|  |  |
| --- | --- |
| **Joint Collaborative Team on Video Coding (JCT-VC)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  16th Meeting: San José, US, 9–17 Jan. 2014 | Document: JCTVC-P0164\_v2 |

|  |  |  |  |
| --- | --- | --- | --- |
| *Title:* | **AHG13: chroma phase offset for SHVC resampling process** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
| *Author(s) or Contact(s):* | Krishna Rapaka  Jianle Chen  Marta Karczewicz  5775 Morehouse Drive, San Diego, CA, 92121, U.S.A | Email: | [krapaka@qti.qualcomm.com](mailto:krapaka@qti.qualcomm.com)  [cjianle@qti.qualcomm.com](mailto:cjianle@qti.qualcomm.com)  [martak@qti.qualcomm.com](mailto:martak@qti.qualcomm.com) |
| *Source:* | Qualcomm Inc. | | |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Abstract

In this contribution, the coding performance impact of chroma sample position in SHVC resampling process are investigated. The test results shows that consideration of the actual chroma sample position in resampling process provides –0.1% to –0.4% Luma BD rate saving, compared to the current SHVC, which assumes position “b” of chroma sample in resampling process.

Additional test results are provided that show –0.1% to –1.0% Luma BD rate saving, compared to when using position “a” for chroma sample in resampling process

# Introduction

In 4:2:0 color format, chroma samples location relatively to luma samples can be one of the 6 cases, as shown in Figure 1. Among the 6 cases, it’s asserted that the position “b” and “d” are mostly used chroma sample position 4:2:0 format video[1].

The chroma position during 4:4:4 to 4:2:0 conversion is not necessary in the scope of video codec so that it’s not specified as mandatory information in HEVC standard decoding process. While the chroma sample position is needed as mandatory information to derive the accurate reference layer sample location in SHVC resampling process. In current SHVC specification draft and reference software, position “b” (half luma sample shift vertically, no shift horizontally) is used in the resampling process since it’s asserted as default chroma sample position.

It was discussed for several times in the past JCTVC meetings whether it’s needed to consider accurate chroma sample position in resampling process. However no concrete decision was made on this topic due to the lack of appropriate test results.

In this contribution, the coding impact of using the accurate chroma sample position during resampling process is evaluated.

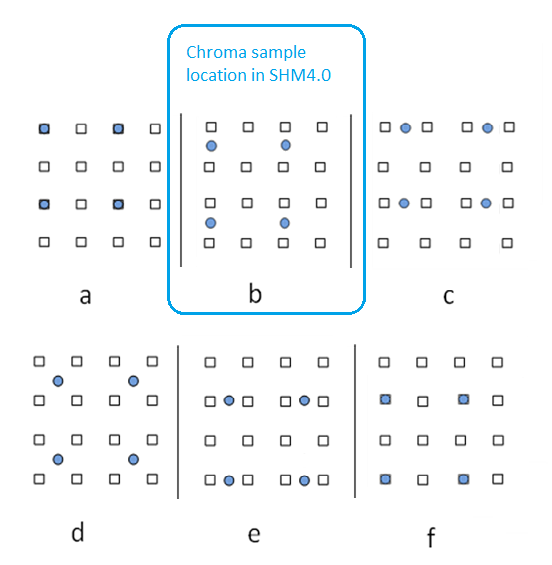


Figure 1 Chroma samples location relatively to Luma samples in 4:2:0 color format.

# Simulation and discussions

## Generation of the 420 sequence with different chroma sample location

The sequences of all 6 chroma positions, as shown in Figure 1, are generated from original 4:4:4 format sequences which are used by JCTVC for HEVC range extension development. The 2D separable 12-tap SHM4.0 downsampler [2] is used to downscale the Cb and Cr components of the 4:4:4 format sequences to form the 4:2:0 sequence. The generated 4:2:0 format sequences are used as enhancement layer input. Then the 4:2:0 format sequence are twice downscaled with SHM4.0 downsampler by considering the accurate chroma sample position to generate the base layer input.

## Simulation

The generated 4:2:0 format sequences with chroma position from “a” to “f” are tested with the following two schemes.

* SHM4.0 upsampling process: assume chroma sample position “b”.
* Resampling process with accurate chroma position: the actual chroma sample position is signaled and taken into account in resampling process.

The coding gain by considering the actual sample position for reference sample location derivation is shown in the following tables. All intra configuration is used in this test. The experimental results show that, compared to SHM4.0, consideration of the actual chroma sample position in resampling process provides –0.1% to –0.4% BD rate saving.

Table 1 BirdInCage

|  |  |  |  |
| --- | --- | --- | --- |
| Chroma position | BD rate saving | | |
| Y | U | V |
| “a” | -0.2% | 0.5% | 0.6% |
| “c” | -0.4% | 0.1% | 0.0% |
| “d” | -0.2% | -0.2% | -0.2% |
| “e” | -0.4% | -0.3% | -0.2% |
| “f” | -0.2% | 0.1% | 0.2% |

Table 2 Crowdrun

|  |  |  |  |
| --- | --- | --- | --- |
| Chroma position | BD rate saving | | |
| Y | U | V |
| “a” | -0.1% | 0.0% | 0.1% |
| “c” | -0.3% | 0.0% | 0.0% |
| “d” | -0.2% | -0.1% | -0.1% |
| “e” | -0.2% | -0.1% | -0.1% |
| “f” | -0.1% | 0.0% | 0.0% |

Table 3 Kimono

|  |  |  |  |
| --- | --- | --- | --- |
| Chroma position | BD rate saving | | |
| Y | U | V |
| “a” | -0.1% | 0.1% | 0.2% |
| “c” | -0.2% | -0.1% | -0.1% |
| “d” | 0.0% | -0.1% | -0.1% |
| “e” | -0.1% | -0.2% | -0.1% |
| “f” | -0.1% | 0.1% | 0.0% |

Table 4 EBURainFruits

|  |  |  |  |
| --- | --- | --- | --- |
| Chroma position | BD rate saving | | |
| Y | U | V |
| “a” | -0.1% | 0.3% | 0.2% |
| “c” | -0.2% | 0.0% | 0.0% |
| “d” | 0.0% | -0.1% | -0.1% |
| “e” | -0.1% | 0.0% | -0.1% |
| “f” | 0.0% | 0.1% | 0.1% |

Table 5 BugBuck

|  |  |  |  |
| --- | --- | --- | --- |
| Chroma position | BD rate saving | | |
| Y | U | V |
| “a” | -0.2% | 0.0% | 0.2% |
| “c” | -0.2% | -0.2% | -0.2% |
| “d” | -0.1% | 0.1% | 0.0% |
| “e” | -0.2% | 0.1% | 0.0% |
| “f” | -0.1% | 0.1% | 0.0% |

Additional experimental results show that, compared to using chroma sample position “a”, consideration of the actual chroma sample position in resampling process provides –0.1% to –1.0% BD rate saving.

Table 1 BirdInCage

|  |  |  |  |
| --- | --- | --- | --- |
| Chroma position | BD rate saving | | |
| Y | U | V |
| “b” | -0.2% | -0.6% | -0.7% |
| “c” | -0.2% | -0.4% | -0.5% |
| “d” | -0.4% | -0.8% | -1.0% |
| “e” | -0.9% | -1.1% | -1.1% |
| “f” | -0.7% | -0.8% | -0.8% |

Table 2 Crowdrun

|  |  |  |  |
| --- | --- | --- | --- |
| Chroma position | BD rate saving | | |
| Y | U | V |
| “b” | -0.1% | -0.1% | -0.1% |
| “c” | -0.2% | -0.1% | -0.1% |
| “d” | -0.3% | -0.1% | -0.2% |
| “e” | -0.6% | -0.2% | -0.3% |
| “f” | -0.4% | -0.2% | -0.2% |

Table 3 Kimono

|  |  |  |  |
| --- | --- | --- | --- |
| Chroma position | BD rate saving | | |
| Y | U | V |
| “b” | -0.1% | -0.2% | -0.2% |
| “c” | -0.1% | -0.2% | -0.2% |
| “d” | -0.1% | -0.3% | -0.3% |
| “e” | -0.3% | -0.5% | -0.5% |
| “f” | -0.3% | -0.3% | -0.3% |

Table 4 EBURainFruits

|  |  |  |  |
| --- | --- | --- | --- |
| Chroma position | BD rate saving | | |
| Y | U | V |
| “b” | 0.0% | -0.3% | -0.2% |
| “c” | -0.1% | -0.3% | -0.2% |
| “d” | -0.1% | -0.4% | -0.3% |
| “e” | -0.3% | -0.4% | -0.3% |
| “f” | -0.2% | -0.3% | -0.1% |

Table 5 BugBuck

|  |  |  |  |
| --- | --- | --- | --- |
| Chroma position | BD rate saving | | |
| Y | U | V |
| “b” | 0.0% | -0.2% | -0.1% |
| “c” | -0.1% | -0.2% | -0.1% |
| “d” | -0.2% | -0.1% | -0.2% |
| “e” | -0.3% | -0.2% | -0.2% |
| “f” | -0.3% | -0.1% | -0.1% |

# Conclusions and discussion

In this contribution, the coding performance impact of chroma sample position in SHVC resampling process are investigated. The test results shows that consideration of the actual chroma sample position in resampling process provides –0.1% to –0.4% comparing to the current SHVC resampling process, which assumes position “b” of chroma sample. It’s also asserted that the position “b” and “d” are mostly used chroma sample position in real world.

Base on the above facts, we recommend one of the following two schemes to be used in SHVC to solve chroma sample location issue.

* Method 1: Resampling process with chroma sample position “b”; no change is needed.
* Method 2: Signal chroma sampling position information in VPS and consider the actual chroma sample position in resampling process.

Between the above two methods, we prefer method 2.

# References

1. Gary Sullivan and Stephen Estrop, “Recommended 8-Bit YUV Formats for Video Rendering”, available at <http://msdn.microsoft.com/en-us/library/windows/desktop/dd206750(v=vs.85).aspx>.
2. J. Chen, J. Boyce, Y. Yan and M. M. Hannuksela, “Scalable HEVC (SHVC) Test Model 4 (SHM 4)”, JCTVC-O1007, 15th JCTVC Meeting, Geneva, CH, Oct. 2013

# Patent rights declaration(s)

**Qualcomm Inc. 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).**

# Spec text modification

## Syntax and semantics

|  |  |
| --- | --- |
| vps\_extension( ) { | Descriptor |
| **….** |  |
| for( i = 1; i <= MaxLayersMinus1; i++ ) |  |
| if( NumDirectRefLayers[ layer\_id\_in\_nuh[ i ] ] = = 0 ) |  |
| **poc\_lsb\_not\_present\_flag**[ i ] | u(1) |
| **cross\_layer\_phase\_alignment\_flag** | u(1) |
| **chroma\_phase\_idc** | u(3) |
| **….** |  |
| } |  |

chroma\_phase\_idc specifies that the locations of the Chroma sample grids for all pictures referring to the VPS. The value of chroma\_phase\_idc shall be in the range of 0 to 5, inclusive. The variable chroma\_phase\_X and chroma\_phase\_Y are derived as follows

chroma\_phase\_X = chroma\_phase\_idc == 0   ||  chroma\_phase\_idc == 1   ||  chroma\_phase\_idc == 5   
chroma\_phase\_Y = (chroma\_phase\_idc >> 2)  ?   2 : (chroma\_phase\_idc & 0x1)

## Decoding process

H.6.2 Derivation process for reference layer sample location used in resampling

Inputs to this process are

– a variable cIdx specifying the color component index,

– a sample location ( xP, yP ) relative to the top-left sample of the color component of the current picture specified by cIdx.

Output of this process is a sample location ( xRef16, yRef16 ) specifying the reference layer sample location in units of 1/16-th sample relative to the top-left sample of the reference layer picture.

The variables offsetX and offsetY are derived as follows:

offsetX = ScaledRefLayerLeftOffset / ( ( cIdx = = 0)  ?  1 :  SubWidthC) (H‑3)  
offsetY = ScaledRefLayerTopOffset / ( ( cIdx = = 0)  ?  1 :  SubHeightC) (H‑4)

The variables phaseX, phaseY, addX and addY are derived as follows:

phaseX = ( cIdx = = 0 ) ? ( cross\_layer\_phase\_alignment\_flag << 1 ) : cross\_layer\_phase\_alignment\_flag  +  chroma\_phase\_X (H‑5)  
phaseY = ( cIdx = = 0 ) ? ( cross\_layer\_phase\_alignment\_flag << 1 ) : cross\_layer\_phase\_alignment\_flag  +  chroma\_phase\_Y (H‑6)

addX = ( ScaleFactorX \* phaseX + 2 ) >> 2 (H‑7)   
addY = ( ScaleFactorY \* phaseY + 2 ) >> 2 (H‑8)

The variables xRef16 and yRef16 are derived as follows:

xRef16 = ( ( ( xP – offsetX ) \* ScaleFactorX  + addX + ( 1 << 11 ) ) >> 12 ) – ( phaseX << 2 ) (H‑9)  
yRef16 = ( ( ( yP – offsetY ) \* ScaleFactorY + addY + ( 1 << 11 ) ) >> 12 ) – ( phaseY << 2 )