

JCTVC-N0094
HEVC version 1 (corrigendum):
Derivation of CPB removal time

Adarsh K. Ramasubramonian

Ye-Kui Wang

Qualcomm

Problem

- Calculation of CPB removal time has a problem
- The problem occurs for pictures that follow the buffering period SEI message that does not initialize the HRD.
- Without any changes, the model could result in CPB overflow in many typical cases

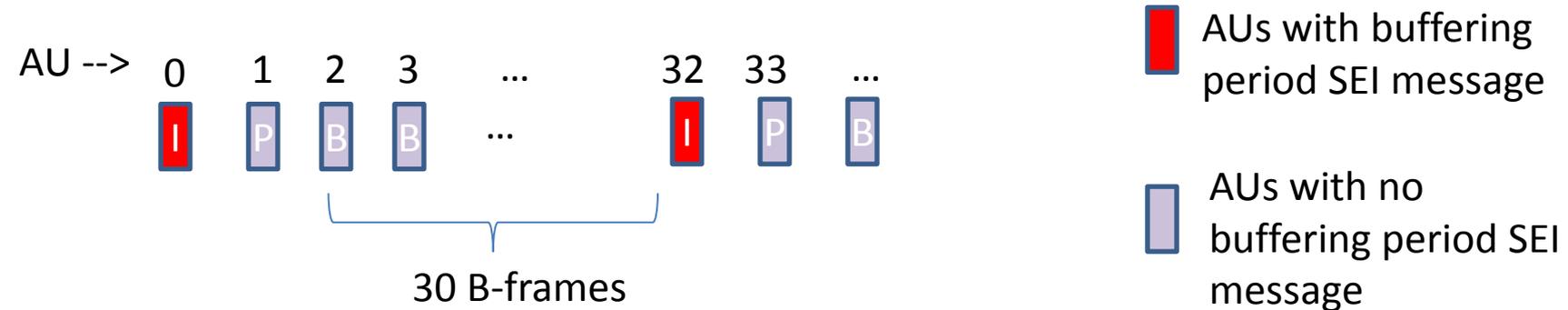
Variables and syntax elements related to CPB removal time

- `au_cpb_removal_delay_minus1`
 - Signaled in the picture timing SEI message
- `AuCpbRemovalDelayVal`
 - Derived from `au_cpb_removal_delay_minus1` (LSB) and derived MSB
- `AuNominalRemovalTime`
 - For picture with BP SEI that does not initialize HRD, it depends on
 - Nominal removal time of first picture in previous BP
 - `AuCpbRemovalDelayVal`
 - For picture without BP SEI
 - Nominal removal time of first picture in current BP
 - `AuCpbRemovalDelayVal`

Calculation of AuCpbRemovalDelayVal

- AuCpbRemovalDelayMsb is derived as follows:
 - if(au_cpb_removal_delay_minus1 <= prevAuCpbRemovalDelayMinus1)
 AuCpbRemovalDelayMsb = prevAuCpbRemovalDelayMsb + maxCpbRemovalDelay
 - else
 AuCpbRemovalDelayMsb = prevAuCpbRemovalDelayMsb
- The variable AuCpbRemovalDelayVal is derived as follows:
 - $\text{AuCpbRemovalDelayVal} = \text{AuCpbRemovalDelayMsb} + \text{au_cpb_removal_delay_minus1} + 1$
- The calculation does not work as intended in many typical cases!

Example



- 32-frame IRAP period, 30 fps, bit_rate = 3 Mbps, CPB size = 2,000,000 bits (250,000 B)
- InitCpbRemovalDelay = 0.666s
- cbr_flag = 1, vps_time_scale = 90,000,000, vps_num_units_in_tick = 100,000
- Pic. Sizes: 200,000 (I), 50,000 (P) and 5000 (B) bytes
- 16 bits to represent au_cpb_removal_delay_minus1

Initial arrival times

AU (decoding order)	0 (I)	1 (P)	2 (B)	3 (B)	4(B)	...	32 (I)	33 (P)
initArrivalTime(s)	0	0.5333	0.6666	0.68	0.6933	...	1.066	1.6

Removal times

AU (decoding order)	0 (I)	1 (P)	2 (B)	3 (B)	4(B)	...	32 (I)	33 (P)
Removal time (s)	0.666	0.8	0.8133	0.82666	0.84	1.7333	1.8666
Desired removal time (in clock ticks)	T	T+120	T+120 + 1x12	T+120 + 2x12	T+120 + 3x12	...	T + 960	T + 960 + 120
Current au_cpb_removal_delay_minus1+1	T	120	132	144	156	...	960	120
Calculated removal time (in clock ticks)	T	T+120	T+120 + 1x12	T+120 + 2x12	T+120 + 3x12	...	T + 960	T + 960 + 120 + 2¹⁶

Proposal

hrd_parameters(commonInfPresentFlag, maxNumSubLayersMinus1) {	Descriptor
if(commonInfPresentFlag) {	
nal_hrd_parameters_present_flag	u(1)
vcl_hrd_parameters_present_flag	u(1)
if(nal_hrd_parameters_present_flag vcl_hrd_parameters_present_flag){	
sub_pic_hrd_params_present_flag	u(1)
....	
initial_cpb_removal_delay_length_minus1	u(5)
au_cpb_removal_delay_length_minus1	u(5)
au_bp_cpb_removal_delay_length_minus1	u(5)
dpb_output_delay_length_minus1	u(5)
....	

au_bp_cpb_removal_delay_length_minus1 plus 1 specifies the length, in bits of the au_cpb_removal_delay_minus1 syntax element of the picture timing SEI message when the picture timing SEI message is associated with an access unit that contains a buffering period SEI message.

The variable AuCpbRemovalLength is derived as follows:

- If the picture timing SEI message is associated with an access unit that is also associated with a buffering period SEI message, the value of AuCpbRemovalLength is set equal to au_bp_cpb_removal_delay_length_minus1 + 1.
- Otherwise, AuCpbRemovalLength is set equal to au_cpb_removal_delay_length_minus1.

Proposal

- The variable `AuCpbRemovalDelayMsb` of the current picture is derived as follows:
 - If the current picture is associated with a buffering period SEI message that is applicable to at least one of the operation points to which the picture timing SEI message applies, `AuCpbRemovalDelayMsb` is set equal to 0.
 - Otherwise, let `prevAnchorPic` be the the previous picture in decoding order that has `TemporalId` equal to 0, that is not a RASL, RADL or sub-layer non-reference picture, and that is within the same buffering period as the current picture, and the following applies:
 - If `prevAnchorPic` is associated with a buffering period SEI message that is applicable to at least one of the operation points to which the picture timing SEI message applies, `AuCpbRemovalDelayMsb` is set equal to 0.
 - Otherwise, the following applies:
 - Let `maxCpbRemovalDelay` be equal to $2^{\text{AuCpbRemovalLength} - \text{au_cpb_removal_delay_length_minus1} + 1}$.
 - Let `prevAuCpbRemovalDelayMinus1` and `prevAuCpbRemovalDelayMsb` be set equal to `au_cpb_removal_delay_minus1` and `AuCpbRemovalDelayMsb`, respectively, of ~~`prevAnchorPic` the previous picture in decoding order that has `TemporalId` equal to 0, that is not a RASL, RADL or sub-layer non-reference picture, and that is within the same buffering period as the current picture.~~
 - `AuCpbRemovalDelayMsb` is derived as follows:
 - if(`au_cpb_removal_delay_minus1` <= `prevAuCpbRemovalDelayMinus1`)
$$\text{AuCpbRemovalDelayMsb} = \text{prevAuCpbRemovalDelayMsb} + \text{maxCpbRemovalDelay} \quad (\text{D-1})$$

else
$$\text{AuCpbRemovalDelayMsb} = \text{prevAuCpbRemovalDelayMsb}$$
- The variable `AuCpbRemovalDelayVal` is derived as follows:
 - $$\text{AuCpbRemovalDelayVal} = \text{AuCpbRemovalDelayMsb} + \text{au_cpb_removal_delay_minus1} + 1 \quad (\text{D-2})$$

Thank you