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| *Title:* | **On independent layer** | | |
| *Status:* | Input Document to JCT-VC and JCT-3V | | |
| *Purpose:* | Proposal | | |
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# Abstract

This contribution proposes to restrict nuh\_layer\_id value dependent syntax so that independent layer can conform to HEVC version 1 syntax. Several syntax changes have been introduced for information exemption, scaling list prediction and POC alignment. However, these syntax changes cause a problem when it is applied to independent layer. Specifically, the version 1 decoder cannot decode the independent layer, which should be decordable nuh\_layer\_id aside. The syntax change can be also halmful because the extraction process could be harder due to the inevitable syntax trans-coding. In this proposal, two options are introduced: one is strictly disallowing syntax change for independent layers, the other is allowing syntax changes only if that is indicated in VPS.

Revision1 proposes Option3 that adds a gating flag which specifies whether slice\_pic\_order\_cnt\_lsb is always present as suggested by BoG.

# Option4

Revision2 includes Option4 that modifies Option3 by adding a condition that NumDirectRefereceLayers is equal to 0 (independent layer) on the gating flag as suggested by JCTVC/JCT3V track on HLS (30 Oct. 16:00-).

**F.7.3.2.1.1 Video parameter set extension syntax**

|  |  |
| --- | --- |
| vps\_extension( ) { | Descriptor |
| **avc\_base\_layer\_flag** | u(1) |
| … |  |
| **max\_one\_active\_ref\_layer\_flag** | u(1) |
| **cross\_layer\_irap\_aligned\_flag** | u(1) |
| for( i = 1; i <= vps\_max\_layers\_minus1; i++ ) |  |
| if (NumDirectRefereceLayers[i]==0) |  |
| **poc\_lsb\_present\_flag[i]** | u(1) |
| **direct\_dep\_type\_len\_minus2** | ue(v) |
| for( i = 1; i <= vps\_max\_layers\_minus1; i++ ) |  |
| for( j = 0; j < i; j++ ) |  |
| if( direct\_dependency\_flag[ i ][ j ] ) |  |
| **direct\_dependency\_type**[ i ][ j ] | u(v) |
| … |  |
| } |  |

**poc\_lsb\_present\_flag**[ i ] equal to 1 specifies that slice\_pic\_order\_cnt\_lsb is present in the slice headers of all pictures with nuh\_layer\_id equal to layer\_id\_in\_nuh[ i ] in the CVS. poc\_lsb\_present\_flag[ i ] equal to 0 specifies that slice\_pic\_order\_cnt\_lsb may or may not be present in the slice headers of all pictures with nuh\_layer\_id equal to layer\_id\_in\_nuh[ i ] in the CVS. When not present, poc\_lsb\_present\_flag[ i ] is inferred to be equal to nuh\_layer\_id > 0 ? 1 : 0.

**F.7.3.6.1 General slice segment header syntax**

|  |  |
| --- | --- |
| slice\_segment\_header( ) { | Descriptor |
| … |  |
| if( !dependent\_slice\_segment\_flag ) { |  |
| if( (poc\_lsb\_present\_flag[nuh\_layer\_id] ~~&& nuh\_layer\_id > 0~~) ||  ( nal\_unit\_type != IDR\_W\_RADL && nal\_unit\_type != IDR\_N\_LP ) ) { |  |
| **slice\_pic\_order\_cnt\_lsb** | u(v) |

# Option3

Revision1 proposes Option3 that adds a gating flag which specifies whether slice\_pic\_order\_cnt\_lsb is always present as suggested by BoG. This can I asserted to produce a capability to prevent slice level changes from HEVC version1.

**F.7.3.2.1.1 Video parameter set extension syntax**

|  |  |
| --- | --- |
| vps\_extension( ) { | Descriptor |
| **avc\_base\_layer\_flag** | u(1) |
| … |  |
| **max\_one\_active\_ref\_layer\_flag** | u(1) |
| **cross\_layer\_irap\_aligned\_flag** | u(1) |
| for( i = 1; i <= vps\_max\_layers\_minus1; i++ ) |  |
| if (NumDirectRefereceLayers[nuh\_layer\_id]==0) |  |
| **poc\_lsb\_present\_flag[i]** | u(1) |
| **direct\_dep\_type\_len\_minus2** | ue(v) |
| for( i = 1; i <= vps\_max\_layers\_minus1; i++ ) |  |
| for( j = 0; j < i; j++ ) |  |
| if( direct\_dependency\_flag[ i ][ j ] ) |  |
| **direct\_dependency\_type**[ i ][ j ] | u(v) |
| … |  |
| } |  |

**poc\_lsb\_present\_flag**[ i ] equal to 1 specifies that slice\_pic\_order\_cnt\_lsb is present in the slice headers of all pictures with nuh\_layer\_id equal to layer\_id\_in\_nuh[ i ] in the CVS. poc\_lsb\_present\_flag[ i ] equal to 0 specifies that slice\_pic\_order\_cnt\_lsb may or may not be present in the slice headers of all pictures with nuh\_layer\_id equal to layer\_id\_in\_nuh[ i ] in the CVS. When not present, poc\_lsb\_present\_flag[ i ] is inferred to be equal to 0.

**F.7.3.6.1 General slice segment header syntax**

|  |  |
| --- | --- |
| slice\_segment\_header( ) { | Descriptor |
| … |  |
| if( !dependent\_slice\_segment\_flag ) { |  |
| if( (poc\_lsb\_present\_flag[nuh\_layer\_id]  ~~nuh\_layer\_id > 0~~ ||  ( nal\_unit\_type != IDR\_W\_RADL && nal\_unit\_type != IDR\_N\_LP ) ) { |  |
| **slice\_pic\_order\_cnt\_lsb** | u(v) |

# Introduction

Independent layer, on which all direct\_dependency\_flag are equal to 0, is supposed to be usedfor the case that the layer is not strongly correlated with other layers. For example, Supplementary video, which is basically synchronized with video in other layers but the content is not correlated with video of other layers, perhaps captured in different viewpoints or in different places. Independent layer could be also used to benefit on easy decoding and extraction.

So far, several syntax changes have been introduced for parameter set prediction or profile level information, POC alignment[1], representing format[2], scaling list prediction and [3] etc as highlighted as follows. However these syntax changes have a problem if it is applied to independent layer.

|  |  |
| --- | --- |
| seq\_parameter\_set\_rbsp( ) { | Descriptor |
| **sps\_video\_parameter\_set\_id** | u(4) |
| if(nuh\_layer\_id = = 0 ) { [1] |  |
| **sps\_max\_sub\_layers\_minus1[M1007]** | u(3) |
| **sps\_temporal\_id\_nesting\_flag [K0276][M1007]** | u(1) |
| profile\_tier\_level( 1, sps\_max\_sub\_layers\_minus1 ) |  |
| } |  |
| **sps\_seq\_parameter\_set\_id** | ue(v) |
| if(nuh\_layer\_id > 0 ) [2] |  |
| **update\_rep\_format\_flag** | u(1) |
| if( update\_rep\_format\_flag ) { |  |
| **chroma\_format\_idc** | ue(v) |
| if( chroma\_format\_idc = = 3 ) |  |
| **separate\_colour\_plane\_flag** | u(1) |
| **pic\_width\_in\_luma\_samples** | ue(v) |
| **pic\_height\_in\_luma\_samples** | ue(v) |
| **}** |  |
| **…** |  |
| if( update\_rep\_format\_flag ) { |  |
| **bit\_depth\_luma\_minus8** | ue(v) |
| **bit\_depth\_chroma\_minus8** | ue(v) |
| **}** |  |
| … |  |
| if( scaling\_list\_enabled\_flag ) { |  |
| if(nuh\_layer\_id > 0 ) [3] |  |
| **sps\_infer\_scaling\_list\_flag** | u(1) |
| if( sps\_infer\_scaling\_list\_flag ) |  |
| **sps\_scaling\_list\_ref\_layer\_id** | u(6) |
| else { |  |
| **sps\_scaling\_list\_data\_present\_flag** | u(1) |
| if( sps\_scaling\_list\_data\_present\_flag ) |  |
| scaling\_list\_data( ) |  |
| } |  |
| } |  |
| **…** |  |
| } |  |

|  |  |
| --- | --- |
| pic\_parameter\_set\_rbsp( ) { | Descriptor |
| **…** |  |
| if(nuh\_layer\_id > 0 ) [3] |  |
| **pps\_infer\_scaling\_list\_flag** | u(1) |
| if( pps\_infer\_scaling\_list\_flag ) |  |
| **pps\_scaling\_list\_ref\_layer\_id** | u(6) |
| else { |  |
| **pps\_scaling\_list\_data\_present\_flag** | u(1) |
| if( pps\_scaling\_list\_data\_present\_flag ) |  |
| scaling\_list\_data( ) |  |
| } |  |
| … |  |
| } |  |

|  |  |
| --- | --- |
| slice\_segment\_header( ) { | Descriptor |
| … |  |
| if( !dependent\_slice\_segment\_flag ) { |  |
| … |  |
| if(nuh\_layer\_id > 0 | [4]|  ( nal\_unit\_type != IDR\_W\_RADL && nal\_unit\_type != IDR\_N\_LP ) ) { |  |
| **slice\_pic\_order\_cnt\_lsb** | u(v) |

# Proposal

We propose two options as follows:

Option1: Disallow any syntax changes when the layer specified by nuh\_layer\_id in independent layer.

Option2: Allow syntax changes when that is indicated in VPS.

We think Option2 is better unless POC alignment for independent layer can be exempted.

Note: Both options needs to read VSP for SPS, PPS and slice decoding to know whether the specific layer is independent or not (or the syntax change is allowed or now). If we need to avoid SPS // PPS to VSP dependency, slice only change might be possible while SPS and PPS syntax change needs to be accepted in this case.

**Option 1: Strict restriction**

|  |  |
| --- | --- |
| seq\_parameter\_set\_rbsp( ) { | Descriptor |
| **sps\_video\_parameter\_set\_id** | u(4) |
| if( IndependentLayerFlag [nuh\_layer\_id] || nuh\_layer\_id = = 0 ) { |  |
| **sps\_max\_sub\_layers\_minus1** | u(3) |
| **sps\_temporal\_id\_nesting\_flag** | u(1) |
| profile\_tier\_level( 1, sps\_max\_sub\_layers\_minus1 ) |  |
| } |  |
| **sps\_seq\_parameter\_set\_id** | ue(v) |
| if(! IndependentLayerFlag [nuh\_layer\_id] && nuh\_layer\_id > 0 ) |  |
| **update\_rep\_format\_flag** | u(1) |
| … |  |
| if( scaling\_list\_enabled\_flag ) { |  |
| if(! IndependentLayerFlag [nuh\_layer\_id] && nuh\_layer\_id > 0 ) |  |
| **sps\_infer\_scaling\_list\_flag** | u(1) |
| **…** |  |
| } |  |

IndependentLayerFlag [nuh\_layer\_id] = (NumDirectRefLayers[nuh\_layer\_id] == 0);

|  |  |
| --- | --- |
| pic\_parameter\_set\_rbsp( ) { | Descriptor |
| **…** |  |
| if(! IndependentLayerFlag [nuh\_layer\_id] && nuh\_layer\_id > 0 ) |  |
| **pps\_infer\_scaling\_list\_flag** | u(1) |
| … |  |
| } |  |

|  |  |
| --- | --- |
| slice\_segment\_header( ) { | Descriptor |
| … |  |
| if( !dependent\_slice\_segment\_flag ) { |  |
| … |  |
| if(! IndependentLayerFlag [nuh\_layer\_id] && nuh\_layer\_id > 0 | |  ( nal\_unit\_type != IDR\_W\_RADL && nal\_unit\_type != IDR\_N\_LP ) ) { |  |
| **slice\_pic\_order\_cnt\_lsb** | u(v) |

**Option 2: Optional restriction**

|  |  |
| --- | --- |
| vps\_extension( ) { | Descriptor |
| … |  |
| **rep\_format\_idx\_present\_flag** | u(1) |
| if( rep\_format\_idx\_present\_flag ) |  |
| **vps\_num\_rep\_formats\_minus1** | u(4) |
| for( i = 0; i <= vps\_num\_rep\_formats\_minus1; i++ ) |  |
| rep\_format( ) |  |
| if( rep\_format\_idx\_present\_flag ) |  |
| for( i = 1; i <= vps\_max\_layers\_minus1; i++ ) |  |
| if( vps\_num\_rep\_formats\_minus1 > 0 ) |  |
| **vps\_rep\_format\_idx**[ i ] | u(4) |
| **vps\_syntax\_change\_by\_layer\_id\_flag** | v(1) |
| **max\_one\_active\_ref\_layer\_flag** | u(1) |
| … |  |
| } |  |

for (i=0; i<vps\_max\_num\_layers\_minus1+1; i++) {

IndependentLayerFlag [nuh\_layer\_id] = (NumDirectRefereceLayers[nuh\_layer\_id]==0);

}

|  |  |
| --- | --- |
| seq\_parameter\_set\_rbsp( ) { | Descriptor |
| **sps\_video\_parameter\_set\_id** | u(4) |
| if( !vps\_syntax\_change\_by\_layer\_id\_flag || nuh\_layer\_id = = 0 ) { |  |
| **sps\_max\_sub\_layers\_minus1** | u(3) |
| **sps\_temporal\_id\_nesting\_flag** | u(1) |
| profile\_tier\_level( 1, sps\_max\_sub\_layers\_minus1 ) |  |
| } |  |
| **sps\_seq\_parameter\_set\_id** | ue(v) |
| if(vps\_syntax\_change\_by\_layer\_id\_flag && nuh\_layer\_id > 0 ) |  |
| **update\_rep\_format\_flag** | u(1) |
| … |  |
| if( scaling\_list\_enabled\_flag ) { |  |
| if(vps\_syntax\_change\_by\_layer\_id\_flag && nuh\_layer\_id > 0 ) |  |
| **sps\_infer\_scaling\_list\_flag** | u(1) |
| **…** |  |
| } |  |

|  |  |
| --- | --- |
| pic\_parameter\_set\_rbsp( ) { | Descriptor |
| **…** |  |
| if(vps\_syntax\_change\_by\_layer\_id\_flag && nuh\_layer\_id > 0 ) |  |
| **pps\_infer\_scaling\_list\_flag** | u(1) |
| … |  |
| } |  |

|  |  |
| --- | --- |
| slice\_segment\_header( ) { | Descriptor |
| … |  |
| if( !dependent\_slice\_segment\_flag ) { |  |
| if( vps\_syntax\_change\_by\_layer\_id\_flag && nuh\_layer\_id > 0 | |  ( nal\_unit\_type != IDR\_W\_RADL && nal\_unit\_type != IDR\_N\_LP ) ) { |  |
| **slice\_pic\_order\_cnt\_lsb** | u(v) |

# Conclusion

It is proposed to disallow syntax change for independent layer to extraction. Two options, the first is strictly disallow syntax change for independent layer, the second is syntax change is allowed if that is indicated in VPS. It is recommended to adopt one proposal (Option2 seems better from proponents understanding).

# Reference

[1] J. Boyce, Y.-K. Wang, NAL unit header and parameter set designs for HEVC extensions, JCTVC-K1007

[2] [A. K. Ramasubramonian](mailto:aramasub@qti.qualcomm.com), [Y.-K. Wang](mailto:yekuiw@qti.qualcomm.com), Y. Chen, J. Boyce, S. Deshpande, MV-HEVC/SHVC HLS: Representation format information in VPS, JCTVC-N0092

[3] S. Deshpande, M. Pettersson, S. Liu, T. Suzuki, MV-HEVC/SHVC HLS: On Scaling List Data Signaling, JCTVC-N0371

[4] M. M. Hannuksela, MV-HEVC/SHVC HLS: On IDR picture constraints, JCTVC-N0065

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