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| **INTERNATIONAL ORGANIZATION FOR STANDARDIZATION ORGANISATION INTERNATIONALE DE NORMALISATION ISO/IEC JTC 1/SC 29/WG 5 MPEG JOINT VIDEO EXPERTS TEAM WITH ITU-T SG 16** |
| **ISO/IEC JTC 1 / SC 29 / WG 5 N 293** |
| **Rennes, FR – 17–24 April 2024** |
| |  |  | | --- | --- | | **Title:** | **Exploration experiment on enhanced compression beyond VVC capability (EE2)** | | **Source:** | **Convenor (Jens-Rainer Ohm)** | | **Type:** | **General** | | **Subtype:** | **Other** | | **Status:** | **Approved** | | **Date:** | **2024-05-28** | | **Expected Action:** | **Info** | | **Action due date:** | **N/A** | | **No. of pages** | **19** (without this cover page) | | **Email of convenor:** | **ohm @ ient . rwth-aachen . de** | | **Committee URL:** | **https://sd.iso.org/documents/ui/#!/browse/iso/iso-iec-jtc-1/iso-iec-jtc-1-sc-29/iso-iec-jtc-1-sc-29-wg-5** | |

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| **Joint Video Experts Team (JVET)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29**  34th Meeting, Rennes, FR, 17–24 April 2024 | Document: JVET-AH2024-v3 |

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| --- | --- | --- | --- |
| *Title:* | **Exploration Experiment on Enhanced Compression beyond VVC capability (EE2)** | | |
| *Status:* | Output document to JVET | | |
| *Purpose:* | EE description | | |
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| *Source:* | EE coordinators | | |

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# Abstract

This document describes Exploration Experiments (EEs) planned to be performed between 34th and 35th JVET meetings to evaluate enhanced compression tools beyond VVC capability.

# Introduction

EE focus is to evaluate individual coding technologies and their combinations. Contributions improving compression efficiency further is highly encouraged.

EE related discussions shall happen on JVET reflector.

EE tests should be implemented on top the ECM software, ECM-13.0 is used as an anchor in the tests.

Tests shall be performed according to the CTC described in JVET-AF2017.

TGM class tests is required for SCC tests and is optional otherwise.

For RPR tests, in addition to ECM CTC the tests are performed following JVET-Q2015, where only LB configuration is mandatory, and the sequences length is reduced to 5 seconds for all classes.

AI and RA test configurations are required for intra tool testing, while RA and LB test configurations are required for inter tool testing. LP configuration is optional. In LB and LP configurations, the sequences length is reduced to 5 seconds for all classes.

If encoder modification is included in EE tests, such encoder optimization, if applicable, introduced to the anchor should be tested.

# Timeline

**T1** = 3 weeks (May 17, 2024) after JVET meeting: ECM is released

**T2** = T1 + 1 week (May 24, 2024): EE description is finalized

**T3** = T2 + 2 weeks (June 7, 2024): Initial software release for EE tests

**T4** = JVET meeting start – 3 weeks (June 21, 2024): Software in EE branches is frozen

# List of tests

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tests** | **Tester** | **Cross-checker** |
| **1 Partitioning** | | | |
| 1.1 | Adaptive dual tree coding in inter slices | F. Le Léannec (InterDigital) |  |
| 1.2a | Restricting BT CUs to apply QT-like partitioning structure | W. Ahmad (Ericsson) | A.Tissier (Xiaomi) |
| 1.2b | Restricting BT CUs to apply QT-like partitioning structure (also at smaller block sizes) | W. Ahmad (Ericsson) |  |
| 1.2c | Restricting BT CUs to apply QT-like partitioning structure (non-normative solution) | W. Ahmad (Ericsson) |  |
| **2 Intra prediction** | | | |
| 2.1 | TIMD merge | M. Abdoli (Xiaomi) |  |
| 2.2 | TIMD with enhanced block vectors deployment | K. Naser (InterDigital)  J. Fu (Peking Univ.) |  |
| 2.3 | Test 2.1 + Test 2.2 | M. Abdoli (Xiaomi)  K. Naser (InterDigital)  J. Fu  (Peking Univ.) |  |
| 2.4a | Additional TIMD mode with different cost metric | D. Bugdayci Sansli (Nokia) |  |
| 2.4b | Additional TIMD mode with different cost metric (no template size change) | D. Bugdayci Sansli (Nokia) |  |
| 2.5a | Intra merge mode | Y.-J. Chang (Qualcomm) |  |
| 2.5b | Intra merge mode without TIMD candidate | Y.-J. Chang (Qualcomm) |  |
| 2.5c | Intra merge mode with adjacent and non-adjacent neighbours used in current ECM intra tools | Y.-J. Chang (Qualcomm) |  |
| 2.5d | Intra merge mode with larger candidate list | Y.-J. Chang (Qualcomm) |  |
| 2.6a | IntraTMP merge candidates clustering based on refinement window | D. Ruiz Coll  (Ofinno) |  |
| 2.6b | IntraTMP search arIntraTMP search area shifting and plus-shape refinement for LIC candidates | K. Naser (InterDigital) |  |
| 2.6c | Test 2.6a + Test 2.6b | D. Ruiz Coll  (Ofinno)  K. Naser (InterDigital) |  |
| 2.7a | Regularized EIP | H. Qin  (TCL) | R. Ishimoto  (Sharp) |
| 2.7b | Regularized CCCM | H. Qin  (TCL) | R. Ishimoto  (Sharp) |
| 2.7c | Test 2.7a + Test 2.7b | H. Qin  (TCL) | R. Ishimoto  (Sharp) |
| 2.8a | MIP with mode and block shape dependent matrices. | H. Wang (Qualcomm) |  |
| 2.8b | MIP with downsampling/upsampling in the process. | H. Wang (Qualcomm) |  |
| 2.8c | Harmonization of the MIP mode and matrix-based conventional intra modes. | H. Wang (Qualcomm) | J. Konieczny (TCL) |
| 2.9a | Derived modes with fusion | Z. Xie  (OPPO) |  |
| 2.9b | MIP-LFNST transform set derivation by upsampled prediction | Z. Xie  (OPPO) |  |
| 2.9c | Test 2.9a + Test 2.9b | Z. Xie  (OPPO) |  |
| **3** **Inter prediction** | | | |
| 3.1a | High accuracy sample based BDOF | M. Salehifar  (Bytedance) |  |
| 3.1b | High accuracy sample based BDOF with no weight | M. Salehifar  (Bytedance) |  |
| 3.2 | Temporal BV for IBC merge list construction | L. Xu  (OPPO)  N. Zhang  (Bytedance) |  |
| 3.3a | GPM with inter prediction and IBC | Y. Wang  (Bytedance) |  |
| 3.3b | Test 3.2 + Test 3.3a | Y. Wang  (Bytedance)  L. Xu  (OPPO) |  |
| 3.4a | Merge candidates with alternative reference indices | Z. Zhang  (Qualcomm) |  |
| 3.4b | Additional TMVP and SbTMVP candidates | Z. Zhang  (Qualcomm) |  |
| 3.4c | Additional bi-TMVP candidates | Z. Zhang  (Qualcomm) |  |
| 3.4d | Test 3.4a + Test 3.4b + Test 3.4c | Z. Zhang  (Qualcomm) |  |
| 3.5a | Additional CMVP candidates introduced in the pairwise merge candidate list. | N. Zhang  (Bytedance) |  |
| 3.5b | Additional CMVP candidates introduced in the initial merge candidate list. | N. Zhang  (Bytedance) |  |
| 3.6 | Adaptive cost function selection in merge mode | K. Cui  (Qualcomm) |  |
| 3.7 | TMVP for chained motion vector prediction | P.-H. Lin  (Qualcomm) |  |
| 3.8a | GPM-affine with MMVD | Y. Wang  (Bytedance) |  |
| 3.8b | GPM-affine with TM | Y. Wang  (Bytedance) |  |
| 3.8c | Test 3.8a + Test 3.8b | Y. Wang  (Bytedance) |  |
| 3.9 | Affine candidates derived from temporal collocated pictures | C. Ma  (Kwai) |  |
| 3.10 | Sharp motion compensation filter for bi-prediction | J. Samuelsson-Allendes  (Sharp) |  |
| **4** **Transform and coefficients coding** | | | |
| 4.1a | Multiple kernel set selection for inter LFNST/NSPT | L. Zhao  (Bytedance) |  |
| 4.1b | LFNST/NSPT for SBT-coded blocks | L. Zhao  (Bytedance) |  |
| 4.1c | Test 4.1a + Test 4.1b | L. Zhao  (Bytedance) |  |
| 4.2a | Shifting quantization center for transform skip coefficient | Y. Yu  (OPPO) | M. Balcilar  (InterDigital) |
| 4.2b | Shifting quantization amount derived from quantization level of individual quantizer | Y. Yu  (OPPO) | M. Balcilar  (InterDigital) |
| 4.2c | Test 4.2a + Test 4.2b | Y. Yu  (OPPO) | M. Balcilar  (InterDigital) |
| 4.3 | 16 States TCQ | M. Balcilar  (InterDigital) |  |
| 4.4a | Multiple transform set selection for intra LFNST/NSPT without complexity reduction | F. Wang  (OPPO)  L. Zhao  (Bytedance)  M. Coban  (Qualcomm) |  |
| 4.4b | Test 4.4a with CU size restriction | F. Wang  (OPPO) |  |
| 4.4c | Test 4.4a with implicit kernel derivation | C. Bonnineau (InterDigital) |  |
| 4.4d | Test 4.4b with implicit kernel derivation | C. Bonnineau (InterDigital) |  |
| 4.4e | Test 4.4a with reduced number of transform candidates | M. Coban  (Qualcomm) |  |
| 4.4f | Test 4.1c from the previous EE | F. Wang  (OPPO) |  |
| 4.5a | Multiple transform set selection for intra MTS | C. Bonnineau (InterDigital) |  |
| 4.5b | Test 4.4a + Test 4.5a | C. Bonnineau (InterDigital) |  |
| **5 In-loop filtering** | | | |
| 5.1a | Modification of ALF RDO criterion | G. Boisson  (InterDigital) |  |
| 5.1b | Modification of ALF APS syntax | G. Boisson  (InterDigital) |  |
| 5.1c | Modification of CTU-level ALF syntax | G. Boisson  (InterDigital) |  |
| 5.1d | Test 5.1b + Test 5.1c | G. Boisson  (InterDigital) |  |
| 5.1e | Test 5.1a + Test 5.1d | G. Boisson  (InterDigital) |  |
| 5.2 | ALF residuals scaling | P.Bordes  (InterDigital) |  |
| 5.3a | CCALF with chroma SAO outputs | Z.Dai, N. Song  (OPPO) |  |
| 5.3b | CCALF with chroma fixed filter outputs | Z.Dai, N. Song (OPPO) |  |
| 5.3c | CCALF with chroma ALF outputs | N. Hu  (Qualcomm) |  |
| 5.3d | Test 5.3a + Test 5.3b + Test 5.3c | N. Hu  (Qualcomm)  Z.Dai, N. Song (OPPO) |  |
| 5.3e | Test 5.3a + Test 5.3c | N. Hu  (Qualcomm)  Z.Dai, N. Song (OPPO) |  |
| **6 Entropy coding** | | | |
| 6.1a | Retrained CABAC contexts | F. Galpin (InterDigital) |  |
| 6.1b | Test 6.1a + some EP bins converted to NEP. | F. Galpin (InterDigital) |  |
| 6.1c | Test 6.1b + some EP bins converted to become context coded | F. Galpin (InterDigital) |  |
| 6.2a | Context offset for gtX | P.Nikitin  (Qualcomm) |  |
| 6.2ba | Test 6.1a + Test 6.2a | P.Nikitin  (Qualcomm) |  |

# Tools description

## Partitioning

**Test 1.1: Adaptive dual tree coding in inter slices (JVET-AH0152)**

In this test, adaptive dual tree coding is used in inter slices as follows.

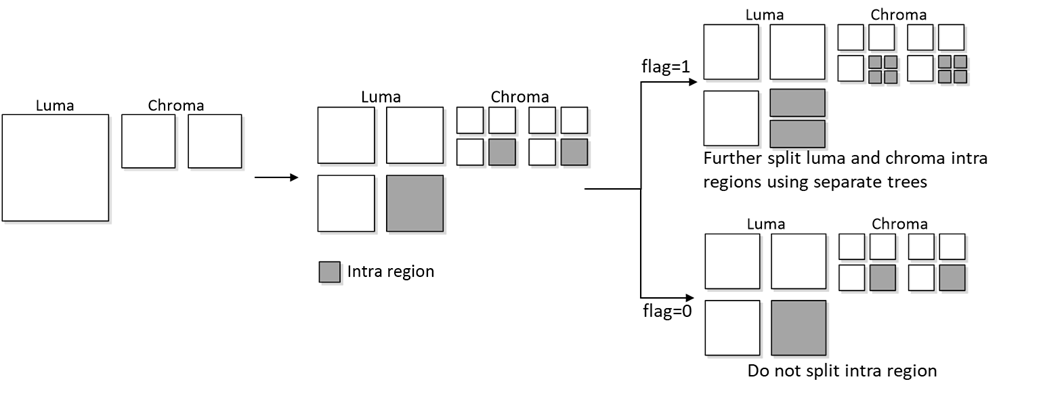
Single tree coding is systematically used at least down to block size 64x64.

Then, for a non-split CU with size at most 64x64 and corresponding to a leaf of the single tree, skip flag and coding mode are signalled. In case of intra mode, they are followed by a separate-tree CU-level flag.

In case separate-tree flag is false, current CU is a leaf of the single tree and is coded as usual.

In case separate-tree flag is true, current CU is the root of a further separate tree representation of luma and chroma. All coding units coded in this local dual tree mode in B slices are intra coded.

In intra slices, only dual tree representation is used, regardless the Intra/IBC coding mode.



***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.1 | Adaptive dual tree coding in inter slices | F. Le Léannec (InterDigital) |

**Test 1.2: Restricting BT CUs to apply QT-like partitioning structure (JVET-AH0155)**

In the current version of ECM (ECM-12.0), the BT CUs are allowed to apply a QT-like partitioning structure even though the QT split is allowed for such CUs.

In this test, a restriction on BT CUs is applied to avoid applying a QT-like partitioning structure. The condition is applied to a square CU for which QT split is allowed and it has QT depth between 0 to N.  A new CABAC context is added to signal split\_cu\_flag. The context is used when the binary split is applied on a luma channel CU, and its first subblock chooses a different binary split compared to the binary split selected by its parent CU.

In Test 1.2a an investigation will be performed to further improve the coding gain and encoding time reduction. In Test 1.2b it will be investigated if N should be set to 2 or another number.  In test 1.2c a non-normative solution will be tested.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.2a | Restricting BT CUs to apply QT-like partitioning structure | W. Ahmad (Ericsson) |
| 1.2b | Restricting BT CUs to apply QT-like partitioning structure (also at smaller block sizes) | W. Ahmad (Ericsson) |
| 1.2c | Restricting BT CUs to apply QT-like partitioning structure (non-normative solution) | W. Ahmad (Ericsson) |

## 2. Intra prediction

### Test 2.1: TIMD merge (JVET-AH0075)

In ECM, TIMD prediction is derived by a fusion of up to 3 intra modes with the smallest SATD cost with the weights corresponding to the template cost.

In the test, TIMD merge list of size 5 is constructed by adding TIMD information (prediction modes, fusion flag, fusion weights and wide-angle conditions of TIMD modes, MTS transform types) from adjacent and non-adjacent neighbouring blocks shown in the next figure.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.1 | TIMD merge | M. Abdoli (Xiaomi) |

### Test 2.2: TIMD with enhanced block vectors deployment (JVET-AH0274, JVET-AH0071)

This test studies using block vectors for TIMD mode, similar to block vector usage for DIMD and SGPM modes. Specifically, the adjacent, non-adjacent and ARBVP block vector can replace any of the three time regular intra prediction mode according the to the template cost.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.2 | TIMD with enhanced block vector deployment | K. Naser (InterDigital)  J. Fu (Peking Univ.) |

### Test 2.3: Combination of TIMD related tests

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.3 | Test 2.1 + Test 2.2 | M. Abdoli (Xiaomi)  K. Naser (InterDigital)  J. Fu  (Peking Univ.) |

### Test 2.4: Additional TIMD mode with different cost metric (JVET-AH0083)

In this test, an additional TIMD mode is tested. In this coding mode, template costs are calculated with mean removed SAD instead of SATD as in regular TIMD, and the list of candidate TIMD modes is modified. This increases the diversity between the regular and additional TIMD mode.

In Test 2.4a, also the template size is modified with respect to regular TIMD.

In Test 2.4b, the template size is kept the same as in regular TIMD.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.4a | Additional TIMD mode with different cost metric | D. Bugdayci Sansli (Nokia) |
| 2.4b | Additional TIMD mode with different cost metric (no template size change) | D. Bugdayci Sansli (Nokia) |

### Test 2.5: Intra merge mode (JVET-AH0211)

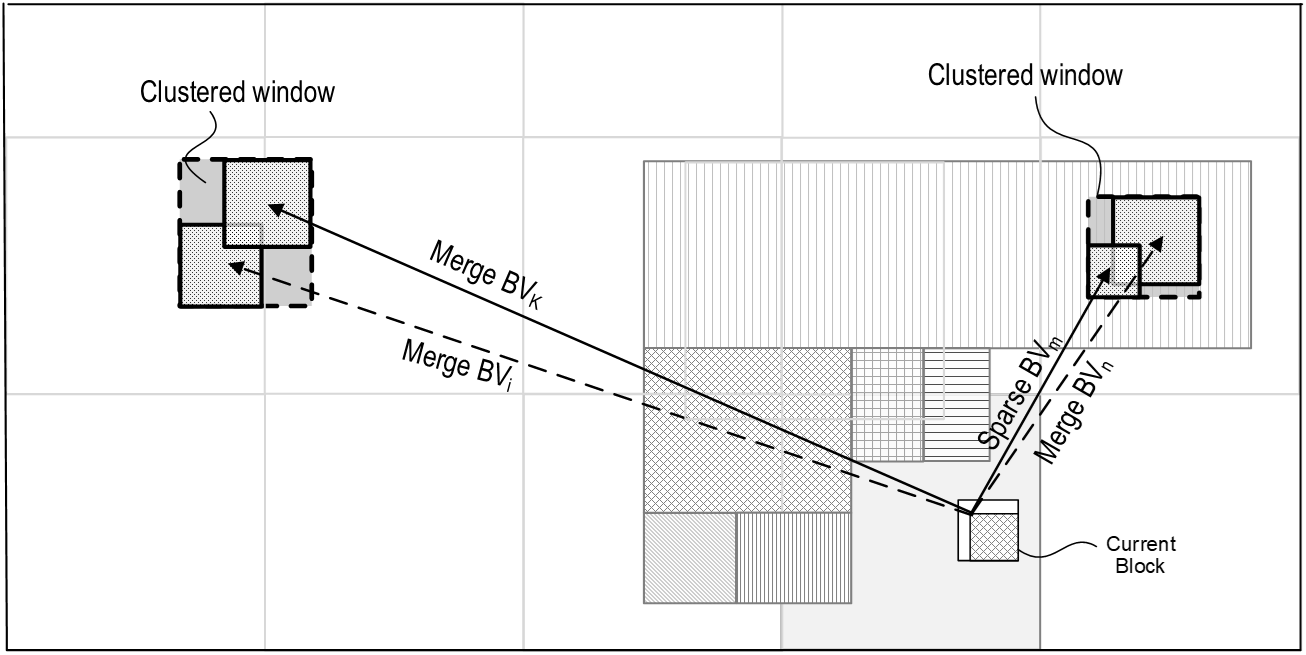
A list of intra mode candidates is constructed using the intra modes from the neighbour blocks. A flag is signalled to indicate whether to enable the proposed intra merge mode. If the flag is true, a list index is signalled to indicate which intra merge list is selected. An index is further signalled to indicate which candidate is used for this CU.

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.5a | Intra merge mode | Y.-J. Chang (Qualcomm) |
| 2.5b | Intra merge mode without TIMD candidate | Y.-J. Chang (Qualcomm) |
| 2.5c | Intra merge mode with adjacent and non-adjacent neighbours used in current ECM intra tools | Y.-J. Chang (Qualcomm) |
| 2.5d | Intra merge mode with larger candidate list | Y.-J. Chang (Qualcomm) |

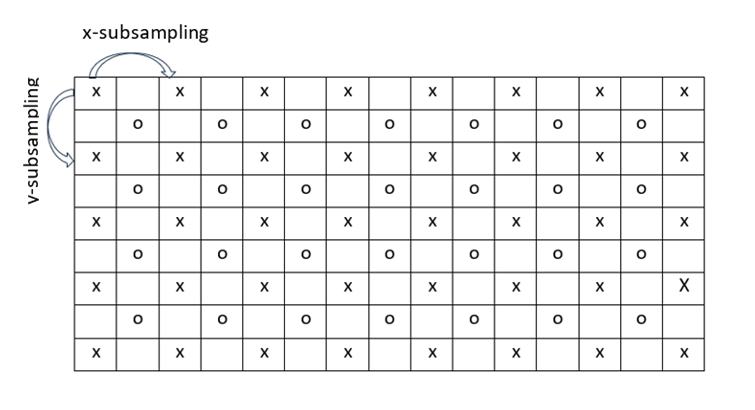
### Test 2.6: IntraTMP candidates with overlapping refinement window enhanced (JVET-AH0151)

IntraTMP introduces a merge candidate list comprising candidates from adjacent and non-adjacent neighbouring PU. In ECM-13.0, the TMP merge list is enriched with the AR-BVP candidates derived from initial BV merge candidates, and additional sparse and refinement lists are also available for the TMP LIC mode.

Test 2.6a explores a method for clustering the merge candidates whose refinement windows overlap with the sparse candidates or among them, determining a new refinement window comprising the individual refinement windows. The AR-BVP candidate extension using the sparse candidates as guiding BVs will also be explored.



Test 2.6b explores removing the overlapping between the IntraTMP block vector candidates between the regular LIC and non-LIC lists. Additionally, a new refinement window shape for candidate duplicity removal will be studied.



Test 2.6c combines the Test 2.6a and Test 2.6b

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.6a | IntraTMP merge candidates clustering based on refinement window | D. Ruiz Coll  (Ofinno) |
| 2.6b | IntraTMP search area shifting and plus-shape refinement for LIC candidates | K. Naser  (InterDigital) |
| 2.6c | Test 2.6a + Test 2.6b | D. Ruiz Coll  (Ofinno)  K. Naser  (InterDigital) |

### Test 2.7: Regularized EIP/CCCM (JVET-AH0095)

In ECM, ordinary least squares method is used to solve EIP and CCCM model coefficients. In this test, it is proposed to use regularized least squares method to solve EIP and CCCM model coefficients.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.7a | Regularized EIP | H. Qin  (TCL) |
| 2.7b | Regularized CCCM | H. Qin  (TCL) |
| 2.7c | Test 2.7a + Test 2.7b | H. Qin  (TCL) |

**Test 2.8: Modifications to Matrix-based intra prediction (JVET-AH0210)**

In this test, new matrices are designed for the MIP mode in ECM. The matrices are applied to L-shaped causal template and the weights of the matrices are mode and block shape dependent. The trade-off between bd-rate and complexity will be studied.

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.8a | MIP with mode and block shape dependent matrices. | H. Wang (Qualcomm) |
| 2.8b | MIP with downsampling/upsampling in the process. | H. Wang (Qualcomm) |
| 2.8c | Harmonization of the MIP mode and matrix-based conventional intra modes. | H. Wang (Qualcomm) |

### Test 2.9: Derived MIP modes with fusion (JVET-AH0058)

In this test, a template-based method is utilized to derive two best MIP modes and transposed flags. Then the proposed method fuses the two derived MIP predictions with weights. For small and non-square blocks, the proposed method applies the DIMD process to the upsampled prediction samples to derive the LFNST transform set.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.9a | Derived modes with fusion | Z. Xie  (OPPO) |
| 2.9b | MIP-LFNST transform set derivation by upsampled prediction | Z. Xie  (OPPO) |
| 2.9c | Test 2.9a + Test 2.9b | Z. Xie  (OPPO) |

## 3. Inter prediction

### Test 3.1: High Accuracy Sample Based BDOF (JVET-AH0178)

It is proposed to use high accuracy formula for BDOF sample. Specifically, the following formula will be reused:

(Gx.Gx+R1) \* vx + Gx.Gy \* vy = dI . Gx - dM . Gx

Gx.Gy \* vx + (Gy.Gy+R1) \* vy = dI . Gy - dM . Gy

In the test a, the summation is a weighted sum, and in test b, no weight is used for the summation.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.1a | High accuracy sample based BDOF | M. Salehifar  (Bytedance) |
| 3.1b | High accuracy sample based BDOF with no weight | M. Salehifar  (Bytedance) |

### Test 3.2: Temporal BV for IBC merge list construction (JVET-AH0059)

In this test, the BVs from the collocated pictures are used as the additional candidates for constructing the IBC/AMVP merge list. The BVs can be obtained from the collocated positions and shifted collocated positions in the collocated pictures.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.2 | Temporal BV for IBC merge list construction | L. Xu  (OPPO)  N. Zhang  (Bytedance) |

**Test 3.3: GPM with inter prediction and IBC (JVET-AH0091)**

GPM with inter prediction and intra block copy (GPM-Inter-IBC) is proposed. In GPM-Inter-IBC, the two sub-partitions divided geometrically are predicted using inter prediction and IBC, individually. To generate the prediction signal of IBC, an IBC candidate list is constructed, and the index of the selected block vector is signalled. The prediction signal of IBC for one sub-partition can be blended with regular GPM, GPM-MMVD, and GPM-Affine for the other sub-partition.

In Test 3.3a, GPM-Inter-IBC is tested. In Test 3.3b, the combination of Test 3.2 and Test 3.2a is tested.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.3a | GPM with inter prediction and IBC | Y. Wang  (Bytedance) |
| 3.3b | Test 3.2 + Test 3.3a | Y. Wang  (Bytedance)  L. Xu  (OPPO) |

**Test 3.4: MVP extension (JVET-AH0213)**

In this test, it adds merge, TMVP and SbTMVP candidates with alternative reference indices, and bi-TMVP candidates based on motion trajectory crossing the current block.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.4a | Merge candidates with alternative reference indices | Z. Zhang  (Qualcomm) |
| 3.4b | Additional TMVP and SbTMVP candidates | Z. Zhang  (Qualcomm) |
| 3.4c | Additional bi-TMVP candidates | Z. Zhang  (Qualcomm) |
| 3.4d | Test3.4a + Test 3.4b + Test 3.4c | Z. Zhang  (Qualcomm) |

### Test 3.5: Additional chained motion vector prediction candidates (JVET-AH0116)

Some additional chained motion vector prediction (CMVP) candidates are introduced in the pairwise/initial merge candidate list. The maximum size of the pairwise/initial merge candidate list is increased. It will reserve some positions for the CMVP candidates.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.5a | Additional CMVP candidates introduced in the pairwise merge candidate list. | N. Zhang  (Bytedance) |
| 3.5b | Additional CMVP candidates introduced in the initial merge candidate list. | N. Zhang  (Bytedance) |

### Test 3.6: Adaptive cost function selection in merge mode (JVET-AH0215)

This test examines the merge index-based cost function selection in merge mode for motion vector refinement process. Alternating between two cost functions, which are selected based on the parity of the merge index, allows for the refinement of the merge candidates in a merge list with different cost functions.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.6 | Adaptive cost function selection in merge mode | K. Cui  (Qualcomm) |

### Test 3.7: TMVP for chained motion vector prediction (JVET-AH0183)

In this test, it adds TMVP with zero reference index if the existed TMVP reference index is not zero. When deriving CMVP from a TMVP merge candidate, the TMVP candidate will be scaled to the zero reference index. The scaled motion vector is stored and used to derive the CMVP candidates. Besides, CMVP is also extended to BMmerge mode.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.7 | TMVP for chained motion vector prediction | P.-H. Lin  (Qualcomm) |

### Test 3.8: GPM-affine with MMVD and TM (JVET-AH0222)

In this test, GPM-affine is combined with GPM-MMVD and GPM-TM. With GPM-affine-MMVD, an MV offset is added to all CPMVs of an affine candidate and the modified CPMVs are used for predicting a GPM sub-partition. The signalling of the affine candidate and the MV offset is the same as GPM-affine and GPM-MMVD. With GPM-affine-TM, an affine candidate could be refined by template matching using the same method in affine mode. A GPM sub-partition can be predicted by GPM-affine-TM or GPM-TM.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.8a | GPM-affine with MMVD | Y. Wang  (Bytedance) |
| 3.8b | GPM-affine with TM | Y. Wang  (Bytedance) |
| 3.8c | Test 3.8a + Test 3.8b | Y. Wang  (Bytedance) |

**Test 3.9: Affine candidates derived from temporal collocated pictures (JVET-AH0208)**

In the test, affine candidates derive from temporal collocated pictures are inserted into the affine merge list. Specifically, by the method, the affine candidates are derived from the temporally scaled control point motion vectors from the temporal collocated pictures.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.9 | Affine candidates derived from temporal collocated pictures | C. Ma  (Kwai) |

**Test 3.10: Sharp motion compensation filter for bi-prediction (JVET-AH0141)**

In the test, a new luma motion compensation (MC) filter is used for bi-predicted blocks, while the existing MC filter is still used for uni-predicted blocks. The tested filter uses the same number of filter taps and coefficient precision as the existing MC filter for luma, but has sharper filter properties.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.10 | Sharp motion compensation filter for bi-prediction | J. Samuelsson-Allendes (Sharp) |

## 4. Transform and coefficients coding

### Test 4.1 Improvements on inter LFNST/NSPT (JVET-AH0219)

In Test 4.1a, the LFNST/NSPT transform set for a GPM-coded block is selected out of multiple candidate sets, which corresponds to multiple intra prediction modes (IPM). A CU level flag indicating the IPM index is signalled.

In Test 4.1b, a CU level LFNST/NSPT index is signalled for an SBT-coded block. When LFNST/NSPT is applied to an SBT-coded CU, the TU with nonzero residual will perform LFNST/NSPT.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.1a | Multiple kernel set selection for inter LFNST/NSPT | L. Zhao  (Bytedance) |
| 4.1b | LFNST/NSPT for SBT-coded blocks | L. Zhao  (Bytedance) |
| 4.1c | Test 4.1a + Test 4.1b | L. Zhao  (Bytedance) |

### Test 4.2: Shifting quantization center (JVET-AH0063)

In this test, shifting quantization center is applied in the transform skip mode. For DQ, the quantization level k of individual quantizer instead of the quantization indices of DQ is used to derive the shifting amount as follows.

((1024-)\*(k) + )\*(k’))>>10 if |k|>0

where i indicates the Q0 or Q1, x is the dequantized coefficient, |Ti| is the size of the lookup table, is the dequantized value of the quantization level k from quantizer Qi, k’ is the auxiliary quantization level that can be calculated as k’=k+(k>0 ?1:-1).

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.2a | Shifting quantization center for transform skip coefficient | Y. Yu  (OPPO) |
| 4.2b | Shifting quantization amount derived from quantization level of individual quantizer | Y. Yu  (OPPO) |
| 4.2c | Test 4.2a + Test 4.2b | Y. Yu  (OPPO) |

### Test 4.3 16 States TCQ (JVET-AH0079)

In this test, the number of the number of Trellis Coded Quantization (TCQ) states in dependent quantization (DQ) is increased. The number of states is increased from 8 to 16, where the 8 new states use similar transition rules as the original ones.

16 states are used and the following state to state transition table where default scalar quantizers are   
Q0 and Q1. The transition depends on the current state and the parity of the quantization index to be either even or odd shown by pn=0 or pn=1 respectively.

An example of transition set that is not achievable by the current 8-states TCQ will be shown.

|  |  |  |  |
| --- | --- | --- | --- |
| state | quantizer used | next state | |
| pn = 0 | pn = 1 |
| 0 | Q0 | 0 | 2 |
| 1 | Q1 | 5 | 7 |
| 2 | Q0 | 1 | 3 |
| 3 | Q1 | 6 | 4 |
| 4 | Q0 | 10 | 8 |
| 5 | Q1 | 12 | 14 |
| 6 | Q0 | 11 | 9 |
| 7 | Q1 | 15 | 13 |
| 8 | Q0 | 8 | 10 |
| 9 | Q1 | 13 | 15 |
| 10 | Q0 | 9 | 11 |
| 11 | Q1 | 14 | 12 |
| 12 | Q0 | 2 | 0 |
| 13 | Q1 | 4 | 6 |
| 14 | Q0 | 3 | 1 |
| 15 | Q1 | 7 | 5 |

In order to control the encoder complexity, different switching mechanism between default 8 and proposed 16 states TCQ will be tested.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.3 | 16 states TCQ | M. Balcilar  (InterDigital) |

**Test 4.4 Multiple Transform Set Selection for intra LFNST/NSPT (JVET-AH0347)**

In this test, the multiple transform set selection (MTSS) method for intra blocks coded with LFNST/NSPT is investigated. In the MTSS method, CUs coded with DIMD/TIMD/SGPM/MIP/EIP/ITMP modes can choose an alternative LFNST/NSPT transform set. The transform set selection is signalled in the bitstream.

The highest possible gain as well as the compression vs. complexity trade-off are investigated.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.4a | Multiple transform set selection for intra LFNST/NSPT without complexity reduction | F. Wang  (OPPO)  L. Zhao  (Bytedance)  M. Coban  (Qualcomm) |
| 4.4b | Test 4.4a with CU size restriction | F. Wang  (OPPO) |
| 4.4c | Test 4.4a with implicit kernel derivation | C. Bonnineau  (InterDigital) |
| 4.4d | Test 4.4b with implicit kernel derivation | C. Bonnineau  (InterDigital) |
| 4.4e | Test 4.4a with reduced number of transform candidates | M. Coban  (Qualcomm) |
| 4.4f | Test 4.1c from the previous EE | F. Wang  (OPPO) |

**Test 4.5 Multiple transform set selection for intra MTS (JVET-AH0307)**

In this test, multiple transform set selection applied to explicit intra MTS is investigated. Specifically, an alternative transform set of the explicit intra MTS lookup-table is considered in addition to the initial transform set for several non-directional intra modes.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.5a | Multiple transform set selection for intra MTS | C. Bonnineau (InterDigital) |
| 4.5b | Test 4.4a + Test 4.5a | C. Bonnineau (InterDigital) |

## 5. In-loop filtering

**Test 5.1: Modifications in ALF syntax (JVET-AH0163)**

In this test, modifications in ALF syntax are tested both at APS and CTU levels. At APS level (Test 5.1b), modifications impact filter coefficient encoding, with the introduction of LUTs that specify an Exp-Golomb order for each coefficient. APS modifications also impact how luma class-to-filter maps are signalled, with predictive coding of filter indices. At CTU level (Test 5.1c), lists of most probable candidates are created for ALF APS, luma filter set and chroma filter, based on neighbouring CTUs. In addition, an encoder-only change is tested with the modification of ALF RDO criterion (Test 5.1a).

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 5.1a | Modification of ALF RDO criterion | G. Boisson  (InterDigital) |
| 5.1b | Modification of ALF APS syntax | G. Boisson  (InterDigital) |
| 5.1c | Modification of CTU-level ALF syntax | G. Boisson  (InterDigital) |
| 5.1d | Test 5.1b + Test 5.1c | G. Boisson  (InterDigital) |
| 5.1e | Test 5.1a + Test 5.1d | G. Boisson  (InterDigital) |

**Test 5.2: ALF residuals scaling (JVET-AH0170)**

In this test, it is proposed scaling of ALF residuals. It is proposed to signal luma scaling factors to be applied on the non-fixed APS-ALF correction residuals. Different scaling factors may be associated with different group of class indexes.

For each alternative filter set of each APS-ALF used in the current slice:

* an index idxGroup signals the number num\_sc of scaling factors (num\_sc = 1 << idxGroup). One scaling factor is associated to one group of consecutive classes.
* num\_sc scaling factors indexes ( idxScale[n] ) are coded. The scaling factor idxScale[n] is associated to nth group of classes. Then a scaling factor index sfi[c] is derived for each of the 25 class indexes ‘c’.

For example:

sfi[.]=3333333333333333333333333         { idxGroup = 0, idxScale={3}              }

sfi[.]=0000000000004444444444444         { idxGroup = 1, idxScale={0,4}           }

sfi[.]=0000004444442222221111111         { idxGroup = 2, idxScale={0,4,2,1}     }

* the mapping scaling factors indexes to scaling factors is derived using pre-defined tables of scaling values tab[].
* the ALF correction corr(s) is scaled using the scaling factor associated to the class index of the sample (class(s)) and added to the reconstructed sample:

rec’(s) = rec(s) + ( corr(s) \* tab[ sfi[ class(s) ] ] + 4 ) >> 3

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 5.2 | ALF residuals scaling | P. Bordes  (InterDigital) |

**Test 5.3: CCALF with chroma inputs (JVET-AH0061, JVET-AH0062 and JVET-AH0275)**

Chroma signals at different stages of the chroma in-loop filtering process have been proposed to be additional inputs to CCALF. These various chroma signals, in combination with the new filter taps, can be used individually or jointly in the new CCALF. The particular chroma signals shown in the table below will be evaluated in this test.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 5.3a | CCALF with chroma SAO outputs | Z. Dai, N. Song  (OPPO) |
| 5.3b | CCALF with chroma fixed filter outputs | Z. Dai, N. Song  (OPPO) |
| 5.3c | CCALF with chroma ALF outputs | N. Hu  (Qualcomm) |
| 5.3d | Test 5.3a + Test 5.3b + Test 5.3c | N. Hu  (Qualcomm)  Z. Dai, N. Song  (OPPO) |
| 5.3e | Test 5.3a + Test 5.3c | N. Hu  (Qualcomm)  Z. Dai, N. Song  (OPPO) |

## 6. Entropy coding

**Test 6.1:** Extended entropy coding with non equiprobable coding **(JVET-AH0085)**

In the first Test 6.1a, ECM13 CABAC context are retrained without changing the ECM13 regular/EP type of existing bins.

Test 6.1b is similar to Test 6.1a, with some EP bins added as trainable, NEP model is added as a new model. EP bins can only become NEP.

Test 6.1c is similar to Test 6.1b but EP bins can choose any model (context/NEP/EP).

For tests 6.1b and 6.1c, the list of bins changed from context coded to NEP or from EP to NEP will be described.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 6.1a | Retrained CABAC contexts | F. Galpin (InterDigital) |
| 6.1b | Test 6.1a + some EP bins converted to NEP | F. Galpin (InterDigital) |
| 6.1c | Test 6.1b + some EP bins converted to become context coded | F. Galpin (InterDigital) |

**Test 6.2: Context offset for gtX (JVET-AH0153)**

In Test 6.2a the new context offset derivation process is applied for gtX flags is studied based on the sum of the decoded coefficients and their position in the transform block.

In Test 6.2b the combination of Test 6.1a and Test 6.2 is tested.

***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| 6.2a | Context offset for gtX | P.Nikitin  (Qualcomm) |
| 6.2b | Test 6.1a + Test 6.2a | P.Nikitin  (Qualcomm) |