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| --- | --- | --- | --- |
| *Title:* | **TE A2: Inter-layer reference picture placement** | | |
| *Status:* | Input Document to JCT-VC | | |
| *Purpose:* | Proposal | | |
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# Abstract

This document presents the experimental results of the inter-layer reference picture placement tool included in Tool Experiment A2 that aims to test inter-layer texture prediction signaling in SHVC. The tool adds inter-layer reference (ILR) picture as an additional entry into the reference picture lists of one enhancement-layer picture, and always places the ILR picture at the end of one reference picture list. The ILR picture can be referenced through the use of ref\_idx. Moreover, given the slice type of the enhancement-layer picture and its position in the corresponding group of pictures (GOP), ILR picture can be inserted into either both reference picture lists L0 and L1, or only reference picture list L0. Experimental results show that the proposed inter-layer reference picture placement tool can reportedly achieve 22.8%, 32.8%, 16.3%, 26.4%, 20.1%, 12.1%, 22.1% and 13% Y BD-rate savings for AI-2x, AI-1.5x, RA-2x, RA-1.5x, RA-SNR, LD-P-2x, LD-P-1.5x and LD-P-SNR, respectively, when compared to the “EL+BL” anchors of simulcast.

This document also presents additional experimental results of the inter-layer reference picture placement tool when forcing motion vectors (MVs) pointed to ILR picture to be zero, and when disabling the use of combined prediction that involves ILR picture as reference. Experimental results show that forcing zero MVs when using ILR picture as reference can reportedly provide additional 0.2%, 0.1%, 0.2%, 0.1%, 0.1%, 0.1%, 0.1% and 0% Y BD-rate savings for AI-2x, AI-1.5x, RA-2x, RA-1.5x, RA-SNR, LD-P-2x, LD-P-1.5x and LD-P-SNR, respectively. On the other hand, disabling the use of combined prediction that involves ILR picture as reference can degrade the performance of the inter-layer reference picture placement tool, by causing 0.3%, 0.5% and 0.6% Y BD-rate losses for RA-2x, RA-1.5x and RA-SNR, respectively.

# Algorithm description

## Inter-layer reference picture placement

With the inter-layer reference picture placement tool, ILR picture is added as one additional reference picture along with temporal reference pictures to predict enhancement-layer video. Currently, ILR picture is always placed at the end of one reference picture list if it is inserted in the reference picture list of the corresponding enhancement-layer picture. There are two settings of adding ILR picture into the reference picture lists of the enhancement-layer picture.

### Setting 1

The first ILR picture placement option is exactly the same as that of the reference picture index signaling framework of the current reference software. More specifically, the ILR picture is added to reference picture list L0 if the current enhancement-layer picture is coded as P-Slice, and is added to both reference picture lists L0 and L1 if the current enhancement-layer picture is coded as B-Slice. For both reference picture lists L0 and L1, the ILR picture is always placed after all temporal enhancement-layer reference pictures.

### Setting 2

The specific process for reference picture list construction of the second ILR picture placement setting is described as follows:

1. The reference picture lists L0 and L1 (if B-Slice) of the enhancement-layer picture are firstly constructed using only temporal enhancement-layer reference pictures, according to the reference picture set (RPS) and the distances between temporal enhancement-layer reference pictures and the current encoded enhancement-layer picture [2].
2. For AI and LD-P coding structure, the ILR picture is inserted to the reference picture list L0 and placed after all temporal enhancement-layer reference pictures.
3. For RA coding structure, the ILR picture is added into both the reference picture lists L0 and L1 of the enhancement-layer pictures that are located in the first temporal level of the hierarchical B structure, but is only added into the reference picture list L0 of the enhancement-layer pictures that are located in the other temporal levels of the hierarchical B structure. In both two cases, the ILR picture is placed after all temporal enhancement-layer reference pictures.

## Constraints on inter-layer prediction

### Constraint 1: ILR zero MV

To explore inter-layer redundancy, the MV between one prediction unit (PU) of the current enhancement-layer picture and its matching block in the ILR picture is determined from the default motion estimation (ME) process of HEVC, where the motion vector predictor obtained by advanced motion vector prediction (AMVP) process is used as the center of motion search [2]. However, given the inherent inaccuracy of AMVP and the small motion (mostly zero) between the current enhancement-layer picture and the ILR picture, motion vector predictor usually provides an inefficient starting point of motion search. This could degrade inter-layer prediction efficiency. Therefore, in this constraint, when ILR picture is selected as reference picture of the enhancement-layer, the corresponding MV is forced to be 0.

Additionally, by forcing the MVs pointing to the ILR picture to be 0, the computational expensive fractional sample interpolation and motion estimation processes can be skipped when the current PU makes reference to the ILR picture for prediction. And, this could significantly reduce the encoding and decoding complexity.

### Constraint 2: ILR uni-prediction only

By this constraint, it is disallowed to combine the signal of the ILR picture with that of temporal enhancement-layer reference picture, or that of the ILR picture if the ILR picture is inserted into both reference picture lists, to predict the current enhancement-layer picture.

# Experiments

## Experimental conditions

The proposed algorithm is implemented based on SMuC0.1.1 and tested under the common test conditions for SHVC.

HM8.1 simulcast is used as reference for BD-rate calculations.

## Experimental results

### Inter-layer reference picture placement (option 1)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **AI HEVC 2x** | | | **AI HEVC 1.5x** | | |  |  |  |
|  | Y | U | V | Y | U | V |  |  |  |
| Class A | -26.9% | -26.2% | -27.1% |  |  |  |  |  |  |
| Class B | -21.2% | -20.1% | -20.0% | -32.8% | -32.9% | -33.1% |  |  |  |
| **Overall (EL+BL)** | -22.8% | -21.9% | -22.0% | -32.8% | -32.9% | -33.1% |  |  |  |
| **Overall (EL)** | -34.8% | -33.7% | -33.9% | -58.5% | -58.2% | -58.7% |  |  |  |
| Enc Time[%] | 246.7% | | | 177.8% | | |  |  |  |
| Dec Time[%] | 101.4% | | | 89.7% | | |  |  |  |
| Enc Mem[%] | #DIV/0! | | | #DIV/0! | | |  |  |  |
| 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 | -17.3% | -4.6% | -6.1% |  |  |  | -20.3% | -8.3% | -7.3% |
| Class B | -14.2% | -5.2% | -3.3% | -25.4% | -18.8% | -16.9% | -17.7% | -5.8% | -1.2% |
| **Overall (EL+BL)** | -15.1% | -5.1% | -4.1% | -25.4% | -18.8% | -16.9% | -18.5% | -6.5% | -2.9% |
| **Overall (EL)** | -23.4% | -8.0% | -6.9% | -46.4% | -35.9% | -32.7% | -29.2% | -11.7% | -6.5% |
| Enc Time[%] | 108.6% | | | 110.1% | | | 112.3% | | |
| Dec Time[%] | 133.9% | | | 138.2% | | | 106.6% | | |
| Enc Mem[%] | #DIV/0! | | | #DIV/0! | | | #DIV/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 | -13.3% | -1.1% | -2.3% |  |  |  | -13.7% | -6.4% | -5.4% |
| Class B | -11.6% | -5.6% | -3.9% | -22.1% | -16.9% | -15.2% | -12.7% | -5.7% | -1.8% |
| **Overall (EL+BL)** | -12.1% | -4.3% | -3.5% | -22.1% | -16.9% | -15.2% | -13.0% | -5.9% | -2.9% |
| **Overall (EL)** | -19.4% | -6.8% | -5.7% | -41.2% | -32.1% | -29.1% | -20.9% | -11.2% | -6.9% |
| Enc Time[%] | 111.7% | | | 100.8% | | | 96.0% | | |
| Dec Time[%] | 147.0% | | | 131.3% | | | 99.3% | | |
| Enc Mem[%] | #DIV/0! | | | #DIV/0! | | | #DIV/0! | | |
| BL Match | Matched | | | Matched | | | Matched | | |

### Inter-layer reference picture placement (option 2)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **AI HEVC 2x** | | | **AI HEVC 1.5x** | | |  |  |  |
|  | Y | U | V | Y | U | V |  |  |  |
| Class A | -26.9% | -26.2% | -27.1% |  |  |  |  |  |  |
| Class B | -21.2% | -20.1% | -20.0% | -32.8% | -32.9% | -33.1% |  |  |  |
| **Overall (EL+BL)** | -22.8% | -21.9% | -22.0% | -32.8% | -32.9% | -33.1% |  |  |  |
| **Overall (EL)** | -34.8% | -33.7% | -33.9% | -58.5% | -58.2% | -58.7% |  |  |  |
| Enc Time[%] | 231.5% | | | 175.7% | | |  |  |  |
| Dec Time[%] | 95.1% | | | 88.8% | | |  |  |  |
| Enc Mem[%] | #DIV/0! | | | #DIV/0! | | |  |  |  |
| 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 | -18.3% | -6.7% | -8.1% |  |  |  | -21.4% | -10.8% | -10.1% |
| Class B | -15.5% | -7.4% | -5.8% | -26.4% | -20.2% | -18.5% | -19.5% | -9.5% | -5.5% |
| **Overall (EL+BL)** | -16.3% | -7.2% | -6.4% | -26.4% | -20.2% | -18.5% | -20.1% | -9.9% | -6.8% |
| **Overall (EL)** | -25.2% | -11.3% | -10.3% | -47.7% | -38.2% | -35.3% | -31.7% | -16.9% | -12.4% |
| Enc Time[%] | 111.1% | | | 110.3% | | | 111.1% | | |
| Dec Time[%] | 138.1% | | | 138.2% | | | 107.3% | | |
| Enc Mem[%] | #DIV/0! | | | #DIV/0! | | | #DIV/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 | -13.3% | -1.1% | -2.3% |  |  |  | -13.7% | -6.4% | -5.4% |
| Class B | -11.6% | -5.6% | -3.9% | -22.1% | -16.9% | -15.2% | -12.7% | -5.7% | -1.8% |
| **Overall (EL+BL)** | -12.1% | -4.3% | -3.5% | -22.1% | -16.9% | -15.2% | -13.0% | -5.9% | -2.9% |
| **Overall (EL)** | -19.4% | -6.8% | -5.7% | -41.2% | -32.1% | -29.1% | -20.9% | -11.2% | -6.9% |
| Enc Time[%] | 110.3% | | | 109.8% | | | 102.2% | | |
| Dec Time[%] | 146.6% | | | 143.5% | | | 105.7% | | |
| Enc Mem[%] | #DIV/0! | | | #DIV/0! | | | #DIV/0! | | |
| BL Match | Matched | | | Matched | | | Matched | | |

### Inter-layer reference picture placement (option 2) & ILR zero MV

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **AI HEVC 2x** | | | **AI HEVC 1.5x** | | |  |  |  |
|  | Y | U | V | Y | U | V |  |  |  |
| Class A | -27.1% | -26.5% | -27.3% |  |  |  |  |  |  |
| Class B | -21.3% | -20.4% | -20.2% | -32.9% | -33.0% | -33.2% |  |  |  |
| **Overall (EL+BL)** | -23.0% | -22.1% | -22.2% | -32.9% | -33.0% | -33.2% |  |  |  |
| **Overall (EL)** | -35.1% | -34.0% | -34.3% | -58.8% | -58.5% | -58.9% |  |  |  |
| Enc Time[%] | 217.3% | | | 173.6% | | |  |  |  |
| Dec Time[%] | 95.7% | | | 95.7% | | |  |  |  |
| Enc Mem[%] | #DIV/0! | | | #DIV/0! | | |  |  |  |
| 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 | -18.5% | -7.2% | -8.6% |  |  |  | -21.5% | -11.3% | -10.6% |
| Class B | -15.7% | -7.9% | -6.2% | -26.5% | -20.5% | -18.8% | -19.7% | -9.9% | -6.0% |
| **Overall (EL+BL)** | -16.5% | -7.7% | -6.9% | -26.5% | -20.5% | -18.8% | -20.2% | -10.3% | -7.3% |
| **Overall (EL)** | -25.4% | -11.9% | -11.0% | -48.0% | -38.6% | -35.8% | -31.9% | -17.5% | -13.2% |
| Enc Time[%] | 113.5% | | | 112.7% | | | 115.5% | | |
| Dec Time[%] | 148.2% | | | 152.1% | | | 115.5% | | |
| Enc Mem[%] | #DIV/0! | | | #DIV/0! | | | #DIV/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 | -13.3% | -1.4% | -2.6% |  |  |  | -13.7% | -6.8% | -5.9% |
| Class B | -11.7% | -5.8% | -4.1% | -22.2% | -16.9% | -15.3% | -12.8% | -6.0% | -2.3% |
| **Overall (EL+BL)** | -12.2% | -4.5% | -3.7% | -22.2% | -16.9% | -15.3% | -13.0% | -6.2% | -3.3% |
| **Overall (EL)** | -19.5% | -7.1% | -6.0% | -41.4% | -32.2% | -29.2% | -21.0% | -11.6% | -7.6% |
| Enc Time[%] | 100.9% | | | 99.7% | | | 89.9% | | |
| Dec Time[%] | 143.9% | | | 137.5% | | | 96.2% | | |
| Enc Mem[%] | #DIV/0! | | | #DIV/0! | | | #DIV/0! | | |
| BL Match | Matched | | | Matched | | | Matched | | |

### Inter-layer reference picture placement (option 2) & ILR uni-prediction only

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **AI HEVC 2x** | | | **AI HEVC 1.5x** | | |  |  |  |
|  | Y | U | V | Y | U | V |  |  |  |
| Class A | -26.9% | -26.2% | -27.1% |  |  |  |  |  |  |
| Class B | -21.2% | -20.1% | -20.0% | -32.8% | -32.9% | -33.1% |  |  |  |
| **Overall (EL+BL)** | -22.8% | -21.9% | -22.0% | -32.8% | -32.9% | -33.1% |  |  |  |
| **Overall (EL)** | -34.8% | -33.7% | -33.9% | -58.5% | -58.2% | -58.7% |  |  |  |
| Enc Time[%] | 225.1% | | | 173.5% | | |  |  |  |
| Dec Time[%] | 80.3% | | | 75.9% | | |  |  |  |
| Enc Mem[%] | #DIV/0! | | | #DIV/0! | | |  |  |  |
| 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 | -18.0% | -6.3% | -7.8% |  |  |  | -21.0% | -10.3% | -9.8% |
| Class B | -15.2% | -7.3% | -5.8% | -25.9% | -20.0% | -18.4% | -18.9% | -9.9% | -6.4% |
| **Overall (EL+BL)** | -16.0% | -7.0% | -6.4% | -25.9% | -20.0% | -18.4% | -19.5% | -10.0% | -7.4% |
| **Overall (EL)** | -24.7% | -11.0% | -10.2% | -47.1% | -37.7% | -35.0% | -30.9% | -17.0% | -13.2% |
| Enc Time[%] | 78.4% | | | 85.0% | | | 83.4% | | |
| Dec Time[%] | 96.0% | | | 99.1% | | | 75.5% | | |
| Enc Mem[%] | #DIV/0! | | | #DIV/0! | | | #DIV/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 | -13.3% | -1.1% | -2.3% |  |  |  | -13.7% | -6.4% | -5.4% |
| Class B | -11.6% | -5.6% | -3.9% | -22.1% | -16.9% | -15.2% | -12.7% | -5.7% | -1.8% |
| **Overall (EL+BL)** | -12.1% | -4.3% | -3.5% | -22.1% | -16.9% | -15.2% | -13.0% | -5.9% | -2.9% |
| **Overall (EL)** | -19.4% | -6.8% | -5.7% | -41.2% | -32.1% | -29.1% | -20.9% | -11.2% | -6.9% |
| Enc Time[%] | 89.3% | | | 88.0% | | | 81.8% | | |
| Dec Time[%] | 108.2% | | | 105.3% | | | 77.4% | | |
| Enc Mem[%] | #DIV/0! | | | #DIV/0! | | | #DIV/0! | | |
| BL Match | Matched | | | Matched | | | Matched | | |

### Inter-layer reference picture placement (option 2) & ILR zero MV & ILR uni-prediction only

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **AI HEVC 2x** | | | **AI HEVC 1.5x** | | |  |  |  |
|  | Y | U | V | Y | U | V |  |  |  |
| Class A | -27.1% | -26.5% | -27.3% |  |  |  |  |  |  |
| Class B | -21.3% | -20.4% | -20.2% | -32.9% | -33.0% | -33.2% |  |  |  |
| **Overall (EL+BL)** | -23.0% | -22.1% | -22.2% | -32.9% | -33.0% | -33.2% |  |  |  |
| **Overall (EL)** | -35.1% | -34.0% | -34.3% | -58.8% | -58.5% | -58.9% |  |  |  |
| Enc Time[%] | 214.1% | | | 162.2% | | |  |  |  |
| Dec Time[%] | 94.5% | | | 89.8% | | |  |  |  |
| Enc Mem[%] | #DIV/0! | | | #DIV/0! | | |  |  |  |
| 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 | -18.2% | -6.9% | -8.4% |  |  |  | -21.1% | -11.0% | -10.5% |
| Class B | -15.3% | -7.8% | -6.3% | -26.1% | -20.2% | -18.7% | -19.1% | -10.4% | -7.0% |
| **Overall (EL+BL)** | -16.1% | -7.5% | -6.9% | -26.1% | -20.2% | -18.7% | -19.7% | -10.5% | -8.0% |
| **Overall (EL)** | -25.0% | -11.6% | -10.9% | -47.4% | -38.2% | -35.5% | -31.2% | -17.8% | -14.1% |
| Enc Time[%] | 102.1% | | | 104.2% | | | 101.1% | | |
| Dec Time[%] | 139.5% | | | 142.2% | | | 104.0% | | |
| Enc Mem[%] | #DIV/0! | | | #DIV/0! | | | #DIV/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 | -13.3% | -1.4% | -2.6% |  |  |  | -13.7% | -6.8% | -5.9% |
| Class B | -11.7% | -5.8% | -4.1% | -22.2% | -16.9% | -15.3% | -12.8% | -6.0% | -2.3% |
| **Overall (EL+BL)** | -12.2% | -4.5% | -3.7% | -22.2% | -16.9% | -15.3% | -13.0% | -6.2% | -3.3% |
| **Overall (EL)** | -19.5% | -7.1% | -6.0% | -41.4% | -32.2% | -29.2% | -21.0% | -11.6% | -7.6% |
| Enc Time[%] | 106.4% | | | 101.0% | | | 99.1% | | |
| Dec Time[%] | 147.9% | | | 136.7% | | | 104.1% | | |
| Enc Mem[%] | #DIV/0! | | | #DIV/0! | | | #DIV/0! | | |
| BL Match | Matched | | | Matched | | | Matched | | |

### Observation

First of all, it can be observed that that the inter-layer reference picture placement can achieve 34.8%, 58.5%, 25.2%, 47.7%, 31.7%, 19.4%, 41.2% and 20.9% Y BD-rate savings for AI-2x, AI-1.5x, RA-2x, RA-1.5x, RA-SNR, LD-P-2x, LD-P-1.5x and LD-P-SNR, respectively, when compared to the “EL” anchors of simulcast. When compared to “EL+BL” anchors of simulcast, the corresponding Y BD-rate savings are 22.8%, 32.8%, 16.3%, 26.4%, 20.1%, 12.1%, 22.1%, 13%, respectively.

Second, forcing enhancement-layer picture to use zero MV when making reference to ILR picture is beneficial to the performance of the inter-layer reference picture placement tool, which can provide additional gain over inter-layer reference picture placement tool by 0.3%, 0.3%, 0.2%, 0.3%, 0.2%, 0.1%, 0.2% and 0.1% Y BD-rate savings for AI-2x, AI-1.5x, RA-2x, RA-1.5x, RA-SNR, LD-P-2x, LD-P-1.5x and LD-P-SNR, respectively, when compared to the “EL” anchors of simulcast. When compared to “EL+BL” anchors of simulcast, the corresponding additional Y BD-rate savings are 0.2%, 0.1%, 0.2%, 0.1%, 0.1%, 0.1%, 0.1% and 0%, respectively. Additionally, forcing zero MV for ILR picture can also reduce encoding and decoding complexity.

Third, disabling the use of combined prediction that involves ILR picture as reference can cause the coding efficiency degradation of the inter-layer reference picture placement tool, by 0.5%, 0.6% and 0.8% Y BD-rate losses for RA-2x, RA-1.5x and RA-SNR, respectively, when compared to the “EL” anchors of simulcast. When compared to “EL+BL” anchors of simulcast, the corresponding BD-rate losses are 0.3%, 0.5% and 0.6%, respectively.

# Conclusion

In this contribution, the performance of the inter-layer reference picture placement tool is investigated for Tool Experiment A2. Currently, the best ILR picture placement setting is to always place the ILR picture at the end of one reference picture list if it is inserted in the reference picture list of the encoded enhancement-layer picture. Additionally, for AI and LD-P coding structure, the ILR picture is inserted to the reference picture list L0; for RA coding structure, the ILR picture is added into both the reference picture lists L0 and L1 of the enhancement-layer pictures that are located in the first temporal level of the hierarchical B structure, but is only added into the reference picture list L0 of the enhancement-layer pictures that are located in the other temporal levels of the hierarchical B structure. On the other hand, fixing MV to be zero when ILR picture is used as reference picture can further improve the performance of the inter-layer reference picture placement tool.

# Patent rights declaration(s)

**InterDigital Communications, LLC 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).**

# References

1. Description of Tool Experiment A2: Inter-layer Texture Prediction Signaling in SHVC. Document no JCTVC-K1102. October 2012.
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