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AHG17: Bitstream constraints on RPL and GDR



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Proposal summary



- We propose the following seven restrictions for RPL and GDR pictures to operate properly:
 1. Active RPL entries shall not be “no reference picture”
 2. RPL entries of a CRA picture shall not precede in output order or decoding order any previous IRAP picture in decoding order
 3. Active RPL entries of a trailing picture shall not be unavailable picture generated for the associated IRAP picture
 4. Pictures that are recovered after a GDR picture shall not use unavailable pictures for reference that were generated for the GDR picture
 5. RPL entries of a trailing picture shall not precede the associated IRAP in output order or decoding order
 6. RADL pictures shall not reference any RASL pictures, unavailable pictures or pictures that precede the associated IRAP picture in decoding order
 7. GDR picture recovery shall result in the same output as if decoding started at an earlier IRAP picture or an earlier GDR picture

Constraint 1



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|-------------------------|--|
| Proposed VVC text | No active entry in RefPicList[0] or RefPicList[1] shall be equal to “no reference picture”. |
| Corresponding HEVC text | There shall be no entry in RefPicSetStCurrBefore, RefPicSetStCurrAfter or RefPicSetLtCurr for which one or more of the following are true: <ul style="list-style-type: none">– The entry is equal to "no reference picture".– ... |

- In section 8.3.2 of the VVC draft, RefPicList[i][j] is set to “no reference picture” for those cases that a picture included in an RPL is not present in the DPB. This may happen in the case a temporal sub-layer has been removed.
- We propose to require VVC bitstreams to not include active entries in RPL that results in RefPicList[i][j] being set to “no reference picture”.

Constraint 2



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| Proposed VVC text | When the current picture is a CRA picture, there shall be no entry in RefPicList[0 or RefPicList[1] that precedes, in output order or decoding order, any preceding IRAP picture in decoding order (when present). |
| Corresponding HEVC text | When the current picture is a CRA picture, there shall be no picture included in the RPS that precedes, in output order or decoding order, any preceding IRAP picture in decoding order (when present). |

- It seems currently to be allowed in the VVC draft for an RPL of a CRA picture to include pictures that precede the IRAP picture preceding the CRA picture. This is not allowed in HEVC and we propose to disallow it also for VVC.

Constraint 3



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|-------------------------|---|
| Proposed VVC text | When the current picture is a trailing picture there shall be no active entry in RefPicList[0] or RefPicList[1] that contains a picture that was generated by the decoding process for generating unavailable reference pictures for the IRAP picture associated with the current picture as specified in clause 8.3.4. |
| Corresponding HEVC text | When the current picture is a trailing picture, there shall be no picture in RefPicSetStCurrBefore, RefPicSetStCurrAfter or RefPicSetLtCurr that was generated by the decoding process for generating unavailable reference pictures as specified in clause 8.3.3. |

- It seems currently to be allowed in the VVC draft for a trailing picture to reference an unavailable reference picture.
- Remember that unavailable reference pictures in VVC are generated when random access is done on a CRA picture and there are RASL pictures that reference pictures that precede the CRA in decoding order. We believe that VVC should only allow RASL picture to reference those unavailable reference pictures.
- Note that we propose that trailing pictures are allowed to reference unavailable pictures that were generated for GDR pictures since allowing that is necessary for random access on GDR pictures to work.

Constraint 4



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| Proposed VVC text | When the current picture is a recovery point picture or a picture that follows the recovery point picture in decoding order, there shall be no active entry in RefPicList[0] or RefPicList[1] that contains a picture that was generated by the decoding process for generating unavailable reference pictures for the GDR picture of the recovery point picture as specified in clause 8.3.4. |
| Corresponding HEVC text | [There is no corresponding HEVC text since normative recovery point pictures and GDR pictures are not part of HEVC] |

- The current VVC draft does not include any RPL restrictions around generated unavailable pictures.
- Our opinion is that since the recovery point picture and the picture that follows the recovery point picture should be clean, there is no use allowing any such clean picture to use any unavailable picture for reference.
- Therefore, we propose to disallow it.

Constraint 5



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| Proposed VVC text | <p>When the current picture is a trailing picture, there shall be no entry in RefPicList[0] or RefPicList[1] that precedes the associated IRAP picture in output order or decoding order.</p> <p>When present, all RADL pictures precede, in decoding order, all trailing pictures of the same associated IRAP picture.</p> <p>When present, all RASL pictures precede, in decoding order, all trailing pictures of the same associated CRA picture.</p> |
| Corresponding HEVC text | <p>When the current picture is a trailing picture, there shall be no picture in the RPS that precedes the associated IRAP picture in output order or decoding order.</p> |

- It seems currently to be allowed in the VVC draft for a trailing picture to reference a picture that precedes the associated IRAP picture in output order or decoding order.

Constraint 6



| | |
|-------------------------|--|
| Proposed VVC text | <p>When the current picture is a RADL picture, there shall be no active entry in RefPicList[0] or RefPicList[1] that is any of the following:</p> <ul style="list-style-type: none">– A RASL picture– A picture that was generated by the decoding process for generating unavailable reference pictures as specified in clause 8.3.4– A picture that precedes the associated IRAP picture in decoding order |
| Corresponding HEVC text | <p>When the current picture is a RADL picture, there shall be no picture included in RefPicSetStCurrBefore, RefPicSetStCurrAfter or RefPicSetLtCurr that is any of the following:</p> <ul style="list-style-type: none">– A RASL picture– A picture that was generated by the decoding process for generating unavailable reference pictures as specified in clause 8.3.3– A picture that precedes the associated IRAP picture in decoding order |

- It seems currently to be allowed in the VVC draft for a RADL picture to use RASL pictures, unavailable pictures and pictures preceding the associated IRAP picture in decoding order for reference.

Constraint 7



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| Proposed VVC text | <p>When gdr_enabled_flag is equal to 1 and PicOrderCntVal of the current picture is greater than or equal to RpPicOrderCntVal of the previous associated GDR picture in decoding order for which there is no IRAP picture between the current picture and the previous GDR picture in decoding order, the following applies:</p> <ul style="list-style-type: none">— It is a requirement of bitstream conformance that the current and subsequent decoded pictures shall be an exact match to the pictures produced by starting the decoding process at the previous IRAP picture, if any, preceding the associated GDR current picture in decoding order.- It is a requirement of bitstream conformance that the current and subsequent decoded pictures shall be an exact match to the pictures produced by starting the decoding process at any GDR picture, if any, for which its recovery point picture precedes the current picture in decoding order. |
| Corresponding HEVC text | [There is no corresponding HEVC text since GDR pictures are not part of HEVC] |

— We see two problems with the current VVC text:

1. The term “previous GDR picture in decoding order” is problematic for overlapping GDR pictures
2. The current VVC text does not cover the case where there are no IRAP pictures at all in the bitstream

Constraint 7 – problem 1

The term “previous GDR picture in decoding order” is problematic for overlapping GDR pictures

- The table to the right shows an example of overlapping GDR pictures
- Reading the current VVC specification with the POC 6 picture as current picture we see the following:

| POC | Picture type | recovery_point_cnt | RpPicOrder CntVal |
|-----|--------------|--------------------|-------------------|
| 0 | IDR | - | - |
| 1 | TRAIL | - | - |
| 2 | GDR | 4 | 6 |
| 3 | TRAIL | - | - |
| 4 | GDR | 4 | 8 |
| 5 | TRAIL | - | - |
| 6 | GDR | 4 | 10 |
| 7 | TRAIL | - | - |
| 8 | GDR | 4 | 12 |

| VVC text | Comment |
|---|---|
| When gdr_enabled_flag is equal to 1 and PicOrderCntVal of the current picture is greater than or equal to RpPicOrderCntVal of the previous GDR picture in decoding order for which there is no IRAP picture between the current picture and the previous GDR picture in decoding order, | “PicOrderCntVal of the current picture” is equal to 6 “the previous GDR picture in decoding order for which there is no IRAP picture between the current picture and the previous GDR picture in decoding order” is the picture with POC=4 ”RpPicOrderCntVal of the previous GDR picture” is equal to 8 |
| it is a requirement of bitstream conformance that the current and subsequent decoded pictures shall be an exact match to the pictures produced by starting the decoding process at the previous IRAP picture preceding the current picture in decoding order. | Since RpPicOrderCntVal is larger than PicOrderCntVal it is possible to interpret the VVC text as there is no requirements on any picture in the example that it shall be an exact match to anything. |

Constraint 7 – problem 2

The current VVC text does not cover the case where there are no IRAP pictures at all in the bitstream

- The VVC requirement above does not cover the case where a bitstream contains no IRAP pictures at all but only GDR pictures
- In this case, there is no previous IRAP picture
- Consider the table, where there are only TRAIL and GDR pictures.
 - Assuming that the current picture is the picture with POC equal to 8, this picture is clean if random access is done at the POC 4 picture
 - The sample values of the current picture (POC equal to 8) should be identical if decoding started on one of the pictures with POC equal to 0 or 2

| POC | Picture type | recovery_point_cnt | RpPicOrder CntVal |
|-----|--------------|--------------------|-------------------|
| 0 | GDR | 4 | 4 |
| 1 | TRAIL | - | - |
| 2 | GDR | 4 | 6 |
| 3 | TRAIL | - | - |
| 4 | GDR | 4 | 8 |
| 5 | TRAIL | - | - |
| 6 | GDR | 4 | 10 |
| 7 | TRAIL | - | - |
| 8 | GDR | 4 | 12 |

Constraint 7 - text



| | |
|-------------------|---|
| Proposed VVC text | <p>When <code>gdr_enabled_flag</code> is equal to 1 and <code>PicOrderCntVal</code> of the current picture is greater than or equal to <code>RpPicOrderCntVal</code> of the associated GDR picture, the following applies:</p> <ul style="list-style-type: none">- It is a requirement of bitstream conformance that the current and subsequent decoded pictures shall be an exact match to the pictures produced by starting the decoding process at the previous IRAP picture, if any, preceding the associated GDR picture in decoding order.- It is a requirement of bitstream conformance that the current and subsequent decoded pictures shall be an exact match to the pictures produced by starting the decoding process at any GDR picture, if any, for which its recovery point picture precedes the current picture in decoding order. |
| Current VVC text | <p>When <code>gdr_enabled_flag</code> is equal to 1 and <code>PicOrderCntVal</code> of the current picture is greater than or equal to <code>RpPicOrderCntVal</code> of the previous GDR picture in decoding order for which there is no IRAP picture between the current picture and the previous GDR picture in decoding order, it is a requirement of bitstream conformance that the current and subsequent decoded pictures shall be an exact match to the pictures produced by starting the decoding process at the previous IRAP picture preceding the current picture in decoding order.</p> |

