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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**  16th Meeting: San José, US, 9–17 Jan. 2014 | Document: JCTVC-P0180 |

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| *Title:* | **RCE3: Results of Subtest D.2 on *N*x*2N*/*2N*x*N*/*N*x*N* Intra Block Copy** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

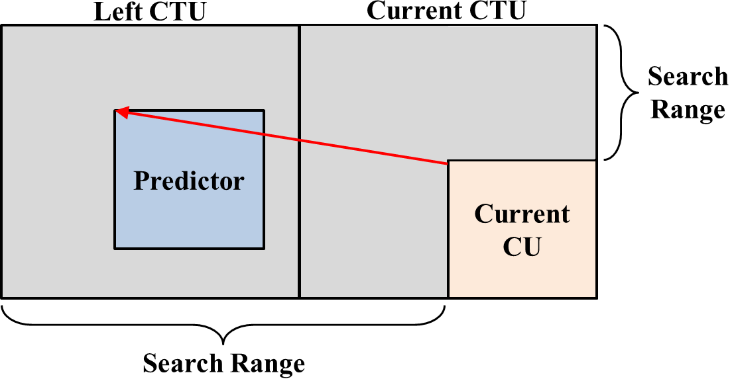
HEVC Range Extensions (RExt) Core Experiment 3(RCE3) was formed to study intra block copy (IntraBC) refinement which was descripted in JCTVC-O1123, where three tools and their combination are included to be tested. This document provides the experimental results for Subtest D.2 which combines *N*x*2N/2N*x*N* and *N*x*N* IntraBC. The average BD-rate reduction for screen contents (Class F/SC RGB444/ SC YUV444) is reported as follows:

* All-Intra : (MT) -3.8/-10.5/-10.0, (Avg. Enc.) 149%, (Avg. Dec.) 103%
* Random Access: (MT) -2.8/-8.8/-8.5, (Avg. Enc.) 98%, (Avg. Dec.) 100%
* Low Delay B : (MT) -1.5/-6.4/-5.7, (Avg. Enc.) 107%, (Avg. Dec.) 103%

# Introduction

At the 14th JCT-VC meeting in Vienna, the IntraBC mode is adopted in the draft HEVC Range Extension standard. Figure 1 demonstrates that the IntraBC block vector (BV) estimation for a current CU is performed by searching a match within the search range covering the reconstructed regions of the left and the current CTUs. A CU-level flag is signaled to switch adaptively between IntraBC mode and those prediction modes specified in HEVC.

To further improve the coding efficiency of the IntraBC mode, currently (a) subtest B.1 on *Nx2N/2NxN* IntraBC [2], and (b) subtest B.3 on *N*x*N* IntraBC with TU process are being tested. Both subtests are combined with chroma BV fix and no TU process.



1. A demonstration of the IntraBC mode, where the gray area represents the search range of a current CU.

# Experimental Results

Experiments were conducted using the HM-12.1+RExt-5.1 software [3] and the RCE3 common test conditions [1] to collect the BD-rate and the encoding and decoding times of the proposed techniques in the All-Intra, Random Access, Low Delay B configurations.

1. Performance of *N*x*2N*/*2N*x*N*/*N*x*N* IntraBC for Lossy coding.

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|  | **All Intra HE Main-tier** | | | **All Intra HE High-tier** | | | **All Intra HE Super-High-tier** | | |
| Y | U | V | Y | U | V | Y | U | V |
| Class F | -3.8% | -3.5% | -3.6% | -3.4% | -3.2% | -3.2% | -2.9% | -2.7% | -2.7% |
| Class B | 0.0% | -0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| SC RGB 444 | -10.5% | -10.4% | -10.4% | -10.8% | -10.8% | -10.8% | -10.8% | -10.7% | -10.7% |
| Animation RGB 444 | -0.2% | -0.2% | -0.2% | -0.2% | -0.2% | -0.2% | -0.1% | -0.2% | -0.2% |
| SC YUV 444 | -10.0% | -9.9% | -9.8% | -10.4% | -10.4% | -10.3% | -10.5% | -10.3% | -10.3% |
| Animation YUV 444 | -0.2% | -0.2% | -0.3% | -0.2% | -0.2% | -0.2% | -0.1% | -0.2% | -0.2% |
| RangeExt | 0.0% | -0.1% | -0.1% | 0.0% | -0.1% | -0.1% | 0.0% | 0.0% | -0.1% |
| SC(444) GBR Optional | -12.0% | -11.7% | -11.7% | -12.9% | -12.5% | -12.5% | -13.2% | -12.6% | -12.6% |
| SC(444) YUV Optional | -13.9% | -13.9% | -13.9% | -15.6% | -15.3% | -15.3% | -16.8% | -16.4% | -16.5% |
| Enc Time[%] | 149% | | | 154% | | | 153% | | |
| Dec Time[%] | 103% | | | 102% | | | 102% | | |

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| --- | --- | --- | --- | --- | --- | --- |
|  | **Random Access HE**  **Main-tier** | | | **Random Access HE**  **High-tier** | | |
| Y | U | V | Y | U | V |
| Class F | -2.8% | -2.6% | -2.6% | -2.5% | -2.4% | -2.4% |
| Class B | 0.0% | 0.0% | -0.1% | 0.0% | 0.0% | -0.1% |
| SC RGB 444 | -8.8% | -8.4% | -8.5% | -8.9% | -8.7% | -8.7% |
| Animation RGB 444 | -0.1% | -0.1% | -0.1% | 0.0% | -0.1% | -0.1% |
| SC YUV 444 | -8.5% | -8.4% | -8.4% | -8.8% | -8.8% | -8.8% |
| Animation YUV 444 | -0.1% | -0.2% | -0.2% | -0.1% | -0.2% | -0.2% |
| RangeExt | 0.0% | 0.0% | -0.1% | 0.0% | 0.0% | -0.1% |
| SC(444) GBR Optional | -9.8% | -9.3% | -9.3% | -11.1% | -10.5% | -10.7% |
| SC(444) YUV Optional | -12.2% | -12.3% | -12.3% | -13.9% | -13.7% | -13.9% |
| Enc Time[%] | 98% | | | 101% | | |
| Dec Time[%] | 100% | | | 101% | | |

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| --- | --- | --- | --- | --- | --- | --- |
|  | **Low delay B HE Main-tier** | | | **Low delay B HE High-tier** | | |
| Y | U | V | Y | U | V |
| Class F | -1.5% | -1.9% | -0.9% | -1.5% | -1.5% | -1.3% |
| Class B | 0.0% | 0.1% | -0.2% | 0.0% | 0.1% | -0.1% |
| SC RGB 444 | -6.4% | -6.0% | -6.2% | -7.0% | -6.6% | -6.7% |
| Animation RGB 444 | 0.0% | -0.1% | 0.0% | -0.1% | -0.1% | 0.0% |
| SC YUV 444 | -5.7% | -5.7% | -5.6% | -6.5% | -6.3% | -6.3% |
| Animation YUV 444 | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| RangeExt | 0.0% | -0.1% | 0.0% | 0.0% | -0.1% | -0.1% |
| SC(444) GBR Optional | -8.1% | -7.9% | -7.9% | -9.3% | -8.8% | -8.8% |
| SC(444) YUV Optional | -10.7% | -10.6% | -10.6% | -12.3% | -12.3% | -12.2% |
| Enc Time[%] | 107% | | | 109% | | |
| Dec Time[%] | 103% | | | 102% | | |

1. Performance of *N*x*2N*/*2N*x*N*/*N*x*N* IntraBC for Lossless coding.

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| --- | --- | --- | --- |
|  | Average bit-rate increase | | |
|  | **AI** | **RA** | **LB** |
| Class F | -1.2% | -0.7% | -0.4% |
| Class B | 0.0% | 0.0% | 0.0% |
| RGB 4:4:4 SC | -7.0% | -5.8% | -5.4% |
| RGB 4:4:4 Animation | 0.0% | 0.0% | 0.0% |
| YCbCr 4:4:4 SC | -7.2% | -5.9% | -5.4% |
| YCbCr 4:4:4 Animation | 0.0% | 0.0% | 0.0% |
| RangeExt | 0.0% | 0.0% | 0.0% |
| RGB 4:4:4 SC (Optional) | -10.9% | -9.2% | -9.2% |
| YCbCr 4:4:4 SC (Optional) | -14.4% | -13.3% | -14.2% |
| Enc Time[%] | 145% | 109% | 104% |
| Dec Time[%] | 93% | 95% | 104% |

# References

1. J. Sole, E. Alshina, D.-K. Kwon, and W.-H. Peng, “HEVC Range Extensions Core Experiment 3 (RCE3): Intra block copy refinement,” JCTVC-O1123, Geneva, Oct. 2013.
2. C. C. Chen, T. S. Chang, R. L. Liao, W. H. Peng, H. M. Hang, C. L. Lin, and F. D. Jou, "AHG8: Line-based Intra Block Copy," JCTVC-O0205, Geneva, Oct. 2013.
3. JCT-VC, “HM-12.1+RExt-5.1,” <https://hevc.hhi.fraunhofer.de/svn/svn_HEVCSoftware/tags/HM-12.1+RExt-5.1/>

# Patent rights declaration(s)

**NCTU may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).**

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