

JVET-N0495

AHG14: Recovery Point Indication NAL Unit

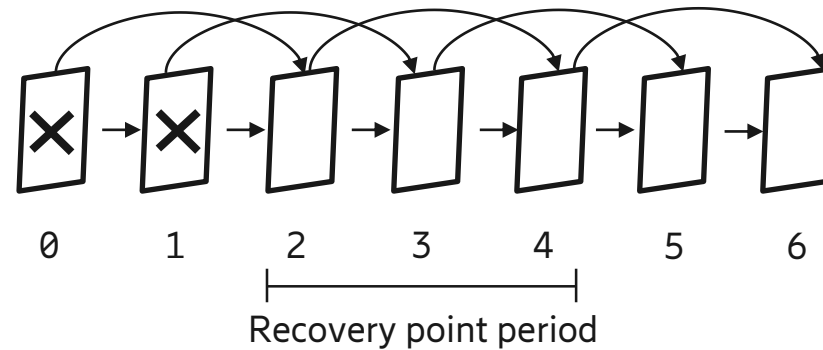


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Background



- AVC and HEVC specify a Recovery point SEI message for random access using progressive intra refresh



- JVET-M0529 proposed to signal the recovery point indication normatively in a non-VCL NAL unit

Proposal Summary



- It is proposed to add a recovery point indication NAL unit to VVC that
 - is a non-VCL NAL unit that defines a recovery point begin (RPB) access unit
 - defines the start and end of the recovery point period
 - may start a CVS similar to the mechanism for CRA pictures
 - includes syntax elements for generating unavailable reference pictures
- Starting the decoding at a recovery point is supported through the following process:
 1. decode a recovery point indication NAL unit
 2. generate unavailable reference pictures from syntax elements in the recovery point indication NAL unit
 3. decode the recovery point begin picture and the pictures that follow it in decoding order
 4. optionally suppress output of the recovery point begin picture and all pictures that follow it in decoding order until the last picture of the recovery point period is decoded

Advantages with normative recovery points



- Decoder support of recovery points
 - The encoder will know that a decoder shall support the recovery point indication NAL unit and no additional IRAP pictures need to be encoded to ensure random access
- Alignment between external specifications
 - By a normative signaling of the recovery point indication in the VVC specification, there is no need for external specifications to mandate the SEI message.
- Splitting of bitstreams
 - A bitstream encoded with normative recovery points may be divided into legal CVSs at the recovery points. A CVS may thus start with a recovery point access unit.
- Specific coding level tools may be used for recovery points
 - Indicating the presence of recovery points normatively enables normative progressive intra coding tools to be used for random access in a straight-forward way.

Benefits of using non-VCL NAL unit instead of VCL NAL unit



- The unavailable reference pictures may be allocated and initialized before starting to decode the tile group header
- The recovery point indication does not become tied to the picture type
 - For the VCL NAL unit approach multiple combinations for NAL unit types may need to be defined, e.g. GDR_TRAIL_N_NUT, GDR_TRAIL_R_NUT
- Can more easily be used to indicate the position of the next IRAP picture to the decoder
- Rewriting bitstreams becomes easier
 - Removing a recovery point requires just removing the recovery point indication NAL unit

Proposed Syntax and Semantics



nal_unit_type	Name of nal_unit_type	Content of NAL unit and RBSP syntax structure	NAL unit type class
...
24	RPI_NUT	Recovery point indication recovery_point_indication_rbsp()	non-VCL
25..27	RSV_NVCL25.. RSV_NVCL27	Reserved non-VCL NAL unit types	non-VCL
28..31	UNSPEC28.. UNSPEC31	Unspecified non-VCL NAL unit types	non-VCL

recovery_point_indication_rbsp() {	Descriptor
recovery_poc_cnt	se(v)
rpi_pic_parameter_set_id	ue(v)
number_of_reference_pictures	ue(v)
for(i = 0; i < number_of_reference_pictures; i++) {	
rpi_long_term_picture_flag[i]	u(1)
rpi_pic_order_cnt_val[i]	se(v)
}	
rbsp_trailing_bits()	
}	

number_of_reference_pictures specifies the number of reference picture that shall be generated if the RPI NAL unit is the first access unit in the CVS or a random access operation is initialized at the RPB access unit.

rpi_long_term_picture_flag[i] equal to 1 specifies that the i'th reference picture is a long-term picture. **rpi_long_term_picture_flag** equal to 0 specifies that the i'th reference picture is a short-term picture.

rpi_pic_order_cnt_val[i] specifies the PicOrderCntValue of the i'th generated unavailable reference picture.

Proposed RPI RBSP Semantics (full)



The RPI NAL unit shall precede any VCL NAL units in the access unit containing the RPI NAL unit. The RPI NAL unit shall follow any SPS or PPS NAL units in the access unit containing the RPI NAL unit. All VCL NAL units in an access unit containing the RPI NAL unit shall have TemporalId equal to 0.

If an RPB access unit containing an RPI NAL unit is not the first access unit in the CVS and a random access operation is not initialized at the RPB access unit, the RPI NAL unit in the RPB access unit shall be ignored.

Otherwise, if an RPB access unit containing an RPI NAL unit is the first access unit in the CVS or a random access operation is initialized at the RPB access unit, the following applies:

- The decoder shall generate unavailable reference pictures according to the process described in 8.3.5.
- The poc_msb_cycle_val for the RPB picture shall be set to 0 when deriving the PicOrderCntVal for the RPB picture.
- The RPB picture and all pictures that follow the RPB picture in decoding order shall be decoded.
- The RPB picture and all pictures that follow the RPB picture in decoding order until but not including the recovery point picture, should not but may be output.
- Any SPS or PPS RBSP that is referred to by the picture in a RPB access unit or by any picture following that picture in decoding order shall be available to the decoding process prior to its activation.

It is a requirement of bitstream conformance that the decoded pictures that follow the recovery point picture in decoding order shall be an exact match to the pictures that would be produced by starting the decoding process at the location of an IRAP or RPB access unit that precedes the RPB picture that belong to the same recovery point period as the recovery point picture in decoding order, if any, in the bitstream.

recovery_poc_cnt specifies picture order count of the recovery point picture. The picture that follows the current picture in decoding order that has PicOrderCntVal equal to the PicOrderCntVal of the current picture plus the value of recovery_poc_cnt is referred to as the recovery point picture. The recovery point picture shall not precede the current picture in decoding order. The value of recovery_poc_cnt shall be in the range of $-\text{MaxPicOrderCntLsb} / 2$ to $\text{MaxPicOrderCntLsb} / 2 - 1$, inclusive.

rpi_pic_parameter_set_id specifies the value of pps_pic_parameter_set_id for the PPS in use. The value of rpi_pic_parameter_set_id shall be identical to the value of tile_group_pic_parameter_set_id of the tile group headers of the coded picture in the RPB access unit.

number_of_reference_pictures specifies the number of reference picture that shall be generated if the RPI NAL unit is the first access unit in the CVS or a random access operation is initialized at the RPB access unit.

rpi_long_term_picture_flag[i] equal to 1 specifies that the i'th reference picture is a long-term picture. rpi_long_term_picture_flag equal to 0 specifies that the i'th reference picture is a short-term picture.

rpi_pic_order_cnt_val[i] specifies the PicOrderCntValue of the i'th generated unavailable reference picture.

Proposed decoding process for generating unavailable reference pictures



This process is invoked for any RPB NAL unit in the bitstream if the corresponding RPB access unit is the first access unit in the CVS or a random access operation is initialized at the RPB access unit.

The following applies:

- The SPS in use is set to the SPS with the value of `sps_seq_parameter_set_id` equal to the value of `pps_seq_parameter_set_id` of the PPS with the value of `pps_pic_parameter_set_id` equal to the value of `rpi_pic_parameter_set_id`.
- For each `i` in the range of 0 to `number_of_reference_pictures - 1`, inclusive, an unavailable picture is generated and the following applies:
 - The value of `PicOrderCntVal` for the generated picture is set equal to `rpi_pic_order_cnt_val[i]`.
 - The value of the variable `tile_group_pic_order_cnt_lsb` for the generated picture is set equal to `PicOrderCntVal % MaxPicOrderCntLsb`.
 - If `rpi_long_term_picture_flag[i]` is equal to 1, the generated picture is marked as "used for long-term reference".
 - If `rpi_long_term_picture_flag[i]` is equal to 0, the generated picture is marked as "used for short-term reference".
 - The variables `BitDepthY`, `BitDepthC` and `ChromaArrayType` is derived for the SPS in use as specified in clause 7.4.3.1.
 - The variable `PicWidthInLumaSamples` is set equal to `pic_width_in_luma_samples` of the SPS in use.
 - The variable `PicHeightInLumaSamples` is set equal to `pic_height_in_luma_samples` of the SPS in use.
 - The value of each element in the sample array S_L for the generated picture is set equal to $1 \ll (\text{BitDepthY} - 1)$.
 - When `ChromaArrayType` is not equal to 0, the value of each element in the sample arrays S_{Cb} and S_{Cr} for the generated picture is set equal to $1 \ll (\text{BitDepthC} - 1)$.
 - The prediction mode `CuPredMode[x][y]` is set equal to `MODE_INTRA` for $x = 0.. \text{PicWidthInLumaSamples} - 1$, $y = 0.. \text{PicHeightInLumaSamples} - 1$.

NOTE – A decoder may choose to generate `sps_max_dec_pic_buffering` number of pictures instead of `number_of_reference_pictures`

Proposed Definitions



coded video sequence (CVS): A sequence of *access units* that consists, in *decoding order*, of an *IRAP access unit* with NoRaslOutputFlag equal to 1 **or an *RPB access unit***, followed by zero or more *access units* that are not *IRAP access units* with NoRaslOutputFlag equal to 1, including all subsequent *access units* up to but not including any subsequent *access unit* that is an *IRAP access unit* with NoRaslOutputFlag equal to 1.

NOTE – An IRAP access unit may be an IDR access unit or a CRA access unit. The value of NoRaslOutputFlag is equal to 1 for each IDR access unit and each CRA access unit that is the first access unit in the bitstream in decoding order, is the first access unit that follows an end of sequence NAL unit in decoding order, or has HandleCraAsCvsStartFlag equal to 1.

recovery point: A point in the *bitstream* where the next bit in the bitstream is the first bit of an RPB access unit.

recovery point begin (RPB) access unit: An *access unit* that contains a recovery point indication NAL unit.

recovery point begin (RPB) picture: The *coded picture* in an RPB access unit.

recovery point period: The set of pictures including an RPB picture and all pictures that follow the RPB picture until and including the recovery point picture indicated by the recovery point indication NAL unit in the access unit containing the RPB picture.

recovery point picture: The last *coded picture* in decoding order in a recovery point period.

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Proposed Syntax and Semantics JVET-M0529



recovery_point_indication_rbsp() {	Descriptor
recovery_poc_cnt	se(v)
rbsp_trailing_bits()	
}	

recovery_poc_cnt specifies picture order count of the recovery point picture. The picture that follows the current picture in decoding order that has PicOrderCntVal equal to the PicOrderCntVal of the current picture plus the value of recovery_poc_cnt is referred to as the recovery point picture. The recovery point picture shall not precede the current picture in decoding order. The value of recovery_poc_cnt shall be in the range of $-\text{MaxPicOrderCntLsb} / 2$ to $\text{MaxPicOrderCntLsb} / 2 - 1$, inclusive.

