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| *Title:* | **AHG4: Harmonized Method for Signalling Entry Points of tiles and WPP Substreams** | | |
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# Abstract

In the last meeting, a harmonized method for signaling entry points for tiles and wavefront parallel processing was proposed (JCTVC-G722). Here, we provide new results with improvements on the method. Specifically, the proposal contains the following features: (1) unified syntax and semantics for tiles and WPP entry points, (2) byte alignment of the WPP substreams to facilitate signaling all entry points as bytes, (3) coding the entry point offsets as u(v), and (4) simplifying the signaling of the entry\_point\_type flag.

It is claimed that the proposed unified syntax and semantic for tiles’ and WPP substreams’ entry points provides simpler signaling method rather than having separate signaling method for tiles and WPP substreams. It is also reported that the remaining modifications improve signaling efficiency by requiring less bits compare to current method of signaling WPP substreams’ and tiles’ entry points, respectively. Gains because of these modifications are about 0.1% for Y, Cb, and Cr for all configurations except intra only.

# Introduction

In Torino meeting, both tiles and WPP technologies were adopted. In addition, for each technology, entry points signaling methods were defined. Entry point signaling allows for decoder parallelization, as a decoder may begin operating at different locations in the bit-stream (indicated by the entry points) in parallel. There are a lot of similarities in the current design of signaling entry points of tiles and WPP; furthermore, tiles and WPP may be used together in which each tiles can have one or more WPP substreams in it. Thus, it is desirable to harmonize the method for signaling entry points of tiles and WPP substreams.

A method for harmonizing the signaling entry points of tiles and WPP substreams was proposed in [1] in the 7th JCT-VC meeting. This document provides new results and improvements of the technique. Specifically, the following changes include:

1. It is proposed that the length of WPP substream should be byte-aligned so that it can be expressed as number of bytes. This will make it the expression of the length of encoded data in WPP substreams and tiles the same, which is in the number of bytes.
2. It is proposed that for the unified entry point signaling solution, the entry point offset expresses the length (i.e., number of bytes) of encoded data between two entry points instead of delta length as currently used by signaling of tiles’ entry points.

The proposed changes to achieve harmonized / unified method for signalling entry points of tiles and WPP substreams are described in the following section.

# Proposed changes

## Byte-aligning the length of WPP substreams

### Padding end of WPP substreams

Since currently the length of WPP substreams is not byte-aligned, we propose to append additional bits at the end of the substream for byte-alignment. Therefore, the length of each substream can be expressed in bytes, not in bits, as illustrated in Figure 1.

A1

A2

A3

A4

A5

A6

A7

A8

B1

B2

B3

B4

B5

B6

B7

B8

**LCU order in bitstream**

**Entry point for WPP**

**substream0**

**Entry point for WPP**

**substream1**

**Length in bytes**

**Length in bytes**

**Byte-aligned bits**

**Byte-aligned bits**

Figure 1 – Byte-aligned WPP substreams

The additional bit padding at the end of WPP substreams achieves byte-alignment at the expense of an increased bit overhead. However, this bit overhead may be compensated by saving 3 bits in the signaling the length of each substream (i.e., 3 bits reduction since we now can expressed the length in byte, not bit). Experimental results provided in Section 3.1.1 shows that, by using current signaling method of WPP substreams’ entry point, this additional bit padding to make WPP substreams byte-aligned imposes very little compression efficiency loss.

### Modification to WPP substreams entry point signaling

Current WPP substreams’ length (i.e., ‘substream\_length [i]’) are coded with u(v) in which the number of bits is determined by ‘substream\_length\_mode’ that give indication to decoder to use either 8, 16, 24, or 32 bits to store substream length information. When using a fixed number of bits to store length information, the anticipated 3 bits saving for changing WPP substreams’ length from bit to byte granularity may not be realized. For example, suppose that we originally needed 12 bits to signal substream\_length [i]; given the current signaling method an encoder will have to use 16 bits. Even after byte-aligning the substreams which in theory will allow us to signal the length with 9 bits, the encoder still has to use 16 bits.

Motivated by the above example 4analysis, we propose to modify the signaling method of WPP substreams’ length from fixed number of bits to a more flexible number of bits. Table 1 tabulates the proposed syntax and semantic. Experiment results provided in Section 3.1.2 shows that the proposed modification improve signaling efficiency. It gives consistent gain about 0.1% for cases except all intra cases.

**Table 1 – Modified signaling WPP substreams’ entry points**

|  |  |
| --- | --- |
| slice\_header( ) { | Descriptor |
| … |  |
| if (num\_substreams\_minus1 > 0) |  |
| { |  |
| **log2\_max\_substream\_length\_minus1** | ue(v) |
| for (i = 0; i < num\_substreams\_minus1; i++) |  |
| { |  |
| **substream\_length [i]** | u(v) |
| } |  |
| } |  |
| … |  |
| } |  |

**log2\_max\_substream\_length\_minus1** plus 1 specifies the number of bits used to signal substream\_length[i] entries

**substream\_length [i]** specifies the number of bytes between two entry points of WPP substream. When i equals 0, it specifies the number of bytes between the end of the slice header and the first entry point in the slice; otherwise, it defines the number of bytes between the entry point i - 1 and entry point i.

## Signalling length of encoded data between two entry points

The previous method of harmonizing the methods for signaling entry points of tiles and WPP substreams [1] uses both the length (i.e., for entry at index = 0) and the length difference (i.e, for entry at index > 0). However, this method may be inefficient because the length difference between two segments (i.e., encoded data between two entry points) can be very large when WPP data is considered. Consequently, since the length difference is coded as se(v), having big value would be a disadvantage since it will require relatively many bits. Therefore, instead of signaling the length difference, signaling the length itself coded as u(v) may be more preferred.

From our investigation, we found that, in practice, the length difference between two segments (i.e., two WPP substreams) can be large. The attached file ‘EncodingLog-BQSquare-SubstreamLength.txt’ shows this fact.

Motivated by the above analysis, since currently tiles’ length are still signaled by using both plain length and length difference, we propose to modify it to signal them as plain length only so that it would be similar to the way WPP substreams are signaled, thus, make it easier for harmonizing them.

## Unified signalling of entry points of tiles and WPP substreams

By using both proposed modification in section 2.1 and section 2.2 above, the proposed solution for harmonizing tile and WPP substream entry points is simplified. The following Table 2 and 3 tabulates our proposed harmonized syntax and semantic for signaling tile and WPP substream entry points.

**Table 2 -- Syntax element in Slice header**

|  |  |
| --- | --- |
| slice\_header( ) { | Descriptor |
| … |  |
| **entry\_point\_locations\_flag** | u(1) |
| if (entry\_point\_locations\_flag == 1) { |  |
| entry\_point\_locations () |  |
| } |  |
| } |  |

**entry\_point\_locations\_flag** indicates the presence of entry point information in the bit-stream When not present, entry\_point\_locations\_flag shall be 0.

**Table 3 -- Entry point location information**

|  |  |
| --- | --- |
| entry\_point\_ locations() | Descriptor |
| **num\_of\_entry\_points\_minus1** | ue(v) |
| **entry\_point\_offset\_length\_minus1** | ue(v) |
| for (i=0; i<=num\_of\_entry\_points\_minus1; i++) { |  |
| if ((num\_tile\_columns\_minus1 > 0 || num\_tile\_rows\_minus1 > 0) && num\_substreams\_minus1 > 0) { |  |
| **entry\_point\_type[i]** | u(1) |
| } |  |
| else if (num\_substreams\_minus1 > 0) { |  |
| entry\_point\_type [i] = 1 |  |
| } |  |
| else { |  |
| entry\_point\_type [i] = 0 |  |
| } |  |
| **entry\_point\_offset[i]** | u(v) |
| } |  |
| } |  |

**num\_of\_entry\_points\_minus1** plus 1defines the number of bit-stream entry points in the slice

**entry\_point\_offset\_length\_minus1** plus 1 specifies the number of bits used to signal entry\_point\_offset[i] entries.

**entry\_point\_type[i]** indicates the entry point type. entry\_point\_type[i] equals to 0 indicates a tile entry point; entry\_point\_type[i] equals to 1 indicates a substream entry point.

**entry\_point\_offset [i]** specifies the number of bytes between two entry points. When i equals 0, it specifies the number of bytes between the end of the slice header and the first entry point in the slice; otherwise, it defines the number of bytes between the entry point i - 1 and entry point i. The length of entry\_point\_offset [i] is entry\_point\_offset\_length\_minus1 + 1 bits.

# Experiment Results

## Results from byte-aligning WPP substreams

The following results are obtained from byte-aligning WPP substreams experiments. The anchor data is produced by using HM-5.0 rev 1733 software in which we modified so that the software always produces maximum number of WPP substreams that are possible for each picture (i.e., number of WPP substreams = number of LCU rows in a picture), which reflects the worst case scenario for this test. The data being tested is produced from the following modification:

1. Modification #1 (results are shown in Section 3.1.1)
   1. Based on software to produce anchor data
   2. Pad end of WPP substreams with byte-aligned bits
2. Modification #2 (results are shown in Section 3.1.2)
   1. Based on modification #1
   2. Modify signaling of substreams length as described in Section 2.1.2

### Byte-aligning WPP without modification to WPP substreams’s entry point signalling

Table 4 tabulates the summary results from byte-aligning WPP substreams without modifying signaling method of their length. Since the way the length is signaled, the 3 bits saving from signaling length in bits to bytes cannot be realized. However, the overhead bits from the byte-aligned padding is arguably negligible.

**Table 4 – Summary of result from byte-aligned WPP substreams   
with original entry point signaling**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Y** | **U** | **V** |
| INHE | 0.0% | 0.0% | 0.0% |
| INLC | 0.0% | 0.0% | 0.0% |
| RAHE | 0.0% | 0.0% | 0.0% |
| RALC | 0.0% | 0.0% | 0.0% |
| LBHE | 0.1% | 0.1% | 0.1% |
| LBLC | 0.1% | 0.1% | 0.1% |
| LPHE | 0.1% | 0.1% | 0.1% |
| LPLC | 0.1% | 0.1% | 0.1% |

### Byte-aligning WPP with modification to WPP substreams’s entry point signalling

Table 5 tabulates the summary results from byte-aligning WPP substreams with modification to the signaling method of their length. The new signaling method is more efficient when the WPP substreams’ length is byte-aligned as the gain is consistent for all test cases.

**Table 5 – Summary of result from byte-aligned WPP substreams   
with modified entry point signaling**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Y** | **U** | **V** |
| INHE | 0.0% | 0.0% | 0.0% |
| INLC | 0.0% | 0.0% | 0.0% |
| RAHE | 0.0% | 0.0% | 0.0% |
| RALC | 0.0% | 0.0% | 0.0% |
| LBHE | -0.1% | -0.1% | -0.1% |
| LBLC | -0.1% | -0.1% | -0.1% |
| LPHE | -0.1% | -0.1% | -0.1% |
| LPLC | -0.1% | -0.1% | -0.1% |

## Results from modifying coding of entry\_length from se(v) to u(v)

The following results are provided to support modification proposed in Section 2.2. We modify the software from the modification #1 above in which the length at index 0 is coded as plain length (i.e, u(e)) and the remaining length are coded as length different (i.e., se(v)). Then, the results from this modification are compared with the results obtained from the modification #2 above.

Table 6 tabulates the summary results for the above test. The new signaling method is more efficient as it consistently gives the gain is consistent for all test cases.

**Table 6 – Summary of result from modified signaling entry length from se(v) to u(v)**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Y** | **U** | **V** |
| INHE | 0.0% | 0.0% | 0.0% |
| INLC | 0.0% | 0.0% | 0.0% |
| RAHE | -0.1% | -0.1% | -0.1% |
| RALC | -0.1% | -0.1% | -0.1% |
| LBHE | -0.1% | -0.1% | -0.1% |
| LBLC | -0.1% | -0.1% | -0.1% |
| LPHE | -0.1% | -0.1% | -0.1% |
| LPLC | -0.1% | -0.1% | -0.1% |

## Results for unified signalling of entry points of tiles and WPP substreams

The following results are provided to support modification proposed in Section 2.3. The anchor data is produced by using HM-5.0 and setting the DBF\_DQP macro to 0 (which prevents multiple tile configuration from crashing in HM-5.0). The setting used for the test is:

- 4 independent tiles (2 rows and 2 columns)

- 2 WPP substreams in each tile (WaveFrontSynchro = 1)

Table 7 tabulates the summary results for the above test. The new signaling method is more efficient as it consistently gives the gain is consistent for all test cases.

**Table 7 – Summary of result for unified signalling of entry points of tiles and WPP substreams**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Y** | **U** | **V** |
| INHE | 0.0% | 0.0% | 0.0% |
| INLC | 0.0% | 0.0% | 0.0% |
| RAHE | -0.2% | -0.2% | -0.2% |
| RALC | -0.2% | -0.2% | -0.2% |
| LBHE | -0.1% | -0.1% | -0.1% |
| LBLC | -0.3% | -0.3% | -0.3% |
| LPHE | -0.3% | -0.3% | -0.3% |
| LPLC | -0.3% | -0.3% | -0.3% |

# Conclusion

This document proposes steps that aim at providing harmonized / unified signalling for entry points of tiles and WPP substreams. Since the proposed method simplifies the syntax structure more efficiently by unifying the method of signaling the entry points of tiles and WPP substreams, it would be beneficial to adopt all the three modification suggested by this proposal.

# Patent rights declaration(s)

**LG Electronics and Sharp 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).**

# Reference

[1] JCTVC-G722, “Harmonization of Entry Points for tiles and Wavefront Processing,” 7th JCT-VC Meeting, 7th Meeting: Geneva, CH, 21-30 November, 2011.