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| **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 189** |
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| **Joint Video Experts Team (JVET)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29**  29th Meeting, by teleconference, 11–20 January 2023 | Document: JVET-AC2024-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 29th and 30th 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-8.0 is used as an anchor in the tests.

Tests shall be performed according to the CTC described in JVET-Y2017.

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.

For GDR tests, the configuration of the tests is specified in the corresponding section of this document.

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 10, 2023) after JVET meeting: ECM is released

**T2** = T1 + 1 week (February 17, 2023): EE description is finalized

**T3** = T2 + 2 weeks (March 3, 2022): Initial software release for EE tests

**T4** = JVET meeting start – 3 weeks (March 31, 2022): Software in EE branches is frozen

# List of tests

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Tests** | **Tester** | **Cross-checker** |
| **1 Intra prediction** | | | |
| 1.1 | Extends the CCCM template selection to six | InterDigital  P. Bordes |  |
| 1.2 | CCCM using multiple downsampling filters | Qualcomm  Y.-J. Chang |  |
| 1.3a | MM-CCLM/MM-CCCM filtering with neighbouring samples | Bytedance  K. Zhang |  |
| 1.3b | Cross-component prediction usage is determined by template cost | Bytedance  K. Zhang |  |
| 1.3c | Cross-component prediction signalling modification | Bytedance  K. Zhang |  |
| 1.3d | Test 1.3a + Test 1.3b + Test 1.3c | Bytedance  K. Zhang |  |
| 1.4a | Non-adjacent cross-component prediction | Bytedance  K. Zhang |  |
| 1.4b | History-based cross-component prediction | Bytedance  K. Zhang |  |
| 1.4c | Test 1.4a + Test 1.4b | Bytedance  K. Zhang |  |
| 1.5 | Inherit cross-component prediction model from neighbours | MediaTek  C.-M. Tsai |  |
| 1.6a | Test 1.4a + Test 1.5 | MediaTek  C.-M. Tsai  Bytedance  K. Zhang |  |
| 1.6b | Test 1.4b + Test 1.5 | MediaTek  C.-M. Tsai  Bytedance  K. Zhang |  |
| 1.6c | Test 1.6a + Test 1.6b | MediaTek  C.-M. Tsai  Bytedance  K. Zhang |  |
| 1.7 | TIMD using selectable template regions | Sharp Y. Yasugi |  |
| 1.8a | HLS tool control with encoder optimization for IBC for camera captured content | Qualcomm  B. Ray |  |
| 1.8b | Test 1.8a + fractional pel BV | Qualcomm  B. Ray |  |
| 1.9a | Fractional pel IBC | Kwai  W. Chen |  |
| 1.9b | Test 1.9a (fractional pel IBC) + Test 1.8a | Kwai  W. Chen  Qualcomm  B. Ray |  |
| 1.10a | Multi-candidate IntraTMP without search procedure change | OPPO  F. Wang |  |
| 1.10b | Multi-candidate IntraTMP with search procedure change | OPPO  F. Wang |  |
| 1.11a | Intra template-matching prediction fusion | OPPO  L. Zhang |  |
| 1.11b | Intra template-matching prediction fusion with no change to the IntraTMP search procedure | OPPO  L. Zhang |  |
| 1.11c | Intra template-matching prediction fusion with different number of candidates | OPPO  L. Zhang |  |
| 1.12 | IntraTMP with sub-pel precision | Alibaba  X. Li |  |
| 1.13 | Fusion of intra template matching | Ittiam  J. R. Arumugam    Dolby  F. Pu |  |
| 1.14a | Extended the adjacent search area of IntraTMP | Xidian Univ.  Y. Ma  H. Du |  |
| 1.14b | Enlarge the search range for small blocks | OPPO  F. Wang |  |
| 1.14c | Test 1.14a + Test 1.14b | Xidian Univ.  Y. Ma  H. Du  OPPO  F. Wang |  |
| 1.15a | Intra template matching based on linear filter model | Xidian Univ.  J. Huo  W. Qiao |  |
| 1.15b | Filtered template matching based intra prediction | Nokia  R. Youvalari |  |
| 1.15c | Test 1.15a+Test 1.15b | Xidian Univ.  J. Huo  W. Qiao  Nokia  R. Youvalari |  |
| 1.16 | IntraTMP fusion with multiple reference blocks | Xidian Univ.  J. Huo  H. Du |  |
| 1.17 | IntraTMP fusion with intra prediction | Bytedance  Y. Wang |  |
| 1.18 | CIIP extension with IntraTMP | InterDigital K. Naser |  |
| 1.19a | IntraTMP left and above template modes | Qualcomm  P.-H. Lin |  |
| 1.19b | IntraTMP L-shape fusion mode | Qualcomm  P.-H. Lin |  |
| 1.19c | Test 1.19a + Test 1.19b | Qualcomm  P.-H. Lin |  |
| 1.20a | Test 1.10 + Test 1.11 | OPPO  F. Wang |  |
| 1.20b | Test 1.10 + Test 1.11 + Test 1.14 | OPPO  F. Wang |  |
| 1.20c | Test 1.14 + Test 1.19 | Qualcomm  P.-H. Lin  Xidian Univ.  J. Huo  OPPO  F. Wang |  |
| 1.20d | Test 1.10 + Test 1.12 + Test 1.14 + Test 1.15 + Test 1.19 | Qualcomm  P.-H. Lin  Xidian Univ.  J. Huo  OPPO  F. Wang  Alibaba  X. Li |  |
| 1.20e | Test 1.13 + Test 1.10 | Ittiam  J. R. Arumugam  OPPO  F. Wang |  |
| 1.20f | Test 1.13 + Test 1.12 | Dolby  F. Pu  Alibaba  X. Li |  |
| 1.20g | Test 1.13 + Test 1.17 | Dolby  F. Pu  Bytedance  Y. Wang |  |
| 1.20h | Test 1.14 + Test 1.15 + Test 1.16 | Xidian Univ.  Y. Ma  H. Zhang |  |
| 1.20i | Test 1.10 + Test 1.11 + Test 1.12 + Test 1.15 + Test 1.16 + Test 1.19 + Test 1.14a | OPPO  F. Wang  Xidian Univ.  Y. Ma  H. Zhang  Qualcomm  P.-H. Lin  Alibaba  X. Li |  |
| 1.20j | Test 1.10 + Test 1.11 + Test 1.12 + Test 1.15 + Test 1.16 + Test 1.19 + Test 1.14c | OPPO  F. Wang  Xidian Univ.  Y. Ma  H. Zhang  Qualcomm  P.-H. Lin  Alibaba  X. Li |  |
| 1.20k | Test 1.12 + Test 1.14c | Alibaba  X. Li  Xidian Univ.  Y. Ma  OPPO  F. Wang |  |
| 1.21a | Checking more neighbouring positions with intra prediction modes replacement by partitioning angles for SGPM/GPM | OPPO  L.Xu |  |
| 1.21b | Angular modes extension from 65 to 129 for TMRL | OPPO  L. Xu |  |
| 1.21c | Test 1.21a + Test 1.21b | OPPO  L. Xu |  |
| 1.22 | Template-based intra MPM list construction | vivo  C. Zhou |  |
| 1.23 | Modification to MPM list derivation | Qualcomm  H. Wang |  |
| 1.24a | Test 1.21 + Test 1.22 | OPPO  L. Xu  vivo  C. Zhou |  |
| 1.24b | Test 1.21 + Test 1.23 | OPPO  L. Xu  Qualcomm  H. Wang |  |
| 1.24c | Test 1.22 + Test 1.23 | vivo  C. Zhou  Qualcomm  H. Wang |  |
| 1.24d | Test 1.21 + Test 1.22 + Test 1.23 | OPPO  L. Xu  vivo  C. Zhou  Qualcomm  H. Wang |  |
| 1.25 | Filtered template matching based intra prediction | Nokia  R. Youvalari |  |
| **2** **Inter prediction** | | | |
| 2.1a | Step 1 of CPMV refinement with simplification | Xiaomi  M. Blestel  Qualcomm  Y. Zhang |  |
| 2.1b | Step 2 of CPMV refinement with simplification | Xiaomi  M. Blestel  Qualcomm  Y. Zhang |  |
| 2.1c | Adaptive DMVR for affine merge + affine DMVR for affine MMVD | Qualcomm  Y. Zhang |  |
| 2.1d | Affine parameter refinement | Alibaba  J. Chen |  |
| 2.1e | Affine parameter refinement with simplification | Alibaba  J. Chen    Xiaomi  M. Blestel |  |
| 2.1f | Test 2.1a + Test 2.1b | Xiaomi  M. Blestel  Qualcomm  Y. Zhang |  |
| 2.1g | Test 2.1a + Test 2.1c | Qualcomm  Y. Zhang  Xiaomi  M. Blestel |  |
| 2.1h | Test 2.1b+ Test 2.1c | Qualcomm  Y. Zhang  Xiaomi  M. Blestel |  |
| 2.1i | Test 2.1c+ Test 2.1f | Qualcomm  Y. Zhang  Xiaomi  M. Blestel |  |
| 2.1j | Test2.1d + Test 2.1a | Alibaba  J. Chen    Xiaomi  M. Blestel    Qualcomm  Y. Zhang |  |
| 2.1k | Test 2.1d + Test 2.1f | Alibaba  J. Chen    Xiaomi  M. Blestel    Qualcomm  Y. Zhang |  |
| 2.1l | Test 2.1d + Test 2.1c | Alibaba  J. Chen    Qualcomm  Y. Zhang |  |
| 2.1m | Test 2.1d + Test 2.1i | Alibaba  J. Chen    Qualcomm  Y. Zhang    Xiaomi  M. Blestel |  |
| 2.2 | AMVP with SbTMVP mode | Alibaba  R.-L. Liao |  |
| 2.3a | SbTMVP with MMVD | Tencent L.-F. Chen |  |
| 2.3b | SbTMVP with MMVD by using TM-based reordering | Tencent L.-F. Chen |  |
| 2.4 | Template matching-based subblock motion refinement | Bytedance  L. Zhao |  |
| 2.5a | Test 2.2 + Test 2.4 | Alibaba  R.-L. Liao  Bytedance  L. Zhao |  |
| 2.5b | Test 2.2 + Test 2.3 | Alibaba  R.-L. Liao  Tencent  L.-F. Chen |  |
| 2.6 | High precision MV refinement for BDOF | Bytedance  M. Salehifar |  |
| 2.7a | LIC for bi-prediction | Kwai  X. Xiu |  |
| 2.7b | Test2.7a + OBMC with LIC | Kwai  X.Xiu |  |
| 2.8a | OBMC flag inheritance in merge mode | Qualcomm  K. Cui |  |
| 2.8b | OBMC flag is signalled only for affine block without MHP | Qualcomm  K. Cui |  |
| 2.9a | OBMC boundary level decision based on prediction samples, keeping the existing CU level OBMC on/off flag | Google  X. Li |  |
| 2.9b | OBMC boundary level decision based on prediction samples, without the existing CU level OBMC on/off flag | Google  X. Li |  |
| 2.9c | OBMC boundary level decision based on reference samples, keeping the existing CU level OBMC on/off flag | Google  X. Li |  |
| 2.9d | OBMC boundary level decision based on reference samples, without the existing CU level OBMC on/off flag | Google  X. Li |  |
| 2.10a | OBMC on/off decision based on prediction samples and neighbouring information | Bytedance  Z. Deng |  |
| 2.10b | Using reference samples rather than prediction samples for OBMC on/off decision | Bytedance  Z. Deng |  |
| 2.11a | OBMC on/off decision at CU level and boundary level based on prediction samples and neighbouring information, with existing CU level OBMC on/off flag | Google  X. Li  Bytedance  Z. Deng |  |
| 2.11b | OBMC on/off decision at CU level and boundary level based on prediction samples and neighbouring information, without existing CU level OBMC on/off flag | Google  X. Li  Bytedance  Z. Deng |  |
| 2.11c | OBMC on/off decision at CU level and boundary level based on reference samples, with existing CU level OBMC on/off flag | Google  X. Li  Bytedance  Z. Deng |  |
| 2.11d | OBMC on/off decision at CU level and boundary level based on reference samples, without existing CU level OBMC on/off flag | Google  X. Li  Bytedance  Z. Deng |  |
| 2.12a | Prediction of MVD magnitude suffix bins (up to 6 bins for blocks with width and height larger than 4, and up to 2 bins otherwise) | Ofinno  A. Filippov |  |
| 2.12b | Prediction of MVD magnitude suffix bins (up to 6 bins for blocks with width and height larger than 4, and up to 4 bins otherwise) | Ofinno  A. Filippov |  |
| 2.12c | Prediction of MVD magnitude suffix bins (up to 6 bins per block) | Ofinno  V. Rufitskiy |  |
| 2.12d | Prediction of MVD magnitude suffix bins (up to 8 bins for blocks with width and height larger than 4, and up to 4 bins otherwise) | Ofinno  V. Rufitskiy |  |
| 2.12e | Prediction of MVD magnitude suffix bins (up to 8 bins for blocks with width and height larger than 4, and up to 6 bins otherwise) | Ofinno  V. Rufitskiy |  |
| 2.12f | Tool-off test for MVD sign prediction as implemented in ECM | Ofinno  V. Rufitskiy |  |
| 2.12g | Test 2.2 + Test 2.12 | Ofinno  V. Rufitskiy  Alibaba  R.-L. Liao |  |
| 2.12h | Test 2.7 + Test 2.12 | Ofinno  A. Filippov  Kwai  X. Xiu |  |
| **3 Screen content coding** | | | |
| 3.1 | TMP using reconstruction-reordered for screen content coding | Ofinno  D. Ruiz Coll |  |
| 3.2a | IBC MBVD list derivation with max BVD offset 128-pel | Qualcomm  Z. Zhang |  |
| 3.2b | IBC MBVD list derivation with max BVD offset 256-pel | Qualcomm  Z. Zhang |  |
| 3.3 | Temporal block vector prediction | Bytedance  N. Zhang |  |
| 3.4a | Copy-padding for IBC | Bytedance  N. Zhang | Hanbat National University  H. Han |
| 3.4b | Test 3.4a + Test 3.3 | Bytedance  N. Zhang |  |
| 3.5 | Template matching for IBC BVD suffix derivation | Qualcomm  P. Nikitin |  |
| 3.6 | IBC-CIIP with adaptive weights | Kwai  C. Ma |  |
| **4 In-loop filtering** | | | |
| 4.1 | Additional fixed-filter for ALF | Bytedance  W. Yin |  |
| 4.2 | ALF classifier based on residual data | Qualcomm  I. Jumakulyyev |  |
| 4.3 | ALF filter shape with more taps applied to fixed filter results | Qualcomm  I. Jumakulyyev |  |
| 4.4a | Test 4.2 + Test 4.3 | Qualcomm  I. Jumakulyyev |  |
| 4.4b | Test 4.4a + Test 4.1 | Qualcomm  I. Jumakulyyev  Bytedance  W. Yin |  |
| **5 GDR** | | | |
| 5.1 | Reference frame padding for GDR | InterDigital  T. Poirier |  |

# GDR test conditions

Tests are conducted using LDB configuration with the following settings:

1. The first picture is coded as an IDR picture.
2. GDR period (distance between 2 GDR picture) is set to frame rate +4
3. GDR interval (distance between GDR picture and associated recovery point picture) is set to frame rate.
4. Each inter picture refers up to 2 immediately preceding pictures in decoding order.
5. The same QP is used for all pictures.

GDR parameters

|  |  |  |
| --- | --- | --- |
| Frame rate | GDR period | GDR interval |
| 20 | 24 | 20 |
| 30 | 34 | 30 |
| 50 | 54 | 50 |
| 60 | 64 | 60 |

Example of the command line: --GdrEnabled=1 --GdrPocStart=54 --GdrPeriod=54 --GdrInterval=50 --IntraQPOffset=0.

The number of reference pictures is hard coded to 2 with GdrEnabled equal to 1.

# Tools description

## Intra prediction

### Test 1.1: CCCM and GL-CCCM extended template selection (JVET-AC0121)

In this test, the template selection is extended to six, for regular CCCM and gradient and location based convolutional cross-component model (GL-CCCM). When one of the 3 extended templates is selected, the model is derived selecting the samples of the template with reconstructed luma value within the range of the reconstructed current CU luma values.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.1 | Extends the CCCM template selection to six | InterDigital  P. Bordes |

### Test 1.2: CCCM using multiple downsampling filters (JVET-AC0148)

Various CCCMs using multiple downsampling filters are investigated in this test. The proposed cross-component models are added as additional CCCM modes, and the choice of the CCCM models are signalled in the bitstream. More specifically, multiple downsampling filters are applied to a group of reconstructed luma samples. The linear combination of these downsampled reconstructed samples is multiplied by derived filter coefficients to form the final chroma predictor. Reduction of encoder run time to improve the tradeoff with the compression gain will be studied as well in this test.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.2 | CCCM using multiple downsampling filters | Qualcomm  Y.-J. Chang |

### Test 1.3: Local-boosting cross-component prediction (JVET-AC0175)

This contribution presents methods of local-boosting cross-component prediction (LB-CCP), comprising two aspects:

Aspect 1: Prediction samples of MM-CCLM/MM-CCCM can be filtered with neighbouring samples.

Aspect 2: Neighbouring template costs are calculated to determine the training sample range, as well as the cross-component prediction method used in the chroma fusion mode.

Aspect 3: Besides, the binarization of cross-component prediction modes is modified.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.3a | MM-CCLM/MM-CCCM filtering with neighbouring samples | Bytedance  K. Zhang |
| 1.3b | Cross-component prediction usage is determined by template cost | Bytedance  K. Zhang |
| 1.3c | Cross-component prediction signalling modification | Bytedance  K. Zhang |
| 1.3d | Test 1.3a + Test 1.3b + Test 1.3c | Bytedance  K. Zhang |

### Test 1.4: Non-local cross-component prediction (JVET-AC0176)

This contribution presents methods of non-local cross-component prediction.

Method 1: Non-adjacent cross-component prediction (NA-CCP) is proposed to derive CCCM models with samples in regions non-adjacent to the current block.

Method 2: History-based cross-component prediction (H-CCP) is proposed to inherit CCCM models from stored models of CCP-coded blocks in history.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.4a | Non-adjacent cross-component prediction | Bytedance  K. Zhang |
| 1.4b | History-based cross-component prediction | Bytedance  K. Zhang |
| 1.4c | Test 1.4a + Test 1.4b | Bytedance  K. Zhang |

### Test 1.5: Cross-component merge mode for chroma intra coding (JVET-AC0315)

In this test, cross-component prediction model for the current chroma block is inherited from its spatial adjacent and non-adjacent neighbours, or default models. An additional flag is signalled indicating whether the proposed mode is used or not after cclm\_mode\_flag syntax element. If the proposed mode is used, a candidate index is additionally signalled.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.5 | Inherit cross-component prediction model from neighbours | MediaTek  C.-M. Tsai |

### Test 1.6: Combination tests of Test 1.4 and Test 1.5

Three tests are performed to show the combination results of Test 1.4a, Test 1.4b, and Test 1.5.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.6a | Test 1.4a + Test 1.5 | MediaTek  C.-M. Tsai  Bytedance  K. Zhang |
| 1.6b | Test 1.4b + Test 1.5 | MediaTek  C.-M. Tsai  Bytedance  K. Zhang |
| 1.6c | Test 1.6a + Test 1.6b | MediaTek  C.-M. Tsai  Bytedance  K. Zhang |

### Test 1.7: Modification of TIMD (JVET-AC0048)

In this test, a selectable template region method is applied to TIMD mode. The template region is selected from T+L (top and left), T(top) and L(left). A mode index is signalled to indicate which region is used.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.7 | TIMD using selectable template regions | Sharp Y. Yasugi |

### Test 1.8: IBC adaptation for coding of natural content (JVET-AC0161)

In this test, IBC is adapted for camera captured content. Aspect 1 involves HLS changes for tools control to be able to disable them at encoder and encoder optimization. Aspect 2 involves enabling fractional pel BV for IBC.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.8a | HLS tools control with encoder optimization for IBC for camera captured content | Qualcomm  B. Ray |
| 1.8b | Test 1.8a + fractional pel BV | Qualcomm  B. Ray |

### Test 1.9: IBC with fractional block vectors (JVET-AB0172)

In this test, the performance of IBC with fractional BVs is studied. For IBC AMVP, additional signalling are introduced for the fractional BV precision. For IBC merge, fractional BVs are inherited from spatial candidates.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.9a | Fractional pel IBC | Kwai  W. Chen |
| 1.9b | Test 1.9a (fractional pel IBC) + Test 1.8a | Kwai  W. Chen |

### Test 1.10: Multi-candidate IntraTMP (JVET-AC0068)

In this test, multi-candidate IntraTMP is investigated. In the proposed multi-candidate IntraTMP method, a candidate list is constructed with the candidate BVs ranked in ascending order of their template matching costs, and the index of selected candidate is signalled in the bitstream. Specially, the following aspects are tested:

* The size of the candidate list
* The search procedure to obtain the candidate BVs

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.10a | Multi-candidate IntraTMP without search procedure change | OPPO  F. Wang |
| 1.10b | Multi-candidate IntraTMP with search procedure change | OPPO  F. Wang |

### Test 1.11: Intra template matching prediction fusion (JVET-AC0069)

In this test, a fusion method of IntraTMP is investigated where the fusion weights are derived by template costs or fixed values. The number of fused blocks is determined by a threshold and up to 3 candidate blocks could be fused. If there is only one block selected for fusion, the final predictor is a fusion of the selected matched block and the intra predictor derived by Planar mode.

In this test, the search procedure of IntraTMP follows what is proposed in JVET-AC0068. The non-modified search procedure is also tested.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.11a | Intra template-matching prediction fusion | OPPO  L. Zhang |
| 1.11b | Intra template-matching prediction fusion with no change to the IntraTMP search procedure | OPPO  L. Zhang |
| 1.11c | Intra template-matching prediction fusion with different number of candidates | OPPO  L. Zhang |

### Test 1.12: IntraTMP with sub-pel precision (JVET-AC0087)

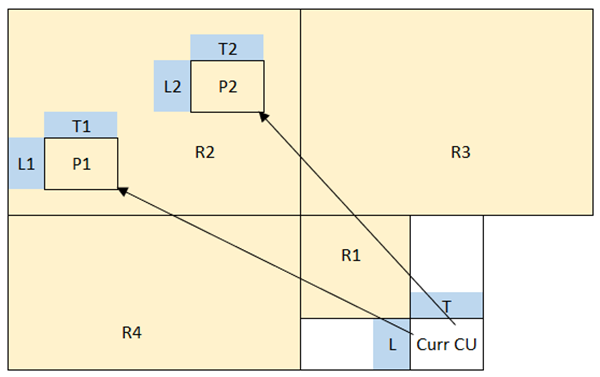
In this test, sub-pel precision is supported in IntraTMP. The sub-pel positions around the integer-pel position obtained by template matching are further enabled to IntraTMP. The DCT-IF filter is used for sub-pel interpolation.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.12 | IntraTMP with sub-pel precision | Alibaba  X. Li |

### Test 1.13: Fusion of intra template matching (JVET-AC0107)

Adaptive IntraTMP fusion with up to two prediction blocks corresponding to the best and second-best TM cost is investigated. Specifically, as shown in the below figure, where P1 is the prediction data with the lowest TM cost and P2 is the prediction data with the second-lowest TM cost. Two conditions are applied to decide whether to apply fusion. The weights derivation is the same as in TIMD. The final fused prediction is defined as the weighted sum of P1 and P2.



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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.13 | Fusion of intra template matching | Ittiam  J. R. Arumugam    Dolby  F. Pu |

### Test 1.14: Extend search area in intra template matching prediction (JVET-AC0108, JVET-AC0068)

In this test, the search range of IntraTMP is investigated for the 2 aspects shown below:

* Extended the adjacent search area of IntraTMP (JVET-AC0108)
* Enlarge the search range for small blocks (JVET-AC0068)

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.14a | Extended the adjacent search area of IntraTMP | Xidian Univ.  Y. Ma  H. Du |
| 1.14b | Enlarge the search range for small blocks | OPPO  F. Wang |
| 1.14c | Test 1.14a + Test 1.14b | Xidian Univ.  Y. Ma  H. Du  OPPO  F. Wang |

### Test 1.15a: Intra template matching based on linear filter model (JVET-AC0109)

In this test, IntraTMP with model derived prediction block is studied. Parameters of a model are derived using a template of the current block and a corresponding matching template. The prediction block is obtained by applying the model to filter the reference block.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.15a | Intra template matching based on linear filter model | Xidian Univ.  J. Huo  W. Qiao |

### Test 1.15b: Filtered template matching based intra prediction (JVET-AC0146)

This test proposes to apply a 6-tap filter for the IntraTMP prediction. The filter input consists of 5 spatial luma samples and a bias term. Filter coefficients are derived via regression based MSE minimization on reconstructed samples over the template areas of the current and reference blocks. The mode is signalled with a flag conditioned on IntraTMP flag.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.15b | Filtered template matching based intra prediction | Nokia  R. Youvalari |

### Test 1.15c: The combination of filtered intra prediction (JVET-AC0109, JVET-AC0146)

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.15c | Test 1.15a+Test 1.15b | Xidian Univ.  J. Huo  W. Qiao  Nokia  R. Youvalari |

### Test 1.16: A fusion method of intra template matching prediction (JVET-AC0110)

In this test, an IntraTMP fusion method is proposed that blends multiple reference blocks to derive the final prediction block. These reference blocks are obtained by Block Vectors (BVs) in template matching search process.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.16 | IntraTMP fusion with multiple reference blocks | Xidian Univ.  J. Huo  H. Du |

### Test 1.17: Fuse intra template matching prediction with intra prediction (JVET-AC0170)

It is proposed to fuse IntraTMP with intra prediction. Specially, the prediction block is the weighted sum of two prediction signals generated by IntraTMP and intra prediction, in which the intra prediction mode derived by TIMD is used for intra prediction. A CU flag is signalled whether the proposed method is used.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.17 | IntraTMP fusion with intra prediction | Bytedance  Y. Wang |

### Test 1.18: CIIP extension with intra template matching (JVET-AC0201)

This test proposes extending CIIP with intra only prediction. This is done by re-using the same fusion of CIIP and replace inter part by IntraTMP prediction. The new prediction mode, named intra-ciip, is signalled as a new mode in intra syntax and can be allowed for both I and non-I slices.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.18 | CIIP extension with IntraTMP | InterDigital K. Naser |

### Test 1.19: IntraTMP with multiple modes (JVET-AC0198)

It is proposed to introduce 3 additional IntraTMP modes: left template, above template and L-shape fusion modes. The left and above template modes use only left side or above side to derive the template matching candidates. The L-shape fusion mode fuses the best 2 template matching candidates by a cost-based linear combination formula.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.19a | IntraTMP left and above template modes | Qualcomm  P.-H. Lin |
| 1.19b | IntraTMP L-shape fusion mode | Qualcomm  P.-H. Lin |
| 1.19c | Test 1.19a + Test 1.19b | Qualcomm  P.-H. Lin |

### Test 1.20: Combination of IntraTMP tests

Combinations of IntraTMP related tests are evaluated as follows.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.20a | Test 1.10 + Test 1.11 | OPPO  F. Wang |
| 1.20b | Test 1.10 + Test 1.11 + Test 1.14 | OPPO  F. Wang |
| 1.20c | Test 1.14 + Test 1.19 | Qualcomm  P.-H. Lin |
| 1.20d | Test 1.10 + Test 1.12 + Test 1.14 + Test 1.15 + Test 1.19 | Qualcomm  P.-H. Lin  Xidian Univ.  J. Huo  OPPO  F. Wang  Alibaba  X. Li |
| 1.20e | Test 1.10 + Test 1.13 | Ittiam  J. R. Arumugam  OPPO  F. Wang |
| 1.20f | Test 1.13 + Test 1.12 | Dolby  F. Pu  Alibaba  X. Li |
| 1.20g | Test 1.13 + Test 1.17 | Dolby  F. Pu  Bytedance  Y. Wang |
| 1.20h | Test 1.14 + Test 1.15 + Test 1.16 | Xidian Univ.  Y. Ma  H. Zhang |
| 1.20i | Test 1.10 + Test 1.11 + Test 1.12 + Test 1.15 + Test 1.16 + Test 1.19 + Test 1.14a | OPPO  F. Wang  Xidian Univ.  Y. Ma  H. Zhang  Qualcomm  P.-H. Lin  Alibaba  X. Li |
| 1.20j | Test 1.10 + Test 1.11 + Test 1.12 + Test 1.15 + Test 1.16 + Test 1.19 + Test 1.14c | OPPO  F. Wang  Xidian Univ.  Y. Ma  H. Zhang  Qualcomm  P.-H. Lin  Alibaba  X. Li |
| 1.20k | Test 1.12 + Test 1.14c | Alibaba  X. Li  Xidian Univ.  Y. Ma  OPPO  F. Wang |

### Test 1.21: Modifications on template-based multiple reference line intra prediction (JVET-AC0067)

In this test, modifications on intra candidate list construction for MPM and TMRL are investigated.

Aspect 1: More neighbouring positions are checked and intra prediction modes are replaced by partitioning angles when the PUs are coded with SGPM/GPM

Aspect 2: The angular precision is extended from 65 to 129 for TMRL

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.21a | Checking more neighbouring positions with intra prediction modes replacement by partitioning angles for SGPM/GPM | OPPO  L. Xu |
| 1.21b | Angular modes extension from 65 to 129 for TMRL | OPPO  L. Xu |
| 1.21c | Test 1.21a + Test 1.21b | OPPO  L. Xu |

### Test 1.22: Template-based intra MPM list construction (JVET-AC0120)

In the test, the MPM list is constructed by the following three steps:

1. The first entry in the general MPM list is always planar mode.
2. The next entries are composed of the intra modes of neighbouring blocks as shown in Figure 1 of JVET-AC0120, and DIMD modes, which are sorted in ascending order of SAD cost. Up to 5 modes with the smallest SAD cost are added. The SAD cost is computed between the prediction and the reconstruction samples of the template.
3. The sorted directional modes with added offset are added into the general MPM list, and then the default modes, until the general MPM list with 22 entries is constructed.

For the signalling part, MPM list is equally divided into four groups and the group index is parsed first. Then, a mode index is further parsed to indicate which mode in the selected group is used.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.22 | Template-based intra MPM list construction | vivo  C. Zhou |

### Test 1.23: Modification to MPM list derivation (JVET-AC0191)

Modified MPM generation is studied in this test. In the proposed method, mode derivation is performed for certain types of CUs and the resulting mode will be used for the MPM generation of future CUs. Secondary MPMs are generated based on the primary MPMs, which include angular neighbour modes and DIMD modes. List re-ordering may be applied based on neighbour block information. TMRL is derived from the same MPM list.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.23 | Modification to MPM list derivation | Qualcomm  H. Wang |

### Test 1.24: Combination of MPM related tests

Combinations of Test 1.21, Test 1.22, and Test 1.23 are investigated.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 1.24a | Test 1.21 + Test 1.22 | OPPO  L. Xu  vivo  C. Zhou |
| 1.24b | Test 1.21 + Test 1.23 | OPPO  L. Xu  Qualcomm  H. Wang |
| 1.24c | Test 1.22 + Test 1.23 | vivo  C. Zhou  Qualcomm  H. Wang |
| 1.24d | Test 1.21 + Test 1.22 + Test 1.23 | OPPO  L. Xu  vivo  C. Zhou  Qualcomm  H. Wang |

## Inter prediction

### Test 2.1: Affine DMVR (JVET-AC0144, JVET-AC0276)

In this test, several methods to improve the trade-off of affine DMVR between coding efficiency and runtime are evaluated.

Some of them are tested on top of the two steps CPMV refinement proposed in JVET-AB0178, which is summarized as follows. Given initial control-point motion vectors initCpMvLX[cpIdx] with cpIdx=0..numCpMv – 1, wherein the numCpMv is the number of CPMVs of the current affine coding block. The method consists in the following two steps:

1. Step 1: For each control-point, perform bilateral matching for a block that centered by the control-points to derive the refined CPMVs bmRefinedCpMvLx[cpIdx]. Loop over combinations of initCpMvLX[cpIdx] and bmRefinedCpMvLx[cpIdx], derive the best set of CPMVs that minimize the bilateral matching cost of the current block.
2. Step 2: Iteratively further refine the CPMVs to minimize the bilateral matching cost of the current block. In each iteration, one CPMV is refined while the others are fixed.

Some of them are tested on top of the affine non-translation parameter refinement proposed in JVET-AB0145, in which one of the CPMVs is fixed as the base MV and the non-translation parameters are searched by minimizing the cost of bilateral matching. After the parameter refinement, the refined CPMV can be derived by the fixed baseMV and the refined parameters. And based on the refined CPMVs, the non-translation parameters can be further refined with another CPMV being fixed as base MV. To control the complexity, fast algorithm or early termination may applied to the search process.

Additionally, affine DMVR is further extended to other modes:adaptive DMVR method of regular inter is applied to affine merge mode, and affine DMVR is applied to affine MMVD.

CPMV refinement and affine parameter refinement may also be combined with affine DMVR extension.

 The tested methods include the following elements.

**Affine DMVR usage according to CU size and shape.**

In this method, affine DMVR tool is deactivated if one of the following conditions is true.

* the width or height is higher than 128 when width and height are equals.
* the width or height is higher than 64 when width and height are different.

Otherwise, the affine CPMV refinement is activated. Other CU size threshold values may be tested.

**Affine DMVR merge candidates’ list modifications**

In this method, the affine DMVR merge candidate list is modified to improve relevance and diversity of candidates.

* First, only non-redundant merge candidates are added to the list. That is, before being added to the list, a potential candidate is compared to all existing candidates in the list. It is added to the list if different from candidates already contained in the list.
* Second, a diversity criterion is imposed to affine DMVR merge candidates. It puts a restriction on the minimum CPMVs distance between a potential candidate and all candidates already in the list. The threshold is adaptive to the PU surface.

**Distortion based early termination in CPMV refinement**

The iterative CPMV refinement step 2 is the most time-consuming step. Early terminations based on the best PU distortion are applied:

* If initial distortion before step 2 of CPMVR refinement is lower than a threshold, then the iterative CPMVs refinement is bypassed. The threshold can be either adaptive to the PU size, or fixed.
* If initial distortion before step 2 is higher than a threshold, the iterative CPMVs refinement is bypassed. The threshold can be either adaptive to the PU size or fixed.

**Early termination for the case of 6-parameters affine model**

During the iterative CPMVs refinement step 2, the CPMVs are successively refined. Thus, in the case of a 6-parameters affine model, three CPMVs are successively refined, and all CPMVs are refined regardless the result of the preceding CPMVs refinement.

In this method an early termination is applied to bypass the third CPMV refinement when the refinements of two first CPMVs are not successful, e.g. do provide sufficient BM cost reduction.

Different elements of CPMV refinement and affine DMVR extension as well as their combinations are also studied with simplification.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.1a | Step 1 of CPMV refinement with simplification | Xiaomi  M. Blestel  Qualcomm  Y. Zhang |
| 2.1b | Step 2 of CPMV refinement with simplification | Xiaomi  M. Blestel  Qualcomm  Y. Zhang |
| 2.1c | Adaptive DMVR for affine merge + affine DMVR for affine MMVD | Qualcomm  Y. Zhang |
| 2.1d | Affine parameter refinement | Alibaba  J. Chen |
| 2.1e | Affine parameter refinement with simplification | Alibaba  J. Chen    Xiaomi  M. Blestel |
| 2.1f | Test 2.1a + Test 2.1b | Xiaomi  M. Blestel  Qualcomm  Y. Zhang |
| 2.1g | Test 2.1a + Test 2.1c | Qualcomm  Y. Zhang  Xiaomi  M. Blestel |
| 2.1h | Test 2.1b+ Test 2.1c | Qualcomm  Y. Zhang  Xiaomi  M. Blestel |
| 2.1i | Test 2.1c+ Test 2.1f | Qualcomm  Y. Zhang  Xiaomi  M. Blestel |
| 2.1j | Test2.1d + Test 2.1a | Alibaba  J. Chen    Xiaomi  M. Blestel    Qualcomm  Y. Zhang |
| 2.1k | Test 2.1d + Test 2.1f | Alibaba  J. Chen    Xiaomi  M. Blestel    Qualcomm  Y. Zhang |
| 2.1l | Test 2.1d + Test 2.1c | Alibaba  J. Chen    Qualcomm  Y. Zhang |
| 2.1m | Test 2.1d + Test 2.1i | Alibaba  J. Chen    Qualcomm  Y. Zhang    Xiaomi  M. Blestel |

### Test 2.2: AMVP mode with subblock-based temporal motion vector prediction (JVET-AC0103)

This test proposes to apply SbTMVP to regular AMVP mode. Given a CU coded in AMVP with SbTMVP mode, the CU is predicted using a similar way to that of SbTMVP in merge mode except that the motion shift, which comprises a derived MVP and a signalled MVD, is signalled in the bitstream instead of deriving from the left neighbouring block.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.2 | AMVP with SbTMVP mode | Alibaba  R.-L. Liao |

### Test 2.3: SbTMVP with MMVD (JVET-AC0213)

The test proposes the MMVD on SbTMVP candidate in subblock MMVD merge list. The syntax element, MMVD index, is signalled to indicate the MMVD offset for the SbTMVP merge candidate, and this MMVD offset is used to derive the offset value of the displacement vector (DV) for each SbTMVP-MMVD candidate. The final DV for each SbTMVP-MMVD candidate is calculated from the DV of SbTMVP merge candidate with the selected offset. By using the different DV offset, different subblock-based motion field could be obtained to form a SbTMVP-MMVD candidate list.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.3a | SbTMVP with MMVD | Tencent L.-F. Chen |
| 2.3b | SbTMVP with MMVD by using TM-based reordering | Tencent L.-F. Chen |

### Test 2.4: Template matching-based subblock motion refinement (JVET-AC0187)

In this test, two aspects are proposed to refine subblock motion based on template matching (TM). In particular, TM-based control points refinement is proposed for affine candidates. Besides, the motion shift to locate SbTMVP is also refined by TM.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.4 | Template matching-based subblock motion refinement | Bytedance  L. Zhao |

### Test 2.5: Combination of subblock related tests

Combination of Test 2.2, Test 2.3 and Test 2.4 are investigated.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.5a | Test 2.2 + Test 2.4 | Alibaba  R.-L. Liao  Bytedance  L. Zhao |
| 2.5b | Test 2.2 + Test 2.3 | Alibaba  R.-L. Liao  Tencent  L.-F. Chen |

### Test 2.6: High-precision MV refinement for BDOF (JVET-AC0182)

High precision MV refinement is proposed for BDOF, based on the accurate BDOF parameter calculation.

BDOF parameters are also calculated, with additional weights. BDOF MV refinement subblock size may be updated.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.6 | High precision MV refinement for BDOF | Bytedance  M. Salehifar |

### Test 2.7: Improvements on local illumination (JVET-AC0164)

Two aspects are proposed for the LIC. Firstly, it is proposed to extend the existing LIC to bi-prediction CUs where two separate linear models are applied to two uni-prediction blocks. Secondly, it is proposed to apply the OBMC to LIC CUs and the LIC is considered when generating OBMC prediction samples.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.7a | LIC for bi-prediction | Kwai  X. Xiu |
| 2.7b | Test 2.7a + OBMC with LIC | Kwai  X. Xiu |

### Test 2.8: OBMC signalling (JVET-AC0158)

This test modifies OBMC flag signalling in AMVP mode and OBMC flag inheritance in merge mode. It will also study the interaction of OBMC with other coding tools, e.g. MHP.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.8a | OBMC flag inheritance in merge mode | Qualcomm  K. Cui. |
| 2.8b | OBMC flag is signalled only for affine block without MHP | Qualcomm  K. Cui |

### Test 2.9: On the condition of OBMC (JVET-AC0160)

In this test, whether applying OBMC is determined at boundary level, with and without the existing CU level OBMC on/off flag. It was requested to further test deciding OBMC on/off based on reference samples instead of prediction samples.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.9a | OBMC boundary level decision based on prediction samples, keeping the existing CU level OBMC on/off flag | Google  X. Li |
| 2.9b | OBMC boundary level decision based on prediction samples, without the existing CU level OBMC on/off flag | Google  X. Li |
| 2.9c | OBMC boundary level decision based on reference samples, keeping the existing CU level OBMC on/off flag | Google  X. Li |
| 2.9d | OBMC boundary level decision based on reference samples, without the existing CU level OBMC on/off flag | Google  X. Li |

### Test 2.10: On OBMC (JVET-AC0190)

In this test, OBMC is adaptively enabled or disabled locally, based on block characteristics.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.10a | OBMC on/off decision based on prediction samples and neighbouring information | Bytedance  Z. Deng |
| 2.10b | Using reference samples rather than prediction samples for OBMC on/off decision | Bytedance  Z. Deng |

### Test 2.11: Combination of OBMC related tests

In this test, the combinations of Test 2.9 and Test 2.10 are tested.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.11a | OBMC on/off decision at CU level and boundary level based on prediction samples and neighbouring information, with existing CU level OBMC on/off flag | Google  X. Li  Bytedance  Z. Deng |
| 2.11b | OBMC on/off decision at CU level and boundary level based on prediction samples and neighbouring information, without existing CU level OBMC on/off flag | Google  X. Li  Bytedance  Z. Deng |
| 2.11c | OBMC on/off decision at CU level and boundary level based on reference samples, with existing CU level OBMC on/off flag | Google  X. Li  Bytedance  Z. Deng |
| 2.11d | OBMC on/off decision at CU level and boundary level based on reference samples, without existing CU level OBMC on/off flag | Google  X. Li  Bytedance  Z. Deng |

### Test 2.12: Prediction of MVD magnitude suffix bins (JVET-AC0239)

Most significant bins of MVD remainder suffixes are predicted using template matching and the correctness of prediction hypotheses are indicated by corresponding MVD suffix bins that are coded in the bitstream using regular CABAC mode. The numbers of bins specified in Tests EE2-2.12a/b/c/d/e comprise the overall number of predicted MVD bins including MVD sign and magnitude suffix bins.

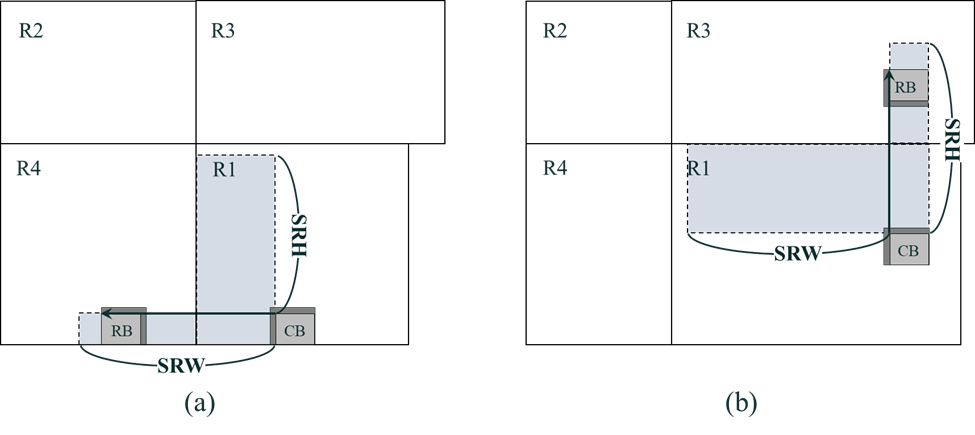
***List of tests to be performed***

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 2.12a | Prediction of MVD magnitude suffix bins (up to 6 bins for blocks with width and height larger than 4, and up to 2 bins otherwise) | Ofinno  A. Filippov |
| 2.12b | Prediction of MVD magnitude suffix bins (up to 6 bins for blocks with width and height larger than 4, and up to 4 bins otherwise) | Ofinno  A. Filippov |
| 2.12c | Prediction of MVD magnitude suffix bins (up to 6 bins per block) | Ofinno  V. Rufitskiy |
| 2.12d | Prediction of MVD magnitude suffix bins (up to 8 bins for blocks with width and height larger than 4, and up to 4 bins otherwise) | Ofinno  V. Rufitskiy |
| 2.12e | Prediction of MVD magnitude suffix bins (up to 8 bins for blocks with width and height larger than 4, and up to 6 bins otherwise) | Ofinno  V. Rufitskiy |
| 2.12f | Tool-off test for MVD sign prediction as implemented in ECM | Ofinno  V. Rufitskiy |
| 2.12g | Test 2.2 + Test 2.12 | Ofinno  V. Rufitskiy  Alibaba  R.-L. Liao |
| 2.12h | Test 2.7 + Test 2.12 | Ofinno  A. Filippov  Kwai  X. Xiu |

## Screen content coding

### Test 3.1: IntraTMP with reconstruction-reordering for screen content coding (JVET-AC0059)

Since symmetry is often observed in screen content, TMP using Reconstruction-Reordered (RR-TMP) is proposed. RR-TMP finds the best-matched between the flipped L-shaped template of the current block and an L-shaped template in a constrained region of the regular TMP reference region. The template may be flipped in the horizontal and vertical directions, as it is shown in the below figure. No additional signalling is required.



**RR-TMP search region for (a) horizontal flip, and (b) vertical flip**

If the RR-TMP mode is selected for the current block, the BV is stored to be used as a neighbour candidate in the IBC list of the subsequent blocks. If the current IBC block selects an RR-TMP BV as a BVP candidate from the candidate list, the current block is predicted using the RRIBC mode, and the BVP is conveniently adjusted according to its direction. Modifications in the search region dimensions will be investigated.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.1 | TMP using reconstruction-reordered for screen content coding (JVET-AC0059) | Ofinno  D. Ruiz Coll |

### Test 3.2: IBC MBVD list derivation (JVET-AC0159)

This test proposes to allow adaptive BVD offsets along MBVD directions. A MBVD list is derived by checking TM cost of a predetermined set of candidates and the neighbour candidates of K lowest TM cost candidates of the predetermined set. It will test max offset of a BDV is equal to 128-pel or 256-pel.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.2a | IBC MBVD list derivation with max BVD offset 128-pel | Qualcomm  Z. Zhang |
| 3.2b | IBC MBVD list derivation with max BVD offset 256-pel | Qualcomm  Z. Zhang |

### Test 3.3: Temporal block vector prediction (JVET-AC0192)

Temporal BV prediction (TBVP) is proposed to mimic TMVP. Temporal BV candidates are introduced to IBC merge/AMVP candidate lists. The IBC merge candidate list includes the regular IBC merge candidate list, the IBC-TM merge candidate list and IBC-MBVD base candidate list, etc.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.3 | Temporal block vector prediction | Bytedance  N. Zhang |

### Test 3.4: Copy-padding for IBC (JVET-AC0193)

Copy-padding can be applied on the overlapped area. With copy-padding, an unreconstructed sample in the overlapped region can be padded by copying its prediction sample.

Copy-padding is performed only if the horizontal BV component is smaller than or equal to 0 and the vertical BV component is smaller than or equal to 0.

Also investigate whether the current sample-by-sample padding can be simplified.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.4a | Copy-padding for IBC | Bytedance  N. Zhang |
| 3.4b | Test 3.4a +Test 3.3 | Bytedance  N. Zhang |

### Test 3.5: Template matching for IBC BVD suffix derivation (JVET-AC0212)

In this test BVD suffix is derived using template matching search in a range depending on the BVD prefix from the current prefix to the next prefix value.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.5 | Template matching for IBC BVD suffix derivation | Qualcomm  P. Nikitin |

**Test 3.6: IBC-CIIP with adaptive weights (JVET-AC0112)**

In this test, IBC-CIIP with adaptive weights is studied. The weights are determined according to the coding modes of neighbouring blocks and intra modes of the current block.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 3.6 | IBC-CIIP with adaptive weights | Kwai  C. Ma |

## In-loop filtering

### Test 4.1: Additional fixed filter for ALF (JVET-AC0323)

In this test, one additional fixed-filter set is introduced into ALF and several fixed-filter-output based taps are extended into the online-trained filters of ALF. These added taps take the output of the additional fixed-filters as input for ALF filtering.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.1 | Additional fixed-filter for ALF | Bytedance  W. Yin |

### Test 4.2: ALF classification based on residual data (JVET-AC0173)

In adaptive loop filter (ALF) process of ECM-7.0, a luma coding tree block (CTB) can reference a filter set in an adaptation parameter set. A Laplacian classifier or a band-based classifier is applied to each 2x2 reconstructed luma block in the CTB. In this proposal, a new classifier that applied to the residual samples is proposed. For each 2x2 luma block, the sum of absolute values of residual samples in a neighbouring window is calculated, and the class index is derived by quantizing the sum. Additionally, fixed filters will be retrained due to ECM-8.0 having fixed filter tap input which should be accommodated in the test. A combination with the pre-deblocking fixed filter of Test 4.1 will be investigated.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.2 | ALF classifier based on residual data | Qualcomm  I. Jumakulyyev |

### Test 4.3: ALF filter shape with more taps on fixed filter results (JVET-AC0173)

In this test, for an online-trained luma filter, the number of taps that applied to the fixed filter results is increased.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.3 | ALF filter shape with more taps applied to fixed filter results | Qualcomm  I. Jumakulyyev |

### Test 4.4: Combination of ALF tests

The following combinations of ALF tests is performed.

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 4.4a | Test 4.2 + Test 4.3 | Qualcomm  I. Jumakulyyev |
| 4.4b | Test 4.4a + Test 4.1 | Qualcomm  I. Jumakulyyev  Bytedance  W. Yin |

## GDR

### Test 5.1: Reference frame padding for GDR (JVET-AC0180)

In this test, for CUs in the clean (refreshed) areas, the dirty areas in reference pictures are filled by padding samples from the clean areas instead of setting unavailable samples to 2*BD-1* .

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

|  |  |  |
| --- | --- | --- |
| # | Test | Tester |
| 5.1 | Reference frame padding for GDR | InterDigital  T. Poirier |