|  |  |
| --- | --- |
| **Joint Collaborative Team on Video Coding (JCT-VC)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  12th Meeting: Geneva, CH, 14–23 Jan. 2013 | Document: JCTVC-L1122r3 |

|  |  |  |  |
| --- | --- | --- | --- |
| *Title:* | **HEVC Range Extensions Core Experiment 2 (RCE2): Intra Prediction for Lossless Coding** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | CE description | | |
| *Author(s) or Contact(s):* | Wen Gao  Huawei Technologies,  Minhua Zhou  Texas Instruments Inc., USA  Peter Amon  Siemens  Sunil Lee  Samsung Electronics Co., Ltd. | Email:  Email:  Email:  Email: | wen.gao@huawei.com  zhou@ti.com  p.amon@siemens.com  sunil.lee@samsung.com |
| *Source:* | CE coordinators | | |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Abstract

This document is a description of the HEVC Range Extensions Core Experiment 2 on intra lossless coding tools.

# Introduction

# Participants

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Participant** | **Person** | **Email address** | **P** | **C** |
| BBC | M. Mrak  M. Naccari | [Marta.Mrak@bbc.co.uk](mailto:Marta.Mrak@bbc.co.uk)  Matteo.Naccari@bbc.co.uk |  |  |
| Samsung | S. Lee  I.-K. Kim | [sunil.lee@samsung.com](mailto:chris.rosewarne@cisra.canon.com.au)  ilkoo.kim@samsung.com | x | x |
| Huawei | W. Gao  H. Yu | [wen.gao@huawei.com](mailto:haoping.yu@huawei.com)  haoping.yu@huawei.com |  | x |
| Siemens | P. Amon  Eugen Wige | [p.amon@siemens.com](mailto:nakamura.hiroya@jvckenwood.com)  wige@lnt.de | x |  |
| Qualcomm | J. Sole  Rajan Joshi | [joels@qti.qualcomm.com](mailto:joels@qti.qualcomm.com) rajanj@[qti.qualcomm.com](mailto:joels@qti.qualcomm.com) |  | x |
| TI | M. Zhou  Madhukar Budagavi | [zhou@ti.com](mailto:sze@ti.com)  madhukar@ti.com | x | x |
| I2R | Y. Tan | yhtan@i2r.a-star.edu.sg | x | x |
| MediaTek | C.-W. Hsu  C.-Y. Chen  C.-Y, Tsai  Y.-W. Huang | [cw.hsu@mediatek.com](mailto:cw.hsu@mediatek.com)  [chingyeh.chen@mediatek.com](mailto:chingyeh.chen@mediatek.com)  [chiayang.tsai@mediatek.com](mailto:chiayang.tsai@mediatek.com)  [yuwen.huang@mediatek.com](mailto:yuwen.huang@mediatek.com) |  |  |
| NEC | Keiichi Chono | chono@ct.jp.nec.com |  |  |
| HHI | Tung Nguyen | tung.nguyen@hhi.fraunhofer.de |  |  |

# Experiments

* 1. Tests

Intra lossless coding tools are to be integrated into the Range Extension base software, i.e. HM 10.0-RExt-2.0. Two code bases are to be created for the tests in this core experiment.

Code base 1: Integration of L0117, L0161 and L0176 into HM 10.0-RExt-2.0, which will be used in Test 1-4 and 6-7.

The following integration process will be used and has been agreed upon among the proponents:

1. TI integrate the L0176 into HM 10.0-RExt-2.0, and pass the software to Samsung
2. Samsung integrate L0117 into TI's Software, and pass it to Siemens
3. Siemens integrate L0161 and create the Code base 1

Code base 2: Integration of JCTVC-K0157 into HM 10.0-RExt-2.0, which will be used in Test 5.

The following configurations are to be tested.

1. Residual DPCM for horizontal/vertical intra prediction directions: method presented in JCTVC-L0117
   * Proponent: Samsung
   * Software: Code base 1 by turning off L0117 and L0161
   * Cross-checker: Huawei
2. Template based sample-adaptive weighted prediction (replaces planar mode) : method presented in JCTVC-L0161
   * Proponent: Siemens
   * Software: Code base 1 by turning off L0117 and L0176
   * Cross-checker: Samsung
3. Sample-based angular intra prediction (SAP): method presented in JCTVC-L0176. SAP is enabled in all 33 angular prediction directions.
   * Proponent: TI
   * Software: Code base 1 by turning off L0117 and L0161
   * Cross-checker: Samsung
4. SAP in only vertical and horizontal direction: a variant of the method as presented in JCTVC-L0176 by only enabling SAP in horizontal and vertical direction.
   * Proponent: TI
   * Software: Code base 1 by turning off L0117 and L0161, and enabling SAP only in horizontal and vertical direction
   * Cross-checker: I2R
5. Residual sample-based prediction: method as presented in JCTVC-K0157
   * Proponent: I2R
   * Software: Code base 2
   * Cross-checker: Huawei
6. Combination of residual DPCM for horizontal/vertical intra prediction directions and template based sample-adaptive weighted prediction: Test the combination of the methods presented in JCTVC-L0117 and JCTVC-L0161 (L0117 + L0161)
   * Proponent: Samsung, Siemens
   * Software: Code base 1 by turning off L0176
   * Cross-checker: TI
7. Combination of SAP and template based sample-adaptive weighted prediction: test the combination of the methods presented in both L0161 and L0176 (L0161 + L0176)
   * Proponent: Siemens, TI
   * Software: Code base 1 by turning off L0117
   * Cross-checker: Qualcomm
   1. Software

HM10.0\_RExt2.0, i.e., r3369 in branches/HM-range-extensions with the following patch, shall be used.



* 1. Test Coding Conditions

The lossless coding test sequences, configurations and test cases recommended by screen content coding (AhG8) will be used. Results for all mandatory test cases shall be provided.

The following test sequences are agreed in AhG8 and will be used for RCE2 mandatory test sequences:

* Class F: all 4 sequencs;
* Class B: Kimono, and Parkscene;
* Screen content (4:4:4 RGB): VenueVue, cad\_waveform, cg\_twist\_tunnel, pcb\_layout, ppt\_doc\_xls, video\_conferencing\_doc\_sharing, web\_browsing, sc\_map, sc\_programming, and sc\_wordEditing;
* Range extension sequences: EBUHorse (4:2:2), EBUWaterRocks (4:2:2), BirdsInCage (4:4:4 YCbCr), and EBURainFruits (4:4:4 YCbCr).

For all RCE2 test, the following configurations are required to achieve lossless coding and also allow comparison between anchor and target tests.

* QP=0
* TransquantBypassEnableFlag=1
* CUTransquantBypassFlagForce=1

For the RGB sequences, the GBR channel order will be used in the encoding process. Thus the following configuration shall be used when encoding the RGB sequences:

* --InputColourSpaceConvert=RGBtoGBR
* --SNRInternalColourSpace=1 (optional)
* --OutputInternalColourSpace=0 (optional)

Note that the setting for SNRInternalColourSpace and OutputInternalColourSpace are optional since they won’t affect the coding performance.

In addition, the following test cases are mandatory for RCE2 experiments:

* AI-main
* LB-main
* RA-main

Other test cases, such as AI-main10, LB-main10, RA-main10, etc., are optional.

* 1. Evaluation of CE Results

Results of the CE will be evaluated on the basis of bit rate and complexity. Complexity assessment is performed on the base of hardware and encoding/decoding complexity.

### Complexity assessment

To measure software run time, HM 10.0-RExt-2.0 software with the anchor configuration (the default frame level lossless coding is turned on) and the proposals implemented on the HM 10.0-RExt-2.0 software shall be used. The computational time must be measured for each test sequence and test case for both anchor and proposals. Relative computational time calculated against the anchor must be presented.

In addition to the simulation time, the following two metrics shall be provided to measure the decoding implementation complexity.

* Number of operations to decode one sample
* Throughput (e.g. number of residual samples or pixels which can be decoded in parallel)

Additional evaluation of the HW and SW complexity of the proposed tools for both encoder and decoder is encouraged.

# Timeline

* 04-Feb-2013: HM-10.0 available.
* 06-Feb-2013: CE description finalized and uploaded.
* 19-Feb-2013: HM 10.0-RExt-2.0 available.
* 22-Feb-2013: Lossless coding test sequences and test cases are finalized by AhG8
* 11-Mar-2013: Cross-check begins: Proponents provide software, draft of contribution text and results to CE participants.
* 05-Apr-2013: Input documents and summary report uploaded.