**3GPP TSG-SA4 SA4#114-eS4-210734**

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| *CR-Form-v12.0* | | | | | | | | |
| **PSEUDO CHANGE REQUEST** | | | | | | | | |
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|  | **26**.**955** | **CR** |  | **rev** |  | **Current version:** |  |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network |  | Core Network |  |

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|  | | | | | | | | | | |
| ***Title:*** | H.265 Characterization against H.264 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | InterDigital | | | | | | | | | |
| ***Source to TSG:*** |  | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** |  | | | | |  | ***Date:*** | | | 11th May 2021 |
|  |  | | | |  | |  | | |  |
| ***Category:*** |  |  | | | | | ***Release:*** | | |  |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) Rel-12 (Release 12)* *Rel-13 (Release 13) Rel-14 (Release 14) Rel-15 (Release 15) Rel-16 (Release 16)* | |
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| ***Reason for change:*** | | Provide initial text for the section 7.2 of the TR | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | |  | | | | | | | | |
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| ***Consequences if not approved:*** | |  | | | | | | | | |
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| ***Clauses affected:*** | |  | | | | | | | | |
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|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  |  | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  |  | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  |  | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

Start of first Change:

# References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 26.114: "IP Multimedia Subsystem (IMS); Multimedia telephony; Media handling and interaction".

[3] 3GPP TS 26.116: "Television (TV) over 3GPP services; Video profiles".

[4] 3GPP TS 26.118: "3GPP Virtual reality profiles for streaming applications".

[5] 3GPP TR 26.925: "Typical traffic characteristics of media services on 3GPP networks".

[6] 3GPP TR 26.928: "Extended Reality over 5G".

[7] Recommendation ITU-T H.264 (06/2017): "Advanced video coding for generic audiovisual services" | ISO/IEC 14496-10:2014/Amd.3 2016: "Information technology - Coding of audio-visual objects - Part 10: Advanced Video Coding".

[8] Recommendation ITU-T H.265 (11/2019): "High efficiency video coding" | ISO/IEC 23008-2:2020: "High Efficiency Coding and Media Delivery in Heterogeneous Environments - Part 2: High Efficiency Video Coding".

[9] 2020 Mobile Internet Phenomena Report, accessible here: <https://www.sandvine.com/download-report-mobile-internet-phenomena-report-2020-sandvine>, February 2020.

[10] 2019 Ericsson Mobility Report, accessible here: https://www.ericsson.com/4acd7e/assets/local/mobility-report/documents/2019/emr-november-2019.pdf, November 2019.

[11] T. Fautier, "New Codecs for 5G", DASH-IF Workshop on "Media Streaming meets 5G", December 2019, accessible here: <https://dashif.org/docs/workshop-2019/04-thierry%20fautier%20-%20Harmonic%20Codec%20Comparison%205G%20Media%20Workshop_Final%20v3.pdf>

[12] Bitmovin Video Developer Report, accessible here: <https://go.bitmovin.com/video-developer-report-2019>, September 2019.

[13] 3GPP TS 26.511: "5G Media Streaming (5GMS); Profiles, codecs and formats".

[14] Recommendation ITU-R BT.709-6 (06/2015): "Parameter values for the HDTV standards for production and international programme exchange".

[15] Recommendation ITU-R BT.2020-2 (10/2015): "Parameter values for ultra-high definition television systems for production and international programme exchange".

[16] Recommendation ITU‑R BT.2100-1 (06/2017): "Image parameter values for high dynamic range television for use in production and international programme exchange".

[17] “You can watch Netflix on any screen you want, but you’re probably watching it on a TV”, https://www.vox.com/2018/3/7/17094610/netflix-70-percent-tv-viewing-statistics

[18] YouTube Revenue and Usage Statistics (2020), https://www.businessofapps.com/data/youtube-statistics/

[19] Ultra HD Forum service tracker B2C, https://ultrahdforum.org/uhd-service-tracker/“

[20] HIS Market “4K-TV and UHD: the whole picture”, <https://cdn.ihs.com/www/pdf/4ktv-uhd-ebook.pdf>

[21] A. Mercat, M. Viitanen, and J. Vanne, “UVG dataset: 50/120fps 4K sequences for video codec analysis and development,” Accepted to ACM Multimedia Syst. Conf., Istanbul, Turkey, June 2020.

[21] R. Jullian, Y. Chen, F. Galpin, E. François, M. Kerdranvat (InterDigital), “Extra results to JVET-N605 “Comparative study of video coding solutions VVC, AV1 and EVC versus HEVC””, document JVET-O0898, 15th Meeting: Gothenburg, SE, 3–12 July 2019.

[22] R. Jullian, Y. Chen, F. Galpin, E. François, M. Kerdranvat (InterDigital), “Comparative study of video coding solutions VVC, AV1 and EVC versus HEVC”, document JVET-N0605, 14th Meeting: Geneva, CH, 19–27 March 2019.

[23] S. Iwamura, S. Nemoto, A. Ichigaya, “[AHG13] Compression performance analysis for 4K and 8K HLG test sequences”, document JVET-N0828, 14th Meeting: Geneva, CH, 19–27 March 2019.

[24] A. Segall, E. François, W. Husak, S. Iwamura, D. Rusanovskyy, “JVET common test conditions and evaluation procedures for HDR/WCG video,” document JVET-P2011, 16th JVET meeting: Geneva, CH, 1–11 Oct. 2019.

[25] Nick Zarzycki, "The Complete Guide to Social Media Video Specs in 2018", July 23, 2018, <https://blog.hootsuite.com/social-media-video-specs/>

[26] YouTube Help, "Recommended upload encoding settings", <https://support.google.com/youtube/answer/1722171?hl=en>

[27] Facebook Help Center, "What are the video format guidelines for live streaming on Facebook?", <https://www.facebook.com/help/1534561009906955>

[28] Deepak Kumar, "All about TikTok video size [ Full Guide]-2020", February 2020, <https://tiktoktip.com/tiktok-size/>

[29] Snapchat business center, "Single Image or Video Specifications", <https://businesshelp.snapchat.com/en-US/article/top-snap-specs>

[30] ISO/IEC 23000-19: "Information Technology Multimedia Application Format (MPEG-A) – Part 19: Common Media Application Format (CMAF) for segmented media".

[31] GSMA White Paper, "Chinese operators make major RCS commitment: Whitepaper", April 9, 2020, <https://www.gsma.com/futurenetworks/latest-news/china-operators-make-major-rcs-commitment-whitepaper/>

[32] 3GPP TS 26.140, "Multimedia Messaging Service (MMS); Media formats and codecs".

[33] GSMA RCC.71, "RCS Universal Profile Service Definition Document", version 2.4, October 2019.

[34] GSMA NG.114, "IMS Profile for Voice, Video and Messaging over 5GS", February 2020.

[35] 3GPP TS 26.223, "Telepresence using the IP Multimedia Subsystem (IMS); Media handling and interaction"

[36] "NVIDIA VIDEO CODEC SDK", <https://developer.nvidia.com/nvidia-video-codec-sdk>

[37] Microsoft Online Documentation, "Real-time media calls and meetings with Microsoft Teams", <https://docs.microsoft.com/en-us/microsoftteams/platform/bots/calls-and-meetings/real-time-media-concepts>

[38] Recommendation ITU-T H.266 (07/2020): "Versatile Video Coding" | ISO/IEC 23090-3:2020: "Information technology — Coded representation of immersive media — Part 3: Versatile video coding".

[39] Recommendation ITU-T H.274 (07/2020): "Versatile supplemental enhancement information for coded video bitstreams" | ISO/IEC 23002-7:2020 "Information technology — MPEG video technologies — Part 7: Supplemental enhancement information messages for coded video bitstreams".

[40] [JCTVC-AA1006](http://phenix.it-sudparis.eu/jct/doc_end_user/current_document.php?id=10735), “Verification test report for HEVC screen content coding extensions” V. Baroncini, H. Yu, R. Joshi, S. Liu, X. Xiu, J. Xu (editors)- 2017-09-08

[41] Intel Xe LP presented at Intel Architecture Day 2020. Slide 101 https://newsroom.intel.com/wp-content/uploads/sites/11/2020/08/Intel-Architecture-Day-2020-Presentation-Slides.pdf

[42] N. Barman, S. Zadtootaghaj, S. Schmidt, M. G. Martini and S. Möller, "GamingVideoSET: A Dataset for Gaming Video Streaming Applications," 2018 16th Annual Workshop on Network and Systems Support for Games (NetGames), Amsterdam, Netherlands, 2018, pp. 1-6. DOI: 10.1109/NetGames.2018.8463362

[43] N. Barman, S. Schmidt, S. Zadtootaghaj, M. G. Martini, and S. Möller. 2018. An Evaluation of Video Quality Assessment Metrics for Passive Gaming Video Streaming. In Proceedings of the 23rd Packet Video Workshop (PV '18). ACM, Amsterdam, Netherlands, 2018, pp. 7-12. DOI: https://doi.org/10.1145/3210424.3210434

[44] Technical Paper ITU-T HSTP-VID-WPOM (07/2020): "Working practices using objective metrics for evaluation of video coding efficiency experiments".

[45] 3GPP TR 26.902, "Video codec performance".

[46] 3GPP TS 26.244, "Transparent end-to-end packet switched streaming service (PSS); 3GPP file format (3GP)"

[47] ISO/IEC 23001-17, "Information technology — MPEG systems technologies — Part 17: Carriage of Uncompressed Video in ISOBMFF"

[48] Recommendation ITU-T P.910 (04/2008): "Subjective video quality assessment methods for multimedia applications".

[49] Ultra HD Forum Guidelines, <https://ultrahdforum.org/wp-content/uploads/UHD-Guidelines-V2.3-final.pdf>

[50] ISO/IEC 23094-1, "Information technology — General video coding — Part 1: Essential video coding"

[51] ISO/IEC 23094-4, " Information technology — General video coding — Part 4: Conformance and Reference software for Essential Video Coding".

[52] ISO/IEC JTC 1/SC 29/WG 04 output document N0047, "Report on Essential Video Coding compression performance verification testing for SDR Content", Online meeting, Jan. 2021. http://www.mpegstandards.org/wp-content/uploads/mpeg\_meetings/133\_OnLine/w20000.zip.

[53] ISO/IEC JTC 1/SC 29/WG 04 output document N0030, "Report on Essential Video Coding compression performance verification testing for HDR/WCG content", Online meeting, Oct. 2020. https://www.mpegstandards.org/wp-content/uploads/mpeg\_meetings/132\_OnLine/w19832.zip.

[54] Z. Wang, E. P. Simoncelli, A. C. Bovik, "Multiscale structural similarity for image quality assessment" in the Proceedings of the Thirty-Seventh Asilomar Conference on Signals, Systems and Computers, Vol. 2, pp. 1398–1402, 2004.

[55] Z. Wang, A. C. Bovik, H. R. Sheikh, E. P. Simoncelli, "Image quality assessment: from error visibility to structural similarity", IEEE Transactions on Image Processing, Vol. 13, No. 4, pp. 600–612, April 2004

[56] Netflix, “VMAF – Video Multi-Method Assessment Fusion,” version 1.3.5, repository, Aug. 2020. https://github.com/Netflix/vmaf/tags

[57] F. Bossen, J. Boyce, X. Li, V. Seregin, K. Sühring, "JVET common test conditions and software reference configurations for SDR video", Joint Video Experts Team (JVET) of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11 document JVET-M1010, 13th JVET meeting, Marrakech, Morocco, January 9-18 2019.

[58] A. Segall, E. François, W. Husak, S. Iwamura, D. Rusanovskyy, "JVET common test conditions and evaluation procedures for HDR/WCG video," Joint Video Experts Team (JVET) of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11 document JVET-P2011, 16th JVET meeting, Geneva, Switzerland, Oct. 2019.

[59] <https://github.com/Netflix/vmaf/blob/master/resource/doc/vmafossexec.md>

[60] IETF RFC4180, Common Format and MIME Type for CSV Files

[61] JVET-T2020: “VVC Verification Test Report for Ultra High Definition (UHD) Standard Dynamic Range (SDR) Video Content”, Mathias Wien, Vottorio Baroncini, Output document, 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.

[62] Fraunhofer HHI, “Fraunhofer Versatile Video Encoder (VVenC),” version 0.1.0 (initial release), https://github.com/fraunhoferhhi/vvenc/tags, online, accessed Oct. 2020.

[63] JVET-T0103:” Information on and analysis of the VVC encoders in the SDR UHD verification test”, Christian Helmrich, Benjamin Bross et al, Input document, 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.

[64] Recommendation ITU-T P.910 (2008), Subjective video quality assessment methods for multimedia applications.

[xx] JCTVC-Q1011: “Report on HEVC compression performance verification testing”, T. K. Tan, et al, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11, Valencia, Spain, April 2014.

[xx] JCTVC-P1011: [1] “HEVC verification test plan”, T. K. Tan, et al, Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG 16 WP 3 and ISO/IEC JTC 1/SC 29/WG 11, San Jose, CA, January 2014.

End of fist Change

Start of second Change:

# 7 Characterization for Existing Codecs

## 7.1 Introduction

This clause provides a characterization of existing codecs. This serves pre-dominantly as an example to introduce the characterization framework.

## 7.2 H.265/HEVC Characterization against H.264/AVC

### 7.2.1 Introduction

This clause provides characterization results for H.265/HEVC against H.264/AVC for different scenarios and metrics.

## 7.3 External Characterization Results

### 7.3.1 Introduction

This clause introduces external characterization results that have been conducted in a similar fashion as introduced in clause 5.7, but are not based on the metrics developed in this report.

### 7.3.2 H.265/HEVC Characterization against H.264/AVC.

In JCTVC-Q1011 [xx] the JCTVC verification test reports that the HEVC standard achieves a substantial improvement in compression capability relative to its predecessor, the AVC standard, in accordance with the “HEVC verication test plan” in JCTVC-P1011 [xx].

The verification test was conducted using the HM12.1 (reference HEVC codec) and JM18.5 (reference AVC codec). Four picture resolutions UHD, 1080p, 720p and 480p were tested. Each resolution was represented by 5 test sequences, giving a total of 20 test sequences. For each test sequence 4 test points were chosen.

A bit depth of 8 bits for 480p, 720p and 1080p sequence and of 8 & 10 bits for 4K sequences was used. The coding structure was a combination of Random Access (RA) with an Intra refresh period at approximately 1 second intervals with picture reordering allowed and Low Delay (LD) with no intra refesh and no picture reordering.

A subjective evaluation was conducted comparing the HEVC Main profile to the AVC High profile. The test compared visual quality for twenty video sequences with resolutions ranging from 480p to Ultra HD (UHD) that were encoded at various bit rates or quality levels.

Analysis of the subjective test results show that HEVC test points at half or less than half the bit rate of the AVC reference were found to achieve comparable quality in 86% of the cases.

Figure 7.3.2-1 provides an overview of the results. Estimation of the bit rate savings from these results confirmed that the HEVC Main profile achieves the same subjective quality as AVC High profile while requiring on average approximately 59% fewer bits.

The bit rate savings are similar for the different resolutions tested, with higher resolution sequences having slightly more savings. The average bit rate savings for test sequences with UHD, 1080p, 720p and 480p resolutions are estimated at approximately 64%, 62%, 56% and 52%, respectively.

Timeline

Description automatically generated

Figure 7.3.2-1: Average bit rate savings (measured by BD-Rate) of HEVC compared to AVC. The average of highest bit rate points over all sequences in each resolution was used in this illustration.

Note: The two encoders used for this test were not configured with similar coding configurations. Therefore, the results might have been impacted by non-normative decisions during the encoding process, e.g., lagrangian parameters used, coding structures, mode decision process, quantization, etc, and may not directly reflect the true coding performance difference between the two standards. They only reflect the performance of these reference encoder implementations under the testing conditions imposed on both independently.

End of Second Change