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| *Title:* | **On SNR Scalability Indication** | | |
| *Status:* | Input Document | | |
| *Purpose:* | Proposal | | |
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# Abstract

This contribution proposes to signal SNR scalability for the needs of re-sampling process, inter-layer filters and certain applications. It would be beneficial to differentiate SNR scalability from spatial scalability in high level syntax so that the encoder and decoder operations can be configured and/or initialized according to the relevant coding tools to be supported.

# Introduction

Scalable video coding supports multiple layers, and each layer could be designed to support spatial scalability, temporal scalability, SNR (Signal-to-Noise Ratio) scalability, or any other type of scalability.

Spatial scalability and SNR scalability are two major scalable cases being evaluated in SHVC common test conditions. For spatial scalability, the video is coded at different resolutions at different layers. For example, the base layer video may have 720p resolution and the enhancement layer may have 1080p resolution. For SNR scalability, the video resolution is the same across multiple layers but different layers may be coded at different quality. For example the base layer may be coded at 33dB, whereas the enhancement layer may be coded at 36dB. In the current SHVC WD 2, a syntax element, scalability\_mask, is included in Video Parameter Set (VPS) to differentiate multiview scalability and spatial/SNR scalability (as shown in Table 1).

1. Mapping of ScalabiltyId to scalability dimensions

|  |  |  |
| --- | --- | --- |
| **scalability\_mask index** | **Scalability dimension** | **ScalabilityId mapping** |
| 0 | Multiview | ViewId |
| 1 | spatial/SNR scalability | DependencyId |
| 2-15 | Reserved |  |

However, in the current SHVC working draft, the scalability\_mask syntax does not differentiate spatial and SNR scalability. The spatial scalability and SNR scalability are two different kinds of scalability requiring different codec operations and memory allocation. Some examples are given below:

* The re-sampling process for reference layer picture samples and reference layer motion field are necessary for spatial scalability but they are unnecessary for SNR scalability.
* Some inter-layer filters, such as fixed alternative resampling filter being evaluated in core experiment SCE3, may achieve significant performance gain in SNR scalability scenario but are not applicable to spatial scalability.
* Certain applications may prefer single-loop design (which was supported by SVC, the scalable extension of H.264) for SNR scalability only.
* The sampling grid work currently undergoing in core experiment SCE1 addresses the particular issues related to spatial scalability, not SNR scalability.

Therefore, it would be beneficial to differentiate SNR and spatial scalability in the high level syntax so that the encoder and decoder operations can be configured and/or initialized according to the relevant coding tools to be supported.

Here we propose a couple of options to signal SNR scalability.

# SNR scalability signaling

## Option 1: Scalability dimension

One straightforward way is to assign spatial scalability and SNR scalability separate scalability dimensions. Table 2 is the modified scalability dimension table where spatial and SNR scalability has their distinct values.

1. Proposed Mapping of ScalabiltyId to scalability dimensions

|  |  |  |
| --- | --- | --- |
| **scalability\_mask index** | **Scalability dimension** | **ScalabilityId mapping** |
| 0 | multiview | ViewId |
| 1 | Spatial scalability | DependencyId |
| 2 | SNR scalability | SnrId |
| 3-15 | Reserved |  |

Besides ViewId and DependencyId specified in SHVC WD 2 section F.7.4.3.1.1, variable SnrId[layer\_id\_in\_nuh[i]] is proposed here as the SNR identifier of the i-th layer. SnrId can be derived as follows:

|  |
| --- |
| for (i = 0; i <= vps\_max\_layers\_minus1; i++) {  for( smIdx= 0, j =0; smIdx< 16; smIdx ++ )  if( ( i ! = 0 ) && scalability\_mask[ smIdx ] )  ScalabilityId[ i ][ smIdx ] = dimension\_id[ i ][ j++ ]  else  ScalabilityId[ i ][ smIdx ] = 0  ViewId[ layer\_id\_in\_nuh[ i ] ] = ScalabilityId[ i ][ 0 ]  DependencyId [ layer\_id\_in\_nuh[ i ] ] = ScalabilityId[ i ][ 1 ]  SnrId [ layer\_id\_in\_nuh[ i ] ] = ScalabilityId[ i ][ 2 ]  } |

## Option 2: SNR scalability flag

Another way to signal the SNR scalability is to add a *SNR\_scalability\_flag* in VPS extension for each dependent reference layer. Table 3 shows the proposed syntax element in the VPS extension.

1. Video parameter set extension syntax

|  |  |
| --- | --- |
| vps\_extension( ) { | Descriptor |
| … |  |
| **max\_one\_active\_ref\_layer\_flag** | 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 ] ) { |  |
| **SNR\_scalability\_flag**[i][j] | u(1) |
| **direct\_dependency\_type**[ i ][ j ] | u(v) |
| } |  |
| **single\_layer\_for\_non\_irap\_flag** | u(1) |
| } |  |

**SNR\_scalability\_flag** equal to 1 specifies the scalability between layers with nuh\_layer\_id equal to layer\_id\_in\_nuh[ i ] and nuh\_layer\_id equal to layer\_id\_in\_nuh[ j ] is SNR scalability. SNR\_scalability\_flag equal to 0 specifies the scalability between layers with nuh\_layer\_id equal to layer\_id\_in\_nuh[i] and nuh\_layer\_id equal to layer\_id\_in\_nuh[j] is not SNR scalability. When SNR\_scalability\_flag is not present, it is inferred to be equal to 0.

With the proposed *SNR\_scalability\_flag*, the resampling process specified in SHVC WD2 G.8.1.4 can be simplified as below:

– if PicWidthInSamplesL is equal to RefLayerPicWidthInSamplesL and PicHeightInSamplesL is equal to RefLayerPicHeightInSamplesL and the values of ScaledRefLayerLeftOffset, ScaledRefLayerTopOffset, ScaledRefLayerRightOffset and ScaledRefLayerBottomOffset are all equal to 0. if SNR\_scalability\_flag[nuh\_layer\_id][dRlIdx] is set to 1,

* + rsPicSample is set equal to rlPicSample,
  + When alt\_collocated\_indication\_flag is equal to 1, rsPicMotion is set equal to rlPicMotion.

– otherwise, rsPic is derived as follows:

* + The picture sample resampling process as specified in subclause G.8.1.4.1 is invoked with the sample values of rlPicSample as input, and with the resampled sample values of rsPicSample as output.
  + When alt\_collocated\_indication\_flag is equal to 1, the picture motion field resampling process as specified in subclause G.8.1.4.2 is invoked with rlPicMotion as input, and with the resampled motion field of rsPicMotion as output.

## Option 3: SPS extensions

Another alternative is to signal the *SNR\_scalability\_flag* in SPS extension instead of in VPS extension. Table 4 depicts an example to signal *SNR\_scalability\_flag* in SPS extensions.

1. Sequence parameter set extension syntax

|  |  |
| --- | --- |
| sps\_extension( ) { | **Descriptor** |
| **inter\_view\_mv\_vert\_constraint\_flag** | u(1) |
| sps\_extension\_vui\_parameters( ) |  |
| **num\_SNR\_scalability\_flags** | ue(v) |
| for (j = 0; j < num\_SNR\_scalability\_flags; j ++) |  |
| **SNR\_scalability\_flag[j]** | u(1) |
| **num\_scaled\_ref\_layer\_offsets** | ue(v) |
| for( i = 0; i < num\_scaled\_ref\_layer\_offsets; i++) { |  |
| **scaled\_ref\_layer\_left\_offset[i]** | se(v) |
| **scaled\_ref\_layer\_top\_offset[i]** | se(v) |
| **scaled\_ref\_layer\_right\_offset[i]** | se(v) |
| **scaled\_ref\_layer\_bottom\_offset[i]** | se(v) |
| } |  |
| } |  |

**num\_SNR\_scalability\_flags** specifies the number of SNR\_scalability\_flag signaled in SPS extension.

**SNR\_scalability\_flag[j]** equal to 1 specifies the scalability between current layer with layer ID equal to nuh\_layer\_id and its j-th direct reference layer is SNR scalability. SNR\_scalability\_flag[j] equal to 0 specifies the scalability between current layer and j-th direct reference layer is not SNR scalability. When SNR\_scalability\_flag is not present, it is inferred to be equal to 0.

In general the value of *num\_SNR\_scalability\_flags* should be equal to the number of direct reference layers of the current enhancement layer.

In addition, the scaled ref layer offset syntax elements signaled in SPS extension can be used to condition whether the scaled offsets between layers are signaled. Because for SNR scalability, the scaled offsets are inferred to be zero. Table 5 shows an example of such signaling and two syntax elements, *num\_SNR\_scalability\_flags* and *num\_scaled\_ref\_layer\_offsets* in Table 5 are merged into a single *num\_ref\_layers* since the values of two syntax elements are identical*.*

1. Proposed sequence parameter set extension syntax

|  |  |
| --- | --- |
| sps\_extension( ) { | **Descriptor** |
| **inter\_view\_mv\_vert\_constraint\_flag** | u(1) |
| **num\_ref\_layers** | ue(v) |
| for( i = 0; i < num\_ref\_layers; i++) { |  |
| **SNR\_scalability\_flag[j]** | u(1) |
| if (SNR\_scalability\_flag[i] == 0) { |  |
| **scaled\_ref\_layer\_left\_offset[i]** | se(v) |
| **scaled\_ref\_layer\_top\_offset[i]** | se(v) |
| **scaled\_ref\_layer\_right\_offset[i]** | se(v) |
| **scaled\_ref\_layer\_bottom\_offset[i]** | se(v) |
| **}** |  |
| } |  |
| } |  |

**num\_ref\_layers** specifies the number of reference layers in the CVS. The value of num\_ref\_layers shall be the same as NumDirectRefLayers[nuh\_layer\_id] derived from VPS extension.

**SNR\_scalability\_flag[j]** equal to 1 specifies the scalability between current layer with layer ID equal to nuh\_layer\_id and its j-th direct reference layer is SNR scalability. SNR\_scalability\_flag[j] equal to 0 specifies the scalability between current layer and j-th direct reference layer is not SNR scalability. When SNR\_scalability\_flag is not present, it is inferred to be equal to 0.

# Patent rights declaration(s)

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