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| *Title:* | **Description of HEVC Scalable Extensions Core Experiment SCE1: Color Gamut and Bit-Depth Scalability** | | |
| *Status:* | Output Document to JCT-VC | | |
| *Purpose:* | CE description | | |
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# Abstract

This document provides the description of Core Experiment 4 (SCE4) on Color Gamut and Bit-Depth Scalability in SHVC.

# Introduction

Color Gamut Scalability has been mentioned in the requirements of Scalable Coding Extension of HEVC. It allows addressing the cases the original Enhancement Layer uses a different color gamut than the Base Layer. This can be useful for instance in case of deployment of UHD services compatible with legacy HD devices: HD is using the Rec.709, while UHD is likely to use some of the parameters defined in the Rec.2020.

The general diagram of a scalable video encoder including a prediction tool for color differences between the base layer (BL) and enhancement layer (EL) is shown in Figure 1.



Figure : Color Space Scalable Encoder.

# Participants

P = Participants (Contribution),

C = Crosscheckers.

|  |  |  |  |  |
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# Test sequences

As decided at the 14th JCTVC meeting in Vienna, the color graded sequences provided in AHG14 [4] and described in SCE4 description [1] (Table 1) are used for this SCE.

For the Enhancement Layer, the sequences have been color graded in DCI-P3 and next expressed in BT.2020 gamut, 3840x2160p. For the Base Layer, the BT.709 sequences are 1920x1080p.

The BT.2020, 3840x2160p sequences are 10-bit, the BT.709, 1920x1080p have been provided in 8-bit and 10-bit. The sequences duration are 300 frames for 60Hz sequences and 250 frames for 50Hz sequences (5 seconds duration).

The sequences with the associated license conditions are available at the Hannover FTP site: [ftp.tnt.uni-hannover.de/scalable/sequences/CGS](ftp://ftp.tnt.uni-hannover.de/scalable/sequences/CGS) with scalability use credentials.

Table : List of test sequences.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Test Sequences** | **size** | **fps** | **Duration** | **Bit-depth** |
| BT709\_Birthday\_1920x1080\_60\_zerophase\_0.9pi.yuv | 1920 x 1080 | 60 | 300 | 8 |
| BT709\_BirthdayFlashPart1\_1920x1080\_60\_zerophase\_0.9pi.yuv | 1920 x 1080 | 60 | 300 | 8 |
| BT709\_BirthdayFlashPart2\_1920x1080\_60\_zerophase\_0.9pi.yuv | 1920 x 1080 | 60 | 300 | 8 |
| BT709\_Parakeets\_1920x1080\_50\_zerophase\_0.9pi.yuv | 1920 x 1080 | 50 | 250 | 8 |
| BT709\_TableCar\_1920x1080\_60\_zerophase\_0.9pi.yuv | 1920 x 1080 | 60 | 300 | 8 |
| BT709\_Birthday\_1920x1080\_60\_10bit\_zerophase\_0.9pi.yuv | 1920 x 1080 | 60 | 300 | 10 |
| BT709\_BirthdayFlashPart1\_1920x1080\_60\_10bit\_zerophase\_0.9pi.yuv | 1920 x 1080 | 60 | 300 | 10 |
| BT709\_BirthdayFlashPart2\_1920x1080\_60\_10bit\_zerophase\_0.9pi.yuv | 1920 x 1080 | 60 | 300 | 10 |
| BT709\_Parakeets\_1920x1080\_50\_10bit\_zerophase\_0.9pi.yuv | 1920 x 1080 | 50 | 250 | 10 |
| BT709\_TableCar\_1920x1080\_60\_10bit\_zerophase\_0.9pi.yuv | 1920 x 1080 | 60 | 300 | 10 |
| BT2020\_Birthday\_3840x2160\_60\_10bit\_zerophase\_0.9pi.yuv | 3840 x 2160 | 60 | 300 | 10 |
| BT2020\_BirthdayFlashPart1\_3840x2160\_60\_10bit\_zerophase\_0.9pi.yuv | 3840 x 2160 | 60 | 300 | 10 |
| BT2020\_BirthdayFlashPart2\_3840x2160\_60\_10bit\_zerophase\_0.9pi.yuv | 3840 x 2160 | 60 | 300 | 10 |
| BT2020\_Parakeets\_3840x2160\_50\_10bit\_zerophase\_0.9pi.yuv | 3840 x 2160 | 50 | 250 | 10 |
| BT2020\_TableCar\_3840x2160\_60\_10bit\_zerophase\_0.9pi.yuv | 3840 x 2160 | 60 | 300 | 10 |

# Reference software (Anchors)

The reference software will be *SHM4.0* including the bit-depth scalability feature and the option to set the weighted prediction restricted to inter-layer, as adopted in JCTVC-O0194. A modification will be made on top of *SHM4.0* to support the insertion of regular Intra Random Access Point (IRAP) to emulate more realistic broadcast/broadband use case as proposed in [3]:

* Regular IRAP insertion: modificationto support insertion of regular SPS, PPS (every *N* frames)*.*

The modified software *SHM4.0\_irap* will be provided by Technicolor. The common SHVC test conditions (QPs) will be used for AI and RA configurations, 2x scalability.

The random access period parameter *N* will be set to nx64 for 60Hz sequences, and to nx48 for 50Hz sequences. This corresponds to inserting the SPS and PPS roughly every n seconds, corresponding to realistic values encountered in broadcast or broadband applications. It is suggested to set n = 2.

The anchors will be based on *SHM4.0* and *SHM4.0\_irap* for use cases 1 and 2 respectively, with WP restricted to inter layer prediction (ILP) enabled in both cases.

# Description of Experiments

Two tests (A and B) will be conducted. The test conditions will be 2x scalability with the following contents:

Table : Test conditions

|  |  |  |
| --- | --- | --- |
|  | **Base layer** | **Enhancement layer** |
| **Test A** | 1920 x 1080, BT. 709, 8-bit | 3840 x 2160, BT.2020, 10-bit |
| **Test B** | 1920 x 1080, BT. 709, 10-bit | 3840 x 2160, BT.2020, 10-bit |

The common SHVC test conditions (QPs) will be used for AI and RA configurations, 2x scalability.

Given remarks of this 15th Meeting report of the JCTVC [3], at the encoder side, the computation of the LUT shall not induce any frame delay. For instance, it can be computed on a picture-basis or RAP-period-basis. Study of the complexity impact of the additional step in inter-layer processing at the decoder will be carried on.

Table  : List of the tests (AI, RA configurations) and corresponding software to use.

|  |  |  |
| --- | --- | --- |
|  | **Use case 1** | **Use case 2** |
| **Test A** | AI, RA with *SHM4.0* | AI, RA with *SHM4.0\_irap* |
| **Test B** | AI, RA with *SHM4.0* | AI, RA with *SHM4.0\_irap* |

## JCTVC-O0159 (Technicolor)

The model is derived from [JCTVC-O0159](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=8273) and is based on the use of a 3D Look-Up Table (LUT) to predict the tri-chromatic color space 2 (EL) samples from the reconstructed BL (color space 1).

Simplified versions of the initial implementation will be explored. In particular, at the encoder side, optimization will be done per RAP period, for instance:

* Use case 1: LUT derived from the first picture of the sequence. In this case, we will use the regular *SHM4.0* software with one single SPS, PPS at the beginning.
* Use case 2: LUT derived using one or several pictures of the previous RAP period. In this case, the modified software *SHM4.0\_irap* will be used, with regular SPS, PPS insertion.

## JCTVC-O0161 (InterDigital)

This test is based on the combined scalability proposed in [JCTVC-O0161](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=8273). In the first step, the proposed scheme uses 3D Look-Up Table (LUT) to achieve bit depth scalability and color gamut scalability at the same time. In the second step, up-sampling is performed without bit depth change.

Simplified versions of the initial implementation will be explored. In particular, at the encoder side, optimization will be done per RAP period, for instance:

* Use case 1: LUT derived from the first picture of the sequence. In this case, we will use the regular SHM4.0 software with one single SPS, PPS at the beginning.
* Use case 2: LUT derived using one or several pictures of the previous RAP period. In this case, the modified software *SHM4.0\_irap* will be used, with regular SPS, PPS insertion.

# Cross-checks

|  |  |  |  |
| --- | --- | --- | --- |
| **Test num.** | **Description** | **Code provided by...** | **Cross-Checker** |
| Use case 1 | 1.A | Technicolor | Sony |
| 1.B | Technicolor | Sony |
| 2.A | InterDigital | Qualcomm |
| 2.B | InterDigital | Qualcomm |
| Use case 2 | 1.A | Technicolor | Qualcomm |
| 1.B | Technicolor | Qualcomm |
| 2.A | InterDigital | Samsung |
| 2.B | InterDigital | Samsung |

# Time-line and Responsibilities

**T0:** Reference software *SHM4.0* release date with WP (restricted to ILP) available and complexity assessment (Samsung).

**T0 + 1 week:** Reference software *SHM4.0\_ irap* distributed to participants by Technicolor.

**2013-Dec-20:** Cross-verification begins: proponents provide software, draft of contribution text and results to cross-verifiers(s) and CE coordinators.

**2014-Jan-5:** Cross-verifiers report results to CE participants.

# References

1. A.Segall, P.Bordes, C.Auyeung, X.Li, E.Alshina, A.Duenas, “Description of Core Experiment SCE4: Color Gamut and Bit-Depth Scalability,” JCTVC-N1104, July 2013, Vienna, AT.
2. A.Segall, P.Bordes, C.Auyeung, X.Li, E.Alshina, A.Duenas, “SCE4: Summary Report of Colour Gamut and Bit Depth Scalability,” JCTVC-O0034, October 2013, Geneva, CH.
3. G.Sullivan, J.R.Ohm, “Meeting report of the 15th meeting of the Joint Collaborative Team on Video Coding (JCT-VC), Geneva, CH, 23 Oct. – 1 Nov. 2013,”.
4. A.Segall, A.Duenas, P.Bordes, J. Dong, D.‑K. Kwon, X. Li, “AHG report: Colour gamut scalability (AHG14),” JCTVC-O0014, October 2013, Geneva, CH.