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| *Title:* | **AHG18: Limiting the worst-case length for coeff\_abs\_level\_remaining syntax element to 32 bits** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal, Information | | |
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# Abstract

This contribution proposes a modification of the binarization for the coeff\_abs\_level\_remaining syntax element. The number of prefix bits is restricted depending upon *MAX\_TR\_DYNAMIC\_RANGE* and a truncated unary representation is used for the prefix. The suffix bits are suitably modified for the highest suffix. It is asserted that with this modification, the length of the coeff\_abs\_level\_remaining syntax in the worst-case is limited to 32. The impact on BD-rate performance is reported to be negligible (less than 0.02%) for AHG18 common test conditions.

# Introduction

In HEVC main and main10 profiles, the length of the coeff\_abs\_level\_remaining syntax element is restricted to 32 bits in the worst-case. This is considered desirable for implementation in hardware as well as in software. In HEVC, irrespective of the bit-depth a video component, the transform coefficients are restricted to be in a 16-bit range (from -215 to (215-1), inclusive). Taking the significance map into account, the largest possible value for coeff\_abs\_level\_remaining syntax element is (215-1).

However in the current HEVC range extensions specification, the range of transform coefficients when using extended precision is -2(B+6) to 2(B+6)-1, inclusive, where B is the bit-depth a video component. For example, when using extended precision, for a 16-bit video component, the range of transform coefficients is -222 to 222-1, inclusive. In this case, the Golomb-Rice/Exponential-Golomb method used for coding coeff\_abs\_level\_remaining syntax element produces worst-case length of 46 bits, which occurs when cRiceParam is 0.

JCTVC-P0061 proposed a method to restrict the worst-case length for coeff\_abs\_level\_remaining syntax element to 32 bits. But an additional table was needed and the binarization was a bit different from the existing HEVC binarization.

# Proposed Method

In the current HEVC range extension specification, *MAX\_TR\_DYNAMIC\_RANGE* for a video component is defined as

*MAX\_TR\_DYNAMIC\_RANGE* = *Max(15, B+6)*, where *B* is the bit-depth of a video component.

Let

*max\_suffix\_length* = *MAX\_TR\_DYNAMIC\_RANGE*

*MAX\_TR\_DYNAMIC\_RANGE* also represents the maximum number of bits needed to represent the value of a coeff\_abs\_level\_remaining syntax element that may be present in a conforming bit-stream. This takes into account the fact that the significance value for a coefficient is sent separately. Also, let

*max\_prefix\_length = 32 – max\_suffix\_length*.

Thus, for 16-bit video component, *max\_suffix\_length* is 22 and *max\_prefix\_length* is 10. We propose the use of truncated unary representation for representing the prefix, where the maximum prefix length is *max\_prefix\_bits*. For the highest prefix (represented by 1111 …), the suffix length is set to *max\_suffix\_bits*. Table 1 and 2 show an examples of the binarization for video component bit-depth = 16.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Input Value | Codeword prefix | Codeword suffix | Prefix code length | Suffix code length | Total codeword length |
| 0 | 0 |  | 1 | 0 | 1 |
| 1 | 10 |  | 2 | 0 | 2 |
| 2 | 110 |  | 3 | 0 | 3 |
| 3 | 1110 |  | 4 | 0 | 4 |
| [4, 5] | 11110 | x | 5 | 1 | 6 |
| [6, 9] | 111110 | xx | 6 | 2 | 8 |
| [10, 17] | 1111110 | xxx | 7 | 3 | 10 |
| [18, 33] | 11111110 | xxxx | 8 | 4 | 12 |
| [34, 65] | 111111110 | xxxxx | 9 | 5 | 14 |
| [66, 129] | 1111111110 | xxxxxx | 10 | 6 | 16 |
| [130, 4194433] | 1111111111 | xxx … 22 times | 10 | 22 | 32 |

Table 1: Proposed binarization for bit-depth = 16, cRiceParam = 0

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Input Value | Codeword prefix | Codeword suffix | Prefix code length | Suffix code length | Total codeword length |
| [0, 3] | 0 | xx | 1 | 2 | 3 |
| [4, 7] | 10 | xx | 2 | 2 | 4 |
| [8, 11] | 110 | xx | 3 | 2 | 5 |
| [12, 15] | 1110 | xx | 4 | 2 | 6 |
| [16, 23] | 11110 | xxx | 5 | 3 | 8 |
| [24, 39] | 111110 | xxxx | 6 | 4 | 10 |
| [40, 71] | 1111110 | xxxxx | 7 | 5 | 12 |
| [72, 135] | 11111110 | xxxxxx | 8 | 6 | 14 |
| [136, 263] | 111111110 | xxxxxxx | 9 | 7 | 16 |
| [264, 519] | 1111111110 | xxxxxxxx | 10 | 8 | 18 |
| [520, 4194823] | 1111111111 | xxx … 22 times | 10 | 22 | 32 |

Table 2: Proposed binarization for bit-depth = 16, cRiceParam = 2

# Simulation Results

The proposal was implemented on top of HM13.0\_RExt6.0. Simulations are performed under AHG18, test conditions. The performance is compared to the anchor in terms of BD-rate savings. The simulations were performed on a LINUX cluster (SUSE 10.4) with gcc v4.1.2 (64 bit). The CPUs were Intel Xeon E5 2680 16-core CPUs (2.7GHz) with 64 GB (shared) memory for a cluster node. Table 3 shows the BD-rate performance under AHG18 lossless test conditions. Table 4 shows the BD-rate performance under AHG18 lossy test conditions.



Table 3: Bit rate changes for the proposed method (anchor: HM13.0\_RExt6.0) under AHG18 lossless test conditions





Table 4: BD-rate for the proposed method (anchor: HM13.0\_RExt6.0) under AHG18 lossy test conditions

# Conclusions

A modification to the binarization for the coeff\_abs\_level\_remaining syntax element is proposed. The number of prefix bits is restricted depending upon *MAX\_TR\_DYNAMIC\_RANGE* and a truncated unary representation is used for the prefix. The suffix bits are suitably modified for the highest suffix to accommodate all conforming values of the coeff\_abs\_level\_remaining syntax element. It is asserted that with this modification, the length of the coeff\_abs\_level\_remaining syntax in the worst-case is limited to 32. The impact on BD-rate performance is reported to be negligible (less than 0.02%) for AHG18 common test conditions.

# Patent rights declaration(s)

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