 ISO/IEC JTC 1/SC 29/WG 5 N0022

**ISO/IEC JTC 1/SC 29/WG 5**

**MPEG Joint Video Coding Team(s) with ITU-T SG 16**

**Convenorship: DE**

**Document type:** General

**Title:** VVC verification test plan (draft 4)

**Status:** Approved

**Date of document:** 2020-10-16

**Source:** ISO/IEC JTC 1/SC 29/WG 5

**Expected action:** Info

**Action due date:** None

**No. of pages: 17** (without cover page)

**Email of Convenor:** ohm @ ient . rwth-aachen . de

**Committee URL:** https://isotc.iso.org/livelink/livelink/open/jtc1sc29wg5

|  |  |
| --- | --- |
| **Joint Video Experts Team (JVET)**  **of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29**  20th Meeting, by teleconference, 7–16 Oct. 2020 | Document: JVET-T2009 |

|  |  |  |  |
| --- | --- | --- | --- |
| *Title:* | **VVC verification test plan (Draft 4)** | | |
| *Status:* | Output document approved by JVET | | |
| *Purpose:* | Verification Test Plan text | | |
| *Author(s) or Contact(s):* | Mathias Wien Vittorio Baroncini Andrew Segall Yan Ye | Tel: Email: | [wien@lfb.rwth-aachen.de](mailto:wien@lfb.rwth-aachen.de) [baroncini@gmx.com](mailto:baroncini@gmx.com) asegall@sharplabs.com [yan.ye@alibaba-inc.com](mailto:yan.ye@alibaba-inc.com) |
| *Source:* | AHG | | |

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

# Introduction

This document contains the draft plan for the video verification test to be conducted to verify the coding performance of the VVC Main profile. A formal subjective evaluation will be conducted comparing the VVC Main 10 profile to the HEVC Main 10 profile.

Verification testing is planned with first priority for the following categories:

* SDR HD, SDR UHD
* HDR UHD (HLG and PQ)
* 360° (extracted viewports)

Verification testing is planned with secondary priority for the following categories:

* Screen content (perhaps with 2 HEVC anchors – Main 10 and SCC profiles)
* Scalability
* 4:4:4 content

The verification tests for the SDR UHD category have been completed by the 20th JVET meeting.

# Verification test coordination

The coordinators of the VVC verification tests are

Vittorio Baroncini Mathias Wien  
VABTECH ltd RWTH Aachen University  
1 Sheldom sqr. Lehrstuhl für Bildverarbeitung  
W2 6TT London 52056 Aachen  
England Germany  
Email: [baroncini@gmx.com](mailto:baroncini@gmx.com) Email: [wien@lfb.rwth-aachen.de](mailto:wien@lfb.rwth-aachen.de)  
Tel.: +39 333 5474643 Tel.: +49-241-80-27867

# Test sites

Test sites capable of conducting formal subjective assessments in accordance with ITU-R BT.500-14 are invited to contact the test coordinators for participation in and contribution to the VVC verification tests. Test sites capable of conducting formal subjective assessments in the following categories are sought:

1. SDR HD 4:2:0 10 bit, 25 to 60 Hz
2. HDR-PQ UHD 4:2:0 10 bit, up to 60 Hz
3. HDR-HLG UHD 4:2:0 10 bit, up to 60 Hz

Test sites are invited to apply for conducting subjective assessments in one or more of the categories listed above. For participation in the verification tests, volunteering test sites are mandated to successfully conduct a calibration experiment.

It is intended to conduct the subjective assessment for each category in more than one test site. The score data of the subjective assessments at all test sites are to be collected and aggregated by the test coordinators.

Test sites conducting subjective assessments for the VVC verification tests are reimbursed by a fee of approximately 100€ per test subject per day. Financial contributions from companies and institutions, especially those that have participated in the development of VVC standard, are hereby called for in order to cover the testing fees. It is guaranteed that any such contribution will be used solely toward covering the fees incurred due to verification testing. In order to ensure that no testing facility will profit preferentially from such donations, the total expense will be calculated and then divided equally among companies and institutions who pledge their financial support, up to the maximum amount pledged by any individual company. Each company or institution will be invoiced by the test labs accordingly.

# Test categories, coding conditions, and test sequences

Test cases for standard dynamic range HD resolution (SDR HD), high dynamic range (HDR), and 360° video content are defined for the verification tests. The test conditions and configurations for these cases are defined below.

## Standard Dynamic Range

### Coding conditions

The following test conditions will be used for the VVC verification test.

1. Number of sequences and video resolutions:
   1. About 5 sequences for HD (1920×1080) resolution each
2. Bitstreams
   1. Generated with VTM 11.0 for VVC bitstreams
   2. Generated with HM 16.22 for HEVC bitstreams
   3. In addition to a. and b., other VVC and/or HEVC bitstreams generated with encoders that are optimized for subjective quality may be tested if available.
3. Encoding parameters
   1. Fixed QP.
      1. Five bitrate points per sequence covering the whole MOS range as much as possible with QP values for the HM and the VTM. The QPs are to be selected such that the subjectively assessed quality is comparable between the two test models.
   2. Bit depth of 10 bits for all video resolutions
   3. Coding structure
      1. HD using Random access, RA (storage/streaming)
         1. Intra refresh at approximately 1 second intervals.
         2. GOP size 32
         3. Picture reordering allowed.
      2. HD using Low delay, LD (video conferencing)
         1. No Intra refresh.
         2. Without picture reordering.
         3. GOP size 4 or 8 (to be determined)
   4. Other settings as in the configuration files, with the Picture Hash SEI deactivated
      1. VTM: cfg/encoder\_randomaccess\_vtm.cfg, and cfg/ encoder\_lowdelay\_vtm.cfg
      2. HM: cfg/encoder\_randomaccess\_main10.cfg and encoder\_lowdelay\_main.cfg

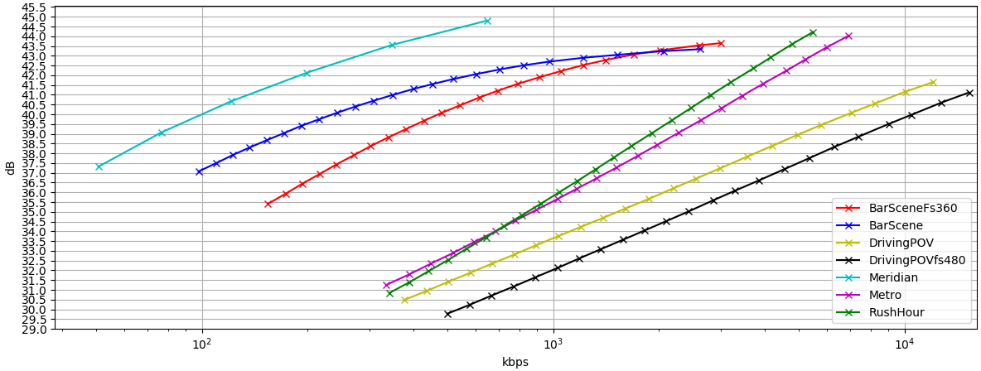
### SDR HD RA test sequences

A proposed set of test sequence candidates in HD resolution for the random-access configuration is listed in Table 1 below. Further SDR HD test sequences are sought and may be added to the candidate test set upon consideration of AHG4.

Table 1 – SDR HD test sequences under consideration for the random-access configuration

|  |  |  |  |
| --- | --- | --- | --- |
| **Test sequence** | **Resolution** | **fps** | **Frames** |
| BarScene (1st part) | 1920×1080 | 60 | 600 |
| BarSceneFs360 (2nd part) | 1920×1080 | 60 | 600 |
| DrivingPOV (1st part) | 1920×1080 | 60 | 600 |
| DrivingPOVFs480 (2nd part) | 1920×1080 | 60 | 600 |
| Metro | 1920×1080 | 60 | 600 |
| RushHour | 1920×1080 | 30 | 300 |
| Meridian1 | 1920×1080 | 60 | 600 |

For characterization of the test sequences under consideration, indicative rate-distortion curves for encoding with VTM using the random access configuration are shown below:



**Figure 1 – Rate-distortion plot for test sequences in Table 1 coded with VVC. PSNR-Y over log bitrate**

For each candidate test sequence, a candidate set of QPs for both HM and VTM have been determined by experts viewing. The proposed QPs are listed in Table 2 below. The QP selection is planned to be confirmed in a dry run experiment before the end of the 21st JVET meeting. Schedule of this task is subject to change depending on the development of the COVID-19 pandemic.

Table 2 – Proposed QPs for the random-access configuration

|  |  |  |
| --- | --- | --- |
| **Sequence** | **HM QPs** | **VTM QPs** |
| BarScene | 40, 36, 32, 28, 23 | 43, 39, 35, 31, 26 |
| BarSceneFs360 | 40, 36, 32, 28, 23 | 43, 39, 35, 31, 26 |
| DrivingPOV | 39, 35, 31, 27, 24 | 42, 38, 34, 30, 26 |
| DrivingPOVFs480 | 39, 35, 31, 27, 23 | 42, 38, 34, 30, 26 |
| Meridian1 | 39, 35, 31, 27, 23 | 42, 38, 34, 30, 26 |
| Metro | 39, 35, 31, 27, 24 | 42, 38, 34, 30, 26 |
| RushHour | 42, 38, 33, 29, 24 | 44, 40, 35, 31, 26 |

**Timeline**

1. Dry-run experiment for confirmation of the chosen QP settings
2. Report on activity by input document to the 21st JVET meeting.

### SDR HD LD test sequences

The set of test sequences for the SDR HD low delay category is designed to include conversational and gaming-type content in order to properly reflect the application case for the low-delay encoder configuration.

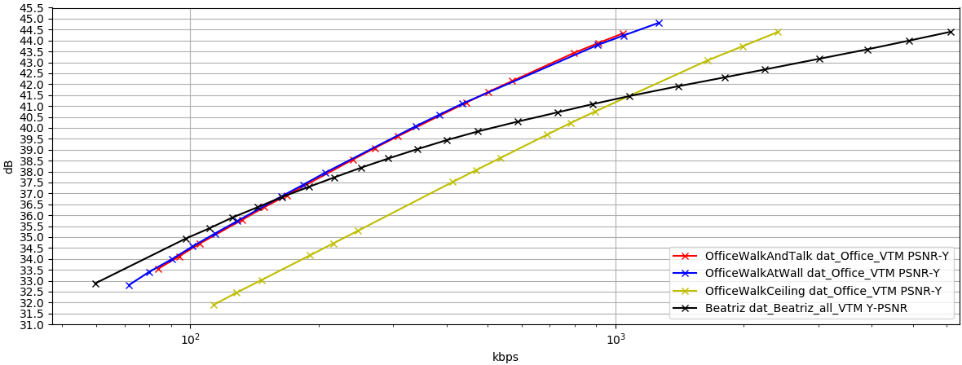
#### Conversational scenario

A set of four test sequences for conversational applications as listed in Table 3 has been identified out of the available set of proposed test sequences for this purpose in JVET-T0060 and JVET-T0120 [8][9]. Further SDR HD test sequences are sought and may be added to the candidate test set upon consideration of AHG4.

Table 3 – SDR HD test sequences under consideration for the conversational scenario

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Test sequence** | **Resolution** | **fps** | **Frames** | **md5** |
| Beatriz\_1920x1080\_50fps\_8bit\_420 | 1920×1080 | 50 | 500 | fe74cd5046fa033b4f743f42b29e69cd |
| OfficeWalkAndTalk\_1920x1080\_30fps\_8bit\_420pf | 1920×1080 | 30 | 300 | 9313b009c1f287915c9eb39a989b8f9b |
| OfficeWalkAtWall\_1920x1080\_30fps\_8bit\_420pf | 1920×1080 | 30 | 300 | 529c15491ea8e1eb0320244a6ff902bb |
| OfficeWalkCeiling\_1920x1080\_30fps\_8bit\_420pf | 1920×1080 | 30 | 300 | 265906bc8f65441fb53d167483b9f726 |

For characterization of the test sequences under consideration, indicative rate-distortion curves for encoding with VTM using the low delay configuration are shown below:



**Figure 2 – Rate-distortion plot for test sequences in Table 1 coded with VVC. PSNR-Y over log bitrate**

For each candidate test sequence, a candidate set of QPs for both, HM and VTM have been determined by experts viewing. The proposed QPs are listed in Table 4 below. The QP selection is planned to be confirmed in a dry run experiment as input to the 21st JVET meeting. The schedule of this task is subject to change depending on the development of the COVID-19 pandemic.

Table 4 – Proposed QPs for the low delay configuration

|  |  |  |
| --- | --- | --- |
| **Sequence** | **HM QPs** | **VTM QPs** |
| Beatriz\_1920x1080\_50fps\_8bit\_420 | 41, 37, 33, 28, 23 | 42, 38, 34, 29, 24 |
| OfficeWalkAtWall\_1920x1080\_30fps\_8bit\_420pf | 46, 42, 38, 32, 26 | 47, 44,40, 34, 27 |
| OfficeWalkAndTalk\_1920x1080\_30fps\_8bit\_420pf | 45, 40, 34, 30, 24 | 46, 42, 37, 32, 28 |
| OfficeWalkCeiling\_1920x1080\_30fps\_8bit\_420pf | 45, 40, 34, 30, 24 | 46, 42, 36, 32, 26 |

**Timeline**

1. Dry-run experiment for confirmation of the chosen QP settings
2. Report on activity by input document to the 21st JVET meeting.

#### Gaming scenario

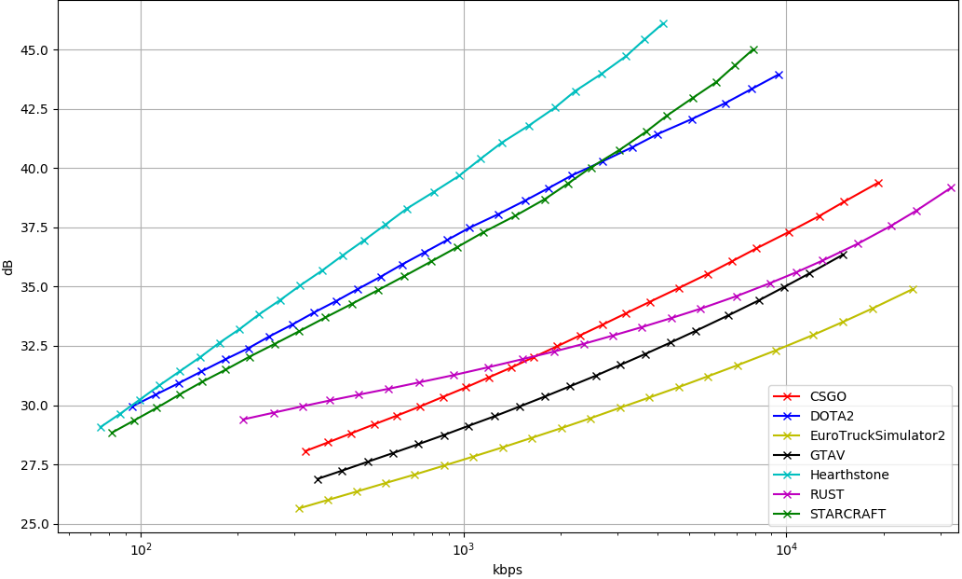
A set of seven test sequences for gaming-type applications as listed in Table 5 has been identified from the DERF data set [10]. Further SDR HD test sequences are sought and may be added to the candidate test set upon consideration of AHG4.

Table 5 – SDR HD test sequences under consideration for the gaming-type scenario

|  |  |  |  |
| --- | --- | --- | --- |
| **Test sequence** | **Resolution** | **fps** | **Frames** |
| GSGO | 1920×1080 | 60 | 600 |
| DOTA2 | 1920×1080 | 60 | 600 |
| EuroTruckSimulator2 | 1920×1080 | 60 | 600 |
| GTAV | 1920×1080 | 60 | 600 |
| Hearthstone | 1920×1080 | 60 | 600 |
| Rust | 1920×1080 | 60 | 600 |
| Starcraft | 1920×1080 | 60 | 600 |

The test sequences listed in Table 5 have been selected from complete clips of 1 minute length each, observing suitability for the subjective evaluation task. Selection criteria included avoidance of extreme camera motion and avoidance of scene cuts as much as possible.

For characterization of the test sequences under consideration, indicative rate-distortion curves for encoding with VTM using the low delay configuration are shown below:



**Figure 2 – Rate-distortion plot for test sequences in Table 5 coded with VVC. PSNR-Y over log bitrate**

## High Dynamic Range

The goal of the High Dynamic Range verification test is to evaluate and verify the performance of VVC for content represented with both HLG and SMPTE ST 2084 transfer functions.

### Coding conditions

The following test conditions will be used for the High Dynamic Range verification test.

1. Number of sequences and video resolutions:
   1. Five sequences represented with the HLG transfer function and with a spatial resolution of UHD (3840×2160)
   2. Five sequences represented with the SMPTE ST 2084 transfer function and with a spatial resolution of UHD (3840×2160)
2. Bitstreams
   1. Generated with VTM 11.0 for VVC bitstreams, where the VTM is configured for HDR content according to the configuration defined in JVET-P2011.
   2. Generated with HM 16.22 for HEVC bitstreams, where the HM is configured for HDR content according to the configuration defined in ISO/IEC TR 23008-14:2018.
   3. In addition to a. and b., other VVC and/or HEVC bitstreams generated with encoders that are optimized for subjective quality may be tested if available.
3. Encoding parameters
   1. Fixed QP.
      1. Five bit rate points per sequence covering the whole MOS range as much as possible with QP values for the HM and the VTM. The QPs are to be selected such that the subjectively assessed quality is comparable between the two test models.
   2. Bit depth of 10bits for all video resolutions
   3. Coding structure
      1. Random access, RA (Storage/Streaming)
         1. Intra refresh at approximately 1 second intervals.
         2. GOP size 32
         3. Picture reordering allowed.
   4. Other settings as in the configuration files, with the Picture Hash SEI deactivated
      1. VTM: Configured for HDR content according to the configuration defined in JVET-S2011.
      2. HM: Configured for HDR content according to the configuration defined in ISO/IEC TR 23008-14:2018.

### HDR HLG test sequences

Based on experts screening of test sequences the following set of sequences is under consideration for evaluation in the verification tests.

Table 6 – HDR HLG test sequences under consideration

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Test sequence** | **Resolution** | **fps** | **Frames** | **Transfer Function** |
| H3\_AMS01\_3840x2160\_10bit\_420\_HLG | 3840×2160 | 60 | 600 | HLG |
| H3\_AMS06\_3840x2160\_10bit\_420\_HLG | 3840×2160 | 60 | 600 | HLG |
| H3\_AMS11\_3840x2160\_10bit\_420\_HLG | 3840×2160 | 60 | 600 | HLG |
| RiverByBoat\_3840x2160\_60fps\_10bit\_HLG\_420\_type2 | 3840×2160 | 60 | 500 | HLG |
| WaterFallWide\_3840x2160\_60fps\_10bit\_HLG\_420\_type2 | 3840×2160 | 60 | 500 | HLG |

For the AMS sequences, a selection of proposed QP points was generated and reviewed in a session of experts. The proposed QP settings are listed in Table 7 below. For the RiverByBoat and WaterFallWide sequences, a chroma artifact was discovered. Rate point selection for these sequences will be conducted after regeneration of these sequences.

Table 7 – Proposed QPs for HDR HLG test sequences under consideration

|  |  |  |
| --- | --- | --- |
| **Sequence** | **HM QPs** | **VTM QPs** |
| H3\_AMS01\_3840x2160\_10bit\_420\_HLG | 39, 36, 32, 28, 24 | 42, 38, 34, 30, 26 |
| H3\_AMS06\_3840x2160\_10bit\_420\_HLG | 40, 36, 32, 28, 24 | 42, 38, 34, 30, 26 |
| H3\_AMS11\_3840x2160\_10bit\_420\_HLG | 39, 35, 31, 27, 23 | 42, 38, 34, 30, 26 |

### HDR PQ test sequences

A set of HDR-PQ candidate test sequences was visually evaluated in multiple online meeting together with JVET experts. The evaluated sequences were:

Table 8 – HDR PQ test sequences under consideration

|  |  |  |  |
| --- | --- | --- | --- |
| **Test sequence** | **Resolution** | **fps** | **Frames** |
| Chimera HDR3 | 3840×2160 | 60 | 600 |
| Chimera HDR5 | 3840×2160 | 60 | 600 |
| Chimera HDR7 | 3840×2160 | 60 | 600 |
| Meridian HDR2 | 3840×2160 | 60 | 600 |
| Meridian HDR5 | 3840×2160 | 60 | 600 |

The conclusion of the evaluation that only 1-2 sequences were suitable for further consideration. These sequences were Meridian2 and (possibly) Chimera 7.

Given this conclusion, additional content for the HDR-PQ verification test is sought as input to the next meeting.

### Timeline and methodology for selection of candidate test sequences

For each candidate test sequence, the rate points to be considered shall be selected such that the full quality range from close-to-transparent (expected DMOS ~8) down to almost bad quality (expected DMOS ~3) is covered. Two types of comparison are considered: Quality improvement at identical rate, and rate saving at identical quality.

For quality improvement comparison at same rate, the lowest point should be selected such that VTM still has somewhat acceptable quality (as would be used by typical application), and HM would show more prominent impairments at the same rate. The highest point should be that VTM starts becoming transparent, and HM still shows artifacts. For the rate comparison, the lowest/highest quality point selection should be identical, but as HM should have somewhat similar quality as VTM, the HM quality could be used as starting point.

The flowing steps are planned to be pursued for achieving this task

1. **Display Calibration**. Calibration of HDR displays will be performed for both the PG and HLG test conditions. This calibration will consist of normalizing the displays to use similar configuration and, if needed, developing a pre-processing stage to create similar dynamic range capabilities. In the event that displays cannot be calibrated for only one of the transfer functions, then the test plan will continue for that transfer function while calibration will continue for the second transfer function.
2. **Encoding.** Bitstreams for HM-16.22 and VTM-11.0 in Random Access configuration with the IRAP interval set to 32,32,64,64,128 for the sequences selected during pre-screening at 24/25Hz, 30Hz, 50Hz, 60Hz, and 120Hz, respectively. An initial QP range of QP=24 to QP=46 with a step size of 1 for the HM and QP=26 to QP=46 with a step size of 4 for the VTM is considered. This range may be extended and refined depending on the visual assessment of the sequences.
3. **Selection.** Based on data generated by the encoding, the test coordinators preselect rate points for the sequences covering the specified quality and rate ranges.
4. **Packing.** Viewing of raw YUV files under laboratory conditions is not expected to be available to all JVET experts under self-isolation rules established in most countries. Therefore, the HM and VTM bitstreams will also be packed in a format suitable for remote assessment without the need for professional viewing equipment.
5. **Viewing.** Packed files are prepared by the test coordinators and distributed to participating experts who are equipped with a computer capable of providing fluid playback of the video sequences on a monitor (or TV set) of at least 32” size; the recommended set-up will be defined as part of the workplan but is anticipated to a UHD OLED TV with HDR capabilities. The viewing is performed during an online meeting with moderation by the test coordinators. Observations and recommendations are collected and documented to form the basis for the selection of candidate sequences and candidate rate points.
6. **Report.** A report on the activity is produced as input to the next meeting.

**Timeline**

1. Dry-run experiment for confirmation of the chosen QP settings
2. Report on activity by input document to the 21st JVET meeting.

## 360° Video

### Coding conditions

The following test conditions will be used for the 360° video part of the VVC verification test.

1. Number of sequences and video resolutions:
   1. 7 sequences at different input resolutions, 8192×4096, 6144×3072, and 4320×2160
2. Bitstreams
   1. Generated with VTM 11.0 and 360Lib 11.0 for VVC bitstreams, in two projection formats, padded equirectangular (PERP) and generalized cubemap projection (GCMP)
   2. Generated with HM 16.22 and a [patched version of 360Lib 5.0](https://vcgit.hhi.fraunhofer.de/sauer/hm-16.16-360lib-5.0-padded-cmp.git) for HEVC bitstreams, in two projection formats, PERP and padded cubemap projection (PCMP).
3. Encoding parameters
   1. Fixed QP.
      1. Five bitrate points per sequence covering the whole MOS range as much as possible with QP values for the HM and the VTM. The QPs are to be selected such that the subjectively assessed quality is comparable between the two test models.
   2. Coding bit depth of 10 bits for all video resolutions, coding resolution depends on the input resolution and coding projection format, as listed in Table 9:

Table 9 – Coding resolution for different input resolutions and coding projection formats

|  |  |  |
| --- | --- | --- |
|  | PCMP/GCMP (before padding) | PERP (before padding) |
| 4K (4320x2160) | 1184×1184 per face  --CodingFaceWidth=1184  --CodingFaceHeight=1184 | 4096×2048  --CodingFaceWidth=4096  --CodingFaceHeight=2048  --WrapAroundOffset=4096 (only for VTM) |
| 6K & 8K | 1280×1280 per face  --CodingFaceWidth=1280  --CodingFaceHeight=1280 | 4432×2216  --CodingFaceWidth=4432  --CodingFaceHeight=2216  --WrapAroundOffset=4432 (only for VTM) |

* 1. Random access, RA (Storage/Streaming) coding structure will be used:
     + 1. Intra refresh at approximately 1 second intervals.
       2. Picture reordering allowed.
  2. Other settings as in the configuration files, with the Picture Hash SEI deactivated
     1. VTM: cfg/encoder\_randomaccess\_vtm.cfg
     2. HM: cfg/encoder\_randomaccess\_main10.cfg
     3. 360Lib: cfg-360Lib/encoder\_360\_PERP.cfg,

cfg-360Lib/encoder\_360\_CMP.cfg,

cfg-360Lib/encoder\_360\_GCMP.cfg

### Test sequences

Out of the previously established set of 360° video test sequence candidates, four sequences as listed in Table 10 have been selected for use in this verification test category.

Table 10 – 360 video test sequences under consideration

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Sequence | Frame rate | Resolution | BD | Camera |
| GT\_Sheriff | 30 | 4320×2160 | 8 | static |
| HarborBiking2 | 30 | 8192×4096 | 8 | moving |
| KiteFliteWalking2 | 30 | 8192×4096 | 8 | moving |
| SkateBoardAtBridge | 30 | 6144×3072 | 8 | moving |

Indicative rate-distortion plots showing luma end-to-end weighted spherical PSNR (E2E WSPSNR) over bitrate are provided in Section 5.

Static and dynamic viewports with 78.1×49.1 degrees of field of view will be used to generate viewport video at the resolution of 1920×1080 and viewed on conventional HD displays. After viewing of extracted viewports, QP settings for the HM and VTM encoding using the PERP and PCMP/GCMP formats are selected and provided in Table 11 and Table 12.

Table 11 – QP settings for the HM and VTM software for the 360° video test sequences using the PERP projection format

|  |  |  |
| --- | --- | --- |
| **Test sequence** | **HM-16.22 QP** | **VTM-11.0** |
| GT\_Sheriff | 36, 32, 28, 24, 20 | 38, 34, 30, 26, 22 |
| HarborBiking2 | 35, 31, 27, 23, 20 | 38, 34, 30, 26, 22 |
| KiteFliteWalking2 | 40, 36, 32, 28, 24 | 42, 38, 34, 30, 26 |
| SkateBoardAtBridge | 39, 35, 31, 27, 24 | 42, 38, 34, 30, 26 |

Table 12 – QP settings for the HM and VTM software for the 360° video test sequences using the PCMP / GCMP projection format

|  |  |  |
| --- | --- | --- |
| **Test sequence** | **HM-16.22 QP** | **VTM-11.0** |
| GT\_Sheriff | 39, 35, 31, 27, 22 | 42, 38, 34, 30, 26 |
| HarborBiking2 | 35, 31,27, 23, 20 | 38, 34, 30, 26, 22 |
| KiteFliteWalking2 | 40, 36, 32, 28, 24 | 42, 38, 34, 30, 26 |
| SkateBoardAtBridge | 38, 34, 30, 27, 23 | 42, 38, 34, 30, 26 |

**Timeline**

1. Dry-run experiment for confirmation of the chosen QP settings
2. Report on activity by input document to the 21st JVET meeting.

# Encoding results

## Standard Dynamic Range

Rate-distortion results for the SDR HD test category will be provided upon determination of the complete test sets for the Low Delay and Random Access configurations.

## HDR

Rate-distortion results for the HDR test category will be provided upon determination of the complete test sets for the HDR HLG and HDR PQ categories.

## 360° Video

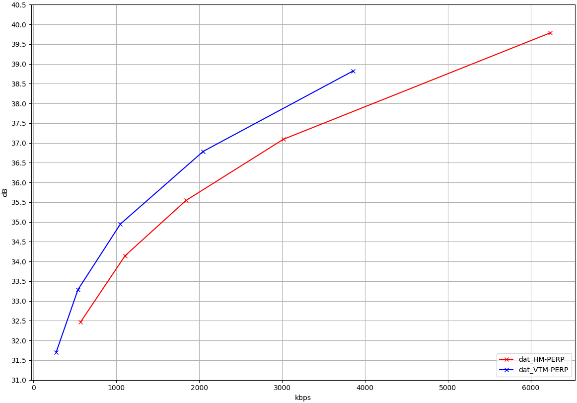
The rate-distortion results in this section are based on data acquired in the preparation phase of the verification test using VTM-8.0 with GOP size 16 and HM-16.20. They do not represent results of the final configuration and quantizer settings.

Table 13 – Preliminary WSPSNR-Y BD rate savings for the 360° video test sequences

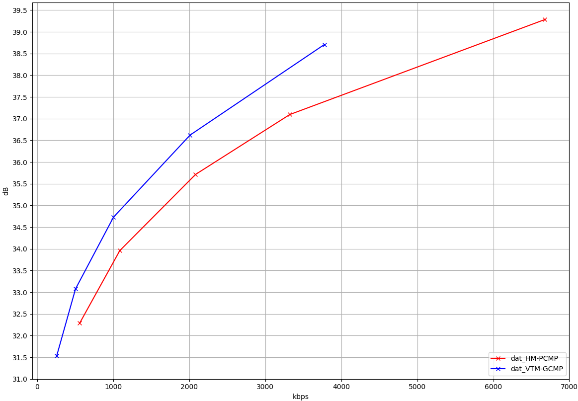
|  |  |  |
| --- | --- | --- |
| **Test sequence** | **PERP WSPSNR Y BD rate savings** | **GCMP/PCMP PSNR Y BD rate savings** |
| GT\_Sheriff | -27.86 % | -31.43 % |
| HarborBiking2 | -40.65 % | -42.66 % |
| KiteFliteWalking2 | -33.64 % | -34.78 % |
| SkateBoardAtBridge | -49.32 % | -56.57 % |

### GT\_Sheriff

#### PERP

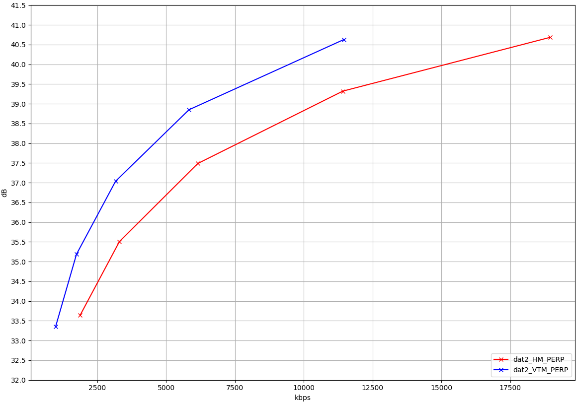


#### PCMP vs. GCMP

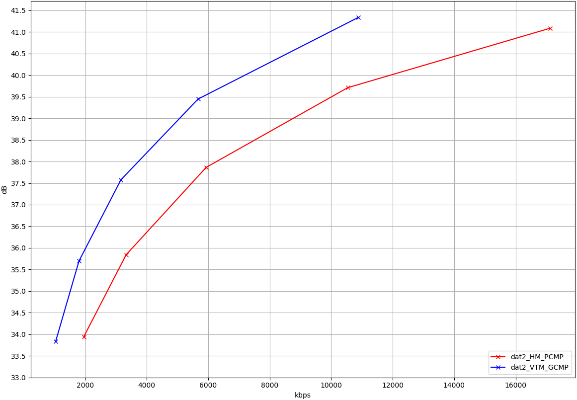


### HarborBiking2

#### PERP

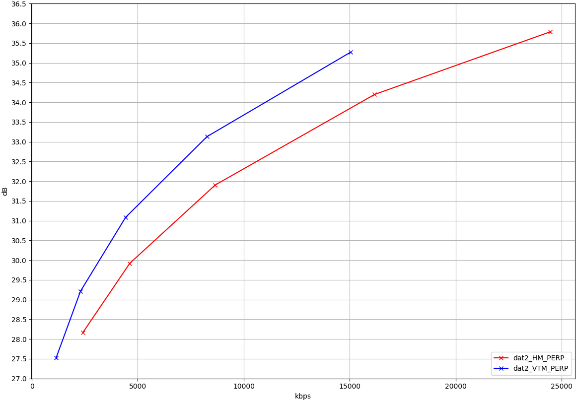


#### PCMP vs. GCMP

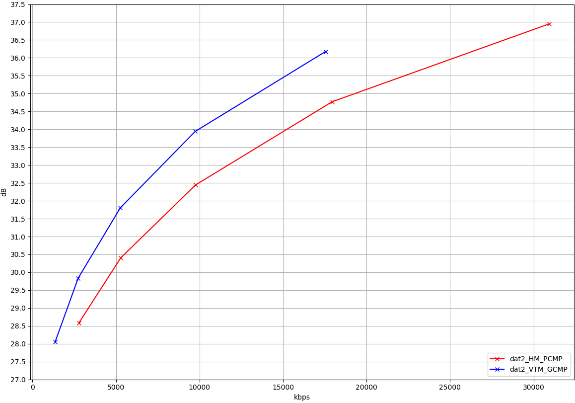


### KiteFliteWalking2

#### PERP

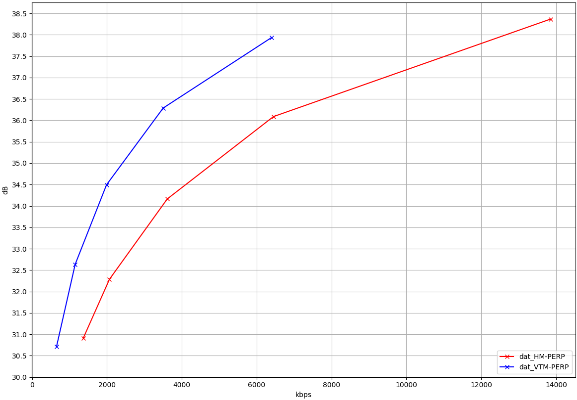


#### PCMP vs. GCMP

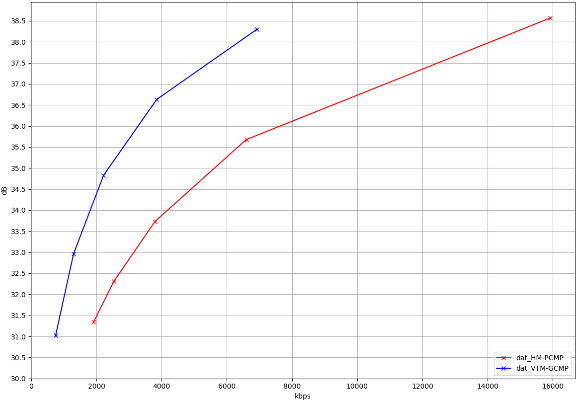


### SkateBoardAtBridge

#### PERP



#### PCMP vs. GCMP



# References

1. Recommendation ITU-R BT.500-14 (2019), *Methodologies for the subjective assessment of the quality of television images*.
2. Recommendation ITU-R BT.2100-2 (2018), *Image parameter values for high dynamic range television for use in production and international programme exchange*.
3. SMPTE ST 2084, *High Dynamic Range Electro-Optical Transfer Function of Mastering Reference Displays*, 2014.
4. SMPTE ST 2036-1, *Ultra High Definition Television – Image Parameter Values for Program Production*, 2014.
5. ETSI TS 101 154, *Digital Video Broadcasting (DVB); Specification for the use of Video and Audio Coding in Broadcast and Broadband Applications*, 2019.
6. G. Bjøntegaard, “Calculation of average PSNR differences between RD-curves,” in ITU-T SG 16 Q.6 document VCEG-M33, 13th VCEG meeting, Austin, Texas, USA, Apr. 2001.
7. J. Ström, K. Andersson, Rickard Sjöberg, A. Segall, F. Bossen, G. J. Sullivan, J.-R. Ohm, A. Tourapis, “Working practices using objective metrics for evaluation of video coding efficiency experiments (Draft 3),” Joint Video Experts Team (JVET) of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11 output document JVET-S2016, 19th JVET meeting by teleconference, June 2020.
8. S. Xu, R.-L. Liao, J. Chen, Y. Ye (Alibaba), “AHG4: new video conference sequences for HD verification testing,” Doc. JVET-T0060, Joint Video Experts Team of VCEG and MPEG, 20th meeting, Oct. 2020.
9. K. Andersson, M. Folkesson (Ericsson), “AHG4: Video conference sequence for HD verification testing,” Doc. JVET-T0120, Joint Video Experts Team of VCEG and MPEG, 20th meeting, Oct. 2020.
10. F. Le Léannec, G. Martin-Cocher (InterDigital), “Game video sequences proposal for the SDR HD low delay VVC verification test,” Doc. JVET-U0043, Joint Video Experts Team of VCEG and MPEG, 21st meeting, Jan. 2021.

# Annex A – Encoding tasks, viewport extraction

## SDR HD RA

[to be filled for the final verification test simulations]

## SDR HD LD

[to be filled for the final verification test simulations]

## HDR

[to be filled for the final verification test simulations]

## 360° Video

[to be filled for the final verification test simulations]