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| **Source** | **WG 04, MPEG Video Coding** |
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# Summary

This document presents the second part of the report on Essential Video Coding (EVC) compression performance verification: Verification Testing of EVC for standard dynamic range (SDR) content. The first part of EVC verification test, on high dynamic range (HDR) and wide colour gamut (WCG) content coding, had already been completed and reported in WG 04 output document N0030, October 30th, 2020.

The purpose of the verification test was to confirm that the coding efficiency objective for the EVC standard has been met: achieving a substantial bit-rate reduction at the same level of subjective visual quality relative to HEVC Main profile for EVC Main profile and AVC High10 profile for EVC Baseline profile, respectively. This document reports the results of the verification test to confirm that this goal was achieved and to estimate the magnitude of this achievement.

The assessment included SDR ultra high definition (UHD, a.k.a. 4K, 3840×2160) test sequences encoded in random access (RA) configuration and SDR full high definition (HD, a.k.a. 2K, 1920×1080) test sequences encoded in low delay (LD) configuration. The average bit rate savings for EVC Main profile compared to HEVC Main10 profile was assessed to be approximately 39% using UHD SDR content encoded in the random access configuration, and approximately 41% using HD SDR content encoded in the low delay configuration. The average bit rate savings for EVC Baseline profile compared to AVC High10 profile was assessed to be approximately 39% using UHD SDR content encoded in the random access configuration, and approximately 34% using HD SDR content encoded in the low delay configuration.

# Standard Dynamic Range Test Conditions

The subjective evaluation was conducted by comparing EVC Main profile [1] to HEVC Main10 profile [2] and comparing EVC Baseline profile [1] to AVC High10 profile [3], respectively. The verification test for EVC included SDR UHD test sequences encoded in random access configuration and SDR HD test sequences encoded in low delay configuration. The details of the test conditions can be found in [4].

# Test video sequences formats and frame rates

All test material is progressively scanned and uses 4:2:0 colour sampling with a bit depth of 10 bits per sample. Table 1 summarizes the test material information.

Table 1. Test video sequences summary information

| **Class** | **Sequence name** | **Resolution** | **Frame count** | **Frame rate** | **Chroma format** | **Bit depth** |
| --- | --- | --- | --- | --- | --- | --- |
| UHD | BarScene | 3840×2160p | 600 | 60 | 4:2:0 | 10 |
| DrivingPOV3 | 3840×2160p | 600 | 60 | 4:2:0 | 10 |
| Marathon2 | 3840×2160p | 300 | 30 | 4:2:0 | 10 |
| CatRobot | 3840×2160p | 600 | 60 | 4:2:0 | 10 |
| HD | BarScene | 1920×1080p | 600 | 60 | 4:2:0 | 10 |
| DrivingPOV | 1920×1080p | 600 | 60 | 4:2:0 | 10 |
| Metro | 1920×1080p | 600 | 60 | 4:2:0 | 10 |
| RushHour | 1920×1080p | 300 | 30 | 4:2:0 | 10 |

# Anchors and test SW

JM19.0 [5] and HM16.22 [6] reference SW was used to encode the anchor data for Baseline and Main profiles testing respectively. ETM7.0 reference SW [7] with corresponding Baseline and Main profile configurations was used to encode the test data. The detailed configuration setting and the configuration files used for the verification test are provided in the verification test plan [4].

# Testing configurations

# Low Delay

Low delay configuration as defined below was used for both Baseline and Main profile testing for HD test sequences.

* No picture reordering between decoder processing and output;
* GOP size 8.

Four QP points per sequence covering a wide MOS range were used. Table 2 and Table 3 provide specific QP values for anchor and test bitstreams for Main and Baseline profiles respectively.

Table 2. Target QP points for ETM Main profile LD verification testing

|  |  | **Target Anchor QP**  **for Main profile** | | | | **ETM7.0 QP**  **for Main profile** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Class** | **Sequence name** | **Rate 1** | **Rate 2** | **Rate 3** | **Rate 4** | **Rate 1** | **Rate 2** | **Rate 3** | **Rate 4** |
| HD | BarScene | 22 | 27 | 32 | 37 | 24 | 30 | 35 | 41 |
| DrivingPOV | 22 | 28 | 32 | 38 | 25 | 30 | 36 | 41 |
| Metro | 22 | 26 | 31 | 35 | 24 | 28 | 33 | 38 |
| RushHour | 23 | 30 | 35 | 40 | 25 | 32 | 37 | 42 |

Table 3. Target QP points for ETM Baseline profile LD verification testing

|  |  | **Target Anchor QP**  **for Baseline profile** | | | | **ETM7.0 QP**  **for Baseline profile** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Class** | **Sequence name** | **Rate 1** | **Rate 2** | **Rate 3** | **Rate 4** | **Rate 1** | **Rate 2** | **Rate 3** | **Rate 4** |
| HD | BarScene | 21 | 26 | 31 | 36 | 23 | 29 | 34 | 38 |
| DrivingPOV | 22 | 25 | 29 | 34 | 24 | 27 | 32 | 37 |
| Metro | 17 | 21 | 27 | 33 | 20 | 24 | 29 | 36 |
| RushHour | 21 | 26 | 31 | 36 | 23 | 28 | 33 | 37 |

# Random Access

Random access configuration as defined below was used for both Baseline and Main profile testing for UHD test sequences.

* IDR picture period 1.1 second or less: 32 pictures or less for a video sequence with a frame rate of 24, 25 or 30 frames per second, 64 pictures or less for a video sequence with a frame rate of 60 frames per second;
* Hierarchical B coding structure, GOP size 16: 16 frames of structural delay, e.g. 16 picture “group of pictures (GOP)”.

Four QP points per sequence covering a wide MOS range were used. Table 4 and Table 5 provide specific QP values for anchor and test bitstreams for Main and Baseline profiles respectively.

Table 4. Target QP points for ETM Main profile RA verification testing

|  |  | **Target Anchor QP**  **for Main profile** | | | | **ETM7.0 QP**  **for Main profile** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Class** | **Sequence name** | **Rate 1** | **Rate 2** | **Rate 3** | **Rate 4** | **Rate 1** | **Rate 2** | **Rate 3** | **Rate 4** |
| UHD | BarScene | 27 | 32 | 38 | 44 | 29 | 35 | 41 | 47 |
| DrivingPOV3 | 30 | 34 | 38 | 43 | 32 | 36 | 40 | 45 |
| Marathon2 | 28 | 33 | 38 | 43 | 30 | 35 | 40 | 46 |
| CatRobot | 27 | 32 | 37 | 42 | 29 | 34 | 39 | 44 |

Table 5. Target QP points for ETM Baseline profile RA verification testing

|  |  | **Target Anchor QP**  **for Baseline profile** | | | | **ETM7.0 QP**  **for Baseline profile** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Class** | **Sequence name** | **Rate 1** | **Rate 2** | **Rate 3** | **Rate 4** | **Rate 1** | **Rate 2** | **Rate 3** | **Rate 4** |
| UHD | BarScene | 25 | 27 | 32 | 39 | 29 | 32 | 38 | 44 |
| DrivingPOV3 | 25 | 29 | 34 | 39 | 30 | 34 | 39 | 45 |
| Marathon2 | 26 | 30 | 34 | 39 | 30 | 34 | 38 | 43 |
| CatRobot | 25 | 30 | 35 | 39 | 30 | 35 | 40 | 45 |

# Evaluation procedure

For SDR content the DSIS test method [8] was used. The SDR subjective test was carried out at GBTech.

Viewing set up at the test laboratory was as follows:

* 65” TV set, with OLED screen set with “standard” viewing option and HDMI 2.1 input interface capable of accepting and displaying 10 bit content.
* Suitable video player system able to play out YUV UHD content up to 60 fps and 420p colour scheme, in a fluid way (i.e. faithful frame rate and no frame jump) and no impairments.
* Protected viewing area (no external video or audio pollutions) with low illumination behind the screen (around 30 nits) not visible to the viewing subject(s) and no other ambient light.
* Two seats for each testing room at a distance of 1m from each other.
* Viewing distance 2H.
* Two separate waiting areas for viewing subjects while resting and waiting.
* 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.
* Further cleaning one hour before each group of subjects came into the lab: using disinfectant spray cans to produce a cleaning tide; then all the rooms were closed for 45 minutes; then fresh air was let in for 15 minutes (opening all windows and doors) before use.
* All viewers and test managers wore high efficiency masks (e.g. U-Mask), washed hands and used disinfectant liquid.
* All viewers and test managers provided a COVID throat swab certificate showing a negative result to a COVID test performed not more than 6 days previously.

# Test results and graphs

Detailed verification test results and graphs can be found in [9].

# SDR HD resolution with LD configuration

This section provides tables and graphs with the results of SDR test at HD resolution in the LD configuration.

Table 6. Table of results for sequence BarScene

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mean | CI | Bitrate (kbps) | QP | CODEC |
| 7,25 | 0,63 | 2226 | Q23 | ETM7.0 Base |
| 5,14 | 0,41 | 842 | Q29 | ETM7.0 Base |
| 3,24 | 0,41 | 452 | Q34 | ETM7.0 Base |
| 1,93 | 0,41 | 296 | Q38 | ETM7.0 Base |
| 8,27 | 0,41 | 2209 | Q22 | HM16.22 |
| 5,72 | 0,32 | 854 | Q27 | HM16.22 |
| 4,21 | 0,39 | 422 | Q32 | HM16.22 |
| 1,95 | 0,42 | 226 | Q37 | HM16.22 |
| 7,29 | 0,49 | 3170 | Q21 | JM19.0 |
| 4,79 | 0,39 | 1480 | Q26 | JM19.0 |
| 3,36 | 0,49 | 830 | Q31 | JM19.0 |
| 1,71 | 0,40 | 505 | Q36 | JM19.0 |
| 8,29 | 0,36 | 1340 | Q24 | ETM7.0 Main |
| 5,93 | 0,36 | 523 | Q30 | ETM7.0 Main |
| 4,29 | 0,36 | 267 | Q35 | ETM7.0 Main |
| 1,93 | 0,41 | 128 | Q41 | ETM7.0 Main |

Fig. 1. Results for sequence BarScene

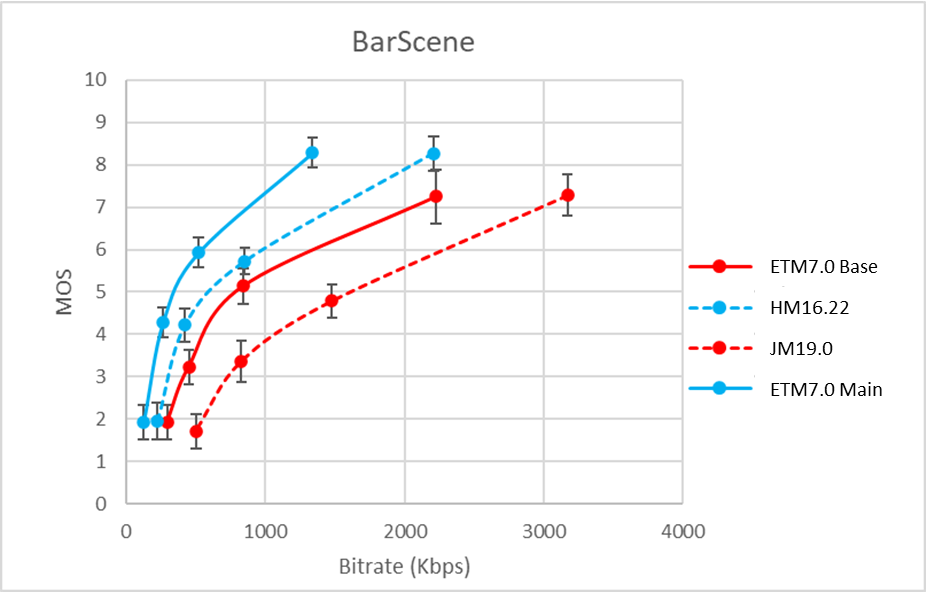


Table 7. Table of results for sequence DrivingPOV

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mean | CI | Bitrate (kbps) | QP | CODEC |
| 7,71 | 0,36 | 12377 | Q24 | ETM7.0 Base |
| 6,07 | 0,62 | 7117 | Q27 | ETM7.0 Base |
| 4,36 | 0,41 | 3198 | Q32 | ETM7.0 Base |
| 2,43 | 0,46 | 1519 | Q37 | ETM7.0 Base |
| 8,14 | 0,32 | 15732 | Q22 | HM16.22 |
| 5,43 | 0,34 | 4873 | Q28 | HM16.22 |
| 3,67 | 0,36 | 2483 | Q32 | HM16.22 |
| 2,36 | 0,33 | 986 | Q38 | HM16.22 |
| 7,50 | 0,54 | 15804 | Q22 | JM19.0 |
| 6,29 | 0,36 | 9704 | Q25 | JM19.0 |
| 4,71 | 0,45 | 5135 | Q29 | JM19.0 |
| 2,50 | 0,50 | 2524 | Q34 | JM19.0 |
| 8,00 | 0,43 | 8070 | Q25 | ETM7.0 Main |
| 5,50 | 0,71 | 3300 | Q30 | ETM7.0 Main |
| 3,93 | 0,45 | 1236 | Q36 | ETM7.0 Main |
| 2,43 | 0,37 | 558 | Q41 | ETM7.0 Main |

Fig. 2. Results for sequence DrivingPOV

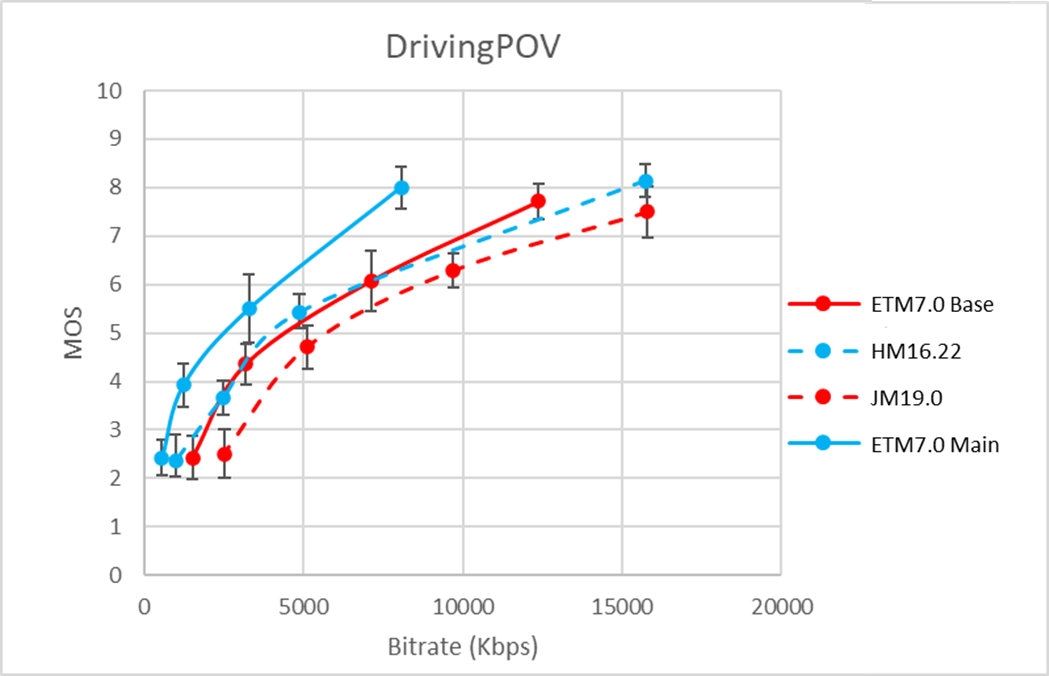


Table 8. Table of results for sequence Metro

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mean | CI | Bitrate (kbps) | QP | CODEC |
| 8,43 | 0,57 | 9874 | Q20 | ETM7.0 Base |
| 7,50 | 0,50 | 5532 | Q24 | ETM7.0 Base |
| 5,79 | 0,44 | 2760 | Q29 | ETM7.0 Base |
| 3,29 | 0,45 | 1056 | Q36 | ETM7.0 Base |
| 7,64 | 0,24 | 6862 | Q22 | HM16.22 |
| 6,65 | 0,47 | 3710 | Q26 | HM16.22 |
| 4,14 | 0,42 | 1747 | Q31 | HM16.22 |
| 2,79 | 0,34 | 1008 | Q35 | HM16.22 |
| 7,79 | 0,42 | 13872 | Q17 | JM19.0 |
| 7,07 | 0,23 | 8185 | Q21 | JM19.0 |
| 5,43 | 0,39 | 3732 | Q27 | JM19.0 |
| 3,07 | 0,59 | 1704 | Q33 | JM19.0 |
| 8,03 | 0,31 | 4685 | Q24 | ETM7.0 Main |
| 6,75 | 0,37 | 2594 | Q28 | ETM7.0 Main |
| 5,34 | 0,24 | 1260 | Q33 | ETM7.0 Main |
| 3,21 | 0,34 | 630 | Q38 | ETM7.0 Main |

Fig. 3. Results for sequence Metro

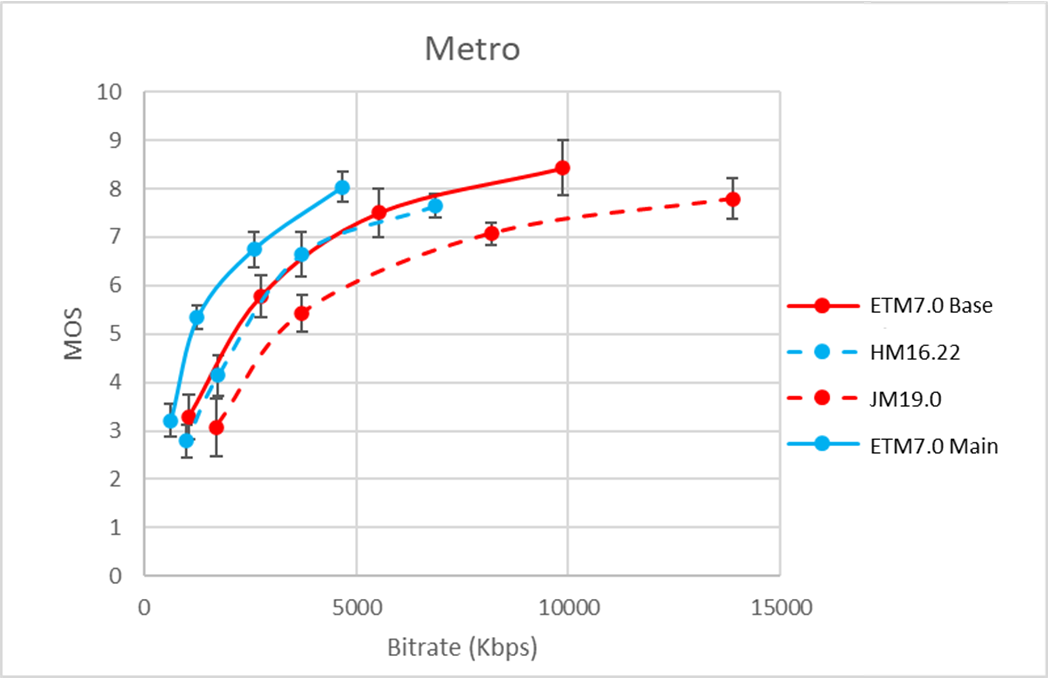
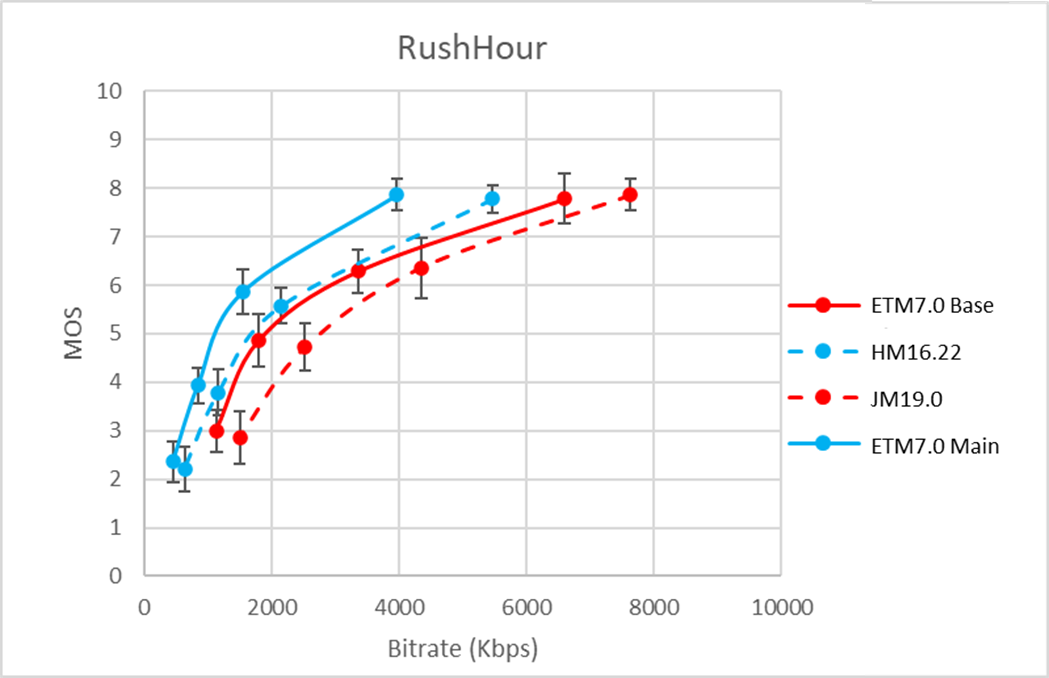


Table 9. Table of results for sequence RushHour

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mean | CI | Bitrate (kbps) | QP | CODEC |
| 7,79 | 0,52 | 6597 | Q23 | ETM7.0 Base |
| 6,29 | 0,45 | 3357 | Q28 | ETM7.0 Base |
| 4,86 | 0,54 | 1801 | Q33 | ETM7.0 Base |
| 3,00 | 0,43 | 1136 | Q37 | ETM7.0 Base |
| 7,79 | 0,28 | 5467 | Q23 | HM16.22 |
| 5,57 | 0,37 | 2149 | Q30 | HM16.22 |
| 3,79 | 0,48 | 1165 | Q35 | HM16.22 |
| 2,21 | 0,46 | 636 | Q40 | HM16.22 |
| 7,86 | 0,32 | 7630 | Q21 | JM19.0 |
| 6,36 | 0,63 | 4351 | Q26 | JM19.0 |
| 4,71 | 0,49 | 2529 | Q31 | JM19.0 |
| 2,86 | 0,54 | 1504 | Q36 | JM19.0 |
| 7,86 | 0,32 | 3968 | Q25 | ETM7.0 Main |
| 5,86 | 0,47 | 1550 | Q32 | ETM7.0 Main |
| 3,93 | 0,36 | 849 | Q37 | ETM7.0 Main |
| 2,36 | 0,41 | 457 | Q42 | ETM7.0 Main |

Fig. 4. Results for sequence RushHour



# SDR UHD resolution with RA configuration

This section provides table and graphs with the results of the SDR test at UHD resolution in the RA configuration.

Table 10. Table of results for sequence CatRobot

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mean | CI | Bitrate (kbps) | QP | CODEC |
| 7,56 | 0,25 | 8977 | Q30 | ETM7.0 Base |
| 5,44 | 0,33 | 4865 | Q35 | ETM7.0 Base |
| 3,17 | 0,35 | 2864 | Q40 | ETM7.0 Base |
| 1,83 | 0,35 | 1824 | Q45 | ETM7.0 Base |
| 8,17 | 0,30 | 10800 | Q27 | HM16.22 |
| 6,72 | 0,57 | 5456 | Q32 | HM16.22 |
| 4,39 | 0,42 | 2962 | Q37 | HM16.22 |
| 1,89 | 0,33 | 1653 | Q42 | HM16.22 |
| 6,78 | 0,44 | 14417 | Q25 | JM19.0 |
| 4,56 | 0,45 | 7725 | Q30 | JM19.0 |
| 3,22 | 0,46 | 4519 | Q35 | JM19.0 |
| 1,78 | 0,40 | 2953 | Q39 | JM19.0 |
| 8,11 | 0,33 | 6828 | Q29 | ETM7.0 Main |
| 6,94 | 0,37 | 3431 | Q34 | ETM7.0 Main |
| 4,61 | 0,23 | 1811 | Q39 | ETM7.0 Main |
| 2,33 | 0,24 | 999 | Q44 | ETM7.0 Main |

Fig. 5. Results for sequence CatRobot

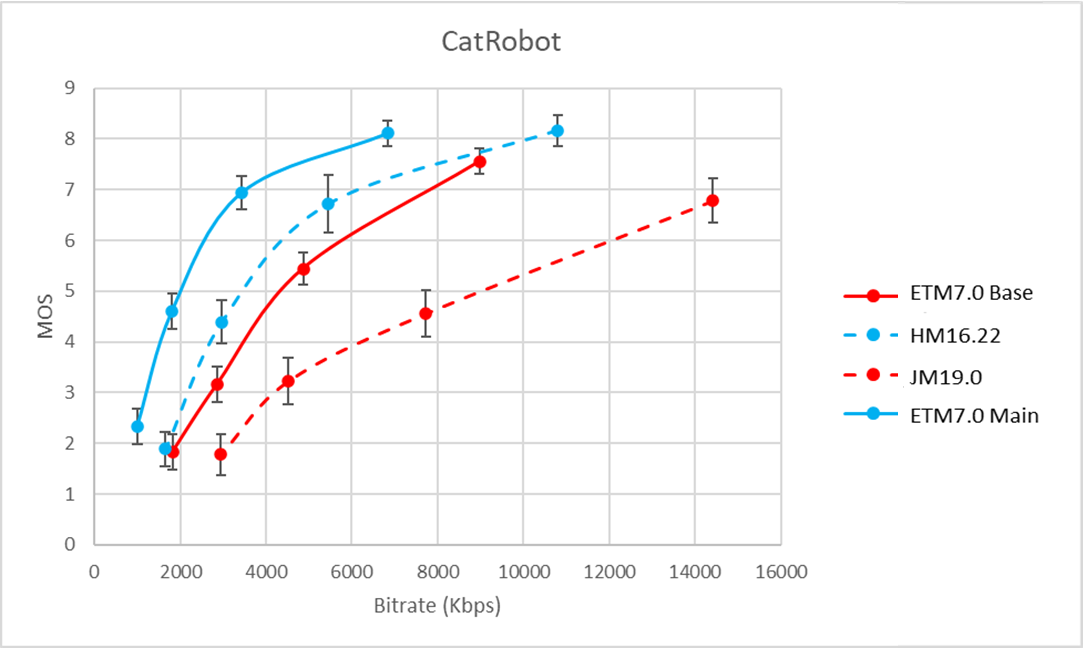


Table 11. Table of results for sequence DrivingPOV3

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mean | CI | Bitrate (kbps) | QP | CODEC |
| 6,97 | 0,22 | 10786 | Q30 | ETM7.0 Base |
| 4,94 | 0,34 | 6008 | Q34 | ETM7.0 Base |
| 2,98 | 0,36 | 3077 | Q39 | ETM7.0 Base |
| 1,74 | 0,32 | 1616 | Q45 | ETM7.0 Base |
| 7,50 | 0,29 | 9142 | Q30 | HM16.22 |
| 5,28 | 0,47 | 4907 | Q34 | HM16.22 |
| 3,06 | 0,34 | 2731 | Q38 | HM16.22 |
| 1,67 | 0,27 | 1406 | Q43 | HM16.22 |
| 6,94 | 0,46 | 17975 | Q25 | JM19.0 |
| 4,94 | 0,34 | 10312 | Q29 | JM19.0 |
| 2,78 | 0,46 | 5643 | Q34 | JM19.0 |
| 1,56 | 0,38 | 3311 | Q39 | JM19.0 |
| 7,20 | 0,34 | 5702 | Q32 | ETM7.0 Main |
| 5,17 | 0,42 | 3034 | Q36 | ETM7.0 Main |
| 3,05 | 0,37 | 1692 | Q40 | ETM7.0 Main |
| 2,01 | 0,31 | 881 | Q45 | ETM7.0 Main |

Fig. 6. Results for sequence DrivingPOV3

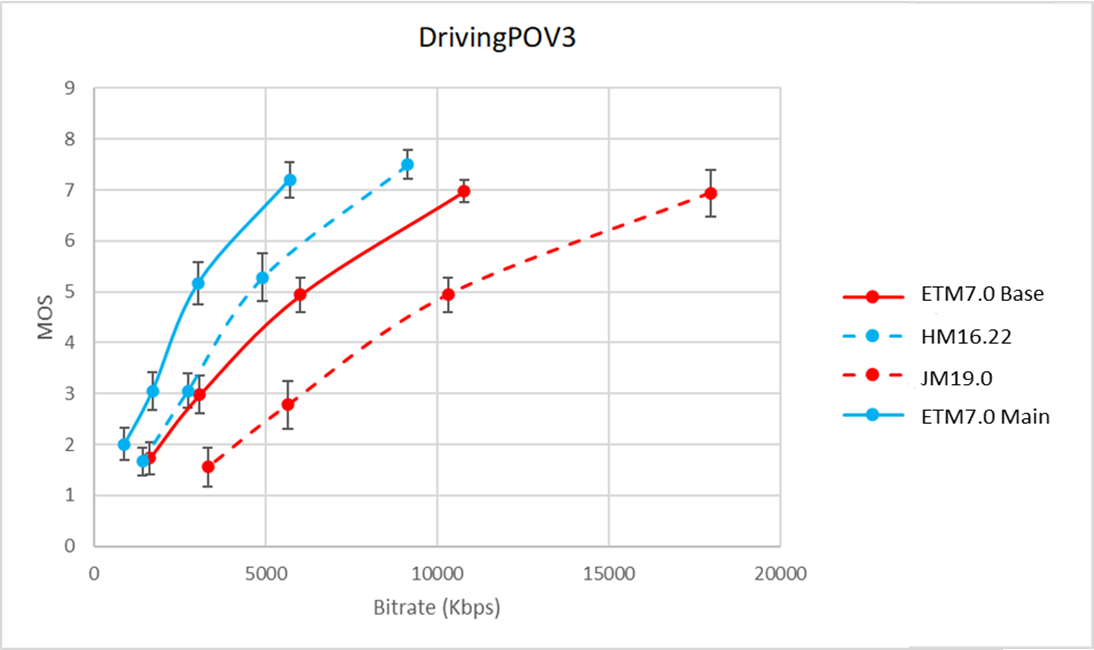


Table 12. Table of results for sequence Marathon2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mean | CI | Bitrate (kbps) | QP | CODEC |
| 7,44 | 0,24 | 14152 | Q30 | ETM7.0 Base |
| 6,06 | 0,46 | 8236 | Q34 | ETM7.0 Base |
| 3,94 | 0,34 | 4976 | Q38 | ETM7.0 Base |
| 1,89 | 0,27 | 2778 | Q43 | ETM7.0 Base |
| 7,67 | 0,42 | 16192 | Q28 | HM16.22 |
| 6,39 | 0,36 | 7691 | Q33 | HM16.22 |
| 4,22 | 0,36 | 3925 | Q38 | HM16.22 |
| 1,50 | 0,43 | 1987 | Q43 | HM16.22 |
| 7,50 | 0,39 | 19078 | Q26 | JM19.0 |
| 6,06 | 0,43 | 10468 | Q30 | JM19.0 |
| 3,89 | 0,44 | 6408 | Q34 | JM19.0 |
| 1,72 | 0,37 | 3523 | Q39 | JM19.0 |
| 8,28 | 0,40 | 10889 | Q30 | ETM7.0 Main |
| 6,61 | 0,45 | 5171 | Q35 | ETM7.0 Main |
| 4,33 | 0,32 | 2565 | Q40 | ETM7.0 Main |
| 1,94 | 0,30 | 1351 | Q46 | ETM7.0 Main |

Fig. 7. Results for sequence Marathon2

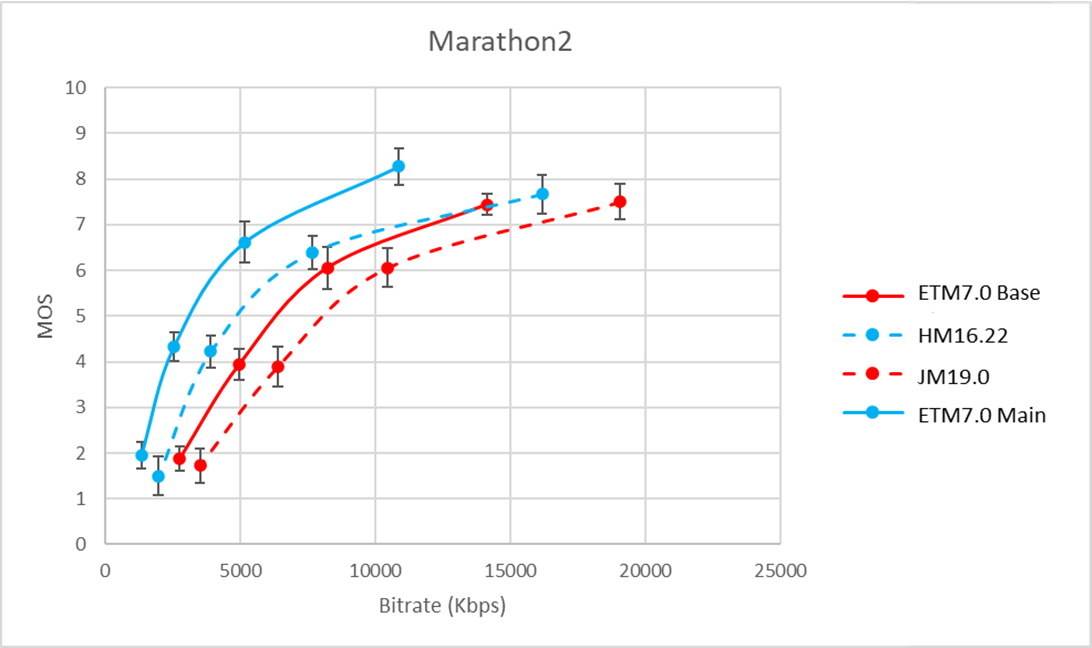
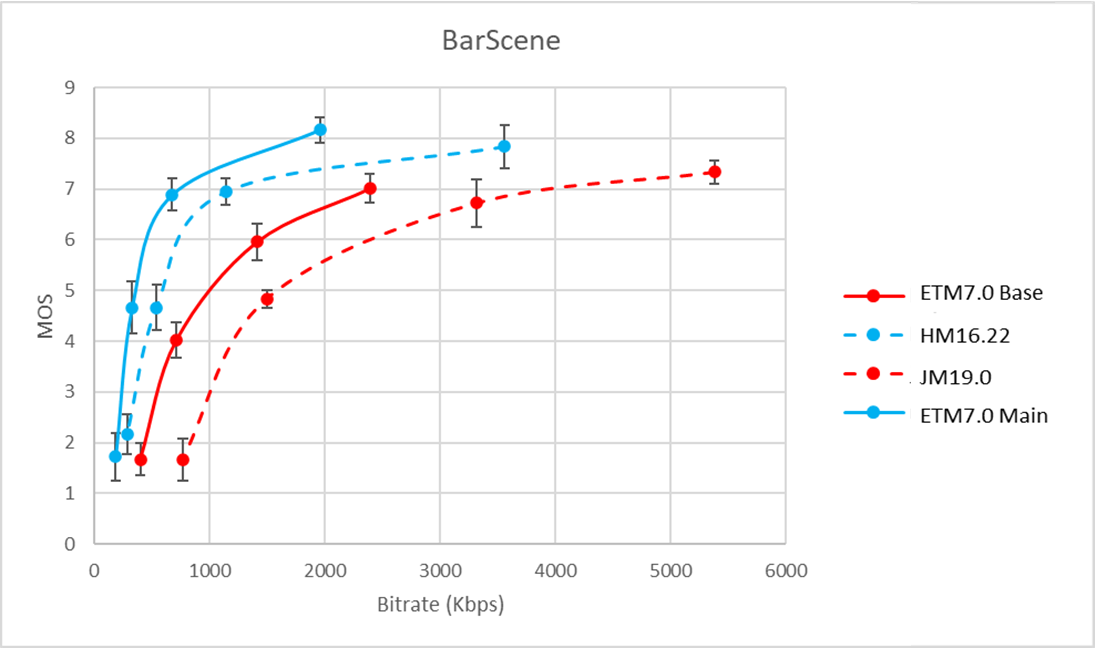


Table 13. Table of results for sequence BarScene

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mean | CI | Bitrate (kbps) | QP | CODEC |
| 7,01 | 0,28 | 2389 | Q29 | ETM7.0 Base |
| 5,96 | 0,35 | 1412 | Q32 | ETM7.0 Base |
| 4,02 | 0,35 | 710 | Q38 | ETM7.0 Base |
| 1,68 | 0,32 | 398 | Q44 | ETM7.0 Base |
| 7,83 | 0,43 | 3557 | Q27 | HM16.22 |
| 6,94 | 0,26 | 1139 | Q32 | HM16.22 |
| 4,67 | 0,44 | 541 | Q38 | HM16.22 |
| 2,17 | 0,39 | 285 | Q44 | HM16.22 |
| 7,33 | 0,22 | 5377 | Q25 | JM19.0 |
| 6,72 | 0,47 | 3314 | Q27 | JM19.0 |
| 4,83 | 0,18 | 1496 | Q32 | JM19.0 |
| 1,67 | 0,41 | 767 | Q39 | JM19.0 |
| 8,17 | 0,25 | 1956 | Q29 | ETM7.0 Main |
| 6,89 | 0,31 | 674 | Q35 | ETM7.0 Main |
| 4,67 | 0,50 | 327 | Q41 | ETM7.0 Main |
| 1,72 | 0,47 | 183 | Q47 | ETM7.0 Main |

Fig. 8. Results for sequence BarSene



# MOS BD-rate

In this section, the average bit rate saving of the EVC profiles relative to the anchors were computed from the MOS vs. bit rate data for each sequence, in the same manner that was done in [10], to further quantify the bit rate savings achieved.

The bit rate savings were averaged over the whole range where the same MOS scores for EVC Main profile, EVC Baseline profile, HEVC and AVC could be interpolated from subjective test results shown in the plots in section 2.

Tables from 14 to 17 show the MOS BD-rate for the sequences in this test. The BD-rate measure described in [11][12] was used with MOS scores taking the place of PSNR. The piecewise cubic interpolation used in the EVC common conditions spreadsheet was used.

Table 14. MOS BD-rate for Main profile at UHD resolution in the RA configuration

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sequence** | | **HM16.22** | | | | **ETM7.0** | | | | **BD-rate (piecewise cubic)** |
| **QP** | **Bitrate (kbps)** | **MOS** | **CI** | **QP** | **Bitrate (kbps)** | **MOS** | **CI** |
| UHD | BarScene | 27 | 3557.35 | 7.83 | 0.43 | 29 | 1955.93 | 8.17 | 0.25 | -39.6% |
| 32 | 1139.06 | 6.94 | 0.26 | 35 | 673.67 | 6.89 | 0.31 |
| 38 | 540.89 | 4.67 | 0.44 | 41 | 326.63 | 4.67 | 0.50 |
| 44 | 284.80 | 2.17 | 0.39 | 47 | 183.50 | 1.72 | 0.47 |
| CatRobot | 27 | 10800.43 | 8.17 | 0.30 | 29 | 6828.29 | 8.11 | 0.33 | -42.0% |
| 32 | 5456.11 | 6.72 | 0.57 | 34 | 3431.08 | 6.94 | 0.37 |
| 37 | 2961.55 | 4.39 | 0.42 | 39 | 1810.50 | 4.61 | 0.23 |
| 42 | 1652.54 | 1.89 | 0.33 | 44 | 999.20 | 2.33 | 0.24 |
| DrivingPOV3 | 30 | 9142.36 | 7.50 | 0.29 | 32 | 5701.60 | 7.20 | 0.34 | -37.1% |
| 34 | 4907.42 | 5.28 | 0.47 | 36 | 3033.82 | 5.17 | 0.42 |
| 38 | 2730.64 | 3.06 | 0.34 | 40 | 1692.19 | 3.05 | 0.37 |
| 43 | 1406.05 | 1.67 | 0.27 | 45 | 880.54 | 2.01 | 0.31 |
| Marathon2 | 28 | 16192.09 | 7.67 | 0.42 | 30 | 10889.27 | 8.28 | 0.40 | -38.4% |
| 33 | 7690.58 | 6.39 | 0.36 | 35 | 5170.60 | 6.61 | 0.45 |
| 38 | 3924.93 | 4.22 | 0.36 | 40 | 2564.99 | 4.33 | 0.32 |
| 43 | 1987.03 | 1.50 | 0.43 | 46 | 1351.13 | 1.94 | 0.30 |
| **Average** | | | | | | | | | | **-39.3%** |

Table 15. MOS BD-rate for Main profile at HD resolution in the LD configuration

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sequence** | | **HM16.22** | | | | **ETM7.0** | | | | **BD-rate (piecewise cubic)** |
| **QP** | **Bitrate (kbps)** | **MOS** | **CI** | **QP** | **Bitrate (kbps)** | **MOS** | **CI** |
| HD | BarScene | 22 | 2209.20 | 8.27 | 0.41 | 24 | 1339.70 | 8.29 | 0.36 | -41.4% |
| 27 | 853.90 | 5.72 | 0.32 | 30 | 522.59 | 5.93 | 0.36 |
| 32 | 422.00 | 4.21 | 0.39 | 35 | 267.18 | 4.29 | 0.36 |
| 37 | 225.55 | 1.95 | 0.42 | 41 | 127.69 | 1.93 | 0.41 |
| DrivingPOV | 22 | 15732.41 | 8.14 | 0.32 | 25 | 8070.33 | 8.00 | 0.43 | -44.1% |
| 28 | 4872.97 | 5.43 | 0.34 | 30 | 3299.77 | 5.50 | 0.71 |
| 32 | 2483.30 | 3.67 | 0.36 | 36 | 1236.13 | 3.93 | 0.45 |
| 38 | 985.67 | 2.36 | 0.33 | 41 | 558.06 | 2.43 | 0.37 |
| Metro | 22 | 6861.68 | 7.64 | 0.24 | 24 | 4684.71 | 8.03 | 0.31 | -45.6% |
| 26 | 3710.13 | 6.65 | 0.47 | 28 | 2594.39 | 6.75 | 0.37 |
| 31 | 1747.19 | 4.14 | 0.42 | 33 | 1260.36 | 5.34 | 0.24 |
| 35 | 1008.20 | 2.79 | 0.34 | 38 | 630.04 | 3.21 | 0.34 |
| RushHour | 23 | 5467.38 | 7.79 | 0.28 | 25 | 3968.22 | 7.86 | 0.32 | -32.8% |
| 30 | 2149.49 | 5.57 | 0.37 | 32 | 1549.91 | 5.86 | 0.47 |
| 35 | 1165.24 | 3.79 | 0.48 | 37 | 849.15 | 3.93 | 0.36 |
| 40 | 635.70 | 2.21 | 0.46 | 42 | 456.52 | 2.36 | 0.41 |
| **Average** | | | | | | | | | | **-41.0%** |

Table 16. MOS BD-rate for Base at UHD resolution in the RA configuration

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sequence** | | **JM19.0** | | | | **ETM7.0** | | | | **BD-rate (piecewise cubic)** |
| **QP** | **Bitrate (kbps)** | **MOS** | **CI** | **QP** | **Bitrate (kbps)** | **MOS** | **CI** |
| UHD | BarScene | 25 | 5377.38 | 7.33 | 0.22 | 29 | 2389.16 | 7.01 | 0.28 | -40.7% |
| 27 | 3314.41 | 6.72 | 0.47 | 32 | 1411.67 | 5.96 | 0.35 |
| 32 | 1496.39 | 4.83 | 0.18 | 38 | 710.34 | 4.02 | 0.35 |
| 39 | 767.12 | 1.67 | 0.41 | 44 | 398.30 | 1.68 | 0.32 |
| CatRobot | 25 | 14417.01 | 6.78 | 0.44 | 30 | 8977.04 | 7.56 | 0.25 | -45.2% |
| 30 | 7724.75 | 4.56 | 0.45 | 35 | 4864.70 | 5.44 | 0.33 |
| 35 | 4519.08 | 3.22 | 0.46 | 40 | 2864.41 | 3.17 | 0.35 |
| 39 | 2952.99 | 1.78 | 0.40 | 45 | 1824.34 | 1.83 | 0.35 |
| DrivingPOV3 | 25 | 17975.32 | 6.94 | 0.46 | 30 | 10786.26 | 6.97 | 0.22 | -45.2% |
| 29 | 10312.45 | 4.94 | 0.34 | 34 | 6008.24 | 4.94 | 0.34 |
| 34 | 5643.47 | 2.78 | 0.46 | 39 | 3076.86 | 2.98 | 0.36 |
| 39 | 3310.95 | 1.56 | 0.38 | 45 | 1616.40 | 1.74 | 0.32 |
| Marathon2 | 26 | 19077.71 | 7.50 | 0.39 | 30 | 14151.64 | 7.44 | 0.24 | -22.9% |
| 30 | 10468.48 | 6.06 | 0.43 | 34 | 8236.44 | 6.06 | 0.46 |
| 34 | 6407.84 | 3.89 | 0.44 | 38 | 4976.06 | 3.94 | 0.34 |
| 39 | 3523.31 | 1.72 | 0.37 | 43 | 2777.87 | 1.89 | 0.27 |
| **Average** | | | | | | | | | | **-38.5%** |

Table 17. MOS BD-rate for Base profile at HD resolution in the LD configuration

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sequence** | | **JM19.0** | | | | **ETM7.0** | | | | **BD-rate (piecewise cubic)** |
| **QP** | **Bitrate (kbps)** | **MOS** | **CI** | **QP** | **Bitrate (kbps)** | **MOS** | **CI** |
| HD | BarScene | 21 | 3169.76 | 7.29 | 0.49 | 23 | 2225.52 | 7.25 | 0.63 | -44.6% |
| 26 | 1480.13 | 4.79 | 0.39 | 29 | 841.99 | 5.14 | 0.41 |
| 31 | 829.87 | 3.36 | 0.49 | 34 | 451.91 | 3.24 | 0.41 |
| 36 | 504.66 | 1.71 | 0.40 | 38 | 296.28 | 1.93 | 0.41 |
| DrivingPOV | 22 | 15804.46 | 7.50 | 0.54 | 24 | 12377.30 | 7.71 | 0.36 | -27.3% |
| 25 | 9704.03 | 6.29 | 0.36 | 27 | 7117.22 | 6.07 | 0.62 |
| 29 | 5135.09 | 4.71 | 0.45 | 32 | 3197.81 | 4.36 | 0.41 |
| 34 | 2524.28 | 2.50 | 0.50 | 37 | 1519.35 | 2.43 | 0.46 |
| Metro | 17 | 13871.52 | 7.79 | 0.42 | 20 | 9874.41 | 8.43 | 0.57 | -39.9% |
| 21 | 8184.98 | 7.07 | 0.23 | 24 | 5531.94 | 7.50 | 0.50 |
| 27 | 3731.63 | 5.43 | 0.39 | 29 | 2760.12 | 5.79 | 0.44 |
| 33 | 1703.77 | 3.07 | 0.59 | 36 | 1056.30 | 3.29 | 0.45 |
| RushHour | 21 | 7630.22 | 7.86 | 0.32 | 23 | 6597.05 | 7.79 | 0.52 | -25.5% |
| 26 | 4351.27 | 6.36 | 0.63 | 28 | 3357.24 | 6.29 | 0.45 |
| 31 | 2528.96 | 4.71 | 0.49 | 33 | 1800.64 | 4.86 | 0.54 |
| 36 | 1504.03 | 2.86 | 0.54 | 37 | 1135.71 | 3.00 | 0.43 |
| **Average** | | | | | | | | | | **-34.3%** |

# Conclusions

This document provides the second part of the report on Essential Video Coding (EVC) compression performance verification: Verification Testing of EVC for standard dynamic range (SDR) content. The assessment included SDR UHD test sequences encoded in random access configuration and SDR HD test sequences encoded in low delay configuration.

The MOS BD-rate calculation shows that the average bit rate saving for EVC Main profile compared to HEVC Main10 profile was approximately 39% using UHD SDR content encoded in random access configuration, and approximately 41% using HD SDR content encoded in low delay configuration. The average bit rate saving for EVC Baseline profile compared to AVC High10 profile was approximately 39% using UHD SDR content encoded in random access configuration, and approximately 34% using HD SDR content encoded in low delay configuration.

The measured subjective test results indicate a significant improvement in coding efficiency for EVC Main profile relative to HEVC Main10 profile, and for EVC Baseline profile relative to AVC High10 profile. It can therefore be concluded that these results prove that the MPEG-5 EVC standard successfully satisfies the coding efficiency objectives given in [13].

# Reference

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. ISO/IEC 14496-10:2020 Information technology — Coding of audio-visual objects — Part 10: Advanced video coding
4. “Updated Verification Test Plan for Essential Video Coding for SDR Content”, ISO/IEC JTC 1/SC 29/WG 04 N0031, Jan. 2021
5. JM19.0 software is available online: https://vcgit.hhi.fraunhofer.de/jct-vc/JM
6. HM16.22 software is available online: https://vcgit.hhi.fraunhofer.de/jct-vc/HM
7. ETM7.0 software is available online: http://mpegx.int-evry.fr/software/MPEG/Video/EVC/ETM
8. International Telecommunication Union – Radio Communication Sector; Recommendation ITU-R BT.500-14
9. V. Baronchini, “Report on EVC verification test”, ISO/IEC JTC 1/SC 29/WG 04 m55942, Jan. 2021
10. T .Tan, M. Mrak, V. Baronicini, N. Ramzan, “Report on HEVC compression performance verification testing”, JCTVC-Q1011, April 2014
11. 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
12. Gisle Bjøntegaard, “Improvements of the BD-PSNR model”, ITU-T SG16/Q6, 35th VCEG Meeting, Berlin, Germany, July, 2008, Doc.VCEG-AI11
13. “Requirements for a New Video Coding Standard”, ISO/IEC JTC1/SC29/WG11, October 2018, Macau SAR, CN, Doc. N17928

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