 ISO/IEC JTC 1/SC 29/WG 04 N0030

**ISO/IEC JTC 1/SC 29/WG 04**

**MPEG Video Coding Convenorship: CN**

**Document type:** Output Document

**Title:** Report on Essential Video Coding compression performance verification testing for HDR/WCG content

**Status:** Approved

**Date of document:** 2020-10-30

**Source:** ISO/IEC JTC 1/SC 29/WG 04

# Expected action: None

# Action due date: None

**No. of pages:** 8 (without cover page)

**Email of Convenor:** yul@zju.edu.cn

**Committee URL:** <https://isotc.iso.org/livelink/livelink/open/jtc1sc29wg4>

**INTERNATIONAL ORGANIZATION FOR STANDARDIZATION**

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**ISO/IEC JTC 1/SC 29/WG 04 MPEG VIDEO CODING**

**ISO/IEC JTC 1/SC 29/WG 04 N0030**

**October 2020, Online**

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| **Title** | **Report on Essential Video Coding compression performance verification testing for HDR/WCG content** |
| **Source** | **WG 04, MPEG Video Coding** |
| **Status** | **Approved** |
| **Serial Number** | **19832** |

## Summary

This document presents a first part of the report on Essential Video Coding (EVC) compression performance verification: Verification Testing of EVC in HDR category.

A major goal for the development of the EVC Main profile was to achieve a substantial improvement in compression capability relative to its predecessor, the HEVC. This document reports the results of a verification test to confirm that this goal was achieved and to estimate the magnitude of that achievement.

A subjective evaluation was conducted comparing the EVC Main profile to the HEVC Main 10 profile. The test compared visual quality for six video sequences in BT.2100/PQ representation at UHD 4k and HD 2k resolutions. Analysis of the subjective test results show that for tested HDR content, EVC provides average bit rate saving around 36% for sequences in UHD 4k resolution and 35% for sequences in HD 2k resolution comparing to its predecessor, the HEVC.

# HDR (High Dynamic Range) Test Conditions

Verification testing in HDR category was conducted through a subjective evaluation, comparing coding performance of the EVC Main profile [1] to the HEVC Main 10 profile [2] for video sequences in BT.2100/PQ representation [3]. Verification test for HDR category followed the procedure specified in the MPEG document N19496 [4].

# Video test sequence formats and frame rates

Verification Test in HDR category will be conducted with the following test sequences:

Test classes:

* Class HDR-A: UHD (4096×2160p and 3840×2160p), BT.2100, PQ, 4:2:0, 10 bits.
* Class HDR-B: HD (1920×1080p), BT.2100, PQ, 4:2:0, 10 bits.

# Software and settings

HDR verification test was conducted with HM16.20 serving as Anchor and ETM6.0.1 reference software. HEVC Anchor was configured for HDR/WCG coding according to ITU-T Recommendation H.Sup15 [5] with configuration file from the reference HEVC software repository, also provided in [4]. EVC reference software was configured as specified in the verification test plan [4]. Utilized software executables were made available on the MPEG FTP.

# Random Access (RA) configuration

* IDR picture period approximately 1 second.

Random access intervals of 1.1 seconds or less): 32 pictures or less for a video sequence with a frame rate of 24, 25 or 30 frames per second, 48 pictures or less for a video sequence with a frame rate of 50 frames per second, 64 pictures or less for a video sequence with a frame rate of 60 frames per second, and 96 pictures or less for a video sequence with a frame rate of 100 frames per second.

* Hierarchical B coding structure.
* 16 frames of structural delay, e.g. 16 pictures “group of pictures (GOP)”.

# Target QP settings

With ongoing complications and restrictions imposed due to COVID-19 spread, and due to tight schedule on planning and the complexity of the HDR subjective testing, subjective test in HDR category was conducted with 3 sequences in each class, as shown in Table below.

Table 1 Target QP points for the HDR category

|  |  | Anchor QP | | | | ETM6.0 QP | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Class | Sequence name | Rate 1 | Rate 2 | Rate 3 | Rate 4 | Rate 1 | Rate 2 | Rate 3 | Rate 4 |
| HDR-A | ChimeraHDR5\_4k | 22 | 27 | 32 | 37 | 23 | 28 | 33 | 39 |
| ChimeraHDR7\_4k | 27 | 32 | 37 | 41 | 28 | 33 | 38 | 42 |
| Meridian2\_4k | 22 | 27 | 32 | 37 | 23 | 29 | 33 | 38 |
| HDR-B | Hurdles | 27 | 34 | 37 | 39 | 28 | 35 | 38 | 40 |
| ChimeraHDR5\_2k | 22 | 27 | 32 | 37 | 23 | 28 | 33 | 38 |
| ChimeraHDR7\_2k | 22 | 27 | 32 | 37 | 23 | 28 | 33 | 38 |

# Evaluation procedure for HDR category

For HDR content the DSIS test method [6] was be used.

# Viewing equipment and laboratory set up

Viewing test was conducted using SONY BVM X300, 30-inch master monitor, and subjective test was organized as follows:

* MUP video player system able to play out YUV UHD content up to 60 fps and 420p colour scheme in BT.2100 PQ, in a fluid way (i.e. faithful frame rate and no frame jump) and no impairments.
* Interface allowing displaying of 10 bit contents in BT.2100 PQ.
* Protected viewing area (no external video or audio pollutions) with low illumination behind the screen not visible to the viewing subject(s) and no other ambient light;
* One seat for each ambient and monitor (this to obey current COVID rules);
* Properly wide waiting area for viewing subject(s) resting and waiting for their viewing run, set up in respect of the current COVID rules);
* Preliminary deep clean-up of both viewing room and waiting room (according to the local COVID rules) to avoid any contamination and protect both viewers and test managers;

*Note: Before beginning any formal subjective assessment session, a careful and deep sanitary screening of the test managers and viewers, according to the local COVID rules and recommendations.*

# Peak brightness normalization

Due to relatively low peak brightness of available HDR viewing equipment (1000cd/m2) compare to the coded HDR content (up-to 4000cd/m2), peak brightness normalization of the original and decoded HDR content to up to 1000cd/m2 was conducted prior to the. Peak brightness normalization was conducted by HDRTools v0.19.1 software [7] by setting NormalizationScale parameters to 40000. Sequences with normalized peak brightness include: ChimeraHDR5\_4k, ChimeraHDR7\_4k, ChimeraHDR5\_2k, ChimeraHDR7\_2k and Hurdles.

# Testing result and graphs

Here below are reported tables and graphs with the results of the HDR test at HD resolution.

**Table 2 HDR-B class: Sequence Chimera5\_2k**



**Table 3 HDR-B class: Sequence Chimera7\_2k**



**Table 4 HDR-B class: Sequence Hurdles**



**Table 5 HDR-A class: Sequence Chimera5\_4k**



**Table 6 HDR-A class: Sequence Chimera7\_4k**



**Table 7 HDR-A class: Sequence Meridian2\_4k**



# MOS BD-rate

In this section, the average bit rate savings of EVC profiles compared to references for each sequence were computed from the MOS vs. bit rate data in the same manner that was done in [8] to further quantify the bit rate savings achieved.

The bit rate savings are averaged over the whole range where the same MOS scores for EVC Main profile and HEVC can be interpolated from subjective test results shown in the plots in section 2. The interval, over which the BD-rate is averaged, is shown as solid lines in each of the plots.

Table 8 show the MOS BD-rate for the sequences in this test. The BD-rate measure described in [9][10] is used with MOS scores taking the place of PSNR. A piece wise cubic interpolation used in the EVC common conditions spreadsheet is used.

Table 8 MOS BD-rate for HDR

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **HDR, Main, RA** | | **HM16.20** | | | **ETM6.0** | | | **BD-rate (piecewise cubic)** |
| **QPISlice** | **bits** | **MOS** | **QPISlice** | **bits** | **MOS** | **bits reduction** |
| HDR-A | ChimeraHDR5 | 22 | 54488219 | 8.79 | 23 | 28928371 | 9.11 | -45.8% |
| 27 | 19311801 | 8.00 | 28 | 11658852 | 8.29 |
| 32 | 8903308 | 6.36 | 33 | 5401148 | 6.39 |
| 37 | 4405775 | 4.93 | 39 | 2326584 | 4.86 |
| ChimeraHDR7 | 27 | 3326652 | 9.21 | 28 | 2127680 | 9.18 | -24.7% |
| 32 | 1711685 | 8.39 | 33 | 1095575 | 7.82 |
| 37 | 936040 | 6.50 | 38 | 603392 | 6.00 |
| 41 | 619571 | 4.54 | 42 | 395069 | 3.96 |
| Meridian2 | 22 | 8987798 | 9.04 | 23 | 4695802 | 8.39 | -37.9% |
| 27 | 2980003 | 7.21 | 29 | 1587915 | 7.21 |
| 32 | 1343550 | 6.14 | 33 | 839590 | 6.25 |
| 37 | 640978 | 3.39 | 38 | 411606 | 2.79 |
| HDR-B | ChimeraHDR5 | 22 | 19632155 | 8.39 | 23 | 10733191 | 8.89 | -51.7% |
| 27 | 7226635 | 6.57 | 28 | 4401733 | 7.00 |
| 32 | 3297088 | 4.89 | 33 | 2019439 | 5.46 |
| 37 | 1599786 | 3.00 | 38 | 986845 | 3.46 |
| ChimeraHDR7 | 22 | 3540874 | 9.11 | 23 | 2066647 | 9.32 | -21.5% |
| 27 | 1403573 | 8.46 | 28 | 923356 | 8.54 |
| 32 | 705344 | 7.00 | 33 | 474195 | 5.96 |
| 37 | 394319 | 4.36 | 38 | 274733 | 3.50 |
| Hurdles | 27 | 4380346 | 8.71 | 28 | 3075951 | 8.93 | -31.4% |
| 34 | 1710449 | 6.79 | 35 | 1144671 | 6.75 |
| 37 | 1180312 | 5.43 | 38 | 806299 | 5.00 |
| 39 | 923333 | 4.07 | 40 | 639654 | 4.39 |
| **Average 4K** | | | | | | | | **-36.1%** |
| **Average 2K** | | | | | | | | **-34.9%** |

The average bit rate savings for EVC Main profile with HDR-UHD and HDR-HD are estimated at approximately 36% and 35% respectively compared to HEVC Main10 profile.

# Conclusions

Analysis of the subjective test results shows that EVC Main profile is able to provide bitrate reduction for tested HDR sequences of around 36% for UHD 4k and 35% for HD 2k resolution It can therefore be concluded that these results prove that MPEG-5 EVC successfully satisfies the requirements given in [11].

# Conclusions

1. ISO/IEC 23094-1:2020 Information technology — General video coding — Part 1: Essential video coding.
2. ISO/IEC 23008-2:2020 Information technology — High efficiency coding and media delivery in heterogeneous environments — Part 2: High efficiency video coding.
3. International Telecommunication Union – Radio Communication Sector, Recommendation ITU-R BT.2100-2: Image parameter values for high dynamic range television for use in production and international programme exchange.
4. “Description of Verification Test of Essential Video Coding”, ISO/IEC JTC1/SC29 (MPEG) document N[19496](http://wg11.sc29.org/doc_end_user/current_document.php?id=75790&id_meeting=183), July 2020.
5. Recommendation ITU-T H.Sup15: Conversion and coding practices for HDR/WCG Y'CbCr 4:2:0 video with PQ transfer characteristics.
6. International Telecommunication Union – Radio Communication Sector; Recommendation ITU-R BT.500-14.
7. HDRTools v0.19.1 software is available online: <https://gitlab.com/standards/HDRTools>.
8. T .Tan, M. Mrak, V. Baronicini, N. Ramzan, “Report on HEVC compression performance verification testing”, JCTVC-Q1011, April 2014.
9. Gisle Bjøntegaard, “Calculation of Average PSNR Differences Between RD Curves”, ITU-T SG16/Q6, 13th VCEG Meeting, Austin, Texas, USA, April 2001, Doc. VCEG-M33.
10. Gisle Bjøntegaard, "Improvements of the BD-PSNR model", ITU-T SG16/Q6, 35th VCEG Meeting, Berlin, Germany, July, 2008, Doc.VCEG-AI11.
11. “Requirements for a New Video Coding Standard”, ISO/IEC JTC1/SC29/WG11, October 2018, Macau SAR, CN, Doc. N17928

# Acknowledgements

The WG4 wishes to thank all the organizations and individuals who contributed to the EVC HDR verification test:

* Qualcomm, Samsung, and Huawei for providing the resources to prepare the test material.
* DBW for conducting the subjective test.
* Dr. Vittorio Baroncini (MPEG Test Chairman) for his guidance and coordination the subjective test.