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| **Joint Collaborative Team on Video Coding (JCT-VC)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  13th Meeting: Incheon, KR, 18–26 Apr. 2013 | Document: JCTVC-M0023 |

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| --- | --- | --- | --- |
| *Title:* | **SCE3: Summary Report of SHVC Core Experiment on Combined Inter- and Interlayer Prediction** | | |
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| *Purpose:* | SCE report | | |
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| *Source:* | SCE coordinators | | |

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# Abstract

This document reports SHVC core experiment activities of combined inter- and inter-layer prediction (SCE3) between the 12th JCT-VC meeting in Geneva, Switzerland (14–23 Jan. 2013) and 13th JCT-VC meeting in Incheon, Korea (18–26 Apr. 2013).

# Introduction

According to [1], combined prediction techniques for SHVC are studied in this SCE.

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# Document list

|  |  |  |  |
| --- | --- | --- | --- |
| Test | Document | Crosschecking | Short description |
| 3.1 | JCTVC-M0119 (MediaTek) | Samsung (JCTVC-M0034) | Adaptive predictor compensation |
| 3.2 | JCTVC-M0294 (Qualcomm) | JCTVC-M0122 (ETRI) | Combined inter mode |
| 3.3 | JCTVC-M0260 (Qualcomm, Nokia, Canon) | JCTVC-M0060 (Intel)  JCTVC-M0339 (Samsung)  JCTVC-M0177  (RWTH-Aachen)  JCTVC-M0108 (Huawei) | Generalized residual prediction |
| 3.4 | JCTVC-M0221 (MediaTek) | JCTVC-M0299 (LG)  JCTVC-M0236 (Qualcomm) | Generalized combined and residue prediction |
| 3.5 | JCTVC-M0109 (Canon) | JCTVC-M0077 (Sharp) | Generalized residual prediction with MC at BL |
| 3.6 | JCTVC-M0073 (Sharp) | JCTVC-M0145 (Sony) | Generalized residual prediction with shorter MC filter |
| 3.7 | JCTVC-M0251 (LG, Vidyo) | JCTVC-M0394 (MediaTek) | Difference domain inter prediction |
| 3.8 | Withdrawn |  | RefIdx based differential coding |
| 3.9 | JCTVC-M0110 (Canon) | JCTVC-M0237 (Qualcomm) | Base Mode with Residual Prediction |

# Summary of Results

## Summary of RD results

“Aver BD-R Y” indicates the average BD-rate reduction of RA and LDP configurations since LDB results are not mandatory.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test | Case | Aver BD-R Y | Config. | BD-R Y | BD-R U | BD-R V | Enc T. | Dec T. |
| 3.1 | Case 1: medium complexity | -1.1% | RA | -0.5% | -2.7% | -3.2% | 104% | 100% |
| LD-P | -1.7% | -4.7% | -5.5% | 104% | 99% |
| LD-B | -0.6% | -2.8% | -3.2% | 103% | 100% |
| 3.2 | Case 1 | -1.1% | RA | -0.5% | -3.1% | -3.7% | 109% | 94% |
| LD-P | -1.7% | -5.6% | -6.5% | 112% | 93% |
| LD-B |  |  |  |  |  |
| 3.3 | Case 1: 3 weights, bi-linear interp., no GRP on chroma | -2.9% | RA | -1.7% | -5.5% | -6.5% | 119% | 100% |
| LD-P | -4.1% | -7.7% | -8.7% | 125% | 99% |
| LD-B | -2.7% | -6.7% | -7.6% | 116% | 101% |
| Case 2: 3 weights, bi-linear interp., 4-tap up-sample., block size constraint | -3.7% | RA | -2.0% | -3.7% | -3.9% | 119% | 126% |
| LD-P | -5.3% | -5.7% | -5.1% | 125% | 128% |
| LD-B | -3.1% | -4.6% | -4.5% | 116% | 127% |
| Case 3: 2 weights, bi-linear interp., 4-tap up-sample., block size constraint | -3.4% | RA | -2.0% | -3.9% | -4.3% | 114% | 126% |
| LD-P | -4.8% | -5.4% | -5.0% | 119% | 128% |
| LD-B | -2.9% | -4.7% | -4.7% | 111% | 127% |
| Case 4: 3 weights, bi-linear interp., 4-tap up-sample., block size constraint, no GRP on chroma | -3.2% | RA | -1.6% | -4.1% | -5.1% | 120% | 126% |
| LD-P | -4.8% | -6.7% | -8.0% | 126% | 127% |
| LD-B | -2.6% | -5.1% | -6.0% | 118% | 126% |
| 3.4 | Case 1: Test1-3GCP On all partition sizes | -3.5% | RA | -2.4% | -4.5% | -4.8% | 127% | 107% |
| LD-P | -4.6% | -4.6% | -4.0% | 131% | 106% |
| LD-B | -4.4% | -6.0% | -5.7% | 124% | 111% |
| Case 2: Test2-3GCP  On 2Nx2N only | -3.2% | RA | -2.2% | -4.1% | -4.4% | 121% | 108% |
| LD-P | -4.2% | -4.2% | -3.5% | 123% | 106% |
| LD-B | -4.1% | -5.4% | -5.1% | 118% | 111% |
| 3.5 | Case 1: One weighting mode (1) | -1.9% | RA | -1.5% | -3.4% | -3.8% | 111% | 106% |
| LD-P | -2.2% | -2.5% | -2.5% | 114% | 106% |
| LD-B | -2.3% | -3.2% | -3.3% | 111% | 106% |
| Case 2: Two weighting modes (0.5, 1) | -2.6% | RA | -1.6% | -3.5% | -4.0% | 119% | 104% |
| LD-P | -3.6% | -3.3% | -2.8% | 122% | 105% |
| LD-B | -2.6% | -3.6% | -3.7% | 119% | 106% |
| 3.6 | Case 1: | -2.6% | RA | -2.4% | -3.9% | -4.4% | 120% | 105% |
| LD-P | -2.8% | -3.3% | -3.3% | 117% | 104% |
| LD-B | -3.6% | -4.4% | -4.7% | 115% | 113% |
| 3.7 | Case 1: Default | -2.1% | RA | -1.9% | -4.0% | -4.6% | 158% | 106% |
| LD-P | -2.2% | -3.3% | -3.5% | 154% | 107% |
| LD-B |  |  |  |  |  |
| Case 2: Default + bilinear interp. | -2.7% | RA | -2.1% | -4.3% | -4.7% | 158% | 107% |
| LD-P | -3.3% | -4.5% | -4.6% | 154% | 108% |
| LD-B |  |  |  |  |  |
| Case 3: Default + weighting 0.5 | -2.0% | RA | -1.3% | -1.9% | -1.9% | 155% | 107% |
| LD-P | -2.7% | -1.3% | -1.1% | 149% | 109% |
| LD-B |  |  |  |  |  |
| Case 4: Default + bilinear interp. + weighting 0.5 | -1.8% | RA | -1.2% | -2.0% | -1.9% | 155% | 107% |
| LD-P | -2.5% | -1.5% | -1.4% | 149% | 109% |
| LD-B |  |  |  |  |  |
| 3.9 | Case 1: Base mode with GRP 8x8 | -1.7% | RA | -1.3% | -1.9% | -2.4% | 103% | 107% |
| LD-P | -2.0% | -1.7% | -1.7% | 103% | 109% |
| LD-B | -1.8% | -1.7% | -1.8% |  |  |
| Case 2: Base mode with GRP 16x16 | -1.3% | RA | -1.1% | -2.1% | -2.4% | 102% | 106% |
| LD-P | -1.6% | -1.9% | -1.8% | 102% | 106% |
| LD-B | -1.4% | -2.1% | -2.1% |  |  |

## Summary of complexity in the worst case

The analysis of worst case is based on the updated complexity template [2] provided by AhG 17. Please note that the worst case here indicates the worst case of the proposed mode. A number less than 100% indicates that the worst case of all modes would be the same as that of HEVC single layer coding.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Test | Case | Mul | Adds | MemBand (4x2) | MemBand (8x2) | Num Ref in Pred | Size of Look-up Tab | Add Pic Buffer |
| 3.1 | Case 1 | 145% | 145% | 133% | 133% | 100% | 100% | 0% |
| 3.2 | Case 1 | 145% | 145% | 133% | 133% | 100% | 100% | 0% |
| 3.3 | Case 1 | 110% | 111% | 100% | 98% | 180% | 113% | 0% |
| Case 2 | 76% | 67% | 108% | 106% | 180% | 146% | 0% |
| Case 3 | 76% | 67% | 108% | 106% | 180% | 146% | 0% |
| Case 4 | 56% | 49% | 70% | 68% | 180% | 146% | 0% |
| 3.4 | Case 1 | 486% | 495% | 383% | 344% | 180% | 100% | 0% |
| Case 2 | 397% | 405% | 333% | 267% | 180% | 100% | 0% |
| 3.5 | Case 1 | 115% | 113% | 126%  99% spatial 3/2 | 126%  100% spatial 3/2 | 180% | 200% | 0% |
| Case 2 | 115% | 113% | 126%  99% spatial 3/2 | 126%  100% spatial 3/2 | 180% | 200% | 0% |
| 3.6 | Case 1 | 286% (B)  211% (P) | 295% (B)  221% (P) | 267% (B)  261% (P) | 267% (B)  233% (P) | 180% | 121% | 0% |
| 3.7 | Case 1 | 486% | 495% | 383% | 344% | 180% | 100% | 0% |
| Case 2 | 200% | 197% | 213% | 219% | 180% | 113% | 0% |
| Case 3 | 486% | 495% | 383% | 344% | 180% | 100% | 0% |
| Case 4 | 200% | 197% | 213% | 219% | 180% | 113% | 0% |
| 3.9 | Case 1 | 200% | 197% | 213%  179% spatial 3/2 | 219%  185% spatial 3/2 | 180% | 108% | 0% |
| Case 2 | 133% | 131% | 137%  116% spatial 3/2 | 137%  97% spatial 3/2 | 180% | 108% | 0% |

## Summary of average complexity

The average complexity is reported by proponents and has been crosschecked by cross-checkers. So far, many bugs on the implementation of complexity assessment in code have been reported. Even after crosschecking, it is difficult to guarantee the average complexity information summarized below is bug free.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Test | Case | Config. | 8b/8b | 64b/256b | 64b/512b | Mults | Adds |
| 3.1 | Case 1: medium complexity | RA | 103% | 103% | 103% | 99% | 99% |
| LD-P | 107% | 105% | 105% | 99% | 100% |
| LD-B | 105% | 104% | 104% | 98% | 99% |
| 3.2 | Case 1 | RA | 104% | 103% | 103% | 103% | 104% |
| LD-P | 109% | 107% | 107% | 109% | 111% |
| LD-B | 106% | 105% | 105% | 105% | 106% |
| 3.3 | Case 1: 3 weights, bi-linear interp., no GRP on chroma | RA | 112% | 111% | 112% | 112% | 112% |
| LD-P | 121% | 118% | 119% | 122% | 123% |
| LD-B | 119% | 116% | 118% | 120% | 120% |
| Case 2: 3 weights, bi-linear interp., 4-tap up-sample., block size constraint | RA | 120% | 120% | 120% | 114% | 111% |
| LD-P | 140% | 143% | 143% | 130% | 125% |
| LD-B | 130% | 130% | 130% | 121% | 117% |
| Case 3: 2 weights, bi-linear interp., 4-tap up-sample., block size constraint | RA | 118% | 119% | 118% | 113% | 111% |
| LD-P | 138% | 143% | 143% | 130% | 125% |
| LD-B | 127% | 128% | 128% | 120% | 117% |
| Case 4: 3 weights, bi-linear interp., 4-tap up-sample., block size constraint, no GRP on chroma | RA | 110% | 109% | 109% | 105% | 104% |
| LD-P | 120% | 119% | 120% | 113% | 109% |
| LD-B | 114% | 112% | 113% | 108% | 105% |
| 3.4 | Case 1: GCP for all blocks | RA | 147% | 148% | 149% | 161% | 165% |
| LD-P | 171% | 172% | 173% | 198% | 203% |
| LD-B | 179% | 180% | 181% | 209% | 215% |
| Case 2: GCP only for 2Nx2N blocks | RA | 147% | 148% | 149% | 161% | 165% |
| LD-P | 171% | 171% | 172% | 197% | 202% |
| LD-B | 180% | 181% | 183% | 210% | 216% |
| 3.5 | Case 1: One weighting mode (1) | RA | 129% | 132% | 133% | 118% | 121% |
| LD-P | 129% | 132% | 132% | 115% | 118% |
| LD-B | 140% | 144% | 145% | 125% | 128% |
| Case 2: Two weighting modes (0.5, 1) | RA | 132% | 136% | 137% | 117% | 119% |
| LD-P | 141% | 146% | 146% | 123% | 127% |
| LD-B | 145% | 150% | 152% | 123% | 127% |
| 3.6 | Case 1: | RA | 136% | 139% | 140% | 129% | 130% |
| LD-P | 155% | 158% | 159% | 148% | 151% |
| LD-B | 160% | 164% | 166% | 149% | 150% |
| 3.7 | Case 1: Default | RA | 133% | 133% | 133% | 114% | 116% |
| LD-P | 138% | 138% | 138% | 118% | 121% |
| LD-B |  |  |  |  |  |
| Case 2: Default + bilinear interp. | RA | 134% | 135% | 136% | 107% | 108% |
| LD-P | 148% | 148% | 150% | 114% | 115% |
| LD-B |  |  |  |  |  |
| Case 3: Default + weighting 0.5 | RA | 129% | 129% | 130% | 110% | 112% |
| LD-P | 146% | 144% | 145% | 116% | 119% |
| LD-B |  |  |  |  |  |
| Case 4: Default + bilinear interp. + weighting 0.5 | RA | 127% | 128% | 129% | 105% | 105% |
| LD-P | 142% | 140% | 142% | 108% | 109% |
| LD-B |  |  |  |  |  |
| 3.9 | Case 1: Base mode with GRP 8x8 | RA | 161% | 204% | 199% | 128% | 132% |
| LD-P | 179% | 229% | 222% | 139% | 145% |
| LD-B | 186% | 241% | 234% | 143% | 150% |
| Case 2: Base mode with GRP 16x16 | RA | 131% | 142% | 151% | 121% | 124% |
| LD-P | 137% | 148% | 159% | 127% | 131% |
| LD-B | 142% | 156% | 168% | 131% | 135% |

# Recommendations

It is recommended to discuss all the proposals in JCT-VC meeting and adopt promising one(s).

# References

1. X. Li, E. Francois, P. Lai, D. Kwon, A. Saxena, “Description of Scalable Extensions Core Experiment 3 (SCE3): Combined Inter and Inter-Layer Prediction in SHVC”, doc. JCTVC-L1103, 12th Meeting of Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11, Geneva, Switzerland, 14–23 Jan. 2013.

1. [E. François](mailto:edouard.francois@crf.canon.fr), [A. Tabatabai](mailto:ali.tabatabai@am.sony.com), [E. Alshina](mailto:elena_a.alshina@samsung.com), BoG report: Methodology for evaluating complexity of combined and residual prediction methods in SHVC, JCTVC-L0440, Geneva, Switzerland, 14–23 Jan. 2013.

# Appendix – list of related non-CE proposals

|  |  |  |
| --- | --- | --- |
| Proposals | Title | Crosschecking documents |
| JCTVC-M0062 (Intel) | nonSCE3: Inter-layer residual prediction with motion prediction | JCTVC-M0319 (Huawei) |
| JCTVC-M0071 (Huawei) | Non-SCE3: Inferred GRP (IGRP) with reduced motion compensation | [JCTVC-M0370](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=7621) (Intel) |
| JCTVC-M0074 (Sharp) | Implicit derivation of weight factor for Generalized Residual Prediction | JCTVC-M0360 (Canon) |
| JCTVC-M0090 (Samsung) | non SCE3: Low-pass filter for Combined Inter Prediction | JCTVC-M0389 (MediaTek) |
| JCTVC-M0092 (Samsung) | Non SCE3: Simplified design for combined prediction (test 3.2) | JCTVC-M0301 (Qualcomm) |
| JCTVC-M0132 (MediaTek) | Non-SCE3.1: Disabling adaptive predictor compensation for 8x8 bi-prediction | [JCTVC-M0252](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=7503) (Samsung) |
| JCTVC-M0143 (Sony) | Non-SCE3: Quantized GRP | [JCTVC-M0078](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=7329) (Sharp) |
| JCTVC-M0154 (Huawei) | Non-SCE3: Combination of Merge and GRP | JCTVC-M0314 (InterDigital) |
| JCTVC-M0155 (Nokia) | Non-CE3: Enhanced inter layer reference picture for RefIdx based scalability |  |
| JCTVC-M0157 (HKUST) | A study of Generalized Residual Predicition |  |
| JCTVC-M0189 (InterDigital) | Non-SCE3: ILR enhancement with differential coding for RefIdx framework | JCTVC-M0362 (Canon) |
| JCTVC-M0220 (TI) | Non-SCE3: Uni-directional combined prediction (UCP) in Inter slice | JCTVC-M0354 (Qualcomm) |
| JCTVC-M0222 (MediaTek) | Non-SCE3.4: Simplified Generalized Combined Prediction | [JCTVC-M0241](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=7492) (Qualcomm) |
| JCTVC-M0275 (Qualcomm) | Non-SCE3: Simplified Generalized Residual Prediction | [JCTVC-M0226](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=7477) (MediaTek)  JCTVC-M0321 (Intel) |
| JCTVC-M0297 (Qualcomm) | Non-SCE3: Bandwidth reduction for combined inter mode | JCTVC-M0347 (Samsung)  JCTVC-M0396 (MediaTek) |