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| **Joint Collaborative Team on Video Coding (JCT-VC)**  **of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11**  6th Meeting: Torino, IT, 14-22 July, 2011 | Document: JCTVC-F461 |

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| *Title:* | **Reference picture loss/error detection** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

This document proposes to conditionally mandate the use of reference picture list modification (RPLM) commands for construction of reference picture lists, to enable decoders detect reference picture losses/errors when gaps\_in\_frame\_num\_value\_allowed\_flag is equal to 1, for applications in error-prone environments. If the proposal of unconditionally mandating RPLM commands in Section 6.2 of JCTVC-F460 is agreed, then this proposal can be ignored.

# Introduction

In error-prone environments, coded pictures or part thereof may get lost. A loss to a non-reference picture would only cause that picture to be incorrectly decoded; hence the effect to the user experience is limited. A loss to a reference picture, however, may cause a serious degradation to the video quality, as it may be directly or indirectly used by many following pictures for inter prediction reference and therefore its loss may result in all those pictures being incorrectly decoded. The problem becomes worse if the decoder side does not know that a loss to a reference picture has happened. If the decoder sides knows that a loss to a reference picture has happened, it may take some action e.g., by requesting the encoder side to encode an intra picture, or an inter picture using only correct reference pictures for inter prediction, to stop the error being further propagated. Therefore, the capability of detecting a reference picture loss is important for the decoder.

Currently, the HEVC draft standard includes a mechanism to enable detecting the loss of reference pictures. When the syntax element gaps\_in\_frame\_num\_value\_allowed\_flag in the active sequence parameter set is equal to 0, a reference picture loss can be detected by detecting a gap in the value of the syntax element frame\_num for two consecutive coded pictures in decoding order. For example, when all pictures are coded as reference pictures, and the value range of frame\_num is 0 to 255, inclusive, then a frame\_num gap is detected if the difference between the frame\_num of the current picture and the frame\_num of the previous picture in decoding order is not equal to 1 or -255.

However, the above mechanism only works when the syntax element gaps\_in\_frame\_num\_value\_allowed\_flag in the active sequence parameter set is equal to 0. When the value is equal to 1, the presence of frame\_num gaps does not necessarily indicate that there has been a reference picture loss, but rather that may be caused by discarding of higher temporal layers of a temporally scalable video bitstream.

This document proposes a way to enable the decoder detect reference picture losses/errors when gaps\_in\_frame\_num\_value\_allowed\_flag is equal to 1.

# Proposal

The proposal is to conditionally mandate reference picture list modification (RPLM) commands for construction of reference picture lists. A flag is proposed to be added to the picture parameter set (PPS).

For applications in error-prone environments, wherein error resiliency is important, the flag is set to 1 and RPLM commands are mandated to be present for each P or B slice referring to the PPS. When a slice contains RPLM commands, upon parsing the slice header, the decoder can derive which reference pictures (i.e., those identified by the RPLM commands) may be used for inter prediction reference, and which reference pictures are not used. In case a reference picture identified by a RPLM command has been entirely or partially lost, or has directly or indirectly used a reference picture that has been entirely or partially lost, for inter prediction reference, the decoder can derive that something is wrong, and may take some action, e.g., by requesting the encoder side to encode an intra picture, or an inter picture using only correct reference pictures for inter prediction, to stop the error being further propagated.

For applications in error-free environments, the flag can be set to 0 and RPLM commands are not mandated.

The proposed text changes are as follows (in relative to HEVC WD3d8). If the proposal of unconditionally mandating RPLM commands in Section 6.2 of JCTVC-F460 is agreed, then this proposal can be ignored.

# 7.3.2.2 Picture parameter set RBSP syntax

|  |  |
| --- | --- |
| pic\_parameter\_set\_rbsp( ) { | Descriptor |
| **pic\_parameter\_set\_id** | ue(v) |
| **seq\_parameter\_set\_id** | ue(v) |
| **entropy\_coding\_mode\_flag** | u(1) |
| **num\_temporal\_layer\_switching\_point\_flags** | ue(v) |
| for( i = 0; i < num\_temporal\_layer\_switching\_point\_flags; i++ ) |  |
| **temporal\_layer\_switching\_point\_flag**[ i ] | u(1) |
| **num\_ref\_idx\_l0\_default\_active\_minus1** | ue(v) |
| **num\_ref\_idx\_l1\_default\_active\_minus1** | ue(v) |
| **rplm\_commands\_present\_flag** | u(1) |
| **pic\_init\_qp\_minus26** **/**\* relative to 26 \*/ | se(v) |
| **constrained\_intra\_pred\_flag** | u(1) |
| **slice\_granularity** | u(2) |
| **shared\_pps\_info\_enabled\_flag** | u(1) |
| if( shared\_pps\_info\_enabled\_flag ) |  |
| if( adaptive\_loop\_filter\_enabled\_flag ) |  |
| alf\_param( ) |  |
| if( cu\_qp\_delta\_enabled\_flag ) |  |
| **max\_cu\_qp\_delta\_depth** | u(4) |
| rbsp\_trailing\_bits( ) |  |
| } |  |

# 7.3.3.1 Reference picture list modification syntax

|  |  |
| --- | --- |
| ref\_pic\_list\_modification( ) { | Descriptor |
| if( slice\_type % 5 != 2 && slice\_type % 5 != 4 ) { |  |
| if( !rplm\_commands\_present\_flag ) |  |
| **ref\_pic\_list\_modification\_flag\_l0** | u(1) |
| if( ref\_pic\_list\_modification\_flag\_l0 ) |  |
| do { |  |
| **modification\_of\_pic\_nums\_idc** | ue(v) |
| if( modification\_of\_pic\_nums\_idc = = 0 | |  modification\_of\_pic\_nums\_idc = = 1 ) |  |
| **abs\_diff\_pic\_num\_minus1** | ue(v) |
| else if( modification\_of\_pic\_nums\_idc = = 2 ) |  |
| **long\_term\_pic\_num** | ue(v) |
| } while( modification\_of\_pic\_nums\_idc != 3 ) |  |
| } |  |
| if( slice\_type % 5 = = 1 ) { |  |
| if( !rplm\_commands\_present\_flag ) |  |
| **ref\_pic\_list\_modification\_flag\_l1** | u(1) |
| if( ref\_pic\_list\_modification\_flag\_l1 ) |  |
| do { |  |
| **modification\_of\_pic\_nums\_idc** | ue(v) |
| if( modification\_of\_pic\_nums\_idc = = 0 | |  modification\_of\_pic\_nums\_idc = = 1 ) |  |
| **abs\_diff\_pic\_num\_minus1** | ue(v) |
| else if( modification\_of\_pic\_nums\_idc = = 2 ) |  |
| **long\_term\_pic\_num** | ue(v) |
| } while( modification\_of\_pic\_nums\_idc != 3 ) |  |
| } |  |
| } |  |

# 7.4.2.2 Picture parameter set RBSP semantics

**…**

**num\_ref\_idx\_l0\_default\_active\_minus1** specifies how num\_ref\_idx\_l0\_active\_minus1 is inferred for P and B slices with num\_ref\_idx\_active\_override\_flag equal to 0. The value of num\_ref\_idx\_l0\_default\_active\_minus1 shall be in the range of 0 to 31, inclusive.

**num\_ref\_idx\_l1\_default\_active\_minus1** specifies how num\_ref\_idx\_l1\_active\_minus1 is inferred for B slices with num\_ref\_idx\_active\_override\_flag equal to 0. The value of num\_ref\_idx\_l1\_default\_active\_minus1 shall be in the range of 0 to 31, inclusive.

**rplm\_commands\_present\_flag** equal to 1 specifies that each P or B slice referring to this picture parameter set contains reference picture list modification commands (i.e., ref\_pic\_list\_modification\_flag\_l0 and, for B slices, ref\_pic\_list\_modification\_flag\_l1, are not present in the slice header and by default equal to 1). rplm\_commands\_present\_flag equal to 0 specifies that each P or B slice referring to this picture parameter set may or may not contain reference picture list modification commands (i.e., ref\_pic\_list\_modification\_flag\_l0 and, for B slices, ref\_pic\_list\_modification\_flag\_l1, are present in the slice header).

**pic\_init\_qp\_minus26** specifies the initial value minus 26 of SliceQPY for each slice. The initial value is modified at the slice layer when a non-zero value of slice\_qp\_delta is decoded, and is modified further when a non-zero value of cu\_qp\_delta is decoded at the coding unit layer. The value of pic\_init\_qp\_minus26 shall be in the range of −(26 + QpBdOffsetY ) to +25, inclusive.

**…**

# 7.4.3.1 Reference picture list modification semantics

The syntax elements modification\_of\_pic\_nums\_idc, abs\_diff\_pic\_num\_minus1, and long\_term\_pic\_num specify the change from the initial reference picture lists to the reference picture lists to be used for decoding the slice.

**ref\_pic\_list\_modification\_flag\_l0** equal to 1 specifies that the syntax element modification\_of\_pic\_nums\_idc is present for specifying reference picture list 0. ref\_pic\_list\_modification\_flag\_l0 equal to 0 specifies that this syntax element is not present. When ref\_pic\_list\_modification\_flag\_l0 is not present for a P or B slice, the value shall be inferred to be equal to 1.

When ref\_pic\_list\_modification\_flag\_l0 is equal to 1, the number of times that modification\_of\_pic\_nums\_idc is not equal to 3 following ref\_pic\_list\_modification\_flag\_l0 shall not exceed num\_ref\_idx\_l0\_active\_minus1 + 1.

When RefPicList0[ num\_ref\_idx\_l0\_active\_minus1 ] in the initial reference picture list produced as specified in subclause  is equal to "no reference picture", ref\_pic\_list\_modification\_flag\_l0 shall be equal to 1 and modification\_of\_pic\_nums\_idc shall not be equal to 3 until RefPicList0[ num\_ref\_idx\_l0\_active\_minus1 ] in the modified list produced as specified in subclause  is not equal to "no reference picture".

**ref\_pic\_list\_modification\_flag\_l1** equal to 1 specifies that the syntax element modification\_of\_pic\_nums\_idc is present for specifying reference picture list 1. ref\_pic\_list\_modification\_flag\_l1 equal to 0 specifies that this syntax element is not present. When ref\_pic\_list\_modification\_flag\_l1 is not present for a P or B slice, the value shall be inferred to be equal to 1.

When ref\_pic\_list\_modification\_flag\_l1 is equal to 1, the number of times that modification\_of\_pic\_nums\_idc is not equal to 3 following ref\_pic\_list\_modification\_flag\_l1 shall not exceed num\_ref\_idx\_l1\_active\_minus1 + 1.

When decoding a slice with slice\_type equal to 1 or 6 and RefPicList1[ num\_ref\_idx\_l1\_active\_minus1 ] in the initial reference picture list produced as specified in subclause  is equal to "no reference picture", ref\_pic\_list\_modification\_flag\_l1 shall be equal to 1 and modification\_of\_pic\_nums\_idc shall not be equal to 3 until RefPicList1[ num\_ref\_idx\_l1\_active\_minus1 ] in the modified list produced as specified in subclause  is not equal to "no reference picture".

**…**

# Patent rights declaration(s)

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