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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 267** |
| **Online – 17–26 January 2024** |
| |  |  | | --- | --- | | **Source:** | **Convenor (Jens-Rainer Ohm)** | | **Title:** | **Exploration experiment on enhanced compression beyond VVC capability (EE2)** | | **Type:** | **General** | | **Subtype:** | **Other** | | **Status:** | **Approved** | | **Date:** | **2024-02-27** | | **Expected Action:** | **Info** | | **Action due date:** | **N/A** | | **Pages:** | **18** (not including 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**  33rd Meeting, by teleconference, 17–26 January 2024 | Document: JVET-AG2024-v2 |

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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 33rd and 34th 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-12.0 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.

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 (February 16, 2024) after JVET meeting: ECM is released

**T2** = T1 + 1 week (February 23, 2024): EE description is finalized

**T3** = T2 + 2 weeks (March 8, 2024): Initial software release for EE tests

**T4** = JVET meeting start – 3 weeks (March 27, 2024): Software in EE branches is frozen

# List of tests

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tests** | **Tester** | **Cross-checker** |
| **1 Partitioning** | | | |
| 1.1a | Temporal prediction of split modes | G. Laroche  (Canon) | R. Utida  (InterDigital) |
| 1.1b | Test 1.1a + Maximum MTT depth adaptation | G. Laroche  (Canon) | R. Utida  (InterDigital) |
| 1.1c | Test 1.1b + Prediction of split syntax elements order | G. Laroche  (Canon) | R. Utida  (InterDigital) |
| **2 Intra prediction** | | | |
| 2.1 | TIMD merge mode | R. Youvalari (Xiaomi) | Y. Wang  (Bytedance) |
| 2.2 | Occurrence-based intra coding | R. Youvalari (Xiaomi) |  |
| 2.3a | Intra prediction using merged histogram of gradients | S. Blasi  (Nokia) |  |
| 2.3b | Intra prediction using merged histogram of gradients (without restrictions) | S. Blasi  (Nokia) |  |
| 2.4 | DIMD merge list | M. Blestel  (Ofinno) |  |
| 2.5a | Test 2.3a + Test 2.4 | S. Blasi  (Nokia)  M. Blestel  (Ofinno) |  |
| 2.5b | Test 2.3a + Test 2.4 + Test 2.2 | R. Youvalari (Xiaomi)  S. Blasi  (Nokia)  M. Blestel  (Ofinno) |  |
| 2.6a | Adaptive MRL fusion with fixed weights | S. Blasi  (Nokia) |  |
| 2.6b | Adaptive MRL fusion with adaptive weights | S. Blasi  (Nokia) |  |
| 2.7 | Relaxing line buffer restriction | Z. Deng  (Bytedance) |  |
| 2.8 | Test 2.6b + Test 2.7 | Z. Deng  (Bytedance)  S. Blasi  (Nokia) |  |
| 2.9a | EIP with bias | J. Lainema (Nokia) |  |
| 2.9b | EIP with clipping | J. Lainema (Nokia) |  |
| 2.9c | EIP with bias and clipping | J. Lainema (Nokia) |  |
| 2.10a | SATD based IntraTMP BV search without signalling | W. Chen  (Kwai) |  |
| 2.10b | SATD based IntraTMP BV search with signalling | K. Naser  (InterDigital) |  |
| 2.10c | MR-SAD based IntraTMP BV search with signalling | K. Naser  (InterDigital) |  |
| 2.10d | IntraTMP BV reordering | W. Chen  (Kwai) |  |
| 2.10e | Test 2.10a + Test 2.10d | W. Chen  (Kwai) |  |
| 2.10f | Test 2.10b + Test 2.10d | K. Naser  (InterDigital)  W. Chen  (Kwai) |  |
| 2.11a | Auto-relocated BVP for IntraTMP merge candidates | L. Zhang  (OPPO)  N. Qiu  (Xidian Univ.) |  |
| 2.11b | Template matching based sorting of IntraTMP merge candidates with maximum list size of N | L. Zhang  (OPPO)  N. Qiu  (Xidian Univ.) |  |
| 2.11c | Test 2.11a + Test 2.11b | L. Zhang  (OPPO)  N. Qiu  (Xidian Univ.) |  |
| 2.11d | Test 2.11c + Restricting the BV range for IntraTMP merge candidates | L. Zhang  (OPPO)  N. Qiu  (Xidian Univ.) |  |
| 2.12a | Chroma mode reordering based on unextended list | X. Li  (Alibaba) |  |
| 2.12b | Chroma mode reordering based on extended list | X. Li  (Alibaba) |  |
| 2.13 | Matrix based intra prediction replacing conventional intra modes | B. Ray  (Qualcomm) |  |
| 2.14a | Bilateral filtering for intra prediction (not applied to planar mode) | W. Yin  (Bytedance) |  |
| 2.14b | Bilateral filtering for intra prediction (applied to planar mode) | W. Yin  (Bytedance) |  |
| **3** **Inter prediction** | | | |
| 3.1a | Chained motion vector prediction | Y. Kidani (KDDI) |  |
| 3.1b | Test 3.1a + Restriction of only motion from collocated pictures | Y. Kidani (KDDI) |  |
| 3.2a | Removing the one-CTU-row temporal buffer constraint for all relevant tools | Z. Deng  (Bytedance) |  |
| 3.2b | Imposing the one-CTU-row temporal buffer constraint on all relevant tools | Z. Deng  (Bytedance) |  |
| 3.2c | Test 3.2a + Test 3.1a | Z. Deng  (Bytedance)  Y. Kidani (KDDI) |  |
| 3.2d | Test 3.2b + Test 3.1a | Z. Deng  (Bytedance)  Y. Kidani (KDDI) |  |
| 3.3 | Inter CCP merge mode with zero luma CBF | Z. Deng  (Bytedance) |  |
| 3.4 | Adaptive GPM blending | L. Zhao  (Bytedance) |  |
| 3.5a | LIC model inheritance for GPM | C.-C. Chen  (Qualcomm) |  |
| 3.5b | Test 3.5a + LIC model inheritance for merge modes at LIC flag swapping stage | C.-C. Chen  (Qualcomm) |  |
| 3.5c | Test 3.5a + LIC model inheritance for merge modes at ARMC stage | C.-C. Chen  (Qualcomm) |  |
| 3.6a | Reference filtering for inter-prediction (with reference sample classification into 2 groups) | V. Rufitskiy (Ofinno) |  |
| 3.6b | Reference filtering for inter-prediction (with reference sample classification into the extended number of groups) | V. Rufitskiy (Ofinno) |  |
| 3.7a | TM-based motion refinement with more candidates for SbTMVP | J. Chen  (Alibaba) |  |
| 3.7b | TM-based motion refinement for affine candidates | J. Chen  (Alibaba) |  |
| 3.7c | Test 3.7a + Test 3.7b | J. Chen (Alibaba) |  |
| **4 Transform and coefficients coding** | | | |
| 4.1 | Multiple transform set selection for LFNST/NSPT | F. Wang  (OPPO) |  |
| 4.2 | Fix on LFNST/NSPT index signalling for inter coding | M. Koo  (LGE) |  |
| 4.3 | 16 states TCQ | M. Balcilar  (InterDigital) | M. Coban  (Qualcomm) |
| **5 In-loop filtering** | | | |
| 5.1a | Adaptive precision for CCALF coefficients | N. Hu  (Qualcomm)  N. Song  (OPPO) |  |
| 5.1b | Adaptive precision for CCALF coefficients with precision used for luma ALF coefficients | N. Hu  (Qualcomm)  N. Song  (OPPO) |  |
| 5.1c | Removal of power of 2 constrain for CCALF coefficients | N. Hu  (Qualcomm) |  |
| 5.1d | Test 5.1a + Test 5.1c | N. Hu  (Qualcomm)  N. Song  (OPPO) |  |
| 5.1e | Test 5.1b + Test 5.1c | N. Hu  (Qualcomm)  N. Song  (OPPO) |  |
| 5.2a | Coding information based classification for ALF (with partitioning info only) | W. Yin  (Bytedance)  N. Hu  (Qualcomm) |  |
| 5.2b | Coding information based classification for ALF (with prediction info only) | W. Yin  (Bytedance)  N. Hu  (Qualcomm) |  |
| 5.2c | Test 5.2a + Test 5.2b | W. Yin  (Bytedance)  N. Hu  (Qualcomm) |  |
| **6 Entropy coding** | | | |
| 6.1a | Switching of context initialization for B-slice at slice level | R.-L. Liao  (Alibaba) |  |
| 6.1b | Switching of context initialization for B-slice at sequence level | R.-L. Liao  (Alibaba) |  |
| 6.2a | Extended entropy coding with non equiprobable coding | F. Galpin (InterDigital) |  |
| 6.2b | Test 6.2a but trained on another dataset | F. Galpin (InterDigital) |  |
| 6.3 | Test 6.1 + Test 6.2 | F. Galpin (InterDigital)  R.-L. Liao  (Alibaba) |  |

# Tools description

## Partitioning

### Test 1.1: Temporal partitioning prediction (JVET-AG0126)

In this test, the temporal prediction of the partitioning is investigated. The allowances of split modes, the increase or decrease of the Maximum MTT depth value as well as the prediction of split syntax elements order are determined for each block according to the partitioning values obtained from a temporal area. These three aspects are studied cumulatively according to the following table.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.1a | Temporal prediction of split modes | G. Laroche (Canon) |
| 1.1b | Test 1.1a + Maximum MTT depth adaptation | G. Laroche (Canon) |
| 1.1c | Test 1.1b + Prediction of split syntax elements order | G. Laroche (Canon) |

## 2. Intra prediction

### Test 2.1: TIMD merge mode (JVET-AG0106)

In this test, TIMD merge mode is studied. The TIMD merge mode inherits the TIMD information (intra prediction modes, fusion weights, wide-angle conditions) from the spatial neighbouring blocks that are coded in TIMD or TIMD merge modes.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.1 | TIMD merge mode | R. Youvalari (Xiaomi) |

### Test 2.2: Occurrence-based intra coding (JVET-AG0141)

This test studies the occurrence-based intra coding (OBIC) mode. The OBIC mode derives up to five intra prediction modes from the spatial neighbouring blocks where the intra modes are selected according to their sample-wise occurrences in that neighbourhood. This is done by creating a histogram of occurrences (HoC) of intra modes and accumulating the sample-wise occurrence of each mode in the HoC. Top five intra modes with highest occurrences are selected from the histogram. The prediction of the selected intra modes along with the planar mode are fused to obtain the prediction of the block.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.2 | Occurrence-based intra coding | R. Youvalari (Xiaomi) |

### Test 2.3: Intra prediction using merged histogram of gradients (JVET-AG0078)

This test studies usage of a new intra prediction mode based on the computation of a Merged Histogram of Gradients using information from neighbouring blocks. The Merged Histogram of Gradients is then used to derive a set of intra modes and weights that are blended together to compute the intra prediction for a block. Test 2.3a studies performance of the method with some normative restrictions. Test 2.3b studies performance of the method without any normative restrictions.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.3a | Intra prediction using merged histogram of gradients | S. Blasi (Nokia) |
| 2.3b | Intra prediction using merged histogram of gradients (without restrictions) | S. Blasi (Nokia) |

### Test 2.4: DIMD merge list (JVET-AG0084)

In this test, the DIMD process is extended by building a DIMD merge candidates list using the DIMD information from neighboring blocks. The best candidate is signalled by an index and is used to generate the DIMD predictor.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.4 | DIMD merge list | M. Blestel (Ofinno) |

### Test 2.5: Combination of DIMD related tests

In this test, the DIMD related tests Test 2.2, Test 2.3, and Test 2.4 are studied in combination.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.5a | Test 2.3a + Test 2.4 | S. Blasi  (Nokia)  M. Blestel  (Ofinno) |
| 2.5b | Test 2.3a + Test 2.4 + Test 2.2 | R. Youvalari  (Xiaomi)  S. Blasi  (Nokia)  M. Blestel  (Ofinno) |

### Test 2.6: Adaptive MRL fusion (JVET-AG0075)

This test studies modifications to MRL fusion. MRL fusion is modified to use two additional predictors. In Test 2.4a, fixed weights are used for the MRL Fusion blending. In Test 2.4b, the fusion weights are determined adaptively for each block.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.6a | Adaptive MRL fusion with fixed weights | S. Blasi (Nokia) |
| 2.6b | Adaptive MRL fusion with adaptive weights | S. Blasi (Nokia) |

### Test 2.7: Relaxing line buffer restriction (JVET-AG0120)

In ECM-11.0, many coding tools can access more than one line buffer, but a few coding tools still follow the limitation of one line buffer restriction as in VVC.

In this test, the one-line buffer restriction (i.e., one line buffering outside of current CTU) is relaxed for coding tools (e.g., MRL related tools, and intra luma fusion) in ECM.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.7 | Relaxing line buffer restriction | Z. Deng (Bytedance ) |

### Test 2.8: Combination of adaptive MRL fusion and relaxing line buffer restriction

In this test, combination of adaptive MRL fusion (JVET-AG0075) and relaxing line buffer restriction (JVET-AG0120) is studied.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.8 | Test 2.6b + Test 2.7 | Z. Deng  (Bytedance)  S. Blasi  (Nokia) |

### Test 2.9: EIP with bias and clipping (JVET-AG0310)

This test studies impacts of inclusion of a bias term and a tighter clipping range for the EIP (Extrapolation filter-based Intra Prediction) tool. In test 2.9a a bias term is implemented as a constant input value which substitutes one of the existing sample inputs to the EIP filter. In test 2.9b clipping of the EIP predicted sample values is modified to use a clipping range derived from the neighbouring samples of the block. Test 2.9c enables both features together.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.9a | EIP with bias | J. Lainema (Nokia) |
| 2.9b | EIP with clipping | J. Lainema (Nokia) |
| 2.9c | EIP with bias and clipping | J. Lainema (Nokia) |

### Test 2.10: Additional metrics for IntraTMP search and BV reordering (JVET-AG0193 and JVET-AG0243)

In this test, two aspects are evaluated to improve IntraTMP. In the first aspect, SATD based cost function is introduced to replace the current IntraTMP BV search on initial search or/and refinement search. In the second aspect, reordering method is introduced to reduce the signalling overhead of IntraTMP BV.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.10a | SATD based IntraTMP BV search without signalling | W. Chen  (Kwai) |
| 2.10b | SATD based IntraTMP BV search with signalling | K. Naser  (InterDigital) |
| 2.10c | MR-SAD based IntraTMP BV search with signalling | K. Naser  (InterDigital) |
| 2.10d | IntraTMP BV reordering | W. Chen  (Kwai) |
| 2.10e | Test 2.10a + Test 2.10d | W. Chen  (Kwai) |
| 2.10f | Test 2.10b + Test 2.10d | K. Naser  (InterDigital)  W. Chen  (Kwai) |

### Test 2.11: Auto-relocated BVP for IntraTMP merge candidates (JVET-AG0063, JVET-AG0080)

In this test, the auto-relocated BVP for IntraTMP merge candidates is investigated. The existing BVs in the merge list and the constructed auto-relocated BVPs will be used as the guiding block vectors to get BVs of reference blocks and construct additional BVPs.

The addition of the auto-relocated BVP candidates and template matching based sorting process of IntraTMP merge candidates are tested separately. Restricting the BV range for IntraTMP merge candidates to be within IBC search range is also tested.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.11a | Auto-relocated BVP for IntraTMP merge candidates | L. Zhang  (OPPO)  N. Qiu  (Xidian Univ.) |
| 2.11b | Template matching based sorting of IntraTMP merge candidates with maximum list size of N | L. Zhang  (OPPO)  N. Qiu  (Xidian Univ.) |
| 2.11c | Test 2.11a + Test 2.11b | L. Zhang  (OPPO)  N. Qiu  (Xidian Univ.) |
| 2.11d | Test 2.11c + Restricting the BV range for IntraTMP merge candidates | L. Zhang  (OPPO)  N. Qiu  (Xidian Univ.) |

### Test 2.12: Chroma mode reordering (JVET-AG0138)

In this test, the non-CCP chroma intra perdition modes are reordered. A non-CCP chroma intra prediction mode list is constructed and reordered. In Test 2.12a, the non-CCP chroma intra perdition modes allowed in ECM-11.0 are used to construct the list. In Test 2.12b, the list is further extended with the additional non-CCP chroma intra prediction modes before reordering.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.12a | Chroma mode reordering based on unextended list | X. Li  (Alibaba) |
| 2.12b | Chroma mode reordering based on extended list | X. Li  (Alibaba) |

### Test 2.13: Matrix based intra prediction replacing conventional intra modes (JVET-**AG0197)**

In this test, a matrix based intra prediction replacing some directional intra modes is proposed where the weights are intra mode and block size and block shape dependent which are applied to L shaped causal template to generate final prediction. The computational complexity of the method will be estimated.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.13 | Matrix based intra prediction replacing conventional intra modes | B. Ray  (Qualcomm) |

### **Test 2.14: Bilateral filtering for intra prediction (JVET-AG0123)**

In this test, the bilateral filter is applied to intra prediction samples to reduce the noise level. The intra prediction samples are filtered before they are used in the later process. The bilateral filter design follows BIF loop filter, the filter length is kept as 2.

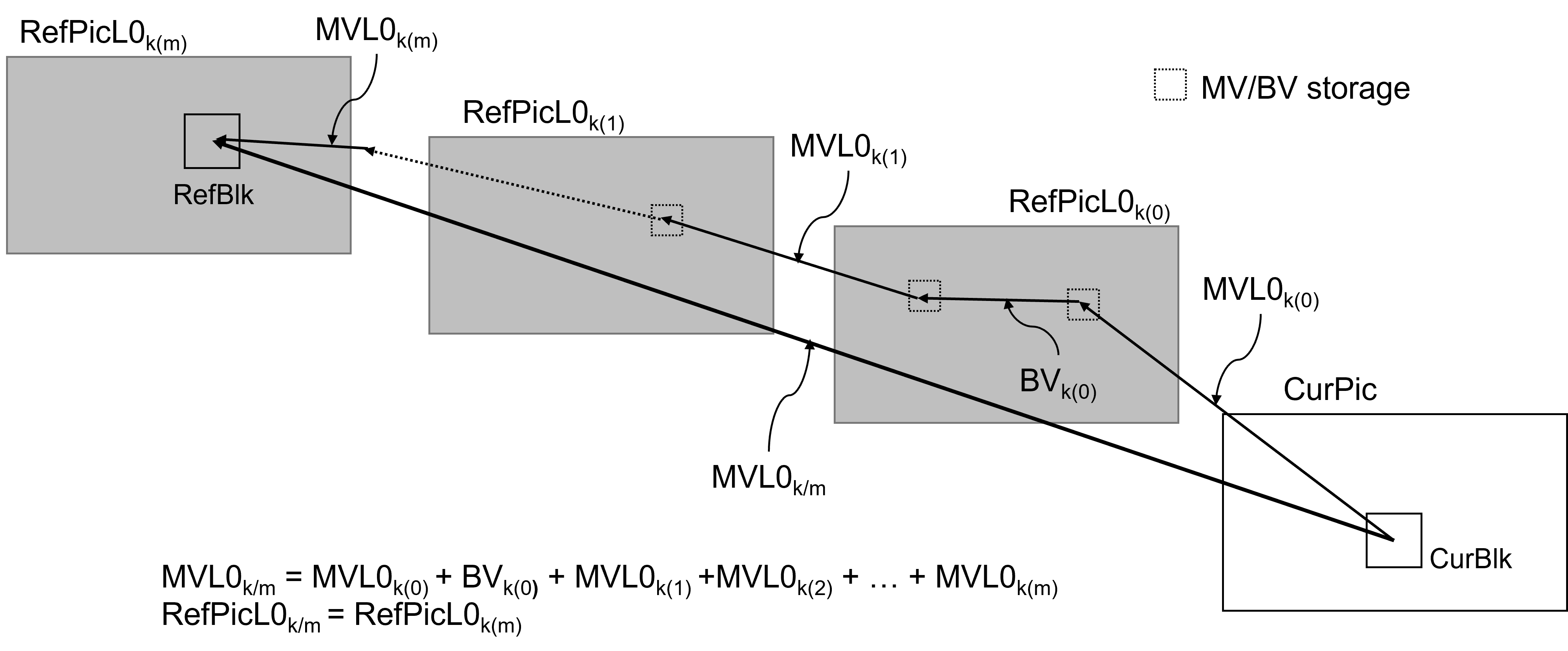
***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.14a | Bilateral filtering for intra prediction (not applied to planar mode) | W. Yin  (Bytedance) |
| 2.14b | Bilateral filtering for intra prediction (applied to planar mode) | W. Yin  (Bytedance) |

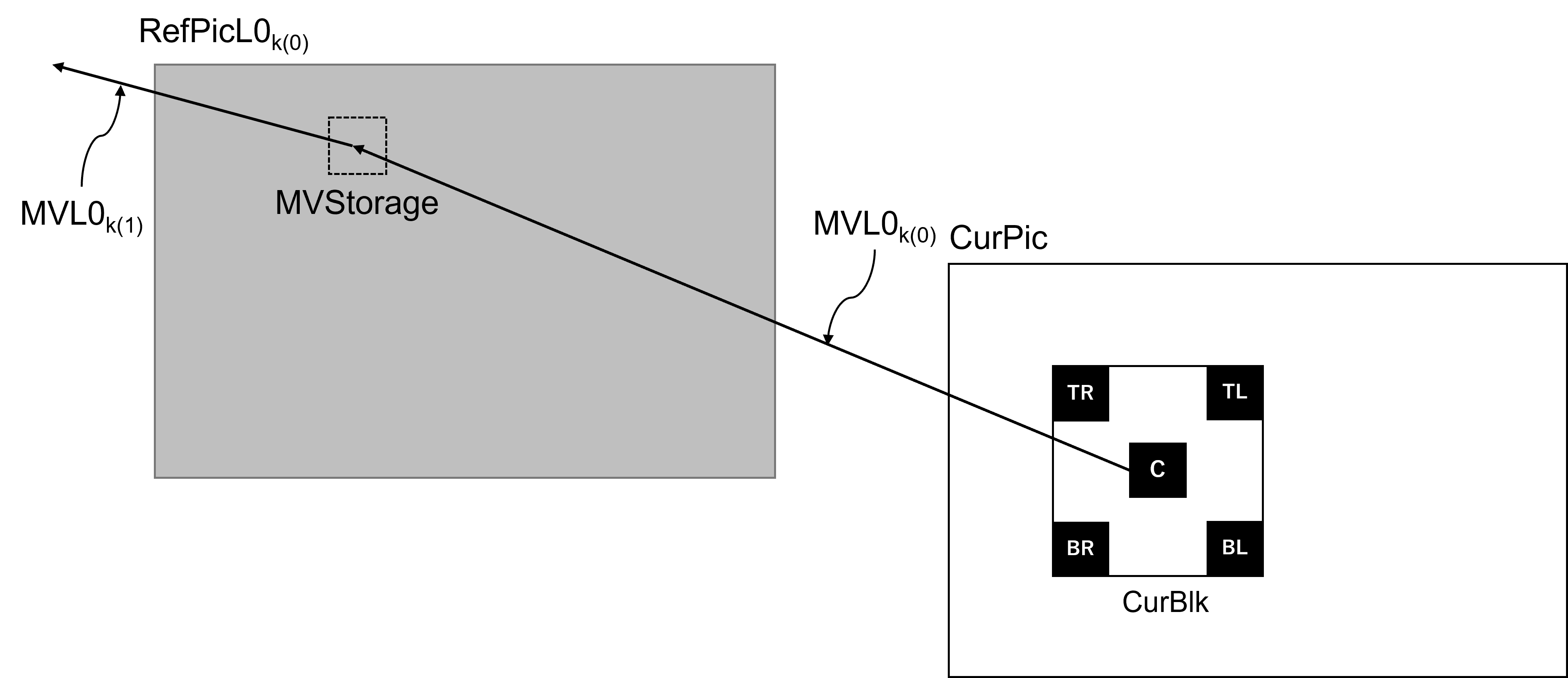
## 3. Inter prediction

### Test 3.1: Chained motion vector prediction (JVET-AG0073)

In this test, chained motion vector prediction (CMVP) is introduced as a new inter merge candidate list construction. As shown in the following figure, CMVP candidates can be derived as the accumulation of the recursively traced motion vectors (MVs) and block vectors (BVs) based on the pre-derived MVs.



When deriving MVk(m), all five-position shown in the following figure including the center, top-left, top-right, bottom-left, and bottom-right of the current block, are checked to find traced MVs or BVs.



CMVP candidates are derived for each merge index, each list (i.e., L0 and L1), and each trace depth, and they are inserted after HMVP candidates for the regular merge and TM merge. The number of traced depths to derive CMPVs is restricted to one (i.e., m=1), the same design as auto-relocated block vector prediction (AR-BVP). The traceable reference pictures are only within the reference picture list.

Two tests are conducted to study the trade-off between coding gains and additional motion storage.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.1a | Chained motion vector prediction | Y. Kidani (KDDI) |
| 3.1b | Test 3.1a + Restriction of only motion from collocated pictures | Y. Kidani (KDDI) |

### Test 3.2: Alignment of temporal buffer usage (JVET-AG0096)

In ECM-11.0, different temporal motion tools use different temporal buffer restrictions in the collocated pictures, some tools use a one-CTU-row buffer, and other tools (i.e., the temporal CCP candidate derivation process in intra CCP merge and inter CCP merge modes) can use the entire collocated picture.

Four tests are conducted to study the impact of the temporal buffer usage for ECM tools.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.2a | Removing the one-CTU-row temporal buffer constraint for all relevant tools | Z. Deng (Bytedance ) |
| 3.2b | Imposing the one-CTU-row temporal buffer constraint on all relevant tools | Z. Deng (Bytedance ) |
| 3.2c | Test 3.2a + Test 3.1a | Z. Deng (Bytedance)  Y. Kidani (KDDI) |
| 3.2d | Test 3.2b + Test3.1a | Z. Deng (Bytedance)  Y. Kidani (KDDI) |

### Test 3.3: Inter CCP merge mode with zero luma CBF (JVET-AG0200)

In this test, inter CCP merge mode is extended to zero luma CBF. With this extension, inter CCP merge mode is allowed when luma CBF or rootCBF is equal to 0. A CU-level flag is signalled to indicate this mode when merge skip mode is applied, and when root CBF is equal to 0.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.3 | Inter CCP merge mode with zero luma CBF | Z. Deng (Bytedance ) |

### Test 3.4: Adaptive GPM blending (JVET-AG0150)

In ECM-11.0, the GPM blending width is determined from a predefined set with five fixed candidates. In this test, an adaptive GPM blending method with two alternative blending width candidate lists is investigated, where the selection of the blending candidate list is determined based on the block size.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.4 | Adaptive GPM blending | L. Zhao  (Bytedance ) |

### **Test 3.5: LIC model inheritance for merge modes (JVET-AG0195)**

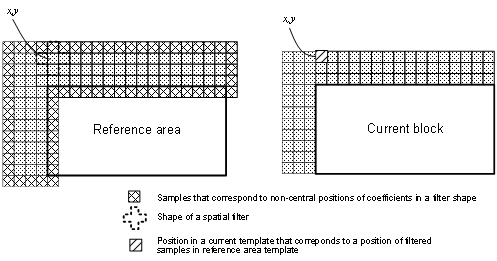
This test enables LIC model inheritance for merge modes instead of deriving it on the fly. Two tests will be evaluated to determine how the new merge candidates are selected in merge candidate list construction process. The first test determines LIC inheritance at LIC flag swapping stage, while the other leaves the new merge candidates in ARMC for reordering. If a new merge candidate stays in merge candidate list and is selected by a merge index, LIC model derivation process could be bypassed in motion compensation. GPM also enables LIC model inheritance in both tests.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.5a | LIC model inheritance for GPM | C.-C. Chen  (Qualcomm) |
| 3.5b | Test 3.5a + LIC model inheritance for merge modes at LIC flag swapping stage | C.-C. Chen  (Qualcomm) |
| 3.5c | Test 3.5a + LIC model inheritance for merge modes at ARMC stage | C.-C. Chen  (Qualcomm) |

### Test 3.6: Reference filtering for inter-prediction (JVET-AG0194)

In this test, a linear filter is applied to interpolated reference area to obtain predicted samples. Linear filter parameters are derived from template areas of current and reference blocks using spatially collocated samples as shown in the figure below.



The method is applied to uni-predicted blocks that are predicted in AMVP or regular merge modes. Several filters with different parameter sets could be applied within the reference area. Selection of filter is performed based on classification that is performed for template areas of reference and current block. The decision on whether reference filtering is applied is taken based on the value of LIC flag, dSAD costs and difference of Histograms of Gradients obtained for reference block and current block templates.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.6a | Reference filtering for inter-prediction (with reference sample classification into 2 groups) | V. Rufitskiy  (Ofinno) |
| 3.6b | Reference filtering for inter-prediction (with reference sample classification into the extended number of groups) | V. Rufitskiy  (Ofinno) |

### Test 3.7: Subblock merge mode improvements (JVET-AG0149)

In this test, the subblock merge mode including SbTMVP candidates and affine candidates are improved. Three tests are conducted to study the performance impact of SbTMVP candidate improvement and affine candidate improvement, respectively. Specifically, in Test 3.7a, template matching based motion vector refinement is applied on SbTMVP candidates and more candidates are added. In Test 3.7b, the current affine TM-based motion refinement is extended to bi-prediction blocks and the affine non-translation parameters are also refined by TM. Test 3.7c is a combined test of Test 3.7a and Test 3.7b.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.7a | TM-based motion refinement with more candidates for SbTMVP | J. Chen  (Alibaba) |
| 3.7b | TM-based motion refinement for affine candidates | J. Chen  (Alibaba) |
| 3.7c | Test 3.7a + Test 3.7b | J. Chen  (Alibaba) |

## 4. Transform and coefficients coding

### Test 4.1: Multiple transform set selection for LFNST/NSPT (JVET-AG0062)

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, MIP, SGPM and ITMP modes can choose an alternative LFNST/NSPT transform set. The transform set selection is signalled in the bit-stream.

The focus of this test is to reduce the encoding time while maintaining the coding gain.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.1 | Multiple transform set selection for LFNST/NSPT | F. Wang  (OPPO) |

### Test 4.2: Fix on LFNST/NSPT index signalling for inter coding (JVET-AG0237)

In current ECM, LFNST/NSPT for inter coding is applied to only Luma component. However, an LFNST/NSPT index is unnecessarily signalled as '0' if last non-zero Luma coefficient is at DC position and there exists at least one non-zero Chroma component in the same TU. In this test, a straightforward fix for the redundant LFNST/NSPT index signalling is tested, with which an LFNST/NSPT index is signalled for inter coding only when last non-zero coefficient is not at DC position for Luma regardless of Chroma components.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.2 | Fix on LFNST/NSPT index signalling for inter coding | M. Koo  (LGE) |

### Test 4.3: 16 states trellis coded quantization (JVET-AG0110)

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 |

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

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

## 5. In-loop filtering

### Test 5.1: Adaptive precision for CCALF coefficients (JVET-AG0233, JVET-AG0065)

In ECM-11.0, 7 bits are used to represent the fractional part of a CCALF coefficient. Each CCALF coefficient can only be a value in the form of power of 2. In this test, adaptive precision for CCALF coefficients is tested. In addition, the impact of power of 2 constraint is tested.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 5.1a | Adaptive precision for CCALF coefficients | N. Hu  (Qualcomm)  N. Song  (OPPO) |
| 5.1b | Adaptive precision for CCALF coefficients with precision used for luma ALF coefficients | N. Hu  (Qualcomm)  N. Song  (OPPO) |
| 5.1c | Removal of power of 2 constrain for CCALF coefficients | N. Hu  (Qualcomm) |
| 5.1d | Test 5.1a + Test 5.1c | N. Hu  (Qualcomm)  N. Song  (OPPO) |
| 5.1e | Test 5.1b + Test 5.1c | N. Hu  (Qualcomm)  N. Song  (OPPO) |

### **Test 5.2: Coding information based classification for ALF (JVET-AG0198)**

In this test, the prediction info and partitioning info are introduced into the luma ALF classification process to build up an additional rule. For each classification unit, it will be classified into N noise levels based on the coding information. The output of the existing classifiers will be mapped into M classes. The final classification results are generated by combining the proposed noise level and the mapped classification output.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 5.2a | Coding information based classification for ALF (with partitioning info only) | W. Yin  (Bytedance)  N. Hu  (Qualcomm) |
| 5.2b | Coding information based classification for ALF (with prediction info only) | W. Yin  (Bytedance)  N. Hu  (Qualcomm) |
| 5.2c | Test 5.2a + Test 5.2b | W. Yin  (Bytedance)  N. Hu  (Qualcomm) |

## 6. Entropy coding

### **Test 6.1: Context model parameters for low delay B condition (JVET-AG0102)**

In this test, context model parameters of low delay B slices are separated from those of non-low delay B slices. In addition to three sets of context model parameters for B-/P-/I-slice types, a fourth set of context model parameters is added for low delay B. The context initialization of B-slice can be switched between the original set or the newly added set at slice level or sequence level.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 6.1a | Switching of context initialization for B-slice at slice level | R.-L. Liao  (Alibaba) |
| 6.1b | Switching of context initialization for B-slice at sequence level | R.-L. Liao  (Alibaba) |

### **Test 6.2: Entropy coding extension (JVET-AG0108)**

**Test 6.2a Extend with NEP coding**

In ECM-11.0 syntax element coding for slice data only used EP (equiprobable) or CABAC coding. In this test, syntax elements originally using EP coding are let free to be coded using non-EP coding whenever possible. Training which includes NEP (non equiprobable) model is performed using the same process as the one used in JVET-AG0196.

**Test 6.2b Extend with NEP coding + training on non-CTC dataset**

Same as in Test 6.2a but dataset for training includes non-CTC sequences. Dataset is taken from the AhG11 official datasets.

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 6.2a | Extended entropy coding with non equiprobable coding | F. Galpin  (InterDigital) |
| 6.2b | Test 6.2a but trained on another dataset | F. Galpin  (InterDigital) |

### Test 6.3: Combination of tests 6.1 and 6.2 (JVET-AG0102, JVET-AG0108)

This test is the combination of tests 6.1 and 6.2.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 6.3 | Test 6.1 + Test 6.2 | F. Galpin  (InterDigital)  R.-L. Liao  (Alibaba) |