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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**  12th Meeting: Geneva, CH, 14–23 Jan. 2013 | Document: JCTVC-L0228\_r1 |

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| *Title:* | **Performance of HLS-only tools in SHVC** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Information | | |
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# Abstract

In this contribution, a set of HLS-only coding tools are combined and implemented in SMuC v0.1.1. The performance of such combination is tested under the SHVC common test conditions. Compared to simulcast, average (Y, U, V) bit rate savings of (-28.5%, -31.6%, -32.5%), (-22.1%, -21.1%, -19.5%), and (-16.5%, -15.0%, -13.3%) are achieved for the AI, RA and LDP cases, respectively.

# Introduction

The SHVC software SMuC v0.1.1 supports two types of signalling for inter layer prediction: IntraBL and ref\_idx. The ref\_idx branch requires HLS-only changes to the enhancement layer codec. The TE2 document JCTVC-L0051 [1] made additional changes to the ref\_idx branch in SMuC v0.1.1 to test performance of different inter layer reference (ILR) placements. It was found that the following setting not only improves coding performance, but also reduces encoder and decoder complexity of the ref\_idx framework:

1. For B pictures, the ILR is placed in both L0 and L1 for the lowest temporal level pictures, and is placed only in L0 for all other pictures.
2. Only zero motion vectors are allowed when using ILR.

In document JCTVC-L0059 , a picture level processing tool is proposed to enhance the signal quality of the chroma planes in the ILR picture. It can significantly improve the enhancement layer chroma coding efficiency. This chroma enhancement tool has been integrated into the TE2 software used in JCTVC-L0051.

In TE5 document JCTVC-L0052 [3], motion field mapping (MFM) is proposed to improve the TMVP process in the EL without requiring block level changes. MFM maps the motion field of the base layer picture into a virtual motion field for the ILR. This virtual motion field is then used for TMVP in the EL. Together with JCTVC-L0059 [2], this MFM tool has also been integrated into the TE2 software used in JCTVC-L0051.

Additionally, there are a number of other picture level processing tools that require HLS-only changes and can be combined with the ref\_idx framework to improve performance. These tools include almost all of the inter layer filtering techniques tested in TE4 [5], the differential mode coding tool in JCTVC-L0213 [4], as well as the skipped slice tool in TE2 [6][7]. It is expected that combination with these tools can further improve the coding performance of HLS-only based SHVC performance. However, due to time constraint, combination with these tools was not implemented or tested.

# Simulation results

The HLS-only coding tools in JCTVC-L0051 [1], JCTVC-L0059 [2], and JCTVC-L0052 [3] are combined together and implemented in SMuC v0.1.1. The encoder-side bug fix for the ref\_idx framework provided in JCTVC-L0167 [8] is also integrated into the same software, although the bug fix does not have an impact on coding performance when the TE2 setting 2 in JCTVC-L0051 is used.

Table 1 shows the summary performance in comparison with simulcast under SHVC common test conditions. Table 2 shows the average BD rate reduction for each prediction setting, AI, RA and LDP. On average, the combined tools achieve BD rates of (-28.5%, -31.6%, -32.5%), (-22.1%, -21.1%, -19.5%), and (-16.5%, -15.0%, -13.3%) for (Y, U, V). Detailed performance data can be found in the accompanying excel files.

Table . Performance comparison of ref\_idx (TE2 setting 2 + zeroMV), motion field mapping, and chroma enhancement vs. Simulcast

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **AI HEVC 2x** | | | **AI HEVC 1.5x** | | |  |  |  |
|  | Y | U | V | Y | U | V |  |  |  |
| Class A | -27.8% | -31.0% | -30.9% |  |  |  |  |  |  |
| Class B | -22.0% | -25.0% | -25.9% | -33.5% | -36.4% | -37.7% |  |  |  |
| **Overall (EL+BL)** | -23.6% | -26.7% | -27.3% | -33.5% | -36.4% | -37.7% |  |  |  |
| **Overall (EL)** | -36.0% | -40.8% | -41.2% | -59.5% | -62.3% | -63.8% |  |  |  |
| Enc Time[%] | 213.0% | | | 157.1% | | |  |  |  |
| Dec Time[%] | 109.8% | | | 99.8% | | |  |  |  |
| BL Match | Matched | | | Matched | | |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
|  | **RA HEVC 2x** | | | **RA HEVC 1.5x** | | | **RA HEVC SNR** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A | -19.8% | -18.5% | -16.3% |  |  |  | -22.7% | -22.0% | -17.8% |
| Class B | -16.8% | -15.9% | -15.7% | -27.4% | -26.9% | -26.3% | -20.8% | -19.0% | -15.9% |
| **Overall (EL+BL)** | -17.6% | -16.7% | -15.9% | -27.4% | -26.9% | -26.3% | -21.4% | -19.8% | -16.4% |
| **Overall (EL)** | -27.2% | -25.8% | -24.2% | -49.1% | -47.5% | -46.2% | -33.7% | -33.2% | -27.7% |
| Enc Time[%] | 103.7% | | | 100.8% | | | 102.6% | | |
| Dec Time[%] | 191.4% | | | 192.5% | | | 137.0% | | |
| BL Match | Matched | | | Matched | | | Matched | | |
|  |  |  |  |  |  |  |  |  |  |
|  | **LD-P HEVC 2x** | | | **LD-P HEVC 1.5x** | | | **LD-P HEVC SNR** | | |
|  | Y | U | V | Y | U | V | Y | U | V |
| Class A | -14.2% | -10.1% | -7.9% |  |  |  | -14.9% | -15.3% | -11.4% |
| Class B | -12.3% | -10.5% | -9.8% | -22.7% | -21.3% | -20.7% | -13.6% | -12.4% | -9.4% |
| **Overall (EL+BL)** | -12.9% | -10.4% | -9.3% | -22.7% | -21.3% | -20.7% | -13.9% | -13.2% | -10.0% |
| **Overall (EL)** | -20.5% | -16.4% | -14.6% | -42.0% | -38.6% | -36.8% | -22.3% | -22.9% | -17.7% |
| Enc Time[%] | 106.2% | | | 94.1% | | | 96.4% | | |
| Dec Time[%] | 197.1% | | | 177.0% | | | 132.6% | | |
| BL Match | Matched | | | Matched | | | Matched | | |



Table . Average BD rate (EL+BL) for each prediction structure

|  |  |  |  |
| --- | --- | --- | --- |
| EL+BL | Y | U | V |
| AI | -28.5% | -31.6% | -32.5% |
| RA | -22.1% | -21.1% | -19.5% |
| LD-P | -16.5% | -15.0% | -13.3% |



# Conclusion

This contribution presents the performance data of combining three HLS-only coding tools together. Compared to simulcast, (Y, U, V) BD rates of (-28.5%, -31.6%, -32.5%), (-22.1%, -21.1%, -19.5%), and (-16.5%, -15.0%, -13.3%) can be achieved for AI, RA, and LDP, respectively. It is noted that additional coding performance improvement can be achieved by incorporating more HLS-only coding tools into the ref\_idx framework in SMuC v0.1.1.

# References

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