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| *Title:* | **CE on Entropy Coding for High Bit Depth and High Bit Rate Coding** | | |
| *Status:* | Output document of JVET | | |
| *Purpose:* | Core Experiment description | | |
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| *Source:* | CE coordinators | | |

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# Abstract

The goal of this Core Experiment (CE) is to conduct a study of Rice parameter derivation proposals submitted to the T meeting of JVET.

Participants in this activity are Kwai, Qualcomm, Sharp and Sony.

The software basis for this CE is VTM-11.0rc1 or later. For the test sequences, configurations and test conditions, the High Bit-depth CTC described in JVET-T2018 is used, unless otherwise specified in the CE description.

# Participants

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# Test conditions and evaluation criteria

The proposals will be tested under the High Bit-Depth CTC specified in 0 in both lossy and lossless configurations. In addition to the sequences included in the CTC, the sequences FireEater2Clip4000r1\_1920x1080p\_25\_12b\_pq\_709\_ct2020\_444 and FireEater2Clip4000r1\_1920x1080p\_25\_12b\_pq\_709\_ct2020\_422 are included in the test sequences as they they have both light and dark areas and thus will have a large variation in coefficient values. This will allow the assessment of adaption techniques. An updated spreadsheet containing the additional sequences will be made available at the same time as the final CE text.

Planned tests in the CE shall be implemented on, and compared with, VTM-11.0rc1 with the modification described in JVET-T2018[1] to enable high bit depth processing. For 16 bit testing, extended precision processing will be enabled, and all results will be compared with an anchor with the same setting. For 12 bit testing, extended precision will be disabled and the results will be compared with an anchor with extended precision disabled.

Transform skip settings will follow CTC settings for all tests.

Proposals will be compared with respect to bit rate, objective quality and complexity. To provide an indication of complexity, comparative run-times for encoding and decoding will be used. In addition, throughput issues should be considered, in particular any change to the bin to bit ratio.

If a proposal changes coding for 8 or 10 bit sources, additional VVC 10 bit CTC results shall be provided.

# Proposals descriptions

## Rice parameter selection for high bit depths (JVET-T0072)

The proposal JVET-T0072 introduces a modification to the VVC Rice parameter derivation method for both regular residual coding (RRC) and transform skip residual coding (TSRC). The modification extends the existing VVC Rice parameter deriviation method by adding an adaption technique based on selecting one of a series of counters. These counters predict the log2 size of each coefficient being coded. The counters are incremented whenever a coefficient is coded which is greater than predicted and decremented whenever a coefficient is less than predicted. When coding a coefficient the log2 predicted size is then used to derive a suitable number of bits to shift right the computed value of *locSumAbs*. This shift is then added to the rice value derived from the lookup table *g\_auiGoRiceParsCoeff*. TSRC is modified to use a similar method to RRC but with locSumAbs computed from five previously coded coefficients to the top left of the current coefficient rather than five to the bottom right.

In addition to the basic technique JVET-T0072 also describes a simplification which reduces both the number of updates of the counters and the regularity of the derivation of predicted values. In addition to the simplification described in JVET-T0072, the simplification for TSRC will in addition replace the use of *locSumAbs* and *g\_auiGoRiceParsCoeff* with a simple offset based on the prediction from the counters.

## Rice parameter derivation for high bit depths (JVET-T0085)

The proposal of JVET-T0085 introduces a modification to the VVC Rice parameters derivation method for regular residual coding (RRC). It is proposed to use a formula instead of conventional look-up table. Specifically, the rice parameter value is predicted based on an adjusted value of the *locSumAbs* using linear prediction with log2 operation. The linear prediction calicurate floorLog2(a \* *locSumAbs* + b) + c. The linear prediction parameter (a, b and c) depend on syntax (i.e. abs\_reminder or dec\_abs\_level). An enablied flag for the proposed method is signalled in SPS. This flag doesn’t affect the process if bitdepth is equal or less than 10.

## Slice based Rice parameter selection for transform skip residual coding (JVET-T0089)

The proposal of JVET-T0089 introduces a modification to the VVC Rice parameters derivation method for transform skip residual coding (TSRC). It is proposed to explicitly signal the Rice parameter for each slice to indicate the Rice parameter for the binary codewords of abs\_remainder. In the proposed method, one control flag is signaled in sequence parameter set to indicate the signaling of Rice parameter for the transform skip blocks is enabled or disabled. When the control flag is signaled as enabled, one syntax element is further signaled for each transform skip slice to indicate the Rice parameter of that slice. When the control flag is signaled as disabled (e.g. set equal to “0”), no further syntax element is signaled at lower level to indicate the Rice parameter for the transform skip slice and a default Rice parameter (e.g. 1) is used for all the transform skip slice.

## On the Rice parameter derivation for high bit-depth coding (JVET-T0105)

The proposal of JVET-T0105 introduces a modification to the VVC Rice parameters derivation method for regular residual coding (RRC). It is proposed for high bitdepth coding to derive rice parameters based on a adjusted value of the *locSumAbs*. Firstly, the *locSumAbs* is scalled/normalized by a scalling factor which derived from signalled syntax ellements and local coefficient activity. Secondly, adjusted localSumAbs value is used to derive Rice parameter via look-up table (Table 128) as in VVC. And finally, Rice parameter is updated using the scaling factor. Parameters controlling the locSumAbs scaling/normalization and Rice parameter update are expressed through thresholds against which locSumAbs is compared and scaling factors/Rice update value. Amount of adjustment (adjustment parameters) can be determined either globally, outside of the currently coded block, directly from signalled parameters, bitdepth, or being locally adaptive, depending on locSumAbs value within currently coded block.

# Planned tests

## Tests on proposed regular residual coding.

|  |  |  |
| --- | --- | --- |
| **Test** | **Proponent(s)** | **Cross-checker(s)** |
| *CE-1.1* | Qualcomm | Sony |
| *CE-1.2* | Qualcomm | Sony |
| *CE-1.3* | Sharp | Kwai |
| *CE-1.4* | Sony | Qualcomm |
| *CE-1.5* | Sony | Qualcomm |

## Tests on proposed transform skip residual coding.

|  |  |  |
| --- | --- | --- |
| **Test** | **Proponent(s)** | **Cross-checker(s)** |
| CE-2.1 | Kwai | Sharp |
| CE-2.2 | Sony | Kwai |
| CE-2.3 | Sony | Kwai |

# Combination Tests

Following the completion of the initial experiments for RRC (CE-1) and TSRC (CE-2), one or more combinations of the experiments will be tested. The deadline for determining the number of combinations and the components being combined is T4. Cross-checkers for the combination tests will also be determined by T4.

|  |  |  |
| --- | --- | --- |
| **Test** | **Proponent(s)** | **Cross-checker(s)** |
| CE-3.1 | Sharp | TBD |
| CE-3.2 | Sony | TBD |
| CE-3.3 | Sony | TBD |
| CE-3.4 | Qualcomm | TBD |
| CE-3.5 | Qualcomm | TBD |
| CE-3.6 | Qualcomm | TBD |

# Tests description:

## CE-1.1: Method of JVET-T0105 without locally adaptivity

In this test, method proposed in JVET-T0105 with globally derived adjusment for rice parameter derivation is being evaluated. Adjustment parameters are determined from signalled syntax elemments, without local adaptation within a block (no dependency on locSumAbs). Two subtests are planned:

* **Test CE-1.1.a:** SPS-level control information is used to derive adjustment parameters.
* **Test CE-1.1.b:** Syntax elements controlling adjustment parameters are signalled at the sub-SPS levels, e.g. at slice level.

## CE-1.2: Method of JVET-T0105 with local adaptivity

In this test, method proposed in JVET-T0105 with locally adaptive adjusment for Rice parameter derivation is being evaluated. Adjustment parameters are determined from signalled syntax elemments, and updated locally, depending on locSumAbs value within currently coded block.

## CE-1.3: Method of JVET-T0085.

For this experiment, method proposed in JVET-T0085, it is proposed to use a formula instead of conventional look-up table for RRC, is evaluated.

## CE-1.4: Method of JVET-T0072 with standard TSRC

The RRC component of the method proposed in JVET-T0072 with rice parameter adaption based on previously coded coefficients. For this experiment the TSRC component of the modification described in JVET-T0072 is disabled and standard VVC TSRC is used.

## CE-1.5: Method of JVET-T0072 with simplification and standard TSRC

The RRC component of the simplification proposed in JVET-T0072 of the technique described in CE-1.4. For this experiment the TSRC component of the modification described in JVET-T0072 is disabled and standard VVC TSRC is used.

## CE-2.1: Method of JVET-T0089

Method proposed in JVET-T0089, it is proposed to explicitly signal the Rice parameter for each slice to indicate the Rice parameter for the binary codewords of abs\_remainder. In the proposed method, one control flag is signaled in sequence parameter set to indicate the signaling of Rice parameter for the transform skip blocks is enabled or disabled. When the control flag is signaled as enabled, one syntax element is further signaled for each transform skip slice to indicate the Rice parameter of that slice. When the control flag is signaled as disabled (e.g. set equal to “0”), no further syntax element is signaled at lower level to indicate the Rice parameter for the transform skip slice and a default Rice parameter (e.g. 1) is used for all the transform skip slice.

## CE-2.2: Method of JVET-T0072 with standard RRC

The TSRC component of the method proposed in JVET-T0072 with rice parameter adaption based on previously coded coefficients. For this experiment the RRC component of the modification described in JVET-T0072 is disabled and standard VVC RRC is used.

## CE-2.3: Method of JVET-T0072 with simplification and standard RRC

The TSRC component of the simplification proposed in JVET-T0072 of the technique described in CE-2.2. In addition, this experiment replaces the usage of locSumAbs and *g\_auiGoRiceParsCoeff* with an offset derived from the value of the selected counter. For this experiment the RRC component of the modification described in JVET-T0072 is disabled and standard VVC RRC is used.

## CE-3.1: Combination of CE-1.3 and CE-2.1

This experiment will test the combination of CE-1.3 and CE-2.1.

## CE-3.2: Combination of CE-1.5 and CE-2.1

This experiment will blend the RRC coding modifications from CE-1.5 with the TSRC coding modifications in CE-2.1.

## CE-3.3: Combination of CE-1.5 and CE-2.3

This experiment will blend the RRC coding modifications from CE-1.5 with the TSRC coding modifications in CE-2.3. The counter update method will be taken from CE-2.2 (the counter update simplification in CE-2.3 will not be applied).

## CE-3.4: Combination of CE-1.2 and CE-2.1

This experiment will blend the RRC coding modifications from CE-1.2.a with the TSRC coding modifications in CE-2.1.

## CE-3.5: Combination of CE-1.2 and CE-1.4/1.5

This experiment will investigate integration of the classification ellements of CE-1.4/1.5 with rice parameter inheritance mechanism and the Rice parameter derivation of the CE-1.2.b.

## CE-3.6: Combination of CE-1.3 and CE-3.5

This experiment will investigate integration of Rice parameter derivation method of CE1.3 with with Rice parameter inheritance mechanism of the CE1.2.b modified with classification ellements of CE-1.4/1.5.

# Time-line and Responsibilities

T1: 2020-October-30: Final CE description uploaded. Any changes of planned tests after this time need to be announced and discussed on the JVET reflector. Initially assigned description numbers shall not be changed later. If a test is skipped, it is to marked as "withdrawn".

T2: 2020-November 27: Integration of all tools into a separate CE branch of the VTM is completed and initial study by cross-checkers begins.

T3: 2020- December-9: Final version of CE software and full results are provided, final cross-check begins.

T4: 2020- December-16: Combination test are decided and corresponding cross-check begins.

T5: 2020-December-30: CE contribution documents including specification text and complete test results are uploaded to the JVET document repository.

# References

[1] A. Browne, T. Ikai, D.  Rusanovskyy, X. Xiu, “Common test conditions for high bit depth and high bit rate video coding”, JVET-T2018, JVET, 20th Meeting: by teleconference, 7-16 Oct. 2020