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| *Title:* | **AHG21: Comments on Signaling of Long-term Reference Pictures** | | |
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# 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 long-term reference pictures. The proposed changes are:

* Replace syntax element ‘delta\_poc\_lsb\_lt\_minus1 [i]’ with ‘delta\_poc\_lsb\_lt [i]’ to enable handling of two long-term reference pictures with the same delta POC LSB relative to current slice
* Allow skip signaling delta POC LSB of long-term reference pictures without removing it from decoded picture buffer.

It is suggested that the proposed changes may improve signaling efficiency without changing the main concept of current signaling approach.

# Introduction

After adoption in the last meeting, long-term reference pictures (LTRPs) are now can be signaled explicitly within slice header. The main difference of signaling of LTRPs and short-term reference pictures (STRPs) are as follows:

* STRPs are signaled in reference picture set (RPS) which can be signaled in PPS or slice header. LTRPs are signaled only in slice header.
* Delta POC for STRPs signaling is absolute delta while delta POC for LTRPs signaling is delta POC of least significant bit (LSB).

In this document, we propose some changes that may improve the current method of signaling of LTRPs.

# Proposed Changes

## On the issue of two LTRP with same POC LSB

One problem with signalling delta POC of LTRPs by using only delta POC LSB is that it cannot have two LTRP with same delta POC LSB relative to POC LSB of current slice at the same time. This might be problem since such situation may often occur in practice.

To overcome the above issue, a simple modification to current syntax element may provide a solution. The necessary modification is as follows:

* Replace syntax element ‘delta\_poc\_lsb\_lt\_minus1 [i]’ with ‘delta\_poc\_lsb\_lt [i]’

With the above modification, we basically allow delta POC LSB to be 0 so that if there are two LTRPs with same POC LSB, the delta POC LSB shall be 0 which will have no problem to be signalled.

Semantic change:

Current semantic:

**delta\_poc\_lsb\_lt\_minus1**[ i ] is used to determine the value of the least significant bits of the picture order count value of the i-th long-term reference picture that is included in the long-term reference picture set of the current picture. delta\_poc\_lsb\_lt\_minus1[ i ] shall be in the range of 0 to MaxPicOrderCntLsb − 1, inclusive.

The variable DeltaPocLt[ i ] is derived as follows.

if (i = = 0)   
 DeltaPocLt[ i ] = delta\_poc\_lsb\_lt\_minus1[ i ] + 1   
 else  
 DeltaPocLt[ i ] = delta\_poc\_lsb\_lt\_minus1[ i ] + 1 + DeltaPocLt[ i – 1 ]

The value of DeltaPocLt[ i ] shall be in the range of 0 to MaxPicOrderCntLsb, inclusive

Proposed semantic:

**delta\_poc\_lsb\_lt**[ i ] is used to determine the value of the least significant bits of the picture order count value of the i-th long-term reference picture that is included in the long-term reference picture set of the current picture. delta\_poc\_lsb\_lt[ i ] shall be in the range of 0 to MaxPicOrderCntLsb − 1, inclusive.

The variable DeltaPocLt[ i ] is derived as follows.

if (i = = 0)   
 DeltaPocLt[ i ] = delta\_poc\_lsb\_lt\_minus1[ i ]   
 else  
 DeltaPocLt[ i ] = delta\_poc\_lsb\_lt\_minus1[ i ] + DeltaPocLt[ i – 1 ]

The value of DeltaPocLt[ i ] shall be in the range of 0 to MaxPicOrderCntLsb, inclusive

### Bit-count Analysis

By removing the “minus1’ term, our investigation shows that basically there is no significant penalty in term bit count for signalling. The following table summarizes amount of bits for signalling LTRPs in the case 2.6 and 3.3.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Case** | **Condition** | **Bits by current method** | | **Bits by proposed method** | |
| **1st half** | **2nd half** | **1st half** | **2nd half** |
| Case 2.6 | 10s-20s-10s-20s | 31199 | 40628 | 31199 | 40636 |
| Case 2.6 | 20s-60s-20s-60s | 62493 | 81676 | 62495 | 81686 |
| Case 3.3 | RTT 100ms | 5191 | 5332 | 5283 | 5424 |
| Case 3.3 | RTT 200ms | 6795 | 7580 | 6835 | 7620 |

In case 2.6, the propose change causes only addition 8 bits, which is negligible whereas for case 3.3, it causes increment of about 0.05% bit-count.

### Error Resilience Analysis

The proposed change does not have any effect on error resiliency feature of the current RPS signalling mechanism.

## Skip signalling LTRP without removing it from DPB

List of LTRPs that must be kept in DPB must be signal in every slice header even though they are not always used and there is no change to the list of LTRPs. This is obviously costly. The following improvement aims at making the signaling more efficient.

Use case scenario:

Suppose that there is a back channel available for encoder to receive delivery status from decoder. Decoder can notify encoder whether or not all encoded pictures successfully received. If encoder knows that all the last encoded picture that have effect to status of LTRP in DPB is successfully received by decoder and there is no change needed in the current picture, it can signal a flag in the current slice header to tell decoder that in the current slice header, list of LTRP is not signaled and there is no change to the existing LTRPs in DPB.

Basic concept:

* Add a flag in PPS called “allow\_skip\_ltrp\_signaling\_flag” that determines whether or not LTRP signaling skip flag is allowed.
* Add a flag in slice header called “skip\_ltrp\_signaling\_flag” that determines whether or not LTRP list is signaled.
* skip\_ltrp\_signaling\_flag is used only when allow\_skip\_ltrp\_signaling\_flag equals 1
* skip\_ltrp\_signaling\_flag equals 1 specifies that list delta\_poc\_lsb\_lt\_minus1[1] is not signaled in the slice header and decoder shall not apply any changes of status to the existing LTRPs in DPB. However, num\_long\_term\_pics and used\_by\_curr\_pic\_lt\_flag [i] are still be signaled to determined whether or not the LTRPs in DPB are used by current slice.

The following syntax element is added to PPS to accommodate the proposed improvement.

|  |  |
| --- | --- |
| pic\_parameter\_set\_rbsp( ) { | **Desc** |
| **…** |  |
| if (long\_term\_ref\_pics\_present\_flag == 1) { |  |
| **allow\_skip\_ltrp\_signaling\_flag** | u(1) |
| } |  |
| **…** |  |
| } |  |

**allow\_skip\_ltrp\_signaling\_flag** specifies whether or not skip\_ltrp\_signaling\_flag is signaled in slice headers. allow\_skip\_ltrp\_signaling\_flag equals 0 indicates that skip\_ltrp\_signaling\_flag is not signaled in slice header and its value by default shall be 0.

|  |  |
| --- | --- |
| Slice\_header( ) { | **Desc** |
| **…** |  |
| If (long\_term\_ref\_pics\_present\_flag == 1) { |  |
| **num\_long\_term\_pics** | ue(v) |
| If (num\_long\_term\_pics > 0 && allow\_ltrp\_signaling\_skip\_flag == 1) { |  |
| **skip\_ltrp\_signaling\_flag** | u(1) |
| } |  |
| for( i = 0; i < num\_long\_term\_pics; i++ ) { |  |
| if (!skip\_ltrp\_signaling\_flag) |  |
| **delta\_poc\_lsb\_lt\_minus1**[ i ] | ue(v) |
| **used\_by\_curr\_pic\_lt\_flag**[ i ] | u(1) |
| } |  |
| } |  |
| } |  |
| **…** |  |
| } |  |

**skip\_ltrp\_signaling\_flag** equals 1 indicates that delta\_poc\_lsb\_lt\_minus1 [i] is not signalled in this slice header and no change of status shall be applied to existing LTRPs in DPB. Otherwise, skip\_ltrp\_signaling\_flag equals 0 indicates that delta\_poc\_lsb\_lt\_minus1 [i] is signalled in this slice header. When num\_long\_term\_pics equals 0 or allow\_ltrp\_signaling\_skip\_flag equals 0, skip\_ltrp\_signaling\_flag is not present and inferred to be 0.

### Bit-count Analysis

The additional of skip flag significantly reduces the number of bits to signal LTRPs. Our investigation shows that for all test cases (2 cases from 2.6 and 2 cases from 3.3) the number of bits to signal LTRPs is reduced to less than 1/3. The following table summarizes amount of bits for signalling LTRPs in the case 2.6 and 3.3.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Case** | **Condition** | **Bits by current method** | | **Bits by proposed method** | |
| **1st half** | **2nd half** | **1st half** | **2nd half** |
| Case 2.6 | 10s-20s-10s-20s | 31199 | 40628 | 9570 | 11978 |
| Case 2.6 | 20s-60s-20s-60s | 62493 | 81676 | 19170 | 23978 |
| Case 3.3 | RTT 100ms | 5191 | 5332 | 1999 | 2030 |
| Case 3.3 | RTT 200ms | 6795 | 7580 | 1787 | 1870 |

Note that the penalty for not using skip flag is only 1 bit (i.e., for signalling allow\_skip\_ltrp\_signaling\_flag = 0 in PPS**).**

### Error Resilience Analysis

Although the use of the proposed method may decrease error resilience capability of decoder, we have design the proposed method to still able to detect of lost has happen. Because only delta\_poc\_lsb\_lt\_minus1[ i ] is skipped when skip\_ltrp\_signaling\_flag = 1, then even if lost happen, decoder can still detect the lost by matching the num\_long\_term\_pics and the actual number of LTRPs in the buffer.

Furthermore, as it has been described, the proposed method is best when there is a back channel from decoder to encoder to inform whether or not previous transmitted picture are safely received.

# Conclusion

This document proposes some changes to the current syntax and semantics elements for signaling long-term reference pictures. While the proposed changes do not change signaling main concept of signaling, they may improve signaling efficiency. We recommend the group to further discuss the proposed changes can consider adopting them.

# Patent rights declaration(s)

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