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| --- | --- | --- | --- |
| *Title:* | A combined proposal from JCTVC-G366, JCTVC-G657, and JCTVC-G768 on context reduction of significance map coding with CABAC | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

This contribution combines the contributions on significant\_coeff\_flag context reduction in JCTVC-G366 from Sony, JCTVC-G657 from RIM, and JCTVC-G768 from Samsung to provide 40 context reductions. The combined proposal resulted in an average BD-Rate of 0.0% for all test cases except I\_HE at QP=12,17, 22, 27 with BD-Rate of 0.1% as specified in the testing conditions in CE11 for context modeling/selection for transform coefficient related syntax elements. This contribution also demonstrated that the proposed significance map context reduction can work with level context reduction such as the CE11 JCTVC-G121 with 0.0% BD-rate difference except 0.1% additional BD-Rate for I\_HE at Low QP and RDOQ-off.

# Introduction

The JCTVC-G366[1], JCTVC-G657[2], and JCTVC-G768[3] proposed significant\_coeff\_flag context reduction with CABAC. There are many commonality in the approaches used in these three proposals. In light of the commonalities, the proponents worked together to identify the combination of the three proposals [1,2,3] with minimal impact on BDR that resulted in more total context reductions than that their individual proposal achieved.

# Joint proposal

In particular, this contribution proposes the following combination of context reduction for a total of 40 context reductions:

* 15 context reduction of 4x4 blocks from JCTC-G657 [2].
* 10 context reduction of 8x8 blocks from JCTC-G366 [1].
* 15 context reduction of 16x16/32x32 blocks from JCTVC-G768 [3].

# WD text

The corresponding technical and WD descriptions are in [2, 1, 3] respectively.

# Simulation results

The context reductions were integrated into HM4.0 with and without the level context reductions from CE11 JCTVC-G121/F132 [4, 5].

As shown in **Table 1**, the combined proposal resulted in an average BD-Rate of 0.0% for all test cases except the 0.1% BD-Rate for I\_HE at QP = 12, 17, 22, 27.

As shown in **Table 2**, when the proposed 40 significance map context reductions were combined with the 36 level contexts reductions from CE11 JCTVC-G121/F132 [4,5] for a total of 76 context reductions, the BD-Rate for I\_HE become 0.1%, 0.2%, 0.1% for normal QP, low QP and RDOQ-off respectively. The impact on BDR for other test cases was less. In particular, the BD-rate for RA\_HE and LB\_HE became 0.0%, 0.0%, 0.0% for normal QP, low QP and RDOQ-off respectively. The BD-rate for LP\_HE became 0.1%, 0.0%, 0.0% for normal QP, low QP and RDOQ-off respectively.

TI kindly agreed to provide the crosscheck for this joint proposal.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | ***All Intra HE*** | | | ***All Intra (Low QP)*** | | | ***All Intra (RDOQ off)*** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A | 0.1% | 0.3% | 0.4% | 0.1% | 0.1% | 0.1% | 0.1% | 0.3% | 0.2% |
| Class B | 0.0% | 0.2% | 0.1% | 0.1% | 0.1% | 0.2% | 0.0% | 0.2% | 0.2% |
| Class C | 0.0% | 0.1% | 0.1% | 0.0% | 0.0% | 0.1% | 0.0% | 0.1% | 0.1% |
| Class D | 0.0% | 0.1% | 0.1% | 0.0% | 0.1% | 0.1% | 0.0% | 0.0% | 0.1% |
| Class E | 0.1% | 0.1% | 0.1% | 0.1% | 0.1% | 0.2% | 0.0% | 0.4% | 0.3% |
| Class F |  |  |  |  |  |  |  |  |  |
| **Overall** | 0.0% | 0.1% | 0.2% | 0.1% | 0.1% | 0.1% | 0.0% | 0.2% | 0.2% |
|  | 0.0% | 0.1% | 0.1% | 0.1% | 0.1% | 0.1% | 0.0% | 0.2% | 0.2% |
| Enc Time[%] | 100% | | | 100% | | | 100% | | |
| Dec Time[%] | 102% | | | 101% | | | 100% | | |
|  |  |  |  |  |  |  |  |  |  |
|  | **Random Access HE** | | | **Random Access (Low QP)** | | | **Random Access(RDOQ off)** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A | -0.1% | 0.4% | 0.6% | 0.0% | 0.2% | 0.3% | 0.0% | 0.0% | 0.1% |
| Class B | 0.0% | 0.1% | 0.0% | 0.1% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| Class C | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Class D | 0.0% | 0.3% | -0.1% | -0.1% | 0.0% | -0.2% | 0.0% | 0.0% | -0.3% |
| Class E |  |  |  |  |  |  |  |  |  |
| Class F |  |  |  |  |  |  |  |  |  |
| **Overall** | 0.0% | 0.2% | 0.1% | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
|  | 0.0% | 0.1% | 0.1% | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| Enc Time[%] | 100% | | | 100% | | | 100% | | |
| Dec Time[%] | 101% | | | 100% | | | 97% | | |
|  |  |  |  |  |  |  |  |  |  |
|  | **Low delay B HE** | | | **Low delay B (Low QP)** | | | **Low delay B (RDOQ off)** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |  |  |  |
| Class B | 0.0% | -0.1% | -0.2% | 0.0% | 0.0% | -0.1% | 0.0% | -0.3% | -0.3% |
| Class C | 0.1% | -0.1% | -0.2% | 0.0% | 0.0% | -0.1% | 0.0% | 0.1% | -0.2% |
| Class D | 0.0% | 0.4% | -0.3% | 0.0% | -0.1% | -0.2% | 0.0% | -1.1% | -0.3% |
| Class E | 0.0% | -0.4% | 0.1% | 0.0% | -0.3% | -0.1% | 0.0% | -0.3% | 0.3% |
| Class F |  |  |  |  |  |  |  |  |  |
| **Overall** | 0.0% | 0.0% | -0.2% | 0.0% | -0.1% | -0.1% | 0.0% | -0.4% | -0.2% |
|  | 0.0% | 0.0% | -0.3% | 0.0% | -0.1% | -0.2% | 0.0% | -0.4% | -0.2% |
| Enc Time[%] | 100% | | | 100% | | | 100% | | |
| Dec Time[%] | 101% | | | 100% | | | 101% | | |
|  |  |  |  |  |  |  |  |  |  |
|  | **Low delay P HE** | | | **Low delay P (Low QP)** | | | **Low delay P (RDOQ off)** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |  |  |  |
| Class B | 0.0% | -0.1% | 0.3% | 0.0% | 0.0% | -0.1% | 0.0% | -0.3% | -0.4% |
| Class C | 0.1% | -0.1% | -0.2% | 0.0% | 0.0% | -0.1% | 0.0% | -0.1% | -0.1% |
| Class D | 0.1% | -0.3% | -0.6% | 0.0% | -0.1% | -0.3% | 0.0% | -1.0% | -0.6% |
| Class E | 0.0% | -0.1% | -0.8% | 0.0% | -0.3% | -0.3% | 0.0% | -1.0% | -0.5% |
| Class F |  |  |  |  |  |  |  |  |  |
| **Overall** | 0.0% | -0.2% | -0.3% | 0.0% | -0.1% | -0.2% | 0.0% | -0.6% | -0.4% |
|  | 0.0% | -0.1% | -0.4% | 0.0% | -0.1% | -0.2% | 0.0% | -0.5% | -0.5% |
| Enc Time[%] | 100% | | | 100% | | | 100% | | |
| Dec Time[%] | 100% | | | 100% | | | 101% | | |

**Table 1: The 40 context reduction proposed in this contribution resulted in average BD-Rate of 0.0% for all test cases in the common test conditions.**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **All Intra HE** | | | **All Intra (Low QP)** | | | **All Intra (RDOQ off)** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A | 0.1% | 0.3% | 0.4% | 0.2% | 0.2% | 0.2% | 0.1% | 0.3% | 0.3% |
| Class B | 0.1% | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% | 0.1% | 0.2% | 0.2% |
| Class C | 0.1% | 0.2% | 0.2% | 0.1% | 0.1% | 0.2% | 0.0% | 0.1% | 0.1% |
| Class D | 0.1% | 0.2% | 0.2% | 0.1% | 0.2% | 0.2% | 0.0% | 0.1% | 0.1% |
| Class E | 0.1% | 0.1% | 0.2% | 0.2% | 0.2% | 0.3% | 0.1% | 0.4% | 0.3% |
| Class F |  |  |  |  |  |  |  |  |  |
| **Overall** | 0.1% | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% | 0.1% | 0.2% | 0.2% |
|  | 0.1% | 0.2% | 0.2% | 0.2% | 0.2% | 0.2% | 0.1% | 0.2% | 0.2% |
| Enc Time[%] | 100% | | | 100% | | | 100% | | |
| Dec Time[%] | 101% | | | 100% | | | 100% | | |
|  |  |  |  |  |  |  |  |  |  |
|  | **Random Access HE** | | | **Random Access (Low QP)** | | | **Random Access(RDOQ off)** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A | -0.1% | 0.4% | 0.3% | 0.0% | 0.2% | 0.3% | 0.0% | -0.1% | 0.0% |
| Class B | 0.0% | 0.1% | 0.2% | 0.1% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% |
| Class C | 0.0% | -0.1% | 0.1% | 0.0% | 0.0% | 0.1% | 0.0% | 0.0% | -0.1% |
| Class D | 0.1% | 0.0% | -0.2% | 0.0% | 0.0% | -0.3% | 0.1% | -0.2% | -0.1% |
| Class E |  |  |  |  |  |  |  |  |  |
| Class F |  |  |  |  |  |  |  |  |  |
| **Overall** | 0.0% | 0.1% | 0.1% | 0.0% | 0.1% | 0.0% | 0.0% | 0.1% | 0.0% |
|  | 0.0% | 0.1% | 0.1% | 0.0% | 0.1% | 0.0% | 0.0% | 0.1% | 0.1% |
| Enc Time[%] | 100% | | | 100% | | | 100% | | |
| Dec Time[%] | 100% | | | 100% | | | 97% | | |
|  |  |  |  |  |  |  |  |  |  |
|  | **Low delay B HE** | | | **Low delay B (Low QP)** | | | **Low delay B (RDOQ off)** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |  |  |  |
| Class B | 0.0% | -0.2% | -0.3% | 0.1% | 0.1% | -0.1% | 0.0% | -0.1% | -0.4% |
| Class C | 0.1% | -0.2% | -0.1% | 0.0% | -0.1% | -0.1% | 0.1% | 0.0% | -0.2% |
| Class D | 0.0% | -0.1% | -0.5% | 0.0% | -0.1% | -0.1% | 0.0% | -0.7% | -0.7% |
| Class E | 0.1% | -0.5% | 0.1% | 0.0% | -0.5% | -0.1% | -0.1% | -1.0% | -0.1% |
| Class F |  |  |  |  |  |  |  |  |  |
| **Overall** | 0.0% | -0.3% | -0.2% | 0.0% | -0.1% | -0.1% | 0.0% | -0.4% | -0.4% |
|  | 0.0% | -0.2% | -0.2% | 0.0% | -0.2% | -0.1% | 0.0% | -0.4% | -0.3% |
| Enc Time[%] | 100% | | | 100% | | | 100% | | |
| Dec Time[%] | 101% | | | 100% | | | 100% | | |
|  |  |  |  |  |  |  |  |  |  |
|  | **Low delay P HE** | | | **Low delay P (Low QP)** | | | **Low delay P (RDOQ off)** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A |  |  |  |  |  |  |  |  |  |
| Class B | 0.0% | 0.0% | -0.3% | 0.1% | 0.1% | -0.1% | 0.0% | -0.3% | -0.5% |
| Class C | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | -0.3% | -0.2% |
| Class D | 0.1% | -0.1% | -0.6% | 0.0% | -0.1% | -0.2% | 0.0% | -0.8% | -1.1% |
| Class E | 0.2% | -0.1% | -0.1% | 0.1% | 0.0% | 0.3% | 0.0% | -1.3% | 0.4% |
| Class F |  |  |  |  |  |  |  |  |  |
| **Overall** | 0.1% | 0.0% | -0.3% | 0.0% | 0.0% | 0.0% | 0.0% | -0.6% | -0.4% |
|  | 0.1% | 0.0% | -0.3% | 0.0% | 0.0% | 0.0% | 0.0% | -0.5% | -0.4% |
| Enc Time[%] | 100% | | | 100% | | | 100% | | |
| Dec Time[%] | 101% | | | 100% | | | 101% | | |

**Table 2: BD-Rate of 76 context reduction: the proposed 40 significance map context reductions combined with 36 level context reductions from JCTVC-G121.**

# Summary

This contribution reduced 40 contexts for the coding of significance map with CABAC and resulted in the average luminance BD-Rate in Table 3:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | I\_HE | RA\_HE | LB\_HE | LP\_HE |
| QP(22,27,32,37) | 0.0 | 0.0 | 0.0 | 0.0 |
| LQP(12,17,22,27) | 0.1 | 0.0 | 0.0 | 0.0 |
| RDOQ-OFF | 0.0 | 0.0 | 0.0 | 0.0 |

Table 3: Average BD-Rate of the proposed 40 significance map context reduction.

When this contribution is combined with the 36 level context reductions from CE11 [6] on JCTVC-G121/F132 [4, 5] for a total of 76 context reductions, the BD-Rate became the results in Table 4.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | I\_HE | RA\_HE | LB\_HE | LP\_HE |
| QP(22,27,32,37) | 0.1 | 0.0 | 0.0 | 0.1 |
| LQP(12,17,22,27) | 0.2 | 0.0 | 0.0 | 0.0 |
| RDOQ-OFF | 0.1 | 0.0 | 0.0 | 0.0 |

Table : Average BD-Rate of proposed significance map context reduction combined with level context reduction from JCTVC-G121/F132 for a total of 76 context reductions.

As reference, the BD-Rate results from JCTVC-G121 are shown in Table 5.

|  |  |  |  |
| --- | --- | --- | --- |
|  | I\_HE | RA\_HE | LD\_HE |
| QP(22,27,32,37) | 0.1 | 0.0 | 0.0 |
| LQP(12,17,22,27) | 0.1 | 0.0 | 0.0 |
| RDOQ-OFF | 0.0 | 0.0 | 0.0 |

Table : Average BD-Rate of JCTVC-G121 for 36 level context reduction as benchmark.

By comparing the results in Table 4 and Table 5, this contribution demonstrated that the proposed significance map context reduction can work with level context reduction in JCTVC-G121 with at the most 0.1% BDR in three out of 12 test cases.

# References

1. Cheung Auyeung and Jun Xu, “Description Context reduction of significance map coding with CABAC”, JCTVC-G366, 7th Meeting: Geneva, CH, 21-30 November, 2011.
2. Gergely Korodi, Jinwen Zan, and Da-ke He, “Encoding and decoding significant coefficient flags for small Transform Units using partition sets”, JCTVC-G657, 7th Meeting: Geneva, CH, 21-30 November, 2011.
3. Yinji Piao, Junghye Min, and JeongHoon Park, “Reduced contexts for significance map coding of large transform in CABAC”, JCTVC-G768, 7th Meeting: Geneva, CH, 21-30 November, 2011.
4. Vivienne Sze, “Reduction in contexts used for significant\_coeff\_flag and coefficient level”, JCTVC-F132, 6th Meeting: Torino, IT, 14-22 July, 2011.
5. Vivienne Sze, “CE11: Reduction in contexts used for coefficient level”, JCTVC-G121, 7th Meeting: Geneva, CH, 21-30 November, 2011.
6. Vivienne Sze, Tung Nguyen, Jianle Chen, Joel Sole, Krit Panusopone, “Description of Core Experiment (CE11): Coefficient scanning and coding”, JCTVC-F911, 6th Meeting: Torino, IT, 14-22 July, 2011.

# Patent rights declaration(s)

**Sony Electronics Inc. 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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