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| *Title:* | **Parallel Processing Indications for Tiles in HEVC Extensions** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

HEVC supports tile based coding to enable parallel processing. In this contribution, some problems are discussed related to parallel processing of tiles across layers and methods are proposed to address the problems and to enable more friendly parallel processing of tiles across layers.

# Problem Statement

Existing solutions for parallel processing in SHVC and MV-HEVC are associated with at least the following problems:

* Inter-layer prediction dependencies across the same access unit require all reference layer pictures to be decoded before starting the decoding of current layer picture if the tile is not aligned across the layers.
* In a picture with more than one tile, up-sampling or inter-layer syntax prediction for some regions may cross tile boundaries in the reference layer picture. Due to parallel processing with tiles, the availability of reconstructed samples in the reference layer picture along tile boundaries cannot be guaranteed and hence the up-sampling or inter-layer filtering may not be properly performed.

# Proposal

In this proposal, besides constrain of cross-layer tile boundary alignment, two methods are proposed to enable parallel processing with tiles across layers. The proposed methods are categorized into,

1. Encoder constraint on inter-layer Prediction
2. Tile based upsampling filter

## Encoder constraint on inter-layer prediction

In this method an encoder constraint is applied so that no CU/PU in an enhancement tile is inter-layer texture predicted or inter-layer syntax predicted from a collocated CU/PU that may have up-sampling across the tiles in the reference layer pictures.

The indication of this restriction could be signalled in VUI or as an SEI message.

A VUI flag could be signaled as below.

|  |  |
| --- | --- |
| Vui\_parameters( ) { | Descriptor |
| … |  |
| **bitstream\_restriction\_flag** | u(1) |
| if( bitstream\_restriction\_flag ) { |  |
| **tiles\_fixed\_structure\_flag** | u(1) |
| **inter\_layerpred\_not\_along\_tile\_boundary\_flag** | u(1) |
| **…** |  |
| } |  |
| } |  |

**inter\_layerpred\_not\_along\_tile\_boundary\_flag** equal to 1 indicates that tile boundaries of different layers are aligned and inter-layer texture prediction and inter-layer syntax prediction are not allowed along/across the tile boundaries such that any enhancement layer tile can decoded without decoding any non-aligned base layer tile.  The alignment of tile boundaries means that any two enhancement layer picture samples that lie within the same enhancement layer tile, the collocated base layer samples shall also lie within the same base layer tile. inter\_layerpred\_not\_along\_tile\_boundary\_flag equal to 0 indicates that there is no restriction on the tile configurations among layers. When inter\_layerpred\_not\_along\_tile\_boundary\_flag is not present in bitstream, it shall be inferred to be equal to 0.

A Prefix SEI message could be as below

|  |  |
| --- | --- |
| tile\_interlayer\_pred\_info( payloadSize ) { | Descriptor |
| **inter\_layerpred\_not\_along\_tile\_boundary\_flag** | u(1) |
| } |  |

## Tile based up-sampling and filtering

Base layer pixels are re-sampled and used as interlayer reference. If the base layer picture is coded with tiles, sub-pixel samples close to the border of the tiles are calculated using the integer samples from neighboring tile.

In this method, it is proposed to signal a flag in SPS extension for enhancement layer to indicate whether tile based up-sampling is enabled.

|  |  |
| --- | --- |
| if( sps\_extension\_flag ) { |  |
| **...** |  |
| **tile\_based\_resampling\_filter\_enable\_flag** | u(1) |
| **...** |  |
| } |  |

**tile\_based\_resampling\_filter\_enable\_flag** equal to 0 specifies that picture based up-sampling is enabled. tile\_based\_resampling\_filter\_enable\_flag equal to 1 specifies that tile based up-sampling is enabled and tile boundaries of different layers are aligned. When tile\_based\_resampling\_filter\_enable\_flag not present it is inferred to be equal to 0.

When tile based up-sampling is enabled, tile boundaries are treated in the same way as that of picture boundaries in up-sampling process. That is, when a pixel sample outside the current tile (may be inside or outside the current picture) is needed for up-sampling, the pixel is generated with pixel padding from those inside the current tile. The padding process is the same as that for defined for pixels outside the current picture.

# Patent rights declaration(s)

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