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| **Joint Collaborative Team on Video Coding (JCT-VC)**  **of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11**  8th Meeting: San José, CA, USA, 1–10 February, 2012 | Document: JCTVC-H0036 |

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| --- | --- | --- | --- |
| *Title:* | **CE6: Summary Report of Core Experiments on Intra Coding Improvements** | | |
| *Status:* | **Input Document to JCT-VC** | | |
| *Purpose:* | **Report** | | |
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# Introduction

This document provides a summary report of the Core Experiments (CE6) results on “Intra prediction and improvements”. The experiments are divided into 4 subsets, as indicated below:

1. Subset CE6a: Intra Chroma Prediction
2. Subset CE6b: Improved Intra Prediction
3. Subset CE6c: Intra mode coding cleanup and simplification

# CE6a: Intra Chroma Prediction

## CE6a Candidate Technologies

### LM mode modifications

Two proposals relate to modifications of the luma-based chroma prediction (LM mode). In this mode, chroma samples are predicted from already reconstructed luma samples.

1. H0171/G244 Luma-based chroma prediction – Model correction [Canon]

In luma-based chroma intra prediction mode (LM), 2 linear mode parameters (alpha, beta) are estimated using OLS (What OLS stands for?) 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 irregularities and to replace the alpha value by a pre-determined value, depending on the type of irregularity. In the current design, 4 types of irregular ities are considered. For each irregularity, one pre-determined alpha value, picked from a table of fixed values (the index is signaled in the slide header or APS), is used.

1. H0544/G358 New modes for chroma intra prediction (LML and LMA) [HKUST]

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.

### New cross-channel prediction modes

Two proposals relate to new cross-channel prediction modes, not directly linked to LM mode.

1. H0295/G173 Cross-channel prediction refinement to improve intra chroma prediction [Intel]

JCTVC-G173 and part of contribution JCTVC-H0295 present a cross-channel prediction refinement technique to improve intra chroma prediction of HM 5.0. The cross-channel prediction refinement technique produces a Cr refinement signal based on a fixed weighting ((=-1/2) of the reconstructed cross-channel Cb residual signal. It is always applied on the process of intra chroma prediction excluding the occurrence of LM mode.

Extensions to JCTVC-G173 have been explored in JCTVC-H0295 where mode dependent weighting factors are introduced. It is recommended to also review the non-CE contribution JCTVC-H0295 in CE6a session.

1. H0171/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 e.g., the DC value is modified in order to compensate for prediction offset value.

## Cross Check Status

The combined software, integrating the 4 proposed individual tools, was delivered by proponents (Canon, HKUST, Intel, KDDI) on Jan 06, 2012. Experiments consisted in tests every possible combinations of the 4 tools. Full results are reported in contribution H0171.

**Table 1 – CE6a: Intra Chroma Prediction**

|  |  |  |  |
| --- | --- | --- | --- |
| **Contribution** | **Tools** | **Proponent** | **Cross-check** |
| JCTVC-G173 | Cross-channel intra chroma residual pred | **Intel** | HKUST  Canon |
| JCTVC-G244 | LM chroma pred – Model correction | **Canon** | Intel  KDDI |
| JCTVC-G346 | Chroma pred based on residual luma samples | **KDDI** | HKUST  Canon |
| JCTVC-G358\* | New modes for Chroma pred (LML,LMA) | **HKUST** | Intel  KDDI |
| Combination of G173, G244 | Cross-channel intra chroma residual pred  LM chroma pred – Model correction | **Intel**, Canon | HKUST  KDDI |
| Combination of G173, G346 | Cross-channel intra chroma residual pred  Chroma pred based on residual luma | Intel, **KDDI** | Canon  HKUST |
| Combination of G173, G358\* | Cross-channel intra chroma residual pred  New modes for Chroma pred (LML,LMA) | Intel, **HKUST** | Canon  KDDI |
| Combination of G244, G346 | LM chroma pred – Model correction  Chroma pred based on residual luma | **Canon**, KDDI | HKUST  Intel OK |
| Combination of G244, G358\* | LM chroma pred – Model correction;  New modes for Chroma pred (LML,LMA) | Canon, **HKUST** | KDDI  Intel OK |
| Combination of G346, G358\* | Chroma pred based on residual luma  New modes for Chroma pred (LML,LMA) | **KDDI**, HKUST | Canon  Intel OK |
| Combination of G173, G244, G346 | Cross-channel intra chroma residual pred;  LM chroma pred – Model correction  Chroma pred based on residual luma | **Intel**, Canon, KDDI | HKUST  NTT |
| Combination of G173, G244, G358\* | Cross-channel intra chroma residual pred;  LM chroma pred – Model correction  New modes for Chroma pred (LML,LMA) | Intel, **Canon**, HKUST | KDDI  NTT |
| Combination of G244, G346,  G358\* | LM chroma pred – Model correction;  Chroma pred based on residual luma  New modes for Chroma pred (LML,LMA) | Canon, **KDDI**, HKUST | Intel  Huawei |
| Combination of G173, G346,  G358\* | Cross-channel intra chroma residual pred;  Chroma pred based on residual luma  New modes for Chroma pred (LML,LMA) | Intel, KDDI, **HKUST** | Canon  Huawei |
| Combination of G173, G244, G346, G358\* | Cross-channel intra chroma residual pred;  LM chroma pred – Model correction  Chroma pred based on residual luma  New modes for Chroma pred (LML,LMA) | **Intel**, Canon, KDDI, HKUST | NTT  Huawei |

## Cross Check Results

Experiments related to LM mode are tested on AI-HE only configuration, since LM mode is disabled for LC configurations. Other experiments are made on AI-HE and AI-LC configurations.

The reported YUV performance is evaluated using the weight recommended in JCTVC-F386: 0.75 Y, 0.125 U and V.

All combinations have been successfully cross-checked.

### Results of individual tools

**Table 2 - JCTVC-G244- Luma-based chroma prediction – Model correction [Canon]**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | |
|  | Y | U | V | YUV |
| Class A (8bit) | -0.1% | -3.3% | -2.0% | -0.5% |
| Class B | -0.1% | -1.7% | -0.7% | -0.2% |
| Class C | -0.1% | -1.4% | -1.4% | -0.3% |
| Class D | -0.1% | -1.1% | -1.2% | -0.3% |
| Class E | 0.0% | -1.9% | -1.7% | -0.3% |
| **Overall** | -0.1% | -1.7% | -1.3% | -0.3% |
|  | -0.1% | -1.7% | -1.3% | -0.3% |
| Class F | -0.2% | -1.0% | -1.0% | -0.3% |
| Enc Time[%] | 100% | | | |
| Dec Time[%] | 101% | | | |

**Table 3 - JCTVC-G358 - New modes for chroma intra prediction (LML and LMA) [HKUST]**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | |
|  | Y | U | V | YUV |
| Class A (8bit) | -0.1% | -2.0% | -1.6% | -0.4% |
| Class B | -0.1% | -2.6% | -2.1% | -0.5% |
| Class C | -0.2% | -2.3% | -2.9% | -0.6% |
| Class D | -0.1% | -2.1% | -2.3% | -0.5% |
| Class E | 0.0% | -1.7% | -1.8% | -0.3% |
| **Overall** | -0.1% | -2.2% | -2.2% | -0.5% |
|  | -0.1% | -2.2% | -2.2% | -0.5% |
| Class F | -0.4% | -2.5% | -3.0% | -0.8% |
| Enc Time[%] | 104% | | | |
| Dec Time[%] | 101% | | | |

**Table 4 - JCTVC-G173 - Cross-channel intra chroma residual prediction [Intel]**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | | **All Intra LC** | | | |
|  | Y | U | V | YUV | Y | U | V | YUV |
| Class A (8bit) | -0.4% | 0.1% | -3.9% | -0.6% | 0.0% | 0.1% | -1.6% | -0.2% |
| Class B | 0.0% | 0.1% | -2.7% | -0.2% | 0.4% | 0.8% | 0.5% | 0.4% |
| Class C | -0.5% | -1.3% | -3.2% | -0.8% | -0.6% | -1.4% | -3.1% | -0.9% |
| Class D | -0.5% | -1.4% | -3.3% | -0.8% | -0.6% | -1.3% | -3.6% | -0.9% |
| Class E | -0.2% | -0.2% | -2.6% | -0.4% | -0.3% | -0.7% | -2.3% | -0.5% |
| **Overall** | -0.3% | -0.6% | -3.1% | -0.6% | -0.2% | -0.5% | -1.9% | -0.4% |
|  | -0.3% | -0.6% | -3.0% | -0.6% | -0.2% | -0.5% | -1.9% | -0.4% |
| Class F | -0.5% | -1.4% | -2.0% | -0.7% | -0.6% | -1.1% | -3.1% | -0.9% |
| Enc Time[%] | 100% | | | | 100% | | | |
| Dec Time[%] | 101% | | | | 101% | | | |

**Table 5 - JCTVC-G346 - Chroma intra prediction based on residual luma samples [KDDI]**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | | **All Intra LC** | | | |
|  | Y | U | V | YUV | Y | U | V | YUV |
| Class A (8bit) | 0.0% | -2.3% | -1.6% | -0.3% | -0.3% | -4.3% | -2.7% | -0.8% |
| Class B | 0.0% | -3.2% | -2.6% | -0.5% | -0.3% | -6.0% | -3.8% | -1.1% |
| Class C | -0.2% | -2.9% | -3.4% | -0.7% | -0.5% | -5.0% | -5.7% | -1.4% |
| Class D | -0.1% | -2.6% | -2.8% | -0.6% | -0.3% | -4.2% | -4.5% | -1.0% |
| Class E | 0.0% | -1.3% | -1.2% | -0.2% | 0.0% | -2.1% | -2.0% | -0.4% |
| **Overall** | -0.1% | -2.6% | -2.5% | -0.5% | -0.3% | -4.5% | -3.9% | -1.0% |
|  | -0.1% | -2.6% | -2.4% | -0.5% | -0.3% | -4.5% | -3.9% | -1.0% |
| Class F | -0.5% | -3.4% | -3.9% | -1.1% | -1.2% | -6.3% | -7.3% | -2.4% |
| Enc Time[%] | 101% | | | | 102% | | | |
| Dec Time[%] | 101% | | | | 101% | | | |

### Results of combinations of tools

The following table reports the overall performance of the different tested combinations. It is observed that gains are not fully additive but are increasing progressively with the number of tools.

**Table 6 - Results of Combinations of tools**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | AIHE | | | | | AILC | | | | | AIHE10 | | | | |
| **Contribution** | Y | U | V | YUV | Enc  Dec | Y | U | V | YUV | Enc  Dec | Y | U | V | YUV | Enc  Dec | |
| G173 | -0.3 | -0.6 | -3.1 | **-0.6** | 100  101 | -0.2 | -0.5 | -1.9 | **-0.4** | 100  101 | -0.3 | -0.6 | -2.9 | **-0.6** | 100  100 | |
| G244 | -0.1 | -1.7 | -1.3 | **-0.3** | 100  101 |  |  |  |  |  | -0.1 | -3.4 | -3.6 | **-0.6** | 99  100 | |
| G346 | -0.1 | -2.6 | -2.5 | **-0.5** | 101  101 | -0.3 | -4.5 | -3.9 | **-1.0** | 102  101 | -0.2 | -4.5 | -4.8 | **-0.9** | 101  101 | |
| G358 | -0.1 | -2.2 | -2.2 | **-0.5** | 104  101 |  |  |  |  |  | -0.2 | -3.5 | -3.7 | **-0.7** | 104  100 | |
| G173+G244 | -0.4 | -2.2 | -3.8 | **-0.8** | 99  101 |  |  |  |  |  | -0.4 | -4.0 | -6.1 | **-1.1** | 99  101 | |
| G173+G346 | -0.4 | -3.2 | -5.2 | **-1.0** | 102  101 | -0.5 | -5.0 | -6.0 | **-1.4** | 103  102 | -0.5 | -5.1 | -7.4 | **-1.4** | 101  101 | |
| G173+G358 | -0.4 | -2.8 | -5.1 | **-1.0** | 107  101 |  |  |  |  |  | -0.5 | -4.1 | -6.4 | **-1.2** | 107  101 | |
| G244+G346 | -0.1 | -3.6 | -3.2 | **-0.7** | 101  100 | -0.3 | -4.5 | -3.9 | **-1.0** | 102  101 | -0.2 | -5.7 | -6.0 | **-1.1** | 101  99 | |
| G244+G358 | -0.1 | -3.5 | -3.3 | **-0.7** | 104  101 |  |  |  |  |  | -0.2 | -5.4 | -5.7 | **-1.0** | 104  100 | |
| G346+G358 | -0.2 | -4.0 | -4.0 | **-0.8** | 108  102 | -0.7 | -7.8 | -7.2 | **-1.9** | 110  101 | -0.3 | -5.9 | -6.5 | **-1.2** | 108  101 | |
| G173+G244+ G346 | -0.4 | -4.1 | -5.6 | **-1.1** | 101  103 |  |  |  |  |  | -0.5 | -6.3 | -8.3 | **-1.6** | 100  102 | |
| G173+G244+ G358 | -0.4 | -4.0 | -5.8 | **-1.2** | 105  101 | -0.9 | -6.4 | -8.2 | **-2.1** | 107  101 | -0.5 | -6.0 | -8.0 | **-1.5** | 105  99 | |
| G244+G346+ G358 | -0.2 | -4.8 | -4.7 | **-1.0** | 108  101 | -0.7 | -7.8 | -7.2 | **-1.9** | 109  102 | -0.3 | -7.0 | -7.4 | **-1.4** | 107  101 | |
| G173+G346+ G358 | -0.4 | -4.5 | -6.5 | **-1.3** | 105  100 | -1.0 | -8.2 | -9.7 | **-2.4** | 109  103 | -0.5 | -6.6 | -8.9 | **-1.7** | 109  99 | |
| G173+G244+ G346+G358 | -0.4 | -5.3 | -7.0 | **-1.4** | 106  102 |  |  |  |  |  | -0.5 | -7.6 | -9.6 | **-1.9** | 106  102 | |

## Related Non-CE6a Submissions

It is also recommended to review in the CE6a session the following non-CE documents:

* JCTVC-H0176 - Non-CE6a: Border adaptive decimation for LM mode
  + [JCTVC-H0206](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=4508) Crosscheck of JCTVC-H0176
* JCTVC-H0295 - CE6.a: Cross-channel prediction refinement to improve intra chroma prediction
  + X-check: JCTVC-H0573 Cross Check for Intel's intra chroma prediction (JCTVC-H0295)
* JCTVC-H0464 - Non-CE6a: Using averaged down-sampling reference pixels in LM parameter generation
  + X-check: [JCTVC-H0624](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=4943) Cross-check of JCTVC-H0464 and JCTVC-H0490
* JCTVC-H0490 - Non-CE6a: Reduce the look-up table entries for LM mode calculation
  + X-check: [JCTVC-H0624](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=4943) Cross-check of JCTVC-H0464 and JCTVC-H0490
* JCTVC-H0491 - Non-CE6a: Remove the large multiplier for LM mode calculation
  + X-check: [JCTVC-H0301](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=4604) Non-CE6.a: Crosscheck of Huawei’s removal of large multiplier for LM mode calculation (JCTVC-H0491)
* [JCTVC-H0177](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=4476) - Non-CE6a: Use of chroma phase in LM mode

## References

1. Y. Chiu, Y. Han, L. Xu, W. Zhang, H. Jiang, “Cross-channel intra chroma residual prediction” in JCTVC-G173, Geneva, Switzerland, Nov., 2011
2. C.Gisquet, E.François, “Non-CE6a: Luma-based chroma prediction - Model correction” in JCTVC-G244, Geneva, Switzerland, Nov., 2011
3. K. Kawamura, T. Yoshino, H. Kato, S. Naito, “Chroma intra prediction based on residual luma samples” in JCTVC-G346, Geneva, Switzerland, Nov., 2011
4. X. Zhang, O. C. Au, J. Dai, F. Zou, C. Pang, X. Wen, “New modes for chroma intra prediction” in JCTVC-G346, Geneva, Switzerland, Nov., 2011
5. TK Tan, F. Bossen, “Chroma RD cost computation in HM3.0,” in JCTVC-F386, Torino, Italy, July, 2011.

**2. Subset CE6.b: Improved Intra Prediction**

**2.1. Candidate Technologies JCTVC-G135/H0437 and JCTVC-G119/H0057**

JCTVC-G135/H0437 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. It also reports NSQT harmonization results with and without 8x2/2x8 transforms.

JCTVC-G119/H0059 proposes to make the total number of remaining intra modes a power of 2 and accordingly use FLC for binarization.

**2.2. Summary** The list of documents and summary results are shown in the following tables.

**Table 7 - The list of proposal and x-check documents on CE6.b**



**Table 8 - Summary results**



**2.2. Cross-checkers' comments**

**Comments to JCTVC-H0437:**

JCTVC-H0268 reports that when the inter\_4x4\_enabled\_flag is activated, the binarization for proposed Intra partition modes and existing (HM) Inter partition modes are different. Further unification on this is desired.

JCTVC-H0403 reports that the lack of detail description of the proposal and brings to the attention the followings : 1) mapping non-square to square for 32x2/2x32 and 8x2/2x8, 2)different intra partition mode contexts from JCTVC-G135 and 3) no support for TU level coefficient interleaving.

**Comments to JCTVC-H0057 (in CE6.b):**

None.

**2.3. Detailed results**

**Table 9 - JCTVC-H0437: 2NxN and Nx2N PU for Intra Prediction**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | **All Intra LC** | | |
|  | Y | U | V | Y | U | V |
| Class A (8bit) | -1.0% | -2.1% | -2.7% | NA | NA | NA |
| Class B | -1.4% | -2.3% | -2.4% | NA | NA | NA |
| Class C | -1.8% | -1.9% | -2.0% | NA | NA | NA |
| Class D | -1.8% | -1.6% | -1.6% | NA | NA | NA |
| Class E | -2.4% | -5.5% | -4.8% | NA | NA | NA |
| **Overall** | -1.7% | -2.5% | -2.6% | NA | NA | NA |
|  | -1.7% | -2.5% | -2.5% | NA | NA | NA |
| Class F | -5.1% | -4.4% | -4.2% | NA | NA | NA |
| Enc Time[%] | 133% | | | NA | | |
| Dec Time[%] | 102% | | | NA | | |

**Table 10 - JCTVC-H0437: 2NxN and Nx2N PU for Intra Prediction with NSQT harmonization**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | **All Intra HE** | | |
|  | Y | U | V | Y | U | V |
| Class A (8bit) | -0.8% | -2.0% | -2.6% | NA | NA | NA |
| Class B | -0.9% | -2.1% | -2.2% | NA | NA | NA |
| Class C | -0.9% | -1.6% | -1.7% | NA | NA | NA |
| Class D | -0.8% | -1.1% | -1.1% | NA | NA | NA |
| Class E | -1.6% | -4.6% | -4.0% | NA | NA | NA |
| **Overall** | -1.0% | -2.2% | -2.2% | NA | NA | NA |
|  | -1.0% | -2.1% | -2.2% | NA | NA | NA |
| Class F | -0.9% | -1.2% | -1.0% | NA | NA | NA |
| Enc Time[%] | 125% | | | #NUM! | | |
| Dec Time[%] | 101% | | | #NUM! | | |

**Table 11 - JCTVC-H0057: Replace two HOR+8 and VER+8 with one bi-prediction mode**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | **All Intra LC** | | |
|  | Y | U | V | Y | U | V |
| Class A (8bit) | -0.1% | 0.1% | 0.1% | -0.2% | 0.0% | -0.1% |
| Class B | 0.0% | 0.0% | 0.0% | -0.1% | 0.0% | -0.1% |
| Class C | -0.1% | 0.0% | 0.0% | -0.1% | -0.1% | -0.1% |
| Class D | -0.1% | 0.0% | 0.0% | -0.1% | -0.1% | -0.1% |
| Class E | 0.0% | 0.2% | 0.2% | -0.1% | 0.1% | 0.0% |
| **Overall** | -0.1% | 0.0% | 0.0% | -0.1% | 0.0% | -0.1% |
|  | -0.1% | 0.0% | 0.0% | -0.1% | 0.0% | -0.1% |
| Class F | 0.2% | 0.1% | 0.2% | 0.1% | 0.0% | 0.0% |
| Enc Time[%] | 99% | | | 99% | | |
| Dec Time[%] | 99% | | | 100% | | |

**2.4 Related Non-CE6b Submissions**

It is also recommended to review in the CE6b session the following non-CE documents:

* JCTVC-H0109 - Non-CE6: Modification/simplification of intra angular prediction
* JCTVC-H0120 - Non-CE6: Improvement of Intra DC prediction for cases without neighbouring samples
* JCTVC-H0238 - Non-CE6: Simplification of intra vertical/horizontal prediction

**3. Subset CE6.c: Intra mode coding cleanup and simplification**

**3.1. Candidate Technologies JCTVC-G119/H0057 and JCTVC-G153/H0075**

**3.2. Summary**

The list of documents and summary results are shown in the following tables.

**Table 12 - The list of proposal and x-check documents on CE6.c.**



**Table 13 - Summary results**



**3.2. Cross-checkers' comments**

None.

**3.3. Detailed results**

**Table 14 - JCTVC-H0057**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | **All Intra LC** | | |
|  | Y | U | V | Y | U | V |
| Class A (8bit) | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Class B | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Class C | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Class D | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| Class E | 0.0% | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% |
| **Overall** | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
|  | 0.0% | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% |
| Class F | 0.1% | 0.1% | 0.0% | 0.2% | 0.1% | 0.1% |
| Enc Time[%] | 100% | | | 99% | | |
| Dec Time[%] | 100% | | | 100% | | |

**Table 15 - JCTVC-H0075 w/o context**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | **All Intra LC** | | |
|  | Y | U | V | Y | U | V |
| Class A (8bit) | -0.2% | 0.0% | 0.1% | -0.1% | 0.0% | 0.1% |
| Class B | -0.1% | -0.1% | 0.0% | -0.1% | -0.1% | 0.0% |
| Class C | 0.1% | -0.1% | 0.0% | 0.1% | 0.0% | 0.0% |
| Class D | 0.1% | 0.1% | 0.0% | 0.1% | -0.1% | 0.0% |
| Class E | -0.1% | 0.1% | 0.2% | -0.1% | 0.1% | 0.1% |
| **Overall** | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
|  | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Class F | 0.1% | -0.2% | 0.0% | 0.1% | 0.0% | -0.1% |
| Enc Time[%] | 100% | | | 101% | | |
| Dec Time[%] | 100% | | | 100% | | |

**Table 16 - JCTVC-H0075 w/ context**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | **All Intra LC** | | |
|  | Y | U | V | Y | U | V |
| Class A (8bit) | -0.3% | -0.1% | 0.0% | -0.3% | -0.1% | 0.0% |
| Class B | -0.2% | -0.1% | -0.1% | -0.2% | -0.1% | 0.0% |
| Class C | -0.2% | -0.2% | -0.1% | -0.2% | -0.1% | -0.1% |
| Class D | -0.2% | 0.0% | -0.1% | -0.1% | -0.1% | -0.1% |
| Class E | -0.3% | -0.1% | 0.0% | -0.3% | -0.1% | 0.0% |
| **Overall** | -0.2% | -0.1% | -0.1% | -0.2% | -0.1% | -0.1% |
|  | -0.2% | -0.1% | -0.1% | -0.2% | -0.1% | -0.1% |
| Class F | -0.2% | -0.1% | -0.2% | -0.2% | -0.2% | -0.2% |
| Enc Time[%] | 101% | | | 102% | | |
| Dec Time[%] | 102% | | | 103% | | |

**3.4 Related Non-CE6c Submissions**

It is also recommended to review in the CE6c session the following non-CE documents:

* JCTVC-H0079 - Non-CE6.c: Unified neighboring positions for intra mode coding
* JCTVC-H0081 - Non-CE6.c: Fixed length binarization of remaining intra prediction mode
* JCTVC-H0098 - Non-CE6: Modified definitions of intra mode and most probable mode
* JCTVC-H0166 - Non CE6: Unification of the number of intra prediction modes
* JCTVC-H0175 - Non-CE6c: Adaptations of intra mode coding
* JCTVC-H0326 - Non-CE6: Simplification of intra chroma mode coding
* JCTVC-H0342 - Non CE6: set intra mode number to be 35 for intra 4x4 PU
* JCTVC-H0407 - Intra mode coding using logical mode numbering
* JCTVC-H0428 - Non-CE6: Postpone MPM sorting
* JCTVC-H0435 - Intra mode coding with fixed length binarization
* JCTVC-H0516 - On MPM determination and Planar mode signaling
* JCTVC-H0534 - Non-CE6: Modifications of intra mode coding
* JCTVC-H0563 - Non-CE6: Intra mode coding simplification