|  |  |
| --- | --- |
| **Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T SG16 WP3 and ISO/IEC JTC1/SC29/WG11**  37th Meeting: Geneva, CH, 4–11 October 2019 | Document: JCTVC-AK\_Notes\_d3 |

|  |  |  |  |
| --- | --- | --- | --- |
| *Title:* | **Meeting report of the 37th meeting of the Joint Collaborative Team on Video Coding (JCT-VC), Geneva, CH, 4–11 October 2019** | | |
| *Status:* | Report document from chairs of JCT-VC | | |
| *Purpose:* | Report | | |
| *Author(s) or Contact(s):* | **Gary Sullivan** Microsoft Corp. 1 Microsoft Way Redmond, WA 98052 USA  **Jens-Rainer Ohm** Institute of Communication Engineering RWTH Aachen University Melatener Straße 23 D-52074 Aachen | Tel: Email:  Tel: Email: | +1 425 703 5308 [garysull@microsoft.com](mailto:garysull@microsoft.com)  +49 241 80 27671 [ohm@ient.rwth-aachen.de](mailto:ohm@ient.rwth-aachen.de) |
| *Source:* | Chairs | | |

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

**Summary**

The Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T WP3/16 and ISO/IEC JTC 1/‌SC 29/‌WG 11 held its thirty-seventh meeting during 4–11 October 2019 at the ITU premises in Geneva, CH. The JCT-VC meeting was held under the chairmanship of Dr Gary Sullivan (Microsoft/USA) and Dr Jens-Rainer Ohm (RWTH Aachen/Germany). For rapid access to particular topics in this report, a subject categorization is found (with hyperlinks) in section 1.14 of this document.

The JCT-VC meeting began at approximately 0900 hours on Friday 4 October 2019 with a half-day of meeting sessions. Two additional meeting sessions were held at 1630 on Monday 7 October 2019, and at 0900 on Thursday 10 October 2019. The meeting was closed at approximately 1120 hours on Thursday 10 October 2019. Approximately 40 people attended the JCT-VC meeting, and 12 input documents and 7 AHG reports were discussed. The meeting took place in a collocated fashion with a meeting of SG16 – one of the two parent bodies of the JCT-VC. The subject matter of the JCT-VC meeting activities consisted of work on the video coding standardization project known as High Efficiency Video Coding (HEVC) and its extensions, and the development of associated conformance test sets, reference software, verification testing, and non-normative guidance information. Further work was performed on the specification of coding-independent code points related to video data. Maintenance and minor enhancement work on the Advanced Video Coding (AVC) standard were also conducted.

One primary goal of the meeting was to review the work that was performed in the interim period since the 36th JCT-VC meeting in producing:

* For HEVC, AVC, and Video CICP text specification maintenance, a description of current errata report items (JCTVC-AJ1004)
* For non-normative guidance on HEVC encoding practices, Update 11 of the HEVC Model (HM) 16 encoding algorithm description (JCTVC-AJ1002)
* For video code points coordination, Draft 5 toward version 2 of the technical report on usage of video signal type code points (JCTVC-AJ1003).

The other most important goals were to review the work on new SEI messages, encoder optimization, and non-normative guidance, and to review other technical input documents. Possible needs for corrections to the prior HEVC specification text were also considered.

The JCT-VC produced 5 output documents from the meeting:

* For HEVC SEI message development:
  + Draft 3 of annotated regions and fisheye video information SEI messages (JCTVC-AK1012)
  + Draft 1 of a shutter interval SEI message (JCTVC-AK1005)
* For HEVC, AVC, and Video CICP text specification maintenance, a description of current errata report items (JCTVC-AK1004)
* For non-normative guidance on HEVC encoding practices, Update 12 of the HEVC Model (HM) 16 encoding algorithm description (JCTVC-AK1002)
* For video code points coordination, Draft 6 toward version 2 of the technical report on usage of video signal type code points (JCTVC-AK1003).

For the organization and planning of its future work, the JCT-VC established 7 "ad hoc groups" (AHGs) to progress the work on particular subject areas. The next four JCT-VC meetings were planned for Fri. 10 – Fri. 17 January 2020 under WG11 auspices in Brussels, BE, during Fri. 17 – Fri. 24 April 2020 under WG 11 auspices in Alpbach, AT, during Thu. 25 June – Wed. 1 July 2020 under ITU-T SG16 auspices in Geneva, CH, and during Fri. 9 – Fri. 16 October 2020 under WG 11 auspices in Rennes, FR.

The document distribution site <http://phenix.it-sudparis.eu/jct/> was used for distribution of all documents.

The reflector to be used for discussions by the JCT-VC and all of its AHGs is the JCT-VC reflector:  
[jct-vc@lists.rwth-aachen.de](mailto:jct-vc@lists.rwth-aachen.de) hosted at RWTH Aachen University. For subscription to this list, see  
<https://lists.rwth-aachen.de/postorius/lists/jct-vc.lists.rwth-aachen.de/>.

# Administrative topics

## Organization

The ITU-T/ISO/IEC Joint Collaborative Team on Video Coding (JCT-VC) is a group of video coding experts from the ITU-T Study Group 16 Visual Coding Experts Group (VCEG) and the ISO/IEC JTC 1/ SC 29/ WG 11 Moving Picture Experts Group (MPEG). The parent bodies of the JCT-VC are ITU-T WP3/16 and ISO/IEC JTC 1/SC 29/WG 11.

The Joint Collaborative Team on Video Coding (JCT-VC) of ITU-T WP3/16 and ISO/IEC JTC 1/‌SC 29/‌WG 11 held its thirty-seventh meeting during 4–11 October 2019 at the ITU premises in Geneva, CH. The JCT-VC meeting was held under the chairmanship of Dr Gary Sullivan (Microsoft/USA) and Dr Jens-Rainer Ohm (RWTH Aachen/Germany).

## Meeting logistics

The JCT-VC meeting began at approximately 0900 hours on Friday 4 October 2019 with a half-day of meeting sessions. Two additional meeting sessions were held at 1630 on Monday 7 October 2019, and at 0900 on Thursday 10 October 2019. The meeting was closed at approximately 1120 hours on Thursday 10 October 2019. Approximately 40 people attended the JCT-VC meeting, and 12 input documents and 7 AHG reports were discussed. The meeting took place in a collocated fashion with a meeting of SG16 – one of the two parent bodies of the JCT-VC. The subject matter of the JCT-VC meeting activities consisted of work on the video coding standardization project known as High Efficiency Video Coding (HEVC) and its extensions, and the development of associated conformance test sets, reference software, verification testing, and non-normative guidance information. Further work was performed on the specification of coding-independent code points related to video data. Maintenance and minor enhancement work on the Advanced Video Coding (AVC) standard were also conducted.

Some statistics are provided below for historical reference purposes:

* 1st "A" meeting (Dresden, 2010-04): 188 people, 40 input documents
* 2nd "B" meeting (Geneva, 2010-07): 221 people, 120 input documents
* 3rd "C" meeting (Guangzhou, 2010-10): 244 people, 300 input documents
* 4th "D" meeting (Daegu, 2011-01): 248 people, 400 input documents
* 5th "E" meeting (Geneva, 2011-03): 226 people, 500 input documents
* 6th "F" meeting (Turin, 2011-07): 254 people, 700 input documents
* 7th "G" meeting (Geneva, 2011-11) 284 people, 1000 input documents
* 8th "H" meeting (San Jose, 2012-02) 255 people, 700 input documents
* 9th "I" meeting (Geneva, 2012-04/05) 241 people, 550 input documents
* 10th "J" meeting (Stockholm, 2012-07) 214 people, 550 input documents
* 11th "K" meeting (Shanghai, 2012-10) 235 people, 350 input documents
* 12th "L" meeting (Geneva, 2013-01) 262 people, 450 input documents
* 13th "M" meeting (Incheon, 2013-04) 183 people, 450 input documents
* 14th "N" meeting (Vienna, 2013-07/08) 162 people, 350 input documents
* 15th "O" meeting (Geneva, 2013-10/11) 195 people, 350 input documents
* 16th "P" meeting (San José, 2014-01) 152 people, 300 input documents
* 17th "Q" meeting (Valencia, 2014-03/04) 126 people, 250 input documents
* 18th "R" meeting (Sapporo, 2014-06/07) 150 people, 350 input documents
* 19th "S" meeting (Strasbourg, 2014-10) 125 people, 300 input documents
* 20th "T" meeting (Geneva, 2015-02) 120 people, 200 input documents
* 21st "U" meeting (Warsaw, 2015-06) 91 people, 150 input documents
* 22nd "V" meeting (Geneva, 2015-10) 155 people, 75 input documents
* 23rd "W" meeting (San Diego, 2016-02) 159 people, 125 input documents
* 24th "X" meeting (Geneva, 2016-05/06) 162 people, 60 input documents
* 25th "Y" meeting (Chengdu, 2016-10) 93 people, 40 input documents
* 26th "Z" meeting (Geneva, 2017-01) 95 people, 30 input documents
* 27th "AA" meeting (Hobart, 2017-03/04) 76 people, 25 input documents
* 28th "AB" meeting (Turin, 2017-07) 71 people, 25 input documents
* 29th "AC" meeting (Macao, 2017-10) 107 people, 21 input documents
* 30th "AD" meeting (Gwangju, 2018-01) 85 people, 4 input documents
* 31st "AE" meeting (San Diego, 2018-04) 37 people, 11 input documents
* 32nd "AF" meeting (Ljubljana, 2018-07) 38 people, 8 input documents
* 33rd "AG" meeting (Macao, 2018-10) 32 people, 9 input documents
* 34th "AH" meeting (Marrakech, 2019-01) 34 people, 7 input documents
* 35th "AI" meeting (Geneva, 2019-03) 29 people, 4 input documents
* 36th "AJ" meeting (Gothenburg, 2019-07) 63 people, 11 input documents
* 37th "AK" meeting (Geneva, 2019-10) 40 people, 12 input documents

Information regarding logistics arrangements for the meeting had been provided via the email reflector [jct-vc@lists.rwth-aachen.de](mailto:jct-vc@lists.rwth-aachen.de) and at <http://wftp3.itu.int/av-arch/jctvc-site/2019_10_AK_Geneva/>.

## Primary goals

One primary goal of the meeting was to review the work that was performed in the interim period since the 36th JCT-VC meeting in producing:

* For HEVC, AVC, and Video CICP text specification maintenance, a description of current errata report items (JCTVC-AJ1004)
* For non-normative guidance on HEVC encoding practices, Update 11 of the HEVC Model (HM) 16 encoding algorithm description (JCTVC-AJ1002)
* For video code points coordination, Draft 5 toward version 2 of the technical report on usage of video signal type code points (JCTVC-AJ1003).

The other most important goals were to review the work on new SEI messages, encoder optimization, and non-normative guidance, and to review other technical input documents. Possible needs for corrections to the prior HEVC specification text were also considered.

## Documents and document handling considerations

### General

The documents of the JCT-VC meeting are listed in Annex A of this report. The documents can be found at <http://phenix.it-sudparis.eu/jct/>.

Registration timestamps, initial upload timestamps, and final upload timestamps are listed in Annex A of this report.

The document registration and upload times and dates listed in Annex A and in headings for documents in this report are in Paris/Geneva time. Dates mentioned for purposes of describing events at the meeting (other than as contribution registration and upload times) follow the local time at the meeting facility.

Highlighting of recorded decisions in this report is done using the keyword “Decision”, e.g., as follows:

* Decisions made by the group that affect the normative content of the draft standard are identified by prefixing the description of the decision with the string "Decision:".
* Decisions that affect the reference software but have no normative effect on the text are marked by the string "Decision (SW):".
* Decisions that fix a "bug" in the specification (an error, oversight, or messiness) are marked by the string "Decision (BF):".
* Decisions regarding things that correct the text to properly reflect the design intent, add supplemental remarks to the text, or clarify the text are marked by the string "Decision (Ed.):".
* Decisions regarding simplification or improvement of design consistency are marked by the string "Decision (Simp.):".
* Decisions regarding complexity reduction (in terms of processing cycles, memory capacity, memory bandwidth, line buffers, number of entropy-coding contexts, number of context-coded bins, etc.) … "Decision (Compl.):".

This meeting report is based primarily on notes taken by the chairs and projected for real-time review by the participants during the meeting discussions. The preliminary notes were also periodically circulated publicly by ftp and http during the meeting for information and coordination purposes. It should be understood by the reader that 1) some notes may appear in abbreviated form, 2) summaries of the content of contributions are often based on abstracts provided by contributing proponents without an intent to imply endorsement of the views expressed therein, and 3) the depth of discussion of the content of the various contributions in this report may not be uniform. Generally, the report is written to include as much information about the contributions and discussions as is feasible (in the interest of aiding study), although this approach may not result in the most polished output report.

### Late and incomplete document considerations

The formal deadline for registering and uploading non-administrative contributions had been announced as Wednesday, 25 September 2019.

Non-administrative documents uploaded after 2359 hours in Paris/Geneva time Thursday 26 September 2019 were to be considered "officially late". Six contributions to this meeting were registered and/or submitted late:

* JCTVC-AK0021 (submitted 30 Sept.), an errata report for HEVC.
* JCTVC-AK0022 (submitted 30 Sept.), an errata report for HEVC.
* JCTVC-AK0023 (submitted 30 Sept.), an errata report for HEVC and AVC.
* JCTVC-AK0029 (submitted 5 Oct.), an information contribution describing an alternative colour representation.
* JCTVC-AK0030 (submitted 6 Oct.), a contribution submitted in response to meeting discussions that requested study, discussing approaches for resolving a memory capacity problem with the example coding structure used in HEVC common test conditions for coding efficiency testing.
* JCTVC-AK0031 (submitted 7 Oct.), a contribution providing software for use in testing the draft fisheye video information SEI messages.

In some cases, contributions were revised after the initial version was uploaded. The contribution document archive website retains publicly-accessible prior versions in such cases. The timing of late document submissions for contributions is recorded in the list of documents in Annex A of this report and is also generally noted in the section discussing each contribution in this report.

Ad hoc group interim activity reports, CE summary results reports, break-out activity reports, and information documents containing the results of experiments requested during the meeting were not subject to the above-described deadline, as these are considered administrative report documents and they may not be possible to produce until after the availability of other input documents.

As a general policy, missing documents were not to be presented, and late documents (and substantial revisions) could only be presented when sufficient time for studying was given after the upload. Again, an exception is applied for AHG reports, CE summaries, and other such reports which can only be produced after the availability of other input documents. There were no objections raised by the group regarding presentation of late contributions for this meeting.

It is noted that documents that are substantially revised after the initial upload are also a problem, as this becomes confusing, interferes with study, and puts an extra burden on synchronization of the discussion. This is especially a problem in cases where the initial upload is clearly incomplete, and in cases where it is difficult to figure out what parts were changed in a revision. For document contributions, revision marking is very helpful to indicate what has been changed. Also, the "comments" field on the web site can be used to indicate what is different in a revision (although this field has seldom been used and is often not checked by our participants).

"Placeholder" contribution documents that are basically empty of content, with perhaps only a brief abstract and some expression of an intent to provide a more complete submission as a revision, are considered unacceptable and were to be rejected in the document management system, as has been agreed since the third meeting. The initial uploads of such contribution documents are rejected as "placeholders" if they are uploaded without any significant content and are not corrected until after the upload deadline. Such “placeholder” cases did not occur at this meeting.

In some cases in recent history, a few contributions have had some problems relating to IPR declarations in the initial uploaded versions (missing declarations, declarations saying they were from the wrong companies, etc.). Any such issues have been corrected by later uploaded versions in a reasonably timely fashion in all cases (to the extent of the awareness of the chairs).

Some other errors may also have been noticed in other initial document uploads (wrong document numbers in headers, uploading of corrupted unreadable files, etc.) which have generally been sorted out in a reasonably timely fashion. The document web site contains an archive of each upload, along with a record of uploading times.

### Outputs of the preceding meeting

The output documents of the previous meeting, particularly including the meeting report JCTVC-AJ1000, the Update 11 of the HEVC Model (HM) 16 encoding algorithm description JCTVC-AJ1002 (delivered during the meeting), the Draft 5 toward version 2 of the technical report on usage of video signal type code points in JCTVC-AJ1003, and the description of current errata report items in AVC, HEVC and Video CICP (JCTVC-AJ1004), were approved.

The group was initially asked to review the prior meeting report for finalization. The meeting report was later approved without modification.

All output documents of the previous meeting and the software had been made available in a reasonably timely fashion.

The chairs asked if there were any issues regarding potential mismatches between perceived technical content prior to adoption and later integration efforts. It was also asked whether there was adequate clarity of precise description of the technology in the associated proposal contributions.

It was remarked that, regarding software development efforts – for cases where "code cleanup" is a goal as well as integration of some intentional functional modification, it was emphasized that these two efforts should be conducted in separate integrations, so that it is possible to understand what is happening and to inspect the intentional functional modifications.

The need for establishing good communication with the software coordinators was also emphasized.

At some previous meetings, it had been remarked that in some cases the software implementation of adopted proposals revealed that the description that had been the basis of the adoption apparently was not precise enough, so that the software unveiled details that were not known before (except possibly for CE participants who had studied the software). Issues of combinations between different features (e.g., different adopted features) also tend to sometimes arise in the work. There should be time to study combinations of different adopted tools with more detail prior to adoption.

## Attendance

The list of participants in the JCT-VC meeting can be found in Annex B of this report.

The meeting was open to those qualified to participate either in ITU-T WP3/16 or ISO/IEC JTC 1/‌SC 29/‌WG 11 (including experts who had been personally invited by the Chairs as permitted by ITU-T or ISO/IEC policies).

Participants had been reminded of the need to be properly qualified to attend. Those seeking further information regarding qualifications to attend future meetings may contact the Chairs.

## Agenda

The agenda for the JCT-VC meeting, for development of the High Efficiency Video Coding (HEVC) standard and its format range (RExt), scalability (SHVC), multi-view (MV-HEVC), 3D (3D-HEVC), screen content coding (SCC), and high-dynamic-range (HDR) extensions, and associated conformance test sets, reference software, verification testing, non-normative guidance information, and coding-independent code point specifications was as follows:

* Opening remarks and review of meeting logistics and communication practices
* IPR policy reminder and declarations
* Contribution document allocation
* Reports of *ad hoc* group activities
* Review of results of previous meeting
* Consideration of contributions and communications on project guidance
* Consideration of errata reports and needs for maintenance and enhancements of the HEVC standard and its associated conformance test specification and reference software
* Consideration of errata reports and needs for maintenance and enhancements of the specification of coding-independent code points for video signal type identification
* Consideration of proposals and preparations toward finalization of in-progress draft specifications of additional supplemental enhancement information metadata for the HEVC standard
* Consideration of errata reports and needs for maintenance and enhancements of supplemental enhancement information and video usability information metadata for the HEVC standard
* Consideration of proposed content toward revision of the technical report on usage of video signal type code point identifiers
* Consideration of information contributions and non-normative guidance relevant to the HEVC standard
* Consideration of agreed related aspects of the AVC standard (esp. regarding supplemental enhancement information)
* Coordination activities relating to the work of the JCT-VC
* Approval of output documents and associated editing periods
* Future planning: Determination of next steps, discussion of working methods, communication practices, establishment of coordinated experiments (if any), establishment of AHGs, meeting planning, refinement of expected standardization timelines, other planning issues
* Other business as appropriate for consideration

## IPR policy reminder

Participants were reminded of the IPR policy established by the parent organizations of the JCT-VC and were referred to the parent body websites for further information. The IPR policy was summarized for the participants.

The ITU-T/ITU-R/ISO/IEC common patent policy shall apply. Participants were particularly reminded that contributions proposing normative technical content shall contain a non-binding informal notice of whether the submitter may have patent rights that would be necessary for implementation of the resulting standard. The notice shall indicate the category of anticipated licensing terms according to the ITU-T/ITU-R/ISO/IEC patent statement and licensing declaration form.

This obligation is supplemental to, and does not replace, any existing obligations of parties to submit formal IPR declarations to ITU-T/ITU-R/ISO/IEC.

Participants were also reminded of the need to formally report patent rights to the top-level parent bodies (using the common reporting form found on the database listed below) and to make verbal and/or document IPR reports within the JCT-VC as necessary in the event that they are aware of unreported patents that are essential to implementation of a standard or of a draft standard under development.

Some relevant links for organizational and IPR policy information are provided below:

* <http://www.itu.int/ITU-T/ipr/index.html> (common patent policy for ITU-T, ITU-R, ISO, and IEC, and guidelines and forms for formal reporting to the parent bodies)
* <http://ftp3.itu.int/av-arch/jctvc-site> (JCT-VC contribution templates)
* <http://www.itu.int/ITU-T/studygroups/com16/jct-vc/index.html> (JCT-VC general information and founding charter)
* <http://www.itu.int/ITU-T/dbase/patent/index.html> (ITU-T IPR database)
* <http://www.itscj.ipsj.or.jp/sc29/29w7proc.htm> (JTC 1/‌SC 29 Procedures)

It is noted that the ITU TSB director's AHG on IPR had issued a clarification of the IPR reporting process for ITU-T standards, as follows, per SG 16 TD 327 (GEN/16):

"TSB has reported to the TSB Director's IPR Ad Hoc Group that they are receiving Patent Statement and Licensing Declaration forms regarding technology submitted in Contributions that may not yet be incorporated in a draft new or revised Recommendation. The IPR Ad Hoc Group observes that, while disclosure of patent information is strongly encouraged as early as possible, the premature submission of Patent Statement and Licensing Declaration forms is not an appropriate tool for such purpose.

In cases where a contributor wishes to disclose patents related to technology in Contributions, this can be done in the Contributions themselves, or informed verbally or otherwise in written form to the technical group (e.g. a Rapporteur's group), disclosure which should then be duly noted in the meeting report for future reference and record keeping.

It should be noted that the TSB may not be able to meaningfully classify Patent Statement and Licensing Declaration forms for technology in Contributions, since sometimes there are no means to identify the exact work item to which the disclosure applies, or there is no way to ascertain whether the proposal in a Contribution would be adopted into a draft Recommendation.

Therefore, patent holders should submit the Patent Statement and Licensing Declaration form at the time the patent holder believes that the patent is essential to the implementation of a draft or approved Recommendation."

The chairs invited participants to make any necessary verbal reports of previously-unreported IPR in draft standards under preparation, and opened the floor for such reports: No such verbal reports were made.

## Software copyright disclaimer header reminder

It was noted that, as had been agreed at the 5th meeting of the JCT-VC and approved by both parent bodies at their collocated meetings at that time, the HEVC reference software copyright license header language is the BSD license with a preceding sentence declaring that other contributor or third party rights, such as patent rights, may exist that are not granted by the license, as recorded in N10791 of the 89th meeting of ISO/IEC JTC 1/‌SC 29/‌WG 11. Both ITU and ISO/IEC will be identified in the <OWNER> and <ORGANIZATION> tags in the header. This software is used in the process of designing the HEVC standard and its extensions, and for evaluating proposals for technology to be included in the design. After finalization of the draft, the software will be published by ITU-T and ISO/IEC as an example implementation of the HEVC standard and for use as the basis of products to promote adoption of the technology.

The same applies for the HDRTools and 360Lib codebases.

Different copyright statements shall not be committed to the committee software repository (in the absence of subsequent review and approval of any such actions). As noted previously, it must be further understood that any initially-adopted such copyright header statement language could further change in response to new information and guidance on the subject in the future.

The JM and other AVC codebases are handled similarly.

## Communication practices

The documents for the meeting can be found at <http://phenix.it-sudparis.eu/jct/>. For the first two JCT-VC meetings, the JCT-VC documents had been made available at <http://ftp3.itu.int/av-arch/jctvc-site>, and documents for the first two JCT-VC meetings remain archived there as well. That site was also used for distribution of the contribution document template and circulation of drafts of this meeting report.

The JCT-VC email list is managed through the site <https://lists.rwth-aachen.de/postorius/lists/jct-vc.lists.rwth-aachen.de/>, and to send email to the reflector, the email address is [jct-vc@lists.rwth-aachen.de](mailto:jct-vc@lists.rwth-aachen.de). Only members of the reflector can send email to the list. However, membership of the reflector is not limited to qualified JCT-VC participants.

It was emphasized that reflector subscriptions and email sent to the reflector must use real names when subscribing and sending messages, and subscribers must respond adequately to basic inquiries regarding the nature of their interest in the work.

It was emphasized that usually discussions concerning CEs and AHGs should be performed using the JCT-VC email reflector.

Currently, JCT-VC is not running any CEs. When such CEs are conducted, CE internal discussions should primarily be concerned with organizational issues. Substantial technical issues that are not reflected by an original CE plan should be openly discussed on the reflector. Any new developments that are result of private communication cannot be considered to be the result of the CE.

For the headers and registrations of CE documents and AHG reports, email addresses of participants and contributors may be obscured or absent (and will be on request), although these will be available (in human readable format – possibly with some "obscurification") for primary CE coordinators and AHG chairs.

## Terminology

Some terminology used in this report is explained below:

* **3D-HEVC**: A set of extensions of HEVC that includes the combined coding of depth and texture information for 3D video coding.
* **ACT**: Adaptive colour transform.
* **Additional Review**: The stage of the ITU-T "alternative approval process" that follows a Last Call if substantial comments are received in the Last Call, during which a proposed revised text is available on the ITU web site for consideration as a candidate for final approval.
* **AHG**: Ad hoc group.
* **AI**: All-intra.
* **AIF**: Adaptive interpolation filtering.
* **ALF**: Adaptive loop filter.
* **AMP**: Asymmetric motion partitioning – a motion prediction partitioning for which the sub-regions of a region are not equal in size (in HEVC, being N/2x2N and 3N/2x2N or 2NxN/2 and 2Nx3N/2 with 2N equal to 16 or 32 for the luma component).
* **AMVP**: Adaptive motion vector prediction.
* **APS**: Active parameter sets.
* **ARC**: Adaptive resolution conversion (synonymous with DRC, and a form of RPR).
* **AU**: Access unit.
* **AUD**: Access unit delimiter.
* **AVC**: Advanced video coding – the video coding standard formally published as ITU-T Recommendation H.264 and ISO/IEC 14496-10.
* **BA**: Block adaptive.
* **BC**: May refer either to block copy (see CPR or IBC) or backward compatibility. In the case of backward compatibility, this often refers to what is more formally called forward compatibility.
* **BD**: Bjøntegaard-delta – a method for measuring percentage bit rate savings at equal PSNR or decibels of PSNR benefit at equal bit rate (e.g., as described in document VCEG-M33 of April 2001).
* **BL**: Base layer.
* **BoG**: Break-out group.
* **BR**: Bit rate.
* **BV**: Block vector (MV used for intra BC prediction, not a term used in the standard).
* **CABAC**: Context-adaptive binary arithmetic coding.
* **CBF**: Coded block flag(s).
* **CC**: May refer to context-coded, common (test) conditions, or cross-component.
* **CCP**: Cross-component prediction.
* **CD**: Committee draft – a draft text of an international standard for the first formal ballot stage of the approval process in ISO/IEC – corresponding to a PDAM for amendment texts.
* **CE**: Core experiment – a coordinated experiment for which there is a draft design and associated test model software that have been established, e.g., as in experiments conducted after the 3rd or subsequent JCT-VC meeting and approved to be considered a CE by the group (see also SCE and SCCE, and TE).
* **CGS**: Colour gamut scalability (historically, also coarse-grained scalability).
* **CL-RAS**: Cross-layer random-access skip.
* **CPR**: Current-picture referencing, also known as IBC – a technique by which sample values are predicted from other samples in the same picture by means of a displacement vector sometimes called a block vector, in a manner basically the same as motion-compensated prediction.
* **Consent**: A step taken in the ITU-T to formally move forward a text as a candidate for final approval (the primary stage of the ITU-T "alternative approval process").
* **CTC**: Common test conditions – a set of agreed conditions for coding experiments.
* **CVS**: Coded video sequence.
* **DAM**: Draft amendment – a draft text of an amendment to an international standard for the second formal ballot stage of the approval process in ISO/IEC – corresponding to a DIS for complete texts.
* **DCT**: Discrete cosine transform (sometimes used loosely to refer to other transforms with conceptually similar characteristics).
* **DCTIF**: DCT-derived interpolation filter.
* **DIS**: Draft international standard – the second formal ballot stage of the approval process in ISO/IEC – corresponding to a DAM for amendment texts.
* **DF**: Deblocking filter.
* **DRC**: Dynamic resolution conversion (synonymous with ARC, and a form of RPR).
* **DT**: Decoding time.
* **ECS**: Entropy coding synchronization (typically synonymous with WPP).
* **EOTF**: Electro-optical transfer function – a function that converts a representation value to a quantity of output light (e.g., light emitted by a display.
* **EPB**: Emulation prevention byte (as in the emulation\_prevention\_byte syntax element of AVC or HEVC).
* **EL**: Enhancement layer.
* **ET**: Encoding time.
* **ETM**: Experimental test model (design and software used for prior HDR/WCG coding experiments in MPEG).
* **FDAM**: Final draft amendment – a draft text of an amendment to an international standard for the third formal ballot stage of the approval process in ISO/IEC – corresponding to an FDIS for complete texts.
* **FDIS**: Final draft international standard – a draft text of an international standard for the third formal ballot stage of the approval process in ISO/IEC – corresponding to an FDAM for amendment texts.
* **HDR**: High dynamic range – referring to video content having a brightness range that includes values greater than approximately 100 nits (often implicitly including WCG as well, since HDR video is typically also WCG video).
* **HDR10**: A term that refers to the single-layer coding of HDR/WCG video content using the HEVC Main 10 profile with a Y′CbCr 4:2:0 10 bit per sample colour representation with ITU-R BT.2020 colour primaries and the PQ transfer characteristics EOTF.
* **HEVC**: High Efficiency Video Coding – the video coding standard developed and extended by the JCT-VC, formalized in ITU-T as Rec. ITU-T H.265 and in ISO/IEC as ISO/IEC 23008-2.
* **HLS**: High-level syntax.
* **HM**: HEVC Test Model – the draft reference software and its (non-normative) encoder algorithms used for HEVC experiments.
* **HRD**: Hypothetical reference decoder.
* **IBC** (also **Intra BC**): Intra block copy, also known as CPR – a technique by which sample values are predicted from other samples in the same picture by means of a displacement vector called a block vector, in a manner conceptually similar to motion-compensated prediction.
* **IBDI**: Internal bit-depth increase – a technique by which lower bit-depth (esp. 8 bits per sample) source video is encoded using higher bit-depth signal processing, ordinarily including higher bit-depth reference picture storage (esp. 12 bits per sample).
* **IBF**: Intra boundary filtering.
* **ILP**: Inter-layer prediction (in scalable coding).
* **IPCM**: Intra pulse-code modulation (as in AVC and HEVC).
* **JM**: Joint model – the primary software codebase and associated (non-normative) encoding algorithms that has been developed for the AVC standard.
* **JSVM**: Joint scalable video model – another software codebase that has been developed for the AVC standard, which includes support for scalable video coding extensions.
* **Last Call**: The stage of the ITU-T "alternative approval process" that follows Consent, during which a proposed text is available on the ITU web site for consideration as a candidate for final approval.
* **LB** or **LDB**: Low-delay B – the variant of the LD conditions that uses B pictures.
* **LD**: Low delay – one of two sets of coding conditions designed to enable interactive real-time communication, with less emphasis on ease of random access (contrast with RA). Typically refers to LB, although also applies to LP.
* **LM**: Linear model.
* **LP** or **LDP**: Low-delay P – the variant of the LD conditions that uses P frames.
* **LUT**: Look-up table.
* **LTRP**: Long-term reference pictures.
* **MANE**: Media-aware network element.
* **MC**: Motion compensation.
* **MCTS**: Motion-constrained tile set.
* **MOS**: Mean opinion score – a measurement of subjective video quality as reported by human test subjects.
* **MPEG**: Moving picture experts group (WG 11, the parent body working group in ISO/IEC JTC 1/‌SC 29, one of the two parent bodies of the JCT-VC).
* **MV**: Motion vector; alternatively, multiview.
* **MV-HEVC**: A set of extensions of HEVC using layered coding to enable the coding of video with multiple views or depth maps.
* **NAL**: Network abstraction layer (as in AVC and HEVC, contrast with VCL).
* **NCL**: Non-constant luminance, a type of colour difference representation.
* **Nits**: Candelas per square metre (cd/m2).
* **NB**: National body (usually used in reference to NBs of the WG 11 parent body).
* **NSQT**: Non-square quadtree.
* **NUH**: NAL unit header.
* **NUT**: NAL unit type (as in AVC and HEVC).
* **OBMC**: Overlapped block motion compensation (e.g., as in H.263 Annex F).
* **OETF**: Opto-electronic transfer function – a function that converts to input light (e.g., light input to a camera) to a representation value.
* **OLS**: Output layer set.
* **OOTF**: Optical-to-optical transfer function – a function that converts input light (e.g., light input to a camera) to output light (e.g., light emitted by a display).
* **PCP**: Parallelization of context processing.
* **PDAM**: Proposed draft amendment – a draft text of an amendment to an international standard for the first formal ballot stage of the ISO/IEC approval process – corresponding to a CD for complete texts.
* **PDTR**: Proposed draft technical report – the draft of a TR that is sent for a ballot in the ISO/IEC approval process.
* **POC**: Picture order count.
* **PoR**: Plan of record.
* **PPS**: Picture parameter set (as in AVC and HEVC).
* **PQ**: Perceptual quantization – the name given to an HDR EOTF curve specified in SMPTE ST 2084 and Rec. ITU-R BT.2100.
* **QM**: Quantization matrix (as in AVC and HEVC).
* **QP**: Quantization parameter (as in AVC and HEVC, sometimes confused with quantization step size).
* **QT**: Quadtree.
* **RA**: Random access – a set of coding conditions designed to enable relatively-frequent random access points in the coded video data, with less emphasis on minimization of delay (contrast with LD).
* **RADL**: Random-access decodable leading.
* **RASL**: Random-access skipped leading.
* **R-D**: Rate-distortion.
* **RDO**: Rate-distortion optimization.
* **RDOQ**: Rate-distortion optimized quantization.
* **RExt**: Format range extensions – a set of extensions of HEVC addressing high bit rate operation, high bit depths, and alternative chroma formats such as monochrome, 4:2:2, 4:4:4, high bit depths, and high throughput.
* **RPR**: Reference picture resampling (e.g., as in H.263 Annex P), a special case of which is also known as ARC or DRC.
* **RPS**: Reference picture set.
* **RQT**: Residual quadtree.
* **RRU**: Reduced-resolution update (e.g. as in H.263 Annex Q).
* **RVM**: Rate variation measure.
* **SAO**: Sample-adaptive offset.
* **SCC**: Screen content coding.
* **SCE**: Scalability core experiment (for SHVC).
* **SCCE**: Screen content core experiment (for SCC).
* **SCM**: Screen coding model (for SCC).
* **SD**: Slice data; alternatively, standard-definition.
* **SDR**: Standard dynamic range – referring to video content having a brightness range that would produce a maximum brightness of approximately 100 nits on a reference display under reference viewing conditions.
* **SEI**: Supplemental enhancement information (as in AVC and HEVC).
* **SH**: Slice header.
* **SHM**: Scalable HM (for SHVC).
* **SHVC**: Scalable high efficiency video coding – a set of extensions of HEVC that uses layered coding to enable the coding of supplemental pictures, quality enhancement layers, spatial resolution enhancement layers, and colour gamut enhancement layers.
* **SIMD**: Single instruction, multiple data.
* **SPS**: Sequence parameter set (as in AVC and HEVC).
* **Supplement**: In ITU-T terminology, a document that assists its readers by providing non-normative information and suggestions (sometimes considered a TR in ISO/IEC terminology).
* **SVC**: Scalable video coding, especially when referring to the associated extensions of AVC.
* **TBA/TBD/TBP**: To be announced/determined/presented.
* **TE**: Tool Experiment – a coordinated experiment conducted toward HEVC design at a more preliminary stage of work than those of CEs, e.g., as between the 1st and 2nd or 2nd and 3rd JCT-VC meetings, or a coordinated experiment conducted toward SHVC design between the 11th and 12th JCT-VC meetings.
* **TGM**: Text and graphics with motion – a category of content that primarily contains rendered text and graphics with motion, mixed with a relatively small amount of camera-captured content.
* **TR**: Technical report – e.g., a collection of non-normative suggestion guidance on appropriate technical practices (sometimes considered a “supplement” in ITU-T terminology).
* **VCEG**: Visual coding experts group (ITU-T Q.6/16, the relevant rapporteur group in ITU-T WP3/16, which is one of the two parent bodies of the JCT-VC).
* **VCL**: Video coding layer (as in AVC and HEVC, contrast with NAL).
* **VPS**: Video parameter set – a parameter set that describes the overall characteristics of a coded video sequence – conceptually sitting above the SPS in the syntax hierarchy.
* **WCG**: Wide colour gamut – referring to video content having a colour gamut that includes colours substantially outside of the range of values that is representable using Rec. ITU-R BT.709.
* **WD**: Working draft – a term for a draft standard, especially one prior to its first ballot in the ISO/IEC approval process, although the term is sometimes used loosely to refer to a draft standard at any actual stage of parent-level approval processes.
* **WG**: Working group, a group of technical experts (usually used to refer to WG 11, a.k.a. MPEG).
* **WPP**: Wavefront parallel processing (usually synonymous with ECS).
* **Block and unit names**:
  + **CTB**: Coding tree block (luma or chroma) – unless the format is monochrome, there are three CTBs per CTU.
  + **CTU**: Coding tree unit (containing both luma and chroma, synonymous with LCU), with a size of 16x16, 32x32, or 64x64 for the luma component.
  + **CB**: Coding block (luma or chroma), a luma or chroma block in a CU.
  + **CU**: Coding unit (containing both luma and chroma), the level at which the prediction mode, such as intra versus inter, is determined in HEVC, with a size of 2Nx2N for 2N equal to 8, 16, 32, or 64 for luma.
  + **LCU**: (formerly LCTU) largest coding unit (name formerly used for CTU before finalization of HEVC version 1).
  + **PB**: Prediction block (luma or chroma), a luma or chroma block of a PU, the level at which the prediction information is conveyed or the level at which the prediction process is performed[[1]](#footnote-2) in HEVC.
  + **PU**: Prediction unit (containing both luma and chroma), the level of the prediction control syntax1 within a CU, with eight shape possibilities in HEVC:
    - **2Nx2N**: Having the full width and height of the CU.
    - **2NxN (or Nx2N)**: Having two areas that each have the full width and half the height of the CU (or having two areas that each have half the width and the full height of the CU).
    - **NxN**: Having four areas that each have half the width and half the height of the CU, with N equal to 4, 8, 16, or 32 for intra-predicted luma and N equal to 8, 16, or 32 for inter-predicted luma – a case only used when 2N×2N is the minimum CU size.
    - **N/2x2N** paired with **3N/2x2N** or **2NxN/2** paired with **2Nx3N/2**: Having two areas that are different in size – cases referred to as AMP, with 2N equal to 16 or 32 for the luma component.
  + **TB**: Transform block (luma or chroma), a luma or chroma block of a TU, with a size of 4x4, 8x8, 16x16, or 32x32.
  + **TU**: Transform unit (containing both luma and chroma), the level of the residual transform (or transform skip or palette coding) segmentation within a CU (which, when using inter prediction in HEVC, may sometimes span across multiple PU regions).

## Liaison activity

The JCT-VC did not directly send or receive formal liaison communications at this meeting. However, there was an exchange of status and project information between the parent bodies.

Also, as the hosting parent body, ITU-T SG16 sent an outgoing liaison statement to various organizations to inform them of the approval of the second edition of the technical report on usage of video signal type code points, to describe the purpose of this report, and the describe the changes introduced in the second edition. The receiving organizations included ARIB, ATSC, AVS, CTA, DASH IF, DTG, DVB, EBU, ETSI, IEC TC 100, IETF AVT, ITU-T SG9, SCTE, SMPTE, UHD Alliance, UHD Forum, and VSF.

ITU-T SG16 also sent an outgoing liaison statement to ITU-R WP6C on the subject of the new technical report. SG16 had received a liaison statement [SG16-TD389/Gen](http://www.itu.int/md/meetingdoc.asp?lang=en&parent=T17-SG16-191007-TD-GEN-0389), a.k.a. [ITU-R WP6C/‌TEMP/312](http://ifa.itu.int/t/2017/ls/itu-rwp6c/sp16-itu-rwp6c-iLS-00068.docx) that contained comments about the content of the first edition of the technical report. In addition to providing updated status information about the second edition, the reply liaison statement from SG16 responded to the specific comments that had been received in the liaison statement from ITU-R WP6C. For further information about the substance of these comments, see section 9 of this report.

## Opening remarks and status of work items

Opening remarks included:

* Meeting logistics, review of communication practices, attendance recording, and registration and badge pick-up reminders
* It was noted that number of contributions to this meeting has continued to be low relative to a few years ago.

Primary topic areas were noted as follows: (additional detail on the status for reference software and conformance would also be desirable)

* HEVC text status:
  + The 5th ed. for ITU had been published on 2018-05-11, the 6th ed. for ITU was Consented in 2019-03 and published on 2019-09-23
  + The 3rd ed. for ISO/IEC had been published in 2017-10, and the 4th edition for ISO/IEC had an FDIS and a DoC issued at the January meeting and had a DIS approved for registration as FDIS on 2019-02-19.
  + DAM1 was issued in ISO/IEC at the January 2019 meeting, containing the annotated regions and fisheye video SEI messages (which were also not yet in the ITU 5th and 6th editions). The DAM ballot started 2019-07-10, and closed 2019-10-02.
  + Software for some of the SEI messages is also available – some software on annotated regions and minimal parsing software for fisheye video.

Issuing a new edition of software and conformance testing may also be possible.

* AVC status:
  + In ISO/IEC, FDAM 1 for adding SEI messages was issued in Macao (October 2018), but was then integrated into the 9th edition by an updated text issued in Marrakech (January 2019). The FDIS ballot had not yet been issued. The overall status was:
    - ISO/IEC 14496-10:2014 (Edition 8), published 2014-09
    - ISO/IEC 14496-10:2014/Amd 1:2015 (Multi-resolution frame compatible stereoscopic video with depth maps, additional supplemental enhancement information and video usability information), published 2015-11
    - ISO/IEC 14496-10:2014/FDAMD 2 (Additional Levels and Supplemental Enhancement Information); stage 50.98, deleted in preparation for Edition 9
    - ISO/IEC 14496-10:2014/Amd 3:2016 (Additional supplemental enhancement information); published 2016-12, published 2016-12
    - ISO/IEC DIS 14496-10:201x (Edition 9); stage 40.99
  + In ITU-T, a new edition was Consented in 2019-03: (06/19, Edition 13) Approved 2019-06-13, published 2019-09-06.
* Policies of ITU-T and ISO/IEC and possible consequences for JCT-VC were noted
  + Standards editing guidelines and publication practicess
  + Rules for standards under ballot in ISO/IEC
* HEVC screen content coding (SCC) status
  + Software (bug fixes and code cleanup remain needed for the SCM to become a completely adequate replacement for the HM); issuing a new edition would be appropriate if this work converges.
  + Conformance – an FDAM was issued in March (skipping FDAM). The new (2nd) edition of the basis text had been published in 2018-08. The new (3rd) edition in ITU-T had been consented at the Ljubljana meeting, Last Call closed 2018-10-13, and pre-publication occurred on 2018-11-27. No particular need for updates/corrections was identified.
  + Reference software – In the last approved version, there were errors in profile/level/constraint syntax for SCC in the SCM. At some point, we should approve a new version. However, we may wish to defer the next version until there is more to put in it.
* HDR/WCG video coding work
  + SEI/VUI has been specified in recent revised editions
  + Two TRs on this subject have been published in ITU-T and ISO/IEC:
    - Conversion and coding practices for HDR/WCG Y′CbCr 4:2:0 video with PQ transfer characteristics
      * ITU-T H.Sup15 (01/17) published 2017-04-12
      * ISO/IEC TR 23008-14:2018 published 2018-08
    - Signalling, backward compatibility and display adaptation for HDR/WCG video coding
      * ITU-T H.Sup18 (10/17) published 2018-01-18
      * ISO/IEC TR 23008-15:2018 published 2018-08
  + Reference software remains to be developed – software relating to HDR was currently in the HM separate from the SCM, plus there is a separate HDRTools library
* A new edition of the TR on signalling combinations in practical use is under development, this is ISO/IEC 23091-4 (published 2019-08) in ISO/IEC and H.Sup.19 in ITU-T version 2019-03 published 2019-04-30. This became TR and was approved by ITU-T in March. Another draft for a revision of the TR was under development, with a plan for approving that version at the current meeting. Ballot comments were received in WG11 document m49982.
* Improvement of test model texts and software manuals was encouraged. The preparation of the test model output of last meeting had fallen behind, but it was under preparation and was delivered on 2019-10-06.
* It was noted that software support for the SEI messages is desirable. Together with HDRTools and 360Lib, we have software for experimentation with some SEI messages. The following items were noted to be desirable additionally.
  + Fisheye projection – this had not seemed mature yet (esp. since no mapping software had been provided). However, it was commented that some software had become available ready for check-in– both for HM (see AHG3 report) and 360Lib (see the JVET AHG6 report JVET-P0006). A bug in the text was also noted – see the AHG3 report. A late contribution JCTVC-AK0031 was also provided.
  + Region-wise packing might be improved to illustrate the use of padding for a cubemap (some degree of support for the SEI message is available in the software)
  + Annotated regions (software has been available and a new contribution JCTVC-AK0025 had been submitted)
* For video CICP, the publication status was noted as follows. Some recent errata reports are relevant to this.
  + Rec. ITU-T H.273 (02/16, Edition 1) Approved 2016-12-22, published 2017-04-27
  + ISO/IEC 23091-2:2019 (previously part of ISO/IEC 23001-8), published 2019-07
* Experimental uses of the HM, SCM, SHM, and HTM reference software remain of interest

Key deliverables initially planned from this meeting:

* Final draft for annotated regions and fisheye SEI messages
* Final TR (ed. 2) on code point usage
* Errata for AVC, HEVC, and Video CICP
* New HM, SHM, and SCM document versions? HM17 with SCM integrated? This was not expected. (Code cleanup remains needed for the SCM to become a completely adequate replacement for the HM.)

A single meeting track was followed for the meeting discussions.

## Scheduling of discussions

Scheduling: Generally, meeting time was scheduled during 0900–2000 hours, with coffee and lunch breaks as convenient. The meeting had been announced to start with AHG reports and then proceed with review of contributions. Ongoing scheduling refinements were announced on the group email reflector as needed.

Some particular scheduling notes are shown below, although not necessarily 100% accurate or complete:

* Fri. 4 October, 1st day
  + 0900–1000 Opening remarks, status review
  + 1000–1100 AHG report reviews
  + 1100–1120 HEVC deployment
  + 1145–1200 Non-normative encoding and software contributions
  + 1200–1330 SEI messages technical contributions
* Mon. 7 October, 4th day
  + 1630–1730 Errata
  + 1730–1800 Information contribution on HDR colour representation
  + 1800–1930 SEI messages technical contributions
  + 1930–2000 GOP structure in common test conditions
  + 2000–2115 Draft report on usage of video signal type code points
* Thu. 10 October, 7th day
  + 0900–1120 Status review, Fisheye, wrap-up

## Contribution topic overview

The approximate subject categories and quantity of contributions per category for the meeting were summarized and categorized as follows. Some plenary sessions were chaired by both co-chairmen, and others by only one. Chairing of discussions is noted for particular topics.

* AHG reports (7) (section 2)
* Project development status and errata reports (6) (section 3)
* Non-normative encoding practices and software development (2) (section 4)
* SEI messages (4) (section 5)
* Technical information contributions (1) (section 6)
* Outputs & planning: AHG plans, Conformance, Reference software, Verification testing, CTC (sections 7, 8, and 9)

NOTE – The number of contributions in each category, as shown in parenthesis above, may not be 100% precise.

## Topics discussed in final wrap-up at the end of the meeting

Notes on potential remainders near the end of the meeting:

* Output preparations (see section 9 for the full list)
* Plans
  + AHGs
  + CEs – None.
  + OLSs to be produced by the parent bodies (and status and project planning information exchanged between each other)
  + Reflectors (jct-vc) & sites (phenix and wftp3) to be used in future work
  + Meeting dates (next meeting to start Friday, 10 January 2020)
  + Document contribution deadline (next meeting deadline Friday 3 January 2020)

There were no requests to present any "TBP" contributions in the closing plenary.

# AHG reports (7)

These reports were discussed Friday 4 Oct. 1000–1100 (chaired by GJS and JRO), except as otherwise noted.

[JCTVC-AK0001](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10974) JCT-VC AHG report: Project management (AHG1) [G. J. Sullivan, J.-R. Ohm]

This document reports on the work of the JCT-VC ad hoc group on Project Management, including an overall status report on the project and the progress made during the interim period since the preceding meeting.

In the interim period since the 36th JCT-VC meeting, work towards finalizing the following (3) documents had been performed:

* For HEVC, AVC, and Video CICP text specification maintenance, a description of current errata report items (JCTVC-AJ1004)
* For non-normative guidance on HEVC encoding practices, Update 11 of the HEVC Model (HM) 16 encoding algorithm description (JCTVC-AJ1002). This document was initially missing due to late of delivery of text for the PCC motion search hint functionality (JCTVC-AJ0028) and was delivered during the meeting.
* For video code points coordination, Draft 5 toward version 2 of technical report on usage of video signal type code points (JCTVC-AJ1003).

The work of the JCT-VC overall had proceeded well in the interim period, although with relatively few input documents submitted to the current meeting. Some discussion had been carried out on the group email reflector (which had approx. 1292 subscribers as of 3 Oct. 2019), and all output documents from the preceding meeting except JCTVC-AJ1002, which was delivered during the meeting on 6 October 2019, had been produced.

The output documents from the preceding meeting had been made available at the "Phenix" site (<http://phenix.it-sudparis.eu/jct/>) or the ITU-based JCT-VC site (<http://wftp3.itu.int/av-arch/jctvc-site/2019_07_AJ_Gothenburg/>), particularly including the following:

* For HEVC, AVC, and Video CICP text specification maintenance, a description of current errata report items (JCTVC-AJ1004)
* For non-normative guidance on HEVC encoding practices, Update 11 of the HEVC Model (HM) 16 encoding algorithm description (JCTVC-AJ1002), which was initially missing at the beginning of the meeting due to late of delivery of text for the PCC motion search hint functionality (JCTVC-AJ0028) and was delivered on 6 October 2019.
* For video code points coordination, Draft 5 toward version 2 of technical report on usage of video signal type code points (JCTVC-AJ1003).

The seven *ad hoc* groups had made progress, and reports from those activities had been submitted.

Software maintenance generally was progressing according to plans. Further action remains necessary for full integration including SCM tools as main branch.

Since the approval of software copyright header language at the March 2011 parent-body meetings, that topic seems to be resolved.

Released versions of the software are available on the SVN server at the following URL:  
https://hevc.hhi.fraunhofer.de/svn/svn\_HEVCSoftware/tags/*version\_number*,  
where *version\_number* corresponds to one of the versions described below – e.g., HM-16.20.

Intermediate code submissions can be found on a variety of branches available at:  
https://hevc.hhi.fraunhofer.de/svn/svn\_HEVCSoftware/branches/*branch\_name*,  
where *branch\_name* corresponds to a branch (e.g., HM-16.20-dev).

Various problem reports relating to asserted bugs in the software, draft specification text, and reference encoder description had been submitted to an informal "bug tracking" system (<https://hevc.hhi.fraunhofer.de/trac/hevc>). That system is not intended as a replacement of our ordinary contribution submission process. However, the bug tracking system was considered to have been helpful to the software coordinators and text editors. The bug tracker reports had been automatically forwarded to the group email reflector, where the issues were discussed – and this is reported to have been helpful.

The ftp site at ITU-T is used to exchange draft conformance testing bitstreams. The ftp site for downloading bitstreams is <http://wftp3.itu.int/av-arch/jctvc-site/bitstream_exchange/>.

A spreadsheet to summarize the status of bitstream exchange, conformance bitstream generation is available in the same directory. It includes the list of bitstreams, codec features and settings, and status of verification.

9 input contributions to the current meeting (not counting the AHG reports) had been registered for consideration at the meeting as of the time of preparation of the PM AHG report. Most of these related to errata reporting, non-normative improvements, and implementation.

A preliminary basis for the document subject allocation and meeting notes for the 37th meeting had been circulated to the participants by being announced in email, and was publicly available on the ITU-hosted ftp site (<http://wftp3.itu.int/av-arch/jctvc-site/2019_10_AK_Geneva/>).

[JCTVC-AK0002](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10975) JCT-VC AHG report: Test model editing and errata reporting (AHG2) [B. Bross, C. Rosewarne, J.-R. Ohm, K. Sharman, G. J. Sullivan, A. Tourapis, Y.-K. Wang]

This document reports the work of the JCT-VC ad hoc group on (HEVC and AVC) test model editing and errata reporting (AHG2) between the 36th meeting in Gothenburg, SE (July 2019) and the 37th meeting in Geneva, CH (October 2019).

At the time of producing this AHG report, candidate text to describe the PCC motion search hint functionality (JCTVC-AJ0028) which had been adopted into the HM had not been provided.

Although the patch provided in the contribution and the later variant from merge request #11 into HM of this functionality was reviewed, it was deemed preferable to obtain textual description from the proponents for integration into an update of the encoder description before integrating this functionality into the softwae.

Accordingly, Update 11 of the encoder description was not yet available. (It was later provided during the meeting on 6 October 2019.)

The errata report JCTVC-AJ1004 output of the previous meeting had been delivered.

Relevant contributions to the current meeting included:

* JCTVC-AK0021 (uploaded 2019-09-30) Some HEVC errata items [Y.-K. Wang (Futurewei), A. Tourapis (Apple), B. Bross (HHI)]
* JCTVC-AK0022 (uploaded 2019-09-30) Some AVC errata items [M. M. Hannuksela (Nokia), D. Tian (InterDigital), Y.-K. Wang (Futurewei)]
* JCTVC-AK0023 (uploaded 2019-09-30) Some errata items for both AVC and HEVC [A. Tourapis (Apple), Y.-K. Wang (Futurewei), G. J. Sullivan (Microsoft)]

The recommendations of the HEVC test model editing and errata reporting AHG were for JCT-VC to:

* Encourage the use of the issue tracker to report issues with the text of both the HEVC specification and the encoder description.
* Confirm resolutions of open tickets (if any) in the issue tracker and close them.
* Confirm behaviour of 3DV ATM versus the corresponding text (see JCTVC-AK0022)
* Review the above-identified input documents.

[JCTVC-AK0003](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10976) JCT-VC AHG report: Software development and software technical evaluation (AHG3) [K. Sühring, B. Li, K. Sharman, V. Seregin, G. Tech, A. Tourapis]

This report summarizes the activities of the AhG on HEVC HM, SCM, SHM, HTM and HDRTools software development and software technical evaluation that have taken place between the 36th and 37th JCT-VC meetings.

The current software model versions are:

* [HM 16.20](C:\\GarySull2\\OneDrive - Microsoft\\2019-10-Geneva\\2019-10-JCTVC-AK-Geneva\\HM-16.20) (svn [HM 16.20](https://hevc.hhi.fraunhofer.de/trac/hevc/browser/tags/HM-16.20)) (Sep. 2018)
* [HM 16.20 + SCM 8.8](C:\\GarySull2\\OneDrive - Microsoft\\2019-10-Geneva\\2019-10-JCTVC-AK-Geneva\\HM 16.20 + SCM 8.8) (svn [HM 16.20 + SCM 8.8](https://hevc.hhi.fraunhofer.de/trac/hevc/browser/tags/HM-16.20%2BSCM-8.8)) (Mar. 2018)
* [SHM 12.4](https://hevc.hhi.fraunhofer.de/trac/shvc/browser/SHVCSoftware/tags/SHM-12.4) (Jan. 2018)
* [HTM 16.3](https://hevc.hhi.fraunhofer.de/trac/3d-hevc/browser/3DVCSoftware/tags/HTM-16.3) (Jul. 2018)
* [JM 19.0](C:\\GarySull2\\OneDrive - Microsoft\\2019-10-Geneva\\2019-10-JCTVC-AK-Geneva\\JM 19.0)
* [3DV ATM 15.0](https://vcgit.hhi.fraunhofer.de/jct-vc/3dv-atm/-/tags/3DV-ATM_v15.0)
* [HDRTools 0.19.1](https://gitlab.com/standards/HDRTools/-/tags/v0.19.1) (Sep. 2019)

There had not been any further releases of the HM reference software, although release of HM 16.21 was imminent.

HM 16.21 was expected to include:

* A change to the default value of FULL\_NBIT to ‘1’ to align with test conditions. The impact of this was previously reported in JCTVC-AI0003.
* A bug has been reported on signed coding (which was recently moved into functions SyntaxElementWriter::xWriteSCode and the equivalent xReadSCode), where sign+magnitude was being coded, not 2’s complement. It was reported that the same bug exists in the VTM, but not in the JM.
* Temporal filtering software, fixed for chroma formats and bit depth
* Annotated regions SEI message support
* Migration to cmake
* Bug fixes for clang, gcc-8.3 bug fix
* Bug fix for the cabac zero word syntax
* JCTVC-AH0024 (improvements for HEVC rate control)
* Fisheye SEI message support.

Remaining for future revisions:

* The adopted changes in JCTVC-Y0038 (Y. T. Peng, A. M. Tourapis, Y. Su, and D. Singer) that include changes in the closed-GOP settings, which require coordination with JVET for JEM development.

It did not seem clear whether this would be followed up.

* JCTVC-AG0026 (Random Access encoding with HM for video-based point cloud coding): Software was provided and reviewed in several rounds. There were concerns from the software coordinators regarding structure and interaction with interlace coding, which had not been resolved yet.
* JCTVC-AJ0028 (Encoder-only Supplemental Motion Vector Estimation for Point cloud Coding content) – to review MR on HM. No corresponding text was provided for AHG2 for this. The software release target for this was thus deferred to HM 16.22. It was agreed that we should make sure this doesn't get checked into the software without adequate documentation; it was reported that the document that had been provided about this has insufficient detail.

The coordinators highlighted a potential bug in the fisheye SEI message semantics regarding the semantics of the region boundary:

* “The sum of fisheye\_rect\_region\_left[ i ] and fisheye\_rect\_region\_width[ i ] shall be less than pic\_width\_in\_luma\_samples − SubWidthC \* conf\_win\_right\_offset.”

It was considered likely that the “shall be less than” term should be “shall be less than or equal to”. The same issue applies for the height as well as the width. In discussion on Thursday 10 October at 0930, this was confirmed and will be fixed in the final text.

The coordinators have previously identified some bug fixes to annotated regions SEI message, which have been addressed in JCTVC-AK0025. However, there was some expression of concern that the number of language strings to maintain is currently equal to the number of objects.

A concern had been raised that the current CTCs which include a 16-GOP random access configuration may violate the DPB constraints (see JCTVC-AJ0030).

* During discussion, it was said that if the report is based on examining the software, it may be an incorrect report since the software has a somewhat different method of counting pictures.
* Additional study during the meeting was requested to determine whether the structure actually violates a 6-frame GOP capacity (including the current picture). See the notes on the later-provided contribution JCTVC-AK0030.

*SEI message support*

The following SEI messages currently did not have any support:

* Motion-constrained tile sets extraction information nesting (159) – R. Skupin was suggested as a contact for this
* SEI manifest and prefix indication (JCTVC-AG1005) (200 & 201) – see JCTVC-AH0027

The following SEI messages currently did not have control mechanisms to configure the encoder to form them (although there is code to put the messages in the bitstream):

* Pan-scan rectangle (payloadType = = 2)
* Filler data payload (3)
* User data registered by ITU-T T.35 (4)
* User data unregistered (5)
* Scene information (9)
* Picture snapshot (15)
* Progressive refinement segments (16, 17)
* Film grain characteristics (19)
* Post filter hint (22)
* Deinterlace field identification (143)
* Content light level information (144)
* Dependent RAP indication (145)
* Coded region completion (146)
* Ambient viewing environment (148)

The following are persistent bug reports where study is encouraged (there were no recent updates in this list):

* High level picture types: IRAP, RASL, RADL, STSA:

Tickets #1096, #1101, #1333, #1334, #1346.

* Rate-control and QP selection – numerous problems with multiple slices:

Tickets #1314, #1338, #1339.

* Field-coding:

Tickets #1145, #1153.

* Decoder picture buffer:

Tickets #1277, #1286, #1287, #1304.

* NoOutputOfPriorPicture processing:

Tickets #1335, #1336, #1393.

* Additional decoder checks:

Tickets #1367, #1383.

There had not been any further developments to SCM during this meeting cycle.

There had not been any further developments to SHM’s SHVC during this meeting cycle.

There had not been any updates to the HTM of MV-HEVC and 3D-HEVC.

There had not been any updates to the JM, JSVM and JMVM software.

HDRTools 0.19 and 0.19.1 had been released. They include the following changes:

* Proper namespace support and other fixes (D. Mehlem)
* Support of possible integration with external software such as the VTM (DM)
* Cmake support (DM)
* Warning elimination for GCC v7.x/v8.x (DM/A. Tourapis)
* Support of R12B/R12L formats (AT)
* Support of P3D65 YUV formats (AT)
* Generalization of 4:2:2 to 4:2:0 conversions (AT)
* Scaling filter fixes and addition of SHVC filtering (for upscaling/downscaling) (AT)
* LUT improvements as per Yonghye Kwon's suggestion (see Issue #3 on gitlab) (AT)

The AHG recommended to:

* Continue to develop reference software based on HM 16.20, HM 16.20 + SCM 8.8, SHM 12.4, HTM 16.3 and HDRTools 0.19.1 and improve their quality.
* Test the reference software more extensively outside of common test conditions.
* Add more conformance checks to the decoder to more easily identify non-conforming bitstreams, especially for profile and level constraints.
* Encourage people who are implementing HEVC based products to report all (potential) bugs that they are finding in that process.
* Encourage people to submit bitstreams that trigger bugs in the HM. Such bitstreams may also be useful for the conformance specification.
* Encourage people to submit configuration files that trigger bugs in HDRTools.
* Continue to investigate the merging of branches.
* Keep common test conditions aligned with JVET.

[JCTVC-AK0004](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10971) JCT-VC AHG report: Conformance test development (AHG4) [T. Suzuki, R. Joshi]

There were no new activities in this AHG since the last meeting. The status of past activities was recorded in the AHG report.

[JCTVC-AK0005](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10972) JCTVC AHG report: Test sequence material (AHG5) [T. Suzuki, V. Baroncini, E. Francois, P. Topiwala, S. Wenger]

There were no new activities in this AHG since the last meeting. The status of past activities was recorded in the AHG report.

It was commented that perhaps for future tracking, we should include information about the EBU SVT database.

[JCTVC-AK0006](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10977) JCT-VC AHG report: Report development for usage of video signal type code points (AHG6) [Y. Syed, C. Fogg]

This report summarizes the activities of the AhG on report development for usage of video signal type code points that had taken place between the 36th and 37th JCT-VC meetings. Activities focused on work on the 2nd edition of ITU-T H-Series Supplement 19 | ISO/IEC 23091-4.

The group worked on producing the output document (JCTVC-AH1003 version 2 draft 5), based on the 36th meeting discussions. This was done without any AhG Calls for this period of time, but with some email exchanges between participants of AHG6. Future work on this document was expected to address the comments that were received for this document.

Some commentary from email discussions was provided:

[Atsuro] confirmed that BT.2100 RGB is narrow range in live broadcast facilities.

[Yasser] add MDCV profile for max\_lum >> 1000 nits, colour gamut wider than P3 ?

[Sean] should a MCDV profile be added for Pulsar ? ([0.005, 4000] nits;  P3D65)

[Atsuro] confirmed that NCL is a label only useful in the context of BT.2020 (SDR/WCG)

[Chris] should the document keep a mention of BT.2100 transfer = 1 for HLG UK broadcast bitstreams (using the alternative transfer characteristics SEI message to indicate HLG in a backward compatible manner)

[Sean] editorial corrections and suggestions:

MDCV and ST 2067-21  P3D65x1000n0005 and BT2100x108n0005 primaries values are swapped

MDCV and ST 2067-21 value for BT2100x108n0005 max mastering luma should be 1080000

indices order in table 10 to be reconsidered.

New substantive proposals:

1. 4000-nit Pulsar reference monitors are used for many high-quality cinematic productions. Thus, it was suggested to add “P3D65x4000n005 – representing a mastering display LED LCD environment for mastering of HDR content with displays having 4000 cd/m2 of peak brightness, 0.005 minimum brightness, and a D65 white point setting within a Recommendation ITU-R BT.2100 colour representation constrained to P3 colour gamut values” Also adding a corresponding column to Table 10.

New editorial suggestions:

1. In Table 10, rows 1-3 (after header), indicate the red, green, and blue correspondence for colour primaries
2. In Table 10, rows 7-9, change the X[] and y[] indices to correspond to MDCV SEI message in HEVC and AVC and indicate the red (index 2), green(index 0), and blue (index 1) correspondence for colour primaries. (This would make the order of the indexes in the Table be 2, 0, 1 for red, green, blue)
3. In Table 10, row 13, indicate red, green, and blue correspondence.
4. Some formatting to improve the readability of the table

Editorial corrections:

1. The MDCV and ST 2067-21 coded values for primaries are swapped for P3D65x1000n0005 and BT2100x108n0005
2. The MDCV and ST 2067-21 coded value for maximum display mastering luminance for BT2100x108n0005 should be 1080000

Publication and ballot status:

[Mayumi Koike] The first edition was published and the second edition was registered.

Ballot started with end date: 1 Oct 2019

The AHG recommended for JCT-VC to review output contributions, resolve the comments, and continue working on the version 2 text for approval.

[JCTVC-AK0007](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10973) JCT-VC AHG Report: Supplemental enhancement information (AHG7) [J. Boyce, C. Fogg, H.-M. Oh, G. J. Sullivan, Y.-K. Wang]

This document summarizes the activity of AHG7: Supplemental enhancement information, between the 36th meeting in Gothenburg, SE (July 2019) and the 37th meeting in Geneva, CH (October 2019).

There were no SEI-related JVET output documents from the previous meeting.

There was no email reflector discussion, which was to take place on the main JCT-VC reflector.

There were 3 SEI related input contributions noted in the AHG report:

* JCTVC-AK0025 is a proposed revision of an SEI message already present in the draft specification. The revision includes both some minor bug fixes and proposes an additional syntax element to fully support an object leaving and re-entering the coded picture area.
* JCTVC-AK0026 is a proposal of a shutter interval information SEI message.
* JCTVC-AK0028 is a proposal of a sub-layer picture rates SEI message for HEVC / AVC

On the status of the annotated regions SEI message

* Software for the annotated regions SEI message had been integrated within the HM software, and accepted by the software coordinators, and was awaiting a new HM software release. The integrated software includes some minor bugs included in contribution JCTVC-AK0025, but does not include the proposed additional syntax element. However, a software patch for that new syntax element was provided with a contribution.

On the status of the fisheye video information SEI message

* Software was provided for the fisheye SEI message to the 360Lib software coordinators. The provided software had not yet been fully integrated in a release of the 360Lib software. The following issues with the provided software were identified:
  + The software supports standalone format conversion (ERP <->FishEye); it does not support integration with the encoding application.
  + The software did not provide any end-to-end metric calculation for fisheye format. WS-PSNR and S-PSNR are currently provided for all other projection formats in 360Lib, to evaluate the end to end conversion quality and coding performance.

This was further discussed Thursday 10 October 2019 (chaired by GJS). The above-noted issues had been resolved by improved software that was delivered to the 360Lib software coordinator in the meantime.

The AHG recommended the following:

* Review input contributions
* Consider the status of the fisheye SEI message

# Project development, status, and guidance (6)

## General (1)

[JCTVC-AK0020](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10968) Deployment status of the HEVC standard [G. J. Sullivan (Microsoft)]

This information contribution was discussed on Friday 4 October 2019 at 1100 (chaired by GJS).

This information contribution contains a survey of deployed products and services using the HEVC standard and the formal specifications in which it is supported, along with a brief introduction to the standard written for broad readership. Revision marking is included to show changes relative to JCTVC-AJ0020-v2 of July 2019.

The following updates were noted to have been included:

* As of September 2019, a developer survey (conducted from 10 June to 5 August 2019) by Bitmovin with 542 respondents from 108 countries (primarily with technical roles) reported:
  + 43% of video developers “currently using” HEVC
  + 32% of video developers “planning to implement within the next 12 months”
* Panasonic AJ-CX4000GJ, an interchangeable-lens shoulder mount broadcast camera, supports HEVC recording up to 4K resolution with 10 bit and HDR capability.
* JVC KA-EN200 streaming adapter (September 2019) was introduced to enable HEVC in its GY-HC550 and GY-HC500 4K cameras
* Hardware chip support for security, surveillance, and Smart Home connectivity by HiSilicon with 8Kp120 playback capability and some encoding capability (September 2019)
* Professional encoding by Beamr
* 3GPP TS 26.116: Universal Mobile Telecommunications System (UMTS); LTE; Television (TV) over 3GPP services; Video profiles (version 13.0.0 published in May 2016, section 4.5) supports several HEVC operating points for 720p, 1080p, and UHD and usage with DASH delivery.
* CTA/CEA core characteristics for “connected” Ultra 4K HDTVs, released June 24, 2014, require that the TV “Decodes IP-delivered video of 3840x2160 resolution that has been compressed using HEVC,” with a minimum capability of “Main Profile, Level 5, Main tier”.

## Errata reports (4)

[JCTVC-AK0021](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10961) Some HEVC errata items [Y.-K. Wang (Futurewei), A.Tourapis (Apple), B. Bross (HHI)] [late]

This contribution was discussed Monday 7 October 2019 at 1645 (chaired by GJS).

This contribution reports some text bugs in the latest HEVC specification text and proposes corresponding fixes.

* The first reported problem is the computation of qPi. The basic issue is using the variable qPi without first giving a value, in the case of non-4:2:0 chroma formats. An error in the constant value (51 vs. 63) was noted in the discussion. Otherwise, the correction is agreed.
* The second reported problem is in regard to HRD parameters presence flags semantics. It was agreed that there is a problem. A spelling error was noted. The language about DUI SEI messages may need some refinement by the editors, and the phrase "NAL HRD parameters" in the second note should be "VCL HRD parameters".
* The third issue relates to "HighestTid is set equal to sps\_max\_sub\_layers\_minus1" in clauses 8.1.2, where it may not be clear which instance of instances of sps\_max\_sub\_layers\_minus1 is involved. Two options are provided. Two possible approaches were described, and it did not seem clear which to choose. This was further discussed Thurday 10 October (chaired by GJS) and it was agreed to use the vps\_max\_sub\_layers\_minus1 approach.
* The fourth issue involves using NoOutputOfPriorPicsFlag instead of no\_output\_of\_prior\_pics\_flag, and was agreed.
* A fifth issue involves mentioning decoding unit information SEI messages in addition to picture timing SEI messages under some circumstances. This was agreed.
* The final issue is whether the pan-scan rectangle SEI message should be in the SingleLayerSeiList in D.3.1. This was also agreed.

[JCTVC-AK0022](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10962) Some AVC errata items [M. M. Hannuksela (Nokia), D. Tian (InterDigital), Y.-K. Wang (Futurewei) [late]

This contribution was discussed Monday 7 October 2019 at 1720 (chaired by GJS).

This contribution reports some text bugs and proposes corresponding fixes for the AVC specifications.

The first category is fixes for Annexes I and J (relating to 3D-AVC). These were agreed.

The second category corresponds to NAL and VCL HRD parameters, similar to what is reported for HEVC in AK0021. See the notes for that contribution.

[JCTVC-AK0023](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10963) Some errata items for both AVC and HEVC [A.Tourapis (Apple), Y.-K. Wang (Futurewei), G. J. Sullivan (Microsoft)] [late]

This contribution was discussed Monday 7 October at 1725 (chaired by GJS).

This contribution reports some text bugs and proposes corresponding fixes on the semantics of rbsp\_byte[ i ], that are asserted to apply to both the HEVC and AVC specifications

This was agreed.

[JCTVC-AK0027](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10967) On HRD for splicing: Bug-fix [Y. Sanchez, R. Skupin, K. Suehring, T. Schierl (Fraunhofer HHI)]

This contribution was discussed Monday 7 October 2019 at 1630 (chaired by GJS).

This contribution provides details of an asserted bug in the Hypothetical Reference Decoder (HRD) model of HEVC for spliced bitstreams. The contribution proposes a fix for the reported issue.

During the previous JCT-VC and JVET meeting, two contributions JCTVC-AJ0026 and JVET-O0496 reported a potential issue in Equation C-10 of the HEVC and VVC specification for bitstream splicing.

It was reported that when concatenationFlag is set to 1, that the AuNominalRemovalTime for the splicing point under some circumstances (non-seamless splicing) may be higher than what is given by AuNominalRemovalTime[ prevNonDiscardablePic ]+ ( auCpbRemovalDelayDeltaMinus1 + 1 ).

The report seemed correct, and this was the second meeting at which the problem had been reported. The basic principle is that the bits that follow a splice point cannot start arriving until all of the bits that precede the splice point have finished arriving.

Decision: Adopt this correction into the next errata collection for action when feasible.

## Communication with parent bodies

No specific communication with the parent bodies was noted. See section 1.11 regarding liaison communication.

# Non-normative encoding and software contributions

[JCTVC-AK0024](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10964) Advanced wavefront-based parallel solution decoding and encoding for MV-HEVC [Y.-B. Cho, W. Liu (Konkuk Univ.)]

This contribution was discussed Friday 4 October 2019 at 1145 (chaired by GJS).

This is a follow-up to JCTVC-AG0024 of 2018-10.

This paper presents an "advanced wavefront parallel processing" method for multiview coding which is proposed to achieve higher intra-frame parallelism.

The concept is the same as in JCTVC-AG0024, but this contribution also provides an encoder.

Some notes from the prior JCTVC-AG0024 review were:

This contribution presents a wavefront parallel processing method which is proposed to achieve higher intra-frame parallelism for MV-HEVC.

The contributor modified the HTM software to support multithreading, with POSIX APIs, showing a substantial speed-up. With more than 16 threads and more than 8 views, the system was said to provide a 14x speedup. The encoding and decoding remained compatible with the HEVC standard.

It was commented that even without wavefront processing, there are parallelization opportunities.

The contributor said they would put their source code on a github repository for study and experimentation. Such experimentation was encouraged.

The contributor said they would provide their source code for study, posting it on their website.

The contributor said the document be revised and a link would be provided for this purpose. However, as of the time of preparation of this report, no revision of the document had been uploaded.

[JCTVC-AK0030](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10979) On GOP-16 structures of the CTC [K. Sharman (Sony), A. Tourapis (Apple)]

This contribution was discussed Monday 7 October 2019 at 1930 (chaired by GJS).

This contribution reports BD-rates on three GOP-16 configurations that are asserted to remove the use of a 7th frame in the DPB as used by the GOP-16 configuration currently specified for CTC testing.

JVET-P0133 proposes an alternative structure. This contribution discusses that one and two others.

"Proposed arrangement 2" has a very small loss, which was said to probably be because some frames in the (constraint-violating) anchor only used a single reference frame, while the alternative scheme kept a high-quality frame in the buffer longer as an available reference.

It was reported that the simulation result had been verified to within a close match.

It was thus agreed to adopt proposed arrangement 2 into the CTC.

It was commented that the previous structure and the modified structure imposes a layered referencing property which is not necessary if the only goal is coding efficiency. Some coding gain could be obtained by violating that nesting relationship, although it is not known how much of an impact this would have.

Further study of additional referencing structures was encouraged.

# SEI message technical contributions (4)

[JCTVC-AK0025](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10965) Proposed revision to Annotated regions SEI message for HEVC and inclusion in AVC [J. Boyce, P. Guruva reddier (Intel)]

This contribution was discussed Friday 4 October 2019 at 1200 (chaired by GJS).

See also the comment from the AHG3 report regarding languages. (No action was taken on that aspect.)

Some revisions are proposed to the draft annotated regions SEI message, with respect to the specification text in JCTVC-AH1012-v1, based on feedback from a review by Karl Sharman. Change marks indicate the revisions.

The changes are summarized as follows:

1. Several minor bug fixes, primarily fixing copy/paste errors
2. Proposed addition of ar\_bounding\_box\_cancel\_flag syntax element, so that an object may continue to be occupy an object\_id value while the object is not present within the picture, so that the same object\_id can be used if the object (re-)enters the picture in future pictures

It is also proposed to also add the annotated regions SEI message to AVC.

The text was reviewed.

It was agreed to proceed to Consent and FDIS on this SEI message, based on this text.

Further discussion was encouraged to consider incorporation into AVC. (No action was taken on the AVC question at this meeting. A CDAM at the next meeting could be considered.)

[JCTVC-AK0026](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10966) AHG7: Shutter interval information SEI message [S. McCarthy, F. Pu, T. Lu, P. Yin, W. Husak (Dolby)]

This contribution was discussed on Friday 4 October 2019 at 1245 (chaired by GJS).

This contribution proposes an SEI message for HEVC and AVC to indicate the shutter interval associated with video content prior to encoding, decoding, and display. The proposed SEI message is called the shutter interval information SEI message.

To enable shutter interval information to be signalled, the contribution proposes two variations of new syntax and semantics to:

1. indicate that shutter interval values are the same or different for different temporal sub-layers; and,
2. to signal one shutter interval value if all sub-layers have the same shutter angle, or signal one shutter interval value for each temporal sub-layer.

There was a prior contribution JCTVC-AJ0029 (and also JVET-O0436). The conclusion of that review was:

The proposal was supported in spirit. It would need to be adapted to deal with the clock tick / frame rate issue. Further work was requested to address the issues noted in the discussion, with a revised syntax and semantics specification expected at the next meeting.

It was reported that ATSC 3.0 has some explicit support for temporal sublayers with differing shutter intervals (referred to as "multiple frame rate temporal filtering", as Annex D of A/341), and it includes some metadata to indicate the likely process that was used to generate the content. A receiving system might try to invert this process.

It was reported that if a system applied this process of varying the shutter interval on a layer-wise basis and the receiving system *does not* try to invert this process, the video would be visually annoying.

Another participant commented that for machine recognition it can be important to have awareness of the exposure time of the frames.

It was noted that referring to SPS syntax elements in the SEI message might create a parsing issue.

Two variants of the syntax/semantics were proposed, with variant 1 being more general, but it was commented that this type of generality did not seem particularly useful, so variant 2 was preferred.

It was asked whether this could be used with the regional nesting SEI message. That seemed reasonable.

The contribution was well received.

The visual annoyance issue for compatibility to systems that do not interpret the message should be further studied.

It was agreed to output a first draft text for this.

[JCTVC-AK0028](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10970) Sub-layer picture rates SEI message for HEVC / AVC [M. Sychev (Huawei)] [late]

This contribution was discussed on Monday 7 October 2019 at 1800 (chaired by GJS).

This contribution proposes a signalling for mapping sub-layers to picture rates in video coding. For signalling of these parameters, it is proposed to use an SEI message. More specifically, the signalling of the table is proposed to map Temporal IDs (TID) of sub-layers to corresponding picture rates.

It was commented that the semantics don't seem well written and it did not seem clear, at least to some participants, what a receiving system should do with the information. Some errors in the semantics were identified.

Further study and clarification of the contribution was encouraged.

[JCTVC-AK0031](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10980) SW implementation of fisheye projection format [H-.M. Oh (LG Electronics)] [late]

This contribution was discussed Monday 7 October 2019 at 1845 (chaired by GJS).

In this contribution, a software implementation of the fisheye projection format is described to study 2D to 3D conversion equations defined for the fisheye video information SEI message. The mapping function is implemented on 360Lib v9.1 which supports conversion with and without encoding, as well as end-to-end PSNR calculation. To verify the implementation, a picture in the ERP format is converted to the fisheye projection format and then converted back to the ERP format. Based on the objective and subjective results of the conversion, the contribution proposes to include the fisheye video information SEI message with the mapping equation in the HEVC standard.

The contributor reported that the proper functioning of the software for format conversion was verified by the software coordinator of the 360Lib software package (Yuwen He).

The previous draft of this SEI message was in JCTVC-AH1012 (of January 2019). It was commented that there is some restructuring of the relevant subclauses of Annex D involved, and it is not clear whether the text of January fits properly into the standard produced in March.

The contributor said that some equations are missing in JCTVC-AH1012. It was commented that some of the equations already in the text appear to overlap with some of what is proposed to be added.

This was further discussed Thursday 10 October 2019 at 0900-1000 (chaired by GJS), and it was agreed to proceed with finalization of this SEI message specification.

# Technical information contributions (1)

[JCTVC-AK0029](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10978) Perceptual redistribution of chroma information for improved HDR colour representation [M. Azimi (UBC), M. T. Pourazad (TELUS), P. Nasiopoulos (UBC)] [late]

This contribution was discussed on Monday 7 October 2019 at 1730 (chaired by GJS).

This contribution proposes a chroma processing method that adds to the existing NCL YCbCr 4:2:0 colour encoding to improve its colour u and hence reduce its associated visible colour errors for HDR colour pixels. The contribution investigates redistribution of code-words for the Cb and Cb chroma channels based on CIE DE2000 metric. To that end, the contribution considers the colours that are represented with visible colour shifts and the ones that are represented without visible errors using 10-bit YCbCr 4:2:0. The contribution proposes a non-linear function to redistribute code-words assigned to chroma values such that more code-words are assigned to those colours that bear larger colour differences due to bit-depth quantization. The new chroma channels (referred to here as Cb\* and Cr\* to distinguish from the original Cb and Cr) are quantized with 10 bits, which is the current standard for HDR video delivery. The quantized YCb\*Cr\* signal is then compressed to evaluate the compression efficiency of the proposed method.

Higher perceptual colour fidelity was reported, both with and without compression, by using this scheme.

An experiment with compression reportedly showed a large improvement in DE100

It was commented that this seems like basically an alternative source video representation. It was commented that this is applying a second transfer function to the Cb and Cr channels prior to quantization to 10 bits.

The tone mapping SEI message was suggested as possibly being capable of signalling this.

The "luma adjustment" technique was not applied in the 4:2:0 conversion, either in the anchor or in the proposed scheme. This could be applied to the proposed scheme in principle.

Using dEITP (ITU-R BT.2124-0, January 2019) was suggested to be considered.

The source data used was half-float EXR. A contribution of January 2014 (JCTVC-P0228, San Jose) described the source processing (by Technicolor).

The analysis work focused on brightness range up to 400 nits, although the scheme applies regardless of the range.

Further study was encouraged.

# Project planning

## Joint meeting

No joint meetings with the parent bodies were held on JCT-VC matters at this meeting.

## Text drafting and software quality

The following agreement has been established: the editorial team has the discretion to not integrate recorded adoptions for which the available text is grossly inadequate (and cannot be fixed with a reasonable degree of effort), if such a situation hypothetically arises. In such an event, the text would record the intent expressed by the committee without including a full integration of the available inadequate text. Similarly, software coordinators have the discretion to evaluate contributed software for suitability in regard to proper code style, bugginess, etc., and to not integrate code that is determined inadequate in software quality.

## Plans for improved efficiency and contribution consideration

The group considered it important to have the full design of proposals documented to enable proper study.

Adoptions need to be based on properly drafted working draft text (on normative elements) and HM encoder algorithm descriptions – relative to the existing drafts. Proposal contributions should also provide a software implementation (or at least such software should be made available for study and testing by other participants at the meeting, and software must be made available to cross-checkers in CEs).

Suggestions for future meetings included the following generally supported principles:

* No review of normative contributions without draft specification text
* HM text is strongly encouraged for non-normative contributions
* Early upload deadline to enable substantial study prior to the meeting
* Using a clock timer to ensure efficient proposal presentations (5 min) and discussions

As general guidance, it was suggested to avoid usage of company names in document titles, software modules, etc., and not to describe a technology by using a company name. Also, core experiment responsibility descriptions should name individuals, not just companies. AHG reports and CE descriptions/summaries are considered to be the contributions of individuals, not companies.

## General issues for CEs and TEs

Group coordinated experiments have been planned in previous work, although none were established at the current meeting. These may generally fall into one of two categories:

* "Core experiments" (CEs) are the experiments for which there is a draft design and associated test model software that have been established.
* "Tool experiments" (TEs) are the coordinated experiments on coding tools at a more preliminary stage of work than those of "core experiments".

A preliminary description of each experiment is to be approved at the meeting at which the experiment plan is established.

It is possible to define sub-experiments within particular CEs and TEs, for example designated as CEX.a, CEX.b, etc., for a CEX, where X is the basic CE number.

As a general rule, it has been agreed that each CE should be run under the same testing conditions using one software codebase, which should be based on the HM software codebase. An experiment is not to be established as a CE unless there is access given to the participants in (any part of) the CE to the software used to perform the experiments.

CE descriptions need to be fully precise – this is intended as a method of enabling full study and testing of a specific technology. Greater discipline in terms of what can be established as a CE may be an approach to helping with such issues. CEs should be more focused on testing just a few specific things, and the description should precisely define what is intended to be tested (available by the end of the meeting when the CE plan is approved).

It was noted that sometimes there is a problem of needing to look up other referenced documents, sometimes through multiple levels of linked references, to understand what technology is being discussed in a contribution – and that this often seems to happen with CE documents. It was emphasized that we need to have some reasonably understandable basic description, within a document, of what it is talking about.

Software study can be a useful and important element of adequate study; however, software availability is not a proper substitute for document clarity.

Software shared for CE purposes needs to be available with adequate time for study. Software of CEs should be available early, to enable close study by cross-checkers (not just provided shortly before the document upload deadline).

The general agreed common conditions for single-layer coding efficiency experiments are as described in the output document JCTVC-AF1100.

The general timeline agreed for CEs was expected to be as follows: 3 weeks to obtain the software to be used as the basis of experimental feature integration, 1 more week to finalize the description and participation, 2 more weeks to finalize the software.

When a CE is planned, a deadline of four weeks after the meeting would be established for organizations to express their interest in participating in a CE to the CE coordinators and for finalization of the CE descriptions by the CE coordinator with the assistance and consensus of the CE participants.

Any change in the scope of what technology will be tested in a CE, beyond what is recorded in the meeting notes, requires discussion on the general JCT-VC reflector.

As a general rule, all CEs are expected to include software available to all participants of the CE, with software to be provided within two (calendar) weeks after the release of the relevant software basis (e.g. the SCM). Exceptions must be justified, discussed on the general JCT-VC reflector, and recorded in the abstract of the summary report.

Final CE descriptions shall clearly describe specific tests to be performed, not describe vague activities. Activities of a less specific nature are delegated to Ad Hoc Groups rather than designated as CEs.

Experiment descriptions should be written in a way such that it is understood as a JCT-VC output document (written from an objective "third party perspective", not a company proponent perspective – e.g. referring to methods as "improved", "optimized" etc.). The experiment descriptions should generally not express opinions or suggest conclusions – rather, they should just describe what technology will be tested, how it will be tested, who will participate, etc. Responsibilities for contributions to CE work should identify individuals in addition to company names.

CE descriptions should not contain excessively verbose descriptions of a technology (at least not unless the technology is not adequately documented elsewhere). Instead, the CE descriptions should refer to the relevant proposal contributions for any necessary further detail. However, the complete detail of what technology will be tested must be available – either in the CE description itself or in referenced documents that are also available in the JCT-VC document archive.

Those who proposed technology in the respective context (by this or the previous meeting) can propose a CE or CE sub-experiment. Harmonizations of multiple such proposals and minor refinements of proposed technology may also be considered. Other subjects would not be designated as CEs.

Any technology must have at least one cross-check partner to establish a CE – a single proponent is not enough. It is highly desirable to have more than just one proponent and one cross-checker.

It is strongly recommended to plan resources carefully and not waste time on CE work on technology that may have little or no apparent benefit – it is also within the responsibility of the CE coordinator to take care of this.

A summary report written by the coordinator (with the assistance of the participants) is expected to be provided to the subsequent meeting. The review of the status of the work on the CE at the meeting is expected to rely heavily on the summary report, so it is important for that report to be well-prepared, thorough, and objective.

A non-final CE plan document would be reviewed and given tentative approval during the meeting (with guidance expressed to suggest modifications to be made in a subsequent revision).

The CE description for each planned CE would be described in an associated output document numbered as, for example, JCTVC-X11xx for CExx, where "xx" is the CE number (xx = 01, 02, etc.). Final CE plans would be recorded as revisions of these documents.

It must be understood that the JCT-VC is not obligated to consider the test methodology or outcome of a CE as being adequate. Good results from a CE do not impose an obligation on the group to accept the result (e.g., if the expert judgment of the group is that further data is needed or that the test methodology was flawed).

Some agreements relating to CE activities have been established as follows:

* Only qualified JCT-VC members can participate in a CE.
* Participation in a CE is possible without a commitment of submitting an input document to the next meeting.
* All software, results, documents produced in the CE should be announced and made available to all CE participants in a timely manner.
* If combinations of proposals are intended to be tested in a CE, the precise description shall be available with the final CE description; otherwise it cannot be claimed to be part of the CE.

## Alternative procedure for handling complicated feature adoptions

The following alternative procedure had been approved at a preceding meeting as a method to be applied for more complicated feature adoptions:

1. Run CE + provide software + text, then, if successful,
2. Adopt into HM, including refinements of software and text (both normative & non-normative); then, if successful,
3. Adopt into WD and common conditions.

Of course, we have the freedom (e.g. for simple things) to skip step 2.

## Common test conditions for HEVC Coding Experiments

No particular changes were noted w.r.t. the prior CTC for work within the current scope of JCT-VC. See the prior output documents JCTVC-AF1100 for HEVC test conditions, JCTVC-X1009 for SHVC test conditions, JCTVC-Z1015 for SCC test conditions, and JCTVC-Z1020 for HDR/WCG test conditions.

## Software development planning

Software coordinators were asked to work out the detailed schedule for software updates with the proponents of adopted changes as applicable.

Any adopted proposals where necessary software is not delivered by the scheduled date in a timely manner may be rejected.

At a previous meeting (Sapporo, July 2014), it was noted that it should be relatively easy to add MV-HEVC capability to the SHVC software, and it was strongly suggested that this should be done. This remains desirable. Further study was encouraged to determine the appropriate approach to future software maintenance, especially in regard to alignment of 3D video software with the SHM software.

# Establishment of ad hoc groups

The ad hoc groups established to progress work on particular subject areas until the next meeting are described in the table below. The discussion list for all of these ad hoc groups was agreed to be the main JCT-VC reflector ([jct-vc@lists.rwth-aachen.de](mailto:jct-vc@lists.rwth-aachen.de)).

|  |  |  |
| --- | --- | --- |
| **Title and Email Reflector** | **Chairs** | **Mtg** |
| **JCT-VC project management (AHG1)**  ([jct-vc@lists.rwth-aachen.de](mailto:jct-vc@lists.rwth-aachen.de))   * Coordinate overall JCT-VC interim efforts. * Report on project status to JCT-VC reflector. * Provide a report to next meeting on project coordination status. | G. J. Sullivan, J.-R. Ohm (co‑chairs) | N |
| **Test model editing and errata reporting (AHG2)**  ([jct-vc@lists.rwth-aachen.de](mailto:jct-vc@lists.rwth-aachen.de))   * Develop proposed improvements to the JCTVC-AK1002 HEVC Test Model 16 (HM 16) Update 12 of Encoder Description * Collect reports of errata for the HEVC and AVC specification and the published HDR-related technical reports. * Gather and address comments for refinement of these documents. * Coordinate with AHG3 on software development and software technical evaluation to address issues relating to mismatches between software and text. | B. Bross, C. Rosewarne (co‑chairs), J.‑R. Ohm, K. Sharman, G. J. Sullivan, A. Tourapis, Y.‑K. Wang (vice‑chairs) | N |
| **Software development and software technical evaluation (AHG3)**  ([jct-vc@lists.rwth-aachen.de](mailto:jct-vc@lists.rwth-aachen.de))   * Coordinate development of the HM, SCM, SHM, HTM, MFC, MFCD, JM, JSVM, JMVM, 3DV-ATM, and HDRTools software and their distribution. * Enable software support for recently standardized additional SEI messages. * Produce documentation of software usage for distribution with the software. * Prepare and deliver results, reporting templates, and anchor test results according to JCT-VC common conditions. * Suggest configuration files for additional testing of tools. * Investigate how to minimize the number of separate codebases maintained for group reference software. * Coordinate with AHG2 on HEVC and AVC test model editing and errata reporting to identify any mismatches between software and text. | K. Sühring (chair), B. Li, K. Sharman, V. Seregin, G. Tech, A. Tourapis (vice‑chairs) | N |
| **Supplemental enhancement information (AHG4)**  ([jct-vc@lists.rwth-aachen.de](mailto:jct-vc@lists.rwth-aachen.de))   * Produce and study the draft texts JCTVC-AK1005 (shutter interval) and JCTVC-AK1012 (annotated regions and fisheye video information) for HEVC * Study the status of text and potential needs for SEI messages for AVC. * Consider proposals for additional SEI message data and associated syntax and semantics specification. * Develop usage scenario descriptions and showcase demonstrations. * Coordinate with AHG3 for software support of SEI messages. | J. Boyce (chair), C. Fogg, S. McCarthy, H.-M. Oh, G. J. Sullivan, Y.-K. Wang (vice‑chairs) | N |
| **Test sequence material (AHG5)**  ([jct-vc@lists.rwth-aachen.de](mailto:jct-vc@lists.rwth-aachen.de))   * Maintain the video sequence test material database for development of HEVC and its RExt, SHVC and SCC extensions. * Identify, collect, and make available a variety of video sequence test material, especially focusing on new needs for HDR/WCG test material and corresponding SDR test material. * Study coding performance and characteristics in relation to video test materials. * Identify and recommend appropriate test materials and corresponding test conditions for use in development of HEVC and its extensions. * Coordinate with the activities in AHG3 and AHG6 regarding HDR/WCG testing. | T. Suzuki, V. Baroncini (co‑chairs), E. François, P. Topiwala, S. Wenger (vice‑chairs) | N |

# Output documents

The following documents were agreed to be produced or endorsed as outputs of the meeting. Names recorded below indicate the editors responsible for the document production.

[JCTVC-AK1000](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10983) Meeting Report of the 37th JCT-VC Meeting [G. J. Sullivan, J.-R. Ohm (chairs)] [2020-01-03] (near next meeting)

Remains valid – not updated: [JCTVC-H1001](http://phenix.it-sudparis.eu/jct/doc_end_user/current_document.php?id=5095) HEVC software guidelines [K. Sühring, D. Flynn, F. Bossen (software coordinators)]

[JCTVC-AK1002](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10984) High Efficiency Video Coding (HEVC) Test Model 16 (HM 16) Encoder Description Update 12 [C. Rosewarne (primary editor), K. Sharman, R. Sjöberg, G. J. Sullivan (co-editors)] (WG 11 N 18920) [2020-01-03] (near next meeting)

This will include a description of the GOP16 structure. The description of the PCC motion search hint functionality of JCTVC-AJ0028 should also be improved. These are to be supported in the HM16.22 software release.

[JCTVC-AK1003](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10981) Usage of video signal type code points (Draft 6 for version 2) [L. Borg, C. Fogg, W. Husak, A. Ichigaya, C. Seeger, G. J. Sullivan, Y. Syed, A. Tourapis (editors)] (WG 11 N 18872 ISO/IEC TR 23091-4:20xx (2nd edition) / H.Sup19 v2) [2019-10-18]

This was discussed Monday at 2000 (chaired by GJS):

Ballot comments received in WG11 document m49982 and the incoming liaison statement [SG16-TD389/Gen](http://www.itu.int/md/meetingdoc.asp?lang=en&parent=T17-SG16-191007-TD-GEN-0389), a.k.a. [ITU-R WP6C/‌TEMP/312](http://ifa.itu.int/t/2017/ls/itu-rwp6c/sp16-itu-rwp6c-iLS-00068.docx) from ITU-R WP6C were noted and reviewed.

* Regarding "NCL", a NOTE was drafted to address this.
* Regarding use of BT.2100 RGB with full range, this does not seem to be widely used – see the note in ITU-R BT.2100. Our intent is to just document what we know to be commonly used.
* Regarding mastering displays with peak brightness around 1000 cd/m2 and a wider colour gamut than P3, we believe the current practice is focused on 1000 cd/m2 and do not see a current need to discuss other uses.
* On mastering displays for with peak brightness around 4000 cd/m2 that have been used for mastering of high valued content, it was agreed to add information about this (splitting the mastering display colour volume descriptions table into two tables to avoid margin problems).
* Regarding terminology, the terminology has been reviewed and we believe the terminology used in the current text is appropriate.
* Vertical text – e.g., in Table 5 needs fixing.
* Regarding the comments from ITU-R WP6C:
  + For comment 1 regarding “NCL”, a note has been added (see above).
  + For the mastering display comment 2 from ITU-R, we acknowledge the distinction that is referred to, and believe the text is consistent with this; if they have specific suggestions for refinement of the text, we would welcome such input for future versions of the report.
  + For comment 3 on mastering displays for with peak brightness around 4000 cd/m2, we have added the necessary information (see above).
  + For comment 4 on review of terminology, the terminology has been refined.

This discussion ended at 2115.

[JCTVC-AK1004](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10985) Errata report items for HEVC, AVC, and Video CICP [G. J. Sullivan, Y.-K. Wang] (WG 11 N 18878 for HEVC, N 18911 for AVC, and N 18912 for Video CICP) (2019-12-13)

In the closing session on Thursday 10 October (chaired by GJS), the following aspects were agreed:

* For the errata on sYCC, it was agreed to condition the interpretation of the transfer\_characteristics syntax element for the value 13 on the value of the matrix\_coeffs syntax element.
* Errata reported in ballot comments for 23008-2/Damd.1 should be included. (In post-meeting study, review of these ballot comments determined that they were all duplicates of previously reported issues.)
* The editors were given discretion to make a final assessment of the maturity of the reported issues and incorporate the mature errata items in the ITU-T Consent text (not in the ISO/IEC text of non-relevant sections).

[JCTVC-AK1005](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10982) Shutter interval SEI message for HEVC (Draft 1) [S. McCarthy, G. J. Sullivan, Y.-K. Wang] (WG 11 N 18928) (2019-11-22)

No output: JCTVC-AK1006

Remains valid – not updated: [JCTVC-V1007](http://phenix.it-sudparis.eu/jct/doc_end_user/current_document.php?id=10312) SHVC Test Model 11 (SHM 11) Introduction and Encoder Description [G. Barroux, J. Boyce, J. Chen, M. M. Hannuksela, Y. Ye (editors)] (WG 11 [N 15778](http://phenix.it-sudparis.eu/mpeg/doc_end_user/current_document.php?id=53941&id_meeting=165))

No output: JCTVC-AK1008

Remains valid – not updated: [JCTVC-X1009](http://phenix.it-sudparis.eu/jct/doc_end_user/current_document.php?id=10572) Common Test Conditions for SHVC [V. Seregin, Y. He (editors)]

Remains valid – not updated [JCTVC-O1010](http://phenix.it-sudparis.eu/jct/doc_end_user/current_document.php?id=8511) Guidelines for Conformance Testing Bitstream Preparation [T. Suzuki, W. Wan (editors)]

No output: JCTVC-AK1011

[JCTVC-AK1012](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10921) Annotated regions and fisheye video information SEI messages for HEVC (Draft 3) (J. Boyce, Y.-K. Wang, G. J. Sullivan) WG 11 FDAM 1 N 18881 [2019-11-22]

See the notes for the AHG 3 report JCTVC-AK1003 regarding a text bug to be fixed in the final text.

WG11 is to also issue a DoCR for the ballot comment responses. YKW to harmonize the text with prior structuring issues for JCTVC-AE1005, JCTVC-AG1005, JCTVC-AH1012, the approved Rec. ITU-T H.265, and the AHG3 bug report.

No output: JCTVC-AK1013

Remains valid – not updated [JCTVC-V1014](http://phenix.it-sudparis.eu/jct/doc_end_user/current_document.php?id=10316) Screen Content Coding Test Model 7 Encoder Description (SCM 7) [R. Joshi, J. Xu, R. Cohen, S. Liu, Y. Ye (editors)] (WG 11 [N 16049](http://phenix.it-sudparis.eu/mpeg/doc_end_user/current_document.php?id=54889&id_meeting=166))

Remains valid – not updated: [JCTVC-Z1015](http://phenix.it-sudparis.eu/jct/doc_end_user/current_document.php?id=10689) Common Test Conditions for Screen Content Coding [H. Yu, R. Cohen, K. Rapaka, J. Xu (editors)] [2017-02-17]

No output: JCTVC-AK1016 through JCTVC-AK1019

Remains valid – not updated: [JCTVC-Z1020](http://phenix.it-sudparis.eu/jct/doc_end_user/current_document.php?id=10692) Common Test Conditions for HDR/WCG Video Coding Experiments [E. François, J. Sole, J. Ström, P. Yin (editors)] [2017-02-17] (1 month)

Remains valid – not updated: – [JCTVC-AF1100](http://phenix.it-sudparis.eu/jct/doc_end_user/current_document.php?id=10693) Common Test Conditions for HM Video Coding Experiments [K. Sharman, K. Sühring (editors)] [2018-09-14]

(Revision only to be issued if needed for coordination; no such need was identified.)

# Future meeting plans, expressions of thanks, and closing of the meeting

Future meeting plans were established according to the following guidelines:

* Meeting under ITU-T SG 16 auspices when it meets (usually starting meetings on the Thursday or Friday of the first week and closing it on the Tuesday or Wednesday of the second week of the SG 16 meeting – a total of 5–6.5 meeting days), and
* Otherwise meeting under ISO/IEC JTC 1/SC 29/WG 11 auspices when it meets (starting meetings on the Friday prior to such meetings and closing it on the last day of the WG 11 meeting – a total of 7.5 meeting days).

Some specific future meeting plans (to be confirmed) were established as follows:

* Fri. 10 – Fri. 17 January 2020, 38th meeting under WG11 auspices in Brussels, BE
* Fri. 17 – Fri. 24 April 2020, 39th meeting, under WG 11 auspices in Alpbach, AT
* Thu. 25 June – Wed. 1 July 2020, 40th meeting, under ITU-T SG16 auspices in Geneva, CH
* Fri. 9 – Fri. 16 October 2020, 41st meeting, under WG 11 auspices in Rennes, FR

The agreed document deadline for the 38th JCT-VC meeting is Friday 3 January 2020. Plans for scheduling of agenda items within that meeting remained TBA.

The SG16 parent body was thanked for the excellent hosting and organization of the 37th meeting of the JCT-VC.

The JCT-VC meeting was closed at approximately 1120 hours on Thursday, 10 October 2019.

# Annex A to JCT-VC report: List of documents

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| [JCT-VC number](http://phenix.int-evry.fr/jct/doc_end_user/current_meeting.php?id_meeting=180&type_order=&sql_type=document_number) | MPEG number | [Created](http://phenix.int-evry.fr/jct/doc_end_user/current_meeting.php?id_meeting=180&type_order=&sql_type=document_date_time) | First Upload | [Last upload](http://phenix.int-evry.fr/jct/doc_end_user/current_meeting.php?id_meeting=180&type_order=&sql_type=upload_document_date_time) | [Title](http://phenix.int-evry.fr/jct/doc_end_user/current_meeting.php?id_meeting=180&type_order=&sql_type=title) | [Source](http://phenix.int-evry.fr/jct/doc_end_user/current_meeting.php?id_meeting=180&type_order=&sql_type=authors) |
| [JCTVC-AK0001](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10974) | m51304 | 2019-10-03 21:27:53 | 2019-10-03 23:19:10 | 2019-10-03 23:19:10 | JCT-VC AHG report: Project management (AHG1) | G. J. Sullivan, J.-R. Ohm |
| [JCTVC-AK0002](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10975) | m51305 | 2019-10-03 22:01:27 | 2019-10-03 22:28:48 | 2019-10-04 10:20:26 | JCT-VC AHG report: Test model editing and errata reporting (AHG2) | B. Bross, C. Rosewarne, J.-R. Ohm, K. Sharman, G. J. Sullivan, A. Tourapis, Y.-K. Wang |
| [JCTVC-AK0003](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10976) | m51306 | 2019-10-03 22:04:11 | 2019-10-04 09:34:19 | 2019-10-04 09:38:29 | JCT-VC AHG report: Software development and software technical evaluation (AHG3) | K. Sühring, B. Li, K. Sharman, V. Seregin, G. Tech, A. Tourapis |
| [JCTVC-AK0004](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10971) | m51148 | 2019-10-01 19:34:36 | 2019-10-01 19:35:09 | 2019-10-01 19:35:09 | JCT-VC AHG report: Conformance test development (AHG4) | [T. Suzuki](mailto:teruhiko.s@sony.com), [R. Joshi](mailto:r.joshi@samsung.com) |
| [JCTVC-AK0005](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10972) | m51149 | 2019-10-01 19:37:53 | 2019-10-03 10:54:10 | 2019-10-03 10:54:10 | JCTVC AHG report: Test sequence material (AHG5) | [T. Suzuki](mailto:teruhiko.s@sony.com), [V. Baroncini](mailto:baroncini@gmx.com), [E. Francois](mailto:Edouard.Francois@InterDigital.com), [P. Topiwala](mailto:pankajtva@gmail.com), [S. Wenger](mailto:stewe@stewe.org) |
| [JCTVC-AK0006](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10977) | m51307 | 2019-10-03 22:24:40 | 2019-10-04 10:20:31 | 2019-10-04 10:20:31 | JCT-VC AHG report: Report development for usage of video signal type code points (AHG6) | Y. Syed, C. Fogg |
| [JCTVC-AK0007](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10973) | m51251 | 2019-10-03 08:49:34 | 2019-10-03 08:52:45 | 2019-10-03 08:52:45 | JCT-VC AHG Report: Supplemental enhancement information (AHG7) | [J. Boyce](mailto:jill.boyce@intel.com), C. Fogg, H.-M. Oh, G. J. Sullivan, Y.-K. Wang |
| [JCTVC-AK0020](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10968) | m50608 | 2019-09-26 00:55:31 | 2019-09-26 00:56:22 | 2019-10-08 10:15:26 | Deployment status of the HEVC standard | [G. J. Sullivan (Microsoft)](mailto:garysull@microsoft.com) |
| [JCTVC-AK0021](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10961) | m50078 | 2019-09-21 07:37:25 | 2019-09-30 10:00:09 | 2019-10-03 07:27:24 | Some HEVC errata items | [Y.-K. Wang (Futurewei)](mailto:ye-kui.wang@futurewei.com), [A.Tourapis (Apple)](mailto:atourapis@apple.com), [B. Bross (HHI)](mailto:benjamin.bross@hhi.fraunhofer.de) |
| [JCTVC-AK0022](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10962) | m50079 | 2019-09-21 07:39:22 | 2019-09-30 14:30:26 | 2019-09-30 14:30:26 | Some AVC errata items | [M. M. Hannuksela (Nokia)](mailto:miska.hannuksela@nokia.com), [D. Tian (InterDigital)](mailto:dong.tian@interdigital.com), [Y.-K. Wang (Futurewei)](mailto:ye-kui.wang@futurewei.com) |
| [JCTVC-AK0023](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10963) | m50081 | 2019-09-21 07:44:17 | 2019-09-30 14:30:47 | 2019-09-30 14:30:47 | Some errata items for both AVC and HEVC | [A.Tourapis (Apple)](mailto:atourapis@apple.com), [Y.-K. Wang (Futurewei)](mailto:ye-kui.wang@futurewei.com), [G. J. Sullivan (Microsoft)](mailto:garysull@microsoft.com) |
| [JCTVC-AK0024](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10964) | m50293 | 2019-09-24 16:39:15 | 2019-09-24 16:40:14 | 2019-09-24 16:40:14 | Advanced wavefront-based parallel solution decoding and encoding for MV-HEVC | [Y.-B. Cho](mailto:ybcho@konkuk.ac.kr), [W. Liu (Konkuk Univ.)](mailto:liuwei1108@konkuk.ac.kr) |
| [JCTVC-AK0025](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10965) | m50442 | 2019-09-25 00:14:46 | 2019-09-25 00:40:30 | 2019-09-25 22:50:47 | Proposed revision to Annotated regions SEI message for HEVC and inclusion in AVC | [J. Boyce](mailto:jill.boyce@intel.com), [P. Guruva reddier (Intel)](mailto:palanivel.guruvareddiar@intel.com) |
| [JCTVC-AK0026](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10966) | m50449 | 2019-09-25 00:30:42 | 2019-09-25 02:01:20 | 2019-10-06 15:38:10 | AHG7: Shutter interval information SEI message | [S. McCarthy](mailto:sean.mccarthy@dolby.com), [F. Pu](mailto:fangjun.pu@dolby.com), [T. Lu](mailto:tlu@dolby.com), [P. Yin](mailto:pyin@dolby.com), [W. Husak (Dolby)](mailto:wjh@dolby.com) |
| [JCTVC-AK0027](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10967) | m50600 | 2019-09-25 14:38:59 | 2019-09-25 14:40:17 | 2019-09-25 14:40:17 | On HRD for splicing: Bug-fix | [Y. Sanchez](mailto:yago.sanchez@hhi.fraunhofer.de), [R. Skupin](mailto:robert.skupin@hhi.fraunhofer.de), [K. Suehring](mailto:karsten.suehring@hhi.fraunhofer.de), [T. Schierl (Fraunhofer HHI)](mailto:thomas.schierl@hhi.fraunhofer.de) |
| [JCTVC-AK0028](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10970) | m50613 | 2019-09-26 11:58:09 | 2019-09-26 12:35:43 | 2019-09-26 12:35:43 | Sub-layer picture rates SEI message for HEVC / AVC | [M. Sychev (Huawei)](mailto:Sychev.Maxim@huawei.com) |
| [JCTVC-AK0029](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10978) | m51401 | 2019-10-05 16:49:07 | 2019-10-05 16:49:38 | 2019-10-05 16:49:38 | Perceptual redistribution of chroma information for improved HDR colour representation | M. Azimi (UBC), M. T. Pourazad (TELUS), P. Nasiopoulos (UBC) |
| [JCTVC-AK0030](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10979) | m51421 | 2019-10-06 10:50:36 | 2019-10-06 11:13:58 | 2019-10-06 11:13:58 | On GOP-16 structures of the CTC | [K. Sharman (Sony)](mailto:karl.sharman@sony.com), [A. Tourapis (Apple)](mailto:atourapis@apple.com) |
| [JCTVC-AK0031](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10980) | m51452 | 2019-10-07 16:08:50 | 2019-10-07 16:10:10 | 2019-10-07 16:10:10 | SW implementation of fisheye projection format | [H-.M. Oh (LGE)](mailto:hyunmook.oh@lge.com) |
| [JCTVC-AK1000](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10983) | m51527 | 2019-10-22 19:42:20 |  |  | Meeting Report of the 37th JCT-VC Meeting | [G. J. Sullivan](mailto:garysull@microsoft.com), [J.-R. Ohm](mailto:ohm@ient.rwth-aachen.de) |
| [JCTVC-AK1002](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10984) | m51528 | 2019-10-22 19:44:10 | 2019-12-17 01:07:48 | 2019-12-17 01:07:48 | High Efficiency Video Coding (HEVC) Test Model 16 (HM 16) Encoder Description Update 12 | C. Rosewarne, K. Sharman, R. Sjöberg, [G. J. Sullivan](mailto:garysull@microsoft.com) |
| [JCTVC-AK1003](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10981) | m51525 | 2019-10-13 15:10:56 | 2019-10-21 16:01:17 | 2019-10-21 16:01:17 | Usage of video signal type code points (Draft 6 for version 2) |  |
| [JCTVC-AK1004](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10985) | m51529 | 2019-10-22 19:45:17 | 2019-12-21 02:03:30 | 2019-12-21 02:03:30 | Errata report items for HEVC, AVC, and Video CICP | [G. J. Sullivan](mailto:garysull@microsoft.com), Y.-K. Wang |
| [JCTVC-AK1005](http://phenix.int-evry.fr/jct/doc_end_user/current_document.php?id=10982) | m51526 | 2019-10-15 01:30:34 |  |  | Shutter interval SEI message for HEVC (Draft 1) | S. McCarthy, [G. J. Sullivan](mailto:garysull@microsoft.com), Y.-K. Wang |

# Annex B to JCT-VC report: List of meeting participants

The participants of the thirty-seventh meeting of the JCT-VC, according to a sign-in sheet circulated during the meeting sessions (approximately 40 people in total), were as follows:

1. Ichiro Ando (Nikon)
2. Jill Boyce (Intel)
3. Benjamin Bross (Fraunhofer HHI)
4. Yong Beom Cho (Konkuk Univ.)
5. Takeshi Chujoh (Sharp)
6. Chad Fogg (MovieLabs)
7. Arild Fuldseth (Cisco)
8. Tomonori Hashimoto (Sharp)
9. Christopher Hollmann (Ericsson)
10. Walt Husak (Dolby Labs)
11. Atsuro Ichigaya (NHK – Japan Broadcasting Corp.)
12. Shunsuke Iwamura (NHK – Japan Broadcasting Corp.)
13. Kei Kawamura (KDDI)
14. Michel Kerdranvat (Technicolor)
15. Konstantinos Konstantinides (Dolby Labs)
16. Jani Lainema (Nokia)
17. Woong Lim (KWU (Kwangwoon Univ.)
18. Lukasz Litwic (Ericsson)
19. Wei Liu (Konkuk Univ.)
20. Sean McCarthy (Dolby Labs)
21. Shimpei Nemoto (NHK – Japan Broadcasting Corp.)
22. Tung Nguyen (Fraunhofer HHI)
23. Hyun Mook Oh (LG Electronics)
24. Jens-Rainer Ohm (RWTH Aachen Univ.)
25. Justin Ridge (Nokia)
26. Christopher Rosewarne (Canon)
27. Dmytro Rusanovskyy (Qualcomm)
28. Karl Sharman (Sony Europe)
29. Masato Shima (Canon)
30. Karsten Sühring (Fraunhofer HHI)
31. Gary Sullivan (Microsoft)
32. Teruhiko Suzuki (Sony)
33. Maxim Sychev (Huawei Tech.)
34. Yasser Syed (Comcast Cable)
35. Alexandros Tourapis (Apple)
36. Wade Wan (Broadcom)
37. Ye-Kui Wang (Futurewei – Huawei R&D USA)
38. Ping Wu (ZTE UK)
39. Peng Yin (Dolby Labs)
40. Minhua Zhou (Broadcom Inc.)

1. The definitions of PB and PU are tricky for a 64x64 intra luma CB when the prediction control information is sent at the 64x64 level but the prediction operation is performed on 32x32 blocks. The PB, PU, TB and TU definitions are also tricky in relation to chroma for the smallest block sizes with the 4:2:0 and 4:2:2 chroma formats. Double-checking of these definitions is encouraged. [↑](#footnote-ref-2)