MERGE_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. five_minus_max_num_merge_cand is set equal to 4.

Functional stage: Test the reconstruction process of motion vector prediction.

Purpose: Check that the decoder can properly decode with the maximum number of merging candidates equal to any value permitted by the standard (i.e. 1, 2, 3, 4, 5).

4.6.4.2 Test bitstreams #MERGE_B

Specification: All slices are coded as I or B slices. Each picture contains only one slice. five_minus_max_num_merge_cand is set equal to 3.

Functional stage: Test the reconstruction process of motion vector prediction.

Purpose: Check that the decoder can properly decode with the maximum number of merging candidates equal to any value permitted by the standard (i.e. 1, 2, 3, 4, 5).

4.6.4.3 Test bitstreams #MERGE_C

Specification: All slices are coded as I or B slices. Each picture contains only one slice. five_minus_max_num_merge_cand is set equal to 2.

Functional stage: Test the reconstruction process of motion vector prediction.

Purpose: Check that the decoder can properly decode with the maximum number of merging candidates equal to any value permitted by the standard (i.e. 1, 2, 3, 4, 5).

4.6.4.4 Test bitstreams #MERGE_D

Specification: All slices are coded as I or B slices. Each picture contains only one slice. five_minus_max_num_merge_cand is set equal to 1.

Functional stage: Test the reconstruction process of motion vector prediction.

Purpose: Check that the decoder can properly decode with the maximum number of merging candidates equal to any value permitted by the standard (i.e. 1, 2, 3, 4, 5).

4.6.4.5 Test bitstreams #MERGE_E

Specification: All slices are coded as I or B slices. Each picture contains only one slice. five_minus_max_num_merge_cand is set equal to 0.

Functional stage: Test the reconstruction process of motion vector prediction.

Purpose: Check that the decoder can properly decode with the maximum number of merging candidates equal to any value permitted by the standard (i.e. 1, 2, 3, 4, 5).

4.6.4.6 Test bitstreams #MERGE_F

Specification: All slices are coded as I or B slices. Each picture contains only one slice. sps_temporal_mvp_enabled_flag is equal to 0 and five_minus_max_num_merge_cand is equal to 0.

Functional stage: Test the reconstruction process of motion vector prediction.

Purpose: Check that the decoder can properly decode when the temporal merging candidate is not included in the merge candidate set.

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4.6.4.7 Test bitstreams #MERGE_G

Specification: All slices are coded as I or B slices. Each picture contains only one slice. five_minus_max_num_merge_cand is set equal to 0.

Functional stage: Test the reconstruction process of motion vector prediction.

Purpose: Check that the decoder can properly decode with merge index ranging from 0 to 4.

4.6.4.8 Test bitstreams #PMERGE_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. log2_parallel_merge_level_minus2 is set equal to 0.

Functional stage: Test the reconstruction process of motion vector prediction.

Purpose: Check that the decoder can properly decode parallel merge level values permitted by the standard (i.e. 2, 3, 4, 5, 6 for luma CTB size 64x64).

4.6.4.9 Test bitstreams #PMERGE_B

Specification: All slices are coded as I or B slices. Each picture contains only one slice. log2_parallel_merge_level_minus2 is set equal to 1.

Functional stage: Test the reconstruction process of motion vector prediction.

Purpose: Check that the decoder can properly decode parallel merge level values permitted by the standard (i.e. 2, 3, 4, 5, 6 for luma CTB size 64x64).

4.6.4.10 Test bitstreams #PMERGE_C

Specification: All slices are coded as I or B slices. Each picture contains only one slice. log2_parallel_merge_level_minus2 is set equal to 2.

Functional stage: Test the reconstruction process of motion vector prediction.

Purpose: Check that the decoder can properly decode the parallel merge level values permitted by the standard (i.e. 2, 3, 4, 5, 6 for luma CTB size 64x64).

4.6.4.11 Test bitstreams #PMERGE_D

Specification: All slices are coded as I or B slices. Each picture contains only one slice. log2_parallel_merge_level_minus2 is set equal to 3.

Functional stage: Test the reconstruction process of motion vector prediction.

Purpose: Check that the decoder can properly decode the parallel merge level values permitted by the standard (i.e. 2, 3, 4, 5, 6 for luma CTB size 64x64).

4.6.4.12 Test bitstreams #PMERGE_E

Specification: All slices are coded as I or B slices. Each picture contains only one slice. log2_parallel_merge_level_minus2 is set equal to 4.

Functional stage: Test the reconstruction process of motion vector prediction.

Purpose: Check that the decoder can properly decode the parallel merge level values permitted by the standard (i.e. 2, 3, 4, 5, 6 for luma CTB size 64x64).

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4.6.4.13 Test bitstreams #AMVP_A

Specification: All slices are coded as I or P slices. Each picture contains only one slice. num_ref_idx_l0_default_active_minus1 is equal to 0, num_ref_idx_l1_default_active_minus1 is equal to 0 and num_ref_idx_active_override_flag is equal to 0.

Functional stage: Test the reconstruction process of motion vector prediction.

Purpose: Check that the decoder can properly decode when motion vector scaling is not needed for spatial motion vector prediction candidate generation (all inter-coded PUs within the same slice have the same inter_pred_idc and ref_idx_l0).

4.6.4.14 Test bitstreams #AMVP_B

Specification: All slices are coded as I or B slices. Each picture contains only one slice. Multiple reference pictures are used. For some slices, num_ref_idx_l0_default_active_minus1 is equal to 3 and num_ref_idx_active_override_flag is equal to 0. For other B slices, num_ref_idx_l0_default_active_minus1 is equal to 1, num_ref_idx_l1_default_active_minus1 is equal to 1 and num_ref_idx_active_override_flag is equal to 0.

Functional stage: Test the reconstruction process of motion vector prediction.

Purpose: Check that the decoder can properly decode when motion vector scaling is not needed for spatial motion vector prediction candidate generation.

4.6.4.15 Test bitstreams #AMVP_C

Specification: All slices are coded as I or P slices. Each picture contains only one slice.

Functional stage: Test the reconstruction process of motion vector prediction, specifically, motion vector prediction during the low delay condition.

Purpose: Check that the decoder can properly decode when motion vector scaling is not needed for spatial motion vector prediction candidate generation.

4.6.4.16 Test bitstreams #TMVP_A

Specification: Each picture contains only one slice. slice_temporal_mvp_enabled_flag is set equal to 0 for pictures 0 to 8 and 1 for pictures 9 to 16.

Functional stage: Test the reconstruction process of motion vector prediction.

Purpose: Check that the decoder can properly decode for different slice_temporal_mvp_enabled_flag values.

4.6.4.17 Test bitstreams #MVDL1ZERO_A

Specification: The bitstream contains multiple B slices per picture. Randomized on and off switching of the mvd_l1_zero_flag is included for multiple B slices.

Functional stage: Test the reconstruction process of motion vector prediction.

Purpose: Check that the decoder can properly decode when the parsing of list 1 motion vector difference for bi-prediction varies according to values of mvd_l1_zero_flag.

4.6.4.18 Test bitstreams #MVCLIP_A

Specification: Each picture contains only one slice. Motion vector prediction and merge candidate motion vectors are clipped to 16-bit values. Clipped motion vector prediction and merge candidates are selected.

Functional stage: Test the reconstruction process of motion vector prediction.

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Purpose: Check that the decoder can properly decode when clipping of motion vector prediction and merge candidate motion vectors to 16-bit values occurs.

4.6.4.19 Test bitstreams #MVEDGE_A

Specification: Each picture contains only one slice. The bitstream includes motion vectors pointing to the padded edge regions in a picture.

Functional stage: Test the reconstruction process of motion vector prediction.

Purpose: Check that the decoder can properly decode motion vectors pointing to the padded edge regions of a picture.

4.6.4.20 Test bitstreams #WP_A

Specification: All slices are coded as I or P slices. Each picture contains only one slice. weighted_pred_flag is equal to 1. Plural reference indices are assigned to each reference picture.

Functional stage: Weighted sample prediction process for P slices with plural reference indices.

Purpose: Check that the decoder can properly decode weighted sample prediction for P slices with plural reference indices.

4.6.4.21 Test bitstreams #WP_B

Specification: All slices are coded as I, P or B slices. Each picture contains only one slice. weighted_pred_flag is equal to 1 and weighted_bipred_flag is equal to 1. Plural reference indices are assigned to each reference picture.

Functional stage: Weighted sample prediction process for P and B slices with plural reference indices.

Purpose: Check that the decoder can properly decode weighted sample prediction for P and B slices with plural reference indices.

4.6.5 Test bitstreams — Transform and quantization

4.6.5.1 Test bitstreams #RQT_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. max_transform_hierarchy_depth_inter and max_transform_hierarchy_depth_intra are both set equal to 0.

Functional stage: Test the reconstruction process of slices with residual quadtree.

Purpose: Check that the decoder can properly decode slices with residual quadtree with intra and inter depth equal to 0.

4.6.5.2 Test bitstreams #RQT_B

Specification: All slices are coded as I or B slices. Each picture contains only one slice. max_transform_hierarchy_depth_inter and max_transform_hierarchy_depth_intra are both set equal to 1.

Functional stage: Test the reconstruction process of slices with residual quadtree.

Purpose: Check that the decoder properly decodes slices with residual quadtree with intra and inter depth equal to 1.

4.6.5.3 Test bitstreams #RQT_C

Specification: All slices are coded as I or B slices. Each picture contains only one slice. max_transform_hierarchy_depth_inter and max_transform_hierarchy_depth_intra are both set equal to 2.

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Functional stage: Test the reconstruction process of slices with residual quadtree.

Purpose: Check that the decoder properly decodes slices with residual quadtree with intra and inter depth equal to 2.

4.6.5.4 Test bitstreams #RQT_D

Specification: All slices are coded as I or B slices. Each picture contains only one slice. max_transform_hierarchy_depth_inter and max_transform_hierarchy_depth_intra are both set equal to 3.

Functional stage: Test the reconstruction process of slices with residual quadtree.

Purpose: Check that the decoder properly decodes slices with residual quadtree with intra and inter depth equal to 3.

4.6.5.5 Test bitstreams #RQT_E

Specification: All slices are coded as I or B slices. Each picture contains only one slice. max_transform_hierarchy_depth_inter and max_transform_hierarchy_depth_intra are both set equal to 4.

Functional stage: Test the reconstruction process of slices with residual quadtree.

Purpose: Check that the decoder properly decodes slices with residual quadtree with intra and inter depth equal to 4.

4.6.5.6 Test bitstreams #RQT_F

Specification: All slices are coded as I or B slices. Each picture contains only one slice. max_transform_hierarchy_depth_inter is set equal to 2 and max_transform_hierarchy_depth_intra is set equal to 0.

Functional stage: Test the reconstruction process of slices with residual quadtree.

Purpose: Check that the decoder properly decodes slices with residual quadtree with different intra and inter depths.

4.6.5.7 Test bitstreams #RQT_G

Specification: All slices are coded as I or B slices. Each picture contains only one slice. max_transform_hierarchy_depth_inter is set equal to 0 and max_transform_hierarchy_depth_intra is set equal to 2.

Functional stage: Test the reconstruction process of slices with residual quadtree.

Purpose: Check that the decoder properly decodes slices with residual quadtree with different intra and inter depths.

4.6.5.8 Test bitstreams #TUSIZE_A

Specification: All slices are coded as I or P slices. Each picture contains only one slice. log2_min_luma_transform_block_size_minus2 is set equal to 2. The maximum luma CB size is 64x64, the minimum luma CB size is 32x32, the minimum transform size for luma is 16x16 and for chroma is 8x8.

Functional stage: Test the reconstruction process of slices with limited minimum transform size.

Purpose: Check that the decoder properly decodes slices with residual quadtree with minimum transform size that are not the default 4x4.

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4.6.5.9 Test bitstreams #DELTAQP_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. The maximum luma CB size is equal to 64x64 and the minimum luma CB size is equal to 8x8. diff_cu_qp_delta_depth is set randomly to values in the range of 0 to 3. CuQpDeltaVal is set randomly from –26 to 25.

Functional stage: Test the reconstruction process of slices with nonzero values of CuQpDeltaVal.

Purpose: Check that the decoder properly decodes slices with different values of CuQpDeltaVal.

4.6.5.10 Test bitstreams #DELTAQP_B

Specification: All slices are coded as I, P or B slices. Each picture contains more than one slice. The maximum luma CB size is equal to 64x64 and the minimum luma CB size is equal to 8x8. CuQpDeltaVal is set randomly from –26 to 25. slice_cb_qp_offset and slice_cr_qp_offset are set randomly from –4 to 4.

Functional stage: Test the reconstruction process of slices with nonzero values of CuQpDeltaVal.

Purpose: Check that the decoder properly handles various combination of chroma QP offset.

4.6.5.11 Test bitstreams #DELTAQP_C

Specification: All slices are coded as I or B slices. Each picture contains only one slice. The maximum luma CB size is equal to 64x64 and the minimum luma CB size is equal to 8x8. diff_cu_qp_delta_depth is set randomly to values in the range of 0 to 3. CuQpDeltaVal is set randomly from –26 to 25. In some TUs, the cbfLuma or cbfChroma is equal to 0.

Functional stage: Test the reconstruction process of slices with nonzero values of CuQpDeltaVal.

Purpose: Check that the decoder properly decodes slices with different values of CuQpDeltaVal.

4.6.5.12 Test bitstreams #INITQP_A

Specification: All slices are coded as I or B slices. The value of init_qp_minus26 is set from –26 to 25.

Functional stage: Test QP initialization based on init_qp_minus26.

Purpose: Check that the decoder properly decodes different init_qp_minus26 values.

4.6.5.13 Test bitstreams #SLIST_A

Specification: All slices are coded as I or B slices. Each picture contains one slice. One SPS and more than one PPS are included. The SPS includes scaling list data. One of the PPSs does not include scaling list data. In other PPSs, different scaling lists data is included. In each picture, the PPS is overriden. scaling_list_enabled_flag is set equal to 1.

Functional stage: Test the reconstruction process of scaling list. Tests switching of scaling list data in SPS and PPS.

Purpose: Check that the decoder properly decodes slices of coded frames with scaling list, with different coding modes of the scaling list, when no scaling list is included in the PPS and when scaling list data is included in the PPS.

4.6.5.14 Test bitstreams #SLIST_B

Specification: All slices are coded as I or B slices. Each picture contains one slice. More than one SPS and more than one PPS are included. One of the SPSs does not include scaling list data. One of the PPSs does not include scaling list data. In other SPSs and PPSs, different scaling lists data is included. In each picture, the PPS is overriden. scaling_list_enabled_flag is set equal to 0 or 1.

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Functional stage: Test the reconstruction process of scaling list. Tests switching of scaling list off, default scaling list and scaling list in parameter sets.

Purpose: Check that the decoder can properly decode slices of coded frames with scaling list, different coding modes of the scaling list and when there are multiple SPSs and PPSs.

4.6.5.15 Test bitstreams #SLIST_C

Specification: All slices are coded as I or B slices. Each picture contains one slice. One SPS and more than one PPS are included. The SPS does not include scaling list data. One of the PPSs does not include scaling list data. In other PPSs, different scaling lists data is included. In each picture, the PPS is overriden. scaling_list_enabled_flag is set equal to 1.

Functional stage: Test the reconstruction process of scaling list. Tests switching of default scaling list and scaling list in PPS.

Purpose: Check that the decoder can properly decode slices of coded frames with scaling list, different coding modes of the scaling list, when no scaling list data is present and switching of default scaling list and scaling list data in PPS occurs.

4.6.5.16 Test bitstreams #SLIST_D

Specification: All slices are coded as I or B slices. Each picture contains more than one slice. More than one SPS and more than one PPS are included. One of the SPSs does not include scaling list data. One of the PPSs does not include scaling list data. In other SPSs and PPSs, different scaling lists data is included. In each picture, the PPS is override. scaling_list_enabled_flag is set equal to 0 or 1.

Functional stage: Test the reconstruction process of scaling list. Tests switching of scaling list off, default scaling list and scaling list in parameter sets.

Purpose: Check that the decoder can properly decode slices of coded frames with scaling list, different coding modes of scaling list and when there are multiple SPSs and PPSs.

4.6.6 Test bitstreams — Deblocking filter

4.6.6.1 Test bitstreams #DBLK_A

Specification: All slices are coded as I, P or B slices. Each picture contains more than one slice. More than one PPS is used. QP is set randomly to values in the range of 22 to 51. pps_beta_offset_div2 is randomly set in each picture from −6 to 6. slice_beta_offset_div2 and slice_tc_offset_div2 are randomly set in each slice from −6 to 6.

Functional stage: Test the deblocking filter process.

Purpose: Check that the decoder can properly decode slices with various combinations of deblocking filter control parameters.

4.6.6.2 Test bitstreams #DBLK_B

Specification: All slices are coded as I, P or B slices. Each picture contains more than one slice. More than one PPS is used. pps_cb_qp_offset and pps_cr_qp_offset are randomly set to values in the range from −12 to 12. slice_cb_qp_offset and slice_cr_qp_offset are randomly set from −4 to 4.

Functional stage: Test the deblocking filter process.

Purpose: Check that the decoder can properly decode when the deblocking filter varies according to various combinations of QP.

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4.6.6.3 Test bitstreams #DBLK_C

Specification: All slices are coded as I, P or B slices. Each picture contains more than one slice. pps_deblocking_filter_disabled_flag is set equal to 0. slice_deblocking_filter_disabled_flag is randomly set equal to 0 or 1.

Functional stage: Test the deblocking filter process.

Purpose: Check that the decoder can properly decode with the deblocking filter being enabled and disabled across slices.

4.6.6.4 Test bitstreams #DBLK_D

Specification: All slices are coded as I or B slices. Each picture contains more than one slice and tile. slice_loop_filter_across_slices_enabled_flag is set equal to 0 and loop_filter_across_tiles_enabled_flag is set equal to 1.

Functional stage: Test the deblocking filter process.

Purpose: Check that the decoder can properly decode with the deblocking filter being enabled and disabled at slice and tile boundaries.

4.6.6.5 Test bitstreams #DBLK_E

Specification: All slices are coded as I or B slices. Each picture contains more than one slice and tile. slice_loop_filter_across_slices_enabled_flag is set equal to 1 and loop_filter_across_tiles_enabled_flag is set equal to 0.

Functional stage: Test the deblocking filter process.

Purpose: Check that the decoder can properly decode with the deblocking filter being enabled and disabled at slice and tile boundaries.

4.6.6.6 Test bitstreams #DBLK_F

Specification: All slices are coded as I or B slices. Each picture contains more than one slice and tile. slice_loop_filter_across_slices_enabled_flag is set equal to 0 and loop_filter_across_tiles_enabled_flag is set equal to 1.

Functional stage: Test the deblocking filter process.

Purpose: Check that the decoder can properly decode with the deblocking filter being enabled and disabled at slice and tile boundaries.

4.6.6.7 Test bitstreams #DBLK_G

Specification: All slices are coded as I or B slices. Each picture contains more than one slice and tile. slice_loop_filter_across_slices_enabled_flag is set equal to 1 and loop_filter_across_tiles_enabled_flag is set equal to 0.

Functional stage: Test the deblocking filter process.

Purpose: Check that the decoder can properly decode with the deblocking filter being enabled and disabled at slice and tile boundaries.

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4.6.7 Test bitstreams — Sample adaptive offset

4.6.7.1 Test bitstreams #SAO_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. sao_merge_left_flag and sao_merge_up_flag are randomly set equal to 0 or 1.

Functional stage: Test the reconstruction process of sample adaptive offset.

Purpose: Check that the decoder can properly decode withrandom SAO merge left/up flag values.

4.6.7.2 Test bitstreams #SAO_B

Specification: All slices are coded as I or B slices. Each picture contains only one slice and contains more than one tile. slice_sao_luma_flag and slice_sao_chroma_flag are randomly set equal to 0 or 1.

Functional stage: Test the reconstruction process of sample adaptive offset.

Purpose: Check that the decoder can properly decode with tiles and randomly enabled SAO for luma and/or SAO for chroma per slice.

4.6.7.3 Test bitstreams #SAO_C

Specification: All slices are coded as I or P slices. Each picture contains only one slice. All SAO offset values in this bitstream have maximum allowed magnitude 7 and random sign.

Functional stage: Test the reconstruction process of sample adaptive offset.

Purpose: Check that the decoder can properly decode with maximum SAO offset values.

4.6.7.4 Test bitstreams #SAO_D

Specification: All slices are coded as I or P slices. Each picture contains only one slice. SAO offset values in this bitstream have random values in the range –7..7.

Functional stage: Test the reconstruction process of sample adaptive offset.

Purpose: Check that the decoder can properly decode with random SAO offset values.

4.6.7.5 Test bitstreams #SAO_E

Specification: All slices are coded as I or B slices. Each picture contains only one slice. A set of SAO parameters is associated with each CTB for all frames, therefore no SAO merge flags (up or left) are used. Only the band offset SAO type is used and the four SAO offset values are set equal to –7 or 7 in a random way. The luma CTB size is set equal to 16x16.

Functional stage: Tests loading of maximum SAO information at CTB level and frame.

Purpose: Check that the decoder can properly decode with the maximum possible SAO information.

4.6.7.6 Test bitstreams #SAO_F

Specification: All slices are coded as I or B slices. Each picture contains only one slice. A set of SAO parameters is associated to each CTB for all frames, therefore, no SAO merge flags (up or left) are used. Only the band offset SAO type is used and the four SAO offset values are set equal to –7 or 7 in a random way. The luma CTB size is set equal to 32x32.

Functional stage: Tests loading of maximum SAO information at CTB level and frame.

Purpose: Check that the decoder can properly decode with the maximum possible SAO information.

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4.6.7.7 Test bitstreams #SAO_G

Specification: All slices are coded as I or B slices. Each picture contains only one slice. A set of SAO parameters is associated to each CTB for all frames, therefore, no SAO merge flags (up or left) are used. Only the band offset SAO type is used and the four SAO offset values are set equal to –7 or 7 in a random way. The luma CTB size is set equal to 64x64.

Functional stage: Tests loading of maximum SAO information at CTB level and frame.

Purpose: Check that the decoder can properly decode with the maximum possible SAO information.

4.6.7.8 Test bitstreams #SAO_H

Specification: All slices are coded as I slices. Each picture contains multiple slices. SAO edge modes 2 and 3 are used (diagonal). slice_loop_filter_across_slices_enabled_flag is set to 0.

Functional stage: Test the SAO decoding process with different diagonal neighbour availability.

Purpose: Check that, when slice_loop_filter_across_slices_enabled_flag is set to zero, the decoder can properly apply the SAO filter in CTU corners regardless of whether diagonally neighbouring CTUs are available or not.

4.6.7.9 Test bitstreams # SAODBLK_A

Specification: All slices are coded as I or P slices. Each picture contains only one slice. The bitstream includes 1) non-rectangular shaped slices and 2) the minimum size of a CTU is used, which for chroma planes takes the value of 8x8 and exactly coincides with a block that is used for deblocking.

Functional stage: Test the SAO decoding process with various coding parameter settings.

Purpose: Check that that the decoder can properly decode loop filtering on slice boundaries.

4.6.7.10 Test bitstreams # SAODBLK_B

Specification: All slices are coded as I or P slices. Each picture contains both tiles and slices. The bitstream includes 1) non-rectangular shaped slices and 2) the minimum size of a CTU is used, which for chroma planes takes the value of 8x8 and exactly coincides with a block that is used for deblocking.

Functional stage: Test the SAO decoding process with various coding parameter settings.

Purpose: Check that that the decoder can properly decode loop filtering on slice boundaries.

4.6.8 Test bitstreams — Entropy coding

4.6.8.1 Test bitstreams #MAXBINS_A

Specification: All slices are coded as I slices. Each picture contains only one slice. The number of bins per CTU is constructed to be within 95% of the maximum number which is 4096 bits per CTU with luma CTB size 16x16. pcm_enabled_flag is set equal to 1.

Functional stage: Test the parsing process.

Purpose: Check that the decoder can properly decode slices with the maximum number of bins per CTU.

4.6.8.2 Test bitstreams #MAXBINS_B

Specification: All slices are coded as I or B slices. Each picture contains only one slice. The number of bins per CTU is constructed to be within 95% of the maximum number which is 4096 bits per CTU with luma CTB size 16x16. pcm_enabled_flag is set equal to 1.

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Functional stage: Test the parsing process.

Purpose: Check that the decoder can properly decode slices with the maximum number of bins per CTU.

4.6.8.3 Test bitstreams #MAXBINS_C

Specification: All slices are coded as I or B slices. Each picture contains only one slice. The number of bins per CTU is constructed to be within 95% of the maximum number which is 4096 bits per CTU with luma CTB size 16x16. pcm_enabled_flag is set equal to 1.

Functional stage: Test the parsing process.

Purpose: Check that the decoder can properly decode slices with the maximum number of bins per CTU.

4.6.8.4 Test bitstreams #CAINIT_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. There is one PPS. cabac_init_present_flag is equal to 0 in PPS.

Functional stage: Test the parsing process.

Purpose: Check that the decoder properly decodes when cabac_init_flag is not signalled in the slice header of P or B slices.

4.6.8.5 Test bitstreams #CAINIT_B

Specification: All slices are coded as I or B slices. Each picture contains only one slice. There is one PPS. cabac_init_present_flag is equal to 1 in PPS. cabac_init_flag is signalled for B slices in the slice header referring the PPS. cabac_init_flag can take on values 0 or 1.

Functional stage: Test the parsing process.

Purpose: Check that the decoder properly decodes with different cabac_init_flag values in B slices.

4.6.8.6 Test bitstreams #CAINIT_C

Specification: All slices are coded as I or P slices. Each picture contains only one slice. There is one PPS. cabac_init_present_flag is equal to 1 in PPS. cabac_init_flag is signalled for P slices in the slice header referring the PPS. cabac_init_flag can take on values 0 or 1.

Functional stage: Test the parsing process.

Purpose: Check that the decoder properly decodes with different cabac_init_flag values in P slices.

4.6.8.7 Test bitstreams #CAINIT_D

Specification: All slices are coded as I or B slices which are uni-directionally predicted. Each picture contains only one slice. There is one PPS. cabac_init_present_flag is equal to 1 in PPS. cabac_init_flag is signalled for B slices in the slice header referring the PPS. cabac_init_flag can take on values 0 or 1.

Functional stage: Test the parsing process.

Purpose: Check that the decoder properly decodes with different cabac_init_flag values in P slices.

4.6.8.8 Test bitstreams #CAINIT_E

Specification: All slices are coded as I or P slices. Each picture contains only one slice. Each slice contains four tiles (two columns of tiles and two rows of tiles with uniform spacing). There is one PPS. cabac_init_present_flag is equal to 1 in PPS. cabac_init_flag is signalled for P slices in the slice header referring the PPS. cabac_init_flag can take on values 0 or 1.

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Functional stage: Test the parsing process.

Purpose: Check that the decoder properly decodes when cabac_init_flag is switched in P slices with the use of tiles.

4.6.8.9 Test bitstreams #CAINIT_F

Specification: All slices are coded as I or uni-directionally predicted B slices. Each picture contains only one slice. Each slice contains four tiles (two columns of tiles and two rows of tiles with uniform spacing). There is one PPS. cabac_init_present_flag is equal to 1 in PPS. cabac_init_flag is signalled for uni-directionally predicted B slices in the slice header referring the PPS. cabac_init_flag can take on values 0 or 1.

Functional stage: Test the parsing process.

Purpose: Check that the decoder properly decodes when cabac_init_flag is switched in B slices with the use of tiles.

4.6.8.10 Test bitstreams #CAINIT_G

Specification: All slices are coded as I or P slices. Each picture contains only one slice. Each slice contains multiple dependent slice segments. Each dependent slice contains three CTUs or less. There is one PPS. cabac_init_present_flag is equal to 1 in PPS. cabac_init_flag is signalled for P slices in the slice header referring the PPS. cabac_init_flag can take on values 0 or 1.

Functional stage: Test the parsing process.

Purpose: Check that the decoder properly decodes when cabac_init_flag is switched in P slices with dependent slice segments.

4.6.8.11 Test bitstreams #CAINIT_H

Specification: All slices are coded as I or uni-directionally predicted B slices. Each picture contains only one slice. Each slice contains multiple dependent slice segments. Each dependent slice contains three CTUs or less. There is one PPS. cabac_init_present_flag is equal to 1 in PPS. cabac_init_flag is signalled for uni-directionally predicted B slices in the slice header referring the PPS. cabac_init_flag can take on values 0 or 1.

Functional stage: Test the parsing process.

Purpose: Check that the decoder properly decodes when cabac_init_flag is switched in B slices with dependent slice segments.

4.6.8.12 Test bitstreams #SDH_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. sign_data_hiding_enabled_flag is set equal to 1. The bitstream includes various configurations of sign data hiding.

Functional stage: Test the parsing process.

Purpose: Check that the decoder properly decodes with sign data hiding.

4.6.9 Test bitstreams — Temporal scalability

4.6.9.1 Test bitstreams #TSCL_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. The bitstream includes four temporal layers.

Functional stage: Test temporal scalability.

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Purpose: Check that the decoder properly decodes temporal layers.

4.6.9.2 Test bitstreams #TSCL_B

Specification: All slices are coded as I or P slices. Each picture contains only one slice. The bitstream includes four temporal layers.

Functional stage: Test temporal scalability.

Purpose: Check that the decoder properly decodes temporal layers.

4.6.10 Test bitstreams — Parallel processing tools

4.6.10.1 Test bitstreams #TILES_A

Specification: All slices are coded as I or P slices. Each picture contains only one slice. num_tile_columns_minus1 and num_tile_rows_minus1 are set equal to 4, which is the maximum value for level 4.1. uniform_spacing_flag is set equal to 0. The values of column_width_minus1[i] and row_height_minus1[i] are set randomly for each picture. loop_filter_across_tiles_enabled_flag is set randomly for each picture.

Functional stage: Test dependency breaks at tile boundaries.

Purpose: Check that the decoder properly decodes when there is random non-uniform tile spacing with a maximum number of tiles and the deblocking filter is enabled and disabled at tile boundaries.

4.6.10.2 Test bitstreams #TILES_B

Specification: All slices are coded as I or P slices. Each picture contains a random number of slices. All slice boundaries are aligned with tile boundaries. num_tile_columns_minus1 and num_tile_rows_minus1 are set equal to 4, which is the maximum value for level 4.1. uniform_spacing_flag is set equal to 0. The values of column_width_minus1[i] and row_height_minus1[i] are set randomly for each picture. loop_filter_across_tiles_enabled_flag is set randomly for each picture. pps_loop_filter_across_slices_enabled_flag is set randomly for each frame. slice_loop_filter_across_slices_enabled_flag is set randomly for each slice.

Functional stage: Test dependency breaks at tile boundaries and enabling/disabling the deblocking filter at tile/slice boundaries.

Purpose: Check that the decoder properly decodes when there is random non-uniform tile spacing with a maximum number of tiles and the deblocking filter is enabled and disabled at tile and slice boundaries.

4.6.10.3 Test bitstreams #WPP_A

Specification: entropy_coding_sync_enabled_flag is set equal to 1. A luma CTB size of 64x64 is used. The bitstream contains six repeated patterns of pictures with a particular ordering and referencing relationship, which are each eight pictures long. The first three of these groups of eight pictures have pictures with the following characteristics:

— One slice in the frame, QP is constant;

— One slice in the frame, the QP of each CU is set equal to a value such that $Abs(QP - SliceQp_Y) > 2$;

— Maximum number of independent slice segments in the frame, at least one slice segment is one CTU long, at least one slice segment is two CTUs long, QP is constant;

— Maximum number of independent slice segments in the frame, at least one slice segment is one CTU long, at least one slice segment is two CTUs long, the QP of each CU is set equal to a value such that $Abs(QP - SliceQp_Y) > 2$;

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— Maximum number of dependent slice segments in the frame, at least one dependent slice segment is one CTU long, at least one dependent slice segment is two CTUs long, QP is constant;

— Maximum number of dependent slice segments in the frame, at least one dependent slice segment is one CTU long, at least one dependent slice segment is two CTUs long, the QP of each CU is set equal to a value such that Abs(QP − SliceQp$_Y$) > 2;

— Random combination of independent/dependent slice segments, QP is constant;

— Random combination of independent/dependent slice segments, the QP of each CU is set equal to a value such that Abs(QP − SliceQp$_Y$) > 2.

The first of these groups of eight pictures is coded using all Intra CUs, and the second is coded with CU skipping disabled. The final three of these groups of eight pictures feature a mixture of single slice pictures, and pictures coded using multiple slices and multiple slice segments. Random amounts of slice segment header extension bytes are encoded in each slice header.

Functional stage: Tests that entropy coding is correctly synchronized with different slice types. Tests that the QP predictor is reset to SliceQp$_Y$ at the beginning of every CTU row. May be used to test handling of entry points by a parallel decoder.

Purpose: Check that the decoder properly decodes when entropy coding synchronization is enabled and handle entry points when slice segment header extension data bytes are present. This bitstream does not conform to the Main profile or Main 10 profile since slice_segment_header_extension_present_flag is equal to 1. However, Main profile and Main 10 profile decoders shall be able to decode this bitstream and ignore the slice segment header extension data bytes.

4.6.10.4 Test bitstreams #WPP_B

Specification: entropy_coding_sync_enabled_flag is set equal to 1. A luma CTB size of 32x32 is used. The bitstream contains six repeated patterns of pictures with a particular ordering and referencing relationship, which are each eight pictures long. The first three of these groups of eight pictures have pictures with the following characteristics:

— One slice in the frame, QP is constant;

— One slice in the frame, the QP of each CU is set equal to a value such that Abs(QP − SliceQp$_Y$) > 2;

— Maximum number of independent slice segments in the frame, at least one slice segment is one CTU long, at least one slice segment is two CTUs long, QP is constant;

— Maximum number of independent slice segments in the frame, at least one slice segment is one CTU long, at least one slice segment is two CTUs long, the QP of each CU is set equal to a value such that Abs(QP − SliceQp$_Y$) > 2;

— Maximum number of dependent slice segments in the frame, at least one dependent slice segment is one CTU long, at least one dependent slice segment is two CTUs long, QP is constant;

— Maximum number of dependent slice segments in the frame, at least one dependent slice segment is one CTU long, at least one dependent slice segment is two CTUs long, the QP of each CU is set equal to a value such that Abs(QP − SliceQp$_Y$) > 2;

— Random combination of independent/dependent slice segments, QP is constant;

— Random combination of independent/dependent slice segments, the QP of each CU is set equal to a value such that Abs(QP − SliceQp$_Y$) > 2.

The first of these groups of eight pictures is coded using all Intra CUs, and the second is coded with CU skipping disabled. The final three of these groups of eight pictures feature a mixture of single slice pictures, and pictures coded using multiple slices and multiple slice segments. Random amounts of slice segment header extension bytes are encoded in each slice header.

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Functional stage: Tests that entropy coding is correctly synchronized with different slice types. Tests that the QP predictor is reset to $SliceQp_Y$ at the beginning of every CTU row. May be used to test handling of entry points by a parallel decoder.

Purpose: Check that the decoder properly decodes when entropy coding synchronization is enabled and and handle entry points when slice segment header extension data bytes are present. This bitstream does not conform to the Main profile or Main 10 profile since slice_segment_header_extension_present_flag is equal to 1. However, Main profile and Main 10 profile decoders shall be able to decode this bitstream and ignore the slice segment header extension data bytes.

4.6.10.5 Test bitstreams #WPP_C

Specification: entropy_coding_sync_enabled_flag is set equal to 1. A luma CTB size of 16x16 is used. The bitstream contains six repeated patterns of pictures with a particular ordering and referencing relationship, which are each eight pictures long. The first three of these groups of eight pictures have pictures with the following characteristics:

— One slice in the frame, QP is constant;

— One slice in the frame, the QP of each CU is set equal to a value such that $Abs(QP - SliceQp_Y) > 2$;

— Maximum number of independent slice segments in the frame, at least one slice segment is one CTU long, at least one slice segment is two CTUs long, QP is constant;

— Maximum number of independent slice segments in the frame, at least one slice segment is one CTU long, at least one slice segment is two CTUs long, the QP of each CU is set equal to a value such that $Abs(QP - SliceQp_Y) > 2$;

— Maximum number of dependent slice segments in the frame, at least one dependent slice segment is one CTU long, at least one dependent slice segment is two CTUs long, QP is constant;

— Maximum number of dependent slice segments in the frame, at least one dependent slice segment is one CTU long, at least one dependent slice segment is two CTUs long, the QP of each CU is set equal to a value such that $Abs(QP - SliceQp_Y) > 2$;

— Random combination of independent/dependent slice segents, QP is constant;

— Random combination of independent/dependent slice segments, the QP of each CU is set equal to a value such that $Abs(QP - SliceQp_Y) > 2$.

The first of these groups of eight pictures is coded using all Intra CUs, and the second is coded with CU skipping disabled. The final three of these groups of eight pictures feature a mixture of single slice pictures, and pictures coded using multiple slices and multiple slice segments. Random amounts of slice segment header extension bytes are encoded in each slice header.

Functional stage: Tests that entropy coding is correctly synchronized with different slice types. Tests that the QP predictor is reset to $SliceQp_Y$ at the beginning of every CTU row. May be used to test handling of entry points by a parallel decoder.

Purpose: Check that the decoder properly decodes when entropy coding synchronization is enabled and and handle entry points when slice segment header extension data bytes are present. This bitstream does not conform to the Main profile or Main 10 profile since slice_segment_header_extension_present_flag is equal to 1. However, Main profile and Main 10 profile decoders shall be able to decode this bitstream and ignore the slice segment header extension data bytes.

4.6.10.6 Test bitstreams #WPP_D

Specification: entropy_coding_sync_enabled_flag is set equal to 1. A luma CTB size of 64x64 is used. The picture is one CTU wide. The bitstream contains six repeated patterns of pictures with a particular ordering and referencing relationship, which are each eight pictures long. These are encoded with varying numbers of slices and slice segments. Even frames have fixed QP, while the QP established at the

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CU level in odd frames is set such that Abs(QP − SliceQp$_Y$) > 2. The first of these groups of eight pictures is coded using all Intra CUs, and the second is coded with CU skipping disabled. Random amounts of slice segment header extension bytes are encoded in each slice header.

Functional stage: Tests that entropy coding is correctly synchronized when a picture is one CTU wide. Tests that the QP predictor is reset to SliceQp$_Y$ at the beginning of every CTU row. May be used to test handling of entry points by a parallel decoder.

Purpose: Check that the decoder properly decodes when a picture is one CTU wide and handle entry points when slice segment header extension data bytes are present. This bitstream does not conform to the Main profile or Main 10 profile since slice_segment_header_extension_present_flag is equal to 1. However, Main profile and Main 10 profile decoders shall be able to decode this bitstream and ignore the slice segment header extension data bytes.

4.6.10.7 Test bitstreams #WPP_E

Specification: entropy_coding_sync_enabled_flag is set equal to 1. A luma CTB size of 64x64 is used. The picture is two CTUs wide. The bitstream contains six repeated patterns of pictures with a particular ordering and referencing relationship, which are each eight pictures long. These are encoded with varying numbers of slices and slice segments. Even frames have fixed QP, while the QP established at the CU level in odd frames is set such that Abs(QP − SliceQp$_Y$) > 2. The first of these groups of eight pictures is coded using all Intra CUs, and the second is coded with CU skipping disabled. Random amounts of slice segment header extension bytes are encoded in each slice header.

Functional stage: Tests that entropy coding is correctly synchronized when a picture is two CTUs wide. Tests that the QP predictor is reset to SliceQp$_Y$ at the beginning of every CTU row. May be used to test handling of entry points by a parallel decoder.

Purpose: Check that the decoder properly decodes when a picture is two CTUs wide and handle entry points when slice segment header extension data bytes are present. This bitstream does not conform to the Main profile or Main 10 profile since slice_segment_header_extension_present_flag is equal to 1. However, Main profile and Main 10 profile decoders shall be able to decode this bitstream and ignore the slice segment header extension data bytes.

4.6.10.8 Test bitstreams #WPP_F

Specification: entropy_coding_sync_enabled_flag is set equal to 1. A luma CTB size of 64x64 is used. The picture is three CTUs wide. The bitstream contains six repeated patterns of pictures with a particular ordering and referencing relationship, which are each eight pictures long. These are encoded with varying numbers of slices and slice segments. Even frames have fixed QP, while the QP established at the CU level in odd frames is set such that Abs(QP − SliceQp$_Y$) > 2. The first of these groups of eight pictures is coded using all Intra CUs, and the second is coded with CU skipping disabled. Random amounts of slice segment header extension bytes are encoded in each slice header.

Functional stage: Tests that entropy coding is correctly synchronized when a picture is three CTUs wide. Tests that the QP predictor is reset to SliceQp$_Y$ at the beginning of every CTU row. May be used to test handling of entry points by a parallel decoder.

Purpose: Check that the decoder properly decodes when a picture is three CTUs wide and handle entry points when slice segment header extension data bytes are present. This bitstream does not conform to the Main profile or Main 10 profile since slice_segment_header_extension_present_flag is equal to 1. However, Main profile and Main 10 profile decoders shall be able to decode this bitstream and ignore the slice segment header extension data bytes.

4.6.10.9 Test bitstreams #ENTP_A

Specification: All slices are coded as I slices. Each picture contains only one slice. Four tiles are included in a picture. num_tile_columns_minus1 and num_tiles_row_minus1 are set equal to 1. uniform_spacing_

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flag is set equal to 1. There are some tiles in the picture with PicOrderCntVal equal to 4 that contain emulation prevention bytes.

Functional stage: Test entry point signalling.

Purpose: Check that the decoder properly decodes when entry point signalling in a slice header is used with tiles and emulation prevention bytes occur in the substream(s).

4.6.10.10 Test bitstreams #ENTP_B

Specification: All slices are coded as I or B slices. Each picture contains only one slice. Six tiles are included in a picture. num_tile_columns_minus1 is set equal to 1 and num_tile_rows_minus1 are set equal to 2. uniform_spacing_flag is set equal to 1. There are some pictures (e.g., with PicOrderCntVal equal to 4, 6, 10, 12, 18, and 20) that contain a tile in which emulation prevention bytes occur.

Functional stage: Test entry point signalling.

Purpose: Check that the decoder properly decodes when entry point signalling in a slice header is used with tiles and emulation prevention bytes occur in the substream(s).

4.6.10.11 Test bitstreams #ENTP_C

Specification: All slices are coded as I or B slices. Each picture contains only one slice. entropy_coding_sync_enabled_flag is set equal to 1.

Functional stage: Test entry point signalling.

Purpose: Check that the decoder properly decodes when entropy coding synchronization is used.

4.6.11 Test bitstreams — Other coding tools

4.6.11.1 Test bitstreams #IPCM_A

Specification: All slices are coded as I slices. Each picture contains only one slice. pcm_enabled_flag is equal to 1. Both pcm_sample_bit_depth_luma_minus1 and pcm_sample_bit_depth_chroma_minus1 are equal to 7. log2_min_pcm_luma_coding_block_size_minus3, log2_diff_max_min_pcm_luma_coding_block_size, and pcm_loop_filter_disabled_flag are equal to 0, 2 and 0, respectively.

Functional stage: Test parsing of pcm_flag in the coding unit syntax.

Purpose: Check that the decoder properly decodes pcm_flag.

4.6.11.2 Test bitstreams #IPCM_B

Specification: All slices are coded as I slices. Each picture contains only one slice. pcm_enabled_flag is equal to 1. Both pcm_sample_bit_depth_luma_minus1 and pcm_sample_bit_depth_chroma_minus1 are equal to 5. log2_min_pcm_luma_coding_block_size_minus3, log2_diff_max_min_pcm_luma_coding_block_size, and pcm_loop_filter_disabled_flag are equal to 0, 1 and 0, respectively.

Functional stage: Test parsing of pcm_flag in the coding unit syntax. Test parsing of pcm_sample_luma and pcm_sample_chroma data.

Purpose: Check that the decoder properly decodes pcm_flag, and pcm_sample_luma and pcm_sample_chroma data.

4.6.11.3 Test bitstreams #IPCM_C

Specification: All slices are coded as I slices. Each picture contains only one slice. pcm_enabled_flag is equal to 1. Both pcm_sample_bit_depth_luma_minus1 and pcm_sample_bit_depth_chroma_minus1

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are equal to 7. log2_min_pcm_luma_coding_block_size_minus3, log2_diff_max_min_pcm_luma_coding_block_size, and pcm_loop_filter_disabled_flag are equal to 0, 1 and 1, respectively.

Functional stage: Test parsing of pcm_flag in the coding unit syntax. Test parsing of pcm_sample_luma and pcm_sample_chroma data. Test skipping of loop filtering on samples associated with pcm_flag equal to 1.

Purpose: Check that the decoder properly decodes pcm_flag, pcm_sample_luma and pcm_sample_chroma data and skips loop filtering on samples associated with pcm_flag equal to 1.

4.6.11.4 Test bitstreams #IPCM_D

Specification: All slices are coded as I slices. Each picture contains only one slice. pcm_enabled_flag is equal to 1. Both pcm_sample_bit_depth_luma_minus1 and pcm_sample_bit_depth_chroma_minus1 are equal to 7. log2_min_pcm_luma_coding_block_size_minus3, log2_diff_max_min_pcm_luma_coding_block_size, and pcm_loop_filter_disable_flag are equal to 0, 1 and 0, respectively. transquant_bypass_enabled_flag is equal to 1.

Functional stage: Test parsing of pcm_flag in the coding unit syntax. Test parsing of pcm_sample_luma and pcm_sample_chroma data. Test skipping of loop filtering on samples associated with both cu_transquant_bypass_flag and pcm_flag equal to 1.

Purpose: Check that the decoder properly decodes pcm_flags, pcm_sample_luma and pcm_sample_chroma data and skips loop filtering on samples associated with both cu_transquant_bypass_flag and pcm_flag equal to 1.

4.6.11.5 Test bitstreams #IPCM_E

Specification: Contain single coded picture. The coded picture contains only one intra slice. pcm_enabled_flag is equal to 1. pcm_sample_bit_depth_luma_minus1 and pcm_sample_bit_depth_chroma_minus1 are equal to 5 and 7, respectively. log2_min_pcm_luma_coding_block_size_minus3, log2_diff_max_min_pcm_luma_coding_block_size, and pcm_loop_filter_disabled_flag are equal to 1, 0 and 0, respectively.

Functional stage: Test parsing of pcm_flag in the coding unit syntax. Test parsing of pcm_sample_luma and pcm_sample_chroma data with different bit depths.

Purpose: Check that the decoder can properly decode pcm_flag, and pcm_sample_luma and pcm_sample_chroma data with different pcm_sample_bit_depth_luma_minus1 and pcm_sample_bit_depth_chroma_minus1 values.

4.6.11.6 Test bitstreams #TS_A

Specification: Each picture contains only one slice. transform_skip_enabled_flag is set equal to 1 for pictures 0 to 8 and 0 for picture 9 to 16.

Functional stage: Test reconstruction process of slices with transform_skip_enabled_flag is equal to 1.

Purpose: Check that the decoder can properly decode transform_skip_enabled_flag.

4.6.11.7 Test bitstreams #AMP_A, #AMP_D, and #AMP_E

Specification: All slices are coded as I, P or B slices. Each picture contains only one slice. All asymmetric motion partition modes (2NxnU, 2NxND, nLx2N, nRx2N) are included.

Functional stage: Test reconstruction process of slices with amp_enabled_flag equal to 1.

Purpose: Check that the decoder can properly decode slices with all asymmetric motion partition modes.

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4.6.11.8 Test bitstreams #AMP_B

Specification: All slices are coded as I, P or B slices. Each picture contains only one slice. Asymmetric motion partition is only utilized for PUs of which size is larger than minimum CU.

Functional stage: Test reconstruction process of slices with amp_enabled_flag equal to 1.

Purpose: Check that the decoder can properly decode slices with a constraint on asymmetric motion partition modes.

4.6.11.9 Test bitstreams #LS_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. All the CUs are transform/quantization/filtering bypass CUs. SAO and deblocking filter are enabled in the SPS and PPS.

Functional stage: Test reconstruction process of transform/quantization/filtering bypass coding.

Purpose: Check that the decoder can properly decode transform/quantization/filtering bypass coding.

4.6.11.10 Test bitstreams #LS_B

Specification: All slices are coded as I or B slices. Each picture contains only one slice. At least 50% of the CUs do not use transform/quantization/filtering bypass, and where there at are least 100 CUs in each of the following categories.

— The luma CB is 64x64, it has cu_transquant_bypass_flag on, at least one of the neighbouring CUs uses SAO, at least one of the neighbouring CUs uses deblocking filtering.

— The luma CB is 32x32, it has cu_transquant_bypass_flag on, at least one of the neighbouring CUs uses SAO, at least one of the neighbouring CUs uses deblocking filtering.

— The luma CB is 16x16, it has cu_transquant_bypass_flag on, at least one of the neighbouring CUs uses SAO, at least one of the neighbouring CUs uses deblocking filtering.

— The luma CB is 8x8, it has cu_transquant_bypass_flag on, at least one of the neighbouring CUs uses SAO, at least one of the neighbouring CUs uses deblocking filtering.

Functional stage: Test reconstruction process of transform/quantization/filtering bypass coding.

Purpose: Check that the decoder can properly decode transform/quantization/filtering bypass coding.

4.6.12 Test bitstreams — High level syntax

4.6.12.1 Test bitstreams #NUT_A

Specification: All slices are coded as I or P slices. Each picture contains only one slice. Three temporal layers are used. The bitstream exercises various VCL NAL unit types.

Functional stage: Test decoding of various VCL NAL unit types.

Purpose: Check that the decoder can properly decode the VCL NAL unit types TRAIL_N, TRAIL_R, TSA_N, TSA_R, STSA_N, STSA_R, RADL_R, RASL_R, RADL_N, RASL_N, BLA_W_LP, BLA_W_RADL, BLA_N_LP, IDR_W_RADL, IDR_N_LP, and CRA_NUT.

4.6.12.2 Test bitstreams #FILLER_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. This bitstream contains some NAL units with nal_unit_type equal to 38 (filler data) at the end of every access unit.

Functional stage: Test decoding with filler data NAL units present.

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Purpose: Check that the decoder can properly decode a bitstream containing NAL units with the NAL unit type FD_NUT.

4.6.12.3 Test bitstreams #VPSID_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. This bitstream contains two VPSs with the correct one having the vps_video_parameter_set_id value 4. The bitstream has 3 temporal layers and the correct VPS has the vps_temporal_id_nesting_flag turned off.

Functional stage: Test decoding of vps_video_parameter_set_id.

Purpose: Check that the decoder properly decodes vps_video_parameter_set_id.

4.6.12.4 Test bitstreams #PS_B

Specification: All slices are coded as I or P slices. Each picture contains only one slice. sps_extension_flag is set equal to 1. Data is included after the sps_extension_flag.

Functional stage: Test decoding of VPS, SPS and PPS.

Purpose: Check that the decoder properly handles the extension_flag in SPS. This bitstream does not conform to the Main profile or Main 10 profile of the first edition of the HEVC specification since sps_extension_flag is equal to 1. However, Main profile and Main 10 profile decoders shall be able to decode this bitstream and ignore the SPS extension.

4.6.12.5 Test bitstreams #VPSSPSPPS_A

Specification: All slices are coded as I slices. The resolution of each picture is changed. All parameter sets are encoded at the beginning of bitstream prior to any pictures. Some of the parameter sets are duplicated and the order of parameter sets is arbitrary.

Functional stage: Test decoding of VPS, SPS and PPS.

Purpose: Check that the decoder properly handles VPS, SPS and PPS.

4.6.12.6 Test bitstreams #PPS_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. Bitstream includes multiple PPS signalling with random PPS parameters (constrained intra, transform skip, tile configurations, WP, loop filter, etc.) that get randomly selected by coded pictures.

Functional stage: Test decoding of PPS.

Purpose: Check that the decoder properly handles multiple PPSs being signalled.

4.6.12.7 Test bitstreams #SLPPLP_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. The bitstream contains three temporal layers (two sublayers).

Functional stage: Test decoding of sub_layer_profile_present_flag and sub_layer_level_present_flag.

Purpose: Check that the decoder properly handles sub_layer_profile_present_flag and sub_layer_level_present_flag.

4.6.12.8 Test bitstreams #OPFLAG_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. The value of output_flag_present_flag is 1, indicating that the syntax element pic_output_flag is signalled in the slice header.

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Functional stage: Test parsing of output_flag_present_flag in the PPS. Test parsing of pic_output_flag in slice header syntax.

Purpose: Check that the decoder properly decodes slice headers containing pic_output_flag.

4.6.12.9 Test bitstreams #OPFLAG_B

Specification: All slices are coded as I slices. Each picture contains only one slice. The value of output_flag_present_flag is 1, indicating that the syntax element pic_output_flag is signalled in the slice header. Pictures with PicOrderCntVal equal to 39 and 73 are set to be not for output.

Functional stage: Test picture output.

Purpose: Check that the decoder properly decodes slice headers containing pic_output_flag.

4.6.12.10 Test bitstreams #OPFLAG_C

Specification: All slices are coded as I or B slices. Each picture contains only one slice. The value of output_flag_present_flag is 1, indicating that the syntax element pic_output_flag is signalled in the slice header. Picture with PicOrderCntVal equal to 20, 31, 56, and 72 are set to be not for output.

Functional stage: Test picture output.

Purpose: Check that the decoder properly decodes slice headers containing pic_output_flag.

4.6.12.11 Test bitstreams #NoOutPrior_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. The value of NoRaslOutputFlag and no_output_of_prior_pics_flag is equal to 1 when a CRA picture follows an end of sequence NAL unit. One CRA picture is included in the middle of the bitstream. An end of sequence NAL unit is present in the bitstream in the decoding order that is right before the CRA picture.

Functional stage: Test picture output.

Purpose: Check that the decoder properly decodes a CRA picture that occurs immediately after an end of sequence NAL unit which should result in all stored decoded pictures in the DPB to be removed without outputting them.

4.6.12.12 Test bitstreams #NoOutPrior_B

Specification: All slices are coded as I or B slices. Each picture contains only one slice. Two IDR pictures are included in the bitstream. The first IDR picture is the first picture in the bitstream. The second IDR picture is in the middle of the bitstream. The value of no_output_of_prior_pics_flag for the second IDR picture is set equal to 1.

Functional stage: Test picture output.

Purpose: Check that the decoder properly decodes an IDR picture with no_output_of_prior_pics_flag equal to 1 which should result in all stored decoded pictures in the DPB to be removed without outputting them.

4.6.12.13 Test bitstreams #PICSIZE_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. Each picture includes four tile columns.

Functional stage: Test picture size capability.

Purpose: Check that the decoder properly decodes pictures whose size is 1056x8440.

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4.6.12.14 Test bitstreams #PICSIZE_B

Specification: All slices are coded as I or B slices. The bitstream is designed to test maximum height for level 5.1. Picture size is 8440x1056. Picture width is not a multiple of 16.

Functional stage: Test picture size capability.

Purpose: Check that the decoder properly decodes pictures whose size is 8440x1056 (picture width not a multiple of 16).

4.6.12.15 Test bitstreams #PICSIZE_C

Specification: All slices are coded as I or B slices. Each picture includes two tile columns.

Functional stage: Test picture size capability.

Purpose: Check that the decoder properly decodes pictures whose size is 528x4216.

4.6.12.16 Test bitstreams #PICSIZE_D

Specification: All slices are coded as I or B slices. The bitstream is designed to test maximum height for level 4.1. Picture size is 4216x528.

Functional stage: Test picture size capability.

Purpose: Check that the decoder properly decodes pictures whose size is 4216x528.

4.6.12.17 Test bitstreams #POC_A

Specification: All slices are coded as I or B slices. The bitstream is designed to test some rules related to PicOrderCntVal derivation.

Functional stage: Test PicOrderCntVal derivation process.

Purpose: Check that the decoder properly decodes different PicOrderCntVal values.

4.6.12.18 Test bitstreams #RAP_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. The first picture in the bitstream is a CRA picture and is followed by seven RASL pictures that are not decodable. There are two subsequent CRA pictures with RASL pictures, following the first CRA picture in this bitstream. These subsequent RASL pictures should be decodable since the associated CRA picture is not the first CRA picture in the bitstream.

Functional stage: Test reconstruction process starting with a CRA picture followed by RASL pictures that cannot be decoded of slices with the inter RPS prediction.

Purpose: Check that the decoder properly decodes when the CRA picture is the first picture in the bitstream and is followed by RASL pictures that are not decodable.

4.6.12.19 Test bitstreams #RAP_B

Specification: All slices are coded as I or B slices. A CRA picture with leading pictures following end of sequence NAL unit is included. VPS, SPS and PPS are present in the bitstream repeatedly. The conformance window for cropping is signalled in the bitstream.

Functional stage: Test reconstruction process of a CRA picture.

Purpose: Check that the decoder properly decodes a CRA picture with leading pictures following an end of sequence NAL unit.

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4.6.12.20 Test bitstreams #RPS_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. The slice header includes the inter-RPS prediction method for sending the RPS for short-term pictures. The last three frames of this 44-frame sequence contain slice header RPS using the inter-RPS in addition to the RPS sent in the PPS.

Functional stage: Test reconstruction process of slices with inter-RPS prediction.

Purpose: Check that the decoder properly decodes slices using the inter-RPS prediction method.

4.6.12.21 Test bitstreams #RPS_B

Specification: All slices are coded as I or B slices. Each picture contains only one slice. The bitstream includes random RPS signalling in slice headers along with random picture coding order within a series of pictures.

Functional stage: Test reconstruction process of slices without inter-RPS prediction.

Purpose: Check that the decoder properly decodes slices using the inter-RPS prediction method.

4.6.12.22 Test bitstreams #RPS_C

Specification: All slices are coded as I or P slices. Each picture contains only one slice. Two temporal layers are used. 15 reference pictures are used. The bitstream exercises short-term reference pictures in the RPS.

Functional stage: Test short-term RPS handling.

Purpose: Check that the decoder properly decodes when short-term picture handling is used in the RPS.

4.6.12.23 Test bitstreams #RPS_D

Specification: All slices are coded as I or P slices. Each picture contains only one slice. Two temporal layers are used. The bitstream exercises short-term and long-term reference pictures in the RPS.

Functional stage: Test long-term and short-term RPS handling.

Purpose: Check that the decoder properly decodes when long-term and short-term picture handling is used in the RPS.

4.6.12.24 Test bitstreams #RPS_E

Specification: All slices are coded as I or B slices. Each picture contains only one slice. The bitstream includes random RPS signalling with LTRPs in slice headers along with random picture coding order within a series of pictures.

Functional stage: Test reconstruction process of slices without inter-RPS prediction.

Purpose: Check that the decoder properly decodes slices with long-term reference pictures without inter-RPS prediction.

4.6.12.25 Test bitstreams #RPS_F

Specification: The inter-RPS prediction signals some RPS entries that are not used by the current picture. (used_by_curr_pic_flag[j] equal to 0 and use_delta_flag[j] equal to 1).

Functional stage: Test reconstruction process of slices without inter-RPS prediction.

Purpose: Check that the decoder properly decodes slices with the inter-RPS prediction method including RPS entries that are not used by the current picture.

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4.6.12.26 Test bitstreams #LTRPSPS_A

Specification: The bitstream is coded under typical random access conditions, with the following modifications. Eight long-term reference picture candidates (four different slice_pic_order_cnt_lsb values and two values of used_by_curr_pic_lt_flag[i], giving a total of eight) are signalled in the SPS. The slice headers refer to long-term reference pictures that are either referred to from the SPS or may be explicitly signalled in the slice header. Reference picture list modification is applied on some pictures.

Functional stage: Test parsing of long_term_ref_pics_present_flag, num_long_term_ref_pics_sps, lt_ref_pic_poc_lsb_sps, and used_by_curr_pic_lt_sps_flag in SPS. Test parsing of num_long_term_sps and lt_idx_sps in slice header syntax.

Purpose: Check that the decoder can properly decode slice headers when long-term reference pictures from the list of candidates in the SPS are specified.

4.6.12.27 Test bitstreams #RPLM_A

Specification: All slices are coded as I or B slices. Each picture contains only one slice. The bitstream includes random reference picture list modification with varying list sizes.

Functional stage: Test reconstruction process of slices with reference list modification.

Purpose: Check that the decoder properly decodes slices with reference list modification.

4.6.12.28 Test bitstreams #RPLM_B

Specification: All slices are coded as I or B slices. Each picture contains more than one slice. The bitstream includes random reference picture list modification with varying list sizes.

Functional stage: Test reconstruction process of slices with reference list modification.

Purpose: Check that the decoder properly decodes slices with reference list modification.

4.6.12.29 Test bitstreams #SLICES_A

Specification: Each picture contains more than one slice with different slice type.

Functional stage: Test reconstruction process of pictures comprising of slices with different slice_type values.

Purpose: Check that the decoder properly decodes pictures comprising of slices with different slice_type values.

4.6.12.30 Test bitstreams #DSLICE_A

Specification: All slices are coded as I or B slices. Each picture contains more than one slice. dependent_slice_segments_enabled_flag is set equal to 1.

Functional stage: Test reconstruction process of independent and dependent slice segments.

Purpose: Check that the decoder properly decodes independent and dependent slice segments.

4.6.12.31 Test bitstreams #DSLICE_B

Specification: All slices are coded as I or B slices. Each picture contains more than one slice. dependent_slice_segments_enabled_flag is set equal to 1. entropy_coding_sync_enabled_flag is set equal to 1.

Functional stage: Test reconstruction process of dependent slice segments.

Purpose: Check that the decoder properly decodes dependent slice segments in combination with entropy coding synchronization.

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4.6.12.32 Test bitstreams #DSLICE_C

Specification: All slices are coded as I or B slices. Each picture contains more than one slice. dependent_slice_segments_enabled_flag is set equal to 1. tiles_enabled_flag is set equal to 1.

Functional stage: Test reconstruction process of dependent slice segments.

Purpose: Check that the decoder properly decodes dependent slice segments in combination with tiles.

4.6.12.33 Test bitstreams #BUMPING_A

Specification: All slices are coded as I or B slices. Each picture contains more than one slice. All pictures with PicOrderCntVal values in the range of 0 to 65 are to be output except the pictures with PicOrderCntVal values equal to 4, 5, 6, 7, 15, 21, 22, 23, 30, 31, 36, 37, 38, 39, 54, 55, and 56. Those pictures are not output since they have not been output yet when IRAP pictures with no_output_of_prior_pics_flag equal to 1 are encountered in the bitstream. Four temporal layers are used and IRAP pictures with no_output_of_prior_pics_flag equal to 1 are present in the bitstream.

Functional stage: Test bumping process.

Purpose: Check that the decoder properly handles tests output order conformance, in particular when applying the bumping process.

4.6.12.34 Test bitstreams #CONFWIN_A

Specification: All slices are coded as I or B slices. Each picture contains more than one slice. The value of conf_win_bottom_offset, conf_win_top_offset, conf_win_left_offset and conf_win_right_offset are set equal to 1.

Functional stage: Test conformance window usage.

Purpose: Check that the decoder properly handles conf_win_bottom_offset, conf_win_top_offset, conf_win_left_offset, and conf_win_right_offset.

4.6.12.35 Test bitstreams #HRD_A

Specification: All slices are coded as I or B slices. Each access unit contains four decoding units. sub_pic_hrd_params_present_flag is set equal to 1 and du_common_cpb_removal_delay_flag is set equal to 0.

Functional stage: Test decoding-unit-based HRD.

Purpose: Check that the decoder can properly decode with decoding-unit-based CPB removal time signalling.

4.6.12.36 Test bitstreams #EXT_A

Specification: A three-picture bitstream containing extension data in the VPS, SPS, PPS, and slice headers. Note that this bitstream is not a conforming bitstream, but conforming decoders are required to be able to parse it and decode the pictures in the bitstream.

Functional stage: Test decoding of bitstreams that contain extension data.

Purpose: Check that the decoder can properly handle extension data. This bitstream does not conform to the Main profile or Main 10 profile since extension data is present. However, Main profile and Main 10 profile decoders shall be able to decode this bitstream and ignore the extension data.

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4.6.13 Test bitstreams — 10 bit

4.6.13.1 Test bitstreams #WP_A_MAIN10

Specification: All slices are coded as I or P slices. Each picture contains only one slice. bit_depth_luma_minus8 is set equal to 2 and bit_depth_chroma_minus8 is set equal to 2. weighted_pred_flag is set equal to 1. Plural reference indices are assigned to each reference picture.

Functional stage: Weighted sample prediction process for P slices with plural reference indices.

Purpose: Check that the decoder can properly decode weighted sample prediction for P slices with plural reference indices.

4.6.13.2 Test bitstreams #WP_B_MAIN10

Specification: All slices are coded as I, P or B slices. Each picture contains only one slice. bit_depth_luma_minus8 is set equal to 2 and bit_depth_chroma_minus8 is set equal to 2. weighted_pred_flag is set equal to 1 and weighted_bipred_flag is equal to 1. Plural reference indices are assigned to each reference picture.

Functional stage: Weighted sample prediction process for P and B slices with plural reference indices.

Purpose: Check that the decoder can properly decode weighted sample prediction for P and B slices with plural reference indices.

4.6.13.3 Test bitstreams #TSUNEQBD_A_MAIN10

Specification: Each picture contains only one slice. bit_depth_luma_minus8 is set equal to 2 and bit_depth_chroma_minus8 is set equal to 1. In the PPS, transform_skip_enabled_flag set equal to 1. In residual_coding(), transform_skip_flag set equal to 1 for Y, Cb, Cr for both intra and inter prediction modes.

Functional stage: Test the parsing and reconstruction process of slices with transform skip mode for luma and chroma with different bit depths.

Purpose: Check that the decoder can properly decode intra and inter prediction slices with transform skip and unequal bit depth (luma: 10-bit, chroma: 9-bit).

4.6.13.4 Test bitstreams #DBLK_A_MAIN10

Specification: All slices are coded as I or B slices. Each picture contains only one slice. bit_depth_luma_minus8 is set equal to 2 and bit_depth_chroma_minus8 is set equal to 2. Some QP values are set to negative values.

Functional stage: Test deblocking filter process for 10 bit video.

Purpose: Check that the decoder can properly decode negative values of QP that affect the deblocking filter process.

4.6.13.5 Test bitstreams #INITQP_B_MAIN10

Specification: All slices are coded as I or B slices. bit_depth_luma_minus8 is set equal to 2 and bit_depth_chroma_minus8 is set equal to 2. The value of init_qp_minus26 is set from −38 to 25.

Functional stage: Test the initial QP.

Purpose: Check that the decoder can properly decode different init_qp_minus26 values.

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4.6.13.6 Test bitstreams #WPP_A_MAIN10

Specification: bit_depth_luma_minus8 is set equal to 2 and bit_depth_chroma_minus8 is set equal to 2. entropy_coding_sync_enabled_flag is set equal to 1. A luma CTB size of 64x64 is used. The bitstream contains six repeated patterns of pictures with a particular ordering and referencing relationship, which are each eight pictures long. The first three of these groups of eight pictures have pictures with the following characteristics:

— One slice in the frame, QP is constant;

— One slice in the frame, the QP of each CU is set equal to a value such that Abs(QP − SliceQp$_Y$) > 2;

— Maximum number of independent slice segments in the frame, at least one slice segment is one CTU long, at least one slice segment is two CTUs long, QP is constant;

— Maximum number of independent slice segments in the frame, at least one slice segment is one CTU long, at least one slice segment is two CTUs long, the QP of each CU is set equal to a value such that Abs(QP − SliceQp$_Y$) > 2;

— Maximum number of dependent slice segments in the frame, at least one dependent slice segment is one CTU long, at least one dependent slice segment is two CTUs long, QP is constant;

— Maximum number of dependent slice segments in the frame, at least one dependent slice segment is one CTU long, at least one dependent slice segment is two CTUs long, the QP of each CU is set equal to a value such that Abs(QP − SliceQp$_Y$) > 2;

— Random combination of independent/dependent slice segments, QP is constant;

— Random combination of independent/dependent slice segments, the QP of each CU is set equal to a value such that Abs(QP − SliceQp$_Y$) > 2.

The first of these groups of eight pictures is coded using all Intra CUs, and the second is coded with CU skipping disabled. The final three of these groups of eight pictures feature a mixture of single slice pictures, and pictures coded using multiple slices and multiple slice segments. Random amounts of slice segment header extension bytes are encoded in each slice header.

Functional stage: Tests that entropy coding is correctly synchronized with different slice types. Tests that the QP predictor is reset to SliceQp$_Y$ at the beginning of every CTU row. May be used to test handling of entry points by a parallel decoder.

Purpose: Check that the decoder properly decodes when entropy coding synchronization is enabled and handle entry points when slice segment header extension data bytes are present. This bitstream does not conform to the Main 10 profile since slice_segment_header_extension_present_flag is equal to 1. However, Main 10 profile decoders shall be able to decode this bitstream and ignore the slice segment header extension data bytes.

4.6.13.7 Test bitstreams #WPP_B_MAIN10

Specification: bit_depth_luma_minus8 is set equal to 2 and bit_depth_chroma_minus8 is set equal to 2. entropy_coding_sync_enabled_flag is set equal to 1. A luma CTB size of 32x32 is used. The bitstream contains six repeated patterns of pictures with a particular ordering and referencing relationship, which are each eight pictures long. The first three of these groups of eight pictures have pictures with the following characteristics:

— One slice in the frame, QP is constant;

— One slice in the frame, the QP of each CU is set equal to a value such that Abs(QP − SliceQp$_Y$) > 2;

— Maximum number of independent slice segments in the frame, at least one slice segment is one CTU long, at least one slice segment is two CTUs long, QP is constant;

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— Maximum number of independent slice segments in the frame, at least one slice segment is one CTU long, at least one slice segment is two CTUs long, the QP of each CU is set equal to a value such that Abs(QP − $SliceQp_Y$) > 2;

— Maximum number of dependent slice segments in the frame, at least one dependent slice segment is one CTU long, at least one dependent slice segment is two CTUs long, QP is constant;

— Maximum number of dependent slice segments in the frame, at least one dependent slice segment is one CTU long, at least one dependent slice segment is two CTUs long, the QP of each CU is set equal to a value such that Abs(QP − $SliceQp_Y$) > 2;

— Random combination of independent/dependent slice segments, QP is constant;

— Random combination of independent/dependent slice segments, the QP of each CU is set equal to a value such that Abs(QP − $SliceQp_Y$) > 2.

The first of these groups of eight pictures is coded using all Intra CUs, and the second is coded with CU skipping disabled. The final three of these groups of eight pictures feature a mixture of single slice pictures, and pictures coded using multiple slices and multiple slice segments. Random amounts of slice segment header extension bytes are encoded in each slice header.

Functional stage: Tests that entropy coding is correctly synchronized with different slice types. Tests that the QP predictor is reset to $SliceQp_Y$ at the beginning of every CTU row. May be used to test handling of entry points by a parallel decoder.

Purpose: Check that the decoder properly decodes when entropy coding synchronization is enabled and handle entry points when slice segment header extension data bytes are present. This bitstream does not conform to the Main 10 profile since slice_segment_header_extension_present_flag is equal to 1. However, Main 10 profile decoders shall be able to decode this bitstream and ignore the slice segment header extension data bytes.

4.6.13.8 Test bitstreams #WPP_C_MAIN10

Specification: bit_depth_luma_minus8 is set equal to 2 and bit_depth_chroma_minus8 is set equal to 2. entropy_coding_sync_enabled_flag is set equal to 1. A luma CTB size of 16x16 is used. The bitstream contains six repeated patterns of pictures with a particular ordering and referencing relationship, which are each eight pictures long. The first three of these groups of eight pictures have pictures with the following characteristics:

— One slice in the frame, QP is constant;

— One slice in the frame, the QP of each CU is set equal to a value such that Abs(QP − $SliceQp_Y$) > 2;

— Maximum number of independent slice segments in the frame, at least one slice segment is one CTU long, at least one slice segment is two CTUs long, QP is constant;

— Maximum number of independent slice segments in the frame, at least one slice segment is one CTU long, at least one slice segment is two CTUs long, the QP of each CU is set equal to a value such that Abs(QP − $SliceQp_Y$) > 2;

— Maximum number of dependent slice segments in the frame, at least one dependent slice segment is one CTU long, at least one dependent slice segment is two CTUs long, QP is constant;

— Maximum number of dependent slice segments in the frame, at least one dependent slice segment is one CTU long, at least one dependent slice segment is two CTUs long, the QP of each CU is set equal to a value such that Abs(QP − $SliceQp_Y$) > 2;

— Random combination of independent/dependent slice segments, QP is constant;

— Random combination of independent/dependent slice segments, the QP of each CU is set equal to a value such that Abs(QP − $SliceQp_Y$) > 2.

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The first of these groups of eight pictures is coded using all Intra CUs, and the second is coded with CU skipping disabled. The final three of these groups of eight pictures feature a mixture of single slice pictures, and pictures coded using multiple slices and multiple slice segments. Random amounts of slice segment header extension bytes are encoded in each slice header.

Functional stage: Tests that entropy coding is correctly synchronized with different slice types. Tests that the QP predictor is reset to $SliceQp_Y$ at the beginning of every CTU row. May be used to test handling of entry points by a parallel decoder.

Purpose: Check that the decoder properly decodes when entropy coding synchronization is enabled and handle entry points when slice segment header extension data bytes are present. This bitstream does not conform to the Main 10 profile since slice_segment_header_extension_present_flag is equal to 1. However, Main 10 profile decoders shall be able to decode this bitstream and ignore the slice segment header extension data bytes.

4.6.13.9 Test bitstreams #WPP_D_MAIN10

Specification: bit_depth_luma_minus8 is set equal to 2 and bit_depth_chroma_minus8 is set equal to 2. entropy_coding_sync_enabled_flag is set equal to 1. A luma CTB size of 64x64 is used. The picture is one CTU wide. The bitstream contains six repeated patterns of pictures with a particular ordering and referencing relationship, which are each eight pictures long. Each of these groups of eight pictures are encoded with varying numbers of slices and slice segments. Even frames have fixed QP, while the QP established at the CU level in odd frames is set such that $Abs(QP - SliceQp_Y) > 2$. The first of these groups of eight pictures is coded using all Intra CUs, and the second is coded with CU skipping disabled. Random amounts of slice segment header extension bytes are encoded in each slice header.

Functional stage: Tests that entropy coding is correctly synchronized when a picture is one CTU wide. Tests that the QP predictor is reset to $SliceQp_Y$ at the beginning of every CTU row. May be used to test handling of entry points by a parallel decoder.

Purpose: Check that the decoder properly decodes when a picture is one CTU wide and handle entry points when slice segment header extension data bytes are present. This bitstream does not conform to the Main 10 profile since slice_segment_header_extension_present_flag is equal to 1. However, Main 10 profile decoders shall be able to decode this bitstream and ignore the slice segment header extension data bytes.

4.6.13.10 Test bitstreams #WPP_E_MAIN10

Specification: bit_depth_luma_minus8 is set equal to 2 and bit_depth_chroma_minus8 is set equal to 2. entropy_coding_sync_enabled_flag is set equal to 1. A luma CTB size of 64x64 is used. The picture is two CTUs wide. The bitstream contains six repeated patterns of pictures with a particular ordering and referencing relationship, which are each eight pictures long. These are encoded with varying numbers of slices and slice segments. Even frames have fixed QP, while the QP established at the CU level in odd frames is set such that $Abs(QP - SliceQp_Y) > 2$. The first of these groups of eight pictures is coded using all Intra CUs, and the second is coded with CU skipping disabled. Random amounts of slice segment header extension bytes are encoded in each slice header.

Functional stage: Tests that entropy coding is correctly synchronized when a picture is two CTUs wide. Tests that the QP predictor is reset to $SliceQp_Y$ at the beginning of every CTU row. May be used to test handling of entry points by a parallel decoder.

Purpose: Check that the decoder properly decodes when a picture is two CTUs wide and handle entry points when slice segment header extension data bytes are present. This bitstream does not conform to the Main 10 profile since slice_segment_header_extension_present_flag is equal to 1. However, Main 10 profile decoders shall be able to decode this bitstream and ignore the slice segment header extension data bytes.

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4.6.13.11 Test bitstreams #WPP_F_MAIN10

Specification: bit_depth_luma_minus8 is set equal to 2 and bit_depth_chroma_minus8 is set equal to 2. entropy_coding_sync_enabled_flag is set equal to 1. A luma CTB size of 64x64 is used. The picture is three CTUs wide. The bitstream contains six repeated patterns of pictures with a particular ordering and referencing relationship, which are each eight pictures long. These are encoded with varying numbers of slices and slice segments. Even frames have fixed QP, while the QP established at the CU level in odd frames is set such that Abs(QP − $SliceQp_Y$) > 2. The first of these groups of eight pictures is coded using all Intra CUs, and the second is coded with CU skipping disabled. Random amounts of slice segment header extension bytes are encoded in each slice header.

Functional stage: Tests that entropy coding is correctly synchronized when a picture is three CTUs wide. Tests that the QP predictor is reset to $SliceQp_Y$ at the beginning of every CTU row. May be used to test handling of entry points by a parallel decoder.

Purpose: Check that the decoder properly decodes when a picture is three CTUs wide and handle entry points when slice segment header extension data bytes are present. This bitstream does not conform to the Main 10 profile since slice_segment_header_extension_present_flag is equal to 1. However, Main 10 profile decoders shall be able to decode this bitstream and ignore the slice segment header extension data bytes.

4.6.14 Test bitstreams — MV-HEVC

4.6.14.1 Test bitstream #MVHEVCS-A

Specification: All slices are coded as I, P or B slices. Only the first picture of each view is coded as an Instantaneous Decoding Refresh (IDR) picture. Each picture contains only one slice. NumViews is equal to 2. NumDirectRefLayers of the non-base view is equal to 1. For each picture in the non-base view, inter-view prediction is enabled. The two views are with the same spatial resolution. All NAL units are encapsulated into the byte stream format specified in Rec. ITU-T H.265 | ISO/IEC 23008-2.

The number of layers is 2, the resolution is 1024x768 and the number of frames is 48.

The output layer sets are specified as the followings:

— OLS_0 - layer: 0, PTL idx: 1 (Main 4), output_layer_flag: 1

— OLS_1 - layer: 0, PTL idx: 1 (Main 4), output_layer_flag: 1

layer: 1, PTL idx: 2 (Multiview Main 4), output_layer_flag: 1

Functional stage: Decoding of two views with inter-view prediction and inter-prediction.

Purpose: To conform the most normal case.

4.6.14.2 Test bitstream #MVHEVCS-B

Specification: All slices of the base view are coded as I slices and all slices of the non-base view are coded with intra prediction or inter-view prediction, thus are P slices. Only the first picture of each view is coded as an IDR picture. Each picture contains only one slice. NumViews is equal to 2. NumDirectRefLayers of the non-base view is equal to 1. The two views are with the same spatial resolution. All NAL units are encapsulated into the byte stream format specified in Rec. ITU-T H.265 | ISO/IEC 23008-2.

The number of layers is 2, the resolution is 1024x768 and the number of frames is 64.

The output layer sets are specified as the followings:

— OLS_0 - layer: 0, PTL idx: 1 (Main 4), output_layer_flag: 1

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— OLS_1 - layer: 0, PTL idx: 1 (Main 4), output_layer_flag: 1

layer: 1, PTL idx: 2 (Multiview Main 4), output_layer_flag: 1

Functional stage: Decoding of two views with only inter-view prediction and intra-prediction.

Purpose: To conform the all intra base view case.

4.6.14.3 Test bitstream #MVHEVCS-C

Specification: All slices are coded as I, P or B slices. Only the first picture of each view is coded as an IDR picture. Each picture contains only one slice. NumViews is equal to 2. NumDirectRefLayers is always equal to 0, meaning inter-view prediction is disabled. The two views are with the same spatial resolution. All NAL units are encapsulated into the byte stream format specified in Rec. ITU-T H.265 | ISO/IEC 23008-2.

The number of layers is 2, the resolution is 1024x768 and the number of frames is 30.

The output layer sets are specified as the followings:

— OLS_0 - layer: 0, PTL idx: 1 (Main 4), output_layer_flag: 1

— OLS_1 - layer: 0, PTL idx: 1 (Main 4), output_layer_flag: 1

layer: 1, PTL idx: 2 (Multiview Main 4), output_layer_flag: 1

Functional stage: Decoding of two views with only inter-prediction and intra-prediction.

Purpose: To conform the case of simulcast case.

4.6.14.4 Test bitstream #MVHEVCS-D

Specification: All slices are coded as I, P or B slices. Only the first picture of each view is coded as an IDR picture. Each picture contains only one slice. NumViews is equal to 2. NumDirectRefLayers is always equal to 0, meaning inter-view prediction is disabled. The two views are with different spatial resolutions. All NAL units are encapsulated into the byte stream format specified in Rec. ITU-T H.265 | ISO/IEC 23008-2.

The number of layers is 2, the resolution is 1024x768 for layer 0 and 512x384 for layer 1, and the number of frames is 25.

The output layer sets are specified as the followings:

— OLS_0 - layer: 0, PTL idx: 1 (Main 5.1), output_layer_flag: 1

— OLS_1 - layer: 0, PTL idx: 1 (Main 5.1), output_layer_flag: 1

layer: 1, PTL idx: 2 (Multiview Main 5.1), output_layer_flag: 1

Functional stage: Decoding of two views with only inter-prediction and intra-prediction.

Purpose: To conform the case when different spatial resolutions for two views are used.

4.6.14.5 Test bitstream #MVHEVCS-E

Specification: All slices are coded as I, P or B slices. Only the first picture of each view is coded as an IDR picture. In addition, every two group of pictures start with an access unit which contains pictures that are all clean random access (CRA) pictures. Each picture contains only one slice. NumViews is equal to 2. NumDirectRefLayers of the non-base view is equal to 1. For each picture in the non-base view, inter-view prediction is enabled. The two views are with the same spatial resolution. All NAL units are encapsulated into the byte stream format specified in Rec. ITU-T H.265 | ISO/IEC 23008-2.

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The number of layers is 2, the resolution is 1024x768 and the number of frames is 48.

The output layer sets are specified as the followings:

— OLS_0 - layer: 0, PTL idx: 1 (Main 4), output_layer_flag: 1

— OLS_1 - layer: 0, PTL idx: 1 (Main 4), output_layer_flag: 1

layer: 1, PTL idx: 2 (Multiview Main 4), output_layer_flag: 1

Functional stage: Decoding of two views with inter-view prediction and inter-prediction.

Purpose: To conform the random access hierarchical B case.

4.6.14.6 Test bitstream #MVHEVCS-F

Specification: All slices are coded as I, P or B slices. Only the first picture of each view is coded as an IDR picture. Thus the first access unit is an IRAP access unit. In addition, for each of every two following group of pictures, an access unit which contains pictures that are all CRA pictures are requested. Other pictures are non-IRAP pictures. Each picture contains only one slice. NumViews is equal to 2. NumActiveRefLayerPics is equal to 1 for each picture in an IRAP access unit of the non-base view, and 0 otherwise, i.e., only for each picture in the non-base view in the IRAP access unit, inter-view prediction is enabled. The two views are with the same spatial resolution. All NAL units are encapsulated into the byte stream format specified in Rec. ITU-T H.265 | ISO/IEC 23008-2.

The number of layers is 2, the resolution is 1024x768 and the number of frames is 48.

The output layer sets are specified as the followings:

— OLS_0 - layer: 0, PTL idx: 1 (Main 4), output_layer_flag: 1

— OLS_1 - layer: 0, PTL idx: 1 (Main 4), output_layer_flag: 1

layer: 1, PTL idx: 2 (Multiview Main 4), output_layer_flag: 1

Functional stage: Decoding of two views with inter-view prediction only for random access points.

Purpose: To conform the flexibility of inter-view prediction applicability scope (inter-view prediction only for IRAP pictures).

4.6.14.7 Test bitstream #MVHEVCS-G

Specification: All slices are coded as I, P or B slices. Only the first picture of each view is coded as an IDR picture. Thus the first access unit is an IRAP access unit. In addition, every two group of pictures start with an access unit which contains pictures that are all CRA pictures. Each picture contains only one slice. NumViews is equal to 3. NumDirectRefLayers of the non-base view is equal to 1. For each picture in the non-base view, inter-view prediction is enabled. The three views are with the same spatial resolution. All NAL units are encapsulated into the byte stream format specified in Rec. ITU-T H.265 | ISO/IEC 23008-2.

The number of layers is 3, the resolution is 1024x768 and the number of frames is 49.

The output layer sets are specified as the followings:

— OLS_0 - layer: 0, PTL idx: 1 (Main 5.1), output_layer_flag: 1

— OLS_1 - layer: 0, PTL idx: 1 (Main 5.1), output_layer_flag: 1

layer: 1, PTL idx: 2 (Multiview Main 5.1), output_layer_flag: 1

— OLS_2- layer: 0, PTL idx: 1 (Main 5.1), output_layer_flag: 1

layer: 1, PTL idx: 2 (Multiview Main 5.1), output_layer_flag: 1

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— OLS_3 - layer: 0, PTL idx: 1 (Main 5.1), output_layer_flag: 1

layer: 1, PTL idx: 2 (Multiview Main 5.1), output_layer_flag: 1

layer: 2, PTL idx: 2 (Multiview Main 5.1), output_layer_flag: 1

Functional stage: Decoding of three views with inter-view prediction and inter-prediction.

Purpose: To conform the random access hierarchical B case (random access 3-view case, PIP configuration: wherein the middle view is the base view and each of the left and right views depends only on the base view).

4.6.14.8 Test bitstream #MVHEVCS-H

Specification: All slices are coded as I, P or B slices. Only the first picture of each view is coded as an IDR picture. Thus the first access unit is an IRAP access unit. In addition, every two group of pictures start with an access unit which contains pictures that are all CRA pictures. Each picture contains only one slice. NumViews is equal to 3. NumDirectRefLayers of the first non-base view is equal to 1 and NumDirectRefLayers of the second non-base view is equal to 2. For each picture in the non-base view, inter-view prediction is enabled. The three views are with the same spatial resolution. All NAL units are encapsulated into the byte stream format specified in Rec. ITU-T H.265 | ISO/IEC 23008-2.

The number of layers is 3, the resolution is 1920x1088 and the number of frames is 50.

The output layer sets are specified as the followings:

— OLS_0 - layer: 0, PTL idx: 1 (Main 5.1), output_layer_flag: 1

— OLS_1 - layer: 0, PTL idx: 1 (Main 5.1), output_layer_flag: 1

layer: 1, PTL idx: 2 (Multiview Main 5.1), output_layer_flag: 1

— OLS_2 - layer: 0, PTL idx: 1 (Main 5.1), output_layer_flag: 1

layer: 1, PTL idx: 2 (Multiview Main 5.1), output_layer_flag: 1

layer: 2, PTL idx: 2 (Multiview Main 5.1), output_layer_flag: 1

Functional stage: Decoding of three views with inter-view prediction and inter-prediction.

Purpose: To conform the random access hierarchical B case (random access 3-view case, IBP configuration: wherein the left view is the base view, right view depends only on the base view and the middle view depends on both left view and right view).

4.6.14.9 Test bitstream #MVHEVCS-I

Specification: All slices are coded as I, P or B slices. Only the first picture of each view is coded as an IDR picture. Thus the first access unit is an IRAP access unit. In addition, every two group of pictures start with an access unit which contains pictures that are all CRA pictures. Each picture contains only one slice. NumViews is equal to 3. NumDirectRefLayers of the first non-base view is equal to 1 and NumDirectRefLayers of the second non-base view is equal to 2. The P view is coded with viewOrderIdx equal to 1. For each picture in the non-base view, inter-view prediction is enabled. Each view contains both texture and depth and the views are with the same spatial resolution. All NAL units are encapsulated into the byte stream format specified in Rec. ITU-T H.265 | ISO/IEC 23008-2. The vertical constraint of the inter-view motion vector applies only to the P view (for both texture layer and depth layer of this view).

The number of layers is 6, the resolution is 1024x768 and the number of frames is 9.

The output layer sets are specified as the followings:

— OLS_0 - layer: 0, PTL idx: 1 (Main 5.1), output_layer_flag: 1, inbld_flag: 0

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— OLS_1 - layer: 0, PTL idx: 1 (Main 5.1), output_layer_flag: 1, inbld_flag: 0

layer: 1, PTL idx: 2 (Multiview Main 5.1), output_layer_flag: 1, inbld_flag: 0

layer: 2, PTL idx: 2 (Multiview Main 5.1), output_layer_flag: 1, inbld_flag: 0

— OLS_2 - layer: 0, PTL idx: 1 (Main 5.1), output_layer_flag: 1, inbld_flag: 0

layer: 1, PTL idx: 2 (Multiview Main 5.1), output_layer_flag: 1, inbld_flag: 0

layer: 2, PTL idx: 2 (Multiview Main 5.1), output_layer_flag: 1, inbld_flag: 0

layer: 3(auxiliary depth), PTL idx: 3 (Main 5.1), output_layer_flag: 1, inbld_flag: 1

layer: 4(auxiliary depth), PTL idx: 2 (Multiview Main 5.1), output_layer_flag: 1, inbld_flag: 0

layer: 5(auxiliary depth), PTL idx: 2 (Multiview Main 5.1), output_layer_flag: 1, inbld_flag: 0

Functional stage: Decoding of three views with inter-view prediction and inter-prediction.

Purpose: To conform the auxiliary picture case.

4.6.15 Test bitstreams — 3D-HEVC

all intra base view configuration: A bitstream in this configuration contains two or three views, each containing one texture view and one depth view. All slices of the base view are coded as I slices and all slices of the non-base view may be coded with only intra prediction or inter-view prediction, thus I or P slices. Only the first picture of each view is coded as an IDR picture. Each picture contains only one slice. NumDirectRefLayers of the non-base views is equal to 1. All texture and depth views are with the same spatial resolution. All NAL units are encapsulated into the byte stream format specified in Rec. ITU-T H.265 | ISO/IEC 23008-2.

random access base view configuration: A bitstream in this configuration contains two or three views, each containing one texture view and one depth view. All slices are coded as I, P or B slices. Only the first picture of each view is coded as an IDR picture. In addition, every two group of pictures start with an access unit which contains pictures that are all CRA pictures. Each picture contains only one slice. NumDirectRefLayers of the non-base view is equal to 1. For each picture in a non-base view, inter-view prediction may be enabled. All texture and depth views are with the same spatial resolution. All NAL units are encapsulated into the byte stream format specified in Rec. ITU-T H.265 | ISO/IEC 23008-2.

3-view configuration: A bitstream in this configuration contains three views, each containing one texture view and one depth view. NumViews is equal to 3. It can be either all intra base view configuration or random access base view configuration.

2-view configuration: A bitstream in this configuration contains two views, each containing one texture view and one depth view. NumViews is equal to 2. It can be either all intra base view configuration or random access base view configuration.

4.6.15.1 Test bitstreams — Texture tools

4.6.15.1.1 General

In this category, test bitstreams are tested with the following default tools enabled. The default tools include inter-view sample prediction, Neighboring Block based Disparity Vector (NBDV, without accessing depth views for disparity vector derivation), and the merge candidate list construction by including additional merge candidates for texture views. The intra prediction tools for depth views are disabled. The inter-component prediction for both the depth dependent texture tools and the texture dependent depth tool are disabled. Specifically, depth refined disparity vector derivation (DoNBDV, as specified by depth_ref_enabled_flag), View Synthesis Prediction (VSP, as specified by vsp_mc_enabled_

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flag) and Depth Predicted Sub-block Partitioning (DBBP, as specified by dbbp_enabled_flag) are disabled.

In the test bistreams of this category, unless specified explicitly, the depth views are coded with MV-HEVC mechanisms (i.e., only inter-view sample prediction and inter-layer motion prediction). Inter-view sample prediction is enabled by allowing an inter-view reference picture to be put into a reference picture list of the current picture.

4.6.15.1.2 Test bitstream #3DHC_T_A

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. In addition to inter-view motion prediction, advanced residual prediction (ARP) is enabled (with iv_res_pred_enabled_flag set equal to 1) in the non-base texture views.

The number of layers is 6, the resolution is 1024x768 and the number of frames is 48.

Functional stage: Decoding of three views with inter-view motion prediction and advanced residual prediction.

Purpose: To conform the ARP.

4.6.15.1.3 Test bitstream #3DHC_T_B

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. In addition to inter-view motion prediction, sub-PU inter-view motion predictionis enabled (with log2_ivmc_sub_pb_size_minus3 less than 3) in the non-base texture views.

The number of layers is 6, the resolution is 1024x768 and the number of frames is 50.

Functional stage: Decoding of three views with sub-PU inter-view motion prediction.

Purpose: To conform the sub-PU inter-view motion prediction.

4.6.15.1.4 Test bitstream #3DHC_T_C

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. In addition to inter-view motion prediction, illumination compensation is enabled (with slice_ic_enabled_flag set equal to 1) in the non-base texture views.

The number of layers is 6, the resolution is 1024x768 and the number of frames is 64.

Functional stage: Decoding of three views with illumination compensation.

Purpose: To conform the illumination compensation.

4.6.15.1.5 Test bitstream #3DHC_T_D

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. In addition to inter-view motion prediction, ARP, sub-PU inter-view motion prediction and illumination compensation are enabled in the non-base texture views.

The number of layers is 6, the resolution is 1024x768 and the number of frames is 64.

Functional stage: Decoding of three views with all texture coding tools enabled.

Purpose: To conform the combined texture coding tools.

4.6.15.1.6 Test bitstream #3DHC_T_E

Specification: The bitstream contains three views, each containing only one texture view but no depth view. All slices are coded as I, P or B slices. Only the first picture of each view is coded as an IDR picture.

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In addition, every two group of pictures start with an access unit which contains pictures that are all CRA pictures. Each picture contains only one slice. NumDirectRefLayers of the non-base view is equal to 1. For each picture in a non-base view, inter-view prediction are enabled, with inter-view motion prediction, ARP, sub-PU inter-view motion prediction and illumination compensation. All NAL units are encapsulated into the byte stream format specified in Rec. ITU-T H.265 | ISO/IEC 23008-2.

The number of layers is 6 and the resolution is 1920x1088 and the number of frames is 60.

Functional stage: Decoding of three texture views only with all texture coding tools enabled.

Purpose: To conform the texture coding tools for texture only bitstream.

4.6.15.2 Test bitstreams — Depth tools

In this category, test bitstreams are tested with the default tools enabled for texture coding. The default tools include inter-view sample prediction, NBDV, and the merge candidate list construction. The intra prediction tools for depth views are disabled by default. The inter-component prediction for both the depth dependent texture tools (DoNBDV, VSP and DBBP) and the texture dependent depth tools are disabled. Depth views are coded by default with MV-HEVC mechanisms (i.e., only inter-view sample prediction).

Depth intra coding tools are tested in both random access base view configuration and all intra base view configuration.

Depth inter coding tools are tested in random access base view configuration.

4.6.15.2.1 Test bitstream #3DHC_D1_A

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. In addition to inter-view sample prediction for depth, depth intra wedge prediction is enabled (with intra_dc_only_wedge_enabled_flag set equal to 1,no_dim_flag set equal to 0 and depth_intra_mode_idx_flag set equal to 0) for depth views.

The number of layers is 6, the resolution is 1920x1088 and the number of frames is 30.

Functional stage: Decoding of three views with depth intra wedge prediction enabled for depth.

Purpose: To conform the depth intra wedge prediction in random access base view configuration.

4.6.15.2.2 Test bitstream #3DHC_D1_B

Specification: The bitstream is coded with all intra base view configuration as well as 3-view configuration. Depth intra wedge prediction is enabled (with intra_dc_only_wedge_enabled_flag set equal to 1, no_dim_flag set equal to 0 and depth_intra_mode_idx_flag set equal to 0) for depth views.

The number of layers is 6, the resolution is 1920x1088 and the number of frames is 3.

Functional stage: Decoding of three views with depth intra wedge prediction enabled for depth.

Purpose: To conform the depth intra wedge prediction in all intra base view configuration.

4.6.15.2.3 Test bitstream #3DHC_D1_C

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. In addition to inter-view sample prediction for depth, intra Segmental DC (SDC) mode is enabled (with intra_dc_only_wedge_enabled_flag set equal to 1 and no_dim_flag set equal to 1) for depth views.

The number of layers is 6, the resolution is 1024x768 and the number of frames is 50.

Functional stage: Decoding of three views with intra SDC enabled for depth.

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Purpose: To conform the intra SDC in random access base view configuration.

4.6.15.2.4 Test bitstream #3DHC_D1_D

Specification: The bitstream is coded with all intra base view configuration as well as 3-view configuration. In addition, intra Segmental DC (SDC) mode is enabled for depth views.

The number of layers is 6, the resolution is 1024x768 and the and the number of frames is 50.

Functional stage: Decoding of three views with intra SDC enabled for depth.

Purpose: To conform the intra SDC in all intra base view configuration.

4.6.15.2.5 Test bitstream #3DHC_D1_E

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. In addition to inter-view sample prediction for depth, intra skip mode (with skip_intra_enabled_flag set equal to 1) is enabled for depth views.

The number of layers is 6, the resolution is 1920x1088 and the number of frames is 30.

Functional stage: Decoding of three views with depth intra skip mode enabled for depth.

Purpose: To conform the depth intra skip mode in random access base view configuration.

4.6.15.2.6 Test bitstream #3DHC_D1_F

Specification: The bitstream is coded with all intra base view configuration as well as 3-view configuration. In addition, intra skip mode is enabled for depth views.

The number of layers is 6, the resolution is 1920x1088 and the number of frames is 30.

Functional stage: Decoding of three views with depth intra skip mode enabled for depth.

Purpose: To conform the depth intra skip mode in all intra base view configuration.

4.6.15.2.7 Test bitstream #3DHC_D1_G

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. In addition to inter-view sample prediction for depth, the all depth intra tools are enabled together with depth lookup table (DLT, with dlt_flag set equal to 1).

The number of layers is 6, the resolution is 1024x768 and the number of frames is 64.

Functional stage: Decoding of three views with depth intra coding tools enabled.

Purpose: To conform the depth Intra coding tools in random access base view configuration.

4.6.15.2.8 Test bitstream #3DHC_D1_H

Specification: The bitstream is coded with all intra base view configuration as well as 3-view configuration. In addition, the all depth Intra tools are enabled together with DLT.

The number of layers is 6, the resolution is 1024x768 and the number of frames is 64.

Functional stage: Decoding of three views with depth intra coding tools enabled.

Purpose: To conform the depth intra coding tools in all intra base view configuration.

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4.6.15.2.9 Test bitstream #3DHC_D2_A

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. In addition to inter-view sample prediction for depth, the inter-view motion prediction is enabled for depth views.

The number of layers is 6, the resolution is 1920x1088 and the number of frames is 60.

Functional stage: Decoding of three views with inter-view motion prediction for depth views.

Purpose: To conform the inter-view motion prediction for depth.

4.6.15.2.10 Test bitstream #3DHC_D2_B

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. In addition to inter-view sample prediction for depth, the inter Segmental SDC (inter SDC) is enabled (with inter_dc_only_enabled_flag set equal to 1) for depth views.

The number of layers is 6, the resolution is 1920x1088 and the number of frames is 50.

Functional stage: Decoding of three views with inter SDC enabled for depth views.

Purpose: To conform the inter SDC for depth.

4.6.15.3 Test bitstreams — Depth dependent texture tools

4.6.15.3.1 General

In this category, test bitstreams are tested with the all texture coding tools enabled. The default tools include inter-view sample prediction, inter-layer motion prediction, NBDV, and the merge candidate list construction. The inter-component prediction for both the depth dependent texture tools (DoNBDV, VSP and DBBP) and the texture dependent depth tools are disabled by default. Depth views are coded by default with MV-HEVC mechanisms (i.e., only inter-view sample prediction and inter-layer motion prediction).

4.6.15.3.2 Test bitstream #3DHC_DT_A

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. In addition to ARP, sub-PU inter-view motion prediction and illumination compensation, depth refined disparity vector derivation (DoNBDV) is enabled (with depth_ref_enabled_flag set equal to 1) for non-base texture views.

The number of layers is 6, the resolution is 1024x768 and the number of frames is 60.

Functional stage: Decoding of three views with DoNBDV enabled for texture views.

Purpose: To conform the DoNBDV for texture.

4.6.15.3.3 Test bitstream #3DHC_DT_B

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. In addition to ARP, sub-PU inter-view motion prediction and illumination compensation, VSP is enabled (with vsp_mc_enabled_flag set equal to 1) for non-base texture views.

The number of layers is 6, the resolution is 1024x768 and the number of frames is 25.

Functional stage: Decoding of three views with VSP enabled for texture views.

Purpose: To conform the VSP for texture.

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4.6.15.3.4 Test bitstream #3DHC_DT_C

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. In addition to ARP, sub-PU inter-view motion prediction and illumination compensation, DBBP is enabled (with dbbp_enabled_flag set equal to 1) for non-base texture views.

The number of layers is 6, the resolution is 1024x768 and the number of frames is 64.

Functional stage: Decoding of three views with DBBP enabled for texture views.

Purpose: To conform the inter DBBP for texture.

4.6.15.3.5 Test bitstream #3DHC_DT_D

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. In addition to ARP, sub-PU inter-view motion prediction and illumination compensation, All the depth dependent texture tools (DoNBDV, VSP and DBBP) are enabled for non-base texture views.

The number of layers is 6, the resolution is 1024x768 and the number of frames is 25.

Functional stage: Decoding of three views with depth dependent texture tools.

Purpose: To conform the combined depth dependent texture tools.

4.6.15.4 Test bitstreams — Texture dependent depth tools

4.6.15.4.1 General

In this category, test bitstreams are tested with the all texture coding tools and depth dependent texture tools enabled for non-base texture views. Depth views are coded with depth coding tools enabled by default and with the texture dependent depth tools disabled unless otherwise specified.

4.6.15.4.2 Test bitstream #3DHC_TD_A

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. In addition to all the texture coding tools, all the depth coding tools and depth dependent texture coding tools, the texture merge candidate with sub-block partitioning (sub-PU MPI) is enabled (with tex_mc_enabled_flag set equal to 1 and log2_texmc_sub_pb_size_minus3 set less than 3).

The number of layers is 6, the resolution is 1024x768 and the number of frames is 48.

Functional stage: Decoding of three views with sub-PU MPI enabled for depth views.

Purpose: To conform the sub-PU MPI for depth.

4.6.15.4.3 Test bitstream #3DHC_TD_B

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. In addition to all the texture coding tools, all the depth coding tools and depth dependent texture coding tools, the texture merge candidate (MPI) is enabled (with tex_mc_enabled_flag set equal to 1 and log2_texmc_sub_pb_size_minus3 set equal to 3).

The number of layers is 6, the resolution is 1920x1088 and the number of frames is 30.

Functional stage: Decoding of three views with MPI enabled for depth views.

Purpose: To conform the MPI for depth.

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4.6.15.4.4 Test bitstream #3DHC_TD_C

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. In addition to all the texture coding tools, all the depth coding tools and depth dependent texture coding tools, quad-tree limitation (QTL) is enabled (with, cqt_cu_part_pred_enabled_flag set equal to 1).

The number of layers is 6, the resolution is 1024x768 and the number of frames is 60.

Functional stage: Decoding of three views with QTL enabled for depth views.

Purpose: To conform the QTL for depth.

4.6.15.4.5 Test bitstream #3DHC_TD_D

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. In addition to all the texture coding tools, all the depth coding tools and depth dependent texture coding tools, depth intra contour prediction mode is enabled (with intra_contour_enabled_flag set equal to 1, no_dim_flag set equal to 0 and depth_intra_mode_idx_flag set equal to 1).

The number of layers is 6, the resolution is 1920x1088 and the number of frames is 30.

Functional stage: Decoding of three views with depth intra contour prediction mode enabled for depth views.

Purpose: To conform the depth intra contour prediction for depth in random access base view configuration.

4.6.15.4.6 Test bitstream #3DHC_TD_E

Specification: The bitstream is coded with all intra base view configuration as well as 3-view configuration. In addition to all the texture coding tools, all the depth coding tools and depth dependent texture coding tools, depth intra contour prediction mode is enabled.

The number of layers is 6, the resolution is 1920x1088 and the number of frames is 3.

Functional stage: Decoding of three views with depth intra contour prediction mode enabled for depth views.

Purpose: To conform the depth intra contour prediction for depth in all intra base view configuration.

4.6.15.5 Test bitstreams — Other combined cases

4.6.15.5.1 Test bitstream #3DHC_C_A

Specification: The bitstream is coded with random access base view configuration as well as 3-view configuration. All the texture coding tools, all the depth coding tools, all the depth dependent texture coding tools and all the texture dependent depth coding tools are enabled.

The number of layers is 6, the resolution is 1920x1088 and the number of frames is 60.

Functional stage: Decoding of three views with coding tools enabled.

Purpose: To conform the common test condition case.

4.6.15.5.2 Test bitstream #3DHC_C_B

Specification: The bitstream is coded with all intra base view configuration as well as 3-view configuration. All the texture coding tools, all the depth coding tools, all the depth dependent texture coding tools and all the texture dependent depth coding tools are enabled.

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The number of layers is 6, the resolution is 1920x1088 and the number of frames is 60.

Functional stage: Decoding of three views with coding tools enabled for all intra base view configuration.

Purpose: To conform the all intra base view configuration.

4.6.15.5.3 Test bitstream #3DHC_C_C

Specification: The bitstream is coded with random access base view configuration as well as 2-view configuration. All the texture coding tools, all the depth coding tools, all the depth dependent texture coding tools and all the texture dependent depth coding tools are enabled.

The number of layers is 4, the resolution is 1024x768 and the number of frames is 64.

Functional stage: Decoding of two views with coding tools enabled.

Purpose: To conform the 2-view case.

4.6.16 Test bitstreams — Format Range Extensions

4.6.16.1 Test bitstreams #ADJUST_IPRED_ANGLE_A_REXt

Specification: All slices are coded as I slices. bit_depth_luma_minus8 is set equal to 2 and bit_depth_chroma_minus8 is set equal to 2. chroma_format_idc is set equal to 2. All intra prediction modes for all PU sizes of chroma (35 modes for each chroma PU size of 16x32, 8x16, and 4x8).

Functional stage: Intra prediction.

Purpose: Check that the decoder properly decodes with all the intra prediction modes.

4.6.16.2 Test bitstreams #CCP_8bit_REXt

Specification: All slices are coded as I or B slices. bit_depth_luma_minus8 is set equal to 0 and bit_depth_chroma_minus8 is set equal to 0. chroma_format_idc is set equal to 3. cross_component_prediction_enabled_flag is set equal to 1.

Functional stage: Test reconstruction process of cross component prediction.

Purpose: Check that the decoder properly decodes with cross-component prediction.

4.6.16.3 Test bitstreams #CCP_10bit_REXt

Specification: All slices are coded as I or B slices. bit_depth_luma_minus8 is set equal to 2 and bit_depth_chroma_minus8 is set equal to 2. chroma_format_idc is set equal to 3. cross_component_prediction_enabled_flag is set equal to 1.

Functional stage: Test the reconstruction process of cross component prediction.

Purpose: Check that the decoder properly decodes with cross-component prediction.

4.6.16.4 Test bitstreams #CCP_12bit_REXt

Specification: All slices are coded as I or B slices. bit_depth_luma_minus8 is set equal to 4 and bit_depth_chroma_minus8 is set equal to 4. chroma_format_idc is set equal to 3. cross_component_prediction_enabled_flag is set equal to 1.

Functional stage: Test the reconstruction process of cross component prediction.

Purpose: Check that the decoder properly decodes with cross-component prediction.

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4.6.16.5 Test bitstreams #Bitdepth_A_RExt

Specification: All slices are coded as I or B slices. The value of bit_depth_luma_minus8 is higher than that of bit_depth_chroma_minus8. chroma_format_idc is set equal to 3.

Functional stage: Test the reconstruction process with different bit depth for luma and chroma.

Purpose: Check that the decoder properly decodes when the bit depth of luma and chroma are not the same.

4.6.16.6 Test bitstreams #Bitdepth_B_RExt

Specification: All slices are coded as I or B slices. The value of bit_depth_chroma_minus8 is higher than that of bit_depth_luma_minus8. chroma_format_idc is set equal to 3.

Functional stage: Test the reconstruction process of different bit depth for luma and chroma.

Purpose: Check that the decoder properly decodes when the bit depth of luma and chroma are not the same.

4.6.16.7 Test bitstreams #QMATRIX_A_RExt

Specification: All slices are coded as I or B slices. The value of general_max_422chroma_constraint_flag, general_max_420chroma_constraint_flag and general_max_monochrome_constraint_flag is equal to 0. Various scaling list data are included with and without transform skip for all transform block sizes over different QP values.

Functional stage: Test the reconstruction process with scaling lists.

Purpose: Check that the decoder properly decodes with various scaling list data, with and without transform skip for all transform block sizes over different QP values.

4.6.16.8 Test bitstreams #SAO_A_RExt

Specification: All slices are coded as I or B slices. bit_depth_luma_minus8 is set equal to 4 and bit_depth_chroma_minus8 is set equal to 4. chroma_format_idc is set equal to 3. log2_sao_offset_scale_luma is set equal to 2. log2_sao_offset_scale_chroma is set equal to 2.

Functional stage: Test the reconstruction process of SAO.

Purpose: Check that the decoder properly decodes the specified PPS bit shift parameters for scaling up the SAO offset values.

4.6.16.9 Test bitstreams #PERSIST_PARAM_A_RExt

Specification: All slices are coded as I slices. bit_depth_luma_minus8 is set equal to 4 and bit_depth_chroma_minus8 is set equal to 4. chroma_format_idc is set equal to 3. persistent_rice_adaptation_enabled_flag is set equal to 0 or 1.

Functional stage: Test the binarization process with persistent Golomb Rice parameters.

Purpose: Check that the decoder properly decodes with the incrementing and decrementing of all four of the persistent Golomb Rice parameters, and the enabling/disabling of the tool.

4.6.16.10 Test bitstreams #HIGH_TP_8BIT_RExt

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 0. chroma_format_idc is set equal to 3. The bitstream consists of a concatenation of two coded video sequences of one frame each:

— the first with extended_precision_processing_flag equal to 0;

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— the second with extended_precision_processing_flag equal to 1.

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the High Throughput 4:4:4 16 Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.11 Test bitstreams #HIGH_TP_10BIT_RExt

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 2. chroma_format_idc is set equal to 3. The bitstream consists of a concatenation of two coded video sequences of one frame each:

— the first with extended_precision_processing_flag equal to 0;

— the second with extended_precision_processing_flag equal to 1.

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the High Throughput 4:4:4 16 Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.12 Test bitstreams #HIGH_TP_12BIT_RExt

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 4. chroma_format_idc is set equal to 3. The bitstream consists of a concatenation of two coded video sequences of one frame each:

— the first with extended_precision_processing_flag equal to 0;

— the second with extended_precision_processing_flag equal to 1.

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the High Throughput 4:4:4 16 Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.13 Test bitstreams #HIGH_TP_16BIT_RExt

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 8. chroma_format_idc is set equal to 3. The bitstream consists of a concatenation of two coded video sequences of one frame each:

— the first with extended_precision_processing_flag equal to 0;

— the second with extended_precision_processing_flag equal to 1.

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the High Throughput 4:4:4 16 Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.14 Test bitstreams #HIGH_TP_8BIT_RExt

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 0. chroma_format_idc is set equal to 3. The bitstream consists of a concatenation of two coded video sequences of one frame each:

— the first with extended_precision_processing_flag equal to 0;

— the second with extended_precision_processing_flag equal to 1.

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Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the Main 4:4:4 16 Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.15 Test bitstreams #HIGH_TP_10BIT_REXt

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 2. chroma_format_idc is set equal to 3. The bitstream consists of a concatenation of two coded video sequences of one frame each:

— the first with extended_precision_processing_flag equal to 0;

— the second with extended_precision_processing_flag equal to 1.

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the Main 4:4:4 16 Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.16 Test bitstreams #HIGH_TP_12BIT_REXt

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 4. chroma_format_idc is set equal to 3. The bitstream consists of a concatenation of two coded video sequences of one frame each:

— the first with extended_precision_processing_flag equal to 0;

— the second with extended_precision_processing_flag equal to 1.

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the Main 4:4:4 16 Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.17 Test bitstreams #HIGH_TP_16BIT_REXt

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 8. chroma_format_idc is set equal to 3. The bitstream consists of a concatenation of two coded video sequences of one frame each:

— the first with extended_precision_processing_flag equal to 0;

— the second with extended_precision_processing_flag equal to 1.

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the Main 4:4:4 16 Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.18 Test bitstreams #IPCM_A_REXt

Specification: All slices are coded as I slices. chroma_format_idc is set equal to 2. pcm_enabled_flag is equal to 1. Both pcm_sample_bit_depth_luma_minus1 and pcm_sample_bit_depth_chroma_minus1 are equal to 7. log2_min_pcm_luma_coding_block_size_minus3, log2_diff_max_min_pcm_luma_coding_block_size, and pcm_loop_filter_disabled_flag are equal to 0, 1 and 0, respectively.

Functional stage: Test the parsing of pcm_flags in coding unit syntax. Test parsing of 4:2:2 format.

Purpose: Check that decoder properly decodes slices of coded frames containing pcm_flag.

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4.6.16.19 Test bitstreams #IPCM_B_RExt

Specification: All slices are coded as I slices. chroma_format_idc is set equal to 3. pcm_enabled_flag is equal to 1. Both pcm_sample_bit_depth_luma_minus1 and pcm_sample_bit_depth_chroma_minus1 are equal to 7. log2_min_pcm_luma_coding_block_size_minus3, log2_diff_max_min_pcm_luma_coding_block_size, and pcm_loop_filter_disabled_flag are equal to 0, 1 and 0, respectively.

Functional stage: Test the parsing of pcm_flags in coding unit syntax. Test parsing of 4:4:4 format, pcm_sample_luma and pcm_sample_chroma data.

Purpose: Check that decoder properly decodes slices of coded frames containing pcm_flag.

4.6.16.20 Test bitstreams #TSCTX_8bit_I_RExt

Specification: All slices are coded as I slices. bit_depth_luma_minus8 is set equal to 0 and bit_depth_chroma_minus8 is set equal to 0. chroma_format_idc is set equal to 3. transform_skip_context_enabled_flag is set equal to 1. log2_max_transform_skip_block_size_minus2 is equal to 0.

Functional stage: Test the reconstruction process with transform skip.

Purpose: Check that decoder properly decodes with transform skip context.

4.6.16.21 Test bitstreams #TSCTX_8bit_RExt

Specification: All slices are coded as I or B slices. bit_depth_luma_minus8 is set equal to 0 and bit_depth_chroma_minus8 is set equal to 0. chroma_format_idc is set equal to 3. transform_skip_context_enabled_flag is set equal to 1. log2_max_transform_skip_block_size_minus2 is equal to 0.

Functional stage: Test the reconstruction process with transform skip.

Purpose: Check that decoder properly decodes with transform skip context.

4.6.16.22 Test bitstreams #TSCTX_10bit_I_RExt

Specification: All slices are coded as I slices. bit_depth_luma_minus8 is set equal to 2 and bit_depth_chroma_minus8 is set equal to 2. chroma_format_idc is set equal to 3. transform_skip_context_enabled_flag is set equal to 1. log2_max_transform_skip_block_size_minus2 is equal to 0.

Functional stage: Test the reconstruction process with transform skip.

Purpose: Check that decoder properly decodes with transform skip context.

4.6.16.23 Test bitstreams #TSCTX_10bit_RExt

Specification: All slices are coded as I or B slices. bit_depth_luma_minus8 is set equal to 2 and bit_depth_chroma_minus8 is set equal to 2. chroma_format_idc is set equal to 3. transform_skip_context_enabled_flag is set equal to 1. log2_max_transform_skip_block_size_minus2 is equal to 0.

Functional stage: Test the reconstruction process with transform skip.

Purpose: Check that decoder properly decodes with transform skip context.

4.6.16.24 Test bitstreams #TSCTX_12bit_I_RExt

Specification: All slices are coded as I slices. bit_depth_luma_minus8 is set equal to 4 and bit_depth_chroma_minus8 is set equal to 4. chroma_format_idc is set equal to 3. transform_skip_context_enabled_flag is set equal to 1. log2_max_transform_skip_block_size_minus2 is equal to 0.

Functional stage: Test the reconstruction process with transform skip.

Purpose: Check that decoder properly decodes with transform skip context.

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4.6.16.25 Test bitstreams #TSCTX_12bit_RExt

Specification: All slices are coded as I or B slices. bit_depth_luma_minus8 is set equal to 4 and bit_depth_chroma_minus8 is set equal to 4. chroma_format_idc is set equal to 3. transform_skip_context_enabled_flag is set equal to 1. log2_max_transform_skip_block_size_minus2 is equal to 0.

Functional stage: Test the reconstruction process with transform skip.

Purpose: Check that decoder properly decodes with transform skip context.

4.6.16.26 Test bitstreams #ExplictRdpcm_A_RExt

Specification: All slices are coded as I or B slices. bit_depth_luma_minus8 is set equal to 4 and bit_depth_chroma_minus8 is set equal to 4. chroma_format_idc is set equal to 3. explicit_rdpcm_enabled_flag is set equal to 1.

Functional stage: Test the reconstruction process with the residual modification process for blocks using a transform bypass.

Purpose: Check that decoder properly decodes with the explicit residual modification process for blocks using a transform bypass where on even numbered TUs the residual modification process for blocks using a transform bypass is disabled while on odd numbered TUs it is decided via prediction error minimization.

4.6.16.27 Test bitstreams #ExplictRdpcm_B_RExt

Specification: All slices are coded as I or B slices. bit_depth_luma_minus8 is set equal to 4 and bit_depth_chroma_minus8 is set equal to 4. chroma_format_idc is set equal to 3. explicit_rdpcm_enabled_flag is set equal to 1.

Functional stage: Test the reconstruction process with the residual modification process for blocks using a transform bypass.

Purpose: Check that decoder properly decodes with explicit the residual modification process for blocks using a transform bypass where on even numbered TUs the residual modification process for blocks using a transform bypass is disabled while on odd numbered TUs it is decided via prediction error minimization.

4.6.16.28 Test bitstreams #Main_422_10_A_RExt

Specification: All slices are coded as I or B slices. bit_depth_luma_minus8 is set equal to 2 and bit_depth_chroma_minus8 is set equal to 2. chroma_format_idc is set equal to 2.

Functional stage: Test the reconstruction process with various combinations of tools.

Purpose: Check that decoder properly decodes with various combinations of coding tools.

4.6.16.29 Test bitstreams #Main_422_10_B_RExt

Specification: All slices are coded as I or B slices. bit_depth_luma_minus8 is set equal to 2 and bit_depth_chroma_minus8 is set equal to 2. chroma_format_idc is set equal to 2.

Functional stage: Test reconstruction process with various combinations of tools.

Purpose: Check that decoder properly decodes bitstream with various combinations of coding tools.

4.6.16.30 Test bitstreams #GENERAL_8b_400_RExt

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 0. chroma_format_idc is set equal to 0.

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Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the Monochrome profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.31 Test bitstreams #GENERAL_8b_420_REext

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 0. chroma_format_idc is set equal to 1.

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the Main Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.32 Test bitstreams #GENERAL_8b_444_REext

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 0. chroma_format_idc is set equal to 3. The stream consists of a concatenation of sequences, each just two pictures:

— the first of each pair has cross_component_prediction_prediction_enabled_flag equal to 0,

— the second has cross_component_prediction_prediction_enabled_flag equal to 1.

The concatenated sequences consist of:

— Sequence 0: transform_skip_rotation_enabled_flag equal to 0, transform_skip_context_enabled_flag equal to 0, implicit_rdpcm_enabled_flag equal to 0, intra_smoothing_disabled_flag equal to 0, persistent_rice_adaptation_enabled_flag equal to 0, chroma_qp_offset_list_enabled_flag equal to 0;

— Sequence 1: as in sequence 0, but with transform_skip_rotation equal to 1;

— Sequence 2: as in sequence 0, but with transform_skip_context equal to 1;

— Sequence 3: as in sequence 0, but with implicit_rdpcm equal to 1;

— Sequence 4: as in sequence 0, but with intra_smoothing_disabled equal to 1;

— Sequence 5: as in sequence 0, but with persistent_rice_adaptation_enabled_flag equal to 1;

— Sequence 6: as in sequence 0, but with chroma_qp_offset_list_enabled_flag equal to 1.

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the Main 4:4:4 Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.33 Test bitstreams #GENERAL_10b_420_REext

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 2. chroma_format_idc is set equal to 1.

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the Main 10 Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

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4.6.16.34 Test bitstreams #GENERAL_10b_422_REext

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 2. chroma_format_idc is set equal to 2. The stream consists of a concatenation of sequences, each containing just one picture:

— Sequence 0: chroma_qp_offset_list_enabled_flag equal to 0;

— Sequence 1: chroma_qp_offset_list_enabled_flag equal to 1

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the Main 4:2:2 10 Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.35 Test bitstreams #GENERAL_10b_444_REext

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 2. chroma_format_idc is set equal to 3. The stream consists of a concatenation of sequences, each just two pictures:

— the first of each pair has cross_component_prediction_prediction_enabled_flag equal to 0,

— the second has cross_component_prediction_prediction_enabled_flag equal to 1.

The concatenated sequences consist of:

— Sequence 0: transform_skip_rotation_enabled_flag equal to 0, transform_skip_context_enabled_flag equal to 0, implicit_rdpcm_enabled_flag equal to 0, intra_smoothing_disabled_flag equal to 0, persistent_rice_adaptation_enabled_flag equal to 0;

— Sequence 1: as in sequence 0, but with transform_skip_rotation equal to 1;

— Sequence 2: as in sequence 0, but with transform_skip_context equal to 1;

— Sequence 3: as in sequence 0, but with implicit_rdpcm equal to 1;

— Sequence 4: as in sequence 0, but with intra_smoothing_disabled equal to 1;

— Sequence 5: as in sequence 0, but with persistent_rice_adaptation_enabled_flag equal to 1.

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the Main 4:4:4 10 Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.36 Test bitstreams #GENERAL_12b_400_REext

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 4. chroma_format_idc is set equal to 0.

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the Monochrome 12 profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.37 Test bitstreams #GENERAL_12b_420_REext

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 4. chroma_format_idc is set equal to 1.

Functional stage: Test the extended precision processing function.

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Purpose: Check that the decoder properly decodes a bitstream for the Main 12 Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.38 Test bitstreams #GENERAL_12b_422_REXT

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 4. chroma_format_idc is set equal to 2. The stream consists of a concatenation of sequences, each containing just one picture:

— Sequence 0: chroma_qp_offset_list_enabled_flag equal to 0;

— Sequence 1: chroma_qp_offset_list_enabled_flag equal to 1.

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the Main 4:2:2 12 Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.39 Test bitstreams #GENERAL_12b_444_REXT

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 4. chroma_format_idc is set equal to 3. The stream consists of a concatenation of sequences, each just two pictures:

— the first of each pair has cross_component_prediction_prediction_enabled_flag equal to 0,

— the second has cross_component_prediction_prediction_enabled_flag equal to 1.

The concatenated sequences consist of:

— Sequence 0: transform_skip_rotation_enabled_flag equal to 0, transform_skip_context_enabled_flag equal to 0, implicit_rdpcm_enabled_flag equal to 0, intra_smoothing_disabled_flag equal to 0, persistent_rice_adaptation_enabled_flag equal to 0, chroma_qp_offset_list_enabled_flag equal to 0;

— Sequence 1: as in sequence 0, but with transform_skip_rotation equal to 1;

— Sequence 2: as in sequence 0, but with transform_skip_context equal to 1;

— Sequence 3: as in sequence 0, but with implicit_rdpcm equal to 1;

— Sequence 4: as in sequence 0, but with intra_smoothing_disabled equal to 1;

— Sequence 5: as in sequence 0, but with persistent_rice_adaptation_enabled_flag equal to 1;

— Sequence 6: as in sequence 0, but with chroma_qp_offset_list_enabled_flag equal to 1.

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the Main 4:4:4 12 Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.40 Test bitstreams #GENERAL_16b_400_REXT

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 8. chroma_format_idc is set equal to 0. The stream consists of a concatenation of sequences, each containing just one picture:

— Sequence 0: transform_skip_rotation_enabled_flag equal to 0, transform_skip_context_enabled_flag equal to 0, implicit_rdpcm_enabled_flag equal to 0, intra_smoothing_disabled_flag equal to 0, persistent_rice_adaptation_enabled_flag equal to 0, extended_precision_processing_flag equal to 0;

— Sequence 1: as in sequence 0, but with transform_skip_rotation equal to 1;

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— Sequence 2: as in sequence 0, but with transform_skip_context equal to 1;

— Sequence 3: as in sequence 0, but with implicit_rdpcm equal to 1;

— Sequence 4: as in sequence 0, but with intra_smoothing_disabled equal to 1;

— Sequence 5: as in sequence 0, but with persistent_rice_adaptation_enabled_flag equal to 1;

— Sequence 6: as in sequence 0, but with extended_precision_processing_flag equal to 1.

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the Monochrome 16 profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.41 Test bitstreams #GENERAL_16b_444_RExt

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 8. chroma_format_idc is set equal to 3. The stream consists of a concatenation of sequences, each just two pictures:

— the first of each pair has cross_component_prediction_prediction_enabled_flag equal to 0,

— the second has cross_component_prediction_prediction_enabled_flag equal to 1.

The concatenated sequences consist of:

— Sequence 0: transform_skip_rotation_enabled_flag equal to 0, transform_skip_context_enabled_flag equal to 0, implicit_rdpcm_enabled_flag equal to 0, intra_smoothing_disabled_flag equal to 0, persistent_rice_adaptation_enabled_flag equal to 0, extended_precision_processing_flag equal to 0, chroma_qp_offset_list_enabled_flag equal to 0;

— Sequence 1: as in sequence 0, but with transform_skip_rotation equal to 1;

— Sequence 2: as in sequence 0, but with transform_skip_context equal to 1;

— Sequence 3: as in sequence 0, but with implicit_rdpcm equal to 1;

— Sequence 4: as in sequence 0, but with intra_smoothing_disabled equal to 1;

— Sequence 5: as in sequence 0, but with persistent_rice_adaptation_enabled_flag equal to 1;

— Sequence 6: as in sequence 0, but with extended_precision_processing_flag equal to 1;

— Sequence 7: as in sequence 0, but with chroma_qp_offset_list_enabled_flag equal to 1.

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the Main 4:4:4 16 Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.42 Test bitstreams #GENERAL_16b_444_HighThroughput_RExt

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 8. chroma_format_idc is set equal to 3. The stream consists of a concatenation of sequences, each just two pictures:

— the first of each pair has cross_component_prediction_prediction_enabled_flag equal to 0,

— the second has cross_component_prediction_prediction_enabled_flag equal to 1.

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The concatenated sequences consist of:

— Sequence 0: transform_skip_rotation_enabled_flag equal to 0, transform_skip_context_enabled_flag equal to 0, implicit_rdpcm_enabled_flag equal to 0, intra_smoothing_disabled_flag equal to 0, persistent_rice_adaptation_enabled_flag equal to 0, extended_precision_processing_flag equal to 0, chroma_qp_offset_list_enabled_flag equal to 0

— Sequence 1: as in sequence 0, but with transform_skip_rotation equal to 1

— Sequence 2: as in sequence 0, but with transform_skip_context equal to 1

— Sequence 3: as in sequence 0, but with implicit_rdpcm equal to 1

— Sequence 4: as in sequence 0, but with intra_smoothing_disabled equal to 1

— Sequence 5: as in sequence 0, but with persistent_rice_adaptation_enabled_flag equal to 1

— Sequence 6: as in sequence 0, but with extended_precision_processing_flag equal to 1

— Sequence 7: as in sequence 0, but with chroma_qp_offset_list_enabled_flag equal to 1

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the High Throughput 4:4:4 16 Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.16.43 Test bitstreams #WAVETILES_RExt

Specification: All slices are coded as I slices. bit_depth_luma_minus8 and bit_depth_chroma_minus8 are set equal to 8. chroma_format_idc is set equal to 3. The purpose of the stream is to exercise the combination of simultaneously using wavefronts and tiles.

The stream consists of four sequences of one picture:

— Sequence 1: 1 slice per picture;

— Sequence 2: 1 slice per tile;

— Sequence 3: 1 slice for at most 6 CTUs;

— Sequence 4: 1 slice segment for at most 6 CTUs;

— Sequences 3 and 4 split the picture into multiple slice/slice segments per tile.

Functional stage: Test the extended precision processing function.

Purpose: Check that the decoder properly decodes a bitstream for the High Throughput 4:4:4 16 Intra profile with general_lower_bit_rate_constraint_flag equal to 1.

4.6.17 Test bitstreams — Scalable extensions

4.6.17.1 Test bitstreams — Layer ID

4.6.17.1.1 Test bitstream #LAYERID_A_NOKIA

Specification: All slices are coded as I, P and B slices. The LAYERID_A_NOKIA bitstream has two layers –with layer ID values 0 and 2. The layer with layer ID equal to 2 is coded as an auxiliary layer. The bitstream contains only nine access units.

Functional stage: Test gaps in the layer ID values.

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Purpose: Check that the decoder can properly decode bitstreams that have layers with gaps in the layer ID values.

Bitstream: LAYERID_A_NOKIA_2.bit

Coding structure: Hierarchical B-frames with GOP size of 8.

Number of access units: 9

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Main profile, Main tier, Level 4.

Output layer sets: The bitstream contains three output layer sets:

— OLS 0 includes the following layer:

  — Layer with layer ID value 0, PTL Idx 1

— OLS 1 includes the following layers:

  — Layer with layer ID value 0, PTL Idx 1

  — Layer with layer ID value 2, PTL Idx 2

— OLS 2 includes the following layer:

  — Layer with layer ID value 2, PTL Idx 2

Resolution of each layer: 1280x720

Frame rate: 24 fps

4.6.17.1.2 Test bitstream #MVD_A_IDCC

Specification: All slices are coded as I, P and B slices. The MVD_A_IDCC bitstream has two layers. The bitstream contains only eight access units. The value of DefaultTargetOutputLayerIdc is set equal to 1. Layer 1 uses inter-layer sample prediction from Layer 0.

Functional stage: Test disabling inter-layer motion vector prediction.

Purpose: Check that the decoder can properly decode when the enhancement layer performs inter-layer sample prediction from the base layer and motion vector prediction is disabled.

Bitstream: MVD_A_IDCC_1.bit

Coding structure: Hierarchical B-frames with four temporal sub-layers.

Number of access units: 8

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.

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Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of layers:

— Layer 0: 960x540 (output), 960x544 (coded);

— Layer 1: 1920x1080 (output), 1920x1280 (coded).

Frame rate: 24 fps

4.6.17.1.3 Test bitstream #MVD_A_NOKIA

Specification: All slices are coded as I and P slices. The MVD_A_NOKIA bitstream has three layers. The bitstream contains only four access units. Layer 1 uses inter-layer sample prediction and inter-layer motion vector prediction from Layer 0. Layer 2 uses inter-layer sample prediction from Layer 1 and inter-layer motion vector prediction from Layer 0.

Functional stage: Test inter-layer sample prediction and inter-layer motion vector prediction from different layers.

Purpose: Check that the decoder can properly decode when the enhancement layer uses inter-layer sample prediction and inter-layer motion vector prediction from different layers.

Bitstream: MVD_A_NOKIA_1.bit

Coding structure: Low delay P.

Number of access units: 4

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.

Output layer sets: The bitstream contains three output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

— OLS 2 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

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— Layer 2, PTL Idx 2.

Resolution of each layer: 1280x720

Frame rate: 24 fps

4.6.17.1.4 Test bitstream #MAXTID_A_ETRI

Specification: All slices are coded as I, P and B slices. The MAXTID_A_ETRI bitstream has three layers. The bitstream contains only nine access units. The values of max_tid_il_ref_pics_plus1[0][1] and max_tid_il_ref_pics_plus1[1][2] are set equal to 3 and 2, respectively.

Functional stage: Test parsing of the syntax elements max_tid_il_ref_pics_plus1[ ][ ] and inter-layer prediction restrictions based on temporal sub-layer.

Purpose: Check that the decoder can properly parse and decode the syntax elements max_tid_ref_present_flag and max_tid_il_ref_pics_plus1[ ][ ].

Bitstream: MAXTID_A_ETRI_2.bit

Coding structure: Hierarchical B-frames with four temporal sub-layers.

Number of access units: 9

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.

Output layer sets: The bitstream contains three output layer sets:

— OLS 0 includes the following layer:

— Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

— Layer 0, PTL Idx 1;

— Layer 1, PTL Idx 2;

— OLS 2 includes the following layers:

— Layer 0, PTL Idx 1;

— Layer 1, PTL Idx 2;

— Layer 2, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x544 (coded);

— Layer 1: 1920x1080;

— Layer 2: 1920x1080.

Frame rate: 24 fps

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4.6.17.1.5 Test bitstream #MAXTID_B_ETRI

Specification: All slices are coded as I, P and B slices. The MAXTID_B_ETRI bitstream has three layers. The bitstream contains only nine access units. The value of the syntax element max_tid_ref_present_flag is set equal to 0.

Functional stage: Test parsing of the syntax element max_tid_ref_present_flag.

Purpose: Check that the decoder can properly parse the syntax element max_tid_ref_present_flag and properly infer values of max_tid_il_ref_pics_plus1[i][j] when max_tid_ref_present_flag equal to 0.

Bitstream: MAXTID_B_ETRI_2.bit

Coding structure: Hierarchical B-frames with four temporal sub-layers.

Number of access units: 9

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.

Output layer sets: The bitstream contains three output layer sets:

— OLS 0 includes the following layers:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

— OLS 2 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2

  — Layer 2, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x544 (coded);

— Layer 1: 1920x1080;

— Layer 2: 1920x1080.

Frame rate: 24 fps

4.6.17.1.6 Test bitstream #MAXTID_C_ETRI

Specification: All slices are coded as I, P and B slices. The MAXTID_C_ETRI bitstream has three layers. The bitstream contains only nine access units. The values of max_tid_il_ref_pics_plus1[0][1] and max_tid_il_ref_pics_plus1[1][2] are both set equal to 0.

Functional stage: Test parsing of the syntax element max_tid_il_ref_pics_plus1[ ][ ] and inter-layer prediction restrictions based on temporal sub-layer.

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Purpose: Check that the decoder can properly parse and decode the syntax elements max_tid_ref_present_flag and max_tid_il_ref_pics_plus1.

Bitstream: MAXTID_C_ETRI_2.bit

Coding structure: Hierarchical B-frames with four temporal sub-layers.

Number of access units: 9

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.

Output layer sets: The bitstream contains three output layer sets:

— OLS 0 includes the following layers:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

— OLS 2 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

  — Layer 2, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x544 (coded);

— Layer 1: 1920x1080;

— Layer 2: 1920x1080.

Frame rate: 24 fps

4.6.17.1.7 Test bitstream #INACTIVE_A_QCOM

Specification: All slices are coded as I, P and B slices. The INACTIVE_A_QCOM bitstream has three layers. The bitstream contains 100 access units. Layer 0 is a direct reference layer of Layer 1, and Layer 0 and Layer 1 are direct reference layers of Layer 2. The value of default_ref_layers_active_flag is set equal to 0 in the VPS. The layers are of the same resolution.

Functional stage: Test parsing of the syntax elements inter_layer_pred_enabled_flag, num_inter_layer_ref_pics_minus1, and inter_layer_pred_layer_idc[ ].

Purpose: Check that the decoder can properly parse and decode the bitstream when the active reference layers are explicitly signalled.

Bitstream: INACTIVE_A_QCOM_1.bit

Coding structure: Random access

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Number of access units: 100

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 2.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 2.1.

Output layer sets: The bitstream contains three output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

— OLS 2 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

  — Layer 2, PTL Idx 2.

Resolution of each layer: 416x240

Frame rate: 50 fps

4.6.17.1.8 Test bitstream #REFLAYER_A_VIDYO

Specification: All slices are coded as I, P and B slices. The bitstream has three layers. The REFLAYER_A_VIDYO bitstream contains 9 access units. Layer 0 is a direct reference layer of Layer 1, and Layer 0 and Layer 1 are direct reference layers of Layer 2. The value of default_ref_layers_active_flag is set equal to 0 in the VPS. The reference layer are used for both inter-layer sample prediction and inter-layer motion vector prediction. The value of direct_dependency_all_layers_flag is equal to 1 and the value of direct_dependency_all_layers_type is equal to 2.

Functional stage: Test multiple active reference layers with different inter-layer prediction layers at different access units.

Purpose: Check that the decoder can properly parse and decode the bitstream when different active reference layers are chosen for prediction at different access units.

Bitstream: REFLAYER_A_VIDYO_2.bit

Coding structure: Low Delay B

Number of access units: 9

Profile, tier and level (PTL) information: Four PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3;

— PTL Idx 2: Scalable Main profile, Main tier, Level 3;

— PTL Idx 3: Scalable Main profile, Main tier, Level 4.

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Output layer sets: The bitstream contains three output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

— OLS 2 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

  — Layer 2, PTL Idx 3.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x544 (coded)

— Layer 1: 960x540 (output), 960x544 (coded)

— Layer 2: 1920x1080 (output), 1920x1080 (coded)

Frame rate: 24 fps

4.6.17.1.9 Test bitstream #REFLAYER_B_VIDYO

Specification: All slices are coded as I and B slices. The bitstream has three layers. The REFLAYER_B_VIDYO bitstream contains 9 access units. Layer 0 is a direct reference layer of Layer 1, and Layer 0 and Layer 1 are direct reference layers of Layer 2. For Layer 1, both inter-layer sample prediction and inter-layer motion vector prediction are performed from Layer 0. For Layer 2, only inter-layer sample prediction is performed from Layer 0, and both inter-layer sample prediction and inter-layer motion vector prediction are performed from Layer 1.

Functional stage: Test multiple active reference layers with different inter-layer prediction layers at different access units, and different layers used for inter-layer sample prediction and inter-layer motion vector prediction.

Purpose: Check that the decoder can properly parse and decode the bitstream when different active reference layers are chosen for prediction at different access units, and different types of inter-layer prediction are performed from different layers.

Bitstream: REFLAYER_B_VIDYO_2.bit

Coding structure: Low Delay B

Number of access units: 9

Profile, tier and level (PTL) information: Four PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3;

— PTL Idx 2: Scalable Main profile, Main tier, Level 3;

— PTL Idx 3: Scalable Main profile, Main tier, Level 4.

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Output layer sets: The bitstream contains three output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

— OLS 2 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

  — Layer 2, PTL Idx 3.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x544 (coded)

— Layer 1: 960x540 (output), 960x544 (coded)

— Layer 2: 1920x1080 (output), 1920x1080 (coded)

Frame rate: 24 fps

4.6.17.1.10 Test bitstream #REFLAYER_C_VIDYO

Specification: All slices are coded as I and B slices. The bitstream has three layers. The REFLAYER_C_VIDYO bitstream contains 9 access units. Layer 0 is a direct reference layer of Layer 1, and Layer 0 and Layer 1 are direct reference layers of Layer 2.

Functional stage: Test multiple active reference layers with different inter-layer prediction layers at different access units.

Purpose: Check that the decoder can properly parse and decode the bitstream when different active reference layers are chosen for prediction at different access units.

Bitstream: REFLAYER_C_VIDYO_2.bit

Coding structure: LowDelay B

Number of access units: 9

Profile, tier and level (PTL) information: Four PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3;

— PTL Idx 2: Scalable Main profile, Main tier, Level 3.1;

— PTL Idx 3: Scalable Main profile, Main tier, Level 4.

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Output layer sets: The bitstream contains three output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

— OLS 2 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

  — Layer 2, PTL Idx 3.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x544 (coded)

— Layer 1: 1280x720 (output), 1280x720 (coded)

— Layer 2: 1920x1080 (output), 1920x1080 (coded)

Frame rate: 24 fps

4.6.17.1.11 Test bitstream #REFLAYER_D_VIDYO

Specification: All slices are coded as I and B slices. The bitstream has three layers. The REFLAYER_D_VIDYO bitstream contains 9 access units. Layer 0 is a direct reference layer of Layer 1, and Layer 0 and Layer 1 are direct reference layers of Layer 2. The reference layer are used for both inter-layer sample prediction and inter-layer motion vector prediction with the direct_dependency_all_layers_flag is equal to 1 and direct_dependency_all_layers_type is equal to 2. Inter-layer prediction restrictions based on the temporal ID are indicated using values of the syntax element max_tid_il_ref_pics_plus1[ ][ ].

Functional stage: Test multiple active reference layers with different inter-layer prediction layers at different access units, where inter-layer prediction may be restricted based on TemporalID value.

Purpose: Check that the decoder can properly parse and decode the bitstream when different active reference layers are chosen for prediction at different access units and inter-layer prediction may be disabled at some access units based on TemporalID value.

Bitstream: REFLAYER_D_VIDYO_2.bit

Coding structure: Random Access B with GOP size 8 and four temporal sub-layers.

Number of access units: 9

Profile, tier and level (PTL) information: Four PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3;

— PTL Idx 2: Scalable Main profile, Main tier, Level 3.1;

— PTL Idx 3: Scalable Main profile, Main tier, Level 4.

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Output layer sets: The bitstream contains four output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

— OLS 2 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

  — Layer 2, PTL Idx 3.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x544 (coded)

— Layer 1: 1280x720 (output), 1280x720 (coded)

— Layer 2: 1920x1080 (output), 1920x1080 (coded)

Frame rate: 24 fps

4.6.17.2 Test bitstreams — VPS syntax

4.6.17.2.1 Test bitstream #SPLITFLAG_A_HHI

Specification: All slices are coded as I, P and B slices. The SPLITFLAG_A_HHI bitstream has two layers and the value of splitting_flag is set equal to 1.

Functional stage: Test inference of layer dimension ID values from the layer ID values.

Purpose: Check that the decoder can properly parse the syntax element splitting_flag and infer the values of dimension ID values from the layer ID values.

Bitstream: SPLITFLAG_A_HHI_1.bit

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0;;

— PTL Idx 1: Main profile, Main tier, Level 3.1.

— PTL Idx 2: Scalable Main profile, Main tier, Level 4

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1

  — Layer 1, PTL Idx 2.

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Resolution of each layer:

— Layer 0: 960x540

— Layer 1: 1920x1080

Frame rate: 24 fps

4.6.17.2.2 Test bitstream #VUI_A_QUALCOMM

Specification: All slices are coded as I, P and B slices. The VUI_A_QUALCOMM bitstream has two layers. The bitstream contains five access units. The value of vps_vui_present_flag is set equal to 1 and VPS VUI syntax structure is signalled.

Functional stage: Test VPS VUI.

Purpose: Check that the decoder can properly parse when VPS VUI is present in the bitstream. The decoder is expected to be able to parse the VPS VUI.

Bitstream: VUI_A_QUALCOMM_1.bit

Coding structure: Random access

Number of access units: 5

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x640 (coded)

— Layer 1: 1920x1080 (output), 1920x1280 (coded)

Frame rate: 50 fps

4.6.17.2.3 Test bitstream #VUI_B_QUALCOMM

Specification: All slices are coded as I, P and B slices. The VUI_B_QUALCOMM bitstream has two layers. The bitstream contains five access units. The value of vps_vui_present_flag is set equal to 1 and VPS VUI syntax structure is signalled. Information about tiles is included in the VUI.

Functional stage: Test VPS VUI.

Purpose: Check that the decoder can properly parse when VPS VUI is present in the bitstream. The decoder is expected to be able to parse the VPS VUI.

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Bitstream: VUI_B_QUALCOMM_1.bit

Coding structure: Random access

Number of access units: 5

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x640 (coded)

— Layer 1: 1920x1080 (output), 1920x1280 (coded)

Frame rate: 50 fps

4.6.17.2.4 Test bitstream #VUI_C_QUALCOMM

Specification: All slices are coded as I, P and B slices. The VUI_C_QUALCOMM bitstream has two layers. The bitstream contains five access units. The value of vps_vui_present_flag is set equal to 1 and VPS VUI syntax structure is signalled. Information about wavefront for each layer is included in the VUI.

Functional stage: Test VPS VUI.

Purpose: Check that the decoder can properly parse when VPS VUI is present in the bitstream. The decoder is expected to be able to parse the VPS VUI.

Bitstream: VUI_C_QUALCOMM_1.bit

Coding structure: Random access

Number of access units: 5

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.1.

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Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x640 (coded)

— Layer 1: 1920x1080 (output), 1920x1280 (coded)

Frame rate: 50 fps

4.6.17.2.5 Test bitstream #NONVUI_A_QUALCOMM

Specification: All slices are coded as I, P and B slices. The NONVUI_A_QUALCOMM bitstream has two layers. The bitstream contains five access units. The value of vps_non_vui_extension_length is set equal to 100 in the VPS extension indicating the presence of VPS non-VUI extension bytes. The bits forming the non-VUI extension are set at random to 0 or 1.

Functional stage: Test VPS non-VUI extension data.

Purpose: Check that the decoder can properly parse the syntax element vps_non_vui_extension_length and the VPS non-VUI extension bytes when present in the bitstream.

Bitstream: NONVUI_A_QUALCOMM_1.bit

Coding structure: Random access

Number of access units: 5

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x640 (coded)

— Layer 1: 1920x1080 (output), 1920x1280 (coded)

Frame rate: 50 fps

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4.6.17.2.6 Test bitstream #NONVUI_B_QUALCOMM

Specification: All slices are coded as I, P and B slices. The NONVUI_B_QUALCOMM bitstream has two layers. The bitstream contains five access units. The value of vps_non_vui_extension_length is set equal to 10 in the VPS extension indicating the presence of VPS non-VUI extension bytes. The bits forming the non-VUI extension are set equal to 1.

Functional stage: Test VPS non-VUI extension data.

Purpose: Check that the decoder can properly parse the syntax element vps_non_vui_extension_length and the VPS non-VUI extension bytes when present in the bitstream.

Bitstream: NONVUI_B_QUALCOMM_1.bit

Coding structure: Random access

Number of access units: 5

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x640 (coded)

— Layer 1: 1920x1080 (output), 1920x1280 (coded)

Frame rate: 50 fps

4.6.17.2.7 Test bitstream #NONVUI_C_QUALCOMM

Specification: All slices are coded as I, P and B slices. The NONVUI_C_QUALCOMM bitstream has two layers. The bitstream contains five access units. The value of vps_non_vui_extension_length is set equal to 10 in the VPS extension indicating the presence of VPS non-VUI extension bytes. The bits forming the non-VUI extension are set equal to 0.

Functional stage: Test VPS non-VUI extension data.

Purpose: Check that the decoder can properly parse the syntax element vps_non_vui_extension_length and the VPS non-VUI extension bytes when present in the bitstream. Emulation prevention bytes would be inserted due to presence of 0's in the VPS non-VUI extension bytes and the decoder is expected to properly remove the emulation prevention bytes and parse the non-VUI extension.

Bitstream: NONVUI_C_QUALCOMM_1.bit

Coding structure: Random access

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Number of access units: 5

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x640 (coded)

— Layer 1: 1920x1080 (output), 1920x1280 (coded)

Frame rate: 50 fps

4.6.17.3 Test bitstreams — DPB

4.6.17.3.1 Test bitstream #DPB_A_VIDYO

Specification: All slices are coded as I, P and B slices. The DPB_A_VIDYO bitstream has two layers and within each layer, there are four temporal sub-layers. The bitstream contains nine access units. The sub-DPB information for the output layer sets are signalled, and the maximum sub-layer DPB size is signalled as four for all sub-layers.

Functional stage: Test sub-DPB behaviour with sizes specified for various sub-DPBs and different maximum sub-layers.

Purpose: Check that the decoder can properly parse the syntax elements in the dpb_size( ) syntax structure and properly decode the bitstream when the sub-layer DPB information is present.

Bitstream: DPB_A_VIDYO_2.bit

Coding structure: Random access

Number of access units: 9

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3;

— PTL Idx 2: Scalable Main profile, Main tier, Level 3.1.

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Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x544 (coded)

— Layer 1: 1280x720

Frame rate: 30 fps

4.6.17.3.2 Test bitstream #DPB_B_VIDYO

Specification: All slices are coded as I and B slices. The DPB_B_VIDYO bitstream has two layers and within each layer, there are three temporal sub-layers. The bitstream contains 9 access units. The sub-DPB information for the output layer sets are signalled, and the value of maximum sub-layer DPB size is different for different maximum sub-layers.

Functional stage: Test sub-DPB behaviour with different sizes specified for various sub-DPBs and different maximum sub-layers.

Purpose: Check that the decoder can properly parse the syntax elements in the dpb_size( ) syntax structure and properly decode the bitstream when the sub-layer DPB information is present.

Bitstream: DPB_B_VIDYO_2.bit

Coding structure: Low Delay B

Number of access units: 9

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3;

— PTL Idx 2: Scalable Main profile, Main tier, Level 3.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x544 (coded)

— Layer 1: 1280x720

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Frame rate: 30 fps

4.6.17.4 Test bitstreams — Picture resolution

4.6.17.4.1 Test bitstream #SRATIOS_A_SAMSUNG

Specification: All slices are coded as I, P and B slices. The SRATIOS_A_SAMSUNG bitstream contains 60 access units. Non-trivial values of ScaledReferenceOffset and ReferenceLayerOffset are used for the resampling process: horizontal ratio of approximately 1.492 (936/627) and vertical ratio of approximately 1.487 (516/347).

Functional stage: Test non-trivial scaling ratios for spatial scalability.

Purpose: Check that the decoder can properly parse and decode the bitstream when the scaling ratio is non-trivial. This bitstream also tests the parsing of the syntax elements related to scaled reference layer offsets and reference layer offsets.

Bitstream: SRATIOS_A_SAMSUNG_3.bit

Coding structure: Random access

Number of access units: 60

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 1280x720 (output), 1280x720 (coded)

— Layer 1: 1920x1080 (output), 1920x1280 (coded)

Frame rate: 60 fps

4.6.17.4.2 Test bitstream #SRATIOS_B_SAMSUNG

Specification: All slices are coded as I, P and B slices. The SRATIOS_B_SAMSUNG bitstream contains 50 access units. Default values of ScaledReferenceOffset and ReferenceLayerOffset are used and unusual picture sizes are used for the resampling process: horizontal ratio of approximately 1.168 (1280/1096) and vertical ratio of approximately 1.169 (720/616).

Functional stage: Test non-trivial scaling ratios for spatial scalability.

Purpose: Check that the decoder can properly parse and decode the bitstream when the scaling ratio is non-trivial.

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Bitstream: SRATIOS_B_SAMSUNG_2.bit

Coding structure: Random access

Number of access units: 50

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 3.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 1096x616

— Layer 1: 1280x720

Frame rate: 50 fps

4.6.17.4.3 Test bitstream #SNR_A_IDCC

Specification: All slices are coded as I, P and B slices. The SNR_A_IDCC bitstream has two layers and they are coded at the same resolution but at different qualities. The bitstream contains four access units. Layer 1 is predicted from Layer 0. The value of DefaultTargetOutputLayerIdc is equal to 1.

Functional stage: Test SNR scalability.

Purpose: Check that the decoder can properly parse and decode the bitstream containing two layers at the same resolution but different qualities.

Bitstream: SNR_A_IDCC_1.bit

Coding structure: Low delay B

Number of access units: 4

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 4;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.

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Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 1920x1080 (output), 1920x1080 (coded)

— Layer 1: 1920x1080 (output), 1920x1280 (coded)

Frame rate: 24 fps

4.6.17.4.4 Test bitstream #SNR_B_IDCC

Specification: All slices are coded as I, P and B slices. The SNR_B_IDCC bitstream has three layers and they are coded at the same resolution but at different qualities. The bitstream contains four access units. Layer 1 is predicted from Layer 0 and Layer 2 is predicted from Layer 1. The value of DefaultTargetOutputLayerIdc is equal to 1.

Functional stage: Test SNR scalability.

Purpose: Check that the decoder can properly parse and decode the bitstream containing two layers at the same resolution but different qualities.

Bitstream: SNR_B_IDCC_1.bit

Coding structure: Low delay B

Number of access units: 4

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 4;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.

Output layer sets: The bitstream contains three output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

— OLS 2 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

  — Layer 2, PTL Idx 2.

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Resolution of each layer:

— Layer 0: 1920x1080 (output), 1920x1080 (coded)

— Layer 1: 1920x1080 (output), 1920x1280 (coded)

— Layer 2: 1920x1080 (output), 1920x1280 (coded)

Frame rate: 24 fps

4.6.17.4.5 Test bitstream #SNR_C_IDCC

Specification: All slices are coded as I, P and B slices. The SNR_C_IDCC bitstream has three layers and they are coded at the same resolution but at different qualities. The bitstream contains four access units. The three layers are at the same resolution and coded at different qualities. Layer 1 is predicted from Layer 0 and Layer 2 is predicted from Layer 1. The value of DefaultTargetOutputLayerIdc is equal to 1.

Functional stage: Test SNR scalability.

Purpose: Check that the decoder can properly parse and decode the bitstream containing two layers at the same resolution but different qualities.

Bitstream: SNR_C_IDCC_1.bit

Coding structure: Low delay B

Number of access units: 4

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 4;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.

Output layer sets: The bitstream contains three output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

  — Layer 2, PTL Idx 2.

Resolution of each layer:

— Layer 0: 1920x1080 (output), 1920x1080 (coded)

— Layer 1: 1920x1080 (output), 1920x1280 (coded)

— Layer 2: 1920x1080 (output), 1920x1280 (coded)

Frame rate: 24 fps

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4.6.17.4.6 Test bitstream #REPFMT_A_VIDYO

Specification: All slices are coded as I and P slices. The REPFMT_A_VIDYO bitstream has two layers; one representation format syntax structure in the VPS extension is signalled and both layers are associated with the same representation format syntax structure. The bitstream contains four access units. The value of the syntax element conformance_window_vps_flag is equal to 1 in the rep_format( ) structure.

Functional stage: Test parsing of representation format syntax structure in the VPS extension.

Purpose: Check that the decoder can properly parse and decode the representation format syntax structure(s) specified in the VPS extension.

Bitstream: REPFMT_A_VIDYO_2.bit

Coding structure: Low delay P

Number of access units: 4

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3;

— PTL Idx 2: Scalable Main profile, Main tier, Level 3.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x544 (coded)

— Layer 1: 960x540 (output), 960x544 (coded)

Frame rate: 30 fps

4.6.17.4.7 Test bitstream #REPFMT_B_VIDYO

Specification: All slices are coded as I and P slices. The REPFMT_B_VIDYO bitstream has three layers; two representation format syntax structures are signalled in the VPS extension. The bitstream contains four access units. The value of the syntax element conformance_window_vps_flag is equal to 1 in one of the rep_format( ) structures.

Functional stage: Test parsing of representation format syntax structure in the VPS extension.

Purpose: Check that the decoder can properly parse and decode representation format syntax structure defined in the VPS extension.

Bitstream: REPFMT_B_VIDYO_2.bit

Coding structure: Low delay P

Number of access units: 4

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Profile, tier and level (PTL) information: Four PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3;

— PTL Idx 2: Scalable Main profile, Main tier, Level 3.1;

— PTL Idx 3: Scalable Main profile, Main tier, Level 4.

Output layer sets: The bitstream contains three output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

— OLS 2 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

  — Layer 2, PTL Idx 3.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x544 (coded)

— Layer 1: 960x540 (output), 960x544 (coded)

— Layer 2: 1920x1080 (coded)

Frame rate: 30 fps

4.6.17.4.8 Test bitstream #REPFMT_C_VIDYO

Specification: All slices are coded as I and P slices. The REPFMT_C_VIDYO bitstream has three layers; two representation format syntax structures are signalled in the VPS extension. The bitstream contains four access units. The value of the syntax element conformance_window_vps_flag is equal to 1 in one of the rep_format( ) structure.

Functional stage: Test parsing of representation format syntax structure in the VPS extension.

Purpose: Check that the decoder can properly parse and decode representation format syntax structure specified in the VPS extension.

Bitstream: REPFMT_C_VIDYO_2.bit

Coding structure: Low delay P

Number of access units: 4

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.

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Output layer sets: The bitstream contains three output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

— OLS 2 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

  — Layer 2, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x544 (coded)

— Layer 1: 1920x1080 (coded)

— Layer 2: 1920x1080 (coded)

Frame rate: 30 fps

4.6.17.4.9 Test bitstream #RESCHANGE_A_VIDYO

Specification: All slices are coded as I and P slices. The RESCHANGE_A_VIDYO bitstream has three layers; two representation format syntax structures are signalled in the VPS extension. The bitstream contains four access units. The active SPS for Layer 0 signals a resolution that is different from the resolution specified in the rep_format( ) structure associated with Layer 0.

Functional stage: Test parsing of representation format syntax structure in the VPS extension and update of picture resolution in the SPS.

Purpose: Check that the decoder can properly parse and decode the bitstream when picture resolution specified in the SPS is different from picture resolution specified in the VPS.

Bitstream: RESCHANGE_A_VIDYO_1.bit

Coding structure: Low delay P

Number of access units: 4

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.

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Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x536

— Layer 1: 1920x1080

Frame rate: 30 fps

4.6.17.4.10 Test bitstream #ADAPTRES_A_ERICSSON

Specification: All slices are coded as I and P slices. The ADAPTRES_A_ERICSSON bitstream contains two layers. At the switch point, the picture at the higher layer is coded as an IRAP picture with P_SLICEs using lower layer picture as inter-layer reference for this use case.

Functional stage: Test adaptive resolution change.

Purpose: Check that the decoder can properly parse and decode the bitstream when skip pictures are used to code IRAP pictures such that multiple layers are used to effect adaptive resolution change.

Bitstream: ADAPTRES_A_ERICSSON_1.bit

Coding structure: Low delay P

Number of access units: 30

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.

Output layer sets: The bitstream contains three output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

— OLS 2 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

  — Layer 2, PTL Idx 2.

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Resolution of each layer:

— Layer 0: 1920x720

— Layer 1: 1920x1080

— Layer 2: 1920x1080

Frame rate: 24 fps

4.6.17.4.11 Test bitstream #SPSREPFMT_A_SONY

Specification: All slices are coded as I, P and B slices. The bitstream has two layers; four representation format syntax structures are signalled in the VPS extension. The default inference rule of the representation format is applied to the layers. In the active SPS of Layer 1, the representation format is updated.

Functional stage: Test representation format update in SPS.

Purpose: Check that the decoder can properly parse and decode the bitstream when picture resolution specified in the SPS is different from picture resolution specified in the VPS.

Bitstream: SPSREPFMT_A_Sony_2.bit

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 5.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 5.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 5.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer: 960x540

Frame rate: 24 fps

4.6.17.4.12 Test bitstream #CONFCROP_A_VIDYO

Specification: All slices are coded as I and P slices. The CONFCROP_A_VIDYO bitstream has two layers and conformance cropping windows are specified for both the layers in the VPS extension. The bitstream contains eight access units.

Functional stage: Test conformance cropping window in VPS extension.

Purpose: Check that the decoder can properly parse and decode the bitstream when conformance cropping windows are specified in the VPS extension, and the output picture is cropped with the right parameters.

Bitstream: CONFCROP_A_VIDYO_2.bit

Coding structure: Low delay P

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Number of access units: 8

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 5.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540 (output), 960x640 (coded)

— Layer 1: 1920x1080 (output), 1920x1280 (coded)

Frame rate: 30 fps

4.6.17.4.13 Test bitstream #CONFCROP_B_VIDYO

Specification: All slices are coded as I and P slices. The CONFCROP_B_VIDYO bitstream has two layers and conformance cropping windows are specified for both the layers in the VPS extension. The bitstream contains eight access units.

Functional stage: Test conformance cropping window in VPS extension.

Purpose: Check that the decoder can properly parse and decode the bitstream when conformance cropping windows are specified in the VPS extension, and the output picture is cropped with the right parameters.

Bitstream: CONFCROP_B_VIDYO_2.bit

Coding structure: Low delay P

Number of access units: 8

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layers:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

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— Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 720x480 (output), 960x536 (coded)

— Layer 1: 1600x900 (output), 1920x1072 (coded)

Frame rate: 30 fps

4.6.17.4.14 Test bitstream #CONFCROP_C_VIDYO

Specification: All slices are coded as I and P slices. The CONFCROP_C_VIDYO bitstream has three layers and conformance cropping windows are specified for all the layers in the VPS extension. The bitstream contains four access units.

Functional stage: Test conformance cropping window in VPS extension.

Purpose: Check that the decoder can properly parse and decode the bitstream when conformance cropping windows are specified in the VPS extension, and the output picture is cropped with the right parameters.

Bitstream: CONFCROP_C_VIDYO_3.bit

Coding structure: Low delay P

Number of access units: 4

Profile, tier and level (PTL) information: Four PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3;

— PTL Idx 2: Scalable Main profile, Main tier, Level 3.1;

— PTL Idx 3: Scalable Main profile, Main tier, Level 4.

Output layer sets: The bitstream contains three output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

— OLS 2 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

  — Layer 2, PTL Idx 3.

Resolution of each layer:

— Layer 0: 720x480 (output), 960x536 (coded)

— Layer 1: 960x540 (output), 1280x720 (coded)

— Layer 2: 1760x900 (output), 1920x1080 (coded)

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Frame rate: 30 fps

4.6.17.5 Test bitstreams — Offsets and phase adjustments

4.6.17.5.1 Test bitstream #SCREFOFF_A_QCOM

Specification: All slices are coded as I, P and B slices. The SCREFOFF_A_QCOM bitstream has two layers. The bitstream contains 20 access units. Layer 0 is a direct reference layer of Layer 1.The scaled reference layer offsets are signalled such that layers have different resolutions and scaling ratio equal to 1.

Functional stage: Test scaled reference layer offsets.

Purpose: Check that the decoder can properly parse the syntax elements related to scaled reference layer offsets in the bitstream and properly decode the bitstream.

Bitstream: SCREFOFF_A_QCOM_1.bit

Coding structure: Random access

Number of access units: 20

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3;

— PTL Idx 2: Scalable Main profile, Main tier, Level 3.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 400x400

— Layer 1: 940x540

Frame rate: 50 fps

4.6.17.5.2 Test bitstream #REFREGOFF_A_SHARP

Specification: All slices are coded as I, P and B slices. The REFREGOFF_A_SHARP bitstream has two layers. The bitstream contains nine access units. Layer 0 is a direct reference layer of Layer 1.The reference region offsets are signalled such that the scaling ratio is equal to 2.

Functional stage: Test reference region offsets in the PPS.

Purpose: Check that the decoder can properly parse the syntax elements related to reference region offsets in the bitstream and properly decode the bitstream.

Bitstream: REFREGOFF_A_SHARP_1.bit

Coding structure: Random access

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Number of access units: 9

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 4.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer: 1280x800

Frame rate: 30 fps

4.6.17.5.3 Test bitstream #RESPHASE_A_SAMSUNG

Specification: All slices are coded as I, P and B slices. The RESPHASE_A_SAMSUNG bitstream has two layers. The bitstream contains 60 access units. Layer 0 is a direct reference layer of Layer 1. Non-trivial resampling phase values are signalled.

Functional stage: Test resampling phase.

Purpose: Check that the decoder can properly parse the syntax elements related to resampling phase in the bitstream and properly decode the bitstream.

Bitstream: RESPHASE_A_SAMSUNG_2.bit

Coding structure: Random access

Number of access units: 60

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

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Resolution of each layer:

— Layer 0: 1280x720 (output), 1280x720 (coded)

— Layer 1: 1920x1080 (output), 1920x1280 (coded)

Frame rate: 60 fps

4.6.17.5.4 Test bitstream #OLS_A_NOKIA

Specification: All slices are coded as I and P slices. The OLS_A_NOKIA bitstream has three layers. The bitstream contains four access units. An additional output layer set is signalled in addition to the three output layers sets specified.

Functional stage: Test additional output layer set.

Purpose: Check that the decoder can properly parse the syntax elements associated with additional output layer sets and properly decode the bitstream.

Bitstream: OLS_A_NOKIA_1.bit

Coding structure: Low delay P

Number of access units: 4

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.

Output layer sets: The bitstream contains four output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

— OLS 2 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

  — Layer 2, PTL Idx 2;

— OLS 3 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

  — Layer 2, PTL Idx 2.

Resolution of each layer: 1280x720

Frame rate: 24 fps

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4.6.17.5.5 Test bitstream #OLS_B_NOKIA

Specification: All slices are coded as I and P slices. The OLS_B_NOKIA bitstream has three layers. The bitstream contains four access units. The value of default_target_output_layer_idc is set equal to 2.

Functional stage: Test non-default output layer sets.

Purpose: Check that the decoder can properly parse the syntax elements associated with explicitly signalled output layer sets and properly decode the bitstream.

Bitstream: OLS_B_NOKIA_1.bit

Coding structure: Low delay P

Number of access units: 4

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.

Output layer sets: The bitstream contains three output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

— OLS 2 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

  — Layer 2, PTL Idx 2.

Resolution of each layer: 1280x720

Frame rate: 24 fps

4.6.17.5.6 Test bitstream #OLS_C_NOKIA

Specification: All slices are coded as I and P slices. The OLS_C_NOKIA bitstream has four layers. The bitstream contains four access units. Layers with layer IDs 1 and 2 are not used for inter-layer prediction in some of the output layer sets, thus making them unnecessary layers for prediction purposes for those output layer sets.

Functional stage: Test layers not necessary for prediction.

Purpose: Check that the decoder can properly decode the bitstream when layers not necessary for prediction are part of output layer sets.

Bitstream: OLS_C_NOKIA_1.bit

Coding structure: Low delay P

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Number of access units: 4

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.

Output layer sets: The bitstream contains four output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2;

— OLS 2 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1 (No PTL);

  — Layer 2, PTL Idx 2;

— OLS 3 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1 (No PTL);

  — Layer 2 (No PTL);

  — Layer 3, PTL Idx 2.

Resolution of each layer: 1280x720

Frame rate: 24 fps

4.6.17.5.7 Test bitstream #DISFLAG_A_QUALCOMM

Specification: All slices are coded as I, P and B slices. The DISFLAG_A_QUALCOMM bitstream has two layers. The bitstream contains eight access units. Some of the pictures are marked as discardable pictures (discardable_flag set equal to 1).

Functional stage: Test discardable pictures.

Purpose: Check that the decoder can properly parse the syntax element discardable_flag and properly decode the bitstream when discardable pictures are present.

Bitstream: DISFLAG_A_QUALCOMM_1.bit

Coding structure: Random access

Number of access units: 8

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

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— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540 (output)

— Layer 1: 1920x1080 (output)

Frame rate: 50 fps

4.6.17.6 Test bitstreams — Scaling lists

4.6.17.6.1 Test bitstream PPSSLIST_A_SONY

Specification: All slices are coded as I, P, and B slices. The PPSSLIST_A_SONY bitstream has two layers. Each picture contains one slice. The value of vps_max_layers_minus1 is set equal to 1 and the value of pps_infer_scaling_list_flag for the enhancement layer is equal to 1.

Functional stage: Test inference of PPS scaling list.

Purpose: Check that the decoder can properly parse the syntax elements associated with inference of scaling list in the PPS, properly infer the scaling list parameter of one PPS from that of another, and properly decode the bitstream.

Bitstream: PPSSLIST_A_Sony_2.bit

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 4.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540

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— Layer 1: 1280x720

4.6.17.6.2 Test bitstream SPSSLIST_A_SONY

Specification: All slices are coded as I, P, and B slices. The SPSSLIST_A_SONY bitstream has two layers. Each picture contains one slice. The value of vps_max_layers_minus1 is set equal to 1 and the value of sps_infer_scaling_list_flag for the enhancement layer is equal to 1.

Functional stage: Test inference of SPS scaling list.

Purpose: Check that the decoder can properly parse the syntax elements associated with inference of scaling list in the SPS, properly infer the scaling list parameter of one SPS from that of another, and properly decode the bitstream.

Bitstream: SPSSLIST_A_SONY_2.bit

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 4.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540

— Layer 1: 1280x720

Frame rate: 24 fps

4.6.17.7 Test bitstreams — Colour gamut scalability

4.6.17.7.1 Test bitstream #CGS_A_TECHNICOLOR

Specification: All slices are coded as I and P slices. The CGS_A_TECHNICOLOR bitstream has two layers. The base layer has bit depth equal to 8 and is coded in BT.709 container; the enhancement layer has bit depth equal to 10 and is coded in BT.2020 container. The bitstream contains one access unit. The value of cm_octant_depth is set equal to 1 and the value of split_octant_flag is set equal to 1.

Functional stage: Test colour gamut scalability with 8-bit base layer and 10-bit enhancement layer.

Purpose: Check that the decoder can properly decode the bitstream when the colour gamut scalability is enabled and the base and the enhancement layers have different bit depths.

Bitstream: CGS_A_TECHNICOLOR_1.bit

Number of access units: 1

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Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 4.1;

— PTL Idx 2: Scalable Main 10 profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer: 1920x1080

Frame rate: 50 fps

4.6.17.7.2 Test bitstream #CGS_B_TECHNICOLOR

Specification: All slices are coded as I and P slices. The CGS_B_TECHNICOLOR bitstream has two layers. The base layer has bit depth equal to 8 and is coded in BT.709 container; the enhancement layer has bit depth equal to 10 and is coded in BT.2020 container. The bitstream contains one access unit. The value of cm_octant_depth is set equal to 0.

Functional stage: Test colour gamut scalability with 8-bit base layer and 10-bit enhancement layer.

Purpose: Check that the decoder can properly decode the bitstream when the colour gamut scalability is enabled and the base and the enhancement layers have different bit depths.

Bitstream: CGS_B_TECHNICOLOR_1.bit

Number of access units: 1

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 4.1;

— PTL Idx 2: Scalable Main 10 profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer: 1920x1080

Frame rate: 50 fps

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4.6.17.7.3 Test bitstream #CGS_C_TECHNICOLOR

Specification: All slices are coded as I and P slices. The CGS_C_TECHNICOLOR bitstream has two layers. The base layer has bit depth equal to 10 and is coded in BT.709 container; the enhancement layer has bit depth equal to 10 and is coded in BT.2020 container. The bitstream contains one access unit. The value of cm_octant_depth is set equal to 1 and the value of split_octant_flag is set equal to 1.

Functional stage: Test colour gamut scalability with 10-bit base layer and 10-bit enhancement layer.

Purpose: Check that the decoder can properly decode the bitstream when the colour gamut scalability is enabled and the base and the enhancement layers have the same bit depths.

Bitstream: CGS_C_TECHNICOLOR_1.bit

Number of access units: 1

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main 10 profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main 10 profile, Main tier, Level 4.1;

— PTL Idx 2: Scalable Main 10 profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer: 1920x1080

Frame rate: 50 fps

4.6.17.7.4 Test bitstream #CGS_D_TECHNICOLOR

Specification: All slices are coded as I and P slices. The CGS_D_TECHNICOLOR bitstream has two layers. The base layer has bit depth equal to 10 and is coded in BT.709 container; the enhancement layer has bit depth equal to 10 and is coded in BT.2020 container. The bitstream contains one access unit. The value of cm_octant_depth is set equal to 0.

Functional stage: Test colour gamut scalability with 10-bit base layer and 10-bit enhancement layer.

Purpose: Check that the decoder can properly decode the bitstream when the colour gamut scalability is enabled and the base and the enhancement layers have the same bit depths.

Bitstream: CGS_D_TECHNICOLOR_1.bit

Number of access units: 1

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main 10 profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main 10 profile, Main tier, Level 4.1;

— PTL Idx 2: Scalable Main 10 profile, Main tier, Level 4.1.

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Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer: 1920x1080

Frame rate: 50 fps

4.6.17.7.5 Test bitstream #CGS_E_TECHNICOLOR

Specification: All slices are coded as I and P slices. The CGS_E_TECHNICOLOR bitstream has two layers. The base layer has bit depth equal to 8 and is coded in BT.709 container; the enhancement layer has bit depth equal to 10 and is coded in BT.2020 container. The bitstream contains one access unit. The value of cm_octant_depth is set equal to 1 and the value of split_octant_flag is set equal to 1.

Functional stage: Test colour gamut scalability with 8-bit base layer and 10-bit enhancement layer together with spatial scalability.

Purpose: Check that the decoder can properly decode the bitstream when the colour gamut scalability is enabled, the base and the enhancement layers have different bit depths and scaling ratio is not equal to 1.

Bitstream: CGS_E_TECHNICOLOR_1.bit

Number of access units: 1

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 4.1;

— PTL Idx 2: Scalable Main 10 profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540

— Layer 1: 1920x1080

Frame rate: 60 fps

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4.6.17.7.6 Test bitstream #CGS_F_TECHNICOLOR

Specification: All slices are coded as I and P slices. The CGS_F_TECHNICOLOR bitstream has two layers. The base layer has bit depth equal to 8 and is coded with BT.709 container; the enhancement layer has bit depth equal to 10 and is coded in BT.2020 container. The bitstream contains one access unit. The value of cm_octant_depth is set equal to 0.

Functional stage: Test colour gamut scalability with 8-bit base layer and 10-bit enhancement layer together with spatial scalability.

Purpose: Check that the decoder can properly decode the bitstream when the colour gamut scalability is enabled, the base and the enhancement layers have different bit depths and scaling ratio is not equal to 1.

Bitstream: CGS_F_TECHNICOLOR_1.bit

Number of access units: 1

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 4.1;

— PTL Idx 2: Scalable Main 10 profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540

— Layer 1: 1920x1080

Frame rate: 60 fps

4.6.17.7.7 Test bitstream #CGS_G_TECHNICOLOR

Specification: All slices are coded as I, P and B slices. The CGS_G_TECHNICOLOR bitstream has two layers. The base layer has bit depth equal to 8 and is coded in BT.709 container; the enhancement layer has bit depth equal to 10 and is coded in BT.2020 container. The bitstream contains one access unit. The value of cm_octant_depth is set equal to 1 and the value of split_octant_flag is set equal to 0.

Functional stage: Test colour gamut scalability with 8-bit base layer and 10-bit in enhancement layer together.

Purpose: Check that the decoder can properly decode the bitstream when the colour gamut scalability is enabled, the base and the enhancement layers have different bit depths and more than one access unit is coded.

Bitstream: CGS_G_TECHNICOLOR_1.bit

Number of access units: 2

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Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 4.1;

— PTL Idx 2: Scalable Main 10 profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer: 1920x1080

Frame rate: 50 fps

4.6.17.7.8 Test bitstream #CGS_H_TECHNICOLOR

Specification: All slices are coded as I, P and B slices. The CGS_H_TECHNICOLOR bitstream has two layers. The base layer has bit depth equal to 10 and is coded with BT.709 container; the enhancement layer has bit depth equal to 10 and is coded in BT.2020 container. The bitstream contains one access unit. The value of cm_octant_depth is set equal to 1 and the value of split_octant_flag is set equal to 0.

Functional stage: Test colour gamut scalability with 10-bit base layer and 10-bit enhancement layer.

Purpose: Check that the decoder can properly decode the bitstream when the colour gamut scalability is enabled, and the base and the enhancement layers have the same bit depths and more than one access unit is coded.

Bitstream: CGS_H_TECHNICOLOR_1.bit

Number of access units: 2

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main 10 profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main 10 profile, Main tier, Level 4.1;

— PTL Idx 2: Scalable Main 10 profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer: 1920x1080

Frame rate: 50 fps

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4.6.17.7.9 Test bitstream #CGS_I_TECHNICOLOR

Specification: All slices are coded as I, P and B slices. The CGS_I_TECHNICOLOR bitstream has two layers. The base layer has bit depth equal to 8 and is coded in BT.709 container; the enhancement layer has bit depth equal to 10 and is coded in BT.2020 container. The bitstream contains one access unit. The value of cm_octant_depth is set equal to 1 and the value of split_octant_flag is set equal to 0. The two layers have different picture resolutions.

Functional stage: Test colour gamut scalability with 8-bit base layer and 10-bit enhancement layer together with spatial scalability.

Purpose: Check that the decoder can properly decode the bitstream when the colour gamut scalability is enabled, the base and the enhancement layers have different bit depths, scaling ratio is not equal to 1, and more than one access unit is coded.

Bitstream: CGS_I_TECHNICOLOR_1.bit

Number of access units: 2

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 4.1;

— PTL Idx 2: Scalable Main 10 profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer:

— Layer 0: 960x540

— Layer 1: 1920x1080

Frame rate: 60 fps

4.6.17.8 Test bitstreams — Additional extensibility

4.6.17.8.1 Test bitstream #PSEXT_A_VIDYO

Specification: All slices are coded as I, P and B slices. The PSEXT_A_VIDYO bitstream has two layers. The bitstream contains four access units. The value of pps_extension_6bits is set equal to 0x5 for both layers, and the value of sps_extension_6bits is set equal to 0 and 0x63 for the base and enhancement layers, respectively.

Functional stage: Test additional extensions of SPS and PPS.

Purpose: Check that the decoder can properly parse the PPS and SPS when the value of sps_extension_6bits and pps_extension_6bits are not equal to 0.

Bitstream: PSEXT_A_VIDYO_2.bit

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Coding structure: Low delay P

Number of access units: 4

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 3.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer: 1280x720

Frame rate: 30 fps

4.6.17.8.2 Test bitstream #LAYERID63_A_HHI

Specification: All slices are coded as I, P and B slices. The LAYERID63_A_HHI bitstream has two layer. The bitstream contains ten access units. Random bits are added to fill the payload of NAL units that have layer ID equal to 63.

Functional stage: Test nuh_layer_id value of 63.

Purpose: Check that the decoder can properly parse NAL units when the value of nuh_layer_id is equal to 63.

Bitstream: LAYERID63_A_HHI_1.bit

Number of access units: 10

4.6.17.9 Test bitstreams — Picture order count

4.6.17.9.1 Test bitstream #POC_A_ERICSSON

Specification: All slices are coded as I and P slices. The POC_A_ERICSSON bitstream has two layers. The bitstream contains nine access units. The value of poc_reset_idc is set equal to 2 and the value of vps_poc_lsb_aligned_flag is set equal to 1, thus resetting the POC of the pictures.

Functional stage: Test unaligned POC and POC reset.

Purpose: Check that the decoder can properly decode when the POC is reset.

Bitstream: POC_A_Ericsoon_1.bit

Coding structure: Low delay P

Number of access units: 9

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Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

Resolution of each layer: 1280x720

— Layer 0: 1280x720

— Layer 1: 1920x1080

Frame rate: 24 fps

4.6.17.9.2 Test bitstream #POC_B_ERICSSON

Specification: All slices are coded as I and P slices. The POC_B_ERICSSON bitstream has two layers. The bitstream contains ten access units. The value of poc_reset_idc is set equal 1 and the value of vps_poc_lsb_aligned_flag is set equal to 0, thus resetting the MSB of the POC of the pictures.

Functional stage: Test reset of POC MSBs.

Purpose: Check that the decoder can properly decode when the POC MSBs are reset.

Bitstream: POC_B_Ericsson_1.bit

Coding structure: Low delay P

Number of access units: 10

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 3.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 includes the following layer:

  — Layer 0, PTL Idx 1;

— OLS 1 includes the following layers:

  — Layer 0, PTL Idx 1;

  — Layer 1, PTL Idx 2.

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Resolution of each layer: 1280x720

— Layer 0: 1280x720

— Layer 1: 1920x1080

Frame rate: 24 fps

4.6.17.10 Test bitstreams — Base layer type

4.6.17.10.1 Test bitstream #HYBRID_A_QUALCOMM

Specification: All slices are coded as P and B slices. The HYBRID_A_QUALCOMM bitstream has two layers, but only the enhancement layer is present in the coded bitstream and the decoded base layer pictures are expected to be provided externally. The bitstream contains 15 access units.

Functional stage: Test hybrid scalability.

Purpose: Check that the decoder can properly decode when the base layer is externally provided and the enhancement layer predicts from the base layer (hybrid scalability).

Bitstream: HYBRID_A_QUALCOMM_1.bit

Coding structure: Random access

Number of access units: 15

Profile, tier and level (PTL) information: Three PTL structures are specified:

— PTL Idx 0: Main profile, Main tier, Level 4.1 (whole bitstream);

— PTL Idx 1: Main profile, Main tier, Level 3.1;

— PTL Idx 2: Scalable Main profile, Main tier, Level 4.1.

Output layer sets: The bitstream contains two output layer sets:

— OLS 0 (externally provided);

— OLS 1 includes the following layer:

  — Layer 1, PTL Idx 2

Resolution of each layer:

— Layer 0: 1280x720 (output), 1280x720 (coded)

— Layer 1: 1920x1080 (output), 1920x1280 (coded)

Frame rate: 30 fps

4.6.17.10.2 Test bitstream #INBLD_A_NOKIA

Specification: All slices are coded as I or P slices. The INBLD_A_NOKIA bitstream has two layers with layer ID values 2 and 3. Layer with Layer ID value 2 is an independent non-base layer. The layers with layer ID value 0 and 1 are not present in the bitstream.

Functional stage: Test independent non-base layer decoding.

Purpose: Check that the decoder can properly decode the bitstream that does not have a layer with layer ID equal to 0 and is indicated to be an independent non-base layer.

Bitstream: INBLD_A_NOKIA_2.bit

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