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# Introduction

This output document provides the description of Core Experiments 6 on “Intra prediction and improvements”. Proposals on intra coding and intra prediction are divided in several subsets of this CE:

1. Subset CE6.a: Intra Chroma Prediction
2. Subset CE6.b: Improved Intra Prediction
3. Subset CE6.c: Intra mode coding cleanup and simplification

# Experimental Conditions

## Software

Tools under test in this CE will be implemented on top of HM 5.0 software that will be released by the software Ad-Hoc group after integrating changes adopted at the 7th JCT-VC meeting in Geneva.

## Common Test Conditions

The common test conditions for all-Intra configuration as defined in the document JCTVC-G1200 released by the software Ad-Hoc group will be used as anchor configuration for tests in all subsets.

Performance evaluations will be mandatory reported for All Intra configuration and for classes A to E.

Optional conditions are the inclusion of class F and the use of Random Access, Low Delay B and Low Delay P configuration.

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## Evaluation of CE Results

Results of this CE will be evaluated on the basis of BDR metric. In addition, subjective evaluation to support the advantage of the proposed tools is highly desirable.

## Evaluation of Complexity

For the complexity measurement, the anchor and the reference software with the tools implemented will be executed on the same machine and the computational time will be measured for each configuration. Then, a time factor is calculated which compares the reference software including the sub-CE test tool and the reference software without the tool.

# Timelines

|  |  |  |
| --- | --- | --- |
| **T1** | **December 19, 2011** | HM 5.0 software available |
| **T2** | **T1 + 2 Wks, 2011** | Codes to be released by proponents |
| **T3** | **January 13, 2012** | Cross-verification completed CE. |
| **T4** | **January 20, 2012** | Report the verification results uploading. |

# CE6.a: Intra Chroma Prediction

The following tools are considered in this CE:

* Cross-channel intra chroma residual prediction (JCTVC-G173)
* Luma-based chroma prediction - Model correction (JCTVC-G244)
* Chroma intra prediction based on residual luma samples (JCTVC-G346)
* New modes for chroma intra prediction (JCTVC-G358)

These tools will be evaluated independently. Combinations will also be explored to identify potential optimal combination in terms of trade-off coding efficiency/complexity.

## Participants list

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## Proposals description

### JCTVC-G173 Cross-channel intra chroma residual prediction [Intel]

G173 presents a cross-channel prediction refinement technique among the chroma channels. The prediction refinement technique applies on the process of intra chroma prediction and no additional control flag is required. This test is focused on a cross-channel residual prediction technique to improve the intra chroma prediction of HM 5.0. It produces a refinement of prediction samples based on the residual of another channel. The test includes the following

1. The test of Cb prediction refined based upon the residual of Cr channel, and the test of Cr prediction refined based upon the residual of Cb channel

To test the coding efficiency performance based upon a linear model with a fixed parameter value

1. The test of Cb prediction and Cr prediction refined based upon the residual of Y channel.

To test the coding efficiency performance based upon a linear model with a fixed parameter value

1. A combination of #1 and #2.

### JCTVC-G244 Luma-based chroma prediction – Model correction [Canon]

**General Concept**

In luma-based chroma intra prediction mode (LM), 2 linear mode parameters (alpha, beta) are estimated using OLS from reconstructed neighboring luma and chroma samples. alpha value is computed in OLS as the ratio of two intermediate parameters A1 and A2. OLS can lead to wrong or even undetermined estimation in specific cases when these two intermediate parameters are of low range. The aim of the proposed method is to detect such ill-cases and to replace the alpha value by a pre-determined value, depending on the ill-case type. In the current design, 4 types of ill-cases are considered. For each ill-case, one pre-determined alpha value, picked from a table of fixed values (the index is signaled in the slide header or APS), is used.

The ill-cases classification consists at most of 5 comparisons involving parameters A1, A2 and alpha. The thresholds (2 values per chroma component) involved in these comparisons are currently signaled in the APS. If none of the 4 possible ill-cases is detected, the normal alpha value is used.

**Bitstream organization**

12 syntax elements (38 bits) are inserted in slice header or APS.

The algorithm settings (number of types, pre-defined alpha values) could be adjusted to reach the best performance. In particular, reduction of the number of types and added syntax elements will be explored. One optimal configuration will be provided and tested in combination with the other tools of CE6b.

### JCTVC-G346 Chroma intra prediction based on residual luma samples [KDDI]

JCTVC-G346 presents additional chroma intra mode based on inter-channel correlation of residual samples. Predicted Cb/Cr values are sum of regular prediction (same as DM) and linear equation using luma residual values with parameter alpha. For further harmonization with HM5.0, each process in the tool, including mode coding, is tuned and simplified. In order to combine JCTVC-G346 with other tools in CE, the test includes the following:

* The parameter alpha is derived and coded on the encoder side.
* The parameter alpha is fixed with simplified preparation of luma residual values.
* A combination of JCTVC-G346 and other tools.

### JCTVC-G358 New modes for chroma intra prediction (LML and LMA) [HKUST]

**General Concept**

JCTVC-G358 contains two new modes, LML and LMA, for chroma intra prediction.  Basically, these two modes take the same steps as LM mode to predict Chroma component, except that the neighboring samples used for deriving alpha and beta are from different locations. For an NxN chroma block, 2N left (and down left) neighboring samples are used in LML mode to calculate alpha and beta, while 2N above (and above right) neighboring samples are used in LMA mode. The down-sampling process of luma component is the same as in LM mode.

There are 3 schemes: Scheme 1(S1) simply adds LMA and LML to the existing 6 modes. Scheme 3 (S3) has 4 modes: DM, LM, LML, LMA. Scheme 2 (S2) has 4+2 modes – it modifies Scheme 3 by adding 2 of 4 removed modes back. Things to be tested include different number and combination of modes, choice of samples to be used, and other variations, especially when combined with other tools.

**Bitstream organization**

No need to modify the bitstream syntax.

## Timeline for software integration

|  |  |  |
| --- | --- | --- |
| **T1** | **T** | HM 5.0 software available |
| **T2** | **T+3 days** | Canon finishes integration of G173, G358, G244 into HM5.0 |
| **T3** | **T+5 days** | Intel finishes check of Canon’s integration / HKUST finishes check of Canon’s integration |
| **T4** | **T+9 days** | Final polishing from Intel and HKUST (if needed) |
| **T5** | **T+13 days** | KDDI finishes integrating G346 |
| **T6** | **T+14 days** | Crosscheck of source code, experiments begin |

## Test plan

The following tests will be performed using the tests conditions defined in section 2.

Proponents in bold font are in charge of providing the simulation results to the cross-checkers.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Combination** | **Contribution** | **Tools** | **Proponent** | **Cross-check** |
| Individual Proposal | JCTVC-G173 | Cross-channel intra chroma residual prediction | **Intel** | HKUST  Canon |
| JCTVC-G244 | Luma-based chroma prediction – Model correction | **Canon** | Intel  KDDI |
| JCTVC-G346 | Chroma intra prediction based on residual luma samples | **KDDI** | HKUST  Canon |
| JCTVC-G358\* | New modes for chroma intra prediction (LML and LMA) | **HKUST** | Intel  KDDI |
| Combination of two proposals | Combination of G173, G244 | Cross-channel intra chroma residual prediction  Luma-based chroma prediction – Model correction | **Intel**, Canon | HKUST  KDDI |
| Combination of G173, G346 | Cross-channel intra chroma residual prediction  Chroma intra prediction based on residual luma samples | Intel, **KDDI** | Canon  HKUST |
| Combination of G173, G358\* | Cross-channel intra chroma residual prediction  New modes for chroma intra prediction (LML and LMA) | Intel, **HKUST** | Canon  KDDI |
| Combination of G244, G346 | Luma-based chroma prediction – Model correction  Chroma intra prediction based on residual luma samples | **Canon**, KDDI | HKUST  Intel |
| Combination of G244, G358\* | Luma-based chroma prediction – Model correction;  New modes for chroma intra prediction (LML and LMA) | Canon, **HKUST** | KDDI  Intel |
| Combination of G346, G358\* | Chroma intra prediction based on residual luma samples  New modes for chroma intra prediction (LML and LMA) | **KDDI**, HKUST | Canon  Intel |
| Combination of three proposals | Combination of G173, G244, G346 | Cross-channel intra chroma residual prediction;  Luma-based chroma prediction – Model correction  Chroma intra prediction based on residual luma samples | **Intel**, Canon, KDDI | HKUST  NTT |
| Combination of G173, G244, G358\* | Cross-channel intra chroma residual prediction;  Luma-based chroma prediction – Model correction  New modes for chroma intra prediction (LML and LMA) | Intel, **Canon**, HKUST | KDDI  NTT |
| Combination of G244, G346,  G358\* | Luma-based chroma prediction – Model correction;  Chroma intra prediction based on residual luma samples  New modes for chroma intra prediction (LML and LMA) | Canon, **KDDI**, HKUST | Intel  Huawei |
| Combination of G173, G346,  G358\* | Cross-channel intra chroma residual prediction;  Chroma intra prediction based on residual luma samples  New modes for chroma intra prediction (LML and LMA) | Intel, KDDI, **HKUST** | Canon  Huawei |
| Combination of four proposals | Combination of G173, G244, G346, G358\* | Cross-channel intra chroma residual prediction;  Luma-based chroma prediction – Model correction  Chroma intra prediction based on residual luma samples  New modes for chroma intra prediction (LML and LMA) | **Intel**, Canon, KDDI, HKUST | NTT  Huawei |

\* G358 has 3 schemes. All of the 3 schemes should be tested.

# CE6.b: Improved Intra Prediction

The goal of this experiment is to enhance Intra prediction of the HEVC Test Model.

The following tools are considered in this experiment:

* Rectangular (2NxN and Nx2N) Intra Prediction (JCTVC-G135)
* Modifications to Intra-frame coding (JCTVC-G119)

## Participants list

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## Proposals description

### Rectangular (2NxN and Nx2N) Intra Prediction (JCTVC-G135)

JCTVC-G135 proposes to add two prediction unit (PU) types (i.e. 2NxN and Nx2N) to Intra coding units (CU) in addition to the existing PU types (i.e. 2Nx2N and NxN) in current HM. Consequently, one Intra prediction mode is applied to each 2NxN and Nx2N PU. The purpose of this experiment is to test the coding efficiency and run-time of the proposed method in harmonization with the NSQT based on HM5.0 software.

### Modifications to Intra-frame coding (JCTVC-G119)

The part 3 of JCTVC-G119 proposes to replace two existing directional intra prediction modes (HOR+8 and VER+8) with one bi-prediction mode that averages the two diagonal prediction values. It also proposes to add HOR+6 as a supplement mode for 4x4 PU. The total number of remaining modes is a power of 2 for all block sizes, and thus the remaining mode index can be binarized with a FLC. This joint design of intra prediction and mode coding will be tested as an improved intra prediction proposal. (Note that this subtest is the superset of subtest 6.2.2.)

## Test plan

Following tests will be performed using the tests conditions defined in section 2.

|  |  |  |  |
| --- | --- | --- | --- |
| **CE6b: Rectangular (2NxN and Nx2N) Intra Prediction** | | | |
| **Contribution** | **Tools** | **Proponent** | **Cross-check** |
| JCTVC-G135 | Rectangular (2NxN and Nx2N) Intra Prediction | MediaTek | Intel  HiSilicon  HHI  Sony |
| JCTVC-G119 | Modifications to Intra-frame coding using a new bi-prediction mode. | Huawei/HiSilicon | I2R  Sony  LG |

# CE6.c: Intra mode coding cleanup and simplification

The goal of this experiment is to cleanup and simplify intra mode coding of the HEVC Test Model.

The following tools are considered in this experiment:

* On intra prediction mode coding (JCTVC-G153)
* Modifications to Intra-frame coding (JCTVC-G119)

## Participants list

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## Proposals description

### On intra prediction mode coding (JCTVC-G153)

The aim of JCTVC-G153 is to streamline intra prediction mode coding. The second part of the contribution proposed to modify remaining mode coding by using a binary+FLC binarization, allowing for 19 prediction modes with 4x4 PUs and 35 prediction modes with 8x8 and larger PUs. This proposed modification will be tested in the CE.

### Modifications to Intra-frame coding (JCTVC-G119)

The part 3 of JCTVC-G119 proposes to replace two existing directional intra prediction modes (HOR+8 and VER+8) with one bi-prediction mode that averages the two diagonal prediction values. It also proposes to add HOR+6 as a supplement mode for 4x4 PU. The total number of remaining modes is a power of 2 for all block sizes, and thus the remaining mode index can be binarized with a FLC. The variant that removes either HOR+8 or VER+8 from current design and does not introduce the bi-prediction mode will be tested as a proposal for Intra mode coding cleanup and simplification.

## Test plan

The following tests will be performed using the tests conditions defined in section 2.

|  |  |  |  |
| --- | --- | --- | --- |
| **CE6c: Intra mode coding cleanup and simplification** | | | |
| **Contribution** | **Tools** | **Proponent** | **Cross-check** |
| JCTVC-G153 | On intra prediction mode coding | I2R | Huawei/HiSilicon  MediaTeK |
| JCTVC-G119 | Modifications to Intra-frame coding removing either HOR+8 or VER+8 | Huawei/HiSilicon | Sony |