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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** |
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| **Geneva, CH, 11–19 July 2023** |
| |  |  | | --- | --- | | **Title:** | **Exploration experiment on enhanced compression beyond VVC capability (EE2)** | | **Source:** | **Convenor (Jens-Rainer Ohm)** | | **Type:** | **General** | | **Subtype:** | **N/A** | | **Status:** | **Approved** | | **Date:** | **2023-08-22** | | **Expected Action:** | **Info** | | **Action due date:** | **N/A** | | **No. of pages** | **13** (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**  31st Meeting, Geneva, CH, 11–19 July 2023 | Document: JVET-AE2024-v2 |

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| --- | --- | --- | --- |
| *Title:* | **Exploration Experiment on Enhanced Compression beyond VVC capability (EE2)** | | |
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| *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 31st and 32nd 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-10.0 is used as an anchor in the tests.

Tests shall be performed according to the CTC described in JVET-AE2017.

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

Palette mode shall be enabled for classes F and TGM in both ECM anchor and EE tests.

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 (August 11, 2023) after JVET meeting: ECM is released

**T2** = T1 + 1 week (August 18, 2023): EE description is finalized

**T3** = T2 + 2 weeks (September 1, 2023): Initial software release for EE tests

**T4** = JVET meeting start – 3 weeks (September 22, 2023): Software in EE branches is frozen

# List of tests

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tests** | **Tester** | **Cross-checker** |
| **1 Partitioning** | | | |
| 1.1a | Non-square quadtree partitioning | LGE  Y. Ahn | InterDigital  R. Utida |
| 1.1b | ECM with maximum MTT depth increments | LGE  Y. Ahn | InterDigital  R. Utida |
| **2 Intra prediction** | | | |
| 2.1a | DIMD merge | Nokia  S. Blasi | Ofinno  P. Andrivon |
| 2.1b | DIMD merge with reduced storage | Nokia  S. Blasi | Ofinno  P. Andrivon |
| 2.2a | DIMD with filtered template | vivo  C. Zhou |  |
| 2.2b | DIMD with filtered template (without modification of gradient operators) | vivo  C. Zhou |  |
| 2.3a | Test 2.1a + Test 2.2a | Nokia  S. Blasi  vivo  C. Zhou |  |
| 2.3b | Test 2.1a + Test 2.2b | Nokia  S. Blasi  vivo  C. Zhou |  |
| 2.3c | Test 2.1b + Test 2.2a | Nokia  S. Blasi  vivo  C. Zhou |  |
| 2.3d | Test 2.1b + Test 2.2b | Nokia  S. Blasi  vivo  C. Zhou |  |
| 2.4 | IntraCIIP as additional mode of IntraTMP | InterDigital  K. Naser |  |
| 2.5a | TIMD with IntraTMP/IBC | InterDigital  K. Naser |  |
| 2.5b | Test 2.5a + Test 2.4 | InterDigital  K. Naser |  |
| 2.6a | Fractional-pel intraTMP BVs are stored at block vector buffer | OPPO  Y. Yu  Qualcomm  P.-H. Lin |  |
| 2.6b | IntraTMP BVs are stored at HMVP | OPPO  Y. Yu  Qualcomm  P.-H. Lin |  |
| 2.6c | Test 2.6a + Test 2.6b | OPPO  Y. Yu  Qualcomm  P.-H. Lin |  |
| 2.7 | An extrapolation filter-based intra prediction mode | OPPO  L. Xu |  |
| 2.8 | DBV improvement | OPPO  L. Xu |  |
| 2.9 | Enable DBV in single tree | Qualcomm  H. Huang |  |
| 2.10 | Combination test of Test 2.8 and Test 2.9 | Qualcomm  H. Huang  OPPO  L. Xu |  |
| **3** **Inter prediction** | | | |
| 3.1a | CCP merge mode for chroma inter coding | MediaTek  M.-S. Chiang | InterDigital K. Naser |
| 3.1b | CCP merge mode for chroma inter coding without the additional second type of shifted temporal candidates | MediaTek  M.-S. Chiang |  |
| 3.2 | LIC flag derivation of merge candidates with template costs | Bytedance  N. Zhang |  |
| 3.3a | Multi-model CCRM | Bytedance  Z. Deng |  |
| 3.3b | CCRM merge mode | Bytedance  Z. Deng |  |
| 3.4a | TM-based subblock motion refinement | Bytedance  L. Zhao |  |
| 3.4b | Interweaved affine prediction | Bytedance  L. Zhao |  |
| 3.4c | RMVF candidate derivation with multiple CUs | Bytedance  L. Zhao |  |
| 3.4d | Test 3.4a + Test 3.4b + Test 3.4c | Bytedance  L. Zhao |  |
| 3.5a | DMVR with robust MV derivation | Ericsson  K. Andersson |  |
| 3.5b | DMVREncSelect from VTM (encoder only) | Ericsson  K. Andersson |  |
| 3.6a | Affine subblock BDOF refinement | Qualcomm  Z. Zhang |  |
| 3.6b | AMVP-merge mode for affine | Qualcomm  Z. Zhang |  |
| 3.6c | Test 3.6a + Test 3.6b | Qualcomm  Z. Zhang |  |
| **4 Reference picture resampling** | | | |
| 4.1a | Enabling template-based reordering for scaled reference pictures | Kwai  X. Xiu |  |
| 4.1b | Test 4.1a + Enabling LIC for scaled reference pictures | Kwai  X. Xiu |  |
| 4.2a | Filtering applied after motion compensation, the post-processing upsampling is not changed | RWTH Aachen Univ.  T. Claßen |  |
| 4.2b | Test 4.2a + perform the filtering after reconstruction | RWTH Aachen Univ.  T. Claßen |  |
| **5 In-loop filtering** | | | |
| 5.1a | Dynamic TU scale factor for BIF with LUTs interpolation | Ericsson  V. Shchukin |  |
| 5.1b | Dynamic TU scale factor for BIF | Ericsson  V. Shchukin |  |
| 5.2a | Luma-residual tap in chroma-ALF | Bytedance  W. Yin |  |
| 5.2b | Test 5.2a + Luma-residual tap in CCALF | Bytedance  W. Yin |  |
| **6 Entropy coding** | | | |
| 6.1a | Spatial CABAC tuning | Nokia  J. Lainema |  |
| 6.1b | Spatial CABAC tuning with reduced memory/latency | Nokia  J. Lainema |  |
| 6.2 | Retrain I-slices context model parameters | Alibaba  R.-L. Liao | InterDigital K. Naser |
| 6.3 | Test 6.2 + Test 6.1 | Nokia  J. Lainema  Alibaba  R.-L. Liao |  |

# Tools description

## Partitioning

**Test 1.1: Non-square quadtree partitioning (JVET-AE0082)**

In this test, non-square quadtree (NQT) partitioning is investigated. Specifically, a quadtree partitioning is allowed for non-square blocks including 2NxN and Nx2N. Reusing conventional syntax for quadtree which is *split\_qt\_flag* and introducing a new syntax element to enhance the signalling efficiency is also studied with additional CABAC context for the NQT partition.

As there are no new partition options, to show benefit, it should be compared with encoders using very similar encoding times. It was suggested to release in ECM the constraint for maximum MTT depth, which would increase the encoding time of ECM and would make the comparison more fair. However, to be attractive for adoption, the encoding time shall be in the ballpark of current ECM.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.1a | Non-square quadtree partitioning | LGE  Y. Ahn |
| 1.1b | ECM with maximum MTT depth increments | LGE  Y. Ahn |

## 2. Intra prediction

### Test 2.1: DIMD merge (JVET-AE0071)

In this test, DIMD merge is studied for improving the coding efficiency of ECM. The method uses the DIMD Histograms of Gradients (HoGs) of neighbouring blocks to predict the current block. When neighbouring blocks encoded with DIMD are available, the DIMD histograms are combined to form a new DIMD merge histogram for the current block. DIMD merge modes and weights are computed based on this merged histogram. It was recommended to investigate reduction of storage needs (as in test 2.1b). Analysis of memory needs is requested and will be provided.

Test 2.1a tests the method in full.

Test 2.1b tests the method with some storage reduction strategies.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.1a | DIMD merge | Nokia  S. Blasi |
| 2.1b | DIMD merge with reduced storage | Nokia  S. Blasi |

### Test 2.2: DIMD with filtered template (JVET-AE0130)

This test proposes a template filtering method for DIMD mode. The template is filtered using a 3x3 filter operator before obtaining the gradient histogram. Two tests are studied:

Test2.2a uses the 3x2 and 2x3 gradient operators when calculating a gradient.

Test2.2b avoids the modification of gradient operators.

The encoding time needs to be largely reduced, without any substantial loss in performance.

It would also be desirable to avoid the modification of gradient operators, e.g. by using unfiltered samples for gradient computation at positions where no filtered samples are available.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.1a | DIMD with filtered template | vivo  C. Zhou |
| 2.1b | DIMD with filtered template (without modification of gradient operators) | vivo  C. Zhou |

### Test 2.3: Combination of DIMD related tests (JVET-AE0071, JVET-AE0130)

Combinations of Test 2.1 and Test 2.2 are investigated.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.3a | Test 2.1a + Test 2.2a | Nokia  S. Blasi  vivo  C. Zhou |
| 2.3b | Test 2.1a + Test 2.2b | Nokia  S. Blasi  vivo  C. Zhou |
| 2.3c | Test 2.1b + Test 2.2a | Nokia  S. Blasi  vivo  C. Zhou |
| 2.3d | Test 2.1b + Test 2.2b | Nokia  S. Blasi  vivo  C. Zhou |

### Test 2.4: IntraCIIP as additional mode of IntraTMP (JVET-AE0214)

This test studies an intra coding mode, named IntraCIIP, that combines the prediction signals generated by regular prediction and IntraTMP. It is based on the existing CIIP blending method. IntraCIIP is signaled as an additional mode of IntraTMP.

It was further commented that there might be inter-dependency with JVET-AE0184, these should be tested in combination.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.4 | IntraCIIP as additional mode of IntraTMP | InterDigital  K. Naser |

### Test 2.5: TIMD with IntraTMP and IBC candidates (JVET-AE0184)

In this test, an extension of TIMD with IBC and IntraTMP is studied. Specifically, IBC and IntraTMP are tested with TIMD template cost along with other default modes. The TIMD process is used to deduce the best modes to combine to generate the final prediction.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.5a | TIMD with IntraTMP/IBC | InterDigital  K. Naser |
| 2.5b | Test 2.5a + Test 2.4 | InterDigital  K. Naser |

### Test 2.6: IntraTMP block vector storing (JVET-AE0075, JVET-AE0124)

In this test, IntraTMP block vectors (BVs) are stored for coding future blocks. More specifically, fractional-pel IntraTMP BVs will be stored at block vector buffer. In addition, IntraTMP BVs will be stored at HMVP too.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| Test 2.6a | Fractional-pel IntraTMP BVs are stored at block vector buffer | OPPO  Y. Yu  Qualcomm  P.-H. Lin |
| Test 2.6b | IntraTMP BVs are stored at HMVP | OPPO  Y. Yu  Qualcomm  P.-H. Lin |
| Test 2.6c | Test 2.6a + Test 2.6b | OPPO  Y. Yu  Qualcomm  P.-H. Lin |

### Test 2.7: An extrapolation filter-based intra prediction mode (JVET-AE0076)

In this test, an extrapolation filter-based intra prediction mode is tested. Firstly, the mode coefficients are obtained from the neighboring reconstructed pixels of the current block with a pre-determined template. Secondly, the tested mode derives prediction for the current block from the top-left position to the bottom-right position in a parallel manner.

A size restriction is applied to the mode.

Further study to reduce encoder run time, and also apply in inter slices.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| Test 2.7 | An extrapolation filter-based intra prediction mode | OPPO  L. Xu |

### Test 2.8: DBV improvement (JVET-AE0167)

In this test, the modifications of chroma DM mode are investigated when the collocated luma area of the chroma block has valid BVs.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| Test 2.8 | DBV improvement | OPPO  L. Xu |

### Test 2.9 Enable DBV in single tree (JVET-AE0098)

In this test, chroma DBV mode is additionally enabled in single tree. A test with a single tree enabled for I-slice (non CTC) is also tested.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| Test 2.9a | Enable DBV in single tree under CTC | Qualcomm  H. Huang |
| Test 2.9b | Enable DBV in single tree when DualITree is set to 0 | Qualcomm  H. Huang |

### Test 2.10: Combination test of Test 2.8 and Test 2.9

In this test, the combination test of Test 2.8 and Test 2.9 is performed.

## 3. Inter prediction

### Test 3.1: CCP merge mode for chroma inter coding (JVET-AE0178)

In this test, the CCP merge mode is extended to inter coding blocks, where the final chroma inter prediction combines motion-compensation and cross-component predicted signals derived using the inherited CCP model. Reduction of encoder runtime should be performed.

Test 3.1a tests the inherited CCP model from the inter CCP merge list.

Test 3.1b tests the inherited CCP model from the inter CCP merge list without the additional second type of shifted temporal candidates.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.1a | CCP merge mode for chroma inter coding | MediaTek  M.-S. Chiang |
| 3.1b | CCP merge mode for chroma inter coding without the additional second type of shifted temporal candidates | MediaTek  M.-S. Chiang |

Test 3.2: **LIC flag derivation of merge candidates with template costs (JVET-AE0109)**

In ECM, the LIC flag is inherited for a merge candidate. It is proposed to derive the LIC flag of a merge candidate based on template costs. A SAD-based template cost, denoted as C0, and a Mean Removal SAD (MRSAD)-based template cost, denoted as C1, are calculated. The LIC flag is set to be false, if C0 < C1 and is set to be true, if C0 >= C1.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.2 | LIC flag derivation of merge candidates with template costs | Bytedance  N. Zhang |

### Test 3.3: CCRM enhancements (JVET-AE0176)

A multi-model CCRM (MM-CCRM) and a CCRM merge mode are tested. When MM-CCRM is applied, samples are separated into two groups and each group can apply its own CCRM model similar to MM-CCCM. Furthermore, CCRM is disabled when the luma coefficients are small. In CCRM merge mode, a CCRM merge candidate list is constructed from previous CCRM-coded blocks, and the CCRM model of a candidate is inherited and used to generate predicted chroma samples for the current block. The CCRM merge mode is signalled as a submode of CCRM.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.3a | Multi-model CCRM | Bytedance  Z. Deng |
| 3.3b | CCRM merge mode | Bytedance  Z. Deng |

**Test 3.4: Enhanced subblock-based motion compensation (JVET-AE0117)**

In test a, template matching (TM) is used to refine subblock motion. In particular, TM-based control points refinement is proposed for affine candidates. Besides, the motion shift to locate SbTMVP can also be refined by TM.

In test b, two auxiliary predictions are generated by affine motion compensation with the two dividing patterns, and the final prediction is calculated as a weighted sum of the two auxiliary predictions. The subblock boundary deblocking/OBMC for affine mode is modified accordingly in this test.

In test c, it is proposed to derive RMVF affine candidates by feeding the motion vector field (MVF) of multiple CUs as regression input. The proposed RMVF candidates can be reordered together with other RMVF candidates through ARMC.

The encoder run time should be further reduced to make it attractive.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.4a | TM-based subblock motion refinement | Bytedance  L. Zhao |
| 3.4b | Interweaved affine prediction | Bytedance  L. Zhao |
| 3.4c | RMVF candidate derivation with multiple CUs | Bytedance  L. Zhao |
| 3.4d | Test 3.4a + Test 3.4b + Test 3.4c | Bytedance  L. Zhao |

### Test 3.5: DMVR with robust MV derivation (JVET-AE0108)

Test 3.5a: Select motion vector that minimize distortion based on both subblock boundary distortion and subblock matching distortion when there is a risk to have unreliable motion vectors based on checks on spatial activity, subblock motion vector differences and boundary differences. The method consists of following steps:

1. Check spatial activity for the reference subblocks centered at the block motion vector. If it is determined that the spatial activity is lower than a threshold go to step 2.
2. Each candidate motion vector for the subblock is compared with a neighboring subblock’s motion vectors across a subblock boundary (if there exists). If the absolute difference between the candidate motion vector and the neighboring subblock’s motion vector for one component is greater than a threshold go to step 3.
3. A boundary check which is based on neighboring samples is made for the top respectively the left subblock boundary. If the boundary check indicates that there not is a true edge along the top subblock boundary or the left subblock boundary continue to step 4.
4. Determine subblock boundary distortion across left and/or top subblock boundary. For any subblock boundary distortion which is greater than a threshold, add the subblock boundary distortion to the block matching distortion and go to step 5.
5. Select motion vectors that minimize the total distortion.

Test 3.5b: Encoder only solution similar to ‘DMVREncSelect’ in VTM. The approach punish selection of DMVR by giving a very high RDO cost for blocks that contain at least one subblock that risk to have unreliable motion vectors based on checks on spatial activity, subblock motion vector differences and boundary differences.

Comparison made in terms of bit rate saving of Test 3.5a versus Test 3.5b both for usual QP range and QP 40, 43, 47 and 50 and some subjective comparison should also be performed (possibly for subjective comparison also using non-CTC sequences, e.g. from verification tests).

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.5a | DMVR with robust MV derivation | Ericsson  K. Andersson |
| 3.5b | DMVREncSelect from VTM (encoder only) | Ericsson  K. Andersson |

### Test 3.6: Affine subblock BDOF refinement (JVET-AE0148)

Test 3.6a proposes to apply BDOF to refine subblock MV for an affine coded block. When an affine coded block meets the BDOF enabling condition and it is decided to do subblock MC, BDOF is applied to refine each subblock MV and do sample adjustments. The proposed method is also applied to SbTMVP mode.

Test 3.6b proposes the AMVP-Merge mode for affine block. When a block is decided to be AMVP-Merge mode, a flag is signalled to further indicate the block is an affine block or not.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.6a | Affine subblock BDOF refinement | Qualcomm  Z. Zhang |
| 3.6b | AMVP-merge mode for affine | Qualcomm  Z. Zhang |
| 3.6c | Test 3.6a + Test 3.6b | Qualcomm  Z. Zhang |

## 4. Reference picture resampling

### Test 4.1 Enabling template-based reordering and LIC for scaled reference pictures (JVET-AE0153)

In the test, it is proposed to enable the template-based inter reordering tools and the LIC for scaled reference pictures when the RPR is applied. Specifically, the designs of the tools are kept unchanged except that the motion compensation filters are replaced by the RPR filters to generate template prediction samples when the resolution of the reference picture is different from that of the current picture.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.1a | Enabling the template-based reordering for scaled reference pictures | Kwai  X. Xiu |
| 4.1b | Test 4.1a + Enabling LIC for scaled reference pictures | Kwai  X. Xiu |

### Test 4.2 Weighted edge enhancement filtering (JVET-AE0103)

In this test, a modification to the upscaling process is investigated. This affects the upscaling of blocks in RPR or the upscaling of pictures. The upscaled pictures or blocks may be filtered by the proposed weighted edge enhancement filter. The purpose is to increase the quality of upscaled content by sharpening edges or other high-frequency content which has been blurred by down- and upscaling. All tests are evaluated for LDB with scale factors of 1.5x and 2.0x according to RPR CTC.

In Test 4.2a, PSNR1 and PSNR2 are used, while only PSNR2 is used for Test 4.2b.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.2a | Filtering applied after motion compensation, the post-processing upsampling is not changed | RWTH Aachen Univ.  T. Claßen |
| 4.2b | Test 4.2a + perform the filtering after reconstruction | RWTH Aachen Univ.  T. Claßen |

## 5. In-loop filtering

**Test 5.1: Dynamic Scaling of Bilateral Filter (BIF) (JVET-AE0044)**

In this test, three modifications are studied to enhance BIF: (1) the TU scale factor depends on the TU shape size; (2) the TU scale factor depends on the mean absolute difference (MAD) of the TU; (3) the BIF LUTs are interpolated. The first test contains all three modifications. The second test contains only (1) and (2) to reduce the complexity.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 5.1a | Dynamic TU scale factor for BIF with LUTs interpolation | Ericsson  V. Shchukin |
| 5.1b | Dynamic TU scale factor for BIF | Ericsson  V. Shchukin |

**Test 5.2: Luma-Residual Taps in Chroma-ALF and CCALF (JVET-AE0121)**

In this test, the luma residual that used in luma ALF is further introduced into chroma ALF and CCALF for filtering. The luma-residual based taps are added into chroma ALF and CCALF filters to further improve the chroma coding performance.

AI configuration should be also studied.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 5.2a | Luma-residual tap in chroma-ALF | Bytedance  W. Yin |
| 5.2b | Test 5.2a + luma-residual tap in CCALF | Bytedance  W. Yin |

## 6. Entropy coding

**Test 6.1: Spatial CABAC tuning (JVET-AE0058)**

This test studies performance of the spatial CABAC tuning technique proposed in JVET-AE0058. The approach uses bins related to the bottom CUs of the above CTU to adapt the context probability states when starting to process a new CTU.

As requested in the previous meeting, the test measures performance of the tool at different memory/latency levels. In addition to the BD-Rate impact, at least the following will be reported:

* Memory required to store the bins and other possibly required elements
* Frequency of the updates as a function of QP or bitrate

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 6.1a | Spatial CABAC tuning | Nokia  J. Lainema |
| 6.1b | Spatial CABAC tuning with reduced memory/latency | Nokia  J. Lainema |

**Test 6.2: Updating I-slices context model parameters (JVET-AE0147)**

This test studies the training script for I-slices context model parameters. The scripts are modified from the one use in VVC’s CE. The initial probability, window size and adaptive weight for I-slices are trained and the rest context model parameters remain unchanged.The test is performed for the retrained contexts using the training script.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 6.2 | Retrain I-slices context model parameters | Alibaba  R.-L. Liao |

**Test 6.3: Combination of Test 6.1 and Test 6.2**

Retraining of the contexts Test 6.2 is added first and then the spatial CABAC tuning from Test 6.1 is applied.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 6.3 | Test 6.2 + Test 6.1 | Nokia  J. Lainema  Alibaba  R.-L. Liao |