|  |  |
| --- | --- |
| **Joint Collaborative Team on Video Coding (JCT-VC)**  **of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11**  8th Meeting: San José, CA, USA, 1–10 February, 2012 | Document: JCTVC-H0196\_r1 |

|  |  |  |  |
| --- | --- | --- | --- |
| *Title:* | **AHG21: Comments on Signaling of Short-term Reference Pictures** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
| *Author(s) or Contact(s):* | Hendry Sang Oh Jeong  Seung Wook Park Byeong Moon Jeon  #221 Yangjae-dong, Seocho-gu,  Seoul 137-130,  Korea | Tel: Email: | - [hendry.hendry@lge.com](mailto:hendry.hendry@lge.com)  [sangoh.jeong@lge.com](mailto:sangoh.jeong@lge.com)  [seungwook.park@lge.com](mailto:seungwook.park@lge.com)  [bm.jeon@lge.com](mailto:bm.jeon@lge.com) |
| *Source:* | LG Electronics | | |

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

# Abstract

In the 7th JCT-VC meeting, method for signaling short-term and long-term reference picture was adopted. This document proposes some changes to the current syntax and semantics elements for signaling short-term reference pictures. It is suggested that the proposed changes does not change the main concept of signaling, it may improve signaling efficiency.

# Introduction

After adoption in the last meeting, short-term reference pictures are now can signaled explicitly within so called reference picture set (RPS) which can be signaled in PPS and slice header. RPS contains information such as number of reference pictures (ie.. divided into number of reference pictures with negative and positive delta POC relative to POC of current slice) that should exists in decoded picture buffer (DPB), delta POC of the reference pictures, and whether or not the reference pictures are used by current slice.

While the concept seems stable, the syntax elements within RPS might still be improved by considering other syntax elements. In this document, we propose some changes to the way of signaling short-term reference pictures in RPS without changing the main concept.

# Proposed Changes

## Signalling of Number of Reference Pictures

Currently, the number of reference pictures that are signalled in RPS is described by number of negative and positive pictures and both are coded as ue(v). Considering other adoption syntax element ‘max\_dec\_frame\_buffering’ in the last meeting, it might be better to apply the following changes:

* Instead of signaling num\_negative\_pics and num\_positive\_pics, it is better to signaled num\_ref\_pics\_minus1, which indicate the number of all reference pictures and num\_positive\_ref\_pics, which indicate the number of positive reference pictures.
* The syntax element num\_ref\_pics\_minus1 shall be coded with unsigned integer using n bits (i.e., u(n)) or with unsigned integer Exp-Golomb-coded syntax element with the left bit first (i.e., ue(v)), depending on the value of of syntax element max\_dec\_frame\_buffering.
* The syntax element num\_positive\_ref\_pics shall be coded with unsigned integer Exp-Golomb-coded syntax element with the left bit first (i.e., ue(v))

Table 1 – Syntax element after proposed item 2.1

|  |  |
| --- | --- |
| ref\_pic\_set( idx ) { | Descriptor |
| **inter\_ref\_pic\_set\_prediction\_flag** | u(1) |
| if( inter\_ref\_pic\_set\_prediction\_flag) { |  |
| **…** |  |
| } |  |
| else { |  |
| **num\_ref\_pics\_minus1** | u(n) | ue(v) |
| **num\_positive\_ref\_pics** | ue(v) |
| for( i = 0; i < num\_all\_ref\_pics\_minus1 - num\_positive\_ref\_pics + 1; i++ ) { |  |
| **delta\_poc\_s0\_minus1**[ i ] | ue(v) |
| **used\_by\_curr\_pic\_s0\_flag**[ i ] | u(1) |
| } |  |
| for( i = 0; i < num\_positive\_ref\_pics; i++ ) { |  |
| **delta\_poc\_s1\_minus1**[ i ] | ue(v) |
| **used\_by\_curr\_pic\_s1\_flag**[ i ] | u(1) |
| } |  |
| } |  |
| } |  |

**num\_ref\_pics\_minus1** plus 1 specifies the number of the sum of the following delta\_poc\_s0\_minus1[ i ] and delta\_poc\_s1\_minus1[ i ] syntax elements. When the value of max\_dec\_frame\_buffering is 0, num\_all\_ref\_pics\_minus1 is coded with unsigned integer Exp-Golomb-coded syntax element with the left bit first, otherwise, num\_all\_ref\_buffering is coded with unsigned integer using n bits where n is ceil(log2(max\_dec\_frame\_buffering)).

The variable NumNegativePics[ idx ] is derived as follows:

NumNegativePics[ idx ] = num\_all\_ref\_pics - num\_positive\_ref\_pics

### Bit-count Analysis

Bit-count analysis for the proposed method of signalling number of reference pictures in RPS is given in file “Bit-count\_Analysis\_For\_Item\_2.1.xlsx”. Note that for case 2.1 ~ 2.7, we use 3 bits to signal the syntax element num\_rf\_pics\_minus1 because the maximum number of required buffer never exceed 8 whereas for case 3.1 and 3.2 we use 2 bits to signal the syntax element since the maximum number of required buffer is 4.

The analysis shows that the proposed method required fewer bits to signal the information about number of reference pictures for most of cases.

### Error Resilience Analysis

The proposed method of signalling number of reference pictures in RPS does not have any effect on error resiliency feature of the current RPS signalling mechanism.

## Signaling used\_by\_curr\_pic\_sX\_flag conditionally

In some condition (e.g., low delay case in current HM common test condition), all reference pictures that exist in DPB (also carried in RPS) is always used by current slice. Thus, in such condition, there is no need to signal the syntax element **used\_by\_curr\_pic\_sX\_flag** (X can be replaced by either 0 or 1) since it will be always 1.

In addition to above, when RPS is signaled in Slice Header and the slice type is intra, then there is no need to signal the syntax element used\_by\_curr\_pic\_sX\_flag (X can be replaced by either 0 or 1) since it will be always 0.

Motivated by possibility saving from the above observation, we propose the following modification:

* Add a flag in PPS called **no\_unused\_ref\_pic\_flag**.
* When **no\_unused\_ref\_pic\_flag** equals 1, then the syntax element **used\_by\_curr\_pic\_sX\_flag** shall not be signaled but instead its value is inferred as 1. Otherwise, when **no\_unused\_ref\_pic\_flag** equals 0, **used\_by\_curr\_pic\_sX\_flag** shall be signalled.
* If idx == **num\_ref\_pic\_sets**, which mean that the RPS is signaled in slice header, and slice type equals intra, then **used\_by\_curr\_pic\_sX\_flag** shall not be signaled by inferred as 0.

The syntax and semantics of modified / added element in RPS are as follows.

Table 2 – Syntax element in PPS after proposed item 2.2

|  |  |
| --- | --- |
| pic\_parameter\_set\_rbsp( ) { | Descriptor |
| … |  |
| **num\_ref\_pic\_sets** | ue(v) |
| **no\_unused\_ref\_pic\_flag** | u(1) |
| for(idx = 0; idx < num\_ref\_pic\_sets; idx++) |  |
| ref\_pic\_set( idx ) |  |
| … |  |
| } |  |

**no\_unused\_ref\_pics\_flag** equals 1 indicates that the syntax element used\_by\_curr\_pic\_sX\_flag is not present in RPS and the value of used\_by\_curr\_pic\_s1\_flag [ i ] can be inferred as 1. Otherwise, when no\_unused\_ref\_pics\_flag equals 0, the syntax element used\_by\_curr\_pic\_sX\_flag is present in RPS.

Table 3 – Syntax element in RPS after proposed item 2.2

|  |  |
| --- | --- |
| ref\_pic\_set( idx ) { | Descriptor |
| **inter\_ref\_pic\_set\_prediction\_flag** | u(1) |
| if( inter\_ref\_pic\_set\_prediction\_flag) { |  |
| **delta\_idx\_minus1** | ue(v) |
| **delta\_rps\_sign** | u(1) |
| **abs\_delta\_rps\_minus1** | ue(v) |
| for( j = 0; j <= NumDeltaPocs[ RIdx ]; j++ ) { |  |
| **ref\_idc0**[ j ] | u(1) |
| if( !ref\_idc0[ j ] && (no\_unused\_ref\_pic\_flag == 0 || (idx == num\_ref\_pic\_sets &&slice\_type = = I)) |  |
| **ref\_idc1**[ j ] | u(1) |
| } |  |
| } |  |
| else { |  |
| **num\_negative\_ref\_pics** | ue(v) |
| **num\_positive\_ref\_pics** | ue(v) |
| for( i = 0; i < num\_negative\_ref\_pics; i++ ) { |  |
| **delta\_poc\_s0\_minus1**[ i ] | ue(v) |
| if (no\_unused\_ref\_pic\_flag == 0) { |  |
| **used\_by\_curr\_pic\_s0\_flag** [ i ] | u(1) |
| } |  |
| else if (idx == num\_ref\_pic\_sets &&slice\_type = = I) |  |
| { |  |
| used\_by\_curr\_pic\_s0\_flag [ i ] = 0 |  |
| } |  |
| else { |  |
| used\_by\_curr\_pic\_s0\_flag [ i ] = 1 |  |
| } |  |
| } |  |
| for( i = 0; i < num\_positive\_ref\_pics; i++ ) { |  |
| **delta\_poc\_s1\_minus1**[ i ] | ue(v) |
| if (no\_unused\_ref\_pic\_flag == 0) { |  |
| **used\_by\_curr\_pic\_s1\_flag** [ i ] | u(1) |
| } |  |
| else if (idx == num\_ref\_pic\_sets &&slice\_type = = I) |  |
| { |  |
| used\_by\_curr\_pic\_s1\_flag [ i ] = 0 |  |
| } |  |
| else { |  |
| used\_by\_curr\_pic\_s1\_flag [ i ] = 1 |  |
| } |  |
| } |  |
| } |  |
| } |  |

The semantic of ref\_idc0[ j ] shall be updated as follows:

if (no\_unused\_ref\_pic\_flag == 1 || (idx == num\_ref\_pic\_sets &&slice\_type = = I)), then:

|  |  |
| --- | --- |
| ref\_idc0[ j ] | Properties of i-th reference picture |
| 1 | Picture is used for reference by the current picture DeltaPoc[ idx ][ i ] = DeltaPoc[ RIdx ][ j ] + DeltaRPS |
| 0 | There is no corresponding i-th reference picture for DeltaPoc[ RIdx ][ j ]. |

Else,

|  |  |  |
| --- | --- | --- |
| ref\_idc0[ j ] | ref\_idc1[ j ] | Properties of i-th reference picture |
| 1 |  | Picture is used for reference by the current picture DeltaPoc[ idx ][ i ] = DeltaPoc[ RIdx ][ j ] + DeltaRPS |
| 0 | 1 | Picture is not used for reference by the current picture (but used by future pictures) DeltaPoc[ idx ][ i ] = DeltaPoc[ RIdx ][ j ] + DeltaRPS |
| 0 | 0 | There is no corresponding i-th reference picture for DeltaPoc[ RIdx ][ j ]. |

### Bit-count Analysis

Compared to the current system method, the proposed changes will impact the bit-count of signalling method as follow:

* For case 2.1 ~ 2.7: overhead cost 1 bit for signalling **no\_unused\_ref\_pic\_flag in PPS**
* For case 3.1: saving 4 bits per RPS (i.e., total 16 bits) and overhead 1 bit for signalling **no\_unused\_ref\_pic\_flag in PPS**
* For case 3.2: saving total 4 bits.
* For case 3.4: overhead cost 1 bit for signalling **no\_unused\_ref\_pic\_flag in PPS**

### Error Resilience Analysis

The proposed method of signalling number of reference pictures in RPS does not have any effect on error resiliency feature of the current RPS signalling mechanism.

# Conclusion

This document proposes some changes to the current syntax and semantics elements for signaling short-term reference pictures. While the proposed changes do not change signaling main concept of signaling, they may improve signaling efficiency. Changes to the current WD text will be provided in the next revision of this document. We recommend the group to further discuss the proposed changes can consider adopting them.

# Patent rights declaration(s)

**LG Electronics 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).**