|  |  |
| --- | --- |
| **Joint Collaborative Team on Video Coding (JCT-VC)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11**  17th Meeting: Valencia, ES, 27 March – 4 April 2014 | Document: JCTVC-Q0013 |

|  |  |  |  |
| --- | --- | --- | --- |
| *Title:* | **JCT-VC AHG report: SHVC inter-layer filtering (AHG13)** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Report | | |
| *Author(s) or Contact(s):* | E. Alshina,  J. Chen,  P. Topiwala,  T. Yamamoto,  Y. Ye | Tel: Email: | [elena\_a.alshina@samsung.com](mailto:elena_a.alshina@samsung.com),  [cjianle@qti.qualcomm.com](mailto:cjianle@qti.qualcomm.com)  [pankaj@fastvdo.com](mailto:pankaj@fastvdo.com)  [yamamoto.tomoyuki@sharp.co.jp](mailto:yamamoto.tomoyuki@sharp.co.jp)  yan.ye@interdigital.com |
| *Source:* | AhG 13 | | |

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

# Abstract

This document reports on the work of the JCT-VC AHG on **SHVC inter-layer filtering** (AHG13) between the 16th JCT-VC meeting in San Jose, US, (9 – 17 Jan. 2014) and 17th JCT-VC meeting in Valencia, Spain, (27 March – 4 April 2014) and, and lists the related input documents.

# Mandate

**SHVC inter-layer filtering (AHG13)**

([jct-vc@lists.rwth-aachen.de](mailto:jct-vc@lists.rwth-aachen.de))

* Study alternative upsampling and downsampling filters for spatial scalability.
* Study the effect of taking into account chroma position alignment during resampling processing.
* Study re-sampling process modification related to extracting regions of interest.
* Discuss and identify additional issues related to inter-layer filtering.

There have not been discussions related to the mandates of this ad-hoc group over the reflector between the 16th JCT-VC meeting and the 17th JCT-VC meeting. However, there was significant activity in input contributions for this meeting.

AhG13 related activity could be classified in 4 major topics:

* Phase shift in re-sampling process adjustment;
* Additional inter-layer filtering;
* Re-sampling process refinement;
* Bug fix in inter-layer filtering for bit-depth scalability.

# Activity summary and list of related contributions

Following contributions fall to the category “***Phase shift in re-sampling process adjustment***”:

|  |  |  |
| --- | --- | --- |
| **Doc #** | **Title** | **Authors** |
| [JCTVC-Q0107](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=8911) | SHVC HLS: On picture level resampling phase filter selection | Y. Ye, Y. He, Y. He (InterDigital) |
| [JCTVC-Q0119](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=8924) | Increased resolution for scaled reference layer offset | K. Minoo, D. Baylon, A. Luthra (ARRIS) |
| [JCTVC-Q0120](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=8925) | Re-sampling using existing phase offset flag signaling | K. Minoo, D. Baylon (ARRIS) |
| [JCTVC-Q0168](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=8979) | On phase offset for resampling process in SHVC | J. Chen, K. Rapaka, M. Karczewicz (Qualcomm) |
| [JCTVC-Q0187](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=8999) | Resampling of reference layer frames in interlaced-to-progressive scalability | [M. M. Hannuksela, K. Ugur (Nokia)](mailto:miska.hannuksela@nokia.com) |

Current SHVC draft distinguishes 2 types relative displacement between base and enhancement pictures introduced by down-sampling process which (zero-phase shift or central position alignment). In re-sampling process Chroma sample in 4:2:0 format is assumed to be half-pel vertically displaced relatively to Luma sample.

Solution which handles interlaced-to-progressivescalability was adopted at JCTVC 16th meeting. Re-sampling process distinguishes 3 cases in current SHVC draft spec: picture to picture, top filed –picture and bottom-field to picture conversion. Phase shift during re-sampling is derived from system of flags indicating one of mentioned above situation.

Proposals in this category suggest reorganizing the syntax for re-sampling process phase adjustment in order to cover wider variety of combinations. In contributions from ARRIS and Nokia phase offsets are still derived from system of flags. In Qualcomm’s and InterDigital’s contributions phase offsets are implicitly signalled.

This is asserted that re-sampling process in current SHVC draft is not well enough suited for interlaced-to-progressive scalability when the base layer contains coded frames. But no performance or subjective test results are reported in order to confirm this statement.

Following contributions fall to the category “***Additional inter-layer filtering***”:

|  |  |  |
| --- | --- | --- |
| **Doc #** | **Title** | **Authors** |
| [JCTVC-Q0043](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=8847) | Non-SCE1: De-noising of inter-layer reference | E. Alshina, A. Alshin (Samsung) |
| [JCTVC-Q0048](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=8852) | SCE1: Color gamut scalability with asymmetric 3D LUT | X. Li, J. Chen, M. Karczewicz (Qualcomm), Y. He, Y. Ye, J. Dong (InterDigital), P. Bordes, P. Andrivon, E. Francois, F. Hiron (Technicolor) |
| [JCTVC-Q0056](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=8860) | Non-SCE1: Encoder improvements for weighted prediction | A. Aminlou, K. Ugur (Nokia), E. Alshina (Samsung) |
| [JCTVC-Q0072](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=8876) | SCE1: Color gamut scalability using gain-offset models | A. Aminlou, K Ugur, M. M. Hannuksela (Nokia) |
| [JCTVC-Q0129](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=8935) | Non-SCE1: Reduction of the number of color space regions in SCE1 test 1.1 | C. Auyeung, K. Sato (Sony) |
| [JCTVC-Q0141](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=8951) | Non-SCE1: Coding of color gamut prediction coefficients | K. Misra, S.-H. Kim, A. Segall (Sharp) |

Proposals in this category were tested using SCE1 settings: base and enhancement layers have different color gamut. Color-conversion methods introduce additional processing step during inter-layer reference picture construction executed before or after re-sampling process.

The highest performance in SCE1 tests (~8% average BD-rate gain) was demonstrated by inter-layer cross-color filter with coefficients depending on triplet (Y,Cb,Cr) position in color space. Roughly speaking this gain is composed from ~5% gain which comes from splitting the color space into multiple regions (up to 8×8×8) and another ~3% comes from cross-color inter-layer filtering [[JCTVC-Q0072](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=8876)]. More details about these tools, comparison and complexity analysis can be found in AhG14 and SCE1 reports.

De-noising for inter-layer reference previously was proposed for SNR scalability only for color-gamut scalability content shows BD-rate gain both for spatial ratio ×1 and ×2. Average gain for inter-layer reference de-noising is ~1% is additive color-gamut conversion tools.

About 1,5% BD-rate gain could be achieved with encoder modifications for weighted prediction utilized in SCE1 anchor for inter-layer color-gamut conversion.

Following contributions fall to the category “***Re-sampling process refinement***”.

|  |  |  |
| --- | --- | --- |
| **Doc #** | **Title** | **Authors** |
| [JCTVC-Q0104](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=8908) | Fix for the computation of scaling factors used in inter-layer prediction | Kenneth Andersson, Jonatan Samuelsson (Ericsson) |
| [JCTVC-Q0122](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=8927) | Increased precision for deriving the reference layer sample locations | K. Minoo, D. Baylon (ARRIS) |
| [JCTVC-Q0159](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=8970) | AHG 13: Sub-region extraction – position calculation and comparison of different approaches | T. Yamamoto, T. Tsukuba, T. Ikai (Sharp) |
| [JCTVC-Q0197](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=9017) | Cross-check for increased precision for deriving the reference layer sample location | [E.Alshina (Samsung)](mailto:elena_a.alshina@samsung.com) |

In Ericsson’s contribution strange performance drop was demonstrated in case of 540p to 720p conversion (spatial ratio 4:3). Proposed solution adds one SPS level flag which affects Scaled Reference Offsets and Scaling factor derivation.

In ARRIS’s contribution the shift value in reference sample position derivation is modified. Shift becomes dependent on reference layer picture size.

In Sharp's contribution, scaling factor and reference sample position derivation for region-of-interest extraction is proposed. It is a re-proposal of the contribution from 15th and 16th JCTVC meetings responding to the request for clarification of application case.

Following contributions fall to the category “***Bug fix in inter-layer filtering for bit-depth scalability***”.

|  |  |  |
| --- | --- | --- |
| **Doc #** | **Title** | **Authors** |
| [JCTVC-Q0130](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=8936) | AHG12: Mismatch of SHVC draft 5 and SHM-5.0 software in bit-depth scalability with 1x scalability | [C. Auyeung (Sony)](mailto:cheung.auyeung@am.sony.com) |
| [JCTVC-Q0198](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=9018) | Cross-check for bit-depth conversion bug fix in SHM reference s/w (JCTVC-Q0130) | E. Alshina, A. Alshin (Samsung) |

This is s/w but-fix for bit-depth conversion. Bit-depth conversion between layers is incorporated with re-sampling process. In case of spatial ratio ×1 it was simply not implemented. Bug fix provides more than 30% BD-rate gain.

# Recommendations

* Review related contributions
* Fix bit-depth conversion for ×1 case in reference s/w.