|  |
| --- |
| **INTERNATIONAL ORGANIZATION FOR STANDARDIZATION ORGANISATION INTERNATIONALE DE NORMALISATION ISO/IEC JTC 1/SC 29/WG 5 MPEG JOINT VIDEO CODING TEAM WITH ITU-T SG 16** |
| **ISO/IEC JTC 1 / SC 29 / WG 5 N 114** |
| **Online, 12–21 January 2022** |
| |  |  | | --- | --- | | **Title:** | **Exploration experiment on enhanced compression beyond VVC capability (EE2)** | | **Source:** | **Convenor (Jens-Rainer Ohm)** | | **Type:** | **General** | | **Subtype:** | **N/A** | | **Status:** | **Approved** | | **Date:** | **2022-02-19** | | **Expected Action:** | **Info** | | **Action due date:** | **N/A** | | **No. of pages** | **15** (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** | |

|  |  |
| --- | --- |
| **Joint Video Experts Team (JVET)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29**  25th Meeting, by teleconference, 12–21 January 2022 | Document: JVET-Y2024-v2 |

|  |  |  |  |
| --- | --- | --- | --- |
| *Title:* | **Exploration Experiment on Enhanced Compression beyond VVC capability (EE2)** | | |
| *Status:* | Output document to JVET | | |
| *Purpose:* | EE description | | |
| *Author(s) or Contact(s):* | Vadim Seregin  Jie Chen  Ling Li  Karam Naser  Jacob Ström  Martin Winken  Xiaoyu Xiu  Kai Zhang | Tel: Email: | [vseregin@qti.qualcomm.com](mailto:vseregin@qti.qualcomm.com)  [jiechen.cj@alibaba-inc.com](mailto:jiechen.cj@alibaba-inc.com)  [aurali@tencent.com](mailto:aurali@tencent.com)  Karam.Naser@InterDigital.com  [jacob.strom@ericsson.com](mailto:jacob.strom@ericsson.com)  [martin.winken@hhi.fraunhofer.de](mailto:martin.winken@hhi.fraunhofer.de)  [xiaoyuxiu@kwai.com](mailto:xiaoyuxiu@kwai.com)  [zhangkai.video@bytedance.com](mailto:zhangkai.video@bytedance.com) |
| *Source:* | EE coordinators | | |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Abstract

This document describes Exploration Experiments (EEs) planned to be performed between 25th and 26th 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 and JVET-CE reflectors.

EE tests should be implemented on top the ECM software, ECM-4.0 is used as an anchor in the tests.

Tests shall be performed according to the CTC described in JVET-Y2017 with an additional TGM 4:2:0 optional class. TGM tests are required for testing SCC tools.

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 (February 11, 2022) after JVET meeting: ECM is released

**T2** = T1 + 1 week (February 18, 2022): EE description is finalized

**T3** = T2 + 2 weeks (March 4, 2022): Initial software release for EE tests

**T4** = JVET meeting start – 3 weeks (March 30, 2022): Software in EE branches is frozen

# List of tests

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tests** | **Tester** | **Cross-checker** |
| **1 Intra prediction** | | | |
| 1.1 | Slope adjustment for CCLM | Nokia  J. Lainema | OPPO  Zhihuang Xie |
| 1.2a | DIMD chroma mode | Alibaba  X. Li | InterDigital  Karam Naser |
| 1.2b | Fusion of chroma intra prediction modes | Alibaba  X. Li | InterDigital  Karam Naser |
| 1.2c | Test 1.2a + Test 1.2b | Alibaba  X. Li |  |
| 1.2d | Test 1.2a with reduced processing + Test 1.2b | Alibaba  X. Li |  |
| 1.3a | Combination of Test 1.1 and Test 1.2c | Nokia  J. Lainema  Alibaba  X. Li |  |
| 1.3b | Combination of Test 1.1 and Test 1.2d | Nokia  J. Lainema  Alibaba  X. Li |  |
| **2 Inter prediction** | | | |
| 2.1a | Extended active reference pictures | Qualcomm  H. Huang |  |
| 2.1b | Block-level reference picture reordering | Qualcomm  H. Huang |  |
| 2.1c | Test 2.1a + Test 2.1b | Qualcomm  H. Huang |  |
| 2.2a | Enhanced bi-directional motion compensation | Kwai  Y.-W. Chen | InterDigital  A. Robert |
| 2.2b | Test 2.2a with BDOF modifications | Qualcomm  Z. Zhang  Kwai  Y.-W. Chen |  |
| 2.2c | Test 2.2b with discarded BDOF offsets | Kwai  Y.-W. Chen  Qualcomm  Z. Zhang |  |
| 2.3 | Template matching based OBMC | vivo  Z. Lv |  |
| 2.4 | Template matching based reordering for GPM split modes | Qualcomm  C.-C. Chen |  |
| 2.5a | ARMC with refined motion | Bytedance  Y. Wang |  |
| 2.5b | Test 2.5a with reduced complexity | Bytedance  Y. Wang |  |
| 2.6a | 12-tap interpolation filter for chroma | Bytedance  X. Xie |  |
| 2.6b | 8-tap interpolation filter for chroma | Bytedance  X. Xie |  |
| 2.6c | 6-tap interpolation filter for chroma | Bytedance  X. Xie |  |
| 2.7a | History based affine inheritance without tables stored in the line buffer | Bytedance  K. Zhang |  |
| 2.7b | History based affine inheritance with tables stored in the line buffer | Bytedance  K. Zhang |  |
| 2.7c | Test 2.7a + affine candidates derived from non-adjacent blocks | Bytedance  K. Zhang |  |
| 2.7d | Test 2.7b + affine candidates derived from non-adjacent blocks | Bytedance  K. Zhang | Qualcomm  Yan Zhang |
| 2.7e | Test 2.7 with template matching disabled | Bytedance  K. Zhang |  |
| 2.8a | Non-adjacent affine model derivation without constrained memory usage | Kwai  W. Chen | Qualcomm  Yan Zhang |
| 2.8b | Non-adjacent affine model derivation with constrained memory usage | Kwai  W. Chen |  |
| 2.8c | Test 2.8 with template matching disabled | Kwai  W. Chen |  |
| 2.9a | Test 2.8a + Test 2.7 | Kwai  W. Chen | Qualcomm  Yan Zhang |
| 2.9b | Test 2.8b + Test 2.7 | Kwai  W. Chen |  |
| **3 Screen content coding** | | | |
| 3.1 | Cross-component palette coding | Bytedance  B. Vishwanath |  |
| 3.2 | IBC with extended reference area | Bytedance  J. Xu | Ofinno  D. Ruiz Coll |
| 3.3 | Enlarged HMVP table for IBC | Bytedance  N. Zhang | Ofinno  D. Ruiz Coll |
| 3.4 | IBC with template matching | InterDigital  A. Robert | Ofinno  D. Ruiz Coll |
| 3.5a | Invalid BVP candidate adjustment based on IBC reference region | Ofinno  D. Ruiz Coll |  |
| 3.5b | Replacement of zero-vector candidates in IBC Merge/AMVP list | Ofinno  D. Ruiz Coll |  |
| 3.5c | Test 3.5a + Test 3.5b | Ofinno  D. Ruiz Coll |  |
| 3.6a | Test 3.2 + Test3.3 | Bytedance  J. Xu, N. Zhang | Ofinno  D. Ruiz Coll |
| 3.6b | Test 3.2 + Test 3.4 | Bytedance  J. Xu  InterDigital  A. Robert | Ofinno  D. Ruiz Coll |
| 3.6c | Test 3.2 + Test 3.5c | Bytedance  J. Xu  Ofinno  D. Ruiz Coll |  |
| 3.6e | Test 3.3 + Test 3.4 | Bytedance  N. Zhang  InterDigital  A. Robert | Ofinno  D. Ruiz Coll |
| 3.6f | Test 3.3 + Test 3.5c | Bytedance  N. Zhang  Ofinno  D. Ruiz Coll |  |
| 3.6g | Test 3.4 + Test 3.5c | InterDigital  A.Robert  Ofinno  D. Ruiz Coll |  |
| 3.6h | Test 3.2 + Test 3.3 + Test 3.4 | Bytedance  J. Xu, N. Zhang  InterDigital  A. Robert | Ofinno  D. Ruiz Coll |
| 3.6i | Test 3.2 + Test 3.3 + Test 3.5c | Bytedance  N. Zhang  Ofinno  D. Ruiz Coll | InterDigital  A. Robert |
| 3.6j | Test 3.2 + Test 3.4 + Test3.5c | Bytedance  J. Xu, N. Zhang  InterDigital  A.Robert  Ofinno  D. Ruiz Coll |  |
| 3.6k | Test 3.3 + Test 3.4 + Test 3.5c | Bytedance  J. Xu, N. Zhang  InterDigital  A.Robert  Ofinno  D. Ruiz Coll |  |
| 3.6l | Test 3.2 + Test 3.3 + Test 3.4 + Test 3.5c | Bytedance  J. Xu, N. Zhang  InterDigital  A.Robert  Ofinno  D. Ruiz Coll |  |
| **4 Entropy coding** | | | |
| 4.1a | Probability estimation with adaptive weights | Kwai  X. Xiu |  |
| 4.1b | Test 4.1a + inherited context initialization | Kwai  X. Xiu |  |
| 4.2a | Temporal CABAC initialization | Qualcomm  J. Dong |  |
| 4.2b | Adaptive window size adjustment | Qualcomm  J. Dong |  |
| 4.2c | Test 4.2a + Test 4.2b | Qualcomm  J. Dong | OPPO  [Kazushi Sato](mailto:kazushi.sato@oppo.com) |
| 4.3 | Test 4.1 + Test 4.2 | Qualcomm  J. Dong  Kwai  X. Xiu |  |

# Tools description

## Intra prediction

### Test 1.1: Slope adjustment for CCLM (JVET-Y0055)

In this test, an adjustment is signalled for the slope parameter(s) used in cross-component linear model (CCLM) prediction of ECM. The adjustment is modifying the linear function which maps luma values to chroma values with respect to a center point determined by the average luma value of the reference samples. The encoder selectable adjustment is represented by an integer between -4 and 4 in 1/8th sample units and can be signalled at the PU level for each CCLM model which uses both top and left reference samples.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.1 | Slope adjustment for CCLM | Nokia  J. Lainema |

### Test 1.2: Chroma intra prediction (JVET-Y0092)

In this test, chroma intra prediction is modified with two aspects. For the first aspect, a new DIMD chroma mode, which derive a chroma intra prediction mode based on the collocated reconstructed luma samples by reusing the DIMD derivation method is proposed. For the second aspect, a non-LM mode can be fused with a LM mode.

Additionally, to reduce processing for deriving DIMD chroma mode from collocated luma samples, modifications will be made such as deriving DIMD chroma mode using neighboring reconstructed samples.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.2a | DIMD chroma mode | Alibaba  X. Li |
| 1.2b | Fusion of chroma intra prediction modes | Alibaba  X. Li |
| 1.2c | Test 1.2a + Test 1.2b | Alibaba  X. Li |
| 1.2d | Test 1.2a with reduced processing + Test 1.2b | Alibaba  X. Li |

### Test 1.3: Combination of intra prediction methods

The design elements included in Test 1.1 and Test 1.2, CCLM slope adjustment, DIMD chroma mode, and fusion of chroma intra prediction modes will be combined and tested.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.3a | Combination of Test 1.1 and Test 1.2c | Nokia  J. Lainema  Alibaba  X. Li |
| 1.3b | Combination of Test 1.1 and Test 1.2d | Nokia  J. Lainema  Alibaba  X. Li |

## Inter prediction

### Test 2.1: Extended active reference pictures and block-level reference picture reordering (JVET-Y0139)

In this test, extending the active reference pictures for ECM in random access configuration and use of block-level reference picture reordering are tested. For the uni-prediction AMVP mode, the reference pictures in List 0 and List 1 are interweaved to generate a joint list. For each hypothesis of the reference picture in the joint list, motion information can be derived accordingly and template matching is performed to calculate the cost. The joint list is reordered based on the template matching cost in ascending order. The index of the selected reference picture in the reordered joint list is signaled in the bitstream. For the bi-prediction AMVP mode, a list of pairs of reference pictures from List 0 and List 1 is generated and similarly reordered based on the template matching cost. The index of the selected pair is signaled in the bitstream.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.1a | Extended active reference pictures | Qualcomm  H. Huang |
| 2.1b | Block level reference picture reordering | Qualcomm  H. Huang |
| 2.1c | Test2.1a + Test 2.1b | Qualcomm  H. Huang |

### Test 2.2: Enhanced bi-directional motion compensation (JVET-Y0125)

#### Test 2.2a: Enhanced bi-directional motion compensation

Since the OOB reference samples are generated through the padding process, the motion compensation (MC) predictors generated using the OOB reference samples may be less effective. In this test, when combining more than one prediction blocks generated by the motion compensation process, the OOB predictors are discarded and only the non-OOB predictors are used to generate the final predictor.

To be specific, the positions of the predictors within the current block are denoted as and , the MV of the current block are denoted as and (x could be 0 or 1 for list 0 and list1, respectively). *, , ,* are the positions of four boundaries of a picture. Since 1/16-pel MV is used in the ECM, all variables are denoted in the unit of the 1/16 sample and thus the value of half\_pixel is set equal to 8.

The predictor is regarded as OOB when at least one of the following conditions holds

()>(+half\_pixel),

()<(- half\_pixel),

()>(+ half\_pixel),

or ()<(- half\_pixel)

otherwise, when none of the above conditions holds, the predictor is regarded as non-OOB.

After the OOB condition is determined for each predictor, the proposed scheme is applied to the bi-directional MC blocks to generate the final predictors where the following procedures are deployed. Please be noted that the same checking mechanism is also applied when BCW is enabled. For those predictors which are modified from bi-directional to uni-directional, the BDOF offsets are discarded since they are no more bi-directional predicted.

If is OOB and is non-OOB

else if is non-OOB and is OOB

else

#### Test 2.2b: Enhanced bi-directional motion compensation with BDOF modification

The following is applied before the predictors are input for BDOF process:

If is OOB and is non-OOB

else if is non-OOB and is OOB

#### Test 2.2c: Enhanced bi-directional motion compensation with discarded BDOF offsets

On top of Test 2.2b, for those predictors which are modified from bi-directional to uni-directional, the BDOF offsets are discarded.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.2a | Enhanced bi-directional motion compensation | Kwai  Y.-W. Chen |
| 2.2b | Test 2.2a with BDOF modifications | Qualcomm  Z. Zhang  Kwai  Y.-W. Chen |
| 2.2c | Test 2.2b with discarded BDOF offsets | Kwai  Y.-W. Chen  Qualcomm  Z. Zhang |

### Test 2.3: Template matching based OBMC (JVET-Y0076)

A method of template matching-based OBMC is tested in Test 2.3. The prediction value of CU boundary samples derivation approach is decided according to the template matching costs instead of directly using the weighted prediction. It chooses from three approaches for each block, including using current block’s motion information only, or using neighboring block’s motion information as well with one of the two blending modes. Furthermore, integer precision is used while 2-tap bilinear filter is used to generate the reference template to reduce the complexity.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.3 | Template matching-based OBMC | vivo  Z. Lv |

### Test 2.4: Template matching based reordering for GPM split modes (JVET-Y0135)

A reordering method for GPM split modes using template matching TM cost is going to be investigated in the test. It relies on the TM cost to reorder all GPM split modes in ascending order. An index is signaled using Golomb-Rice code to indicate the use of split mode from a subset of reordered GPM split modes.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.4 | Template matching based reordering for GPM split modes | Qualcomm  C.-C. Chen |

### Test 2.5: Adaptive reordering of merge candidates with refined motion (JVET-Y0151)

ARMC with refined motion was proposed in JVET-Y0151. Each merge candidate in the merge candidate list is refined using TM/multi-pass DMVR first and the refined motion will be used in ARMC to re-order the merge candidate list. ARMC with refined motion is applied to inter modes such as template matching merge (TM merge) mode, adaptive DMVR mode, and template matching for advanced motion vector prediction (TM-AMVP) mode.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.5a | ARMC with refined motion | Bytedance  Y. Wang |
| 2.5b | Test 2.5a with reduced complexity | Bytedance  Y. Wang |

### Test 2.6: Chroma long tap interpolation filtering (JVET-Y0172)

This contribution proposes to replace the 4-tap interpolation filter for chroma components in motion compensation with a long tap interpolation filter.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.6a | 12-tap interpolation filter for chroma | Bytedance  X. Xie |
| 2.6b | 8-tap interpolation filter for chroma | Bytedance  X. Xie |
| 2.6c | 6-tap interpolation filter for chroma | Bytedance  X. Xie |

### Test 2.7: History-parameter-based affine model inheritance (JVET-Y0145, JVET-Y0161)

A method of history-parameter-based affine model inheritance is proposed in JVET-Y0145. In this method, affine parameters of previously affine-coded block are stored in a History-Parameter Table (HPT). New affine merge and AMVP candidates as well as new regular merge candidates can be constructed with affine parameters fetched from HPT and base MVs fetched from neighbouring blocks, and put into the sub-block-based merge candidate list, the affine AMVP candidate list and the regular merge candidate list, respectively. Pruning is applied to avoid redundant candidates. The size of a merge candidate list could be increased accordingly.

Several extensions are also presented in JVET-Y0161, including:

Aspect #1: All the affine merge candidates can be involved in the ARMC process.

Aspect #2: The number of neighboring blocks, which are used to generate affine merge candidates jointly with affine models stored in tables, can be increased.

Aspect #3: A second history-parameter table with base MV information is appended. And the history-parameter tables stored in neighbouring CTU(s) can also be used to generate candidates.

Aspect #4: Pair-wised affine merge candidates are generated by two affine merge candidates.

The History based affine inheritance method will be tested jointly with affine candidates derived from non-adjacent blocks.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.7a | History based affine inheritance without tables stored in the line buffer | Bytedance  K. Zhang |
| 2.7b | History based affine inheritance with tables stored in the line buffer | Bytedance  K. Zhang |
| 2.7c | Test 2.7a + affine candidates derived from non-adjacent blocks | Bytedance  K. Zhang |
| 2.7d | Test 2.7b + affine candidates derived from non-adjacent blocks | Bytedance  K. Zhang |
| 2.7e | Test 2.7 with template matching disabled | Bytedance  K. Zhang |

### Test 2.8: Non-adjacent neighbor for affine model derivation (JVET-Y0153)

A method of non-adjacent neighbor for affine model derivation is tested. In the method, the motion information of non-adjacent neighbors is utilized to derive additional candidates for different inter modes, including but not limited to affine merge, affine AMVP, etc. The derived candidates are then inserted into the existing candidate list of corresponding coding modes.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.8a | Non-adjacent affine model derivation without constrained memory usage | Kwai  W. Chen |
| 2.8b | Non-adjacent affine model derivation with constrained memory usage | Kwai  W. Chen |
| 2.8c | Test 2.8 with template matching disabled | Kwai  W. Chen |

### Test 2.9: Combination of affine derivation methods

Combination of the affine related proposal Tests 2.7 and Tests 2.8 are tested.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.9a | Test 2.8a + Test 2.7 | Kwai  W. Chen |
| 2.9b | Test 2.8b + Test 2.7 | Kwai  W. Chen |

## Screen content coding

### Test 3.1: Cross-component palette coding (JVET-Y0062)

Cross-component palette coding (CC-PLT) is tested. CC-PLT employs a lookup table to record the corresponding chroma sample value, given a luma sample value. The lookup table is built based on neighboring reconstructed samples from multiple reference lines. For non 4:4:4 sequences, a multi-filter approach is employed to derive co-located luma values.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.1 | Cross-component palette coding | Bytedance  B. Vishwanath |

### Test 3.2: IBC with extended reference area (JVET-Y0124)

This test presents IBC with an extended reference area. By extending the reference area to cover more CTUs that have been used by other coding modes in the current and above CTU rows.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.2 | IBC with extended reference area | Bytedance  J. Xu |

### Test 3.3: Enlarged HMVP table for IBC (JVET-Y0160)

The HMVP table size for IBC is increased to a number larger than 5 (such as 30). And the size of IBC merge list could be enlarged correspondingly.

All the IBC merge candidates can be involved in the reordering process. After reordering, the first M candidates with the lowest costs can be selected as the final candidates in the IBC merge list.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.3 | Enlarged HMVP table for IBC | Bytedance  N. Zhang |

### Test 3.4: IBC with Template Matching (JVET-Y0088)

This test allows using Template Matching on top of IBC merge and AMVP modes. The IBC merge list is adapted with a pruning method with a motion distance between candidates and zero motion fulfillment is replaced by left, top and top-left neighbors by using the width and height of the current CU. TM refinement is constraint to be at integer-pel precision and within the reference region as IBC motion vectors.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.4 | IBC with template matching | InterDigital  A. Robert |

### Test 3.5: BVP candidate adjustment based on IBC reference region (JVET-Y0133)

Two modifications to the IBC Merge/AMVP list construction are tested. First, before checking the validity of the BVP candidates, an adjustment of the candidates pointing outside of the reference region to the nearest boundary of the IBC reference region is applied. Second, a method is tested to replace the zero-padding candidates included to complete the candidate list when there are no sufficient valid candidates by a set of valid candidates distributed in the IBC reference region.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.5a | Invalid BVP candidate adjustment based on IBC reference region | Ofinno  D. Ruiz Coll |
| 3.5b | Replacement of zero-vector candidates in IBC Merge/AMVP list | Ofinno  D. Ruiz Coll |
| 3.5c | Test 3.5a + Test 3.5b | Ofinno  D. Ruiz Coll |

### Test 3.6: Combined IBC tests

This test combines the different tests on IBC.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.6a | Test 3.2 + Test3.3 | Bytedance  J. Xu, N. Zhang |
| 3.6b | Test 3.2 + Test 3.4 | Bytedance  J. Xu  InterDigital  A. Robert |
| 3.6c | Test 3.2 + Test 3.5c | Bytedance  J. Xu  Ofinno  D. Ruiz Coll |
| 3.6e | Test 3.3 + Test 3.4 | Bytedance  N. Zhang  InterDigital  A. Robert |
| 3.6f | Test 3.3 **+** Test 3.5c | Bytedance  N. Zhang  Ofinno  D. Ruiz Coll |
| 3.6g | Test 3.4 + Test 3.5c | InterDigital  A. Robert  Ofinno  D. Ruiz Coll |
| 3.6h | Test 3.2 + Test 3.3 + Test 3.4 | Bytedance  J. Xu, N. Zhang  InterDigital  A. Robert |
| 3.6i | Test 3.2 + Test 3.3 + Test 3.5c | Bytedance  N. Zhang  Ofinno  D. Ruiz Coll |
| 3.6j | Test 3.2 + Test 3.4+ Test3.5c | Bytedance  J. Xu, N. Zhang  InterDigital  A. Robert  Ofinno  D. Ruiz Coll |
| 3.6k | Test 3.3 + Test 3.4 + Test 3.5c | Bytedance  J. Xu, N. Zhang  InterDigital  A. Robert  Ofinno  D. Ruiz Coll |
| 3.6l | Test 3.2 + Test 3.3 + Test 3.4 + Test 3.5c | Bytedance  J. Xu, N. Zhang  InterDigital  A. Robert  Ofinno  D. Ruiz Coll |

## Entropy coding

### Test 4.1: Improved probability estimation for CABAC (JVET-Y0157)

Multi-hypothesis-based probability based on adaptive weights is tested. Same to ECM-3.1, two separate probability estimates and are maintained for each context and updated according to their own adaptation rates. But, instead of simple average, additional weights are introduced to derive the final probability used for the arithmetic coding.

Inherited context initialization method is studied where the probability and adaption rates of one previously coded slice that has the same slice type and the same QP value are used to initialize the context states of the current slice.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.1 | Probability estimation with adaptive weights | Kwai  X. Xiu |
| 4.2 | 4.1 + inherited context initialization | Kwai  X. Xiu |

### Test 4.2: CABAC initialization from previous inter picture (JVET-Y0181)

If the current slice type is a B or P, the CABAC state of each context model is first obtained after coding CTUs up to a specified location and stored. Then, the stored CABAC state will be used as an initialization for the corresponding context model in the next B- or P-slice coded with the same quantization parameter (QP).

The window size of a context model can be adjusted at the bin level, according to the preceding M-bin memory. The adjustment values are stored in a look-up table. The trade-offs of different numbers of preceding bins, ranges of the adjustment, and other ways for LUT size reduction will be studied and tested.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.2a | Temporal CABAC initialization | Qualcomm  J. Dong |
| 4.2b | Adaptive window size adjustment | Qualcomm  J. Dong |
| 4.2c | Test 4.2a + Test 4.2b | Qualcomm  J. Dong |

### Test 4.3: Combination of entropy coding methods

The three design elements in Test 4.1 and Test 4.2, temporal initialization, weighted probability estimation, and CABAC windows adaptation will be combined and tested.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.3 | Test 4.1 + Test 4.2 | Qualcomm  J. Dong  Kwai  X. Xiu |