JCTVC-K0123: AHG9: Reference picture set clean-ups

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Summary

1. Addition of restrictions such that each LTRP signalled (explicitly or indexed) in the slice header shall be a distinct reference picture
2. Addition of a restriction that an LTRP entry shall not be directly signalled in any slice header when an equivalent LTRP entry is included in the SPS
3. Addition of a restriction that disallows duplicate LTRP entries signalled in the SPS
4. Addition of a restriction that disallows duplicate short-term RPS candidates in the SPS and a short-term RPS pattern in the SPS being repeatedly (i.e. explicitly) signalled in the slice header
5. Removal of the restriction that POC LSBs for LTRPs are signalled in a non-increasing order
6. Not counting STRPs in determination of sending MSB cycle for LTRPs

1. LTRP should not be repeated in slice header

- Same LTRP may be signalled (either indexed or explicitly) in the slice header

- The used_by_curr_pic_lt_flag could be signalled both zero and one for different instances

- Solution: the POC value of no two entries in RefPicSetLtCurr[i] or RefPicSetLtFoll[i] should be identical.

For each i in the range of 0 to NumPocLtCurr − 1, inclusive, it is a requirement of bitstream conformance that the following conditions apply:

    …
    There shall be no j in the range of 0 to NumPocLtCurr − 1, inclusive, where j is not equal to i, for which PicOrderCntVal of RefPicSetLtCurr[i] is equal to PicOrderCntVal of RefPicSetLtCurr[j].

For each i in the range of 0 to NumPocLtFoll − 1, inclusive, when RefPicSetLtFoll[i] is not equal to "no reference picture", it is a requirement of bitstream conformance that the following conditions apply:

    …
    There shall be no j in the range of 0 to NumPocLtCurr − 1, inclusive, for which PicOrderCntVal of RefPicSetLtFoll[i] is equal to PicOrderCntVal of RefPicSetLtCurr[j].
    There shall be no j in the range of 0 to NumPocLtFoll − 1, inclusive, where j is not equal to i and RefPicSetLtFoll[j] is not equal to "no reference picture", for which PicOrderCntVal of RefPicSetLtFoll[i] is equal to PicOrderCntVal of RefPicSetLtFoll[j].

2. LTRP in SPS should be indexed in slice header

- LTRP entry in SPS – indexed using lt_idx_sps[i]
- No advantage is explicitly signalling (using poc_lsb_lt[i])
- Solution: Restrict semantics of used_by_curr_pic_lt_flag[i] to disallow above.

used_by_curr_pic_lt_flag[i] equal to 0 specifies that the i-th candidate long-term reference picture to be included in the long-term reference picture set of the current picture is not used for reference by the current picture. For any value of j in the range of 0 to num_long_term_ref_pics_sps – 1, inclusive, if poc_lsb_lt[i] equals lt_ref_pic_poc_lsb_sps[j], used_by_curr_pic_lt_flag[i] shall not equal used_by_curr_pic_lt_sps_flag[j].

3. LTRPs in the SPS should not be repeated

- No restriction in repeating LTRP entries in the SPS

- Solution: restrict semantics of used_by_curr_pic_lt_sps_flag[i]

used_by_curr_pic_lt_sps_flag[i] equal to 0 specifies that the i-th candiate long-term reference picture specified in the sequence parameter set is not used for reference by a picture that includes in its reference picture set the i-th candidate long-term reference picture specified in the sequence parameter set. For any i and j in the range of 0 to num_long_term_ref_pics_sps – 1, inclusive, if i is not equal to j and lt_ref_pic_poc_lsb_sps[i] is equal to lt_ref_pic_poc_lsb_sps[j], then used_by_curr_pic_lt_sps_flag[i] shall not be equal to used_by_curr_pic_lt_sps_flag[j].

4. Disallow short-term RPS duplication

- ## Short-term RPS candidates in SPS

  - may repeat

  - may be explicitly signalled in slice header

For any two different values of idxA and idxB in the range of 0 to num_short_term_ref_pic_sets, inclusive, one or more of the following shall be true.

- NumNegativePics[idxA] is not equal to NumNegativePics[idxB].
- NumPositivePics[idxA] is not equal to NumPositivePics[idxB].
- When NumNegativePics[idxA] and NumPositivePics[idxA] equal NumNegativePics[idxB] and NumPositivePics[idxB], respectively, there exists either an i in the range of 0 to NumNegativePics[idxB] – 1, inclusive, for which UsedByCurrPicS0[idxA][i] is not equal to UsedByCurrPicS0[idxB][i] or DeltaPocS0[idxA][i] is not equal to DeltaPocS0[idxB][i], or there exists a j in the range of 0 to NumPositivePics[idxB] - 1, inclusive, for which UsedByCurrPicS1[idxA][j] is not equal to UsedByCurrPicS1[idxB][j] or DeltaPocS1[idxA][j] is not equal to DeltaPocS1[idxB][j], or both such i and j.

NOTE 5 – No two short-term reference picture set candidates signalled in the sequence parameter set can be identical, and a short-term reference picture set pattern cannot be explicitly signalled in the slice header if an identical candidate is present in the candidate list in the sequence parameter set.

5. Remove non-increasing order of POC LSBs

- POC LSBs have non-increasing restriction
  - Useful when LSBs were signalled ue(v)
  - Disallows optimal order that may avoid RPLM signalling
  - Less efficient
- Removal of non-increasing constraint
  - Remove the constraint in semantics of poc_lsb_lt[i] and lt_idx_sps[i]
  - Remove one condition in derivation of DeltaPocMsbCycleLt[i]

Example – current signalling

POC = 308
LSB = 20
MSB cycle = 9

LTRP[0]

POC = 84
LSB = 20
MSB cycle = 2

LTRP[1]

POC = 170
LSB = 10
MSB cycle = 5

LTRP[2]

POC = 311

current picture

DeltaPocMSBCycleLt[i]	1
poc_lsb_lt[i]	20
delta_poc_msb_cycle_lt[i]	1
# of bits for MSB cycle	3

DeltaPocMSBCycleLt[i]	8
poc_lsb_lt[i]	20
delta_poc_msb_cycle_lt[i]	7
# of bits for MSB cycle	7

DeltaPocMSBCycleLt[i]	5
poc_lsb_lt[i]	10
delta_poc_msb_cycle_lt[i]	5
# of bits for MSB cycle	5

Total bits for
MSB cycle = 15

poc_lsb_lt[i] specifies 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. The length of the poc_lsb_lt[i] syntax element is log2_max_pic_order_cnt_lsb_minus4 + 4 bits. For any values of j and k in the range of num_long_term_sps to num_long_term_sps + num_long_term_pics − 1, inclusive, if j is less than k, poc_lsb_lt[j] shall not be less than poc_lsb_lt[k].

$$\text{if}(i == 0 \,\|\, i == num\_long\_term\_sps \,\|\, PocLsbLt[i-1] \,!= PocLsbLt[i])$$
$$\quad DeltaPocMSBCycleLt[i] = delta\_poc\_msb\_cycle\_lt[i] \qquad (7\text{-}37)$$
$$\text{else}$$
$$\quad DeltaPocMSBCycleLt[i] = delta\_poc\_msb\_cycle\_lt[i] + DeltaPocMSBCycleLt[i−1]$$

Example – proposed signalling

POC = 308
LSB = 20
MSB cycle = 9

LTRP[0]

POC = 170
LSB = 10
MSB cycle = 5

LTRP[1]

POC = 84
LSB = 20
MSB cycle = 2

LTRP[2]

POC = 311

current picture

DeltaPocMSBCycleLt[i]	1
poc_lsb_lt[i]	20
delta_poc_msb_cycle_lt[i]	1
# of bits for MSB cycle	3

DeltaPocMSBCycleLt[i]	5
poc_lsb_lt[i]	10
delta_poc_msb_cycle_lt[i]	4
# of bits for MSB cycle	5

DeltaPocMSBCycleLt[i]	8
poc_lsb_lt[i]	20
delta_poc_msb_cycle_lt[i]	3
# of bits for MSB cycle	5

Total bits for
MSB cycle = 13

poc_lsb_lt[i] specifies 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. The length of the poc_lsb_lt[i] syntax element is log2_max_pic_order_cnt_lsb_minus4 + 4 bits. ~~For any values of j and k in the range of num_long_term_sps to num_long_term_sps + num_long_term_pics – 1, inclusive, if j is less than k, poc_lsb_lt[j] shall not be less than poc_lsb_lt[k].~~

if(i = = 0 || i = = num_long_term_sps || ~~PocLsbLt[i − 1] != PocLsbLt[i]~~)
    DeltaPocMSBCycleLt[i] = delta_poc_msb_cycle_lt[i]   (7-37)
else
    DeltaPocMSBCycleLt[i] = delta_poc_msb_cycle_lt[i]+ DeltaPocMSBCycleLt[i−1]

6. Not counting STRPs to decide sending of LTRP MSBs

- When an LTRP and STRP with the same LSB are signalled as reference for current picture, and no other ref. picture in DPB has same LSB, the MSB cycle of the LTRP need not be sent

- Modify constraints on RPS subset constraints to implement this; also reduce number of constraints.

Derivation process of RPS

…

For each i in the range of 0 to NumPocLtCurr − 1, inclusive, when CurrDeltaPocMsbPresentFlag[i] is equal to 1, it is a requirement of bitstream conformance that the following conditions apply:

- There shall be no j in the range of 0 to NumPocStCurrBefore − 1, inclusive, for which PocLtCurr[i] is equal to PocStCurrBefore[j].
- There shall be no j in the range of 0 to NumPocStCurrAfter − 1, inclusive, for which PocLtCurr[i] is equal to PocStCurrAfter[j].
- There shall be no j in the range of 0 to NumPocStFoll − 1, inclusive, for which PocLtCurr[i] is equal to PocStFoll[j].

For each i in the range of 0 to NumPocLtFoll − 1, inclusive, when FollDeltaPocMsbPresentFlag[i] is equal to 1, it is a requirement of bitstream conformance that the following conditions apply:

- There shall be no j in the range of 0 to NumPocStCurrBefore − 1, inclusive, for which PocLtFoll[i] is equal to PocStCurrBefore[j].
- There shall be no j in the range of 0 to NumPocStCurrAfter − 1, inclusive, for which PocLtFoll[i] is equal to PocStCurrAfter[j].
- There shall be no j in the range of 0 to NumPocStFoll − 1, inclusive, for which PocLtFoll[i] is equal to PocStFoll[j].

For each i in the range of 0 to NumPocLtCurr − 1, inclusive, when CurrDeltaPocMsbPresentFlag[i] is equal to 0, it is a requirement of bitstream conformance that the following conditions apply:

- There shall be no j in the range of 0 to NumPocStCurrBefore − 1, inclusive, for which PocLtCurr[i] is equal to (PocStCurrBefore[j] & (MaxPicOrderCntLsb − 1)).
- There shall be no j in the range of 0 to NumPocStCurrAfter − 1, inclusive, for which PocLtCurr[i] is equal to (PocStCurrAfter[j] & (MaxPicOrderCntLsb − 1)).
- There shall be no j in the range of 0 to NumPocStFoll − 1, inclusive, for which PocLtCurr[i] is equal to (PocStFoll[j] & (MaxPicOrderCntLsb − 1)).

For each i in the range of 0 to NumPocLtFoll − 1, inclusive, when FollDeltaPocMsbPresentFlag[i] is equal to 0, it is a requirement of bitstream conformance that the following conditions apply:

- There shall be no j in the range of 0 to NumPocStCurrBefore − 1, inclusive, for which PocLtFoll[i] is equal to (PocStCurrBefore[j] & (MaxPicOrderCntLsb − 1)).
- There shall be no j in the range of 0 to NumPocStCurrAfter − 1, inclusive, for which PocLtFoll[i] is equal to (PocStCurrAfter[j] & (MaxPicOrderCntLsb − 1)).
- There shall be no j in the range of 0 to NumPocStFoll − 1, inclusive, for which PocLtFoll[i] is equal to (PocStFoll[j] & (MaxPicOrderCntLsb − 1)).

Reference picture marking

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for( i = 0; i < NumPocLtCurr; i++ )
 if( !CurrDeltaPocMsbPresentFlag[ i ] )
  if( there is a long-term reference picture picX in the DPB [Ed. (JB): Should be made more precise. (GJS): Seems roughly OK
     to me.] with pic_order_cnt_lsb equal to PocLtCurr[ i ] )
   RefPicSetLtCurr[ i ] = picX
  else if( there is a short-term reference picture picY in the DPB with pic_order_cnt_lsb equal to PocLtCurr[ i ]
        and with PicOrderCntVal not in any of PocStCurrBefore[ ], PocStCurrAfter[ ], and PocStFoll[ ] )
   RefPicSetLtCurr[ i ] = picY
  else
   RefPicSetLtCurr[ i ] = "no reference picture"
 else
  if( there is a long-term reference picture picX in the DPB
     with PicOrderCntVal equal to PocLtCurr[ i ] )
   RefPicSetLtCurr[ i ] = picX
  else if( there is a short-term reference picture picY in the DPB
        with PicOrderCntVal equal to PocLtCurr[ i ] )
   RefPicSetLtCurr[ i ] = picY
  else
   RefPicSetLtCurr[ i ] = "no reference picture"                        (8-6)
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Similarly for long-term reference picture not used by current picture, i.e. RefPicSetLtFoll[i]

Other conditions added

All reference pictures included in RefPicSetLtCurr and RefPicSetLtFoll are marked as "used for long-term reference", and the following constraints apply.

For each i in the range of 0 to NumPocLtCurr − 1, inclusive, it is a requirement of bitstream conformance that the following conditions apply:
- There shall be no j in the range of 0 to NumPocStCurrBefore − 1, inclusive, for which PicOrderCntVal of RefPicSetLtCurr[i] is equal to PocStCurrBefore[j].
- There shall be no j in the range of 0 to NumPocStCurrAfter − 1, inclusive, for which PicOrderCntVal of RefPicSetLtCurr[i] is equal to PocStCurrAfter[j].
- There shall be no j in the range of 0 to NumPocStFoll − 1, inclusive, for which PicOrderCntVal of RefPicSetLtCurr[i] is equal to PocStFoll[j].
- There shall be no j in the range of 0 to NumPocLtCurr − 1, inclusive, where j is not equal to i, for which PicOrderCntVal of RefPicSetLtCurr[i] is equal to PicOrderCntVal of RefPicSetLtCurr[j].

For each i in the range of 0 to NumPocLtFoll − 1, inclusive, when RefPicSetLtFoll[i] is not equal to "no reference picture", it is a requirement of bitstream conformance that the following conditions apply:
- There shall be no j in the range of 0 to NumPocStCurrBefore − 1, inclusive, for which PicOrderCntVal of RefPicSetLtFoll[i] is equal to PocStCurrBefore[j].
- There shall be no j in the range of 0 to NumPocStCurrAfter − 1, inclusive, for which PicOrderCntVal of RefPicSetLtFoll[i] is equal to PocStCurrAfter[j].
- There shall be no j in the range of 0 to NumPocStFoll − 1, inclusive, for which PicOrderCntVal of RefPicSetLtFoll[i] is equal to PocStFoll[j].
- There shall be no j in the range of 0 to NumPocLtCurr − 1, inclusive, for which PicOrderCntVal of RefPicSetLtFoll[i] is equal to PicOrderCntVal of RefPicSetLtCurr[j].
- There shall be no j in the range of 0 to NumPocLtFoll − 1, inclusive, where j is not equal to i and RefPicSetLtFoll[j] is not equal to "no reference picture", for which PicOrderCntVal of RefPicSetLtFoll[i] is equal to PicOrderCntVal of RefPicSetLtFoll[j].