

SHVC HLS: support for unequal BL and EL GOP lengths

JCTVC-L0171

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Summary of proposals

1. To specify an access unit to contain VCL NAL units of a single value of `nuh_layer_id` only.
 - Consequently, to require that `nuh_layer_id` of the access unit delimiter NAL unit (if present) shall be equal to `nuh_layer_id` of the VCL NAL units contained in the access unit.
2. To allow a decoding/bitstream order of coded pictures with a certain value of `nuh_layer_id` to differ from the decoding/bitstream order of coded pictures with another value of `nuh_layer_id`.

Proposal #1 on SHVC access unit: background

- In SVC, access unit was specified to contain all dependency representations originating from the input picture for encoding, presumably because the single-loop decoding property had the following consequences:
 - The decoding of syntax elements from any reference layer might be needed when decoding the target layer.
 - No reference layer data can be removed from the CPB before the decoding of the target dependency/layer representation has been completed.
 - Decoding of an access unit resulted into one decoded picture (at the target layer).

Bottom line: due to the single-loop decoding, an access unit definition going “across layers” made sense in SVC

Proposal #1 on SHVC access unit: motivation

- An access unit has been defined as follows in HEVC:
 - **access unit:** A set of *NAL units* that are associated with each other according to a specified classification rule, are consecutive in *decoding order*, and contain exactly one *coded picture*.

NOTE 1 – In addition to containing the coded slice segment NAL units of the coded picture, an access unit may also contain other NAL units not containing slice segments of the coded picture. The decoding of an access unit always results in a decoded picture.
- Consequences of multi-loop decoding:
 - Each coded picture (having a certain value of `nuh_layer_id`) can be removed from the CPB as soon as it has been decoded.
 - Decoding of each coded picture (having a certain value of `nuh_layer_id`) results into one decoded picture.

Proposal #1 on SHVC access unit

Define an access unit in SHVC to contain one coded picture (having a certain value of nuh_layer_id).

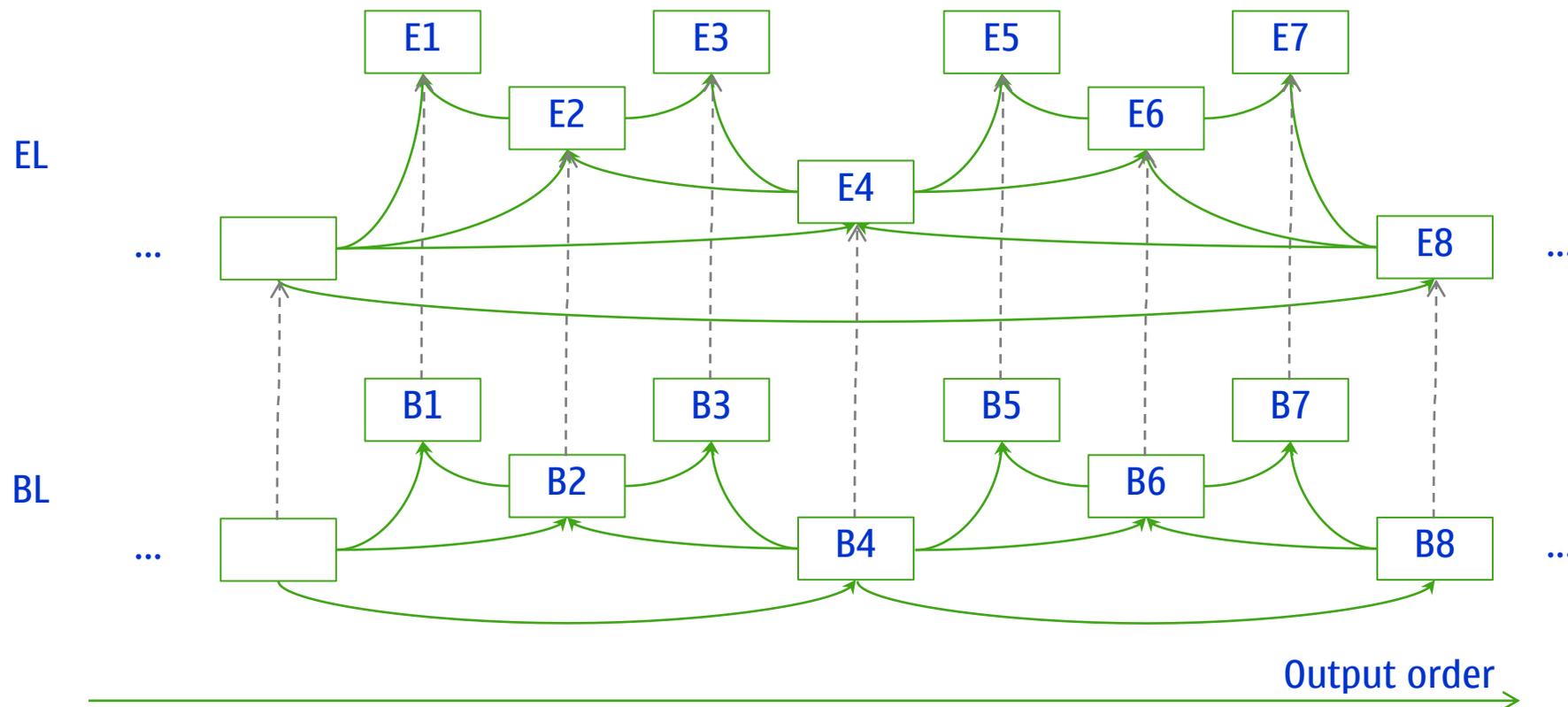
- We believe that no changes in the HEVC v1 definitions of an access unit and a coded picture are needed.
- Enables smaller CPB buffering delay.
- Also enables layers having different decoding/bitstream orders without substantial additions into the SHVC specification text.

As a consequence of the proposed definition of an access unit, it is proposed that nuh_layer_id of the access unit delimiter NAL unit (if present) shall be equal to nuh_layer_id of the VCL NAL units contained in the access unit.

Proposal #2: background

- Different GOP length between layers enables the encoder to have the **flexibility** to:
 - **Improve the compression efficiency** by having longer GOPs in the enhancement layer than in the base layer.
 - **Reduce the DPB memory use** by having shorter GOPs in the enhancement layer than in the base layer.
- Due to different GOP lengths the decoding order of BL and EL differ from each other

Proposal #2: example of unequal GOP lengths



Decoding order: ..., B4, B2, B1, B3, B8, E8, E4, E2, E1, E3, B6, E6, B5, E5, B7, E7, ...

Addition memory use: 2 BL pictures in DPB (B1, B3)

Proposal #2: Simulation Results 1

EL GOP 16 using SHVC 0.1.1 configuration, where the anchor is SHVC 0.1.1 and all the hooks disabled (in both).

	RA HEVC 2x			RA HEVC 1.5x			RA HEVC SNR		
	Y	U	V	Y	U	V	Y	U	V
Class A	-3,2%	-6,4%	-7,1%				-3,0%	-5,6%	-6,2%
Class B	-1,3%	-6,7%	-8,5%	-1,1%	-6,9%	-8,1%	-0,7%	-4,9%	-6,5%
Overall (EL+BL)	-1,8%	-6,6%	-8,1%	-1,1%	-6,9%	-8,1%	-1,3%	-5,1%	-6,4%
Overall (EL)	-3,0%	-10,5%	-12,6%	-1,2%	-14,5%	-16,3%	-2,1%	-10,4%	-12,3%

Proposal #2: Simulation Results 2

EL GOP 16, when motion hook in SHVC 0.1.1 is enabled (also in anchor)

	RA HEVC 2x			RA HEVC 1.5x			RA HEVC SNR		
	Y	U	V	Y	U	V	Y	U	V
Class A	-3,1%	-6,2%	-6,9%				-2,6%	-5,3%	-5,9%
Class B	-1,1%	-6,4%	-8,3%	-0,8%	-6,5%	-7,6%	-0,3%	-4,8%	-6,5%
Overall (EL+BL)	-1,7%	-6,4%	-7,9%	-0,8%	-6,5%	-7,6%	-0,9%	-4,9%	-6,3%
Overall (EL)	-2,7%	-9,9%	-12,0%	-0,4%	-13,3%	-15,1%	-1,3%	-10,1%	-12,0%

Proposal #2: impacts on specification

1. In addition to marking of pictures as “used for reference” and “unused for reference” for inter prediction within a layer, pictures can be marked as “used for inter-layer reference” and “unused for inter-layer reference”.
 - A picture with `nuh_layer_id` equal to LID is marked as “used for inter-layer reference” immediately after its decoding, if LID is not a leaf layer within the target operation point. Otherwise (the picture is on a leaf layer within the target operation point), the picture is marked as “unused for inter-layer reference”.
 - A picture is subsequently marked as “unused for inter-layer reference”, when all pictures (of the same POC value and within the same target operation point) that use the picture as inter-layer reference (according to the dependencies provided in the active VPS) have been decoded.
 - The bumping process of the DPB is modified to remove a picture from the DPB when it is marked as “unused for reference”, “unused for inter-layer reference” and “not needed for output”.
2. POC-based reference picture selection in inter-layer motion prediction
 - Similar to HEVC v1

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Thank you

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