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| **Joint Collaborative Team on Video Coding (JCT-VC)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  15th Meeting: Geneva, CH, 23 Oct. – 1 Nov. 2013 | Document: JCTVC-O0056 |

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| **Joint Collaborative Team on 3D Video Coding Extensions**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  6th Meeting: Geneva, CH, 25 Oct. – 1 Nov. 2013 | Document: JCT3V-F0033 |

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| *Title:* | **MV-HEVC/SHVC HLS: On conversion to ROI-oriented multi-layer bitstream** | | |
| *Status:* | Input Document to JCT-VC and JCT-3V | | |
| *Purpose:* | Proposal | | |
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# Abstract

This contribution proposes support of bitstream conversion to ROI-capable multi-layer bitstream. First part of this contribution introduces a conversion process with enhancement-layer picture size modification. Second part of this contribution proposes normative changes to SHVC/MV-HEVC to support the described conversion process. The proposed change includes signalling of the information on phase shift between enhancement-layer luma pixel and reference-layer luma pixel. The proposed changes are asserted to help to keep the phase shift after cropping.

# Introduction

In recent meetings, there are several adoptions and contributions related to the ROI functionality in HEVC or SHVC. A potential solution to achieve ROI is to apply independently decodable tiles or tile sets. In the distribution server or middle box, one might want to reduce the bandwidth by converting original multi-layer bitstream into the ROI-oriented multi-layer bitstream. One approach is converting non-significant tiles to light-weight slices (with skipped slice, no-coefficient slice data etc.). The other approach, which will be mainly discussed in this contributing, is dropping all non-significant tiles as well as changing picture and conformance window sizes.

In the rest of this contribution, we firstly introduce how to convert to ROI-oriented multi-layer bitstream with picture size change. Then, we will introduce normative changes needed to support such conversion.

# Conversion to ROI-oriented multi-layer bitstream

We will introduce how original multi-layer bitstream encoded using constraint tiles could be converted into ROI-oriented multi-layer bitstream.

(1) Drop non-significant tile region

Non-significant tile is the tile that is completely outside of ROI. All VCL NAL units corresponding to the slices included in the non-significant tiles are removed from the bitstream.

(2) Rewrite picture information

Picture information is rewritten including picture size (pic\_{width,height}\_in\_luma\_samples) and conformance information (conformance\_window\_flag, conf\_win\_{left,right,top,bottom}\_offset). Modified picture size must correspond to the remaining tiles (i.e. significant tiles). Modified conformance window size should correspond to ROI.

(3) Rewrite tile information

Tile information is rewritten including tiles\_enabled\_flag, number of tiles (num\_tile\_{columns,rows}\_minus1), and tile sizes (column\_width\_minus1, row\_height\_minus1).

(4) Add BL ROI region information

When ROI is extracted only in EL and whole region remains in BL, the information on which part of BL corresponds to the extracted BL. This information can be signalled using negative values for scaled reference layer offset parameters. Alternatively, ROI region offset in BL coordinates can be signalled in EL SPS. The former preserves the EL-to-BL phase shift correspondence while the latter uses less bits for the ROI region information.

(5) Add EL-to-BL phase shift information

When both EL ROI and BL ROI are extracted, EL-to-BL phase shift correspondence need to be signalled to keep it preserved. To achieve that, negative value for scaled reference layer offset can be reused.

# Proposed modification

To support decoding of the converted bitstream described in the previous section, EL-to-BL phase shift information should be added.

## Syntax for EL-to-BL phase shift information

**[Option 1A]**

Following syntax are added.

**num\_cropped\_ref\_layer\_offsets** : the number of cropped reference layer offsets to be signalled.

**cropped\_ref\_layer\_left/top\_offset**[i] : the position of the top-left luma sample of the resampled reference picture relative to the nearest luma sample position whose corresponding position on the reference picture is an integer position.

G. 7.3.2.2.1 Sequence parameter set extension syntax

|  |  |
| --- | --- |
| sps\_extension( ) { | **Descriptor** |
| **inter\_view\_mv\_vert\_constraint\_flag** | u(1) |
| sps\_extension\_vui\_parameters( ) |  |
| **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\_cropped\_ref\_layer\_offsets** | ue(v) |
| for( i = 0; i < num\_cropped\_ref\_layer\_offsets; i++) { |  |
| **cropped\_ref\_layer\_left\_offset**[ i ] | ue(v) |
| **cropped\_ref\_layer\_top\_offset**[ i ] | ue(v) |
| **}** |  |
| **}** |  |

**num\_cropped\_ref\_layer\_offsets** specifies the number of sets of cropped reference layer offset parameters that are present in the SPS.

**cropped\_ref\_layer\_left\_offset**[ i ] specifies the horizontal offset, in units of two luma samples, between the upper-left luma sample of the resampled i-th direct reference layer picture used for inter-layer prediction and the luma sample of the resampled picture whose corresponding position on the reference picture is integer position. When not present, the value of seq\_cropped\_ref\_layer\_left\_offset[ i ] is inferred to be equal to 0.

**cropped\_ref\_layer\_top\_offset**[ i ] specifies the vertical offset, in units of two luma samples, between the upper-left luma sample of the resampled i-th direct reference layer picture used for inter-layer prediction and the luma sample of the resampled picture whose corresponding position on the reference picture is integer position. When not present, the value of seq\_cropped\_ref\_layer\_top\_offset[ i ] is inferred to be equal to 0.

**[Option 2]**

Alternatively, following SPS definition can be used. In this option, the phase offset value for the top-left luma sample of the current picture relative to the reference layer picture is directly signalled. Note that, in this case, the phase-shift correspondence is not as accurate as Option 1 while the amount of the additional information is smaller.

G. 7.3.2.2.1 Sequence parameter set extension syntax

|  |  |
| --- | --- |
| sps\_extension( ) { | **Descriptor** |
| **inter\_view\_mv\_vert\_constraint\_flag** | u(1) |
| sps\_extension\_vui\_parameters( ) |  |
| **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\_ref\_layer\_phase\_offsets** | ue(v) |
| for( i = 0; i < num\_ref\_layer\_phase\_offsets; i++) { |  |
| **cropped\_ref\_layer\_left\_phase\_offset**[ i ] | u(4) |
| **cropped\_ref\_layer\_top\_phase\_offset**[ i ] | u(4) |
| **}** |  |
| **}** |  |

**num\_ ref\_layer\_phase\_offsets** specifies the number of sets of reference layer phase offset parameters that are present in the SPS.

**cropped\_ref\_layer\_left\_phase\_offset**[ i ] specifies the horizontal phase offset in unit of 1/16 between the upper-left luma sample of the current picture and the upper-left luma sample of the resampled i-th direct reference layer picture used for inter-layer prediction.

**cropped\_ref\_layer\_top\_phase\_offset**[ i ] specifies the vertical phase offset in unit of 1/16 between the upper-left luma sample of the current picture and the upper-left luma sample of the resampled i-th direct reference layer picture used for inter-layer prediction.

## Decoding process relating to EL-to-BL phase shift information

G.8.1.4 Resampling process for inter layer reference pictures

**[Syntax Option 1A]**

The variables offsetX and offsetY are derived as follows:

offsetX = (– cropped\_ref\_layer\_left\_offset[dRlIdx] << 1) / ( ( cIdx = = 0)  ?  1 :  SubWidthC) (G‑XX)  
offsetY = (– cropped\_ref\_layer\_top\_offset[dRlIdx] << 1) / ( ( cIdx = = 0)  ?  1 :  SubHeightC) (G‑XX)

The variables RefLayerLeftPhaseOffset and RefLayerTopPhaseOffset are derived as follows:

RefLayerLeftPhaseOffset = ( ( ( xP – offsetX ) \* ScaleFactorX  + ( 1 << 11 ) ) >> 12 ) % 16  (G‑XX)  
RefLayerTopPhaseOffset = ( ( ( yP – offsetY ) \* ScaleFactorY + ( 1 << 11 ) ) >> 12 ) % 16 (G‑XX)

**[Syntax Option 2]**

The variables RefLayerLeftPhaseOffset and RefLayerTopPhaseOffset are derived as follows:

RefLayerLeftPhaseOffset = cropped\_ref\_layer\_left\_phase\_offset[dRlIdx] (G‑XX)  
RefLayerTopPhaseOffset = cropped\_ref\_layer\_top\_phase\_offset[dRlIdx] (G‑XX)

G.8.1.4.1.3 Luma sample interpolation process

...

The value of the interpolated luma sample IntLumaSample  is derived by applying the following ordered steps:

1. The derivation process for reference layer sample location used in resampling as specified in sub clause G.6.2 is invoked with cIdx equal to 0 and luma sample location ( xP, yP ) given as the inputs and ( xRef16, yRef16 ) in units of 1/16-th sample as output.
2. The variables xRef16 and yRef16 are modified as follows:

xRef16 += RefLayerLeftPhaseOffset (G-XX)

yRef16 += RefLayerTopPhaseOffset (G-XX)

1. The variables xRef and xPhase are derived as follows:

xRef     = ( xRef16 >> 4 ) (G‑22)

xPhase = ( xRef16 ) % 16 (G‑23)

G.8.1.4.1.4 Chroma sample interpolation process

...

The value of the interpolated chroma sample value intChromaSample is derived by applying the following ordered steps:

1. The derivation process for reference layer sample location in resampling as specified in subclause G.6.2 is invoked with cIdx and chroma sample location ( xPC, yPC ) given as the inputs and ( xRef16, yRef16 ) in units of 1/16-th sample as output.
2. The variables xRef16 and yRef16 are modified as follows:

xRef16 += RefLayerLeftPhaseOffset (G-XX)

yRef16 += RefLayerTopPhaseOffset (G-XX)

1. The variables xRef and xPhase are derived by

xRef     = ( xRef16 >> 4 ) (G‑30)

xPhase = ( xRef16 ) % 16 (G‑31)

# Conclusion

This contribution proposes support of bitstream conversion to ROI-capable multi-layer bitstream. First part of this contribution introduces a conversion process with enhancement-layer picture size modification. Second part of this contribution proposes normative changes to SHVC/MV-HEVC to support the described conversion process. The proposed change includes signalling of the information on phase shift between enhancement-layer luma pixel and reference-layer luma pixel. The proposed changes are asserted to help to keep the phase shift after cropping. It is recommended to agree on supporting the introduced conversion and to adopt the proposed change to SHVC/MV-HEVC.

# Patent rights declaration(s)

**SHARP Corporation may have current or pending patent rights relating to the technology described in this contribution and, conditioned on reciprocity, is prepared to grant licenses under reasonable and non-discriminatory terms as necessary for implementation of the resulting ITU-T Recommendation | ISO/IEC International Standard (per box 2 of the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form).**